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GLOBAL CLIMATE CHANGE AND THE U.S. CLIMATE ACTION REPORT

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

JULY 11, 2002

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ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

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CONTENTS

	Page
Hearing held on July 11, 2002	1
Statement of Senator Allen	14
Statement of Senator Boxer	8
Prepared statement and executive summaries	8
Statement of Senator Burns	7
Prepared statement of Senator Dorgan	16
Statement of Senator Kerry	1
Article, dated June 14, 2002, entitled Dangerous Climate Impacts and the Kyota Protocol	83
Statement of Senator McCain	5
Statement of Senator Nelson	16

WITNESSES

Connaughton, Hon. James L., Chairman, White House Council on Environmental Quality	18
Prepared statement	21
Hubbard, Hon. R. Glenn, Chairman, Council of Economic Advisers	23
Prepared statement	26
Mahoney, Hon. James R., Ph.D., Assistant Secretary of Commerce for Oceans and Atmosphere	47
Prepared statement	49
Marburger III, Hon. John H., Director, Office of Science and Technology Policy	43
Prepared statement	45

APPENDIX

McPherson, Ronald D., American Meteorological Society, Executive Director, letter to Hon. Ernest F. Hollings	93
Snowe, Hon. Olympia J., U.S. Senator from Maine, prepared statement	91
Response to written questions submitted by Hon. John F. Kerry to:	
Hon. James L. Connaughton	93
Hon. R. Glenn Hubbard	114
Hon. James R. Mahoney	135
Hon. John H. Marburger III	132
Response to written questions submitted by Hon. Ernest F. Hollings to:	
Hon. James L. Connaughton	102
Hon. James R. Mahoney	133
Hon. John H. Marburger III	129
Response to written questions submitted by Hon. John McCain to:	
Hon. James L. Connaughton	103
Hon. R. Glenn Hubbard	109
Hon. John H. Marburger III	130

GLOBAL CLIMATE CHANGE AND THE U.S. CLIMATE ACTION REPORT

THURSDAY, JULY 11, 2002

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 9:35 a.m. in room SR–253, Russell Senate Office Building, Hon. John F. Kerry, presiding.

OPENING STATEMENT OF HON. JOHN F. KERRY, U.S. SENATOR FROM MASSACHUSETTS

Senator KERRY. Good morning. The hearing will come to order. I apologize to the witnesses and my colleagues for being a moment late.

I want to thank Chairman Hollings and Ranking Member, Senator McCain, for their continued interest in this subject and for their support for this hearing today. I am particularly grateful to Senator McCain for his ongoing interest. When he was chairing this Committee last year in the early part of the year, he began a series of hearings into the subject of global warming, and I think they helped this Committee to lay an important benchmark—a baseline, if you will, for some of the issues before the Committee today.

Today we're going to be hearing from key representatives of the Bush Administration regarding climate policy in the Administration. We have some concerns on the Committee about who is in charge, about differing views on global climate change policy within the Administration, and the proposed strategy, as it is called, for dealing with this critical issue.

I remember taking part in the Rio meetings as a member of the official Senate observer delegation when the original convention was signed, and I have attended each of the meetings since then—Kyoto, The Hague, Buenos Aires. I will be officially leading the delegation, together with Senator McCain, to South Africa at the end of August in order to continue the Senate's participation in what we consider to be this most important process.

It was precisely 1 year and 1 day ago that this Committee last held a hearing to consider the issue of global climate change. At that time, we requested the Administration share its views on climate change, and particularly looked for some insights into the technologies and policies that it would advocate as a means of addressing increasing global temperatures. I noted at the opening of that hearing that it was time to shift our focus from questions

about the science, to the solutions of what we were really going to do in order to reduce global emissions.

Unfortunately at that time, the Administration was reluctant to join in that policy discussion. This was despite the Administration's, "unprecedented Cabinet-level attention." I think Secretary O'Neill and others were then focused on the issue, but now after months of Cabinet-level meetings and staff discussions, the Administration's policy appears to have taken several steps backwards, away from real solutions.

Last year, in lieu of presenting policy, the Administration sent Dr. David Evans, a respected scientist and head of NOAA research, to speak about the state of scientific knowledge on climate change. Dr. Evans presented compelling evidence that reaffirmed the steady growth in the atmosphere of CO_2, increasing, according to his testimony, by more than 30 percent over the industrial era compared with the preceding 750 years.

Dr. Evans summarized his assessment of the science in this way, "Emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that are expected to affect the climate." He said also, "Stabilizing concentrations means that we must ultimately end up with much lower net emissions." That was the Administration's witness last year.

Since Dr. Evans' testimony before the Committee a year ago, the scientific evidence of increasing global temperatures associated with increasing atmospheric levels of CO_2 and the associated threats to our people and our environment has continued to grow. The Administration's own report, U.S. Climate Action Report 2002, only adds to the volume of evidence. Yet, the Administration continues to emphasize the uncertainty, promote delay, and limit near-term action to additional research.

Today, the Administration will explain its "action plan" for global climate change, reducing greenhouse gas intensity—this is a new word in the context of planning for global climate change, "intensity"—through voluntary measures. I must say to each of the witnesses beforehand, just to set the stage for this hearing, that reducing intensity corresponds to increasing emissions, and 10 years of voluntary action has so far failed to decrease aggregate emissions. So many of us have very, very little confidence that the Administration is about to assert any responsible global environmental leadership on climate change.

While the United States is responsible for 25 percent of all the greenhouse gas produced globally, we refuse to commit to any kind of fixed cap program or advance any serious alternative to the Kyoto Protocol, which the Administration has declared dead.

By my own assessment of the new proposal, there is really no offering of anything that is new. It is founded on the notion that the science of climate change remains in doubt and that more research is needed. It also relies on voluntary action and adaptation as the primary response.

So let me say that there are many of us in Congress—Democrats, Republicans, Independents—who were very disappointed that the President seems to have gone backwards on his own campaign commitment about the problem of CO_2. The United States is the largest producer of CO_2 in the world. Utilities and transportation

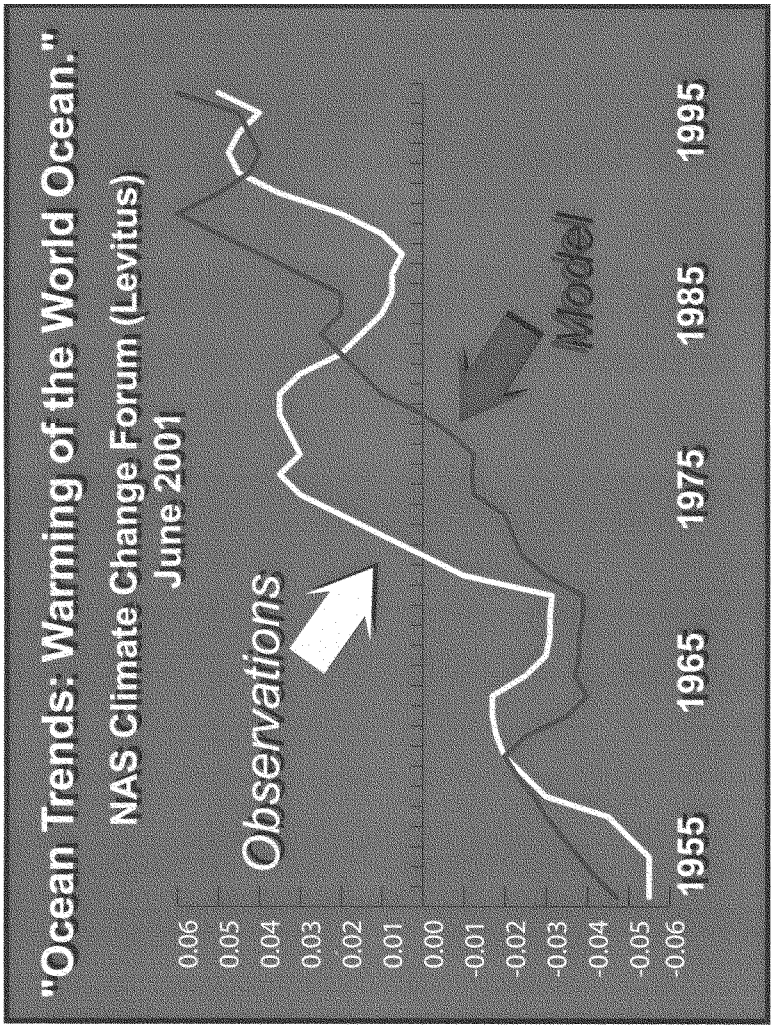
account for two-thirds of our emissions, and yet the Administration failed repeatedly to acknowledge the threat of increasing CO_2 emissions or to present to Congress any real policies, programs or strategies to deal with it.

To their credit, the states are taking a lead on this. Massachusetts has adopted the first CO_2 cap and trade program. Now California has passed a law to reduce greenhouse gas emissions from automobiles.

The impacts threatened by climate change may be projected, gentlemen, but they are based on observations that are increasingly real and supported by model projections. I know my friend, Senator Stevens, will also want to talk about that model projection.

There's always some uncertainty in science. We know that. But that can't be an excuse for no action in the face of the risks that have been described to us.

I would just like to point very quickly to a graph, which brings home the reality of this threat. I have chaired the Oceans Subcommittee on this Committee since I've been on this Committee. We have been following this very closely and have had many scientists from NOAA and elsewhere testify. It shows that the rising world ocean temperatures measured by NOAA since the 1950s and that the ocean has absorbed 90 percent of the heat resulting from human-induced temperature increases since the 1950s. Scientists have told us that as the oceans reach a point, which they can't absolutely predict, they cannot any longer absorb the heat. So, at some point, we can expect a climate surprise beyond those that have been modeled or which we are capable of modeling. These risks, gentlemen, are real, they're based on science, and they offer us some major choices with respect to our efforts to reduce the human input.


"Ocean Trends: Warming of the World Ocean."
NAS Climate Change Forum (Levitus)
June 2001
Observations
Model
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We are slipping backwards, not going forwards. That's what I think most of us are most concerned about. The Administration's energy policy has sought to promote national energy security by simply increasing the development of oil, gas, coal, and other fossil fuels for energy production as the major component of our energy future. It opposed a plan by Senator Hollings, Senator McCain, myself and others to try to grab some reductions back, in terms of automobile emissions.

The Climate Report acknowledges that energy-related CO_2 emissions, even without the proposals in the National Energy Plan, are projected to increase by 33.6 percent before the year 2020. So we have to challenge, I think, the Administration's current notion of how we are going to address what it has accepted in its own report as a serious problem. I believe that the commitment thus far stated by the Administration on global climate change, remains rhetorical with respect to the acceptance of the science and has no substance with respect to any guarantee of reduced emissions overall. Today we need to talk, obviously, about the intensity issue.

So we look forward to this explanation today about how greenhouse gas intensity could possibly be a more meaningful measure of progress than actual reductions in emissions in the atmosphere, which is the standard by which most countries are proceeding forward.

I know Senator McCain and I and other Members of this Committee share a belief that we would like to look to the market forces to find solutions, which is why we like capping alternatives. We like trading. We think there are many ways to bring the corporate community into a least-cost, least-intrusive, most-effective solution. But, gentlemen, this issue has been talked and talked about for too long now. It really is time for leadership and for new direction, and we look forward to hopefully achieving that in the near term.

Senator McCain.

STATEMENT OF HON. JOHN McCAIN, U.S. SENATOR FROM ARIZONA

Senator McCAIN. Thank you, Mr. Chairman. Thank you for holding today's hearing. I would like to thank the witnesses for being here today, and I thank you for your patience.

The State of Arizona is in the driest year in 120 years, according to scientists that I recently had a meeting with in Flagstaff, Arizona. The Rodeo Chaddisky wildfire consumed approximately 500,000 acres of woodland, destroyed over 1,300 archeological sites, consumed over 420 structures, and required over 4,400 people to contain it. Its effects on the lives of our citizens are yet to be fully determined. Many other devastating fires have also been occurring in our country.

It's believed by some that these fires are linked to climate change. Interestingly, in trying to find out whether any scientific basis existed for these beliefs, it was found in the U.S. Climate Action Report 2002, the subject of today's hearing. Chapter six of the report identifies key regional vulnerability and consequence issues. According to the report, the Southwest was identified as having increased fire potential because of the replacement of desert eco-

systems in many areas with grasslands and shrub lands as a result of increased precipitation.

Arizona is not the only place that is experiencing the effects of climate change. Fires have raged throughout the summer in a dozen western states. Ecosystems around the globe are showing the effects of climate change. The United Nations estimates that as much as 60 percent of the world's coral reefs are at risk of destruction, along with 27 percent that is already beyond recovery. Coral reefs, as we all know, are highly sensitive to water temperature changes and, thus, are particularly vulnerable to climate change. In fact, the largest known cause of coral loss was a massive climate-related coral-bleaching event in 1998 in which more than 70 percent of the corals died across a wide region of the Indian Ocean.

The National Research Council recently issued a report entitled, "Abrupt Climate Change, Inevitable Surprises." That report states, "The new paradigm of an abruptly changing climatic system has been well established by research over the past decade. But this new thinking is little known and scarcely appreciated in the wider community of natural and social scientists and policymakers." The report further states that, "Because climate change will likely continue in the coming decades, denying the likelihood or downplaying the relevance of past abrupt events could be costly."

Many of us assume that the climate system responds linearly to greenhouse gases, and, therefore, we have ample time to design long-term response strategies. What happens if the climate's response is not linear? According to the National Research Council's report, we have no idea.

Although we have not taken any definitive actions on reducing the emission of greenhouse gases at the federal level, I am pleased to see that the California legislature has passed a measure that would require mandatory reductions in greenhouse gases from automobiles. The measure now awaits the governor's signature.

Mr. Chairman, you and I were not in a position to endorse the specific state proposal. We did endorse the underlying goals of the California measure in our joint letter to Governor Gray Davis and members of the legislature, many of whom I spoke to personally. I hope that the governor signs the bill and makes California the first state to limit the emission of greenhouse gases. I know several other states are also considering legislation in this area and hope they are successful.

With this growing interest at the state level to limit greenhouse gas emissions, it's only reasonable that Congress also address this issue. I think we've made some progress in the recent Senate-passed energy bill. The establishment of a registry with appropriate measurement and verification standards will go a long way toward assisting the many companies and entities who are already trading emission credits. The emission reporting required in the bill will give us a greater understanding of how much greenhouse gas we are emitting.

Mr. Chairman, as you mentioned, the two of us have participated in a number of hearings on climate change over the past few years. We've listened to scientific and policy experts talk about the certainties and uncertainties associated with the science of climate change. The U.S. Climate Action Report 2002 summarizes many of

the previous reports on which we have held hearings. The report also lays out the Administration's approach to climate change.

As I've stated previously, I disagreed with the President's decision to remove the United States from the Kyoto Protocol. I felt we could be much more effective remaining within and achieving our national goals rather than remaining outside of it. The U.S. produces approximately 25 percent of the total greenhouse gas emissions; therefore, leadership from the United States is needed. It's disappointing to know that although many of the world's leading industrialized countries, such as Japan and those in the European Union, are taking proactive steps to reduce emissions, the Administration has decided to essentially continue the United States' business-as-usual approach.

Again, Mr. Chairman, thank you. I thank the witnesses, and I look forward to hearing from them on this—what I feel is an incredibly vital and important issue to the future of this Nation and the world.

I thank you, Mr. Chairman.

Senator KERRY. Thank you very much, Senator McCain.

Senator Burns.

STATEMENT OF HON. CONRAD BURNS, U.S. SENATOR FROM MONTANA

Senator BURNS. Thank you, Mr. Chairman.

First of all, this morning I want to say there's some good news. That's surprising. We have good news here. The American dream is still alive, and it's still well. First of all, that our country, alone, accounts for about a quarter of the world's gross domestic product, all the production, and all of the wealth, and gives us the resources to spend a great deal of money on research. The United States spends $1.6 billion annually on climate science—more than Japan and the 15 E.U. countries combined.

As a result of that science, we still have more questions than we do answers. But what else is new? Because climate will always hold more questions than it will answers. It's the biggest weather forecast of all time, and it's expensive, and it's complicated.

The goods and services we produce and consume in this country require electricity and transportation. As a result, Americans create a great deal of energy. This should come as no surprise. Productivity and energy use are related. We use all kinds of energy in this country, some of which produces carbon dioxide. Again, this is no surprise. If you turned the light switch on, there's a 50–50 chance that that electricity was produced by coal.

There are two important and related points here. The United States is a very efficient producer of energy, which is a part of the reason that we are so productive. Even though the total carbon emissions from the United States are relatively high, our ratio of emissions to GDP is not high at all. In fact, we do very well with what we've got.

I was just noticing—and I should have made a chart of this—but as our GDP has increased, our tons of carbon dioxide per thousand dollars of GDP has actually declined, and we must make note of that.

Can we do better? You bet we can do better. We will. I point to the Senate's decision on Yucca Mountain on Tuesday, for example. While some of my colleagues may not see the connection between nuclear power and reducing the carbon intensity of our economy, I will remind them that a part of the reason that the United States is already so efficient is because we produce 20 percent of our energy from nuclear sources. Two of the only countries who do better than we do is Japan and France, who depend heavily on nuclear power.

Besides nuclear, we have so many options. The Department of Energy is continually working on clean coal technologies so that we can use our coal resources more efficiently. We are building and improving fuel cell technology every day, which will run our homes and our automobiles. Hydropower is an incredible source in this country, which can improve, and we can build upon. We can and will reduce carbon intensity of our economy, but we will do it through American ingenuity and better technology, not through rules or regulations that we may pass.

The President is working on developing an effective and science-based approach to addressing global climate change, and I support his efforts. We need to be consistent, though, we need to be flexible, and we need to be smart, and we need to use the best technology that we can possibly find and still use the market-based approach. Most importantly, we need to cooperate with countries all over the world in this effort.

These figures, Mr. Chairman, I want to make a part of the record——

Senator KERRY. Without objection.

Senator BURNS.—because I think they are very important.*

Senator BURNS. And then we hear the criticism that the White House has, sort of, not really come forward. Keep in mind, we have two nominees before this Committee, that's being blocked, to head the Office of Science and Technology Policy, and one of them is highly qualified. And until we get some of those folks in place, it's pretty hard to put together a policy that one can rely on.

So I would—I appreciate the witnesses today. I look forward to their testimony. I thank the Chairman for holding this hearing today.

Senator KERRY. Thank you, Senator Burns.

Senator Boxer.

STATEMENT OF HON. BARBARA BOXER,
U.S. SENATOR FROM CALIFORNIA

Senator BOXER. Mr. Chairman, I'd like to put my statement in the record and summarize very briefly.

First of all, my thanks to you and Senator McCain. This is very important.

This country should be leading the way on global warming. We are not leading the way. I want to compliment Senator Jeffords of my—Chair of my Environment Committee. We did vote out a bill by one slim vote to reduce carbon emissions at power plants. The Administration is strongly opposed to this, and it was very conten-

*The information referred to was not avaiolable at the time this hearing went to press.

tious, but we managed to get the bill out. That's a tribute to Senator Jeffords. That's the only action I've seen in the Senate, in terms of a Committee, that's done the right thing. I hope we have a chance to do something, as well.

Let me say how proud I am about my state. I believe Governor Davis will sign the bill that was alluded to. I want to pay a special tribute to my predecessor in the House of Representatives John Burton, who is now the Senate pro tem of the California Senate. I talked with him at length as this bill was moving through, and it was very difficult. He believed in it. He really believed in it. I think he is probably the only person—this is truly what I believe—to have been able to have gotten that bill out of the State Senate, and I want to thank him publicly for that.

It's wonderful that states like California and Massachusetts and others are starting to do something about this problem, but we all know it's ridiculous. This has got to be done by our President and our Administration if it's going to really have an impact.

Let me just simply cite two studies. I'd like to put the executive summaries in the record.

Senator KERRY. Without objection.

[The prepared statement and executive summaries of Senator Boxer follow:]

PREPARED STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM CALIFORNIA

Mr. Chairman, I want to thank you for holding this important hearing. In a little over a month, the United States will participate in the World Summit on Sustainable Development in South Africa, where climate will be a primary topic of discussion. I am eager to hear from this panel what position the U.S. will present in that international forum.

Based on the lack of meaningful recommendations in the Administration's recent climate report to the United Nations, I fear the U.S. delegation will not have much to say. Meanwhile, our international colleagues are, to their credit, moving forward with the Kyoto Protocol and its binding emission standards without us.

The timing of this hearing is also perfect because it allows me to brag for a minute about California.

Once again, California is leading the way for the rest of the nation.

Last week, the state legislature passed legislation that will regulate tailpipe emissions of carbon dioxide from all new, non-commercial vehicles (including cars, light trucks, and SUVs).

If Governor Davis signs it, which he has signaled he is likely to do and which I am strongly encouraging him to do, this will be one of the most significant steps ever taken in the United States to contend with carbon.

This is vital given that the transportation sector nationally accounts for approximately 26 percent of carbon emissions and in California it accounts for approximately 40 percent.

The bill directs the California Air Resources Board to develop by January 2005 the maximum technologically feasible, yet cost effective, standards for greenhouse gas reductions from new non-commercial vehicles. To give industry time to adjust, these new standards would not apply to vehicles manufactured before 2009.

It is expected that California's new standards will push U.S. automakers to produce cars that burn less fuel more cleanly.

While California is moving ahead, this Administration is just catching up with mainstream scientific opinion.

In the Bush report we will hear about today, the Administration wrote:

> "There is general agreement that the observed warming is real and has been particularly strong within the past 20 years. Human-induced warming and associated sea-level rises are expected to continue through the 21st century. Secondary effects include increases in rainfall rates and increased susceptibility of semiarid regions to drought."

This is not news. The National Academy of Sciences and the Intergovernmental Panel on Climate Change have said this for years. What is news is that President Bush has finally admitted it.

I have a particular interest in Mr. Bush's admission—and in some of the dire predictions contained in the report—because California is believed to be particularly vulnerable to the impacts of climate change.

Around the time that the Bush report was released, a group of scientists released the findings of the most comprehensive regional climate change model ever completed, which provides detailed models of the temperature and precipitation impacts on California.

Their peer-reviewed climate model predicts by the year 2050 California will face higher average temperatures every month of the year in every part of the state. The average temperature in June in the Sierra Nevada mountains, for instance, will increase by 11 degrees Fahrenheit.

The snowpack in the Sierra, which is a vital source of water in the state, is expected to drop by 13 feet and to have melted entirely nearly 2 months earlier than it does now. This means that the precious water we now rely upon for agriculture, drinking water, and other purposes will no longer be available.

So, California has a lot at stake with regard to Mr. Bush's next steps.

But unfortunately, President Bush shows no signs of taking meaningful action.

Despite the frightening predictions in the Bush report, the recent California study I mentioned, and numerous other scientific assessments, the President proposes no real plan for reducing carbon emissions. Instead, the report notes we will simply have to learn to "adapt" to climate change.

To me, this incredible abdication of responsibility provides further justification for the Senate to step in where the President won't. I hope at some point we will be able to move forward with Senator Jeffords' Clean Power Act, which establishes a standard for carbon emissions that the first Bush Administration committed to (and the Senate ratified) as part of the UN Convention on Global Climate Change at Rio.

While the United States has done much to contribute to the carbon in our global atmosphere, we have done little to fulfill our commitment to now reduce it.

California appears poised to do its part.

I am eager to hear from this panel how and when the rest of the United States is going to join them.

EXECUTIVE SUMMARY: SCORCHED EARTH BY THE BLUE WATER NETWORK

GLOBAL CLIMATE CHANGE IMPACTS ON PUBLIC LANDS AND WATER

Protection and conservation of special ecosystems and wildlife has long been a fundamental American value. The Federal Government has responded by setting aside protected lands to provide a safe-haven for our nation's unique and biologically diverse ecosystems.

The need for protective measures was recognized in 1872, when Yellowstone became the country's first national park. The National Wildlife Refuge System, America's only network of federal lands dedicated specifically to wildlife conservation, was founded in 1903, and the Forest Service was created in 1905 after President Theodore Roosevelt visited Yellowstone National Park and resolved to prevent further destruction of surrounding lands. By 1916, Congress understood that many other spectacular natural areas were worth preserving, and thus the National Park System was born. In 1972, the importance of preserving marine life was also recognized with the establishment of the National Marine Sanctuaries Program to protect ocean and coasts.

Unfortunately, global climate change threatens the ecosystems of every national park, national forest, wildlife refuge, and marine sanctuary. *Scorched Earth* describes the expected impacts of global climate change on these public lands and waters; outlines the relevant legal requirements of federal agencies charged with protecting these resources; and provides recommendations for safeguarding these special places and the wildlife they protect.

Chapter 1 begins with a comprehensive outline of climate changes expected over the next century, emphasizing the impacts these changes will have on species migration and survival, air quality, wildfires, glaciers, coastal lands, water resources, and visitor experience.

Over the past 100 years, emissions of greenhouse gas pollution have led to increased global temperatures of more than 1 °F, which is unprecedented in the past 1,000 years. Scientists worldwide predict that the pace of global climate change will accelerate over the next century and impact ecosystems with increasingly dramatic

results. Average global temperatures could increase by up to 10.4 °F, a change unprecedented over the past 10,000 years. This temperature increase is projected to result in reduced water availability, increased catastrophic wildfires and storms, and habitat impacts that could wipe out entire species and ecosystems. Scientists predict a rise in sea level of up to 2.89 feet as a result of projected global temperature increases. Coupled with increasingly severe storm events, a sea level rise of this magnitude will reshape coastlines and submerge low-elevation islands entirely in both the U.S. and abroad. These global climate change impacts will occur so rapidly that many plant and wildlife species will not survive.

In chapter 2, impacts are detailed for 5 high-profile examples of protected public lands and waters: Yellowstone National Park, the Arctic National Wildlife Refuge, Florida Keys National Marine Sanctuary, Tahoe National Forest, and Cape Cod National Seashore. Since global climate change will impact every region of the nation, chapter three highlights expected impacts at one important national park, wildlife sanctuary, marine sanctuary, or national forest in each state.

From these profiles, it is clear that climate change will profoundly affect the protected lands and waters that are important to Americans for their unique wildlife habitats, magnificent scenery, and role in America's natural and cultural heritage. For example:

• A sea level rise of up to 30-inches over the next century will submerge much of the Florida Keys and Everglades National Park and Preserve, where large areas are less than three feet above sea level.

• All of Glacier National Park's glaciers will disappear within 28 years if temperatures continue to rise as predicted. Over the past 150 years, the Park's glaciers have shrunk by 73 percent.

• Arctic National Wildlife Refuge's entire North Slope tundra is expected to disappear by 2100.

• The Florida Coral Reef Tract will suffer severe bleaching and mortality from increased temperatures, atmospheric carbon dioxide, and sedimentation from storm-induced coastal erosion. In fact, scientists predict that by 2100 coral reefs could be dead in most areas of the world.

• A 2 °F temperature increase at Cape Cod National Seashore could transform a relatively benign mosquito-borne malaria parasite into a fully potent one, and could also increase the Lyme-disease-carrying tick population.

• Warming rivers and streams at Yosemite National Park could devastate whitefish, brook trout, and Chinook salmon populations.

• At Alaska's Arctic National Wildlife Refuge, early onset of spring in the refuge's caribou calving grounds will disrupt the caribou herd's precisely-timed migration schedule, endangering its survival.

• Even a slight warming and drying of Yellowstone National Park's climate could result in the elimination of 90 percent of the park's whitebark pine habitat, decimating the park's grizzly bear population, which relies on the forests for a major portion of its diet.

• Native forests all across the nation will give way to non-native species more tolerant of higher temperatures, including the maple-dominated forests at Great Meadows National Wildlife Refuge, which could decrease by 30–60 percent; the forested areas of Yosemite National Park, which are expected to decline by up to 50 percent; and the spruce forests of Alaska, where 4 million acres of trees are dead or dying from a spruce bark beetle infestation—the greatest tree loss ever recorded in North America.

• Non-native species are already out-competing native Hawaiian rainforest species—a situation that will only worsen with global climate change because non-native species are far more tolerant of changes in temperature, rainfall, and wildfire.

• Decreased precipitation and past fire-suppression efforts have left 40 percent of Yellowstone National Park vulnerable to catastrophic wildfire, a situation that will be greatly exacerbated by further global climate change.

• Tahoe National Forest will lose two-thirds of its snowpack, threatening California's water supplies and the winter recreation industry.

• Wildfires are expected to more than double in some areas. The National Interagency Fire Center in Boise, Idaho declared that the nation is at Level 5 fire risk as of June 2002—the highest fire danger ever recorded this early in the season. This indicates that fires have the potential to exhaust all available federal firefighting personnel and equipment.

Chapter 3 ends with a special section outlining impacts to visitors, whose enjoyment of public lands and waters will also be severely impacted by the effects of global climate change. For instance, at the Grand Canyon National Park, smog formation from rising air temperatures and smoke from increased fires could obscure canyon views for the park's more than 4 million annual visitors. Decreased snowpack

in areas such as California's Tahoe National Forest could reduce skiing areas and shorten the ski season. Lower summer stream flows could diminish recreational activities such as fishing, rafting, and kayaking at many parks and forests, including Grand Canyon National Park.

Chapter 4 outlines the legal mandates of the 4 federal agencies—the National Park Service, the Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, and the U.S. Forest Service—entrusted with managing and protecting these public lands. All 4 agencies have clear legal mandates to guard the public lands and waters in their care for the enjoyment of current and future generations.

The time has come for public land-management agencies to incorporate new scientific knowledge of global climate change into their planning and take steps to safeguard vulnerable natural resources from its impacts. In chapter 5, *Scorched Earth* concludes with specific recommendations for these agencies to address present and future global climate change impacts on public lands and waters. Specifically, agencies should:

(1) Conduct complete and thorough analyses to determine the full scope and breadth of projected impacts from global climate change;

(2) Conduct long-term planning to guide management actions with regard to climate change;

(3) Consider potential mitigation measures, including establishing corridors for wildlife migration; increasing emphasis on protecting endangered species and their critical habitats; and reassessing the boundaries of national forests and parks, wildlife refuges, and national marine sanctuaries to ensure that borders are adequate to protect resources and wildlife from climate change impacts; and

(4) Reduce greenhouse gas emissions from their own operations, by using renewable energy sources for power generation and renewable fuels for their vehicle and equipment fleets.

These recommendations are echoed in formal petitions that Bluewater Network has filed with relevant federal agencies. In light of the devastating impacts expected from global climate change over the next 100 years, it is imperative that comprehensive action is taken immediately to protect our unique natural heritage for future generations.

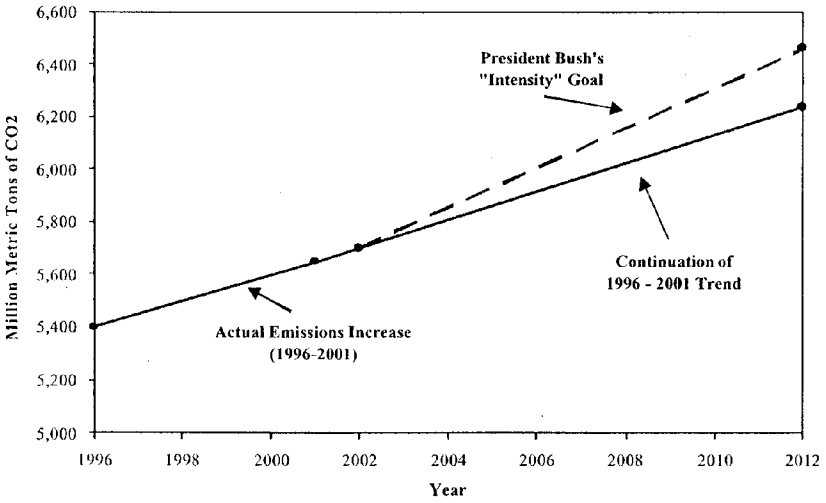
EXECUTIVE SUMMARY: BENEATH THE HOT AIR—NEW GOVERNMENT DATA EXPOSE THE TRUTH BEHIND PRESIDENT BUSH'S GLOBAL WARMING PLAN BY THE NATIONAL WILDLIFE FEDERATION

In February, President Bush announced a global warming plan that he claimed will reduce the nation's greenhouse gas emissions. But according to new Department of Energy data, the President's plan would allow more global warming pollution at a faster rate than if we simply continue the pollution trend of the past 5 years.

The new data indicate that the amount of carbon dioxide (CO_2) that the United States is adding to the atmosphere each year increased by 4.6 percent over the past 5 years (1996–2001), due to the nation's increasing dependence on coal, oil, and natural gas. If these trends were to continue for the next 10 years, we would expect the nation's CO_2 emissions from energy to grow by another 9.5 percent.

The President's plan includes an emissions goal that he stated would "set America on a path to slow the growth of our greenhouse gas emissions." But the President's goal is stated in terms of emissions "intensity"—the amount of greenhouse gas emissions relative to the size of the economy—and not in terms of actual emissions levels. This "intensity" goal actually hides an emissions increase that is likely to be larger and faster than what we experienced in the past 5 years. Based on the White House's predictions of economic growth, the President's target translates into an emissions increase of 13 percent over the next decade.

Figure 1. U.S. Carbon Dioxide Emissions from Energy



Notes: This graph compares recent trends in U.S. CO_2 emissions from energy to what would happen if CO_2 emissions "intensity" in the energy sector declined by 18.0 percent (a goal established by the President for all greenhouse gas emissions) and assuming the level of economic growth predicted by the White House. CO_2 from energy accounts for 80 percent of the nation's greenhouse gas emissions.

The discrepancy exposes the truth behind the sound bites: President Bush's global warming response is simply a smokescreen of accounting schemes that hides the increased pollution from the President's energy plan and his efforts to relax enforcement of the Clean Air Act. The President's energy priorities, such as promoting more coal-fired power plants, will increase the nation's dependence on fossil fuels and accelerate the buildup of global warming pollution in the atmosphere.

How does the Bush Administration claim that the President's emissions goal is a reduction when the nation would have to accelerate its pollution in order to meet it? The White House compares the President's emissions targets to a Department of Energy forecast that envisions hypothetical, skyrocketing emissions growth over the next decade. Analysis of the Department of Energy's new data provides a factually-based historical context for assessing future emissions targets.

The new Department of energy data also demonstrate that, using even the yardstick of emissions "intensity" that President Bush favors, the President's target would do worse than the trend of the past 5 years. The past 5 years altogether marked a period of robust economic growth. Emissions "intensity" is measured as the amount of U.S. greenhouse gases emitted per dollar of economic output. Over the past 5 years, the "intensity" of the nation's CO_2 emissions improved more quickly (a rate equal to a 23 percent improvement per decade) than the goal established by the President (an 18 percent improvement over the next decade).

In other words, the President's goal would enable the United States to emit more CO_2 emissions per dollar of economic output in 2012 than it would by continuing the trend in emissions intensity improvement of the past 5 years. The new emissions data demonstrate the futility of establishing finely-tuned "intensity" targets in the face of uncertain emissions forecasts and underscore the need for mandatory policies and clear emission limits to control the nation's runaway pollution levels.

The new emissions data follows closely on the heels of a Bush Administration report that detailed the unacceptable environmental threat global warming poses to wildlife, wild places, and the quality of life for Americans throughout the nation. Altogether, this new information provides an opportunity for President Bush to change course and take real action that prudently reverses the nation's rising emissions and protects America from the threat of global warming.

Senator BOXER. One is called "Scorched Earth." It was put out by the Blue Water Network, and they took a look at all the global warming work, and they said that this would be what would hap-

pen. In 28 years, Montana's Glacier National Park will disappear. Rising sea levels will submerge much of the Florida Keys and Everglades. Wildfires will double in some areas. Massachusetts' Cape Cod will become home to a large tick-carrying population carrying Lyme Disease. Lake Tahoe, Nevada, will lose 75 percent of its snow cover. This is what they have come up with as they look at the scientists' predictions.

The other—this is an amazing report that just came out, like, 10 minutes ago, and my staff just got it, the National Wildlife Federation, it's called "Beneath the Hot Air, New Government Data Expose, The Truth Behind President Bush's Global Warming Plan." I'm just going to read two paragraphs.

"In February, President Bush announced a global warming plan that he claimed will reduce the nation's greenhouse gas emissions. The President's plan includes an emissions goal that he stated would set America on a path to slow the growth of greenhouse gas emissions, but the President's goal is stated in terms of emissions intensity"——intensity——"the amount of greenhouse gas emissions relative to the size of the economy and not in terms of actual emission levels."

Now, the point here is the atmosphere doesn't understand what gross domestic product is or gross national product. It doesn't understand that. The atmosphere is going to do what it does. What they say is, "The President's plan would allow more global warming, pollution at a faster rate than if we simply continue the pollution trend of the past 5 years. President Bush's global warming response is simply a smokescreen of accounting schemes that hides the increased pollution from the President's energy plan and his efforts to relax enforcement of the Clean Air Act."

So, Mr. Chairman, this is an important debate, a debate that is worth having. It's unpleasant. It's—we want to be united. We want to go together down a path that makes sense, but, at this point, I think this is a fight, and I'm very glad that you've had this hearing this morning.

Senator KERRY. Thank you very much, Senator Boxer.

Senator Allen.

STATEMENT OF HON. GEORGE ALLEN, U.S. SENATOR FROM VIRGINIA

Senator ALLEN. Thank you, Mr. Chairman, for holding this hearing, and thank all these esteemed leaders that are here at this hearing for sharing their views with us. I'm sure it'll be an issue-filled hearing where we'll discuss various matters. I think we'll all agree on certain goals—that we need to improve our environment while also making sure there are job opportunities and competitiveness there for the American people, and they should not be mutually exclusive.

I do want to associate myself with the remarks of Senator Burns' very eloquent remarks and sentiments, which I do very much share. In all due respect to some of the comments that have been made, and I know there are terrible fires—record-breaking fires in Arizona. I would not blame it on climate change or greenhouse gases. I don't need any scientists or studies to know why those fires are going. People started them. They criminally set these fires.

When you set a fire in a dry, arid area of the country with low humidity and dense woods, fire will spread, especially with winds. I think that what we need to do is, in these areas, look at ways that we can improve our environment.

Now, as far as climate change, in our known history of the world, climate is always changing. It always has, whether it's ice ages or different times of our world's history. The issue is the extent to which humans are changing that climate. Climate will always change. The question we should be asking is: What are the human impacts on climate change?

We need to improve the air quality in our country. We know that, regardless of climate change. The same with water quality. Now, as we move forward, I think we need to analyze the science and the impact of various proposals on people and their property and their jobs. As Senator Burns said, I feel very strongly that we must embrace and utilize the advances in technologies that improve our lives in so many ways such as improving jobs and improving the quality of consumer products. There are cleaner methods of manufacturing where there are fewer toxics, less waste, which helps our competitiveness as a country as well as our environment.

I think the President has stated long-term goals that help stabilize the concentration of greenhouse gases in the atmosphere. I think he's pursuing the long-term goals in a correct way. I do think that first we have to make sure we're using the best science available to identify what is the current state of our environment. Second, we have to recognize that there are uncertainties; and, where there are uncertainties, I think we ought to target future research to fill in these scientific gaps. Third, we need to take action to address the climate-change issue where there are technically and economically viable means to do so. Fourth, I think that we need to set realistic goals that can be set and be achieved through innovation without causing undue stress on the economy or jobs. And fifth, I do think we ought to put in place a review mechanism to ensure that we're truly meeting the goals that we're setting out to accomplish.

I hope that we will, at the least, in this hearing, begin to get some movement in the right direction. I do think the President's moving toward the right goal. The Kyoto Protocol, in my view—we could debate this later—would be very harmful to jobs in this country. I know, in Virginia alone, it has been estimated that there would be 12,500 manufacturing jobs lost out of the 35,000 total lost throughout the state.

Regardless, I think there are things that we can do to improve the environment by using sound science and the best technology, in the future, and I think that's what people want us to do. We should not take drastic, hasty steps, but take reasonable, measured steps to improve our environment and also keep jobs for Americans.

So I thank you, Mr. Chairman, and look forward to this hearing.

Senator KERRY. Thank you very much, Senator Allen.

Senator Nelson.

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. Thank you, Mr. Chairman.

Senator Burns, since you used the word "heavenly," may I try to give you—I'd like to try to give you a perspective, a "heavenly" perspective, on the issue at hand.

When you look out the window of a spacecraft back at the earth and look at the rim of the earth, you can see a thin little film. That film sustains all of our life. It's called the atmosphere. As you look at the perspective of earth, even with the naked eye you can see how we're messing it up. For example, coming across South America, with the naked eye you can see the destruction of the rain forest in the Upper Amazon region. You can see that because of the color contrast. Then in the same window, you can look to the east and see part of the reason—of the result of that destruction. For, at the mouth of the Amazon, the waters of the Atlantic are discolored for hundreds of miles as a result of the silt that has been added as a result of the destruction of the trees upriver.

When you come across a part of the earth, such as my state, you see this peninsula sticking down into what we know—we natives know—as "hurricane highway," and you realize that a place all along that Gulf Coast and the eastern seaboard is so ravaged by storms. So when we look at the question of whether or not the earth is warming, the opportunity, because of warming, not only from the obvious, from that perspective of a spacecraft's window, of the rising seas of what it would do to all of the coastal communities in a place like Florida and the eastern seaboard, but also what it does in causing the temperature rises, or the increased ferocity of storms, the increase of pestilence, the increase of the level of the sea on the coast, and what that profoundly would affect.

So it's just hard for me to understand how the Administration cannot take this and do everything possible to confront what the scientific community has clearly said is a real problem.

Mr. Chairman, thank you for allowing me to get my perspective shared with the Committee.

Senator KERRY. Senator Nelson, thank you very much. I think that's an eloquent and important statement, and it probably underscores, in ways that other arguments couldn't, the value having had a young congressman go up into space on the shuttle, and I think that it's an important observation that you've made, and I thank you for it.

Senator Dorgan had to go to the floor, and I specifically wanted to note that he was here, and his statement will be put in the record, and he hopes to get back here.

[The prepared statement of Senator Dorgan follows:]

PREPARED STATEMENT OF HON. BYRON L. DORGAN,
U.S. SENATOR FROM NORTH DAKOTA

I see that James Connaughton from CEQ is testifying this morning. I am disappointed that he was able to be here for this hearing, but couldn't testify at a hearing I chaired yesterday on Missouri River management issues, nor could he send a representative from CEQ.

I find the parallels between these two issues very interesting. In both cases, the Administration is ignoring and backing away from years of scientific data. The Army Corps of Engineers and the Fish and Wildlife Service have more than 12

years of scientific and economic data on the Missouri River. Yet, the Administration has not moved forward with revisions to the River's operating plan, based on sound science, even though the current plan is 40 years old and quite out of date, and scientific and economic data reflect the changing realities that have taken place along the River.

Similarly, several agencies have collected significant scientific information on climate change and concluded that global warming is a serious problem and, indeed, that human activity is contributing to climate change and increases in greenhouse gas emissions. This information was published in the *U.S. Climate Action Report—2002,* which serves as "our nation's official submission to the international community on the issue." Regrettably, however, about a week after the report was released, President Bush and EPA Administrator Whitman tried to distance themselves from the report's conclusions by announcing that they had nothing to do with the report, had not seen the report, and that the report was the responsibility of the "bureaucracy."

A great deal of scientific information exists—enough to draw at least some conclusions and enable the Administration to take concrete, "no regrets" actions. But, the Administration has decided to back away from the scientific information provided in this and other studies and to do nothing instead.

I am concerned because, for example, climate models predict that the Great Plains are likely to experience more frequent and intense drought. The Western part of my state is already suffering from drought and fires.

So, I think we should be taking "no regrets" actions that can save energy, save money, and reduce greenhouse gas emissions to help avoid or mitigate droughts and other regional climate impacts.

This situation is absurd. I am frustrated that the Administration is choosing politics over policy and sound science. What we have here is "a barrel-full of politics and a thimble-full of policy."

Senator KERRY. Before we begin with the witnesses, I—we obviously don't want to get into a debate at this moment between us. We see some of the divergent views already in the openings. But I do want to emphasize to my colleagues, who have sort of spoken, I guess, in support of not doing anything——

[Laughter.]

Senator KERRY.—that no one is suggesting that we do anything drastic or hasty. I don't think that 160 nations spending 10 years to come to an agreement about trying to stay at 1990 levels can be deemed drastic or hasty. Nor do I think that the presidents and prime ministers and leaders of all those countries that have embraced this deserve the sort of back of the hand that the United States of America seems to be giving their thinking process and their politics, which is committed to moving forward.

I would just say very quickly to Senator Burns, who talked about efficiencies of American production, if "efficiency" is defined by producing a lot, then, yeah, we're pretty efficient. But if the measurement is true efficiency, we're really pretty inefficient, because the average coal-burning plant in America actually only converts about 33 to 38 percent of the energy that it consumes into electricity, and the rest is all lost—lost—as heat. That's pretty inefficient.

So the truth is that America is not a paragon of efficiency with respect to this, unless you measure it just by the amount. We do a lot, and we produce a lot for our people.

I have suggested, and I say this to my friends, that we should embrace several principles as we approach this. I think we should say that we should do nothing that doesn't make economic sense. I think we can make economic sense out of our choices. I don't think we have to ask any American to give up any smidgen of quality of life. There is no requirement to give up quality of life in anything we have to do. I think most of the efficiencies we're going to

gain are going to come from the current energy regime for the next 30 or 40 years.

The issue is whether we're going to start to move in the right direction. California has made a decision. It is the fifth largest economy in the world. I hope the Governor will sign that. As Senator McCain has said, and we've tried to intervene, in a polite way, to suggest that it's important to do so. But if California does, then what the Senate rejected, in trying to offer some common sense about automobile emissions, will, in fact, become a reality, because one state in the country decides to do it, because the automobile industry will have no choice but to market to the fifth largest economy of the world, and that will be to the benefit of all the rest of our states. So I applaud their leadership and think that they can have a profound impact that will dwarf what the U.S. Senate itself was prepared to do.

I'd like to turn now to our witnesses, and we thank you for your patience, but I think it's an important setting of the stage for you to hear, sort of, these opinions. I welcome the Chairman of the Council of Environmental Quality, Jim Connaughton; the distinguished Chairman of the Council of Economic Advisors, Glenn Hubbard; the Director of the Office of Science and Technology Policy, John Marburger; and the Assistant Secretary for Oceans and Atmosphere, Jim Mahoney. We welcome all of you. Thank you very much.

Do you want to just begin, Mr. Connaughton, and then we'll just sort of run down the table? Thank you.

STATEMENT OF HON. JAMES L. CONNAUGHTON, CHAIRMAN, WHITE HOUSE COUNCIL ON ENVIRONMENTAL QUALITY

Mr. CONNAUGHTON. OK. Thank you very much, Mr. Chairman, Senator McCain and other Members of the Committee. I appreciate the opportunity to testify here before you today to discuss the Bush Administration's strategy to address this important issue, as all have recognized. It's an issue that's long term, it's highly complex, and it's going to be quite challenging.

I hope, during the course of today's discussion, we can actually spend a fair amount of time talking about the significant common ground, when it comes down to policies and measures, to address this challenge. I've had the good fortune, over the last year, to spend a lot of time on domestic policy issues, as well as speaking with my counterparts internationally. When you look at what the world is doing, in concrete terms, in taking the next steps toward addressing this challenge, there is a tremendous amount of common ground. So I hope that we can discuss that here today.

I'm very pleased to share this panel with my colleagues in the Administration, Dr. Hubbard, Dr. Marburger, and Dr. Mahoney. It's nice to be here with the 3 doctors, being a mister myself.

President Bush has committed the nation to ambitious, focused, and meaningful goals, programs, and initiatives that, in our view, provide a sensible, and, most importantly, a constructive path forward. The President's strategy is predicated on ensuring the strength and the growth of the American economy, building on our nation's tremendous and demonstrated record of leadership in science, as well as the promise of continued American technological

innovation on which any response to the climate-change issue depends.

As the President stated over a year ago, we will act, learn, and act again, adjusting our approaches as science advances and technology evolves. He elaborated on this point again just this past February. Global climate change presents a different set of challenges and requires a different strategy from policies designed to reduce air pollution. The science is more complex, the answers are less certain, and the technology is less developed. So we need a flexible approach that can adjust to new information and new technology.

The flexible path toward long-term progress that I will outline for you today sharply contrasts with the view of some that the only acceptable policy approach is near-term legislative restrictions that will needlessly hurt our economy and cost American jobs.

The President has committed the Nation to an immediate goal of reducing America's greenhouse gas emissions, relative to the size of our economy, by 18 percent in the next 10 years. This will set America on a path to slow the growth of our greenhouse gas emissions and, if science justifies, to stop that growth and then reverse the growth of those emissions. Dr. Hubbard will speak in detail about the compelling advantages of this national goal and how it will be measured.

I would emphasize that achieving this ambitious, yet realistic, national goal will require a sustained commitment and a significant investment in effort from our nation's farmers, small businesses, workers, industries, and individual citizens, that will rival the hard gains and efficiency in productivity that we have earned and actually enjoyed over the last several decades.

To achieve this goal, the Administration is actively engaged and moving forward on many fronts looking at every sector of our economy, with the recognition that meaningful progress depends on the development and deployment of new technology. With the continued support of Congress, we are, one, advancing climate science; two, developing and promoting energy efficiency, conservation, and sequestration technologies and practices; three, we're pursuing near-term greenhouse gas mitigation programs; and, finally, we are expanding, not diminishing, international cooperation.

The President has reaffirmed America's commitment to the goal of stabilizing atmospheric greenhouse gas concentrations at a level that will prevent dangerous interference with the climate. At the same time, however, the President has noted that, given significant scientific uncertainties, no one today knows what that level is. This underscores the importance of the President's focus on science and technology.

The President has called for nearly $700 million in additional funding for the Federal Government's commitment to climate change in fiscal year 2003. That's a 17-percent increase from last year. This will support a $4.5 billion program of research on climate science and energy technology, on mitigation incentives and programs, and on international technology transfer and outreach. This commitment is unmatched in the world.

The President's recent report to Congress on federal climate-change expenditures details the numerous programs that this fund-

ing will support. Dr. Marburger and Dr. Mahoney will describe for you our Cabinet-level effort to bring more effective high-level management and focus to this significant investment of the Nation's public resources.

Importantly, the President's request includes $555 million in clean energy tax incentives. That's the first part of a $4.6 billion commitment over the next 5 years, that will reach $7.1 billion over the next 10 years. Again, these are sums unmatched in the world.

These incentives will spur investments in and purchases of renewable energy, including solar, wind, and biomass, as well as advanced hybrid and fuel-cell vehicles, cogeneration, and landfill gas conversion. We are also promoting clean coal technology as well as nuclear power. Of course, as the Senators noted earlier, nuclear power produces no greenhouse gas emissions. So any serious climate policy must include nuclear power in its mix. We are working to safely improve fuel economy for our cars and trucks. We are also advancing the prospect of breakthrough technologies such as the very real promise of zero-emission fuel-cell vehicles through the Department of Energy's Freedom Car Initiative.

Let's look to another sector, an often overlooked one. Under the recently enacted Farm bill and existing authorizations, we will invest up to $47 billion—that's the "B" word—in the next decade for conservation on our farms and forest lands. Not only will these incentives and this partnership with our nation's farmers and small landowners help protect the water and air, and secure and enhance habitat for wildlife, but they will also provide opportunities to store significant quantities of carbon in the trees and soil as well as promote other activities on our nation's farms and ranches that will mitigate greenhouse gas emissions. I say, again, this level of commitment and incentivization, and bringing stewards forward to assist in the greenhouse effort is unmatched in the world.

We are also making substantial progress on the effort to create world-class standards for measuring and registering greenhouse gas emissions reductions, with organizations receiving transferable credits for the reduction in the emissions they secure. At the same time, we are making progress on the President's challenge to businesses to further reduce their emissions. EPA's Climate Leaders Program is well underway, and we are looking forward to securing new commitments from a number of different sectors and even greater reductions as a result of these efforts.

These are simply a few of the more than 60 federal programs that are currently underway—some are mandatory and, in fact, quite regulatory; some are incentive based; and some are voluntary—that will help to slow the growth in U.S. greenhouse gas emissions over the next decade and beyond.

Finally, the President's strategy has also created a new framework for expanding international cooperation. We are investing $25 million in climate observation systems in developing countries. We're increasing our funding for tropical forest conservation to $50 million in response to the point that I think Senator Nelson very eloquently raised. We're providing $178 million for the Global Environment Facility next year, which includes a substantial $70 million payment for arrears incurred during the prior administration.

The President's fiscal year 2003 budget also requests $156 million in funding for USAID climate-change programs.

In the past year alone, the Administration has entered into bilateral agreements with Japan, Australia, Canada, Italy, the European Union, CONCAUSA, which is the Central American countries, China, and India on climate-change science, energy, and sequestration technology and policy approaches. We have had more engagement internationally on this range of issues than anyone might have imagined. The conversation is quite dynamic right now.

Senator KERRY. Mr. Connaughton, I need to just keep you mindful of the time frame.

Mr. CONNAUGHTON. Certainly.

President Bush's philosophy, which ties our benchmark for progress with economic growth, represents a careful balancing that promises significant emission reductions over the course of the next decade, while preserving the strength of the American economy. Only sustained economic growth, both here and abroad, will allow for the significant new investments in energy and sequestration technologies that will be needed to address this long-term challenge.

Again, I thank you for inviting me here today, and I'll be pleased to answer any questions that you may have. I ask that the written material accompanying my testimony be entered into the record.

[The prepared statement of Mr. Connaughton follows:]

PREPARED STATEMENT OF HON. JAMES L. CONNAUGHTON, CHAIRMAN, WHITE HOUSE COUNCIL ON ENVIRONMENTAL QUALITY

Mr. Chairman, Senator McCain and Members of the Committee:

I appreciate the opportunity to appear before the Committee today to discuss the Bush Administration's strategy to address the important, long-term, and highly complex challenge of global climate change. I am pleased to share this panel with my colleagues Dr. Hubbard, Dr. Marburger, and Dr. Mahoney.

President Bush has committed the nation to ambitious, focused and meaningful goals, programs and initiatives that provide a sensible and constructive path forward. The President's strategy is predicated on ensuring the strength and growth of the American economy, building on our nation's tremendous and demonstrated record of leadership in science and the promise of continued American technological innovation. As the President stated over a year ago: "We will act, learn, and act again, adjusting our approaches as science advances and technology evolves." He elaborated on this point this past February: "[G]lobal climate change presents a different set of challenges and requires a different strategy [from policies designed to reduce air pollution]. The science is more complex, the answers are less certain, and the technology is less developed. So we need a flexible approach that can adjust to new information and new technology."

The flexible path toward long term progress that I will outline for you today sharply contrasts with the view of some that the only acceptable policy approach is near term, legislated restrictions that will needlessly hurt our economy and cost American jobs.

The President committed the nation to an immediate goal of reducing America's greenhouse gas emissions relative to the size of our economy by 18 percent in the next 10 years. This will set America on a path to slow the growth of our greenhouse gas emissions and, if science justifies, to stop and then reverse the growth of emissions. Dr. Hubbard will speak in detail about the compelling advantages of this national goal and how it will be measured. I would emphasize that achieving this ambitious, yet realistic, national goal will require a sustained commitment and significant investment and effort from our nation's farmers, small businesses, workers, industries, and citizens that rivals the hard gains in efficiency and productivity we have earned over the last several decades.

To achieve this goal, the Administration is actively engaged and moving forward on many fronts, looking at every sector of our economy, with the recognition that meaningful progress depends on the development and deployment of new tech-

nology. With the continued support of Congress, we are advancing climate science, developing and promoting energy efficiency, conservation, and sequestration technologies and practices, pursuing near term greenhouse gas mitigation programs and expanding international cooperation.

The President has reaffirmed America's commitment to the goal of stabilizing atmospheric greenhouse gas concentrations at a level that will prevent dangerous interference with the climate. At the same time, the President noted that given current scientific uncertainties, no one knows what that level is. This underscores the importance of the President's focus on science and technology.

The President has called for nearly $700 million in additional funding for the Federal Government's commitment to climate change in Fiscal Year 2003—a 17 percent increase from last year—to support a $4.5 billion program of research on climate science and energy technology, mitigation incentives and programs, and international technology transfer and outreach. This commitment is unmatched in the world. The President's recent Report to Congress on Federal Climate Change Expenditures details the numerous programs that this funding will support. Dr. Marburger and Dr. Mahoney will describe for you our Cabinet-level effort to bring more effective, high level management and focus to this significant investment of public resources.

Importantly, the President's request includes $555 million in clean energy tax incentives, the first part of a $4.6 billion commitment over the next 5 years, reaching $7.1 billion over the next 10 years. These incentives will spur investments in and purchases of renewable energy—including solar, wind, and biomass—as well as advanced hybrid and fuel cell vehicles, cogeneration, and landfill gas conversion. We also are promoting clean coal technology, as well as nuclear power—which produces no greenhouse gas emissions—and are working to safely improve fuel economy for our cars and trucks. We are advancing the prospect of breakthrough technologies, such as the promise of zero-emission fuel cell vehicles through the Department of Energy's Freedom Car Initiative.

Under the recently-enacted Farm bill and existing authorizations, we will invest up to $47 billion in the next decade for conservation on our farms and forest lands. Not only will this partnership with farmers and small land owners help protect the water and air, and secure and enhance habitat for wildlife, it will also provide opportunities to store significant quantities of carbon in trees and the soil, and promote other activities to mitigate greenhouse gas emissions.

We also are making substantial progress on the effort to create world-class standards for measuring and registering greenhouse gas emissions reductions, with organizations receiving transferable credits for the reductions in emissions they secure. At the same time, we are making progress on the President's challenge to businesses to further reduce their emissions. EPA's Climate Leaders Program is well underway. We look forward to seeing new commitments and even greater reductions.

These are simply a few significant examples of more than 60 federal programs—some mandatory, some incentive-based, some voluntary—that will help to slow the growth in U.S. greenhouse gas emissions over the next decade and beyond.

The President's strategy has also created a new framework for expanding international cooperation. We are investing $25 million in climate observation systems in developing countries, increasing funding for tropical forest conservation to $50 million, and providing $178 million for the Global Environmental Facility next year, which includes a substantial $70 million payment for arrears incurred during the prior administration. The President's FY03 budget also requests $156 million in funding for USAID climate change programs. In the past year alone, the Administration has entered into bilateral agreements with Japan, Australia, Canada, Italy, the European Union, CONCAUSA, China and India on climate change science, energy and sequestration technology, and policy approaches.

The President's climate change strategy is the product of an ongoing, combined working group of the National Security Council, the Domestic Policy Council and the National Economic Council. Our actions have been and will continue to be guided by the six principles that the President outlined last June:

1. *Consistency with the long-term goal of stabilizing concentrations* of greenhouse gases in the atmosphere at a level that will prevent dangerous interference with the climate system, recognizing that we currently do not know what that level is;
2. *Measured* actions, as we learn more from science and build on it;
3. *Flexibility* to adjust to new information and take advantage of new technology;
4. *Ensuring continued economic growth and prosperity* for the United States and the world;
5. *Pursuing market-based incentives* and spurring technological innovation; and
6. *Global participation,* including developing countries.

The Bush Administration's strategy for action and progress—a solid policy framework, a meaningful national emissions reduction goal, and a suite of policies to achieve that goal—is calibrated to the actual state of scientific knowledge and guards against costly and misdirected policy errors. Commentary that continues to equate action on climate change with acceptance of the Kyoto Protocol ignores the bipartisan record of opposition to its approach. The Kyoto Protocol would have cost our economy up to $400 billion and caused the loss of up to 4.9 million jobs, risking the welfare of the American people and American workers. And without the participation of the world's developing countries, many of which will experience rapid growth in coming decades, it represented an ineffective policy response to this global challenge.

President Bush's philosophy—which ties our benchmark for progress with economic growth—represents a careful balancing that promises significant emissions reductions over the course of the next decade, while preserving the strength of the American economy. Only sustained economic growth, both here and abroad, will allow for the significant new investments in energy and sequestration technologies that will be needed to address this long term challenge.

Again, thank you for inviting me today. I would be pleased to answer any questions that you may have and ask that the written material accompanying my testimony be entered into the record.

APPENDICES [1]

1. Statement of President George Bush (June 11, 2001)
2. Policy Book Accompanying Presidential Statement (June 11, 2001)
3. Statement of President George Bush (February 14, 2002)
4. Policy Book Accompanying Presidential Statement (February 14, 2002)
5. Report of Federal Climate Change Expenditures (July 9, 2002)
6. Review of Bilateral Agreements and Initiatives

Senator KERRY. Let me say that, for each of you, your full statements will be placed in the record as if read in full. If we could try to do the summaries in the 5 minutes appropriated, then that will give us more time to have some dialog. Thank you.

Dr. Hubbard.

STATEMENT OF HON. R. GLENN HUBBARD, CHAIRMAN, COUNCIL OF ECONOMIC ADVISERS

Dr. HUBBARD. Thank you, Mr. Chairman, Members of the Committee. I'll try to keep my remarks very brief, both absolutely and in intensity. I have a longer version of the testimony, but also would refer you to the Economic Report of the President this year, where there's a much longer discussion of the economic arguments that I'll make.

I really just want to bring up three points. First is, as a matter of economic policy—and this question is so important, as you teed up, Mr. Chairman—How should one think about economic policy elements? Second, How would you design a goal, once you realize how important this problem is? And, third, How would you carry it out?

The President's strategy really has three prongs. First, as has been noted, slowing the growth of net greenhouse gas emissions, then laying the groundwork for both current and future action. And, importantly, working with other nations to develop an efficient and effective response.

This first element of the U.S. strategy is really slowing the growth of our greenhouse gas emissions. As you know, the President has set a greenhouse gas intensity target, that is emissions per dollar of GDP, a reduction of 18 percent over the next 10 years,

[1] The Appendices will be maintained in Committee files.

as the picture here indicates. Two things I just want to stress about this picture. You'll notice that under current efforts, we would still have an improvement. As Senator Burns noted, the economy has efficiencies here anyway. We're not just producing more. We are doing it better. But the President has also requested improvement.

One difference between an intensity target and an absolute target is as a problem of decision making under uncertainty; and, in here, in this respect, an intensity target will do much less damage to our economy, as I'll explain in a moment.

The second element of the President's plan focuses on foundations for current and future policies, investments in science, technology, and institutions. You don't leap from textbook to practice here. Institutions do not develop overnight. Science does not develop overnight. These are very long-term efforts.

The final element of the President's approach incorporates international elements, because, as we all know, without participation, eventually, of developing countries, we go nowhere.

Now, to this question of uncertainty, the uncertainty surrounding the ultimate consequences of climate change and the necessity of the long-term effort here make it a point of economics that very sharp, short-term responses, as would have been required, for example, under the Kyoto Protocol, are not warranted. They are simply not the right medicine for the problem at hand.

A quick analogy might be more instructive than economics and math. If you smell smoke in your house, it would be silly to simply lie there and pretend you don't smell it, but nor would you throw your children out the window and jump yourself. You'd probably get up, check it out, and then decide how to proceed.

Starting in that right direction, President Bush responded to the need for a serious and measured response by calling for an intensity target, the very two—two very important features of this, the way in which this target is defined, and then how you get to 18 percent.

Again, most of the discussion, as the Chairman helpfully indicated in his opening remarks, has been about absolute targets. This is a real problem when you have uncertainty. Much of the uncertainty, of course, is over economic growth rates as well as it is about science and the costs and benefits here. We could wind up doing very large damage to the economy were the economy simply to grow more rapidly. I'll come to the point about one way of satisfying Kyoto Protocols, as being simply to grow more slowly, in a moment.

Indeed, while emissions growth rates varied a lot across countries in the 1990s, almost all of that variation can be explained by differing rates of economic growth, as my testimony indicated. That is also true over time for the United States. You simply cannot have a policy here that does not acknowledge this intensity fact. Intensity has a nice analog to other things, too. It's called productivity. Normally, when we think about giving incentives for innovation, we focus there.

Now, how does one think about the 18 percent and designing a more responsible path than Kyoto? First, it's important to point out, as this picture indicates, that this is a real improvement over

business as usual, and that's a business as usual that already assumes significant technological advance.

The ability to achieve what the President has set out here is very similar to forecasts that my predecessors in the Clinton Administration had noted. For example, my predecessor, Janet Yellen, testified in 1998, under a set of trading assumptions that I wouldn't necessarily ascribe to, would produce a reduction roughly of the sort that we're talking about here. So there's really no disagreement at all under the economics. This is widely accepted in my profession.

It's also important to note that the 4½ percent reduction extra that the President is asking for is, in fact, comparable to the average reductions required under Kyoto. Now, you're asking yourself, "How can that possibly be?" Well, you have to remember that much of the reductions under Kyoto aren't real. That is, they involve the trading of hot air. They are commercial and financial transactions. They are not bonafide long-term reductions. Or, put more starkly, the overall target could be met quite easily and always by simply using undesirably poor economic growth in some subset of countries. That's not good development policy. It's not good environmental policy. A group of economists at MIT has also come to the same conclusion that roughly the Kyoto reductions would match what we're talking about here.

We need a long-term response to a long-term problem. This is a problem of greenhouse gas concentrations, which can be taken out, as they can be put in—that is, over time. The key is to do it in the lowest-cost way and to find the lowest-cost ways first before going to the highest-cost ways. Just to give you a quick example, a 30-percent reduction in emissions in the near term is not twice as costly as a 15 percent reduction. It's six times as costly. Timing matters a lot.

Now, the other economic feature I'd highlight for you is that the signposts here are really marked by institutions. Just as in the trade area, we have spent 50 years building institutions to support an international trading regime; so, too, is it important to build institutions here. Jim has already referred to a set of institution-building mechanisms that are happening domestically. I just want to highlight a couple that are important for the economics.

We cannot leap to systems without having infrastructure in place. We need a voluntary emissions registry. We need to provide transferable credits for voluntary real emissions reductions. We have to build these institutions. As Jim indicated, it is also important to join, as we have vigorously, the building of international institutions.

So, just to close where I began, Mr. Chairman, again, I think there are three salient points here as a matter of economic policy. When you have decision making under uncertainty, you go slow, you take the lowest cost first, and you build institutions. When you design a goal, you make it match the problem, and that's intensity. Implementation is about building those institutions.

Thank you very much.

[The prepared statement of Dr. Hubbard follows:]

PREPARED STATEMENT OF HON. R. GLENN HUBBARD, CHAIRMAN, COUNCIL OF ECONOMIC ADVISERS

Mr. Chairman, Senator McCain, and Members of the Committee, I am pleased to appear before you this morning to discuss the Administration's climate change policy. On February 14, President Bush announced his effective and science-based strategy for moving forward on climate change. This strategy establishes environmentally and economically sensible goals, concrete steps to meet the goals, and a balanced portfolio of research, emission reductions, and international cooperation.

The U.S. strategy has three-prongs: slowing the growth of net greenhouse gas (GHG) emissions, laying important groundwork for both current and future action, and working with other nations to develop an efficient and effective global response. This strategy builds on the Administration's June 2001 commitment to improve our understanding of the causes and potential harms posed by climate change, and to develop technologies that offer promise to significantly slow the growth of emissions. It is also the first step in a long-term commitment to slow and, if the science justifies, stop and then reverse the growth of GHG emissions. Importantly, it takes advantage of our growing experience with building better and more flexible institutions to address environmental problems—a topic discussed at length in this year's *Economic Report of the President*.

The first element of the United States climate strategy is slowing the growth of our GHG emissions. The President set a national goal of reducing U.S. greenhouse gas intensity (GHG emissions per dollar of GDP) by 18 percent over the next 10 years. Like an absolute emissions target, an intensity reduction of this magnitude requires real effort. Unlike an absolute emission target, an intensity target will not inadvertently hurt our economy.

The second element focuses on creating a solid foundation for current and future policies—investments in science, technology, and institutions. Better science promotes better decision-making. Better technology offers the promise to slow emissions growth significantly. Better institutions enable us to pursue the lowest-cost emissions reduction opportunities, whatever they may be, whenever they arise over time, and wherever they occur both within and across nations. Improvements in the existing voluntary registry of greenhouse gas emissions, along with transferable credits for real emission reductions, are an important part of this institutional foundation. The registry improvements include better measurement and verification of the different greenhouse gases emitted by a wide variety of sources and activities, providing greater confidence in the reported results and encouraging firms to take account of their emissions. Credits for real emission reductions provide a mechanism that allows firms to avoid being penalized under any future climate policy or be rewarded under any future incentive policy, provides tangible evidence of the impacts of voluntarily adopting superior technologies, and provides incentives to curb future emissions.

The final element of the President's approach incorporates international efforts, recognizing the critical importance of developing-country participation in any effective international response to climate change. This participation includes both near-term efforts to slow the growth in emissions and longer-term efforts to build capacity for future cooperation.

Importantly, the President's approach addresses key shortcomings of the Kyoto Protocol. These shortcomings include an arbitrary short-run emissions reduction target that was far too severe given the long-run aspects of climate change and remaining scientific uncertainties, and that was unresponsive to economic growth. Indeed, as I will note below, reductions from domestic sources in 2012 under the President's approach are expected to be roughly comparable to those anticipated under the Kyoto Protocol, but without the Protocol's undesirable features. The Kyoto Protocol's focus on near-term *targets*, rather than on building up the *science*, *technologies* and *institutions* that could minimize the economic impact of meeting long-run goals, is particularly faulty given the limited ability to mount a flexible and cost-effective response in the near term. Finally, the Kyoto Protocol failed to include developing countries, limiting the effectiveness of any international effort.

A JOURNEY OF A THOUSAND MILES BEGINS WITH A SINGLE STEP

While the potential for human-induced climate change is real and deserves serious attention, there is significant uncertainty about how increases in concentrations translate into changes in temperatures and climate patterns, especially on regional and local levels. Global climate models, with all their uncertainties, are unable to predict regional and local impacts reliably. The role of natural variation in climate is not well understood. There is still more uncertainty about how temperature and changes in the climate would impact the environment and human populations. In

addition, the extent to which concentrations will rise in the future is unclear because neither future emission trends nor potential absorption of emissions by the ocean, vegetation, and other "sinks" is known with certainty.

These large uncertainties underlay the President's decision in June 2001 to focus spending on climate-related research, by creating the U.S. Climate Change Research Initiative. This initiative will identify and study priority areas where increased research can make the most significant strides toward reducing uncertainty. Over the next year alone, the United States will spend $1.75 billion for basic research on climate change.[1] Indeed, the United States will spend as much as the rest of the world combined on research in this important area.

A distinguishing characteristic of climate change is that any successful effort to address the potential risk of climate change from most greenhouse gases will stem from cumulative efforts over decades, not just a few years. In 2000, for example, global CO_2 emissions contributed to an increase in atmospheric concentrations of less than 0.5 percent,[2] a small increase compared to the 20 percent to 200 percent increase in concentrations that researchers often propose as a possible long-term stabilization goal.[3] As substantial changes in concentration only result from cumulative emissions over a period of decades, the future benefits of efforts to reduce emissions will be nearly the same whether the reductions, ton for ton, occur today or years in the future.

The uncertainty surrounding the ultimate consequences of climate change and the necessity of a long-term effort to address it combine to suggest that severe and costly near-term measures to reduce emissions are not warranted. Instead, a serious but measured first step is in order. A helpful analogy is posed by M.I.T. economist Richard Schmalensee and his colleagues: If you smell smoke in your house, it would be silly to do nothing until you actually see flames, but you also should not hose down the house after one whiff of what might be smoke.

STARTING IN THE RIGHT DIRECTION

President Bush responded to the need for a serious but measured response by calling for an 18 percent reduction in greenhouse gas intensity (emissions of greenhouse gases per dollar of economic output) by 2012. As the President explained, this is the first step in a policy that will first slow, and if the science dictates the necessity, stop and reverse growth in greenhouse gas emissions (see Chart 1). There are two important features of this goal—the way in which the goal is defined based on GHG intensity, and the specific 18 percent target.

Redefining Short-term Goals

Most discussions of goals for slowing the growth of greenhouse gas emissions at the national level have focused on absolute emission targets, exemplified by the Kyoto Protocol. Meeting absolute emission targets can be costly, however, because of the substantial uncertainty regarding how difficult it will be to meet them. This uncertainty about the difficulty or cost associated with achieving an absolute target is, in turn, primarily driven by uncertainty regarding how emissions would grow absent such a target and therefore the reductions required to meet it. The Intergovernmental Panel on Climate Change recently developed a number of possible scenarios for growth in emissions over the coming century. While it is not surprising that projections for growth over a century may vary widely, it is somewhat surprising that the various scenarios of potential growth in CO_2 emissions from 2000 to 2010 alone ranged from under 4 percent to almost 40 percent.[4]

Much of the significant variation in projections of emissions growth reflects uncertainty about future economic growth. Indeed, Chart 2 shows that, while emissions growth rates varied substantially across countries during the 1990s, much of this variation can be explained by differing rates of economic growth (hence the upward sloping pattern when these variables are plotted together). Moreover, looking at

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[1] See Global Climate Change Policy Book, http://www.whitehouse.gov/news/releases/2002/02/climatechange.html.

[2] Data Source: C.D. Keeling, T.P. Whorf, and the Carbon Dioxide Research Group, Scripps Institution of Oceanography (SIO), University of California, La Jolla, California. See http://cdiac.ornl.gov/ftp/ndp001/maunaloa.co2.

[3] This calculation is based on increasing from current concentration levels of approximately 370 ppmv to future stabilization targets ranging from 450 to 750 ppmv. See "Climate Change 2001: The Scientific Basis," Intergovernmental Panel on Climate Change: Working Group One, Third Assessment Report, page 14 (http://www.ipcc.ch/pub/spm22–01.pdf) and C.D. Keeling, T.P. Whorf, and the Carbon Dioxide Research Group, Scripps Institution of Oceanography (SIO), University of California, La Jolla, California. See http://cdiac.ornl.gov/ftp/ndp001/maunaloa.co2.

[4] See "Emission Scenarios," Intergovernmental Panel on Climate Change: Working Group Three, pages 247, 386, and 511.

changes in emissions growth rates across time, Chart 3 shows that while U.S. GHG emissions growth over the past two decades was somewhat erratic, it has closely tracked economic growth. This correlation is largely due to the impact of economic growth on demand for energy and, in turn, the GHG emissions associated with the generation of that energy. The relationship is not exact, of course; energy efficiency has improved throughout the years, and nuclear power and renewable sources for electricity generation, among other factors, have limited the growth in fossil fuel use necessary to meet rising energy demands. Nonetheless, economic growth continues to be the key driver of emissions growth. By acknowledging and incorporating this relationship, an intensity-based goal linked to changes in economic output reduces uncertainty about the required level of effort.

Just as an absolute goal, an intensity-based goal could be viewed as establishing a target for future emissions. The expected tonnage target equals the intensity goal times the expected level of economic output:

Expected Tonnage Emissions Target (tons of carbon) = Intensity Target (tons of carbon per dollar) × Expected Economic Output (dollars).

If economic growth were *certain*, then the two types of goals would be identical. However, the most fundamental feature of climate change is uncertainty, and the pace of economic growth is one source of uncertainty. For this reason, the previous Administration, in discussing developing country participation in the Kyoto Protocol argued that "An emissions target . . . could be indexed to a country's economic performance (such as GDP) . . . Such targets could avoid a crunch arising from faster than projected economic growth between now and the commitment period." [5]

Thus, if economic growth is as expected, an absolute target can mimic the intensity target. However, if economic growth turns out to be much faster than expected, the intensity target flexibly adjusts the tonnage target upward to permit taking advantage of the benefits of additional resources from growth. Should growth be slower than expected, the intensity target permits a lower tonnage target in a way that an absolute emissions goal cannot.

The long-term, cumulative feature of the climate change problem implies that the economic advantages of an intensity-based goal come with minimal environmental disadvantages. To see this, if an intensity-based goal results in higher than expected emissions over the next decade, then more aggressive emissions reductions can remedy the problem in the future with little consequence for the environment.

Designing a More Responsible Path Than Kyoto

Reaching a goal of 18 percent reduction in emissions intensity will require real effort over the next decade. In the past, emissions intensity has gradually fallen as a result of investment and innovations producing a number of significant changes in the economy: An increasing share of less energy-intensive sectors in national economic output, technological advances in pollution control and the cleaner use of fuels, and reductions in the emissions-intensity of electricity production due to (among other factors) the increased contribution of natural gas and nuclear power to electricity production. Even as these trends continue, independent forecasts by the Energy Information Administration predict only a 14 percent further improvement in emissions intensity over the next 10 years.[6] The President's goal will require emissions intensity to fall 30 percent faster, resulting in a 4½ percent—or 100 million metric ton (carbon-equivalent)—*additional* decline in 2012 emissions relative to the EIA forecast (see Chart 4).

The President's 4½ percent reduction plan results in roughly the same volume of domestic reductions as envisioned by the previous Administration. In March 4, 1998, testimony before the House Subcommittee on Energy and Power concerning the Kyoto Protocol, CEA Chair Janet Yellen argued that *with* key developing country participation and an efficient trading program (neither of which is true under the Kyoto Protocol under the Marrakech Accords), the U.S. would reduce between 100 and 150 million metric tons of carbon relative to business as usual. While I am skeptical that these developing countries would voluntarily agree to emission limits under the Protocol and, even if they chose to participate, that they could efficiently trade in emission reductions, I do agree that domestic reductions of 100 million metric tons relative to forecast 2010 levels is a reasonable target.[7]

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[5] See *Economic Report of the President 2000*, Washington: U.S. Government Printing Office, Box 7–6, page 269.

[6] See Addendum to the Global Climate Change Policy Book, http://www.whitehouse.gov/news/releases/2002/02/addendum.pdf.

[7] See Testimony of Janet Yellen, Chairman, Council of Economic Advisers, on H271–9 before the Subcommittee on Power and Energy of the House Committee on Commerce, page 323, lines 26 and 29.

The 4½ percent reduction is also comparable to the average reductions required under the Kyoto Protocol for countries remaining in that agreement. Chart 5 shows the U.S. commitment alongside estimates of the average required reductions for the remaining countries with emission limits under the Kyoto Protocol. While some regions, such as Canada and Japan, have particularly onerous targets, others, such as the transitional economies of the former Soviet Union and Eastern Europe, have targets far exceeding their forecast emissions—hot air. According to one set of estimates by the Energy Information Administration, this hot air exceeds the needs of other countries with actual reduction targets, with a net effect of zero required average reductions. Put more starkly, the overall target would be met by using undesirably poor economic growth in some countries as the route to compliance in the remainder. Another set of estimates from a group at MIT shows required average reductions of 7.2 percent. Viewed together, these forecasts suggest an effort to reduce emissions among remaining Kyoto countries that is roughly comparable to the U.S. commitment.[8]

Developing a Long-term Response to a Long-term Problem

Reducing greenhouse gas intensity requires a portfolio of policies including both research on future reduction technologies as well as investment in current technologies. Each potential short-term effort to limit the growth of GHG emissions should be evaluated in comparison with the option to shift effort to later decades, while still maintaining the same long-term cumulative reduction goal and desired level of environmental protection. Two alternative schedules of emissions reductions can lead to different levels of emissions over time, but the same ultimate level of GHG concentrations. The appropriate choice between paths that differ in near-term versus long-term emissions reductions depends on whether we can reduce overall costs by spending more on research and less on emission reductions now, in order to achieve greater, but significantly cheaper, emission reductions in the future thanks to improved technologies. It also depends on whether reductions now require early retirement of productive assets; throwing away something valuable is a real cost. Consideration of the appropriate timing of emissions reduction is all the more important because the cost of achieving reductions over a short horizon increases dramatically with the scale of reductions. One estimate suggests that a 30 percent reduction in emissions in the near term is 6 times more expensive than a 15 percent reduction. That is, doubling the near-term reduction target increases costs sixfold.[9]

A substantial body of research has examined this issue of balancing current and future emission reductions.[10] It has focused on the key features of the climate change problem—the uncertainty associated with the benefits and costs of addressing climate change; the replacement of existing energy-using equipment, structures, and other physical assets required to reduce emissions; and improvements in technology over time. These features commonly lead to two related conclusions. First, there is significant value associated with better information, suggesting a critical role for climate science. Second, the least expensive way to achieve a particular concentration target involves a gradual approach that avoids drastic changes to the capital stock.

In addition to lowering overall costs, a more gradual approach to reducing greenhouse gas emissions reduces the possibility that an unnecessarily onerous economic burden will discourage pursuit of the long-term problem. The long-term response to climate change can be likened to running a marathon, in which the efforts in the next decade are analogous to the first few miles. The 30 percent reduction required of the United States under the Kyoto Protocol would entail progressing a third of the way towards the long-term response in the first 10 years. That would be equiva-

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[8] See Energy Information Administration (EIA), *International Energy Outlook 2001,* DOE/EIA–0484 (2001) (Washington, DC, March 2001); and John Reilly, MIT Joint Program on the Science and Policy of Global Change, Snowmass Summer Workshop (August 6, 2001). The *IEO 2001* estimates that total required reductions among the Annex I countries (those required to reduce emissions under the Kyoto Protocol) would be 554 million metric tons in 2010. Of that, the United States' burden is 558 million metric tons (page 14), leaving a marginal surplus of reductions—without any further effort—among remaining participants after U.S. withdrawal from the Protocol. The MIT study provides slightly higher estimates of the burden among remaining participants (7 percent, or 290 million metric tons).

[9] Numerous estimates of the cost to the United States of different levels of emissions reductions are presented in John Weyant and Jennifer Hill, "Introduction and Overview," *The Energy Journal* (Special Issue, 1999), page *xxxvii*.

[10] A summary of the research on this topic can be found in Michael Toman, "Moving Ahead with Climate Policy," *RFF Climate Change Issues Brief,* 2000. An additional summary of studies on this topic can be found in "Climate Change 2001: Mitigation," Intergovernmental Panel on Climate Change: Working Group Three, Third Assessment Report, pages 544–552. See http://www.ipcc.ch/pub/wg3spm.pdf.

lent to sprinting the first few miles of a marathon. The risk of such a strategy is that, after sprinting the first few miles, a runner may be in such pain that she decides to quit the race even though she could otherwise have finished it had she started more gradually.

THE JOURNEY'S SIGNPOSTS ARE MARKED BY INSTITUTIONS

In addition to setting a responsible short-term goal, the President's approach recognizes that cost-effective climate change policies in the future are made possible only by building institutions to facilitate those policies today. Numerous studies demonstrate that taking advantage of low-cost opportunities to reduce emissions, wherever those opportunities occur, reduces the overall cost of meeting an emissions goal.[11] Therefore expanding the set of reduction opportunities targeted by a policy—for instance, by including each of the various GHGs or a wider variety of sources—can substantially lower the cost of reaching a particular goal.

The United States and the rest of the global community are still, however, far from being able to tap fully this flexibility in responding to climate change. On the one hand, the capacity already exists in the United States to encourage efficient reductions from energy-related sources that make up a substantial share of our aggregate GHG emissions. The $4.6 billion in tax incentives for renewable energy and energy efficiency programs in the President's 5-year budget plan are examples of this kind of capacity. On the other hand, research suggests that about two-thirds of the low-cost reductions opportunities stem from the very sources for which we do not yet have this capacity; even less capacity exists in other nations. We need to build institutions to capture these opportunities.

The President's recommendation to improve the nation's voluntary emissions registry and to provide transferable credits for voluntary real emission reductions—these are concrete steps to start building institutions. The improved emission registry will allow improved tracking of emissions from hard-to-reach sources that offer low-cost reductions. Transferable credits for real reductions—including credit for adoption of new energy-saving technologies and practices, reductions of non-CO_2 gases, and sequestration—means that firms seeking insurance against future policy action on, or reward from future incentives for, climate change can obtain it from the lowest-cost sources. This approach fosters the creation of institutions—standards, protocols, technology, and popular awareness—that provide access to inexpensive reductions and help the country meet our emission goals efficiently.

Flexibility Matters

In contrast to many environmental problems that result from a specific chemical or a narrow set of activities located in a confined area, the risk of climate change depends on the combined accumulation in the atmosphere of many different GHGs emitted from all over the world. While the contribution of a given amount of each GHG to climate change varies according to its relative potency in trapping energy and how long it naturally remains in the atmosphere, emission reductions of the various gases, adjusted for these differences, are equally valuable.[12] Moreover, because atmospheric concentration of GHGs matter, not emissions, sequestration (e.g., absorption into forests and soil) of gases already in the atmosphere provides additional opportunities to reduce climate change risks.

The large contribution of carbon dioxide emissions to overall increases in the atmospheric GHG concentrations implies that reducing the growth in GHG emissions will be important to any long-term strategy to address climate change. Other gases comprised only 18 percent of total U.S. GHG emissions in 1999, while land-use changes and forestry in the United States sequestered the equivalent of roughly 15 percent of total emissions.[13] However, emissions of these other gases and sequestration offer the bulk of inexpensive reduction opportunities for the United States right now—nearly twice as much as carbon dioxide emissions according to a recent EPA study—making it essential to include them in any cost-effective approach.[14]

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[11] A summary of studies on this topic can be found in "Climate Change 2001: Mitigation," Intergovernmental Panel on Climate Change: Working Group Three, Third Assessment Report, pages 522–523 and 536–542.

[12] As a result, emissions of greenhouse gases are often measured in tons of carbon equivalent, which weights the emissions of each gas according to the combined effect of its relative potency and residence time in the atmosphere.

[13] See Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–1999,* (April 2001). See http://www.epa.gov/globalwarming/publications/emissions/us2001/pdf/table-es-1.pdf.

[14] See Environmental Protection Agency, *Analysis of Multi-emissions Proposals for the U.S. Electricity Sector, Requested by Senators Smith, Voinovich, and Brownback*. See http://www.epa.gov/oar/meproposalsanalysis.pdf.

GHG emissions reductions also have the same climate change benefits wherever they occur—within a company, across the country, and around the world. In sharp contrast to emissions of pollutants like sulfur dioxide and nitrogen oxides that have both local and regional consequences, GHG emissions in Asia—or anywhere else—will have exactly the same consequences for the United States as GHG emissions within the United States. Not only do we want to encourage efficient emissions reductions across gases and activities, but across the country and around the world as well.

While the *absolute* estimates of the costs and cost savings associated with various policies are subject to considerable uncertainty and disagreement, flexible policies undeniably lead to large *relative* cost savings compared to less flexible alternatives—if the right institutions are in place.

Flexibility Requires New Institutions

Realizing the potential cost savings from flexible polices as we pursue our 18 percent intensity goal requires a certain set of institutions—regardless of whether the policy is based on voluntary challenges, or tax incentives, or possibly broad-based market programs in the future. Emissions and reductions must be measurable with equivalent treatment for equivalent emission consequences. Incentives are needed to motivate firms to seek reductions. Skills are needed to evaluate incentives and options. Awareness is required to uncover as many opportunities as possible. The President's plan addresses these needs in a creative and responsible manner.

Perhaps the most desirable feature of a flexible system is to encourage the measurement and monitoring of emissions from a wide variety of sources. It is impossible to identify inexpensive opportunities to reduce emissions if emissions cannot be measured. Among greenhouse gases, these emissions can come from widely dispersed sources and/or be difficult to directly or indirectly monitor. The development of standardized protocols—such as the improved emission registry called for by the President—can overcome these difficulties, but it will take time.

Once various emissions are measurable, reductions can be encouraged by an incentive. Here, U.S. policy has challenged businesses to help meet the goal, provided a set of tax incentives to spur certain activities, indicated additional measures may be forthcoming in response to both scientific, technological, and economic progress, and provided a means—the transferable credit system—for firms to protect their current actions from penalization, or to obtain rewards from incentives, under a future policy. By granting credits for real reductions from any source, and allowing anyone to buy those credits, the President has set up a program that allows firms to insure against, or take advantage of, future actions in the most flexible possible way. This approach creates a clear incentive to reduce emissions toward the nation's intensity goal, but because the program is voluntary, no one is compelled to do anything.

The U.S. Approach Provides the Building Blocks

Developing the capacity to address climate change now and in the future will require substantial effort, institution building, and innovation. In his climate change statement on February 14, the President directed the Secretary of Energy to recommend improvements to an existing voluntary registry of emissions reductions established by the 1992 Energy Policy Act. The Secretary's recommendations, sent to the President on Monday of this week, and attached as an appendix to this testimony, emphasize means of improving the accuracy, reliability, and verifiability of measurements of emissions and reductions, as well as means of providing transferable credits for real emission reductions that will avoid penalizing firms for those reductions under any future program.

Improvements to the existing emission registry address one of the institutions required for a flexible policy—improved standards and protocols for emissions measurement from as many sources (and sinks) as possible, treating all real reductions equivalently. The provision of transferable credits, along with tax incentives and the President's national challenge, addresses another: incentives. In addition to the obvious incentives associated with tax incentives and a Presidential challenge, transferable credits provide an opportunity for firms to obtain insurance against, and take advantage of, future climate policy actions. That opportunity is an incentive, one enhanced by several features of the President's initiative.

First, the President has indicated that these credits should protect firms who reduce their emissions now from penalization, or permit rewards from incentives, under any future policy. This protection *per se* has value. The creation of such a hedge is analogous to the purchase of automobile insurance—a fixed expenditure now that may become more valuable precisely in the face of an adverse outcome

(stricter emission limits in the climate context or an auto accident in the insurance context).

Second, the credits are only given for real reductions, as determined by an accurate, reliable, and verifiable emissions registry. As the existing registry is improved and the rules for crediting are developed, they will be designed to create the utmost confidence in the measured reductions. It is this confidence, as much as statements and statutes, that ensures that future policy will honor these credits in later years—if the science, technology, and economic considerations require it.

Third, the credits are transferable, allowing businesses that want to insure against penalties, or take advantage of incentives, in future policy and even speculators to purchase these government-sanctioned reductions—regardless of their own reduction opportunities. Firms and individuals with the greatest interest in hedging against future climate policies may want more credits than they can generate through their own reduction opportunities. Likewise, firms and individuals with significant low-cost reduction opportunities may not want as many credits as they can generate. Trading allows those who want more credits to buy them from the cheapest sources, inside or outside of their own firm.

Regardless of whether one is concerned about encouraging voluntary reductions now, or preparing for possible cost-effective responses in the future, registry enhancement and transferable credit for real reductions create the right institutions for current and future policies.

A SUCCESSFUL JOURNEY REQUIRES BROAD PARTICIPATION

The U.S. climate change initiative has taken a number of explicit steps to develop an efficient and practical international response to climate change, and a number of its domestic elements have significant implications for broadening international participation. A major focus of the new approach is increasing the capacity of developing countries to contribute to international efforts to address climate change. The participation of developing countries is critical for two reasons. First, in the long run, the ability of any effort to mitigate effectively potential human-induced climate change depends on the participation of developing countries as those countries make up a majority of total GHG emissions now and much of the expected growth in coming years. Second, many low-cost opportunities for reducing net GHG emissions can be found in developing countries. Ignoring these opportunities raises the overall potential cost of addressing climate change for the world as a whole.

The United States is providing assistance to increase the capacity of developing countries to address climate change. The President has requested $50 million to fund tropical forestry conservation in developing countries; up to $40 million of these funds may be used for the Tropical Forest Conservation Act, reducing countries' debt burdens while protecting existing greenhouse gases sequestered in forests and biomass. In addition, the President has requested $178 million in funding for the United Nations' Global Environment Facility. The Global Environment Facility funds the extra costs (over normal development costs) of reducing greenhouse gas emissions in energy and other projects in developing countries. The President has also requested $156 million for climate change programs through the U.S. Agency for International Development. Also, the President has focused on helping developing countries prevent illegal logging.

Efforts by developing countries to limit GHG emissions will be promoted by these direct steps, and also by the introduction of an intensity-based goal and development of improved methods for measuring and crediting emissions reductions. A key concern for developing countries contemplating efforts to reduce GHG emissions is how absolute, Kyoto-like, emissions targets could limit opportunities for economic growth. In contrast, an intensity-based approach explicitly takes account of economic growth, adjusting the emissions goal in tandem with changes in economic output. By shifting toward such a goal, one can highlight a way of defining short-term goals that would be more attractive to developing countries than are absolute targets. Note that an 18 percent intensity goal, adopted by all nations over the next 10 years, would lower world emissions by more than 800 million metric tons relative to forecast levels.[15]

Standardizing means of measuring net emissions from a wide variety of sources through registry enhancements also has implications for developing-country participation. For many developing countries, energy-related activities are a much smaller share of total GHG emissions, while more difficult to measure activities—for exam-

[15] This estimate is based on world GDP and carbon dioxide emissions forecasts from Energy Information Administration (EIA), *International Energy Outlook 2002,* Tables A3 and A10. See http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2002).pdf.

ple, agriculture—are an even greater contributor than in the United States.[16] An improved ability to measure reductions in such emissions will enhance the capacity to tap into cheap emissions reduction opportunities in those developing countries. At the same time, not only will efforts to reduce the growth of GHG emissions occur at a low cost, but they may also yield health benefits in developing countries by reducing emissions of harmful pollutants.

A BALANCED APPROACH IS THE WAY TO MOVE FORWARD

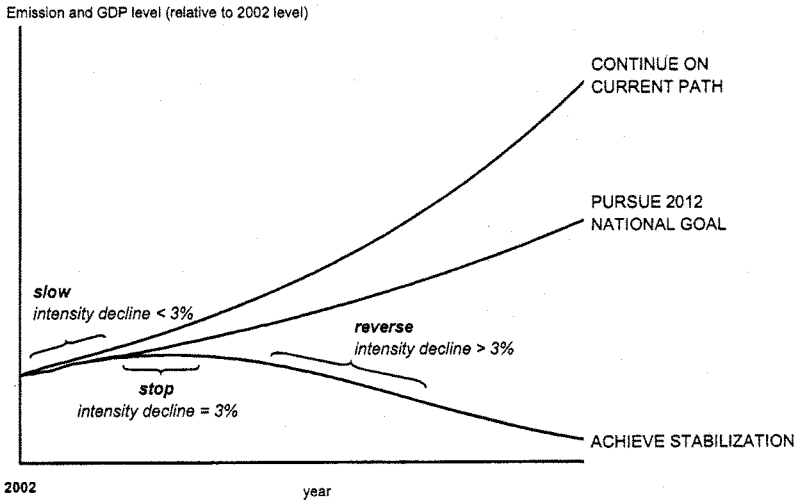
The Administration's approach to climate change carefully balances the need for immediate emission reductions, the need to develop strong, flexible institutions, and the need to learn more about the science and available technologies. First, the approach sets an intensity goal that requires real reductions while accommodating economic growth. Voluntary programs coupled with more than $4.6 billion in tax incentives over the next 5 years offer businesses and individuals opportunities and incentives to meet the goal. Second, the approach develops knowledge and institutions to address policies in the future. An enhanced emission registry, transferable credit for real emission reductions, $1.2 billion for technology research, development, and deployment to reduce emissions, and $1.7 billion for fundamental science this year related to climate change are substantial investments in our future capacity to address climate change. Finally, the approach emphasizes the importance of international, and especially developing-country, cooperation—looking for opportunities but recognizing constraints. These opportunities include both bilateral efforts (e.g., debt-for-nature swaps and technology transfer programs) and multilateral efforts (e.g., funding for the Global Environmental Facility and the illegal logging initiative).

Most importantly, the U.S. approach looks beyond the next decade. Climate change is a long-term issue that for too long has been mischaracterized as a short-term crisis. In particular, divisive efforts to seek dramatic short-term reductions ignore the need for a long-term architecture that is flexible in the face of economic growth and can adjust to new information. Intensity targets are a more sensible way to think about the evolution of goals, as absolute emission targets tend to penalize growing economies—precisely the countries that need to be included for an international response to work. Improved science, technology, and institutions are more valuable—and more achievable—than dramatic emission reductions right now.

Thank you, Mr. Chairman. I look forward to answering any questions you or Members of the Committee may have.

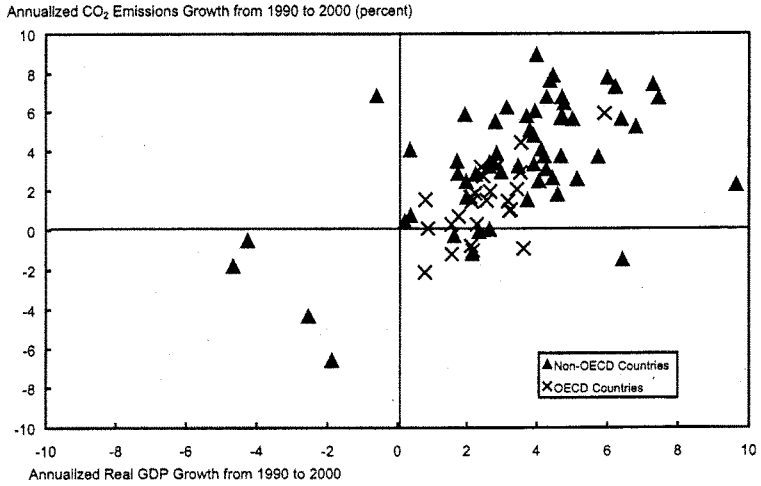
[16] See "Asia Least-Cost Greenhouse Gas Abatement Strategy: India National Report," Table no. 1–1. Manila: Asian Development Bank, ADB–GEF–UNDP, 1998. See http://www.ccasia.teri.res.in/country/india/ghg/tables.htm.

Chart 1 **Path to Long-Term Stabilization**
An 18 percent reduction in greenhouse gas intensity by 2012 is the first step in a policy that will first slow, and if the science dictates the necessity, stop and reverse growth in greenhouse gas emissions.



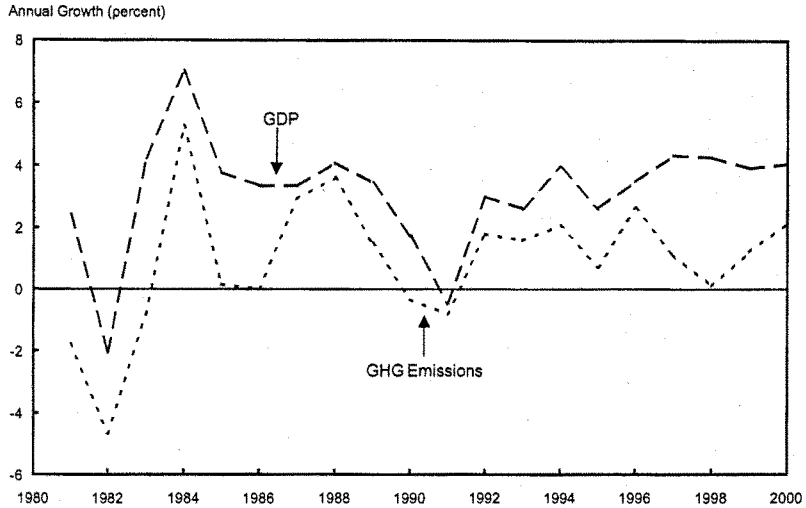
Source: Department of Energy (Energy Information Administration).

Chart 2 **Growth in GDP and CO_2 Emissions in OECD and Non-OECD Countries: 1990 to 2000.**
Much of the difference in the growth of CO_2 emissions across countries can be explained by differences in economic growth rates. This relationship holds for both developed and developing countries.



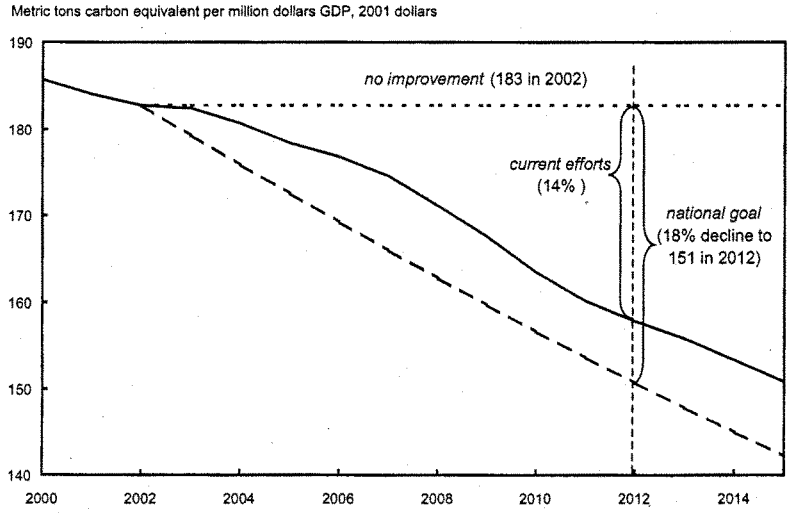
Source: Department of Energy (Energy Information Administration).

Chart 3 **U.S. Economic and GHG Emissions Growth: 1981 to 2000.**
While annual GHG emissions growth has varied substantially over the past two decades, it has closely tracked variation in economic growth.



Source: Department of Energy (Energy Information Administration).

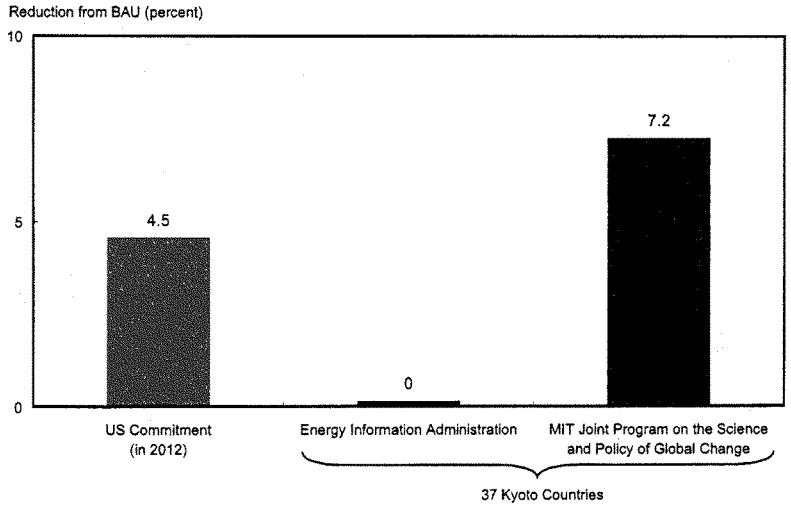
Chart 4 **Reduce GHG Intensity 18% Over the Next Decade.**
The President's goal requires emissions intensity to fall 30 percent faster than current efforts, resulting in a 100 million metric ton (carbon equivalent) *additional* decline relative to the EIA forecast.



Source: Department of Energy (Energy Information Administration)

Chart 5 **Reductions from Forecast Levels**

U.S. reductions from forecast levels are consistent with the average reductions in Kyoto countries.



Source: Department of Energy (Energy Information Administration) and MIT Joint Program on the Science and Policy of Global Change.

July 8, 2002

The President
The White House
Washington, DC 20500

Dear Mr. President:

The Department of Energy's Voluntary Reporting of Greenhouse Gases program has been operational since 1994. The program records the results of voluntary measures to reduce, avoid, or sequester greenhouse gas emissions. In your February 14, 2002, climate change announcement, you recognized the need to enhance the greenhouse gas registry by improving the program's accuracy, reliability, and verifiability as a means of more effectively promoting innovative and effective ways to reduce greenhouse gas emissions. An enhanced registry will encourage participation by increasing confidence that actions are accurately recorded and credited.

On February, 14, 2002, you:

> *Directed the Secretary of Energy, in consultation with the Secretary of Commerce, the Secretary of Agriculture, and the Administrator of the Environmental Protection Agency, to propose improvements to the current voluntary emissions reduction registration program under section 1605(b) of the 1992 Energy Policy Act within 120 days. These improvements will enhance measurement accuracy, reliability, and verifiability, working with and taking into account emerging domestic and international approaches.*
>
> *Directed the Secretary of Energy to recommend reforms to ensure that businesses and individuals that register reductions are not penalized under a future climate policy and to give transferable credits to companies that can show real emissions reductions.*
>
> *Directed the Secretary of Agriculture, in consultation with the Environmental Protection Agency and the Department of Energy, to develop accounting rules and guidelines for crediting sequestration projects, taking into account emerging domestic and international approaches.*

We view the directives to improve the greenhouse gas registry and credit those who voluntarily make real reductions in greenhouse gas emissions as key

components of this Administration's overall climate program. The *National Energy Policy*, the June 11, 2001, climate announcement focusing on science and technology initiatives, and the February 14, 2002, announcement focusing on reaching an 18 percent improvement in greenhouse gas intensity by 2012, clarify the Administration's commitment to:

- Enhance and prioritize research, through the *Climate Change Research Initiative*, to reduce the significant uncertainties that remain on the likely causes and possible long-term effects of global climate change;

- Support focused research and development, through the *National Climate Change Technology Initiative*, to develop and deploy the technologies needed to sustain economic growth and reduce the projected growth in emissions;

- Provide economic incentives to reduce emissions, including tax incentives for hybrid cars, residential solar energy systems, methane capture, combined heat and power systems, and electricity from wind and biomass;

- Encourage voluntary action to achieve real reductions of greenhouse gas emissions and increases in carbon sequestration, in conjunction with more than 60 mandatory, voluntary, and incentive-based Federal programs and similar efforts in the States; and

- Promote new and expanded international cooperation to address climate change, including accelerated adoption of clean energy technologies.

The current Voluntary Reporting of Greenhouse Gases program, created pursuant to the 1992 Energy Policy Act and managed by the Department of Energy's Energy Information Administration (EIA), has been operational since 1994. EIA's *Voluntary Reporting of Greenhouse Gases 2000* contains reports from 222 corporations, associations, and individuals. About half of these reports are "entity" (corporate-wide) reports. In addition, there are 1,882 project-level greenhouse gas and sequestration reports.

In response to your directive, we have undertaken several actions to improve the voluntary greenhouse gas registry and consider options to credit real reductions and sequestration.

First, we initiated simultaneous outreach efforts to the general public; industry; environmental, agricultural, and forestry groups; the financial community; and public policy organizations to solicit views on how to improve the greenhouse gas registry. We also met with fourteen States and several organizations that represent State and local energy and air pollution agencies. We issued a Notice of Inquiry with a 30-day public comment period, which ended June 5, 2002. To date, we have received over 80 sets of comments from a broad cross-section of stakeholders representing a wide range of views. Many written comments came from groups with whom we have met.

Second, we charged an interagency team with identifying options for improving the program. This team critically reviewed the existing Voluntary Reporting of Greenhouse Gases program, examined emerging State programs and international approaches to greenhouse gas reporting, met with stakeholders, and met with managers of analogous government programs in Japan, Australia, and the United Kingdom.

Third, we established an interagency team to identify options for developing accounting rules and guidelines for agriculture and forestry projects. This team is conducting a review of the existing accounting methods for forest and agricultural activities and developing recommendations for establishing standardized reporting guidelines for agriculture and forestry that are consistent with the crediting system.

Fourth, because of the business community's broad interest in voluntary efforts to address climate change, we met with trade associations and companies who may want to take on additional or new agreements to meet the challenge you made in the February 14, 2002, announcement.

Fifth, at your directive, the Department of Energy and the Department of Commerce instituted the cabinet level Committee on Climate Change Science and Technology Integration and the deputies level Interagency Working Group to aggressively move ahead and craft a path forward on our science and technology programs.

During this process, we encountered many significantly different views about what to report, what should "count" as a real reduction, how companies' emissions reductions and carbon sequestration could be credited under future policy, ways to ensure data accuracy, credibility, and transparency, and the importance of consistency between State and Federal reporting systems. We were also encouraged to maintain a fully inclusive process as we consider revisions to the program. The stakeholder process has been very useful and has underscored the need for more thorough public involvement, as outlined below.

We view our primary goal as creating a credible and transparent program to report and credit real reductions that support the national goal of reducing U.S. emissions intensity by 18 percent by 2012. Our discussions – both internally and with our stakeholders – have led us to identify the following recommended improvements to the Voluntary Reporting of Greenhouse Gases program:

1. *Develop fair, objective, and practical methods for reporting baselines, reporting boundaries, calculating real results, and awarding transferable credits for actions that lead to real reductions.* Developing such methods is central to achieving the objective of "measurement accuracy, reliability, and verifiability," as specified in the February 14, 2002, announcement.

2. *Standardize widely accepted, transparent accounting methods.* In 1994, when DOE's voluntary greenhouse gas reporting program was launched, accounting methods were deliberately flexible to promote broad participation. Since then, a large body of work on corporate and project-level emissions, reductions, and sequestration accounting has been developed. The revised and standardized voluntary reporting program will take these methods into consideration and establish a systematic and transparent approach for updating accounting rules as they evolve.

3. *Support independent verification of registry reports.* As the current voluntary program evolves from a reporting program toward a crediting program, it is important to ensure that reports are accurately and consistently prepared and in compliance with specified accounting rules. Requiring independent verification of reports, particularly those that qualify for transferable credits, will enhance the accuracy, acceptability, and credibility of the program.

4. *Encourage reporters to report greenhouse gas intensity (emissions per unit of output) as well as emissions or emissions reductions.* Reporting emissions intensity allows firms to take growth into consideration and is consistent with the overall goal of achieving an improvement in greenhouse gas intensity by 2012. To verify the intensity measures, reporters will need to submit the data necessary to calculate emissions intensity.

5. *Encourage corporate or entity-wide reporting.* The revised voluntary reporting program should encourage corporate or entity-wide reporting. However, many important prospective emission reductions actions, such as those relating to sequestration, energy efficiency, small-scale renewable energy, or actions that reduce greenhouse gases other than carbon dioxide may be difficult to accommodate within the context of entity-wide

emissions reporting. Encouraging entity-wide reporting while allowing for opportunities to report by projects acknowledges the importance of recognizing a broad range of actions and facilitating cost effective ways to reduce direct and indirect emissions.

6. *Provide credits for actions to remove carbon dioxide from the atmosphere as well as for actions to reduce emissions.* Sequestration activities can provide a valuable contribution to meeting our 2012 goal. Providing incentives and recognition for actions to reduce the concentration of greenhouse gases in the atmosphere will facilitate their adoption.

7. *Develop a process for evaluating the extent to which past reductions may qualify for credits.* A process needs to be developed for evaluating these past efforts against the criteria now being developed for consistent and accurate reporting.

8. *Assure the voluntary reporting program is an effective tool for reaching the 18 percent goal.* The enhanced registry and reporting program is one piece of a broad domestic effort to reach our 18 percent goal. It is important to link voluntary programs, such as the Environmental Protection Agency's Climate Leaders and Business Challenges, with reporting guidelines to encourage consistency between private actions and public goals.

9. *Factor in international strategies as well as State-level efforts.* As directed on February 14, 2002, we need to carefully review emerging international approaches, including other national efforts such as those of Australia, Canada, Japan, Denmark, and the United Kingdom (and other Member States of the European Union). In addition, public and private domestic approaches should be closely considered.

10. *Minimize transactions costs for reporters and administrative costs for the Government, where possible, without compromising the foregoing recommendations.*

While this effort is considerably more complex than the creation of the program in 1992-1994, we nevertheless propose an expedited process based on these recommendations and additional ideas we expect to emerge from our ongoing outreach efforts. The process, which will culminate in new guidelines by January 2004, (for reporting 2003 data) includes: several stakeholder workshops; sufficient time to update technical guidelines based on analysis and workshops; public comment periods to review the revised guidelines; development of reporting forms, software, and a public-use database; and required Office of Management and Budget review and clearance of new reporting forms.

We will continue to aggressively pursue the improvements directed in the February 14, 2002, announcement. We are convinced that by creating a process that fully engages the many stakeholders who are concerned about climate change, we can develop a reporting and crediting system with broad support that will result in significant and credible actions to help us meet our climate goals.

Sincerely,

Spencer Abraham

Donald L. Evans

Ann M. Veneman

Christine Todd Whitman

Senator KERRY. Thank you very much, Dr. Hubbard.
Dr. Marburger.

STATEMENT OF HON. JOHN H. MARBURGER III, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. MARBURGER. Good morning, Mr. Chairman and Members of the Committee. I, too, am grateful for this opportunity to testify before you on this important subject of global climate change.

The President takes the issue of global climate change very seriously, as we all do. In a series of clear and public statements, beginning June 11th last year, the President has described climate change as a complex, long-term challenge that requires an effective and science-based response. He's acknowledged the responsibility of the United States to lead in dealing with this challenge, and he has reaffirmed America's commitment to the United Nations Framework Convention and its central goal, to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate. He understands that the current state of climate science does not tell us what that level is.

To accelerate our understanding of climate change, the President has taken steps to engage the best science and technology, stating that, "The policy challenge is to act in a serious and sensible way given the limits of our knowledge. While scientific uncertainties remain, we can begin now to address the factors that contribute to climate change."

To begin the process within his Administration, the President last year requested the National Academy of Sciences to produce a report on the state of climate-change science. That report, the report that subsequently appeared, contains a sentence that is often half quoted, and I would like to read it here in its entirety. "The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability." Later on in the report, the report says that, "Because of the large and still uncertain level of natural variability inherent in the climate record and the uncertainties and the time histories of the various forcing agents, a causal linkage between the buildup of greenhouse gases in the atmosphere and the observed climate changes during the 20th century cannot be unequivocably established. The fact that the magnitude of the observed warming is large in comparison with natural variability in simulated climate models is suggestive of such a linkage, but it does not constitute proof of one, because the model simulations could be deficient in natural variability on the decadal to century time scale."

This entire report, available on the National Academy's Web site, provides valuable insights into the state of climate science, including the areas of fundamental uncertainty that require additional investigation. Even a cursory reading of this report indicates that the uncertainties are real, and they are significant.

Mr. Chairman, I ask that this important report from our national academies be included as part of the record of this hearing.* It's

*The Information referred to has been retained in the Committee files.

the best summary of current science that I'm aware of on this issue.

I would like to address some concerns that have arisen since the Climate Action Report was released several weeks ago. Some press accounts have said that this report acknowledged a dire, near-term threat to the environment from climate change. This is not true. Since much of the discussion of climate change and its impact centers on the use of computer models that attempt to look into the future, it may be useful to say a few words about them.

Climate forecasting is similar to weather forecasting. With the most powerful computers, we can forecast the weather reliably only a few days ahead. How, then, can we hope to predict climatic conditions far into the future? Well, science has developed approaches to long-term climate modeling that do not attempt to give the fine detail that we expect in a weather report.

Long-term climate models are sets of computer programs that attempt to simulate all the processes of nature that affect the atmosphere. The best current models average these properties over an area roughly the size of the State of Connecticut. It is not enough to model just the atmosphere, because climate is affected by the cloud cover, by vast ocean currents, by the polar ice sheets, by the presence of atmospheric chemicals and light-absorbing or -reflecting particles, and by the interaction of all these with life processes—trees, crops, ocean organisms and human beings. All these processes need to be understood quantitatively before they can be modeled. This is the ongoing challenge of climate-change research.

Once the models are constructed, a task that is by no means complete today, they have to be loaded with current conditions before they can be used for prediction. That means the state of the entire earth must be determined at a given instant of time by measurements on land, sea, and air. Satellite imagery is important, but not sufficient for this task. Since the output of the models depends on the input, incomplete knowledge of the state of the earth translates to uncertainty in the predictions, and the output is notoriously sensitive to the input.

This is why the Intergovernmental Panel on Climate Change concluded, in it's third assessment report, that, "Science cannot predict the climate and its impacts in Milwaukee, Mombai, or Moscow half a century ahead very accurately, and it may never be able to do so."

Today's climate models cannot be used for definite predictions of regional or local conditions. They are typically run many times for a range of input assumptions, and the results are assessed with statistical methods. Given our present state of knowledge, it is not surprising that the results vary widely, leading to apparently contradictory results. That is why reports such as the 2002 U.S. Climate Action Report do not claim to make predictions about future impacts. That report employs scenarios that are invented to capture the range of results of multiple runs of different climate models with different ad hoc input assumptions.

The scenarios are then used to make "projections," a word that is carefully defined in an important footnote on page 84 of this report, where it says that prediction is meant to indicate forecasting of an outcome that will occur as a result of the prevailing situation

and recent trends, such as tomorrow's weather or next winter's El Niño event; whereas, "projection" is used to refer to potential outcomes that would be expected if some scenario of future conditions were to come about. Notice that such projections can give no information about when or even if the assumed scenarios occur. I fear that many readers of the Climate Action Report have mistaken its projections for forecasts.

President Bush is addressing the serious issue of climate change through a focused and vigorously managed program. He's engaging science to increase our understanding and technology to devise ways of meeting our responsibility to future generations while preserving our quality of life and maintaining the competitiveness of our economy.

Thank you again for this opportunity to make these statements, and I'll be glad to answer questions, as well.

[The prepared statement of Dr. Marburger follows:]

PREPARED STATEMENT OF HON. JOHN H. MARBURGER III, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Good morning, Mr. Chairman and Members of the Committee. I am grateful for this opportunity to testify before you on the important subject of global climate change.

The President takes the issue of global climate change very seriously, and so do I. In a series of clear and public statements, the President has described climate change as a complex, long-term challenge that requires an effective and science-based response. The President has acknowledged the responsibility of the United States to lead in dealing with this challenge.

On June 11 of last year, President Bush said that "the issue of climate change respects no border. Its effects cannot be reined in by an army or advanced by any ideology. Climate change, with its potential to impact every corner of the world, is an issue that must be addressed by the world."

In a subsequent speech on February 14 the President reaffirmed America's commitment to the United Nations Framework Convention and its central goal, to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate. At the same time, the President noted that given current scientific uncertainties, no one knows what that level is. This clear statement challenges the scientific community to improve our understanding of this and other important uncertainties that remain, including the effect of natural variations in climate on warming, the actual degree and rate of warming, and how some of our actions could impact it.

To accelerate our understanding of climate change, the President has taken steps to engage the best science and technology on these issues, stating, "The policy challenge is to act in a serious and sensible way, given the limits of our knowledge. While scientific uncertainties remain, we can begin now to address the factors that contribute to climate change."

The climate change at issue is a global phenomenon, and dealing with it requires actions that will affect the economies of nations. The "serious and sensible" approach advocated by the President responds to the breadth of this challenge, and also to the quality of judgment needed to address it. To begin the process within his administration, the President last year requested the National Academy of Sciences to produce a report on the state of climate change science. The 2001 National Academy Report on climate change that subsequently appeared contains a sentence that is often half-quoted, and I would like to read it here in its entirety: "The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability." This is the third sentence in the summary at the very beginning of the report. The entire report, available on the National Academies website, provides valuable insights into the state of climate science, including areas of fundamental uncertainty that require additional investigation. Even a cursory reading of the report indicates that the uncertainties are real and they are significant. Mr. Chairman, I ask that this important report from our National Academies be included as part of the record of this hearing.

I would like to address some concerns that have arisen since the Climate Action Report was released several weeks ago. Some press accounts have said that this report acknowledged a dire, near term threat to the environment from climate change. This is not true. Since much of the discussion of climate change and its impacts centers on the use of computer models that attempt to look into the future, it may be useful to reflect for a moment on these models and how they are employed.

"Climate" is a general term for physical properties of the atmosphere, especially air temperature and pressure, wind, water vapor, and particle content. Air is a substance that obeys laws of motion that can be solved for small volumes using a computer. The same equations are used to estimate, or "forecast," future weather, based on current conditions. With the most powerful computers, we can forecast the weather reliably only a few days ahead, as you know. How then can we hope to predict climatic conditions far into the future? Science has developed approaches to long-term climate modeling that do not attempt to give the fine detail we expect in a weather report.

Long-term climate models are sets of computer programs that attempt to simulate all the processes of nature that affect the atmosphere. The best current models average these properties over an area roughly the size of the State of Connecticut. It is not enough to model just the atmosphere, because climate is affected by the cloud cover, by vast ocean currents, by the polar ice sheets, by the presence of atmospheric chemicals and light absorbing or reflecting particles, and by the interaction of all these with life processes—trees, crops, ocean organisms, and human beings. All these processes need to be understood *quantitatively* before they can be modeled. This is the ongoing challenge of climate change research.

Once the models are constructed—a task that is by no means complete today—they have to be loaded with current conditions before they can be used for prediction. That means the state of the entire earth must be determined at a given instant of time by measurements on land, sea, and air. Satellite imagery is important but not sufficient for this task. Since the output of the models depends on the input, incomplete knowledge of the state of the earth translates to uncertainty in the predictions. And the output is notoriously sensitive to the input. This is why the Intergovernmental Panel on Climate Change concluded in its Third Assessment Report that "Science cannot predict the climate and its impacts in Milwaukee, Mumbai, or Moscow half a century ahead very accurately, and it may never be able to do so."

Today's climate models cannot be used for definite predictions of regional or local conditions. They are typically run many times, for a range of input assumptions, and the results are assessed with statistical methods. Given our present state of knowledge, it is not surprising that the results vary widely, leading to apparently contradictory results.

That is why reports such as the 2002 U.S. Climate Action Report do not claim to make *predictions* about future impacts. That report employs "scenarios" that are invented to capture the range of results of multiple runs of different climate models with different ad hoc input assumptions. The scenarios are then used to make "*projections*," a word that is carefully defined in an important footnote on page 84 of the report: ". . . *prediction* is meant to indicate forecasting of an outcome that will occur as a result of the prevailing situation and recent trends (e.g. tomorrow's weather or next winter's El Niño event), whereas *projection* is used to refer to potential outcomes that would be expected *if* some scenario of future conditions were to come about. . . ." Notice that such projections can give no information about when, or even if, the assumed scenarios occur. I fear that many readers of the Climate Action Report have mistaken its "projections" for forecasts.

The President believes, and I strongly concur, that responsible implementation of public policy on a scale commensurate with global climate change requires the best possible understanding of the phenomena we wish to influence. The uncertainties have to be reduced. That is why the President established a new management structure to advance and coordinate climate change science and technology research. Under this structure, we are accelerating work in areas needed to create better tools to provide science-based policy guidance, and developing a technology base that matches the climate change challenge. To these ends, the President established a Cabinet-level Committee on Climate Change Science and Technology Integration to oversee the entire effort. The Secretary of Commerce and Secretary of Energy are leading the effort, in close coordination with my office, the Office of Science and Technology Policy (OSTP), and this effort incorporates work conducted under the Global Change Research Act of 1990. OSTP will continue to perform important coordinating functions within this new framework. I want to emphasize that the point of the new organization is to take advantage of the global change research that is under way, and focus it on the current urgent need to improve climate change analysis tools.

The President's FY03 budget proposal dedicates $1.7 billion for fundamental scientific research on climate change and $1.2 billion to fund research on advanced technologies including energy production and carbon sequestration technologies relevant to the climate issues. These figures include $80 million in funding dedicated to implementation of the Climate Change Research Initiative (CCRI) and the National Climate Change Technology Initiative (NCCTI) announced last year. My colleagues on this panel will be providing you with more details about these two initiatives.

President Bush is addressing the serious issue of climate change through a focused and vigorously managed program. He is engaging science to increase our understanding, and technology to devise ways of meeting our responsibility to future generations while preserving our quality of life and maintaining the competitiveness of our economy.

Thank you again for the opportunity to speak with you today. I will be glad to respond to specific questions on these important issues.

Senator KERRY. Thank you very much, Dr. Marburger.

Dr. Mahoney.

STATEMENT OF HON. JAMES R. MAHONEY, PH.D., ASSISTANT SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE

Dr. MAHONEY. Thank you, Mr. Chairman, Mr. McCain, and other Members of the Committee.

I'll start by just noting it's 6 months ago since I appeared before you in my confirmation hearing, and I simply thank you for your vote in sending my confirmation to the floor. At least I think I thank you. I'm delighted to be back. It's been a busy time.

I'm appearing specifically in my capacity as the Director of the interagency science activity for the government. There are 12 agencies named at the beginning of my statement, all of the ones you would expect, who are collaborating in the development of this work. In turn, we report to my colleagues at the table here, the Council on Environmental Quality, the Council of Economic Advisors, and the President's Science Advisor, Dr. Marburger.

To start my comments, I'd note first that the status of the entire earth system, with all of its challenges and its concern about global and climate change, is the capstone environmental issue of our generation, and I feel certain it will be the capstone issue of the next generation, as well. I had hoped that, by the generation of our grandchildren, that advances in technology will take this back off the table as such a capstone issue. This sets somewhat of the same view of the long-term nature of the very serious questions and challenges we face.

In the science work, I'd start by noting that comprehensive, objective, transparent, and well-reviewed scientific inquiry must be at the core of the methodologies we use to examine the complex interrelationships between climate parameters and ecosystem parameters. We intend that all of the U.S. Global Change Science Program represent the gold standard of thoughtful, careful, and well-reviewed scientific reporting to the Nation and in contribution to the world community, as well.

During the last 13 years, the United States, as I think we heard a few minutes ago, has made the world's largest scientific investment in the areas of global change and climate change. The amount of that investment is already approximately $20 billion. And very much scientific progress has been made since 1970 when the Global Change Research Act was passed. But substantial uncertainties remain to be addressed.

To cite just one key example, among the community of very well-understood climate models today, the projections of century-long temperature increases expected for the earth's atmosphere range from as small as 1 degree centigrade or Celsius to as much as 4½ degrees centigrade or Celsius out by the year 2100. Obviously that range of uncertainty covers territory from a relatively small to a relatively significant range of impact.

Similarly, the scientific knowledge about the interaction between climate parameters, like carbon dioxide, greenhouse gases, and black carbon aerosol, is a matter of great increasing concern in the scientific community. These arise especially from low-temperature combustion and literally millions of home heating units and small heaters and boilers in small industries and apartment complexes in many parts of the developing world. We're just beginning to get a better handle on much of this.

Our theme is this: Because of the substantial scientific accomplishments already attained in the last decade and longer, we have now finished what we might call a period of discovery and characterization of the problem. We have a problem, and we know that, and we are entering a period of differentiation and strategy evaluation. The issue now is not, "Do we have a problem?" The issue is, "What do we do about the problem?" This puts an even higher demand upon our best thoughts and our best good will about addressing this.

I want to very quickly note the kinds of things we're doing with the science program about this. First of all, there's an organizational matter. You all know that the Global Change Research Program is 12 years old and counting, and the President began last year his Climate Change Research Initiative. I want to be clear that we have integrated the two of these. There are very different goals for the two of these, so, as they meet their goals, they're separate, but the management of this activity, with a very robust collaboration of all 12 federal agencies who play a role, is fully integrated. The agency key representatives and the overall management group for this is exactly the same.

Just to mention on our current products, we will have a new annual report, the next version of "Our Changing Planet" out in September, as scheduled. We are actively developing a new strategic plan that will lay a path forward, both about our inquiry, about which I'll speak in just a moment, as well as our plans to report findings and positions. I will talk about that more in a minute, because that's really at the center of our strategy. We have been and will continue to look to the National Academy of Sciences' National Research Council for a very robust review of all of our activities.

We are proceeding in the science program with a clear understanding of three tiers of inquiry. Those tiers, in a word, and then just a word about them, are, first of all, the continued science inquiry; second, a major increase in focus on global observing systems so that we maximize our development of data based on real observations, not only for climate parameters, but for ecosystem parameters. We look specifically at the evidence for change and try to understand that change in the world's ecosystems as well as in the climate system. Third, and perhaps most importantly, we're moving very aggressively to convert our models and all of our sci-

entific data into a robust set of decision tools. Just as my colleagues have already laid out, what we have to do is begin using our best available information to make the projections for many different kinds of cases and to make the variational analysis so that we can find the optimal path forward. This is why you hear us consistently talk about the concept of taking all the obvious steps first, keep measuring, keep watching, and then build on that going forward.

I'll close by noting the special effort we're putting into the issue of credibility of all of our scientific inquiries and all of this decision tool and strategy analysis reporting going forward. As a first step in this process, we are planning a very significant open public workshop on global climate change and global change to be held here in the Washington area in early December of this year. We will have a specific date very soon.

Let me just mention the formulation of that. We are now very actively developing our updated strategic plan. We will publish this plan and pass forward—in particular, we'll put it on our Web site with a target time of October of this year. It's taking us that long to get through this very complex process. As soon as we have it, it will be on the Web site. We are asking all of the scientific community, all of the stakeholders and our international colleagues as well, to read this information and consider it a strawman path forward about our analyses and our reporting methodologies. Then we will conduct a very robust workshop to have debate about all these matters. More than that, we'll leave the record open after the workshops so that everybody who attends, or even if they don't, can make their full set of comments, which we'll take under consideration before issuing a final plan.

At the same time, we'll be engaging the National Academy of Sciences to watch this whole process of the development of this open approach to our science and reporting and to give us and the Nation their views, not only on the process, but on the plan that emerges from all of that. This is our commitment to having the best possible path forward so that we can put in front of our Nation and our colleagues around the world our very, very best views about the developments that will best serve our analysis on this challenging problem for the years ahead.

Thank you, Mr. Chairman and all, and I'll—of course, will be glad to answer questions.

[The prepared statement of Dr. Mahoney follows:]

PREPARED STATEMENT OF HON. JAMES R. MAHONEY, PH.D., ASSISTANT SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE

Good morning, Senator Kerry, Senator McCain and Members of the Committee. I am James R. Mahoney, Assistant Secretary of Commerce and Deputy Administrator of the National Oceanic and Atmospheric Administration. I am appearing today in my capacity as Director of the Climate Change Science Program of the Interagency Working Group on Climate Change Science and Technology. The Climate Change Science Program integrates the federal research on global change and climate change, as sponsored by twelve federal agencies (NSF, DOC, DOE, EPA, NASA, DOS, DOI, USDA, HHS, DOT, DoD and the Smithsonian Institution) and overseen by the Office of Science and Technology Policy, the Council on Environmental Quality, the National Economic Council and the Office of Management and Budget.

I am very pleased to have this opportunity to present testimony on the Administration's scientific research program on global change and climate change. The sta-

tus of the entire earth system, including the potential impacts of climate and ecosystem variability (regardless of its origin), is a capstone issue for our generation and will continue to be so for our children. The Administration fully embraces the need to provide the best possible scientific basis for understanding the complex interactions that determine the constantly changing nature of our earth's life systems. Moreover, the Administration is committed to making full use of our best scientific information to determine optimal investments and actions on the global, national and regional scales to mitigate adverse anthropogenic changes, and to adapt to unavoidable natural changes.

Comprehensive, objective, transparent and well-reviewed scientific inquiry must be the core methodology used to evaluate the complex relationships between natural and anthropogenic influences on earth systems, and to project the expected outcomes of the many different investment and action strategies that have been proposed to mitigate or adapt to potential changes in global conditions. If we fail to fully evaluate the scientific information bearing on global change, we would be subject to the justifiable criticism that our strategy to cope with potentially our largest-ever investment in environmental management would be seen as a "ready-fire-aim" approach.

During the past 13 years the United States has made the world's largest scientific investment in the areas of climate change and global change research—a total investment of almost $20 billion. The U.S. Global Change Research Program (USGCRP), in collaboration with several other national and international science programs, has documented and characterized several important aspects of the sources, abundances and lifetimes of greenhouse gases; has mounted extensive space-based monitoring systems for global-wide monitoring of climate and ecosystem parameters; has begun to address the complex issues of various aerosol species that may significantly influence climate parameters; has advanced our understanding of the global water and carbon cycles (but with major remaining uncertainties); and has developed several approaches to computer modeling of the global climate.

Much scientific progress has been made since 1990, but substantial uncertainties remain to be addressed. For example, various global climate models project significantly different temperature profiles: from approximately 1 degree Celsius by the year 2100, to more than 4 degrees Celsius during the same period. Resolving this scientific uncertainty in global climate models will have a major impact on determining optimal types, amounts and schedules of greenhouse gas emission management; will help resolve key questions of the relative importance of the management of greenhouse gases, carbon-based aerosols and sulfate-based aerosols on long-term climate parameters; and will be essential to understanding the scope of any climate change impact on global ecosystems.

Scientific knowledge of the interactions between climate variability and global ecosystems has improved during recent years. However, understanding of specific cause-effect relationships, and prioritization of the most important relationships, is just beginning to emerge. Information about both "forcing" and "feedback" relationships in ocean-atmosphere-ecosystems interactions is urgently needed to understand the fundamental mechanisms, and to prioritize the important effects to be addressed. The climate-ecosystems questions require continued scientific inquiry on both global and regional scales.

Because of the scientific accomplishments achieved by USGCRP and other research programs during a productive *"period of discovery and characterization"* since 1990, we are now ready to move into a new *"period of differentiation and strategy investigation"*, which is the theme of the President's Climate Change Research Initiative (CCRI). In announcing the CCRI, the President directed us to reestablish priorities for climate change research, including a focus on identifying the scientific information that can be developed within 2 to 5 years to assist the nation's evaluation of optimal strategies to address global change risks. The President also called for improved coordination among federal agencies, to assure that research results are made available to all stakeholders, from national policy leaders to local resource managers.

We are energetically responding to the direction of the President, and the following comments summarize the actions taken by the Interagency Task Force to develop the most useful information to address climate and global change issues.

1. CONSOLIDATING MANAGEMENT OF THE USGCRP AND CCRI ACTIVITIES

The President's direction for CCRI, focusing on the development of near-term decision support information, requires close integration with the many existing programs managed under the U.S. Global Change Research Program. This will ensure

internal consistency of the CCRI research with the full body of global change information developed under the USGCRP.

To accomplish this integration of USGCRP and CCRI activities, the Interagency Climate Change Science Program has assumed oversight of both programs, with a single interagency committee responsible for the entire range of science projects sponsored by both programs. The Interagency Climate Change Science Program retains the responsibility for compliance with the requirements of the Global Change Research Act (GCRA) of 1990, including its provisions for annual reporting of findings and short-term plans, scientific reviews by the National Academy of Sciences/National Research Council, and periodic publication of a 10-year strategic plan for the program. Plans for these activities include:

• **Annual Report:** *Our Changing Planet* for FY03 is currently undergoing agency review, and it will be published in September 2002. The *Our Changing Planet* series will be continued in future years, with increasing emphasis on detailed analyses of proposed mitigation strategies and other national "decision support tool" information.

• **Strategic Plan:** The 1990 GCRA stipulates that an updated 10-year "National Global Change Research Plan" be prepared for USGCRP every 3 years. In fact, no such 10-year plan responding to this requirement has been published since the original plan resulting from the 1990 Act was adopted. A fully updated strategic plan for the combined USGCRP and CCRI activities is currently being developed by the interagency group, based on the following information resources: the draft 10-year USGCRP strategic plan prepared prior to the President's CCRI initiative, the August 2001 CCRI summary of research options, the interagency review draft of *Our Changing Planet* for FY03, a comprehensive interagency inventory of climate and global change research programs completed during the past 2 months, and an updated statement of interagency research goals and priorities currently in final review. The updated draft plan will be posted on the USGCRP/CCRI web site by November 1, 2002, to be available for comprehensive review by the scientific community, interested stakeholders, the general public and interested international specialists at a public USGCRP/CCRI workshop planned for the Washington, DC area in early December 2002. (This workshop is further discussed below.) A final version of the plan, taking account of workshop and Academy review comments, will be published in March 2003.

• **Academy Review:** We will be requesting a full NAS/NRC review of the combined USGCRP/CCRI planning process and products. The National Academy will be asked to review the interagency draft plan available by November 1, 2002, the public review workshop process, and the post-workshop final strategic plan to be published in March 2003.

2. IMPLEMENTING A NEW RESEARCH STRATEGY: A THREE-TIER SCOPE OF INQUIRY

Consistent with the move from the *"period of discovery and characterization"* to the "*period of differentiation and strategy evaluation*", future plans for the combined USGCRP/CCRI program are being focused on 3 broad tiers of activities: (1) *scientific inquiry*, which has been the core activity over the years, with several key issues continuing to await resolution, (2) *observations and monitoring systems*, which have always been part of the program, but which have not been sufficiently integrated or focused to support strategy analyses, and (3) development of *decision support tools*, including detailed analyses of projected environmental, economic and energy system outcomes of various proposed scenarios. The CCRI initiative will supplement the ongoing USGCRP work by providing targeted focus to elements of each of the 3 tiers, where significant 2 to 5 year improvements in decision-relevant information is possible.

The 3 tiers of inquiry are intended to focus the necessary resources on the key categories of information needed to underpin national decision-making on global change response strategy.

• **Continued Science Inquiry:** Much has been learned about greenhouse gas emissions, abundance in the atmosphere, radiative properties, reaction rates and removal rates; and global climate models have developed to the point of moderate utility as analysis tools for application on a global scale and over long time averaged conditions. However, significant uncertainties remain regarding several issues that are critically important for defining optimal strategies for the management of global change. Among several key uncertainties, the following are illustrative of the continuing need for improved scientific understanding:

- The significant differences in long-term global average temperature changes projected by various well-recognized climate models.

- The relative importance of (1) carbon-based (black carbon) aerosols, (2) sulfate-based aerosols and (3) CO_2 and other greenhouse gases in influencing climate change—each related to differing control strategies.
- The uncertainties in understanding the dynamics of marine ecosystems in the carbon cycle. Typical ocean uptake of CO_2 by biological productivity is many times larger than total global fossil fuel CO_2 emissions. Enhancement of this biological productivity could affect future atmospheric CO_2 levels.
- Major uncertainties in climate-ecosystems interactions, and land use/land cover influences on climate.
- Uncertainties in understanding global water cycles, including the current inability of general circulation models to successfully represent water vapor transport in the equatorial regions.
- The poor regional performance of current general circulation models, which severely restricts the examination of potential global change influences on key regional ecosystems such as bays, estuaries, and inland watersheds.

• **Increased Emphasis on Measurements and Monitoring Systems for Climate and Ecosystem Information:** Observations and monitoring systems have been major elements of the USGCRP-sponsored scientific studies throughout the past 13 years. Because additional space-based and *in situ* data are needed to improve our scientific analyses and computer models, and because stable, long-term measurement records are essential to interpret earth system variability and trend data, there is a critical need for a well-designed, comprehensive climate and ecosystem monitoring system. A comprehensive monitoring system will necessarily be global in scope, and the United States should continue to make leadership contributions to the global system design and implementation. The United States is already contributing to the development and operation of several global observing systems, including support for a wide array of NASA and NOAA satellites, the ARGO floats being deployed in the world's oceans, the Global Climate Observing System (GCOS) sponsored by the World Meteorological Organization, and the Global Ocean Observing System (GOOS) sponsored by the Intergovernmental Oceanographic Commission. Within the next few years data from these systems will provide substantially improved information for calibrating global atmospheric and oceanic circulation models and for understanding the mechanisms that contribute to climate and ecosystem variability.

The combined USGCRP and CCRI program will place major emphasis on requirements-driven specification of comprehensive monitoring systems that incorporate the following attributes:

- Development of "climate quality" data, with stable measurement methods, consistent exposures, good intercomparison between data sets, and back- and forward-standardization of long-term data records.
- Provisions for high quality data assimilation methods, combined with efficient archiving and retrieval methods, to facilitate research, analysis and forecasting applications.
- Creative capture of the relevant information from the myriad of special research projects conducted throughout the world during recent decades, to optimize the information available for scientific analysis and computer model evaluations of global change and climate change.
- Special emphasis on the complex observations and monitoring systems needed to analyze terrestrial and aquatic ecosystem variability.

• **Substantially Increased Focus on the Development of Decision Support Tools:** The potential economic and energy security impacts of several commonly suggested global change and climate change mitigation strategies are very large—substantially larger than all other environmental controls imposed during the past 30 years for some suggested strategies. In view of the potentially high costs and energy security impacts, careful evaluation of the projected outcomes of a wide array of suggested mitigation strategies should be undertaken. Note that the scientific analysis should not be aimed at recommending specific strategies. The scientific analysis should address *"if . . ., then . . ."* questions, and should focus on *comparisons* between suggested mitigation strategies.

The *highest and best use* of the scientific information developed in the combined USGCRP and CCRI programs should be the development of *comparative information* that will assist decision makers, stakeholders and the general public in debating and selecting optimal strategies for mitigating global change, while maintaining sound economic and energy security conditions in the United States and throughout the world. Significant progress in developing and applying science-based decision tools during the next 1 to 3 years is a key goal of the combined USGCRP and CCRI

program. Examples of analyses expected to be completed during this time period include:

- Long-term global climate model projections (*e.g.,* up to the year 2100) for a wide selection of potential mitigation strategies, to evaluate the expected range of outcomes for the different strategies.
- Detailed analysis of variations from defined "base" strategies, to investigate the importance of specific factors, and to search for strategies with optimum effectiveness.
- Linked climate change and ecosystem change analyses for several suggested strategies, to search for optimum benefits.
- Detailed analyses of the outcomes that would be expected from application of the wide selection of energy conservation technologies, and carbon sequestration strategies, currently being investigated by the National Climate Change Technology Initiative.

3. MAINTAINING A CULTURE OF OPEN, TRANSPARENT, WELL-REVIEWED SCIENTIFIC INQUIRY

The United States global change and climate change research programs must consistently meet the highest standards of credibility, transparency and responsiveness to the scientific community, all interested constituencies, and our international partners. To assure credibility, the scientific inquiries must be policy-neutral, and must focus on *"if . . ., then . . ."* questions. Appropriate products of the scientific inquiries include:

- The best scientific descriptions of current climate and ecosystems status, with particular emphasis on the factors that can impact (positively or negatively) the current conditions.
- Prioritization of the importance of the various factors that can change current climate and ecosystems conditions.
- Trend information (based on careful evaluation of measurement records, supplemented by reference to scientific and computer model analysis) that helps identify significant patterns of variability, and that suggests the high priority concerns regarding future changes in climate and ecosystems conditions.
- Descriptions of cause-effect relationships between key climate and ecosystem parameters. These descriptions should typically include both one-by-one cause-effect descriptions relative to individual key factors, and multiple-relationship descriptions involving the combined influence of several key factors acting jointly.
- Global climate models, ocean circulation models and other integrated computer models that integrate our scientific information about climate change and ecosystem impacts, and that project future conditions expected to result from various strategies.
- Scientific evaluation of technology initiatives that translate the effects of proposed mitigation technologies into scientific parameters suitable for scenario analyses.
- Cost, economic and energy supply analyses related to various suggested scenarios that allow projections of the outcomes expected to result from the scenarios.
- Comparisons between a wide selection of suggested scenarios, that facilitate our search for the most effective and efficient approaches to mitigate the effects of both natural and anthropogenic caused climate change.
- Careful statements of the scientific uncertainties relative to each of the matters described above. Note that appropriate uncertainty statements should always be part of scientific descriptions.

To facilitate the development of scientific credibility in the conduct of the combined USGCRP and CCRI program, the following steps are being taken:

- All upcoming program plan and result information will be published for open review as soon as practical in each case.
- The planned December 2002 workshop will "jump start" a comprehensive review of the updated plans for the combined USGCRP and CCRI program.
- Ongoing reviews of the combined USGCRP/CCRI program will be sought from the National Academy of Sciences/National Research Council. Specifically, the Academy will be asked to review both the process and the substance of the updated program planning (including the public workshop) to be completed during upcoming months.
- The USGCRP/CCRI program management is regularly involved in ongoing discussions with a wide array of members of the national and international scientific community. The program encourages comments and critiques from

all sources and welcomes in-person discussions, subject only to the practical limitations of staff time.

- The USGCRP/CCRI program management also welcomes communication and meetings (time permitting) with interested stakeholders and advocates for specific positions. The management has a clear guideline of strict neutrality in these communications, and a guideline of equal access for representatives of all positions.
- The program management will provide all plans and reports to interested Members of Congress and their staff, as soon as such information is available. Program representatives are available to meet with Members and staff upon request.

4. PROGRAM STATUS AND PLANS

The following comments summarize elements of the current status and near-term action plans for the combined USGCRP/CCRI program, for the interest of the Committee.

- **Ongoing USGCRP Project Work:** Current USGCRP projects (*i.e.*, as funded in the FY02 budget) are underway according to the plans of the individual sponsoring agencies. The USGCRP coordinating office staff continues to collect interagency project information for integrated reporting. The USGCRP coordinating office staff will be augmented with additional specialists to address the focused questions raised by the President as part of the CCRI initiative. The combined USGCRP/CCRI coordinating office staff will move to 1717 Pennsylvania Avenue, NW in Washington as of October 1, 2002, when the lease on the current coordinating office space expires.
- **The August 2001 CCRI Document:** A climate research planning group hosted by the Commerce Department prepared a working plan document (*i.e.,* not a final reviewed strategic plan) in August 2001, discussing options for additional, focused research aimed at improving short-term decision making related to climate change, as part of the Climate Change Research Initiative. This draft document was provided to the House Science Committee at their request, and is available to the public. This document is one of several resources being used to develop the new strategic plan for the combined USGCRP/CCRI program.
- **The 10-Year National Global Change Research Plan for USGCRP:** A draft 10-year strategic plan was prepared in 2001, prior to the announcement of the President's Climate Change Research Initiative. The draft strategic plan is being updated to incorporate consideration of the CCRI activities. A revised draft strategic plan will be placed on the USGCRP/CCRI web site by November 1, 2002, in preparation for the December 2002 climate science planning workshop. The final version of the plan will be published in March 2003.
- **FY04 Budget Planning:** The interagency Climate Science Program working group is actively engaged in the development of FY04 agency budget requests that reflect the themes of the President's Climate Change Research Initiative: focused efforts to reduce scientific uncertainties on key issues; improved specification, development and operation of various climate and ecosystem monitoring systems; and increased emphasis on the development and testing of decision support tools to facilitate public debate on climate change issues.
- **December 2002 Workshop on USGCRP/CCRI Plans:** This workshop is being planned for the Washington, DC area, to provide a mechanism for broad scientific community and stakeholder community comment on the program plans and the expected reporting schedule for the USGCRP/CCRI activities. The workshop will address:
  - The focus on key unresolved scientific issues,
  - The plans for a comprehensive approach to climate and ecosystem observations and monitoring systems,
  - The plans to develop and demonstrate decision support tools to facilitate public and stakeholder debate about global change and climate change issues,
  - The plans and schedules for future USGCRP/CCRI reports on specific findings, monitoring system designs and scenario analyses.

Thank you, Mr. Chairman and Members of the Committee. I look forward to the opportunity to respond to any questions you may have.

Senator KERRY. Thank you very much, Dr. Mahoney. Thank you all for your testimonies.

Senator McCain apologizes that he had to leave, and his questions will be made part of the record, and we will submit them.

I must say, I'm sitting here a little bit overwhelmed by the barrage of pronouncements of how well we're doing. It's hard to begin to figure out quite where to start, though I think I have a good sense of it.

I must say that—Dr. Hubbard, to hear the enthusiasm of your embracing of the amount of money that's being spent really surprises me, given the fact that, as a Member of the Finance Committee, I remember how hard we fought your Administration to put in the balance for which you're now claiming credit with respect to the tax incentives and technology initiatives. Most of the money you refer to, I might add, is in the tax incentive structure, though some of it is in direct spending. I'm not fighting it. I just want to say that the real issue here, despite all the words that we've just heard, is the question of reductions—of whether or not we're going to get reductions and of what the best methodology is to try to achieve that.

Let me begin, if I may, by trying to sort of clarify the climate report that was issued in May. Can you tell me, Dr. Hubbard, who was responsible for that? Did you or other CEQ personnel write and edit the report?

Dr. HUBBARD. I mean, do you want to speak to the process? I mean, certainly the document was widely circulated within the Administration and figured as part of our climate change process.

Senator KERRY. OK. So it was approved by you and others for the Administration?

Dr. HUBBARD. That's correct.

Senator KERRY. OK. Why did the President try to dismiss it and say it was put out by the bureaucracy and third-level personnel? Do you consider yourself a third-level person?

Mr. CONNAUGHTON. Actually, the CEQ is coordinating this process, Senator, so perhaps I could speak to that. The Climate Action——

Senator KERRY. But I assume, if he's not a third-level person, he can speak for himself.

Mr. CONNAUGHTON. Well, actually, Senator, I don't think the President ever uttered the words "third-level person." The fact of the matter is the report was prepared by the bureaucracy. This was a very intensive interagency effort involving—going well beyond even the 12 agencies that Dr. Mahoney has talked about—as well as going through two rounds of public comment on which substantial public comment was received. So it was, in fact, a widespread——

Senator KERRY. Well, he distanced——

Mr. CONNAUGHTON.—governmental effort——

Senator KERRY.—he distanced himself from the report. He didn't embrace it and say, "This is a valued report which we have to respond to."

Mr. CONNAUGHTON. Well, actually, the characterization of "dismissive" was actually the characterization by a reporter. What the President was describing was the fact that there was not a story to be had in terms of the foundation that the information in this report provided for the Administration. This really underpins the strategy that we're considering.

Senator KERRY. Well, I'm delighted to hear he embraces it fully, because let me share it with you a little bit. The Bush Administration, therefore, agrees, according to your own report, that greenhouse gases are accumulating in the earth's atmosphere as a result of human activities causing global mean surface air temperature and subsurface ocean temperature to rise. You have warned us—you have warned the Nation and the world, in submitting it to the United Nations, of grave consequences likely to occur as a result of climate change in the United States. In the report, you list the following that you believe are likely to occur as a result of climate change.

"Coastal communities will be at greater risk of storm surges, especially in the Southeastern United States." That's page 82.

"The continuing growth in greenhouse gas emissions is likely to lead to an annual average warming over the United States that could be as much as 3 to 9 degrees Farenheit during the 21st century." That's page 84.

"Climate change and the resulting rise in sea level are likely to exacerbate threats to buildings, roads, power lines, and other infrastructure in climate-sensitive areas. For example, infrastructure damage is expected to result from permafrost melting in Alaska and from sea-level rise and storm surges in low-lying coastal areas." Page 89.

"Habitats of alpine and subalpine spruce fur in the contiguous United States are likely to be reduced and possibly, in the long term, eliminated as their mountain habitats warm. The extent of aspen, eastern birch, and sugar maple are likely to contract dramatically in the United States." Page 98.

"Hurricanes that do develop are likely to have higher wind speeds and produce more rainfall." Page 101.

"Warming is likely to alter coastal weather and could affect the intensity, frequency, and extent of severe storms. Melting of glaciers and ice sheets and thermal expansion of ocean waters will cause sea levels to rise, which is likely to intensify erosion and endanger coastal structures." Page 103.

"Even a small rise in sea level can produce a large inland shift of the shoreline. The rise will be particularly important if the frequency or intensity of storm surges or hurricanes increases." Page 103.

"Coastal erosion increases the threats to coastal development, transportation infrastructure, tourism, freshwater aquifers, fisheries, many of which are already stressed by human activities"—those are your words—"and coastal ecosystems. Coastal cities and towns, especially those in storm-prone regions such as the Southeast, are particularly vulnerable." Page 103.

"The projected increase in the current rate of sea-level rise is very likely to exacerbate the nationwide rate of loss of existing coastal wetlands." Page 104.

"Increases in the frequency of heat waves are very likely." Page 82.

"Drying is likely to create a greater susceptibility to fire," Senator Allen, "and then loss of the vegetation that helps to control erosion and sediment flows." Page 100.

"Changes in the frequency and intensity of flood, drought, or fire events," page 102.

"Increases in heavy precipitation events are likely to flush more contaminants and sediments into lakes and rivers, degrading water quality." Page 100.

"The resulting changes in the amount and timing or runoff are very likely to have significant implications for some basins of water management, flood protection, power production, water quality, the availability of water resources," and so forth. This goes on. I have a whole other two pages of your dire warnings to this country about the implications of increased global warning. Yet you have a policy that has no reduction of emissions guarantee at all. Purely voluntary? Can you tell us why?

Dr. MARBURGER. I'll start, and my colleagues will add, as necessary, in those areas that I'm not——

Senator KERRY. Well, first of all——

Dr. MARBURGER. Yes?

Senator KERRY.—do you accept the findings of the report that you've issued?*ST

Dr. MARBURGER. The——

Senator KERRY. Are all of these real warnings to Americans that you have issued?

Dr. MARBURGER. Let me characterize——

Senator KERRY. Answer that question. Are they real warnings to Americans that you have issued?

Dr. MARBURGER. No, I don't accept them in those terms.

Senator KERRY. Well, you just said you signed off on the report.

Dr. MARBURGER. That's correct. But one of the points of my testimony was to make it——

Senator KERRY. No, I want to ask you how you sign off on a report, and now you reject the report?

Dr. MARBURGER. OK. I'm not rejecting the report.

Senator KERRY. You just did.

Dr. MARBURGER. No, I'm only rejecting your characterizations of the statement——

Senator KERRY. Well, these are your words, not my words. I'm reading your words. You say these are the things likely to happen as a consequence of global warming.

Dr. MARBURGER. Let me say a few words about the nature of these statements in the report. These are all from the chapter footnoted by the statement that I read in my testimony, on Page 84. These are projections based on scenarios that are what-if scenarios. They're consequences of warming events that may or may not occur on a regional basis. They are consequences that have been known for some time, were quite well known to the President when he made his June 11th statement last year. The seriousness of these consequences is precisely why the President takes global warming seriously and why we're here today to work out the best possible approach to dealing with the issues as they now exist.

All of the statements in the chapter that you're referring to of the CAR report are projections based on scenarios that are not derived from climate models, but from a whole range of possible results that may occur. They are not predictions. They are not——

Senator KERRY. The word you use is "likely," not "may."

Dr. MARBURGER. The word that is used in the report is "likely" based on——

Senator KERRY. I quote "likely."

Dr. MARBURGER.—based on what-if scenarios.

Senator KERRY. But the what-if scenarios—these are based on——

Dr. MARBURGER.—the report makes it very clear——

Senator KERRY.—these are based on modeling. This is what most of the models suggest. Let me ask you whether or not you embrace the language that was signed into law by the U.S. Congress and by the President of the United States, George Bush, 41, in 1992. I attended that conference. I know how hard-fought it was and how serious the concern was. In 1992, we signed and ratified the framework, which states, as a goal, "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change." Do you support that commitment of the United States?

Dr. MARBURGER. Yes, I do.

Senator KERRY. Do all of you support that commitment of the United States?

Dr. HUBBARD. Absolutely. The framework convention is perfectly underlying the President's policy.

Senator KERRY. If we continue on our current path, with emissions rising every year, we don't achieve that goal.

Dr. HUBBARD. But, Senator, that's not, of course, what the President is proposing. One, we don't know what the appropriate level is. As the science informs that, the President plans to first slow, then stop and reverse as we know more about the science and about the benefits and the costs of any mitigating actions. So I don't see any inconsistency there.

Senator KERRY. There is an inconsistency, Dr. Hubbard, because the President doesn't reduce the level of emissions to the level set in the framework convention. The goal is not met. Emissions will increase each year under your program. You may slow the rate, but you don't reduce emissions.

Dr. HUBBARD. You're talking about the first phase of the program. Remember, we mentioned 3 things. One was slowing in the first phase as we improve intensity, as we learn more about the science and the costs and benefits of mitigation, then stopping and eventually reversing. You're right, of course, to get to stabilizing concentrations—that, we must do. But we have 2 fundamental uncertainties—uncertainty about the level toward which we're reverting and over what the right pace is at which to revert.

Senator KERRY. Well, again, according to—there's a chart here. I could show you. Where is the chart on the intensity levels?

I've gone over my time, but I want to come back to this. Maybe I should do that. In fairness to my colleagues, why don't I do that.

But I will show you how the measurement of intensity, in fact, allows the emissions to grow in complete violation of what we set out in the framework, in complete violation of what other nations are adopting under Kyoto, and contrary to all of the best science of what we have to do in order to respond to this problem. So I will

come back to that and talk to you about this new intensity measurement.

Senator Boxer is next.

Senator BOXER. Thank you very much, Mr. Chairman, and also for your line of questioning.

Mr. Connaughton—did I say that right?

Mr. CONNAUGHTON. Yes, thank you.

Senator BOXER. You're welcome.

Mr. CONNAUGHTON. It's rare.

Senator BOXER. You're the Chairman of the Council on Environmental Quality.

Mr. CONNAUGHTON. Right.

Senator BOXER. I am interested in who was consulted in the drafting of the President's Climate Change Initiative.

Mr. CONNAUGHTON. The number of people is quite vast, actually, and it starts at the top with the President and his Cabinet-level review process, which went on during—from the start of the Administration all the way through the February 14th announcement and carries on to this day. That involved 8 Cabinet Members, the President's senior staff, being briefed by a range of scientists, of economists, some NGO representatives, and then, beyond that, every Cabinet officer involved in that process——

Senator BOXER. Were there any industry groups——

Mr. CONNAUGHTON.—every——

Senator BOXER.—were there any industry groups that came in to give their point of view on this?

Mr. CONNAUGHTON. Well, this is the next part of what I was about to say. Virtually every Cabinet officer, and then as well as myself, Glenn Hubbard, and others involved in that process, had countless conversations with representatives of NGO groups——

Senator BOXER. For example——

Mr. CONNAUGHTON.—of industry participants, with academics——

Senator BOXER.—give me an example of an NGO group.

Mr. CONNAUGHTON. I sat down with the Natural Resources Defense Council, would be one.

Senator BOXER. OK.

Mr. CONNAUGHTON. I've talked with Eileen Claussen at the Pew Center a number of times.

Senator BOXER. Uh-huh.

Mr. CONNAUGHTON. Fred Krupp, of Environmental Defense, the World Wildlife Fund, various groups both came in to sit down, as well as provided significant written letters, the kinds of studies that you even referred to today.

Senator BOXER. Uh-huh.

Mr. CONNAUGHTON. The record of activity—and I want to make clear, too, that each of the Cabinet officers, then, had a variety of different conversations, certainly, over at NOAA. Secretary Evans, Deputy Secretary——

Senator BOXER. So let me just cut to the reason I'm asking. As you know, we have a lot of problems finding out who Vice President Cheney met with before the energy policy came forward. So you would provide us with a list of those that you met with to develop this.

Mr. CONNAUGHTON. You're looking for a list of the people that I met with to discuss climate change?

Senator BOXER. The Council for Environment Quality.

Mr. CONNAUGHTON. Yes, I can provide you that information.

Senator BOXER. Yes, that would be very helpful.

Mr. CONNAUGHTON. But I do want you to know, Senator, that my conversations were a mere fraction of the level of discourse that's occurred across the Administration, with a wide range of actors, and particularly in the science and economics——

Senator BOXER. OK, well, we may ask that of others, but I would appreciate knowing who you, personally, met with from outside the government.

Now, who came up with this intensity idea?

Mr. CONNAUGHTON. Well, actually, the—I'll speak at the high level, then I'll turn it over to Glenn. The intensity idea was actually—when folks were looking—many years ago, before Kyoto—looking at various ways of—how can we articulate a goal to which people can respond? I think the intensity idea actually had its genesis long ago. It was brought to the fore in our policy dialog as we were trying to capture a goal around which both our domestic actors, but also our international partners could actually orient their policies and actually create the kind of metric for success that isn't tied to this dimension that Dr. Hubbard described of, you know, taking credit for economies that are going bankrupt.

Senator BOXER. Well, who came up with this intensity idea? Do you recall who it was who used the word and—it seems to be now the central—centerpiece of this Administration's global warming policy, "intensity." Let me tell you that I think it's a smokescreen for doing very little. I think it takes us off the mark.

Let me explain why I say that. Let's say there's a 400-pound man, clearly not well, needs help, goes to the doctor, and the doctors says, "Mr. Smith, you need to lose 200 pounds. You need to get down to 200 pounds to be healthy." Everyone agrees that that's the level. That's what he needs to do to be healthy. Now he goes up to 500 pounds. It's going to take greater intensity for him to get to his desired weight. But they can't say now, "Go to 300 pounds." Because 200 pounds is where he needs to go, even if he goes up to 500 pounds or 600 pounds.

So it seems to me that what you're losing here is the fact that there is a point we have to reach here to be healthy as a planet. The more we wait, by the way, the worse off we are, the harder it is, and it still doesn't change the fact, whatever the economic growth, of what we have to do.

So I would say that this report that came out today is—by the World—National Wildlife—is absolutely on target. This is a mess, and we're going to explode it. It's baloney. It's way out of this to talk about intensity, because if we're going to stay healthy, we have to preserve this planet, as our friend said, who got an unbelievable chance to see what our challenge is. So——

Mr. CONNAUGHTON. But, Senator——

Senator BOXER.—you're saying this idea of intensity didn't come up—it's just something that's developed over the years, but you grabbed onto it about when?

Mr. CONNAUGHTON. Well, we actually grabbed onto it during the course of our Cabinet-level review process. Dr. Lindsey had spoken of it, Dr. Hubbard has spoken of it in the past——

Senator BOXER. Uh-huh.

Mr. CONNAUGHTON.—it had shown up in various Senator formulations most recently.

Senator BOXER. It didn't show up in the report, though.

Mr. CONNAUGHTON. I'm sorry?

Senator BOXER. It didn't show up in the report that Senator Kerry talks about, did it?

Mr. CONNAUGHTON. Oh, it's described in great detail in the Administration's Climate Action Report. But, Senator, in particular, I would hope to diminish the suspicion or your frustration with the concept, because it has two very important components to it that actually are going to create an environment in which we can have a meaningful dialog, not just nationally, but internationally. The intensity metric really comes down to efficiency, which we all support and we're pushing for, and productivity. The goal is to create the quality of life that we ought to enjoy, and do it with fewer emissions. That's what the intensity metric represents.

And what it enables us to do, however, you know, unlike the situation in Russia, where their economy just cratered—but arguably you could say let's take credit for all the greenhouse gas emissions avoided from the bank——

Senator BOXER. Wait a minute.

Mr. CONNAUGHTON.—from the cratering of the Russian economy.

Senator BOXER. The Russian economy cratered because they're doing so much about global warming?

Mr. CONNAUGHTON. No, I'm saying—when you say Russia now has credits for their greenhouse gas emissions, it's because they had a 1990 baseline that preceded the collapse of their economy. Now, we shouldn't be taking credit—we shouldn't be looking at policies that are promoting economic stagnation as a way to reduce our greenhouse gas emissions.

Senator BOXER. Who has suggested that?

Mr. CONNAUGHTON. That is the suggestion of just——

Senator BOXER.—has suggested that?

Mr. CONNAUGHTON.—of just looking at absolute——

Senator BOXER. What a strong man that is. Listen, I want to talk to you about something. When I was a county supervisor, I had a great job. I went into the Air Pollution Control District. The first thing you heard when you got there is, "Oh, my lord"—and this was a very long time—you were really young then—and they said, "Oh, we can't do anything. We can't use best-available technology, because that will ruin our economy. We can't get better fuel economy"—those days it was, like, at 12 miles per gallon—"it will ruin us."

I have to tell you, sir, it doesn't happen. The fact is, when you do the right thing by the environment, you create so many jobs. We have proof of it. I can send you the proof of it. We've seen it in California as we are on the cutting edge of environmental protection. We are creating industries where we export.

Have you ever driven a hybrid car?

Mr. CONNAUGHTON. Yes, I have.

Senator BOXER. Isn't it an experience?

Mr. CONNAUGHTON. Yeah, it's great.

Senator BOXER. You know what? You can get 52 miles per gallon right now as we sit here. You know what that——

Mr. CONNAUGHTON. It is very encouraging that many of the manufacturers are now coming out with those. It's a very great development. Through our tax incentive package, we're actually—we seek to promote that and create——

Senator BOXER. Well, you wouldn't——

Mr. CONNAUGHTON.—much more purchase of those kinds of vehicles.

Senator BOXER.—you wouldn't know it from your energy plan, but good.

Mr. CONNAUGHTON. Well, it's in the energy——

Senator BOXER. The bottom——

Mr. CONNAUGHTON.—plan, Senator.

Senator BOXER. Well, may I just say, if you look at this energy plan the President sent over, it's real light. It's real light on new ways to save energy. So I have to say I'm glad you're enthusiastic. The point if you were that enthusiastic, you wouldn't sit here and say it's going to be economic stagnation. Because I can get to work just as easily in my hybrid car and save money and have more money to spend somewhere else instead of to the oil companies.

One last question. I don't mean to be difficult. It's just that I disagree with you, so that's where we are. It's one of those things. What did you do before you got this appointment? Because I don't have your bio in front of me.

Mr. CONNAUGHTON. I negotiated international environmental standards on environmental management practices on environmental——

Senator BOXER. Who did——

Mr. CONNAUGHTON.—life-cycle assessment.

Senator BOXER.—you represent?

Mr. CONNAUGHTON. I represented a coalition of businesses and trade associations and other groups in an international consensus process, which is actually quite dynamic and created products that are now being used around the world. It was a consensus process that involved NGO's——

Senator BOXER. Good.

Mr. CONNAUGHTON.—academics, governments—it was really quite something. Then I spent 5 years, immediately before taking this job——

Senator BOXER. What was the name of the group you represented?

Mr. CONNAUGHTON. Well, the process was called the U.S. Technical Advisory——

Senator BOXER. No, the group you represented.

Mr. CONNAUGHTON. There was no name of the group. It was a——

Senator BOXER. OK.

Mr. CONNAUGHTON.—it was an ad hoc group of private-sector entities.

Senator BOXER. OK, well, I'd like——

Mr. CONNAUGHTON. But I——

Senator BOXER.—to see that.

Mr. CONNAUGHTON.—I would note——

Senator BOXER. And I——

Mr. CONNAUGHTON.—I would note, though——

Senator BOXER. And I want to ask you one more question.

Senator KERRY. Barbara, let him answer.

Senator BOXER. Go ahead.

Mr. CONNAUGHTON. You asked my background. I actually spent 5 years before coming to this job working with private firms doing environmental management systems, and I would note that, as a result—the reason I'm so optimistic, you know, in each of those exercises—I worked with 50 to 70 different firms around the United States, Latin America, and Asia—they're all looking at efficiency and at productivity as the way to, one, save money, but also it's limiting their emissions, and it's going to have substantial greenhouse benefits.

There's a tide going on out there in the private-sector community. As long as you can orient it around efficiency and productivity, because that's what their business people care about, that's what they respond to, that's what they set goals to. That's why this metric is so meaningful, because it's actually the way we do business, and it's what our economics policy——

Senator BOXER. I would say even further——

Mr. CONNAUGHTON.—support.

Senator BOXER.—because I have a meeting at just 11:30 with Dupont, who's doing a lot of that——

Mr. CONNAUGHTON. Yeah, it's great.

Senator BOXER.—and doing it wonderfully. I would say if we set some—something in law, it would be a greater incentive. One of the problems you have—there's a lot of businesses who want to do more, and there's no law, and they're wondering, "Why am I doing all this when my competitor isn't?" So I would say, you know, we need to tap into that with some laws here that would make it work.

I know my time is up. I want to ask you one more question. Your chief of staff, is from the Petroleum Institute. Is that correct?

Mr. CONNAUGHTON. He came from the American Petroleum Institute, yes.

Senator BOXER. OK. Well, let me just say to you, I hope, after this hearing—and who knows what you think about this hearing, but I just want to say this—that you will understand why we're frustrated. There's a report that comes out, goes to the United Nations, which basically spells out what could happen if we don't act. Then we see this Administration opposing the Jeffords bill—we get it out by a hair—opposing reductions of CO_2 for utilities, not doing very much on the energy bill, despite what you say about a couple of credits—that's great, but—not doing enough on fuel efficiency—you can talk to, you know, our Chair today about his frustration on that front—not backing that, and sitting here today saying, yeah, this is a problem, using this idea of intensity, which we're really being told here the President's plan would allow more global warming pollution at a faster rate than if we simply continue the pollution trend of the past 5 years. These people have science in this report.

So it is exceedingly frustrating, and I hope you can talk to the President and let him know that particularly in this day where corporations don't seem to be reaching for the highest and the best for society, that perhaps they can take another look, you can take another look, at what your position really is here, because it's frustrating for us. We feel we need to act, we need to be a leader. Senator Kerry, from Massachusetts, I'm from California, we see forward-looking legislators and governors in our states, and we'd like to just see a little of that in this Administration, and we don't see it, frankly.

Senator KERRY. Senator Allen.

Senator ALLEN. Thank you, Mr. Chairman.

I'm going to use some time on Senator Boxer's comments. I think businesses like to use efficient means of production where they have less waste, fewer toxics, and can recycle them in their systems. It is good for the environment, but it also makes economic sense to them. You just look at the semiconductor fabrication facilities and see how they have improved over the decades with fewer toxics and few emissions. It also allows them to compete, because those substances or gases cost a great deal of money—one, to purchase, and, two, obviously to dispose of.

Mr. Connaughton's comments about the energy bill—there were some differences of opinion, but I think one thing that I thought was the most forward-looking of the whole energy bill were the incentives for fuel-cell technology, hybrid vehicles, electric vehicles, the clean coal technology generally for energy, but it was premised on that positive approach to consumer choice. Right now consumers have a great number of choices in the vehicles, and I think that's the approach that ought to be taken. I do think fuel cell technology, electric vehicles, hybrid and so forth, really are the future.

What this measure, if it will become law in this aspect of it, the tax provisions, will, positively affect consumer choice and options as opposed to arbitrary government dictates forcing people into smaller, unsafe vehicles that mothers and fathers don't want for themselves or their families.

Now, those are the sort of reasonable actions I think we ought to take. We have heard here from Senator Nelson about his State of Florida and the sedimentation plumes from the forestry practices or logging practices in the Amazon, heard about coral reefs. I do think humans did start the forest fires out West. But for them starting these forest fires, they would not have occurred. But we have all these concerns about nutrients and sedimentation and so forth.

I know that in this area, here, one of our greatest estuaries or resources is the Chesapeake Bay. In Virginia, we banned phosphate detergents to cut down on those nutrients derived from phosphates. Also, we have a goal of many states working in this region to get forestation and grass strips and buffers along the rivers and tributaries of the Chesapeake. We have requested in the budget oyster reefs. Oysters are down about 12 percent of what their historic levels were. They're good for the economy, but they're also great for cleansing the waters of the Chesapeake Bay.

Then we have, presently, a clear and present danger of 97 ships of the so-called ghost fleet of which—out of these 97, 71 of these

ships are obsolete. They're holding nearly eight million gallons of fuels and oils sitting at the lower end of the James River. I've asked this Committee since this spring to hold a hearing on this issue. If these ships break loose and are not disposed of properly, you're going to have an environmental disaster. Now, there's something we can do something about. Unfortunately, nothing has been done. Senator Warner and I are working with the Administration, also this Committee and Appropriations, to get that done.

Now, as far as incentives from the Bush Administration—I guess I'll go to Dr. Hubbard on this—you mentioned that many people have expressed concerns about the price of addressing climate change to the U.S. economy. If you or others want to break in on it, too—do you think that innovative technologies can help meet our environmental goals as well as our economic goals simultaneously? And if so, could you give us some examples?

Dr. HUBBARD. Sure. I think this is a critical part of the argument. Earlier, I guess when Senator Boxer had said it's more costly or harder the longer we wait, that's, of course, just false. That's the whole point of this. You want to take the lowest-cost actions first, and then provide the incentives for such innovation.

Technological innovation doesn't happen in a vacuum. It happens because of incentives. So having tax incentives, having these voluntary goals, giving people credit for doing more through voluntary credits that could be transferable provide the incentives for innovation.

We're already seeing innovation in the private sector. The hybrid car was an excellent example of that.

Senator ALLEN. Dr. Marburger, let me ask you a question. You mentioned various uncertainties as far as the predictions, and they've been documented by the National Research Council—if you want to list any of these uncertainties for the record, that is fine—but also I would ask you whether or not our U.S. scientists, including state climatologists, should conduct an independent assessment of their input into the U.N. IPCC to remove any bias that may be driven by the differences or agendas of different nations?

Dr. MARBURGER. Well, first, Senator, I do believe that the IPCC working groups have adequate scientific expertise and representation that broadly represents the scientific community. I think that, in fact, the U.S.-supported chairman of the working group No. 1, which is the one that's most directly relevant to science, is Susan Solomon, who happens to be a government employee, and we're satisfied that good science is being done in those working groups.

With respect to the uncertainties in the model, this is, indeed, a very difficult problem. There are problems of measuring, getting the right input, understanding what's happening to the globe in all its dimensions and different ecosystems and parts of ocean and ice caps and atmospheric phenomena. Many of these issues are understood. A lot of progress has been made in the last decade, and computer modeling is improving very rapidly with the computer technology.

But there are still some basic—a very, very important uncertainty, such as clouds, which are very dynamic. High clouds have a warming effect. Low clouds have a cooling effect. The mechanisms that create clouds in the first place, and the mixing of water

vapor with air that goes with them, are all occurring on a much smaller scale than the scale that are—of the nets or the grids that our models can accommodate. So we have to have some ad hoc way of putting in the cloud mechanism, which is one of the most important factors in determining the heat input to the earth.

So we have these very large uncertainties. I believe that science is capable of narrowing the uncertainties, and that's why the President implemented the Climate Change Research Initiative that Dr. Mahoney is leading so effectively right now.

So I'm optimistic about how much science can tell us about the alternatives and the technical path forward that we should take. But, at this point, we cannot make those predictions with the certainty required to make the kind of tough policy choices that we will have to make in the future.

Senator ALLEN. Let me ask you—again, follow up on state climatologists. Do you see them as being of value, as far as having the practical, pragmatic view from their state's perspective when trying to develop these policies?

Dr. MARBURGER. Dr. Mahoney is a meteorologist. I'm going to ask him to——

Senator ALLEN. All right. Dr. Mahoney.

Dr. MARBURGER.—to respond to that question.

Dr. MAHONEY. Yes, I'm pleased to respond, Senator Allen, and say that I think there is a definite contributing role from the state and regional climatologists and others with special technical information.

You know, we've had some great dispute about how well the global scale computer models can really characterize what goes on on a smaller scale, and I think that it's still pretty widely agreed in the scientific community that this is a—that the small or regional-scale issues are beyond the capability of the global model's calculations, not just because of computer technology, but because of the underlying science.

Meanwhile, at the same time, we have a major resource of data and understanding of problems because those climatologists are there—the state climatologists, in particular, as well as the—of course, all of the climate and weather-service capabilities and the National Weather Service as part of NOAA.

So one of the themes that we're after, and one of the themes we're after in the science generally, is that we need to make sure we make the best use of the real information we have, the measured information and the measured judgment in various cases. I'm not saying that as a policy argument. I'm saying that when we try to do our best science, what we need to do is to, of course, use the computer models for the global circulation, and, at the same time, we really need to be factoring in our best observations, both global observations and definitely the regional observations of the sort—it's the regional observations and the information and the history that the state climatologists and others have.

Senator ALLEN. Good, thank you. My time's up.

Thank you, Mr. Chairman. Thank you, gentlemen.

Senator KERRY. Thank you very much, Senator Allen.

Senator Nelson.

Senator NELSON. Thank you, Mr. Chairman.

Dr. Mahoney, I enjoyed your testimony the most, and I'd like to get some clarification for the Committee, if I may. Would you describe for the Committee the greenhouse effect?

Dr. MAHONEY. Certainly. I'll try to do it in very brief form but in form that gets to the issue. It's called the greenhouse effect because it is of the same nature as we have with greenhouses, to start with. The concept is that the energy in the earth comes from the sun to—the very vast majority—a little bit of cosmic radiation and so forth, but basically from the sun. It comes to the surface, or it's reflected off of clouds, where they exist.

Then the—every heated surface—every surface all—of all sorts emanates radiation back, away from itself and, in the case of the earth, as a system which you had a chance to observe, emanates it back to space.

The amount of the long-wave radiation that emanates back out, the heat radiation, is controlled, in large part, by the amount of greenhouse trapping—that is, some substances hold that in. Far and away the dominant greenhouse gas is water vapor because—in fact, if we look at other planetary atmospheres and we compare the earth, the biggest difference with the earth is the earth is much warmer in the range that it can support life of the sort that we know, with carbon-based amino acids, for example, because it's temperature is much higher than it would be if it didn't have an atmosphere with water vapor.

Other gases, in addition to water vapor, also affect—also have greenhouse properties. Now, the best known of those, and the most commonly observed, clearly is carbon dioxide. Carbon dioxide occurs naturally, but it certainly also occurs as a result of combustion of fossil fuels. We know quite well that the carbon dioxide concentration in the atmosphere was around 280 parts per million before the industrial revolution began. It is now around 365 parts per million, and growing. We are all familiar with the annual track—the sawtooth track, because there's a seasonal variation. But if you look at it in the measurements that Dr. Keeling, from Scripps, says it conducted at Mauna Loa from way back now—we've seen that kind of thing and had that confirmed very widely in the world.

We know there are several other greenhouse gases, as well. Methane and the other carbon-based—other hydrocarbons. We have, in the last 2 years, I would say, and especially in the last year, an increasing understanding that one class of aerosols, the fine particles that we may not have been focusing on as much in the past, is really key, and those are the so-called "black-carbon aerosols." For a long time, we thought of aerosols predominantly as those that arise also from fossil fuel combustion in the sense of large industrial sources with sulphur in them. So we have sulphate aerosols, and we've studied those quite a bit.

What we haven't done as much until more recently as we're getting more observations around the world, is to look at the fact that very inefficient combustion—and I made a reference in my opening statement to millions of home heaters and so forth, especially in the highly populated underdeveloped countries—it's easy to cite China and India as two examples. They're not the only ones, but certainly, in terms of the large populations, they are good examples—with millions of sources of this sort, we are now beginning

to develop information, much of it published in the last year, and much of it currently in debate, which would suggest that tropical circulation patterns are being heavily influenced by the change in radiation reaching the surface because of the large amounts of so-called Asian brown cloud in many cases that we've seen carry out over the Pacific for a fairly large region, as well.

Let me note, for emphasis, too, I'm not trying to target one or another country. I'm just trying to say that's an easy way to observe this effect, which I'm sure occurs around the world various ways.

This whole matter is, in a sense, a sobering reminder to us that when we think of the atmosphere, it's easy to think of just the greenhouse and warming and we're done with it. The fact is, the atmosphere and ocean system is a tremendously complex system where it may be that the energy flow from atmosphere to ocean and from the equator regions, the tropical regions, toward the poles is heavily influenced by the amount of precipitation and cloud cover, that the energy in creating water vapor out of liquid water is very large, so we're being brought back to some sort of first principles.

One of the first things we learned in global meteorology is the concept that if it weren't for the flow in the atmosphere, the motion, our tropical areas would be much hotter than they are, and the poles would be extremely cold. But the atmosphere is a great engine to move these things around.

It's enough of this long answer to your question, Senator but the point is, there's no question that the greenhouse gases, by themselves, have a warming influence. Most would agree—most scientists, I think, would agree that there are some cooling influences as a result of scattering back to space from sulphate aerosols and other general aerosols and from more clouds, if there are more clouds.

I would add one other matter that we're beginning to see the real concern of possible climate impacts from these other inefficient combustion sources, which suggest, by the way, to get—to make the point clear—that it may be—massive increase in providing technology transfer to get better heating and combustion sources in developing countries may be the most important thing that we could do over the next decade. I'm not ready to say that for sure. Note I said "may." I'm trying to give an illustration.

So I'm trying to illustrate that there are some real key questions to address, and there is a humbling level of uncertainty about the whole system when we try to understand. I'm not trying to make that as an argument that we should do nothing. I don't think—I'm very aware that the President's program is not to do nothing. It is to take a series of steps. But I certainly think we need to intensively improve our understanding of the atmosphere-ocean system and their effects on the ecosystems right now and in the next several years.

Senator NELSON. Thank you for that comprehensive answer.

[Laughter.]

Dr. MAHONEY. Thank you. I deserved that.

Senator NELSON. I take it it's—because of how you described that, is why, in your statement earlier today, that you said that we do have a problem.

Dr. MAHONEY. Yes.

Senator NELSON. Now, you're saying that there might be a source of many different reasons of why we have a problem. Would—and I take it from your comprehensive answer that you suggest that carbon dioxide is one of those sources. So in your—is it fair to summarize your statement that you're just not sure which is the greatest cause of the greenhouse effect that we see, as you articulated that we've gone from 280 to 365 parts per—was that billion or million?

Dr. MAHONEY. Parts per million.

Senator NELSON.—parts per million of——

Dr. MAHONEY. Of CO_2, carbon dioxide.

Senator NELSON. Of CO_2. That statement, in itself, would lend one to be quite concerned about the increase of CO_2. Can you elucidate the Committee on that?

Dr. MAHONEY. I'd better give the brief-squared version, but I will say that rise has been not exactly linear, but it has occurred over 200 years, and it has certainly—we've had more of it as fossil-fuel use has increased, I would say, in the last—since World War II, is perhaps one good measure, as the world economies began using more energy. But interesting to note——

Senator NELSON. Which is a pretty good indicator, is it not, that they're——

Dr. MAHONEY. Well, yes, but the——

Senator NELSON.—the——

Dr. MAHONEY.—but the increase in CO_2 occurred over the whole time. And now——

Senator NELSON. I thought you said it accelerated more recently.

Dr. MAHONEY. No, we don't have the data to make that kind of statement. I'm just saying that I know the fossil-fuel use has increased a lot, and some data certainly suggest it's more than linear, but I'm not prepared to say how much off a linear track it is.

What strikes me is that we did not, for—we did not see what we would think of as climate—temperature effects, and other possible effects, emerging over the last 150 years, until more recently. Now, two ways too look at that. One of them is, aha, we found the trigger. We did enough of it, and now we have a real problem. Another way is to say, no, we have a lot of record that says that climate doesn't change much—temperature and other effects don't change much directly as a result of this, and that what we have is more random effects in the atmosphere.

Even the IPCC in the National Academy, for example, carefully state—and the U.S. Climate Action Report quotes them—on the matter that we have a great uncertainty about that. As I said in my own statement, we're now looking at the matter that temperature change, not CO_2 change, with our best models, is—are projected to run from just over 1 degree centigrade over the century or over 98 years, to 4½ degrees. That's a tremendous range of uncertainty, because if it's 1 degree over a century, it's one thing. If it's almost 5 degrees over a century, it's something quite different. That is the compelling reason to be first to, of course, address our

science carefully and prove our measurements and really work on our projection models and debate them very openly. It is also the reason I want to stick to the science.

But I think that that scenario suggests the idea of: take steps, but don't go way down one road completely so we don't have the ability to go down another road if, 5 years from now, we have a different view about what we ought to be controlling.

Senator NELSON. You suggested that water vapor might be one of the causes. Water vapor would certainly occur all the more as the greenhouse effect heated up the greenhouse. You'd have more water vapor. Is that not a reason to accelerate our concern of finding exactly what that is that is causing the greenhouse effect?

Dr. MAHONEY. Well, yes, but with a significant caution. Simple temperature increase would, of course, lead to more water vapor and a—literally a greenhouse, a kind of a fixed box. When we talk about the dynamic system that the atmosphere and the atmosphere-ocean system are, in fact, there are some suggestions that increased precipitation rates in the tropics may result in somewhat less net water in the atmosphere.

I say that not argumentatively. I think, not only do I not know for sure, I don't think we can give a strong answer about that in the scientific community at this time, but I'd say it's part of what we need to—while we have our broad view on, we looking at the atmosphere not just as a greenhouse, but as a moving, dynamic system where water moves through the whole series of cycles.

Perhaps instructive on that, in this major program in the global change and climate change research that you've been—continue to authorize and appropriate for—two of the most significant working groups in our study area are a global water measure panel and a global carbon major panel. The reason for that is if we take everything else out of the way, we have to say how well can we characterize these things, and exactly what we're trying to do is to carry all these concepts back over to investigate the technology scenarios, but the—that Jim is talking about and that are led by the Department of Energy with input from all of us, as a matter of fact.

Senator NELSON. Well, I appreciate your answers. Are you aware that your expressions here, basically that CO_2 is not necessarily the culprit—and I think that's a fair statement of what you've just said—are you aware that that would be in the significant minority of opinion in the scientific community?

Dr. MAHONEY. I don't accept the characterization that I said that CO_2 is not necessarily the culprit. What I was trying to say is that there—that I don't think we can simply look at CO_2 as the predominant culprit to the level that there are not other considerations that we need to pay attention to. It is in that context I take the black carbon aerosol issue.

To say it directly, I think that insofar as we project changes in climate conditions, I think CO_2, by any measure, is first order. It is a major player and likely the major player. What I am saying is that there are other considerations, and I would name two—first, the black carbon aerosols we talked about; and second, the—what I might call the hydrodynamics of the atmosphere, the change in precipitation patterns and the like and the differences in tropical conditions that may also be first order.

But I'm glad you asked, because I'm not trying to somehow take CO_2 out of the first rank. It's definitely first rank.

Senator NELSON. Well, on the basis of what you've said, and this global climate is so complex, as you, I think, have accurately tried to describe it, one may be affecting another. You're talking about the changes in precipitation, you're talking about the changes in wind patterns, and so forth. And who knows? That may be because of the rising temperature that may be as a result of the explosion of the CO_2 per—parts per million.

It just seems to me, in an abundance of caution of us being good stewards of what we have, which, as I said earlier, looks so fragile from the perspective of out there looking back at home, that it would seem that the conservative, cautious approach would be to do things that are reasonable that will stop the CO—that will lessen the CO_2 emissions. That is what I wanted to get across to you, and I appreciate your testimony, Dr. Mahoney.

Dr. MAHONEY. Thank you, Senator.

Senator KERRY. Thank you, Senator Nelson. I appreciate it.

Gentlemen, let me try to see if we can pursue a couple of lines of questioning here, and I want to do so, hopefully, you know, not combatively, but with a good dialog and see if we can try to get at your thinking and understand where we're heading here.

At one of our hearings on climate change last year—and I addressed this to Dr. Marburger and Dr. Mahoney—Dr. Kevin Trenberth—do you know him? Are you familiar with him? At the National—he's at the climate center. He made a point that resonated with me and I think with—I hope with some other Members. But he said that because of the long residence time of CO_2 in the atmosphere, achieving the targets of Kyoto would literally only buy us 10 years of time to figure out how to effectively reduce emissions beyond that.

His point was that achieving the Kyoto targets would only slow the rate of carbon emissions currently loading the atmosphere, not stabilize, and not even reduce greenhouse gas emissions in the atmosphere. So, in other words, that's only a first step, and more needs to be done.

Now, as a scientist, do you agree with that?

Dr. MARBURGER. I believe that it's important to take action on mechanisms that you know will have an impact on future climate. The problem is that the link between any specific actions that we take and the actual impact on the climate has to be forged through these models. The question is what exactly is it—what exactly is a sensible approach? That—the Administration's position is that it is taking a sensible approach, that it——

Senator KERRY. But that's not——

Dr. MARBURGER.—it is taking action.

Senator KERRY. Let me stop you there, because I'm willing to have a dialog, but I do want to have my questions answered. I'm not asking you to say whether the Administration is having a sensible approach or not. I'm just trying to get at the science here.

Do you agree that there is a long residence time of CO_2 in the atmosphere?

Dr. MARBURGER. Absolutely.

Senator KERRY. OK. Given the long residence time, do you agree that, given the Kyoto level of reduction, does that only buy you 10 years of time in terms of reduction of emissions? I'm not talking about whether the model says you get an impact.

Dr. MARBURGER. As long as we talk about the emissions and the greenhouse gases, as opposed to the warming effect, I'm with you, yes.

Senator KERRY. OK. So you agree with that.

Dr. MARBURGER. Yes.

Senator KERRY. All right. Now, if achieving the Kyoto target only gets us 10 years to plan and doesn't stabilize the greenhouse gas, the approach that you're taking essentially discards the notion that there is a relationship between the greenhouse gas and the warming effect, because you're effectively willing to live notwithstanding that negative consequence.

Dr. MARBURGER. No, I disagree with that statement.

Senator KERRY. Well, help me with it, then. Do you—is there a linkage? Your report says human emissions are contributing to global warming, correct? That is the principal finding of the report.

Dr. MARBURGER. That's not necessarily the principal finding of the report, because there are, in fact, uncertainties about the link between the emissions and the climate. That's just the critical point.

Senator KERRY. Well, Doctor, I've looked at a lot of those models for the last years since we've been going at this—I agree there are uncertainties in the modeling. I don't disagree with that. I can't sit here and tell you with certainty that I know exactly what the relationship reduction is, but I also know, just as a matter of reasoning, that there's a certain level of cause and effect that scientists have accepted. And you do, too.

Dr. MARBURGER. Correct.

Senator KERRY. Based on that, I have a responsibility as a public official to try to decide, well, what can we do—we, humans—to reduce what is in our power that we know we're affecting in terms of the cause and effect? It's the precautionary principle, so to speak. Do you think that principle ought to be completely discarded here?

Dr. MARBURGER. No, that's a good principle. The question is, should we just turn off all the power plants, for example——

Senator KERRY. No one has suggested that, Doctor.

Please, that is an extreme——

Dr. MARBURGER. That is——

Senator KERRY.—comment.

Dr. MARBURGER. Yes, that is extreme. The other extreme is doing nothing. The really important issue is where do you draw the line? What is reasonable, given our current state of knowledge and our current understanding of the situation?

Senator KERRY. Well, let me ask you about that. Why is it reasonable, in Europe and in other countries, for presidents and prime ministers of their countries to decide they're going to accept fixed targets? Do we know something they don't know?

Dr. MARBURGER. No, we don't. That's why they're anxious to collaborate with us to improve their knowledge of the climate system, as well.

Senator KERRY. But they're doing it.

Dr. MARBURGER. But they have different economic conditions than we do, and I believe that the primary input into the decision about where to draw that line, or one of the inputs, science being a major one, is the economic status of——

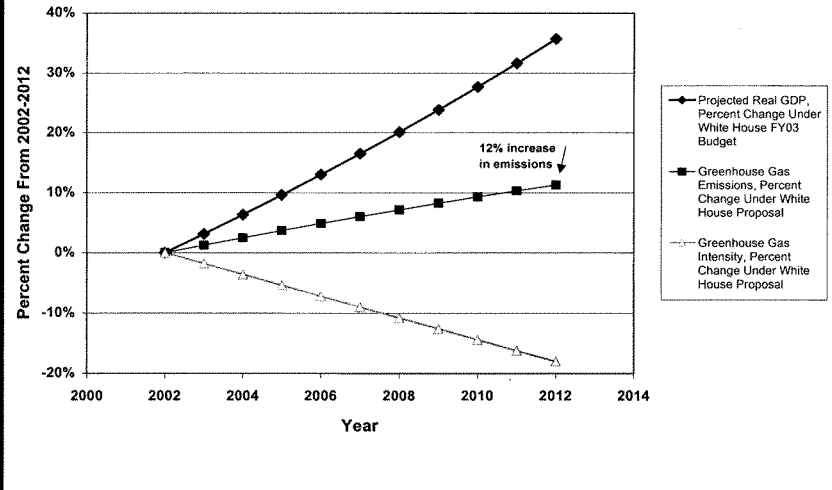
Senator KERRY. Well, let's talk about that economic status. That's a—it's a good place to go, I think, a little bit here to, sort of, see what the variations are.

Let me start by showing you a chart, which is your White House climate proposal, which talks about greenhouse gas intensity. This is your intensity theory of how you're doing something under the intensity theory.

Can we get that up? Is there a—so we can share it with them? Is there an easel, or do you want to hold it on the chair here so that the witness can see it? If you'd just hold it right there so they can see it up front. Thanks.

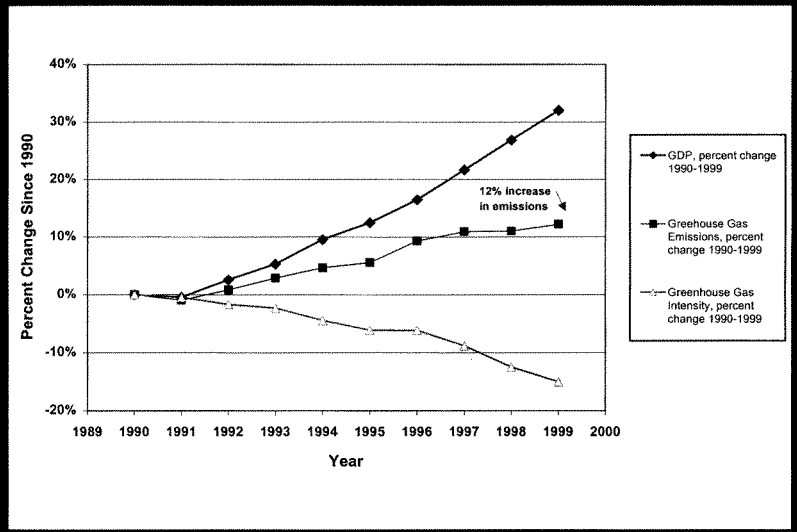
This is from your report. What it shows is—you say—and you honestly acknowledge that there'll be some increase here of emissions, but you show a reduction in intensity even as the gross domestic product goes up. So you show a projected increase in gross domestic product, a reduction in intensity, but a 12-percent increase in emissions.

White House Climate Proposal:
As in past, GHG emissions rise 12%



Now, if we go to 1990 to 1999 to apply your intensity theory to the economy, here's how it actually would have happened. Yours is a projection. I want to show you what would happen. There was a lesser reduction in intensity over that period of time. There is an increase in the gross domestic product between 1990—it was up in the total about 33 percent, but there is a 12-percent increase in emissions that actually took place during that period of time.

1990-1999: Intensity Drops 17% but Emissions Rise by 12%



So emissions are growing. That's what's going to happen. We are sitting here being told by you that you have this fancy concept of measuring intensity, which is related to the gross domestic product. There's no specific requirement of any company having to adopt any procedure—not specific. It's completely voluntary. So whether companies are going to do it or not, nobody knows.

So effectively, the United States is not requiring anything. You're hoping there will be this reduction of intensity. But it's linked to the growth of the economy. It's not linked to any reductions of emissions, which is the critical issue here—reduction of CO_2, reduction of methane, reduction of any of the greenhouse gases that are the problem that you've acknowledged exists.

Now, why should any American be satisfied that that is a legitimate response to this crisis or problem, that we face?

Dr. MARBURGER. Yes. I'm going to let Dr. Hubbard address that, and I may add at the end.

Dr. HUBBARD. Well, I think, Senator, you raise the very important tension between emission reduction and economic growth. In the short run, a very important reason to have an intensity target is because you do have long live capital that you're encouraging to turn over.

One reason it is very costly to pursue very rapid reductions of the sort that Kyoto would have done for the United States is, in a rapidly growing economy, we would have essentially still quite productive capital.

You can always find a link between an efficiency target and an absolute target. That's arithmetic. But that's in a world of certainty. If we have uncertainty about the rate of economic growth, we can agree on an intensity target and still have very different effects on the economy.

The third thing I'd like to say——

Senator KERRY. But that depends on what assumptions you're making, Doctor, about the economy. If you make an assumption that a requirement to reduce emissions has a negative impact, then you come up with one outcome. But there are plenty of models around that would suggest that reductions have a positive impact.

Dr. HUBBARD. I know of very few such models, Senator.

Senator KERRY. Well, let me give you one.

Dr. HUBBARD. The three——

Senator KERRY. Let me give you one. Jim Rogers, the CEO of Synergy, Inc., testified before Congress that his utility company supported placing a carbon commitment in any power plant legislation, because "without some sense of what our carbon commitment"—this is him speaking; I'm quoting him—"might be over the next 10, 15, or 20 years, how can I, or any other utility CEO, think we can have a complete picture of what major requirements our plants may face?" There is a plea for certainty in the marketplace to know where they're going.

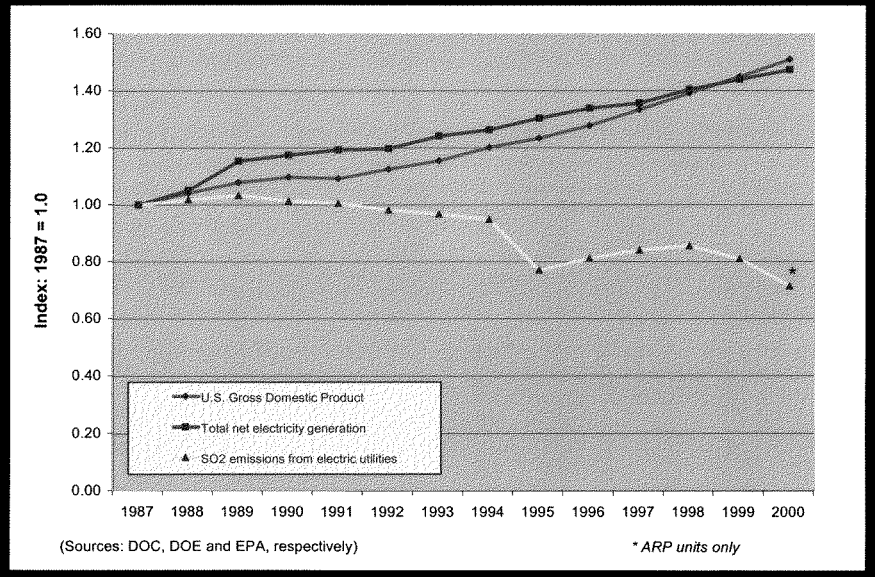
Second, in a hearing before our Science and Technology Subcommittee last year, a representative from American Electric Power talked about their programs in forest sequestration, including large-scale programs in which AEP and the Nature Conservancy purchased forest land in Brazil and other countries. They make the point that domestic or international trading in carbon

credits afforded by sequestration would not alone stabilize the concentrations. You need actual emission reductions. They would like to see targets and timetables, because that enables them to actually use the marketplace more effectively.

Third example, in the Clean Air Act, we had predictions from the industry that the cost—and I remember being involved in those negotiations in 1990—the cost was going to be $8 billion, and they couldn't do it in the timetable. The environmental community said the cost of reducing SO_2 and grabbing it back was going to be about $4 billion and thought we could do it in the timetable. In fact, we beat the timetable, and it cost only $2 billion, because nobody properly factored in the exponential benefit or impact of the technology advances that would be made because you set a fixed target. That fixed target was achieved, even as our gross domestic product grew. I believe we have a chart that shows that.

We show that the SO_2 cap and trade program, specific cap and trade program—here's your gross domestic product going up. That's the blue line. The total net electricity generation is your red line—also went up. Your SO_2 emissions from electricity went down at the same time. So it completely contradicts your notion that you can't be specific and still have a growing economy and create jobs.

SO_2 "Cap and Trade" Program: GDP Rose While Emissions Dropped



GDP and SO2: Absolute targets = Economic growth, pollution reduction

Dr. HUBBARD. If I might, Senator, I think you raise three very important points. First, on the issue of the effect on the economy as a whole, let me be stronger. There is no model of which I'm aware in the energy modeling form studies over the years that would suggest the economy as a whole benefits from putting shadow prices on carbon. That does not mean this is not an interesting discussion, only that there's a tradeoff.

Second, on the point about certainty, you're quite right that business people do want a sense of how we value carbon. I think there, what the Administration is saying, we have a lot of institution-building to do with registries, with developing credit mechanisms that are very, very important to generate certainty and valuation.

On the point about trading mechanisms, of course, economists are the key fans of the program that you mentioned. It's a hallmark of economic success and regulation. But, again, it's an issue of a tradeoff. No one I know of is suggesting it wasn't costly to do the program, simply that it was done in the most efficient way possible.

Senator KERRY. Well, but that doesn't—that's just a non-response with respect to why we can't do that now with respect to these greenhouse gases. I mean——

Dr. HUBBARD. When a——

Senator KERRY.—it just doesn't respond to it. It leaves me baffled.

Dr. HUBBARD. With due respect, Senator, we believe the President's program does respond to that.

Senator KERRY. No. With all due respect, it doesn't, because it doesn't set a cap, it doesn't have a specific requirement, and there's no market force that's going to take effect here that's going to require what was required there.

Dr. HUBBARD. Senator, if I might, you——

Senator KERRY. We required that in the Clean Air Act. We set a specific goal. And President Bush, 41, signed it.

Dr. HUBBARD. If I might, Senator, you do not have the infrastructure—we do not, as a country, have the infrastructure in place to implement a cap and trade——

Senator KERRY. Well, that's very interesting. The State of Massachusetts just put a program in place, and they're going to do it. I disagree with you. There is a capacity to do cap and trade in this country today.

Dr. HUBBARD. There's a significant amount of institution-building that would have to be done for a mandatory program, Senator, for reporting——

Senator KERRY. Well, let's start to do it.

Dr. HUBBARD.—for verification, for——

Senator KERRY. Why don't we do that?

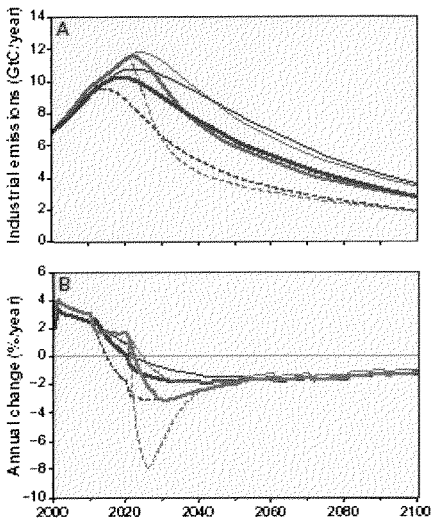
Dr. HUBBARD. Senator, we are proposing registries, the development of credits which could be used in any programs. Those are very important steps.

Senator KERRY. Let me confront you, if I may, with an article by a scientist. It appears in Science Compass Policy Forum—I don't know if you've seen it—by Brian C. O'Neil and Michael Oppenheimer. Have you read that, Dr. Marburger?

Dr. MARBURGER. I've seen it.

Senator KERRY. He [Dr. Oppenheimer] is an authority on climate change and a member of the IPCC. He's at Princeton University, and Dr. Brian O'Neil is at Brown University. They show that, in order to prevent, "dangerous anthropogenic interference in the climate system or dangerous climate change ranging from elimination of all coral reef systems to disintegration of the West Antarctic ice sheet, it's necessary to begin reducing total actual emissions within the next two decades." According to these scientists, any delay beyond that timeframe would have irreversible effects on the climate system. They say that the sooner emissions drop, the easier it will be to achieve concentrations necessary to prevent dangerous climate change.

I read the article entitled, *Dangerous Climate Impacts and the Kyoto Protocol*. It talks about delay until 2020 risks foreclosing the option of stabilizing concentrations at 450 ppm. You're talking about 350 today. Just going out with the Kyoto target level, they find that you'd have to begin now in order to avoid that.



Effects of delay. Global CO_2 emissions (A), and annual change in CO_2 emissions (B), 2000 to 2100, leading to stabilization of atmospheric CO_2 at 450 ppm by 2100 for a scenario consistent with the Kyoto Protocol (magenta) and a scenario with a 10-year delay (green). Three carbon-cycle parameterizations are used (see text): best guess (thick solid lines), strong uptake (thin solid lines), and weak uptake (thin dashed lines).

A Narrow Time Window for Action, A Steep Price for Delay

B.C. O'Neill and M. Oppenheimer, "Dangerous Climate Impacts And the Kyoto Protocol," 296 Science 1972 (14 June 2002).

Now, I would assume—I don't know if this will happen. It's obviously over a long period of time that it would happen. But it's clear that if you don't begin that emissions reduction process now with some seriousness, we, as a generation, may have it on our shoulders that we were unwilling to be responsible when we had the chance to.

Where does the precautionary principle fit into the science that they are discussing now in your proposal?

I would also put this article in the record.

[The information referred to follows:]

SCIENCE'S COMPASS, POLICY FORUM: CLIMATE CHANGE

DANGEROUS CLIMATE IMPACTS AND THE KYOTO PROTOCOL

(By Brian C. O'Neill and Michael Oppenheimer)*

Defining a long-term goal for climate change policy remains a critical international challenge. Article 2 of the UN Framework Convention on Climate Change defines the long-term objective of that agreement as stabilization of greenhouse gas concentrations at a level that avoids "dangerous anthropogenic interference" with the climate system. "Dangerous interference" can be viewed from a variety of perspectives, and the choice will ultimately involve a mixture of scientific, economic, political, ethical, and cultural considerations, among others.[1] In addition, the links among emissions, greenhouse gas concentrations, climate change, and impacts are uncertain. Furthermore, what might be considered dangerous could change over time.

However, both proponents and detractors of the Kyoto Protocol, which was designed as an initial step to implement the Framework Convention, have begun to demand a definition of long-term objectives. For example, on 11 June 2001, U.S. President George W. Bush stated that the emissions targets embodied in the Kyoto Protocol "were arbitrary and not based upon science" and "no one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."

Here, we propose several plausible interpretations of dangerous interference in terms of particular environmental outcomes[2] and examine the consistency between the Kyoto Protocol and emissions changes over time that would avoid these outcomes. Although the emissions limits required by the Kyoto Protocol would reduce warming only marginally,[3] we show that the accord provides a first step that may be necessary for avoiding dangerous interference.

WHAT IMPACTS ARE "DANGEROUS"?

Attempts to develop limits to warming predate the Framework Convention and have taken a variety of analytical approaches,[4] including the recent elaboration in the Inter-governmental Panel on Climate Change (IPCC) Third Assessment Report of a detailed ecological and geophysical framework for interpreting Article 2. We examine the implications of defining "dangerous" according to two of the criteria of "concern" identified by the IPCC:[1] warming involving risk to unique and threatened systems and warming engendering a risk of large-scale discontinuities in the climate system. These choices can be used to infer an upper limit for future concentrations.[5,*ERR17**ERR17* *ERR17**ERR17*6]

Large-scale eradication of coral reef systems provides one marker for policy-makers. Even before the development of the Framework Convention, which calls for a long-term target that will "allow ecosystems to adapt naturally," coral reefs were cited as a potential indicator system.[4] Coral reefs are charismatic ecosystems with high local economic value and a high degree of biodiversity. They can be found in most of the world's oceans in the latitude belt between 30°N and 30°S. By and large, coral reefs are thought to thrive in climate conditions that are close to their thermal limits for existence. As waters warm toward this limit, corals expel symbiotic zooxanthellae in a process called bleaching. Sustained bleaching over consecu-

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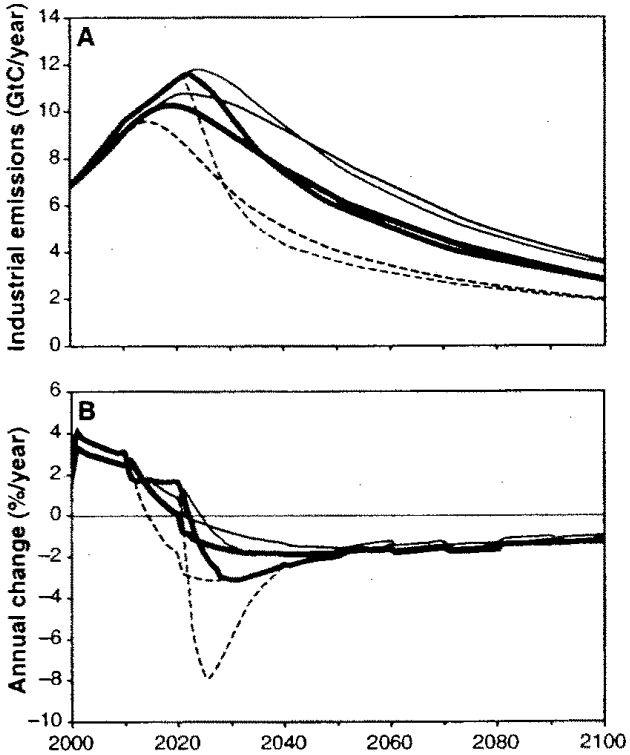
tive warm seasons increases the risks permanent loss of the reefs. Widespread bleaching has occurred in the Northern Hemisphere during recent El Niño events, indicating that for some coral reefs, the climate limit is only slightly above current seasonal maximum temperatures. Hoegh-Guldberg[7] has estimated that sustained global warming in excess of 1 °C would cause bleaching to become an annual event in most oceans, leading to "severe" effects worldwide, even allowing that some acclimation and/or genetic adaptation may occur.[8]



Effects of delay. Global CO_2 emmissions (A), and annual change in CO_2 emissions (B), 2000 to 2100, leading to stabilization of atmospheric CO_2 at 450 ppm by 2100 for a scenario consistent with the Kyoto Protocol (magenta) and a scenario with a 10-year delay (green). Three carbon-cycle parameterizations are used (see text): best gusee (thick solid linens), strong uptake (thin solid lines), and weak uptake (thin dashed lines).

Outcomes that have even a low probability of occurrence at a given level of warming, particularly within a century or two, but that clearly would be disruptive to societies, could provide markers for policy-makers. Alternatively, so could outcomes that have high probability but a low risk of causing widespread disruption. An example of the first case would be disintegration of the West Antarctic Ice Sheet (WAIS). An example of the second may be the weakening or shutdown of the density-driven, large-scale circulation of the oceans (thermohaline circulation or THC). Complete disintegration of WAIS would raise sea level by 4 to 6 meters, an outcome that certainly ranks as disruptive, even if it occurs gradually. Views on the probability and rate of disintegration for a given global warming vary widely,[9] largely because current models do not adequately capture certain dynamical features of ice sheets. In general, the probability is thought to be low during this century, increasing gradually thereafter. Limited evidence from proxy data suggests WAIS may have disintegrated in the past during periods only modestly warmer (~ 2 °C global mean) than today; other estimates suggest that disintegration could ultimately occur from about 3 °C (global mean) to 10 °C (local mean).[9] The process of disintegration could extend over anywhere from 5 to 50 centuries, although shorter time scales have also been proposed.

There is strong evidence that the THC had shut down in the past, in association with abrupt regional and perhaps global climate changes.[10] Most coupled atmosphere-ocean model experiments show weakening of the THC during this century in response to increasing concentrations of greenhouse gases, with some projecting a shutdown if the trends continue.[11]

Whether a shutdown results in large consequences is sensitive to the timing of regional cooling from shutdown versus regional warming [e.g., in northwest Europe],[12] as well as the magnitude of ocean heat transport to the North Atlantic region. The influence of the latter on regional climate may be smaller than some investigators have previously supposed.[13] We interpret the current state of affairs as a substantial likelihood that forcing due to unrestrained emissions would slow or shut down the THC, but modest probability that THC changes will yield unmanageable outcomes beyond a local scale.

PLAUSIBLE TARGETS

A long-term target of 1 °C above 1990 global temperatures would prevent severe damage to some reef systems. Taking a precautionary approach because of the very large uncertainties, a limit of 2 °C above 1990 global average temperature is justified to protect WAIS. To avert shutdown of the THC, we define a limit at 3 °C warming over 100 years, based on Stocker and Schmittner.[14]

The implications of the temperature limits for concentrations of CO_2 are subject to uncertainties in both the climate sensitivity and future levels of other radiatively active trace gases. For CO_2 stabilization at 450, 550, or 650 ppm, corresponding ranges of global warming over the next 100 years are about 1.2° to 2.3 °C, 1.5° to 2.9 °C, and 1.7° to 3.2 °C, respectively.[11]

Full protection of coral reefs is probably not feasible for this concentration range. It is plausible that achieving stabilization at 450 ppm would forestall the disintegration of WAIS, but it is by no means certain, because additional warming would occur beyond 2100.[15] Avoiding the shutdown of the THC is likely for 450 ppm. We adopt 450 ppm for our illustration as one that could conceivably be applied to these examples.

IMPLICATIONS OF TIMING

Some studies find justification for preferring reductions sooner rather than later in order to account for the inertia of energy systems, to stimulate technological development, or to hedge against uncertain future concentration limits.[16] Others conclude that although early investment in research and development may be justified, undertaking emissions reductions later can lower costs, even when accounting for uncertain concentration limits, by avoiding premature retirement of capital, taking advantage of the marginal productivity of capital, and allowing for technical progress.[17] However, at a certain point, postponing mitigation requires unrealistically rapid emissions reductions, especially for low stabilization targets.[18] Our ability to identify this point is constrained by our incomplete understanding of the carbon cycle.

The consequences of delay if one assumes a goal of stabilization of atmospheric CO_2 at 450 ppm by 2100 is illustrated in the figure. Because assumptions about the strength of carbon uptake by the terrestrial biosphere are an important determinant of required emissions, we include estimates that span a plausible range of levels of terrestrial uptake.[19] In one scenario, industrialized countries are assumed to meet the cumulative Kyoto emissions target in 2010; the rest of the world follows a reference path.[20] Beyond 2010, global emissions necessary to achieve stabilization are calculated with a global carbon-cycle model.[21] In a second scenario, mitigation is delayed by 10 years, with industrialized countries meeting the Kyoto target in 2020. If reductions are delayed by a decade, growth in global emissions must then be quickly reversed. The subsequent rates of decline in global emissions depend critically on the carbon cycle: with strong terrestrial uptake, required emissions reductions peak at 2 percent per year; if terrestrial uptake is weak, reductions reach a staggering 8 percent per year before 2040. Given inertia in energy systems, such high rates of reduction may be prohibitively costly.[22] Some relief is possible by allowing temporary overshoot of the 450 ppm limit,[23] although this strategy may still require rapid reductions and also leads to greater climate change over the next century or more.[24]

Thus delay until 2020 risks foreclosing the option of stabilizing concentrations at 450 ppm, especially if the terrestrial carbon sink turns out to be weak. In contrast, the scenario consistent with the Kyoto targets in 2010 requires challenging but substantially lower reduction rates. Global emissions peak between 2010 and 2020, and fall at between 1 and 3 percent annually between 2020 and 2040, depending on the

carbon-cycle parameterization. Beyond 2050, reductions proceed at about 1.5 percent per year in all cases.

Stabilizing CO_2 concentrations near 450 ppm would likely preserve the option of avoiding shutdown of the THC and may also forestall the disintegration of WAIS, although it appears to be inadequate for preventing severe damage to at least one unique ecosystem. Taking into account uncertainties in the working of the carbon cycle, the cumulative Kyoto target is consistent with this goal. Delaying reductions by industrial countries beyond 2010 risks foreclosing the 450 ppm option.

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25. The authors acknowledge partial support from Environmental Defense, and thank C. Azar, J. Smith, T. Stocker, R. Stouffer, F. Toth, T. Wigley, and anonymous reviewers for helpful comments.

Dr. MARBURGER. I'll have to—I don't specifically recall that particular paper. I would have to look at it carefully before com-

menting on it, but I would be very glad to comment for the record in a written response.[1]

Senator KERRY. I would appreciate that, and I'm happy to do that. I will submit it. I regret—I'm afraid that other Senate responsibilities are impeding on this. This is a discussion which really needs to go on.

The President himself has said that he recognizes America's responsibility to decrease emissions. "But we don't do it." For the entire period of what you're offering us, you're saying, yourselves, there's a 12-percent increase. I mean, you cannot tell me that under your current approach that you've offered, greenhouse gas intensity, greenhouse gas emissions will rise. Correct? Is that true?

Mr. CONNAUGHTON. Senator, greenhouse gas emissions will rise under our approach, no question about that. The question is—the question, as stated, and as the President articulated, and the international challenge, is how do we get everybody mobilized, including the developing countries, who are putting even more—they're—they've got an increasing rate—how do we get everyone off business as usual to slow the rate of growth? That is what we can do in this near term. Then that enables us to create the capital cycles that Dr. Hubbard has spoken of. That is where, as you saw in the—in our materials, there are three steps, and we need to get the institutions going, and we need to get the world mobilized.

I would note that, for example, China—you know, China is now looking at this issue, and they're looking at this issue in a way by which they can articulate a meaningful goal for themselves. They're looking at intensity as a way of developing their economy, because we hope that they do a better job than business as usual right now because they're kind of inefficient. I think that's a real——

Senator KERRY. Mr. Connaughton.

Mr. CONNAUGHTON.—they——

Senator KERRY. Mr. Connaughton.

Mr. CONNAUGHTON. Yes, sir.

Senator KERRY. Let me tell you something. China is reducing its emission rate, and has done a better job than the United States over the last years of making decisions to do that. I'm very familiar with what they've been doing.

Mr. CONNAUGHTON. Well, but, in fact, Senator——

Senator KERRY. China has done a more aggressive job of restraining its emissions rate of growth than the United States.

Mr. CONNAUGHTON. We are actually—by the way, we should be looking at Japan as the hallmark, because they have the——

Senator KERRY. You're now switching——

Mr. CONNAUGHTON.—they have the best intensity.

Senator KERRY.—countries, right?

Mr. CONNAUGHTON. No, but I want to put in perspective——

Senator KERRY. Well, I'm trying to put it in perspective.

Mr. CONNAUGHTON. If we're trying to get the world oriented toward an approach by which we can remove the total amount of carbon going into the atmosphere, we have to get everybody on a track

[1] Discussion of Oppenheimer-Brown article is included in questions and answers submitted for the record.

of slowing that rate of growth. As China has done. By the way, as we have done. As we have done over the last decade. We had—we made substantial progress, but it did not come without cost, and it came with a significant amount of innovation——

Senator KERRY. Well——

Mr. CONNAUGHTON. OK? That's what we need to spur and motivate in order to reduce the rate of——

Senator KERRY. I don't disagree. I've been fighting for that on this Committee for years as a Member of the Science and Technology Subcommittee. I've created tax credits for it. I'm all in favor of doing it, but I can tell the difference between a serious effort to engage in this and one that isn't. I say to you respectfully—you know, I've been to those meetings. I've sat in The Hague and in Buenos Aries and elsewhere and negotiated and talked to the Chinese and to the Japanese and to others about the difficulties of getting these rates.

Their economies were also affected, may I say to you, about the choices that they had to make at Kyoto. All of them. The United States, which is 4 percent of the world's population, is currently contributing 25 percent of the world's global warming gases.

Now, I have talked until I'm blue in the face with some of the representatives of those countries about how they have to be part of the solution. Let me remind you, sir, I was the one who managed the floor amendment with Senator Byrd and Senator Hagel that said to President Clinton we wouldn't go forward and shouldn't go forward with Kyoto as it was until we also include less developed countries. I understand that we have to do that. But I don't see the kind of concerted effort that's going to make that happen.

In fact, let me just share with you that I was disturbed to learn at the recent meetings in Bonn, I believe. There was a disturbing report.

It's my understanding that observers there reported to the Committee that this Administration—your Administration—worked with a number of the developing countries led by Saudi Arabia to literally dilute the role played by the IPCC scientists and their latest state of Science Report, and a U.S. negotiator objected to the use of the word "robust" to characterize the IPCC assessment, even though the National Academy of Sciences had, in fact, characterized it that way. So I don't understand why, if you're so earnest about including them and bringing them into the process, you're actually working to marginalize them at the international level in that way.

Mr. CONNAUGHTON. Well, I would just disagree there, Senator respectfully. We've not marginalized at all.

Senator KERRY. Well, was there objection——

Mr. CONNAUGHTON. In fact, the nature of our——

Senator KERRY .—was there objection to the use of the word "robust," which——

Mr. CONNAUGHTON. I don't know the specifics of what you're saying. So——

Senator KERRY. Well, then you can't object to what I'm saying.

Mr. CONNAUGHTON. No, no. I would—you took a specific negotiating point and amplified it out as a characterization of the kinds of conversations we were having with our partners both in the um-

brella group, in Europe, and as well as with the developing countries, and I think that's a wholly——

Senator KERRY. Well, I'd like——

Mr. CONNAUGHTON .—inaccurate characterization.

Senator KERRY.—to ask you if you would submit to the Committee a full account of those negotiations.

Mr. CONNAUGHTON. Actually, attached as one of the tabs to my testimony is an extensive outline of the kinds of conversations we have been having.

Senator KERRY. Well, I was in Kyoto, Saudi Arabia was one of the problem countries, with respect to reaching an agreement. Saudi Arabia, interestingly enough, has also adopted your intensity measurement. That may be a message.

Mr. CONNAUGHTON. Well, I would note there, Senator, if you look at Japan and at Germany and several other countries, when you look at the domestic measures that they're employing, Japan is talking with their industry about an intensity measure, Germany is talking with its industry about an intensity measure——

Senator KERRY. Well, you may well have opened an option for a lot of countries to kind of get out from under something that we were moving in a different direction, and that may be even more of a tragedy, then.

Mr. CONNAUGHTON. But what you——

Senator KERRY. I don't take——

Mr. CONNAUGHTON.—what I would disagree with—in fact, the Japanese are trying to work—their industry, by the way, has made substantial strides, as has American manufacturing enterprises. I mean, they've got a reduction——

Senator KERRY. But you see, these countries have their—you see, their companies, here's the dynamics, sir—with all due respect—their companies want to compete in the world, too. Their companies come screaming to their government saying, "Gee whiz, you guys have committed us to this thing in Kyoto, but look at what the United States is doing. They're thumbing their nose at us and at it. So we now are at a competitive disadvantage." I'd do exactly what they're doing. That is precisely what many of us predicted would be the consequence of the United States not showing leadership on this.

So if we're going to take this seriously—now, look, I'm not a scientist. I am a lawyer, and I learned pretty well, in doing some cases, how to become immersed in something for a period of time and begin to understand it so you can plead your case adequately. Just speaking as somebody who's spent now a long time on this Committee listening to a lot—I mean, I began way down the line there sitting next to Al Gore, long before Al Gore wrote a book on it, and we heard a lot of hearings here, and we've been through this for a long period of time. Too many scientists that I know and respect, too many people in too many countries that we know and respect, have accepted this science.

Only in this country are we still arguing about uncertainties. Scientists in other countries and leaders in other countries scratch their heads in befuddlement and in frustration over our unwillingness to fully embrace the science.

Now, I'm not crazy folks. I understand the importance of our economy. I represent a state that thrives on cutting-edge technological, high value-added job creation. I just happen to have a different view of how we can harness the energy of that creative entrepreneurial spirit to begin to find the solutions to this in, as I say, a least-cost, least-intrusive, most-productivity oriented, most profitable fashion for us.

I think we're fighting a useless, stupid fight here. The fight ought to be to get the corporations to the table and figure out—saying to them, "Look, you guys—how do we do this in the most sensible way?" But I'll tell you, there are too many people, like the chairman Lloyd Brown of British Petroleum, and our own Secretary of the Treasury, who, when he was chair of Alcoa, before he came into the Administration, all of whom have accepted the need for us to be more responsible and do something. I think, unless you start setting some targets and goals or embracing some more realistic efforts, the United States is going to encourage other countries to seek ways to get out from under, rather than to move forward.

Now, unfortunately, I regret, it's not my unwillingness to sit here, nor yours, and I understand that. I appreciate your patience enormously. Perhaps we will continue this discussion. I hope we can. I am anxious to work with you to find sensible ways. Nobody wants to—and I might add—and I want to make sure the record reflects this—I think there have been some stupid environmental demands that have found their way into legislative forum that don't adequately reflect the difference between a big company or a small company or the capacity to find some market-oriented solutions. Command and control doesn't have to be the solution, even as we set some targets. But we've got to recognize the need to move here, or I think we're going to find ourselves inheriting the wind, so to speak. I think it would be a tragedy for our generation of leaders not to have been more responsible about it.

So I welcome a good dialog about it, but I don't want to call something what it isn't here, and I think we've got to find a better solution. So——

Do you want to have the last word? I don't want to——

Mr. CONNAUGHTON. I'd just——

Senator KERRY.—not allow you to do that.

Mr. CONNAUGHTON.—like to just make an offer, Senator, following what you just said. Obviously, from an economic perspective, I believe what the President put forth is best. I would welcome a chance to talk further with you or your staff and give you a sense, from our end, on what we think the implied shadow prices on carbon and effects on the economy are from any proposal you'd like to consider.

Senator KERRY. Well, I appreciate that, and we'll follow up on that in good faith and see if we can move it.

As I said, Senator McCain and I, and I think Senator Hagel, and I hope a few others, will be traveling to South Africa. We intend to engage these other countries and hopefully you in a constructive effort to move this issue forward.

I thank you very much for taking time to be here this morning. We stand adjourned.

[Whereupon, at 12:10 p.m., the hearing was adjourned.]

APPENDIX

PREPARED STATEMENT OF HON. OLYMPIA J. SNOWE, U.S. SENATOR FROM MAINE

As Harvard University professor E.O. Wilson has said, "Because all politics is ultimately ethical at its base—or at least pretends to be—the decision making processes that will save the natural environment must be grounded in moral reasoning fed into political life through education." You are the President's team of advisors for the nation's climate change goals and strategies and I am looking forward to your further educating us today as to how the Administration plans to address this pressing issue, and how we can help in this process.

There is now a large amount of peer-reviewed scientific literature that documents that the burning of fossil fuels, and the subsequent release of carbon dioxide, is impacting the environment—and may literally be changing the climate. Significantly, the U.S. Climate Action Report—2002, recently submitted to the United Nations' Secretariat, states that human actions, namely burning fossil fuels, are largely to blame for rising global temperatures, and that increasing temperatures could significantly alter daily life and ecosystems in the United States over the next few decades. The Report was the third formal national communication submitted to the U.N. by the United States as a signer of the 1992 UN Framework Convention on Climate Change, or UNFCCC.

While scientific uncertainties remain, certain facts are known and we must listen to the scientific body of knowledge before us while continuing to probe the unanswered questions through further research and technological development. The fact is that, since about 1750, the concentrations of greenhouse gases have increased: carbon dioxide by 31 percent, methane by 151 percent, and nitrous oxide by 17 percent. Evidence also shows that the 20th century was the warmest in the last 1,000 years, and the 1990s the warmest decade.

Since 1983, we have experienced the 10 warmest years—seven of them since 1990, with 1988 being the warmest year in the past millennium. At the same time, changes in precipitation patterns and rises in sea level have been noted around the world. I believe the United States need not only adapt to the changes to which the vast majority of scientists are alerting us, but we also must give serious consideration to taking steps to reverse this trend, taking into account both the environment and the economy.

I think we can safely say that, like the times, the climate is changing and how we respond to these changes, how we mitigate and how we adapt to these changes are of utmost importance to our moral obligation as to how we leave the planet for the generations that will follow.

Climate change is now better understood by our constituents who are increasingly aware of the concerns raised by scientists throughout the world. I am interested to hear what the Administration plans to do to address the potential impacts of climate and global change on our society.

Climate change has also become a concern to U.S. businesses, who worry that they might miss out on the economic and technological advantages that are developing to address climate change in the international marketplace as they watch most of the rest of the world move forward with international agreements.

There is an interesting report that came out last month entitled, "Global Climate Change: Fact or Fiction? It Doesn't Matter—The Issue Is Here to Stay." This was one of the Executive Action series produced by The Conference Board—a group of over 3,000 concerned business leaders representing a variety of major industries around the globe. The report's thesis is that: ". . . while science is unlikely to provide unequivocal answers to the global climate change debate, governments and markets are likely to act on their perception of the science. The only certainty right now is that these actions will have an impact on global business."

The conclusion reached by the authors of the report is that: ". . . climate change as an issue for business leaders will not go away. It will increasingly affect the way business is done. But . . . by effectively meeting the challenge of climate change, businesses will also deal effectively with several other issues, ([such as] energy

costs, reliability, and volatility) that affect competitiveness. New business opportunities will very likely be discovered in the process. Forward-looking business managers who approach climate change from this perspective can expect to gain long-term competitive advantage as a result."

I am interested in hearing from you today what the Administration is currently doing, and is planning to do, to address the concerns of the business sector that is requesting future certainty for receiving credit for actions they are taking, or can take now, to reduce greenhouse gas emissions.

I also await the Administration's views on the Senate's provisions in the Energy bill, especially the Corzine-Brownback bipartisan amendment for Title XI, for which I am a cosponsor. Working with industry representatives and environmental groups, I believe we have found common ground for a meaningful approach to reduce man-made emissions impacting the climate by crafting provisions that set up a national greenhouse gas database. The provisions set up an inventory of greenhouse gas emissions from significant sources and also a registry of voluntary reductions.

I believe it is time to send a clear signal to the nation's larger polluters that they can voluntarily report but, if, in the next 5 years, the industry has not stepped up to the plate to create a vibrant voluntarily system for reporting that reaches a threshold of at least 60 percent of total national aggregate greenhouse gas emissions—and one that heads us in the direction of reducing greenhouse gas emissions—the program will become mandatory for all large GHG emitters. Overall, the Title XI provisions provide a strong incentive for companies to measure their emissions and find ways to reduce them sooner rather than later.

Dr. Mahoney, I realize that you are fairly new to your position at NOAA and are in the planning process for a new research strategy as required under Section 104 of Public Law 101–606, the Global Change Research Act of 1990. I expect that you must have progressed far enough to determine, as the Act calls for, "the goals and priorities for federal global change research which most effectively advance scientific understanding of global change and provide usable information on which to base policy decisions relating to global change." I understand that you are integrating the GCRP with the President's new initiative, the Climate Change Research Initiative, or CCRI.

Based on recommendations of the 2001 National Research Council report on "The Science of Regional and Global Change", the President, in his June 11th report, directed your Department ". . . to maximize coordination among federal agencies" in addressing global and climate change issues. I am familiar with multi-agency programs in the past that have had laudatory goals to address complex, multidisciplinary problems—programs that, following implementation, have produced fragmented results from individual agencies with no sense of synthesis or cohesiveness.

It appears to me that the agencies have gone down their individual paths and done their own thing without an eye toward the big picture. The research program did not look at the broad questions that needed answering, but rather at what an agency is doing that could perhaps contribute to an isolated piece of an answer. There was no forethought as to what issues need to be addressed and how we get there. Rather, it was what answers can we produce, and does there happen to be a question that we can pose that fits that answer.

There is a vast wealth of scientific information and innumerable products that have been generated by the individual agencies involved in the global change research program—and there will be far more generated in the future. Providing a unified view of the research program will be of benefit to all stakeholders involved and to the program itself. As required by the Global Change Research Act, there is a need to focus on understanding the nature of and interaction among physical, chemical, biological, and social processes related to global change.

So, again, I am interested in hearing your plans to ensure that the approaches to climate and global change questions are taken from a comprehensive perspective, rather than from individual agency perspectives. I feel that this is an extremely important distinction in the approach to the issue. I am particularly interested in hearing what your plan will do to estimate the societal vulnerabilities in the U.S. to climatic variability and change.

I look forward to your testimonies this morning and also look forward to working with you and the Administration in the very near future for what I consider to be an issue of environmental security.

Thank you Mr. Chairman.

AMERICAN METEOROLOGICAL SOCIETY,
Boston, MA, July 9, 2002.

Hon. ERNEST F. HOLLINGS,
U.S. Senate,
Washington, DC.

DEAR SENATOR HOLLINGS:

The American Meteorological Society wishes to comment on the scientific basis for the recent publication. *U.S. Climate Action Report—2002.* The following statement has been approved by the AMS Committee on Public Policy:

The AMS has not reviewed the EPA report U.S. Climate Action Report—2002 in its entirety and consequently is unable to take a position regarding the report. The AMS does, however, endorse the science-based documents that were used, in part, within the report to present the state-of-the-science and the uncertainties within that science. These documents include: IPCC Third Assessment Report—Climate Change 2001 and the 2001 NRC report, " Climate Change Science: an Analysis of Some Key Questions."

I appreciate the opportunity for the atmospheric sciences and services community represented by the AMS to comment on this important report.

Sincerely,

RONALD D. MCPHERSON,
Executive Director.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO HON. JAMES L. CONNAUGHTON

ACCOUNTING OF PROJECTED "REDUCTIONS"

Question 1. The Administration has stated that its proposal to reduce emissions intensity, using voluntary action, will result in lowering emissions per million dollars of GDP from 183 metric tons to 151 metric tons in 2012 and that this plan will achieve "100 million metric tons of reduced emissions" in 2012.

However, these are mere *projections* based on assumptions that are not clear. Based on the Climate Action Report, it is clear that total emissions to the atmosphere will continue to increase over today's levels, even as emissions intensity decreases. Mr. Connaughton, you told the Committee on July 11th that "there is no question about that."

With a projected increase in emissions, I don't understand how you arrived at the claim of 100 million metric tons of reduced emissions.

Answer. The reductions are measured from the Annual Energy Outlook (AEO) 2002 reference case, augmented by an EPA forecast of non-energy related greenhouse gas emissions. In 2012, the AEO2002 projected energy related carbon emissions to be 1892 mmtce, while an internal EPA forecast of growth rates for non-energy-related GHG yielded an additional 387 mmtce in 2012, for a total of 2279 mmtce in 2012 in the reference case. If carbon intensity were to be reduced by 18 percent between 2002 and 2012, total GHG in 2012 would be 2173 mmtce. Thus, the reduction in emissions would be 106 mmtce in 2012.

Question 2. Is this a reduction from the projected rate of increase under "business as usual" or are the reductions measured from today's emissions levels?

Answer. See above. This reduction is from the AEO2002 reference case in 2012, not today's emission levels.

Question 3. What are the assumptions that underlie any business as usual emission projections and your projection?

Answer. The assumptions for the reference case are those of the AEO2002, including world oil price, macroeconomic growth rate, and other assumptions including technology improvement embedded in the National Energy Modeling System. The forecast assumes current laws and regulations. Therefore, the emission projections in the reference case do not assume any caps on future energy-related carbon emissions.

Question 4. Please describe exactly what "reductions" you are measuring, and from what baseline.

Answer. As stated above, the reductions are total GHG emissions in 2012 from a reference case projection for 2012 based on the AEO2002 and an estimate of non-energy related GHG emissions from an internal EPA forecast of non-energy related GHG emission growth rates. The total reduction as a result of the Administration's proposal would be 106 mmtce in 2012, relative to that baseline.

VOLUNTARY MEASURES

Question 5. The U.S. has advocated and supported voluntary actions to reduce emissions—including under the Clinton Administration. Yet after a decade of such voluntary actions, emissions continue to increase rapidly both for the United States and the rest of the world. Even those who are supporters of voluntary emissions reductions point to the record and observe that in the aggregate, voluntary actions have not succeeded at curbing the overall growth in U.S. emissions. And the data in the Report support that view.

Mr. Connaughton, does it make sense to spend another 10 years proving what the record already tells us?

Answer. President Bush has stated that addressing global climate change will require a sustained effort over many generations. The Administration recognizes that achieving long-term stabilization of atmospheric greenhouse gas concentrations at a level to prevent dangerous interference with the climate system, may eventually involve, as the science justifies, stopping and reversing greenhouse gas emissions growth. Slowing the growth of these emissions in the next decade is a serious, but measured mitigation response and it allows time for the development of new technologies that will most likely help to substantially reduce greenhouse gas emissions in the long term, without the risk of harming the economy in the short term.

Voluntary approaches can offer substantial reductions in emissions in greenhouse gases over the next 10 years. Voluntary programs, when properly designed, are capable of substantial emissions reductions from business-as-usual and will help capture the significant greenhouse gas emissions reductions and energy bill savings from these normal capital stock turnover opportunities. In addition, the President's budget has devoted $588 million towards the research and development of energy conservation technologies and will spend $408 million towards research and development on renewable energy (including $150 million for the FreedomCAR initiative—which will advance the prospect of breakthrough zero-emission fuel cell technology) to ensure that the next generation of technologies plays a central role in an effective long term response to climate change. Finally, President Bush's energy plan provides $4.6 billion over the next 5 years in clean energy tax incentives to encourage purchases of hybrid and fuel cell vehicles, to promote residential solar energy, and to reward investments in wind, solar, and biomass energy production.

Question 6. What data does the Administration have to support the effectiveness of voluntary measures in reducing *actual* emissions?

Answer. Chapter 4 of the recently released *U.S. Climate Action Report 2002* highlights the accomplishments of many of the voluntary climate protection programs that are being implemented by the Department of Energy, the Department of Transportation, the Department of Agriculture and the EPA. In 2000 alone, U.S. climate change programs reduced the growth in greenhouse gas emissions by 242 teragrams of carbon dioxide equivalent (66 MMTCE). To date, these voluntary programs have been very effective. They have slowed the growth of greenhouse gases, while reducing air pollution and saving businesses, organizations, and consumers billions of dollars on their energy bills, all in a period of strong economic growth.

Examples of successful voluntary programs include the Energy Star labeling program, the EPA's Voluntary Aluminum Industrial Partnership, the AGStar program, and various initiatives to reduce methane. EPA's Energy Star labeling program is reshaping the way manufacturers make products and the way consumers purchase them. Over 600 million Energy Star products have been purchased to date across over 30 product categories.

Twelve of the 13 U.S. primary aluminum producers, representing 96 percent of the U.S. primary aluminum production capacity, have joined EPA's Voluntary Aluminum Industrial Partnership. Companies participating in this program have committed to make reductions in two potent PFCs, tetrafluoromethane (CF4), and hexafluoroethane (CF6). The program met its 2000 goal to reduce PFC emissions from U.S. primary aluminum smelting by 45 percent—equivalent to 1.8 million metric tons of carbon—using cost-effective approaches that make economic and environmental sense for the partners.

In the agriculture sector, USDA and EPA have partnered on the Ag-STAR program and the Ruminant Livestock Efficiency Program (RLEP), which focus on reducing methane emissions. The overall impact of these two programs on greenhouse gas emissions has been small on a national scale, but program stakeholders in the agricultural community have demonstrated that the practices can reduce greenhouse gas emissions and increase productivity.

Because of the potency of methane relative to carbon dioxide, a "methane-first" strategy for greenhouse gas mitigation is cost-effective. A variety of U.S. industry and government partnerships have reduced methane emissions, and they are ex-

pected to hold emissions at or below 1990 levels through and beyond 2010. Partners in EPA's methane programs are projected to maintain emissions below 1990 levels through 2010.

EPA's Natural Gas STAR program includes companies representing 40 percent of the U.S. natural gas production, 72 percent of transmission company pipeline miles, 49 percent of distribution company service connections, and 23 percent of processing throughput. This partnership has achieved significant reductions. In 2000, EPA estimates a reduction in methane emissions of 4 million metric tons of carbon equivalent, and projects for 2010 a reduction of 6 million metric tons of carbon equivalent.

EPA's Coalbed Methane Outreach Program (CMOP) encourages industry to reduce methane emissions from underground coal mines. The program provides technical assistance to mining companies on technologies for recovered methane. EPA estimates that CMOP reduced 2 million metric tons carbon equivalent in 2000.

The President's plan builds on this success with new partnerships, with tax incentives, with expanded research and reporting programs. For example, the question below elaborates on the Administration's current plans, in response to the President's directive, to improve the Department of Energy's national greenhouse gas emissions reduction registry.

Question 7. What kinds of "voluntary measures" and *verifiable* emissions reductions will be implemented over the next 10 years with the two largest sources of emissions and growth in emissions: *transportation and utilities*?

Answer. President Bush's plan calls for improvements to be made to DOE's Voluntary Emissions Reduction Registry, which will result in much higher standards for registered emissions reductions, including verification standards. These new standards should encourage greater confidence in the federal registry and thus encourage increased efforts and participation by many sectors, including transportation, electricity generation, commercial and residential.

The President has also challenged American industries and businesses to make specific commitments to improve the greenhouse gas intensity of their operations and to reduce emissions. The President's plan will build on successful sector challenges, such as agreements with the semiconductor and aluminum industries, with broader agreements and greater reductions. EPA's Climate Leaders program was launched in 2002 and now has more than 31 major corporate partners. Additionally, DOE has been working with representatives of major energy intensive industrial sectors to identify opportunities for cost effective greenhouse gas reductions and to facilitate consensus building within these sectors on common reporting methodologies and voluntary strategies.

Developing new technologies to improve the energy efficiency of transportation in the United States will be a key element in achieving reductions in greenhouse gas emissions. The Administration is currently promoting the development of fuel-efficient motor vehicles and trucks, researching options for producing cleaner fuels, and implementing programs to improve energy efficiency. Research and development of breakthrough technology, such as the zero-emission fuel cell technology towards which FreedomCAR is working, is a long-term strategic goal. Along with these advances, the Administration also expects results in the next 10 years through tax credits for new hybrid or fuel cell vehicles. These credits will encourage the purchase of highly fuel-efficient vehicles that incorporate advanced automotive technologies and will help move hybrid and fuel cell vehicles from the laboratory to the highway. In 2001, EPA agreed to license to the Ford Motor Company a unique, high efficiency "hydraulic hybrid" technology that has the long term potential to reduce energy consumption and greenhouse gas emissions. The first application of this technology, planned for model year 2005, will result in a minimum 30 percent improvement in vehicle fuel economy (with a payback period of less than 3 years); the second phase, planned for as early as 2009, should double fuel economy (with a payback of less than 2 years). EPA has also launched voluntary programs focusing on commuter choice benefits to reduce vehicle miles traveled and reducing emissions from trucking fleet operations.

As a final point, I associate myself with the views that Dr. Glenn Hubbard, Chairman of the Council of Economic Advisors, shared with the Committee. The Administration is also taking action on developing new CAFE standards that are based on sound science and consider passenger safety and utility. The National Energy Policy recommended that the Department of Transportation review and provide recommendations on establishing CAFE standards with due consideration of the National Academy of Sciences 2001 study, "The Effectiveness and Impact of CAFE Standards."

"NO REGRETS" POLICIES—TRANSPORTATION AND UTILITIES

Question 8. The *Climate Action Report* states that as the largest source of U.S. greenhouse gases, CO_2 accounted for 82 percent of total U.S. greenhouse gas emissions in 1999. Carbon dioxide from fossil fuel combustion was the dominant contributor, with 31 percent of CO_2 emissions coming from transportation activities.

The Administration's proposal emphasizes the importance of technological innovation to address climate change, but is missing some great opportunities—forcing the use of technology today will spur jobs and reduce emissions right now. For example, the NAS study on corporate average fuel economy pointed to existing technologies that would accomplish multiple goals in a cost-effective way.

This is the ultimate "no regrets" action: reducing on oil imports while reducing greenhouse gas and other emissions.

(a) Given the rapid increase in greenhouse gas emissions due to transportation, what is being done to curb emissions?

(b) What action has the Administration taken on developing CAFE standards through rule-making to address this source of CO_2 emissions?

(c) Will technical innovation that moves us away from a fossil fuel economy occur rapidly enough to prevent "dangerous climate change" as defined by the UNFCCC's Article II?

(d) What is the U.S. Government's present investment in renewable and alternative energies and technologies relative to the last 10 years of government investments in the same categories, factoring in inflation?

Answer. I associate myself with the views that Dr. Glenn Hubbard, Chairman of the Council of Economic Advisors, shared with the committee. The Administration does not agree that "forcing the use of technology" represents a "great opportunity." In contrast to many environmental problems that result from a specific chemical or a narrow set of activities located in a confined area, the risk of climate change depends on the combined accumulation in the atmosphere of many different GHGs emitted from all over the world. While the contribution of a given amount of each GHG to climate change varies according to its relative potency in trapping energy and how long it naturally remains in the atmosphere, emission reductions of the various gases, adjusted for these differences, are equally valuable.[1] Moreover, because atmospheric concentration of GHGs matter, not emissions, carbon sequestration (e.g., absorption into forests and soil) of gases already in the atmosphere provides additional opportunities to reduce climate change risks.

The large contribution of carbon dioxide emissions to overall increases in the atmospheric GHG concentrations implies that reducing the growth in carbon dioxide emissions will be important to any long-term strategy to address climate change. Other gases comprised only 18 percent of total U.S. GHG emissions in 1999, while land-use changes and forestry in the United States sequestered the equivalent of roughly 15 percent of total emissions.[2] However, emissions of these other gases and carbon sequestration offer the bulk of inexpensive reduction opportunities for the U.S. right now—nearly twice as much as carbon dioxide emissions according to a recent EPA study—making it essential to include them in any cost-effective approach.[3] These facts represent the genesis of the Administration's approach to climate change, which is holistic, rather than sector-specific, and stresses efficiency and cost-effectiveness.

At the sector-specific level, addressing greenhouse gas emissions in the transportation sector would include action taken on Corporate Average Fuel Economy (CAFE) standards. The Administration is taking action on developing new CAFE standards: the National Energy Policy recommended that the Department of Transportation review and provide recommendations on establishing CAFE standards with due consideration of the National Academy of Sciences 2001 study on The Effectiveness and Impact of CAFE Standards. The Administration believes that CAFE standards should be addressed analytically and be based on sound science, considering passenger safety and utility.

In addition, the Administration is proceeding with the FreedomCAR program and the recently announced "New Vision for the 21st Century Truck Partnership." Both

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[1] As a result, emissions of greenhouse gases are often measured in tons of carbon equivalent, which weights the emissions of each gas according to the combined effect of its relative potency and residence time in the atmosphere.

[2] Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–1999,* (April 2001). See http://www.epa.gov/globalwarming/publications/emissions/us2001/pdf/table-es-1.pdf.

[3] Environmental Protection Agency, *Analysis of Multi-emissions Proposals for the U.S. Electricity Sector, Requested by Senators Smith, Voinovich, and Brownback*. See http://www.epa.gov/oar/meproposalsanalysis.pdf.

partnerships move the U.S. toward a vision of a safe and cost-effective transportation sector that is not reliant on imported oil, and creates no harmful emissions, of either criteria pollutants or greenhouse gases.

Regarding technological innovation, the IPCC reports an entire family of scenarios in which technological change is sufficient to maintain CO_2 concentration levels between 550–750 ppm through 2100 (see IPCC, "Climate Change 2001, Mitigation" Report of Working Group III, p. 4). The scientific community is as yet unable to determine what level of greenhouse gas concentrations or cumulative climate change leads to a "dangerous level" and this Administration is committed to advancing our understanding of climate science. The United States will continue to be a leader in science and technology under this Administration.

Below is a table of the Office of Energy Efficiency and Renewable Energy's budget for the past 10 years, in real 2002 dollars. EERE is the Department of Energy's primary program for research and development of energy efficiency and alternative energy sources and technologies, and as such represents the bulk of U.S. Government spending in this area. The EERE program is responsible for strengthening America's energy security, environmental quality, and economic vitality through public-private partnerships that enhance energy efficiency and productivity to bring clean, reliable and affordable energy technologies to the marketplace, and enhancing consumer's energy choices.

EERE Budget

[2002 Real Dollars in Thousands]

Year	Budget
2002	$1,298,394
2001	$1,198,448
2000	$1,087,759
1999	$1,081,546
1998	$971,667
1997	$907,355
1996	$933,186
1995	$1,262,202
1994	$1,173,037
1993	$986,025

It is also important to note that the President's FY03 budget proposal seeks $4.6 billion in clean energy tax incentives over the next 5 years. These tax credits will spur investments in renewable energies such as solar, wind, and biomass, hybrid and fuel cell vehicles, cogeneration, and landfill gas.

ADMINISTRATION VIEW OF IPCC

Question 9. I understand the Administration recently sent representatives to Bonn to participate in technical negotiations under the Framework Convention.

I was shocked to hear from observers that the Administration worked, together with developing countries, led by Saudi Arabia—to strongly dilute the role played by IPCC scientists and their latest "state of the science" report (the Third Assessment)—including its role in helping policymakers consider if concentrations are trending toward stabilization.

A U.S. negotiator even objected to the use of the word "robust" to characterize this IPCC Assessment, even though our own NAS characterized it this way.

What is the Administration's position on the role of the IPCC under the UNFCCC—to which I remind you, the U.S. is a Party?

Answer. The Administration regards the IPCC as an essential organization for coordinating international work on climate change.

Question 10. Does this Administration support the IPCC as the appropriate body to assess available information on the science, the impacts, and the economics of- and the options for mitigating and/or adapting to-climate change; and to provide scientific, technical and socio-economic advice to the Parties to the UNFCCC?

Answer. The Administration does regard the IPCC as an appropriate body for these functions.

Question 11. As discussed during the July 11th hearing, I would like a full account of these negotiations as soon as possible.

Answer. As a general matter in the negotiation process, the U.S. delegation is cognizant of the need to ensure that UNFCCC conclusions are accurately characterized and are likely to lead to outcomes that are in the U.S. interest.

With respect to the specific instance raised in your question, the U.S. delegation did not question the robustness of the findings of the IPCC generally. As noted above, the U.S. concurs with the NAS report, which is largely positive with respect to the accuracy of IPCC assessment, and the position of the U.S. delegation in Bonn was fully consistent with this position. Rather, the delegation questioned whether the IPCC's findings with respect to the objective of the Convention (Article 2) could be characterized as robust.

This point was relevant given the stated desires of some other delegations to move toward a determination of specific levels for what constitutes a "dangerous" level under Article 2. While the U.S. delegation was willing to make reference to the objective of the Convention in the conclusions of the Subsidiary Body for Scientific and Technical Advise (SBSTA) under the UNFCCC conclusions as a point for further discussion, the delegation considered that any such discussion should adequately account for the numerous remaining uncertainties regarding the nature and timing of climate change. An EU proposal would have put "robust findings" and "uncertainties" on equal footing, which the U.S. delegation indicated it did not consider appropriate in the context of the ultimate objective of the Convention.

The U.S. view on this matter is supported by findings in the IPCC Synthesis Report. In its intervention on this point, the U.S. delegation cited and quoted the paragraph on page 22 of the IPCC Synthesis Report, which notes the advances made in understanding the qualitative character of the impacts of climate change, but notes that because of a number of uncertainties (listed in the paragraph), "comprehensive, quantitative estimates of the benefits of stabilization at various levels of atmospheric concentrations of greenhouse gases do not yet exist."

Similarly, the U.S. position is consistent with the NAS report, which did not identify a "safe" level of greenhouse gas emissions, but instead identified a number of variables. The report notes:

• "The course of future climate change will depend on the nature of the climate forcing (e.g., the rate and magnitude of changes in greenhouse gases, aerosols) and the sensitivity of the climate system. Therefore, determination of an acceptable concentration of greenhouse gases depends on the ability to determine the sensitivity of the climate system as well as knowledge of the full range of the other forcing factors, and an assessment of the risks and vulnerabilities. Climate models reflect a range of climate sensitivities even with the same emission scenario . . ."

• "The range of model sensitivities and the challenge of projecting the sign of the precipitation changes for some regions represent a substantial limitation in assessing climate impacts . . . The differences among climate model projections are sufficiently large to limit the ability to define an "acceptable concentration" of atmospheric greenhouse gases. In addition, technological breakthroughs that could improve the capabilities to adapt are not known . . ."

KYOTO ALTERNATIVE

Question 12. The President has publicly registered his concern with the Kyoto Protocol, stating it is "fundamentally flawed" because it does not include developing countries and its targets are "precipitous." Yet his Climate Change policy announcement acknowledges the seriousness of climate change and states that "the President recognizes American's responsibility to reduce emissions."

Assuming the Administration continues to oppose the Kyoto Protocol, are you developing an alternative international approach to ensure meaningful reductions of *actual* greenhouse gas emissions? When can we expect such a proposal?

Answer. The U.S. Senate in 1997 advised the prior Administration, in its unanimous Senate Resolution, 98, against entering into an agreement that exempted developing countries or risked serious harm to the American economy. Given our strong confidence and commitment to the United Nation Framework Convention on Climate Change, we do not have plans to put forward any additional approach through the multilateral system at this time. Other countries have expressed their desire to go forward with the Kyoto Protocol based on their own circumstances, and the Administration has respected their desire. We consider that at this point, it is most constructive for us to move forward with the President's plan, and to work cooperatively with others in the context of the UNFCCC and through bilateral and regional cooperation. We are actively engaged in both of these efforts.

As for the question of "actual" reductions, this is not a measure used in the Kyoto Protocol itself. Eight countries in Annex 1 have targets under the Kyoto Protocol that are above the 1990 emissions levels (a level that was arbitrarily set, with no basis in science), including 5 in the EU; in fact, if the UK and Germany are excluded from the EU's overall target of −8 percent (since they experienced substantial emissions reductions unrelated to climate policy), the remaining 13 EU member

states have an overall average growth target (note 0.5 percent increase). Another dozen countries are former socialist states whose targets are above their projected emissions for the Kyoto commitment period because of severe economic weakness in the past decade. Still others will meet much of their target through substantial purchases of overseas credits, often generated from faltering economies, or through generous accounting of carbon sinks.

Not only is "actual reductions" not a Kyoto benchmark, it does not say very much, about the level of effort required by different countries under Kyoto. The United States' target under Kyoto was uniquely stringent, due to the unparalleled growth in both our economy and population in the 1990s compared to other countries. As a result, "actual" reductions could not possibly be achieved in the 6 years left before the Kyoto commitment period without a very substantial and unnecessary cost, since it would mean reducing emissions by over ⅓ of total U.S. emissions.

This fact was well recognized by the previous administration. According to its economic analysis, the United States would have achieved only a fraction of the required reduction under Kyoto at home (100–150 tons), meaning that actual U.S. emissions would have grown substantially (by some 20–30 percent). Its analysis also projected a need to meet Kyoto's target primarily through the purchase of credits from Russia and other countries, resulting in a transfer of U.S. wealth to these countries of billions of dollars.

Question 13. The President's initiative declares that "Greenhouse Gas Intensity" is a more "practical way to discuss goals with developing countries," suggesting that the United States may be advocating the use of this measure with developing nations in evaluating progress toward meeting the goals of the Framework Convention.

What direction has the Administration provided you regarding the promotion of this metric of "progress" *instead* of total emissions or atmospheric concentrations in international discussions, including under the Framework Convention or in the IPCC?

Answer. At this stage, we are working with a number of countries bilaterally and regionally on a broad range of issues covering scientific and technological cooperation and policy dialogue. In many of our interactions, we have explained the advantages of the President's greenhouse gas intensity approach, as well as other aspects of our policy that we believe they will find favorable.

We believe that an approach using greenhouse gas intensity is likely to be an attractive alternative to absolute targets for many developing countries, particularly since absolute emissions are difficult to gauge in economies that have unpredictable rates of growth. Where growth rates are unpredictable, countries are likely to be more reluctant to agree to an absolute target, because they are more likely to overshoot their projections. They understand that if their economic growth rate is greater than projected, meeting an absolute target would require them effectively to impose a ceiling on economic development simply due to this miscalculation. At the recent Eight Conference of the Parties to the UNFCCC, Indian Prime Minister Vajpayee noted the intensity metric in his remarks to the Conference: "As the cumulative effect of all these policies and measures, the *energy intensity* of our GDP has been declining steadily."

Notably, even the prior administration's economic advisors acknowledged the advantages of an intensity metric: "Consistent with the Framework Convention on Climate Change, targets for developing countries should help promote their sustainable development. For them to do so, such targets should accommodate emissions growth, because some growth is emissions is an unavoidable consequence of development . . . An emissions target could also take other forms. It could for example, be indexed to a country's economic performance (such as GDP) between now and the 2008–12 commitment period. Such targets could avoid the risk of a crunch arising from faster than projected economic growth between now and the commitment period." (Economic Report of the President, February, 2000).

Question 14. Are the Administration's actions and positions in international negotiations consistent with that goal?

Answer. Yes. A greenhouse gas intensity goal as a metric is a measure that links progress to the rate of economic growth, rather than setting an absolute quantitative goal at a moment in time. In either case (intensity or quantitative goal), the goal can be adjusted to meet most objectives that could now be envisioned under the UNFCCC.

Question 15. Is the Administration working to convince other countries to reduce their emissions, or is it true that the Administration is trying to convince them to only reduce "intensity"?

Answer. The Administration has not discussed this issue in such specific terms. We have articulated a reasonable and aggressive target for ourselves that would slow the growth of emissions over the next 10 years.

As noted above, this is also consistent with the previous administration's approach to reductions in its plans to implement the Kyoto Protocol. The previous administration, in its own economic analysis, did not envision an absolute reduction in U.S. greenhouse gas emissions, but rather a reduction from business-as-usual emissions growth of between 100 and 150 million metric tons of carbon—comparable to the amount envisioned in the President's plan.

Question 16. How would using this metric worldwide have any effect on emissions reduction in our lifetime?

If all the countries in the world—or even the major emitters from both developed and developing countries—began to reduce their greenhouse gas intensity, there is no question that the effect on emissions could be quite substantial—far more so, in fact, than the approach taken under the Kyoto Protocol, which called for unpredictable and in some cases unrealistic targets for a small minority of countries, with many other countries taking on absolutely no targets whatsoever. Whether the Kyoto Protocol ever enters into force and whether the countries participating in it actually achieve their targets, remains very unclear.

The Administration recognizes that achieving long-term stabilization of atmospheric greenhouse gas concentrations to avoid dangerous interference with the climate system may involve—as the science justifies—stopping and reversing greenhouse gas emissions growth. Slowing the growth of these emissions through expanded use of voluntary initiatives and proposed tax incentives will allow for the development of technology to substantially reduce greenhouse gas emissions in the long term, without the risk of harming the economy in the short term. The President has also committed that if progress is not sufficient by 2012 and sound science justifies further action, the United States will respond with additional measures that may include a broad, market-based program, as well as additional incentives and on voluntary measures designed to accelerate technology development and deployment.

Question 17. From the testimony submitted on July 11th, it appears inconsistent for the Administration to simultaneously claim that, on the one hand, meeting the Kyoto targets would ruin the U.S. economy, and on the other hand, the President's plan achieves as much reductions as other nations under the Kyoto protocol.

Answer. This question was also asked very appropriately of Dr. Glenn Hubbard, Chairman of the Council of Economic Advisors. I associate myself with his answer and attach a copy, (Attachment A) for your convenience.

Had the United States intended to meet its Kyoto target exclusively through domestic abatement, we would have had to reduce our greenhouse gas intensity in 2012 significantly more than 4 percent below the baseline projected in the AEO 2002.

As Dr. Hubbard mentioned in his testimony, Janet Yellen, a former CEA chair, testified that domestic reductions of 100 to 150 million metric tons could be obtained.[4] This is close to the 106 million, or 4.5 percent reduction called for by the President.

For your convenience, Chart 5 from Dr. Hubbard's testimony is below. Chart 5 shows the U.S. commitment alongside estimates of the average required reductions for the remaining countries with emission limits under the Kyoto Protocol. While some countries, such as Canada and Japan, have challenging targets, others, such as the transitional economies of the former Soviet Union and Eastern Europe, have targets that are much greater than the current emissions. According to one set of estimates by the Energy Information Administration, these surplus allowances exceed the needs of other countries with targets that require reductions below their baseline, with a net effect that required reductions through domestic abatement activities are zero. Another set of estimates from a group at MIT shows required average reductions of 7.2 percent below baselines. Viewed together, these forecasts suggest domestic abatement efforts to reduce emissions among remaining Kyoto countries would be roughly comparable to the U.S. commitment.[5]

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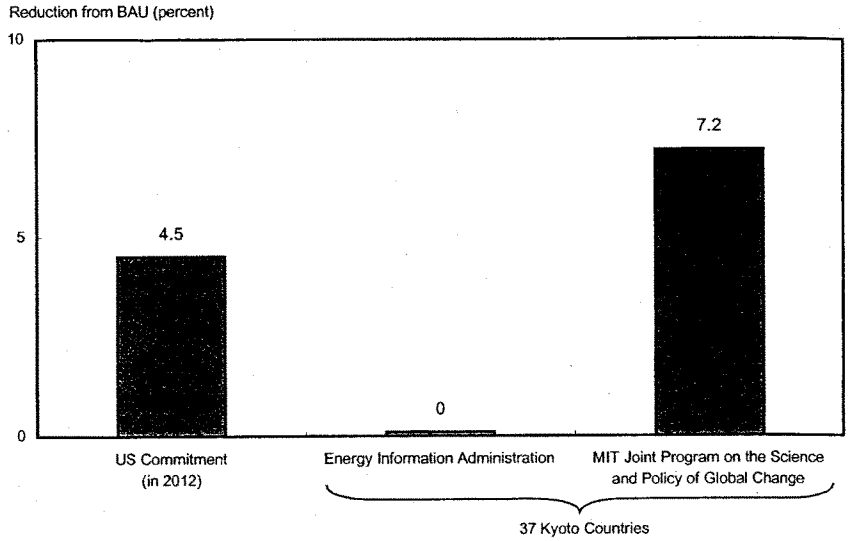
[4] See Testimony of Janet Yellen, Chairman, Council of Economic Advisers, on H271–9 before the Subcommittee on Power and Energy of the House Committee on Commerce, page 323, lines 26 and 29.

[5] See Energy Information Administration (EIA), *International Energy Outlook 2001,* DOE/EIA–0484 (2001) (Washington, DC, March 2001); and John Reilly, MIT Joint Program on the Science and Policy of Global Change, Snowmass Summer Workshop (August 6, 2001). The *IEO 2001* estimates that total required reductions among the Annex I countries (those required to reduce emissions under the Kyoto Protocol) would be 554 million metric tons in 2010. Of that,

Chart 5 **Reductions from Forecast Levels**

U.S. reductions from forecast levels are consistent with the average reductions in Kyoto countries.



Source: Department of Energy (Energy Information Administration) and MIT Joint Program on the Science and Policy of Global Change.

Question 18. Mr. Connaughton, you submitted testimony that implementing the provisions contained in the Kyoto Protocol would have a $400 billion impact on the economy, as CO_2 emissions are reduced to 7 percent below 1990. However, Dr. Hubbard testified that the U.S. greenhouse gas reductions that will result from the President's plan are "comparable to the average reductions required under the Koto Protocol for countries remaining in the agreement." I understand that Dr. Hubbard's assessment is based on the notion that countries would buy the credits they need through international trading.

Answer. Addressed above.

Question 19. Mr. Connaughton, does the $400 billion impact figure that you came up with consider international trading and the other mechanisms found in the provisions of the Kyoto Protocol?

Answer. For more information, please refer to answer to CEQ Question #1. It is noteworthy that the Annex B Parties that have decided to participate in the Kyoto Protocol have imposed constraints on Kyoto's Clean Development Mechanism.

Question 20. Can you provide the specific assumptions relevant to the Kyoto flexibility mechanisms (international trading, sinks, and non-CO_2 gas trading) behind the $400 billion figure on the one hand, and on Dr. Hubbard's assessment of emissions on the other?

Answer. Please see the answer to CEQ Question #1 for information regarding the assumptions behind the $400 billion loss to the economy estimated by the EIA, as a result of the Kyoto Protocol.

Question 21. Could you provide for me a consistent assessment (based on the same set of assumptions) of the cost of implementing the Kyoto Protocol and achieving the 7 percent reduction in CO_2, and on the President's plan achieving the same level of CO_2 reductions?

Answer. Please see the answer to CEQ Question #1.

Question 22. What is the present assessment of the economic impact of the projections presented as "likely" in the Climate Action Report?

Answer. I associate myself with the views that Dr. Glenn Hubbard, Chairman of the White House Council of Economic Advisors, has shared with the Committee.

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the United States' burden is 558 million metric tons (page 14), leaving a marginal surplus of reductions—without any further effort—among remaining participants after U.S. withdrawal from the Protocol. The MIT study provides slightly higher estimates of the burden among remaining participants (7 percent or 290 million metric tons).

From an economic perspective, due to the fundamental gaps that remain in our current understanding of human-induced global climate change, significant uncertainty surrounds any attempt to estimate the benefits of greenhouse gas reductions, generally. However, the President's aggressive national goal, that significantly exceeds (by 28 percent) the projected reductions in our greenhouse gas intensity in the next decade, represents an appropriate, near-term response to the seriousness of this long-term issue.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ERNEST F. HOLLINGS TO JAMES L. CONNAUGHTON

CAFE

Question 1. At the hearing, you stated that the Administration is "working" to "improve fuel economy for our cars and trucks," yet the Administration to my knowledge has not articulated any plan to improve fuel economy, or even a timeline for doing so. This lack of action—encapsulated in your "Climate Action Report"—is remarkable, since the National Academy of Sciences came out 2 years ago advocating improvements in automotive fuel economy to both reduce reliance on imported oil and reduce dangerous emissions of greenhouse gases. The NAS also specifically advocated doing more than what the market forces alone would require.

What is the Administration's view of the NAS report findings?

Answer. The NAS report included two important findings: (1) that fuel economy can be significantly increased through the use of new and existing technology without compromising safety, and (2) that the current CAFE system has created an incentive for manufacturers to produce smaller and lighter cars, which the majority of the NAS committee believes has led to many additional traffic injuries and fatalities. The Administration is deeply concerned about the NAS study's findings about the adverse impact the current CAFE program has had on safety.

In light of their findings, the NAS committee made specific recommendations for reforming the CAFE system. Most significantly, the report recommended that the current CAFE system should be replaced with an attribute-based system (such as weight-based standards), and that a system of freely tradable fuel economy credits should be established. Accordingly, the Administration is also interested in obtaining legislation that would authorize the Department of Transportation to reform the CAFE program, giving full consideration to NAS report findings. The NAS committee also recommended that NHTSA update its 1997 size and safety study. NHTSA has already undertaken the effort to update the study and it should be completed later this year.

Question 2. Does the Administration advocate increasing fuel economy of the fleet?

Answer. The Administration supports increasing fuel economy by encouraging new technologies that reduce our dependence on imported oil while protecting passenger safety and American jobs.

Question 3. What is the Administration actually doing to improve fuel economy, aside from funding fundamentally the same long-term research as the Clinton Administration?

Answer. The Administration has taken several actions aimed at improving fuel economy. In a letter sent on July 10, 2001, Secretary Mineta requested that Congress remove the appropriations rider that had prevented the Department of Transportation from revising CAFE standards for six fiscal years. Once Congress finally removed the appropriations rider on December 18, 2001, the Department's National Highway Traffic Safety Administration (NHTSA) has moved expeditiously in resuming its CAFE rulemaking responsibilities. On February 7, NHTSA issued a Request for Comment in the *Federal Register* to acquire information the agency needs to develop a rulemaking proposal for new CAFE standards for light trucks beginning in model year (MY) 2005. The Request for Comment also sought public comment on reforms to the CAFE system, particularly those recommended in the NAS report. NHTSA plans to cover all or some of model years 2005 to 2010 in its proposal this fall. A final rule establishing the new CAFE standards for light trucks will be issued no later than April 1, 2003. To encourage Americans to buy more fuel efficient vehicles today, the President has proposed tax incentives for the purchase of hybrid and fuel cell vehicles. To advance and accelerate the development of even more fuel efficient vehicles in the future, the Administration is funding and working with partners (research universities and the private sector) to leverage resources for research and development of new vehicle and fuel technologies, including the new fuel cell FreedomCAR initiative, hybrid vehicles, and ultra-low sulfur fuels.

Question 4. If gasoline prices remain low, and CAFE standards remain the same, how can the Bush Administration expect to promote purchases of fuel efficient cars? Does this conform to the modeling and findings of the NAS?

Answer. To encourage Americans to buy more fuel efficient vehicles, the President's energy plan proposes tax incentives for the purchase of hybrid and fuel cell vehicles totaling more than $3 billion (from 2002 to 2012). The NAS study mentions (pg. 94) that such a system would provide incentives for manufacturers to pursue advanced technology research and then bring those new technologies to market and for consumers to buy these products. However, because it was beyond the scope of the study, the committee did not evaluate such policy instruments.

Question 5. What is the status of the rulemaking NHTSA announced it was collecting information on?

Answer. NHTSA is currently completing its analysis of light truck CAFE standards for MY 2005 and beyond. A proposed rule for light truck CAFE standards will be published soon. NHTSA plans to cover all or some of model years 2005 to 2010 in its proposal. A final rule establishing the new CAFE standards for light trucks will be issued no later than April 1, 2003.

Question 6. Will NHTSA issue a rule to improve fuel economy of both passenger cars and light trucks?

Answer. Because NHTSA is statutorily required to issue the MY 2005 light truck standard before April 1, 2003, the agency's current rulemaking is focused on establishing CAFE standards for light trucks for MY 2005 and beyond.

Question 7. When is NHTSA expected to issue a proposed and final rule to increase fuel economy under the CAFE program?

Answer. NHTSA will issue a proposed rule to increase the fuel economy of MY 2005 light trucks and beyond in Fall 2002. NHTSA will issue a final rule establishing light truck CAFE standards for all or some of MYs 2005–2010 by April 1, 2003.

Question 8. What greenhouse gas emissions savings do you project from improved fuel economy?

Answer. Until we determine the level of the new standards, we cannot quantify the amount of greenhouse gas emissions savings that will be realized as a result of our rulemaking action.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO JAMES L. CONNAUGHTON

Question 1. Your statement mentions that the Kyoto Protocol would have cost the United States $400 billion and 4.9 million jobs. What are those numbers based upon? What are the key assumptions that support the numbers?

Answer. I associate myself with the views that Dr. Glenn Hubbard, Chairman of the Council of Economic Advisors, shared with the Committee. The Energy Information Administration created a report titled *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity.* Specifically, Chapter 6—"Assessment of Economic Impacts" addresses the issue of model assumptions and development.

The macroeconomic impacts were derived by simulations of the Data Resources, Inc. (DRI) model of the U.S. economy. Two key features shape the magnitude of the macroeconomic impacts: (1) the disposition of funds collected with a permit auction run by the Federal Government; and (2) the international trading of carbon permits.

Regarding the disposition of funds, the default analysis returned collected revenues to consumers through personal income tax rebates. The alternative analysis assumed a reduction in payroll tax rates.

The role of international trading and sinks is handled through the specification of alternative targets for carbon reduction. It should be noted that non-CO_2 gases are not addressed in the EIA Kyoto study. The inclusion of sinks provides a 3 percent offset to the most stringent case (the 7 percent reduction relative to 1990 levels of carbon emissions). The movement to other cases (1990, 9 percent increase, 14 percent increase, and 24 percent increase) represent increasing purchases of international permits, at lower international permit price assumptions.

Pooling this information, as one proceeds from the most stringent case (7 percent decline) to the least stringent case (24 percent increase), the impacts on the economy diminish. The $400 billion figure mentioned refers specifically to the default analysis with a 7 percent decline relative to the reference case.

The 4.9 million job loss is also associated with the aforementioned default analysis with a negative 7 percent reduction relative to 1990 levels of carbon emissions. Although the EIA report, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity,* does not explicitly calculate the employment impacts, the loss of

jobs figure can be calculated by comparing the labor force level and unemployment rate after the Kyoto Protocol relative to the base case. Given the 7 percent decline and default analysis, the level of the labor force declined and the unemployment rate rose relative to the base case. Consequently, these two effects combine for an employment loss relative to the baseline of approximately 4.9 million jobs.

Question 2. The President has stated that the emissions level in the Kyoto Protocol is too costly for the U.S. Is there some level of emissions that would not be too costly?

Answer. The national mitigation goal articulated by the President in February focuses on significantly accelerating projected reductions in greenhouse gas emissions intensity, or greenhouse gas emissions per dollar of GDP, specifically a reduction of 18 percent in the next decade. This goal significantly exceeds current projections of an approximate 14 percent reduction in the next decade, which will result in the avoidance of over 100 million metric tons of carbon equivalent emissions in 2012.

The philosophy underlying the Administration's policy was best summed up by the President on February 14, 2002. "My approach recognizes that sustained economic growth is the solution, not the problem—because a nation that grows its economy is a nation that can afford investments in efficiency, new technologies, and a cleaner environment." This philosophy, of course, represents a sharp contrast to the policy formulated by the prior Administration, which would have imposed sharp constraints on the U.S. economy in order to meet the arbitrary, near term emissions reduction targets of the Kyoto Protocol. The problem with that approach toward mitigation is that it represented a costly, unbalanced and ineffective overreaction to this long-term challenge and thus enjoyed no political support (e.g., Senate Resolution 98 passed by a 95–0 vote).

I associate myself with the views that Dr. Glenn Hubbard, Chairman of the Council of Economic Advisors, shared with the Committee. Growing economies—especially those with significant population growth—use more energy and generate more emissions. Even with aggressive programs to increase energy efficiency, this relationship is unlikely to change in the near term. Currently, there are few viable alternatives to fossil fuels, other than nuclear power, that can provide large amounts of energy. Under these conditions, it makes sense first to slow the growth of net greenhouse gas emissions, lay important groundwork for both current and future action, and work with other nations to develop an efficient and effective global response. Emissions may rise in the near term, but climate change must be viewed as a long-term problem, requiring a long-term solution that has broad-based country-level participation and allows for the economic turnover of our existing capital stock toward the advanced energy and sequestration technologies of the future. At this point, some model estimates predict that mandatory reductions, such as those called upon for the Kyoto Protocol, could cost the U.S. up to $400 billion and 4.9 million jobs.

Question 3. The U.S. Climate Action Report 2002 states that developed and developing nations must work together to address climate change effectively. Can you update the Committee on the U.S.'s technology transfer efforts, including the transfer of equipment and capacity building?

Answer. The Administration considers technology transfer to be a key component of assistance for developing countries and economies in transition in addressing their greenhouse gas emissions and their energy needs.

The Administration's FY03 budget request seeks $155 million to fund technology transfer and capacity building programs to address climate change, that are administered by the U.S. Agency for International Development. In addition, the Administration has requested $178 million to fund the Global Environment Facility ("GEF") in FY03, to maintain its strong technology transfer programs and pay arrears incurred by the United States during the last Administration. The GEF is the primary international institution for transferring energy and sequestration technologies to the developing world under the United Nations Framework Convention on Climate Change (UNFCCC).

Also, in response to the recommendation of the National Academy of Sciences for improving and expanding climate observation systems throughout the developing world, the President has allocated $25 million and challenged other developed nations to match the United States' commitment.

The United States has for some time been a leader in efforts to promote technology transfer internationally. In 1997 the United States established the Technology Cooperation Agreement Pilot Project (TCAPP) to demonstrate the benefits of an integrated approach to technology transfer, one of the first formal initiatives in support of the technology transfer goals of the U.N. Framework Convention on Climate Change. Last year, this project was transformed into the Technology Coopera-

tion Initiative (TCI), which serves as a coordination mechanism for agencies involved in multilateral and bilateral climate-related technology transfer activities.

In addition to extensive technology transfer and related capacity building activities conducted on an ongoing basis through various agencies such as DOE, EPA, State, USAID, and the national laboratories, the U.S. has also been very active in multilateral technology transfer activities through the Climate Technology Initiative (CTI). This activity, launched in 1995 by 23 OECD countries and the European Commission, supports the objective of the UN Framework Convention on Climate Change by fostering international cooperation to accelerate the more rapid development and diffusion of advanced technologies and practices.

During the past several years, CTI's efforts have been principally focused on working with developing and transition countries to assess their technology needs and develop a practical plan to implement these technologies in a manner consistent with the long term sustainable development goals of the country. Such a country-driven assessment provides for the more efficient targeting of capacity building and training along with enhanced access to technology information. Critical to this process is the identification of any institutional or other potential barriers that need to be addressed in order to provide the necessary enabling environment essential to the active engagement of the business and financial communities. In addition to positive feedback from the developing and transition countries participating directly, CTI has been recognized by the Framework Convention Secretariat as making a valuable contribution to technology transfer under the Convention. A listing of U.S. technology information activities developed for a U.S. submission to the UNFCCC appears below:

ANNEX I: Selected U.S. Technology Information Activities

The U.S. Government has supported and continues to support a range of technology information projects that can be considered as elements of the new FCCC Clearinghouse. Some examples include:

1. The Climate Technology Initiative (CTI) (www.climatetech.net): The U.S., through CTI, supported work that helped to develop early designs for the broad architecture of a prototype website. We continue to support development and demonstration of a dedicated search engine for user friendly access to high quality information by technology, region, etc., and development of a searchable directory of technology expert centers in developing countries (demonstration site at (http://itdomino1.icfconsulting.com/unfccc/climate.nsf).

2. The Global Technology Network (GTN) (*http://www.usgtn.net/*). The GTN is a program of the U.S. Agency for International Development (USAID) with the mission: "To facilitate sustainable economic growth in developing countries and emerging markets through business linkages and technology transfer." GTN facilitates the transfer of technology and services through the identification, dissemination and matching of industry specific requests for quotations (RFQs) for our member companies located in the United States, developing countries and transition economies. Regionally driven leads are electronically matched to pre-qualified U.S. registered suppliers or companies participating in our intra-regional trade programs in Africa, Asia and Southeast Europe. While there is a likelihood that GTN can lead to direct sales, there is also an emphasis on sustainable, long-term opportunities for suppliers, in the area of direct investment, establishing joint ventures and selecting regional/national agents and distributors in areas of the world that USAID has an active presence. GTN primarily focuses on four key industry sectors: Agribusiness Technology; Information & Communication Technology (ICT); Environmental & Energy Technology; and Health & Medical Technology and currently has operations in Africa, Asia/Near East, Europe & Eurasia, and Latin America & Caribbean.

3. The Global Network of Environment & Technology (GNET) (http://www.gnet.org): GNET, sponsored by the U.S. Department of Energy's Office of Science and Technology, contains information resources on environmental news, innovative environmental technologies, government environmental technology programs, contracting opportunities, market assessments, market information, current events and other material of interest to the environmental technology community. GNET uses communications and state-of-the-art technology to bring together the information, resources and people that shape the environment and technology marketplace. GNET is not merely a website, but a practical system for managing business activities and solving problems in the environmental technology marketplace. More than an information archive, GNET provides services to enhance efforts to communicate, gather and exchange information, and conduct business.

4. ECOLINKS (www.ecolinks.org): This USAID initiative promotes market-based solutions to urban and industrial environmental problems in Central and Eastern Europe and Eurasia. It focuses on the environmental needs of businesses, associa-

tions and municipalities through partnership grants, trade and investment, and information technology. The latter is accomplished through the U.S. Clean Technology Exchange (*www.cleantechexchange.com*).

5. US Asia Environment Partnership (www.usaep.org): The United States-Asia Environmental Partnership (US–AEP) is a public-private initiative that promotes environmentally sustainable development in Asia. US–AEP works in four program areas—Policy, Urban, Industry and Technology Cooperation. It embodies a model of cooperative development that encourages U.S. and Asian partnerships, engages key decision-makers who affect economic change and environmental awareness in Asia and the U.S. With a wide range of partners-governments, NGOs, academia, and the private sector, US–AEP has become a flexible, responsive vehicle for delivering timely answers to environmental questions.

6. The Information for Africa Climate Technology Transfer (iACTT) Pilot Project: Recently, the U.S. EPA has initiated this pilot project to build institutional capacity and to provide additional information tools to African decision makers and technical experts on environmentally sound technologies, services and financing. The coordinating technical institution will be the Environmental Development Action in the Third World (ENDA) (www.enda.sn) in Dakar, Senegal. Initial pilot activities will be carried out in Nigeria, Senegal, South Africa and Uganda.

Question 4. The U.S. Climate Action Report 2002 highlights a major obstacle to a global solution to climate change, when it states that "higher anthropogenic greenhouse gas emissions are a consequence of robust economic growth." As countries such as India and China reach higher stages of industrialization, it is expected that their greenhouse gas emissions will skyrocket. What steps can the United States take to aid developing countries in reaching greater economic development without causing a tremendous increase in greenhouse gas emissions?

Answer. Many aspects of the preceding answer to Question #3 highlight the unrivaled leadership of the Untied States in transferring advanced energy and sequestration technologies to the developing world, as well as enhancing their capacity to deploy these technologies and understand their current and projected emissions profiles.

Action to address climate change will require action by countries from all regions of the world, not just the developed countries listed in the Kyoto Protocol. As the President stated on June 11, 2001, we want to work cooperatively with these countries in their efforts to reduce greenhouse emissions and maintain economic growth. The President's approach provides a significant opportunity toward engaging developing countries in a more meaningful partnership than in the past. The President's plan expands cooperation with developing countries through substantial increases in funding for the Global Environment Facility and international forest conservation programs that will sequester carbon, as well as dedicating significant funding for bilateral technical assistance and the technology transfer programs of the U.S. Agency for International Development.

The Administration is actively engaged in enhancing bilateral cooperation with India, China and other countries with significant greenhouse gas emissions, including Korea, Mexico, and Brazil. In February 2002, President Bush and President Jiang of China agreed on a joint working panel on environment and climate change. The Administration has since been working with Chinese agencies to strengthen the already very broad range of cooperative activities between our governments relating to clean energy and climate change. The President and Indian Prime Minister Vajpayee agreed to expand cooperation on environment and energy issues, and the Administration is building on one of the most effective bilateral assistance programs in the world for addressing climate change. The Department of Energy and the Agency for International Development are engaged in projects to promote energy efficiency and cleaner fuels that they estimate are resulting in a reduction of 10 million metric tons of CO_2 equivalent annually. And recently at the World Summit on Sustainable Development, the U.S. announced an investment of up to $43 million in 2003 to leverage $400 million in clean energy initiatives. This commitment will enhance access to energy through Global Village Partnership (AID), enhance energy efficiency through Energy Efficiency for Sustainable Development Initiative (DOE) and focus on phasing out lead in gasoline and eliminating polluting home cooking stoves through the Clean Air and Healthy Homes initiative. These types of activities provide a solid foundation from which to deepen our cooperation with these countries, and show them that economic development and protection of the environment can go hand in hand.

In the longer term, investment in technology research and development will be a cornerstone of an effective strategy for helping all countries grow their economies while reducing projected greenhouse gas emission increases. The President's unprecedented investment in climate change research and development, through the Na-

tional Climate Change Technology Initiative and other programs, as well as through investment incentives for firms and households, represents a unique level of commitment toward these new technologies. As technologies become available, the United States will continue to promote approaches that enable developing countries to invest in and effectively apply these technologies. As indicated in question 3 above, the United States has been a leader in the development of an effective framework for technology diffusion in the developing world, and this will continue to be a point of emphasis in our future cooperative efforts.

Question 5. One of the principles of the President's plan from last June is to foster global participation in meeting the challenge of climate change. However, many developing countries feel betrayed by the irrational exuberance of the Rio Summit's promise of "win-win" economic development and environmental protections and the later struggle over the Kyoto Protocol. What steps can the Administration take to restore confidence in the idea of "sustainable development" to help developing countries make the hard choices between economic growth and environmental protection?

Answer. The recent "Delhi Declaration" issued at the Eighth Conference of the Parties to the UNFCCC resolves: "Parties should have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific condition of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change."

The Administration strongly believes that economic development is a necessary prerequisite for environmental protection. Strong economies generate the resources necessary to invest in the environment. Last February, President Bush stressed this point:

> "This is the common sense way to measure progress. Our nation must have economic growth—growth to create opportunity, growth to create a higher quality of life for our citizens. Growth is also what pays for investments in clean technologies, increased conservation, and energy efficiency. . . . Addressing global climate change will require a sustained effort over many generations. My approach recognizes that economic growth is the solution, not the problem. Because a nation that grows its economy is a nation that can afford investments and new technologies. . . . To clean the air, and to address climate change, we need to recognize that economic growth and environmental protection go hand in hand. Affluent societies are the ones that demand, and can therefore afford, the most environmental protection. Prosperity is what allows us to commit more and more resources to environmental protection. And in the coming decades, the world needs to develop and deploy billions of dollars of technologies that generate energy in cleaner ways. And we need strong economic growth to make that possible. . . .

We believe that it is possible to convince countries that they can develop on a cleaner path without threatening economic development. Unfortunately, many developing countries consider the possibility that they will need to assume the kinds of drastic and inflexible targets contained in the Kyoto Protocol to pose just such a threat. Previous efforts to impose Kyoto-like measures on developing countries were soundly and almost universally rejected.

We believe that there are many aspects to the President's plan that will be of great interest to developing countries in looking toward a new approach, and that can also help to move beyond the current North-South stalemate. For example, the Administration's use of greenhouse gas intensity as a way of measuring progress provides countries with a more manageable and flexible approach than that contained in the Kyoto Protocol, particularly because it is premised on their economic growth and reinforces their legitimate aspirations for improved living standards. As President Bush said last February:

> "It would be unfair—indeed, counter-productive—to condemn developing nations to slow growth or no growth by insisting that they take on impractical and unrealistic greenhouse gas targets. . . . The greenhouse gas intensity approach I put forward today gives developing countries a yardstick for progress on climate change that recognizes their right to economic development."

This is especially important for developing countries, whose growth rates can be highly variable from year to year. The Administration's plan also substantially increases U.S. funding for climate change-related technical assistance, and we are moving forward aggressively to develop partnerships to promote clean energy technologies, both in our climate change activities and in other contexts, such as the recent World Summit on Sustainable Development. As noted above, we believe that

in the longer term, technology will be the key for all countries to address climate change in a cost-effective manner, and we are working together with developing countries to promote the deployment of cleaner technologies.

The basis for all of our cooperative activities is our shared view that economic growth and environmental protection can and should be mutually reinforcing. We believe that our activities now can serve as the foundation for a more cooperative and effective partnership with the developing world on climate change as we deal with this long-term challenge.

Question 6. The United Nations Framework Convention on Climate Change has a voluntary goal of limiting year 2000 emissions to 1990 levels. This was attempted through voluntary measures over the last decade, but the data in the *U.S. Climate Action Report 2002* demonstrates that this was not accomplished. Yet, again, what the Administration proposes for the future are largely voluntary programs and the goal does not get the U.S. back to 1990 emission levels, as called for in the Convention. Is there any basis for believing that continued reliance on voluntary measures has a reasonable chance of achieving the objective of the Framework Convention?

Answer. The U.S. did not meet the voluntary reporting aim of the Convention for emissions in the year 2000 because, in retrospect, given the strong performance of the U.S. economy and relatively high population growth, it was the wrong aim: the aim itself could not have been realistically achieved without dramatically slowing the U.S. economy. Moreover, very few nations that experienced economic growth in the 1990s, achieved this non-binding reporting "aim." For example, carbon emission in 10 European Union countries actually increased between 1990 and 1999, according to International Energy Agency data.

The fact that the target was overly stringent does not negate the effectiveness of voluntary measures during the 1990s, which contributed to significant decoupling of the rates of economic growth and growth in greenhouse gas emissions. It is estimated that Federal Government programs alone achieved 66 million metric tons of carbon equivalent reductions or avoidance in 2000. There is strong reason for optimism that there will be broader and more committed private sector participation in voluntary programs under the President's plan than was the case in the 1990s. Many companies postponed decisions during and after the Kyoto negotiations because they had fundamental questions about the direction of U.S. climate change policy. The President's approach sends a strong signal to the private sector about the kinds of measures that will be effective over the next 10 years. We believe that these signals reflect a consensus for aggressive but realistic action, and that we will see significant reductions over this period as a result. The President's proposal to enhance the reporting system under Section 1605(b) of the Energy Policy Act provides an additional incentive to act, since companies will receive recognition for their actions.

As for the question of whether voluntary measures have a reasonable chance of achieving the long-term objective of the Convention, to avoid dangerous interference with the climate system, there are many variables that are unknown at this time, and it is too early for an informed answer. We do not know, for example, the level and timing of effort needed to meet the objective of the Convention, because of gaps in knowledge about the behavior of the climate system. The Administration is working aggressively to reduce those gaps in a timely manner, but fundamental questions will likely remain in the foreseeable future. We also do not yet know the extent to which future technologies will help us meet the objective as they are developed in the future and introduced into the market.

While no one knows at what level of greenhouse concentrations may need to be stabilized to meet the objective of the Convention, the Administration recognizes that achieving long-term stabilization of atmospheric greenhouse gas concentrations may involve—as the science justifies—stopping and reversing greenhouse gas emissions growth. Slowing the growth of these emissions through expanded use of voluntary initiatives, continued implementation of numerous mandatory programs (e.g., Corporate Average Fuel Economy and energy efficiency standards) and proposed tax incentives will enable the development of technology to substantially reduce greenhouse gas emissions in the long-term without the risk of harming the economy in the short term. The President has also committed that if progress is not sufficient by 2012 and sound science justifies further action, the United States will respond with additional measures that may include a broad, market-based program, and/or additional incentives and voluntary measures designed to accelerate technology development and deployment.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO HON. R. GLENN HUBBARD

Question 1. The greenhouse gas intensity is defined as emissions of greenhouse gases per dollar of economic output. Is it possible that under certain conditions, the President's 18 percent target could be met, while the actual amount of emissions increase?

Answer. Growing economies—especially those with significant population growth—use more energy and generate more emissions. Even with aggressive programs to increase energy efficiency, this relationship is unlikely to change in the near term. Currently, there are few viable alternatives to fossil fuels, other than nuclear power, that can provide large amounts of energy. Under these conditions, it makes sense to slow the growth of net greenhouse gas emissions, lay important groundwork for both current and future action, and work with other nations to develop an efficient and effective global response. Emissions may rise in the near term, but climate change must be viewed as a long-term problem, requiring a long-term solution that has broad-based country-level participation. At this point, some model estimates predict that a hard cap, such as that called upon by the Kyoto Protocol, could cost the U.S. up to $400 billion and 4.9 million jobs.

Consequently, the President's plan seeks to continue the process of developing new energy and sequestration technologies and reducing fundamental uncertainties in our current state of scientific knowledge about global change, while nurturing the growth of the economy. To this end, the President created the National Climate Change Technology Initiative, which builds upon America's leadership in technology and innovation within the area of climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

Question 2. In the attachment to your testimony, you included comments by the Secretaries of Energy, Commerce, and Agriculture, and the EPA Administrator on improving the DOE's greenhouse gas registry. When Senator Brownback and myself were developing our registry bill, industry told us that it was preferable to start an entirely new registry rather than modifying the existing DOE registry. Given the extensive amount of work necessary to improve the DOE registry as indicated by the comments from the Cabinet Members, why is it important that the DOE registry be maintained?

Answer. We have found a wide range of views on this point, reflecting more than one perspective of the purposes, functions, and proper design of a greenhouse gas registry. An extensive amount of work will be necessary to develop a registry that is a significant improvement over the existing program, and it seems wise and prudent to build on the experience gained by DOE and more than 200 reporters in developing, operating, and participating in the Voluntary Reporting of Greenhouse Gases Program over the past 10 years.

We concur that this effort is considerably more complex than the creation of the program in 1992–1994, but leaving this task with DOE leads to an expedited process based on the recommendations and additional ideas we expect to emerge from our ongoing outreach efforts. The process, which will culminate in new guidelines by January 2004 (for reporting 2003 data) includes: several stakeholder workshops; sufficient time to update technical guidelines based on analysis and workshops; public comment periods to review the revised guidelines; development of reporting forms, software, and a public-use database; and required Office of Management and Budget (OMB) review and clearance of new reporting forms.

Question 3. The U.S. Climate Action Report 2002 states that the U.S. plan will reduce the greenhouse gas intensity of the U.S. economy by 18 percent over the next 10 years. The report also states that a 14 percent reduction would be achieved in the absence of additional proposed policies and measures. What is the value of the additional 4 percent reduction?

Answer. We view the actual 4 percent greenhouse gas intensity reduction as an incomplete measure of the value of the President's plan. Taking into account the vast uncertainties associated with climate change, on both the cost and benefit side, the President adopted a flexible, but aggressive, strategy to promote technological change without undermining the ultimate source of that technological advance—productivity growth. As I outlined in my testimony, the Administration's strategy has three-prongs: slowing the growth of net greenhouse gas emissions, laying important groundwork for both current and future action, and working with other nations to develop an efficient and effective global response. This strategy builds on the Ad-

ministration's June 2001 commitment to improve our understanding of the causes and potential harms posed by climate change, and to develop technologies that offer promise to significantly slow the growth of emissions. It is also the first step in a long-term commitment to slow and, if the science justifies, stop and then reverse the growth of GHG emissions. Importantly, it takes advantage of our growing experience with building better and more flexible institutions to address environmental problems—a topic discussed at length in this year's *Economic Report of the President*.

The President's plan seeks to continue the process of developing new energy and sequestration technologies and reducing fundamental uncertainties in our current state of scientific knowledge about global change, while nurturing the growth of the economy. To this end, the President created the National Climate Change Technology Initiative, which builds upon America's leadership in technology and innovation within the area of climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

From an economic perspective, due to the fundamental gaps that remain in our current understanding of human-induced global climate change, significant uncertainty surrounds any attempt to estimate the benefits of greenhouse gas reductions, generally. However, the President's aggressive national goal, that significantly exceeds (by 28 percent) the projected reductions in our greenhouse gas intensity in the next decade, represents an appropriate, near-term response to the seriousness of this long-term issue. If achieved, and if advanced energy and carbon sequestration technologies are successfully developed in the next decade, our country will be in a far stronger position to increase its contribution toward addressing this global challenge, as the science may justify going forward.

Question 4. As you know, the Congress just passed legislation that would allow for the long-term storage of high level nuclear waste at Yucca Mountain in Nevada. Do you feel that this decision will provide a stimulus for the construction of new nuclear power plants? Do any of your projections for emissions intensity take into account any increases in nuclear power generation?

Answer. The recent passage of legislation in support of moving forward with the construction and licensing of a facility for long term storage of high-level nuclear waste at Yucca Mountain could in part stimulate building new nuclear power plants, but not in and of itself. Having a safe, scientifically tested, geologic repository can be looked at as a resolution to one of the few difficult issues that are keeping power companies from choosing the nuclear option today. A high-level waste repository—both for dealing with spent fuel already generated and with spent fuel to be generated from continued operation of current plants and operation of new plants—is necessary, but not likely sufficient to stimulate new orders.

The Annual Energy Outlook, 2002, produced by DOE's Energy Information Administration (EIA) projects in its reference case that energy-related carbon dioxide emissions intensity will decrease 14 percent between 2002 and 2012. This projected baseline, which assumes no change in policies beyond those in place at the time projections were made, estimates no additional generation from nuclear power. Rather, it assumes nuclear generation will decline from 8 percent of total U.S. energy consumption to about 6.5 percent. Any efforts, such as incentive policies, R&D to reduce costs, or efforts to address nuclear waste, such as Yucca Mountain, could maintain or increase nuclear generating plant capacity and thus further lower U.S. emission intensity.

Question 5. In your statement, you indicate that the "4½ percent reduction" in the emission intensity is comparable to the average reductions required under the Kyoto Protocol for countries remaining in the agreement. How does the 4½ percent reduction compare to the original target for the U.S. in the protocol?

Answer. Had the United States intended to meet its Kyoto target exclusively through domestic abatement, we would have had to reduce our greenhouse gas intensity in 2012 more than 4 percent below the baseline projected in the AEO 2002.

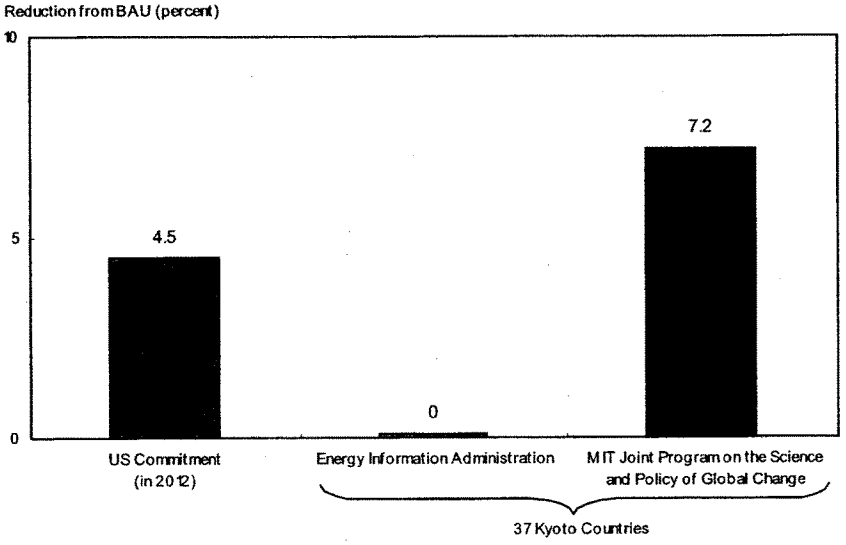
As I mentioned in my testimony, Janet Yellen, a former CEA chair, testified that domestic reductions of 100 to 150 million metric tons could be obtained under Kyoto.[1] This is close to the 106 million, or 4½ percent, reduction called for by the President.

[1] See Testimony of Janet Yellen, Chairman, Council of Economic Advisers, on H271–9 before the Subcommittee on Power and Energy of the House Committee on Commerce, page 323, lines 26 and 29.

For your convenience, I extract Chart 5 from my testimony and present it below. Chart 5 shows the U.S. commitment alongside estimates of the average required reductions for the remaining countries with emission limits under the Kyoto Protocol. While some regions, such as Canada and Japan, have onerous targets, others, such as the transitional economies of the former Soviet Union and Eastern Europe, have targets that are much greater than current emissions. According to one set of estimates by the Energy Information Administration, these surplus allowances exceed the needs of other countries with targets that require reductions below their baseline, with a net effect that required reductions through domestic abatement activities are zero. Another set of estimates from a group at MIT shows required average reductions of 7.2 percent below baselines. Viewed together, these forecasts suggest domestic abatement efforts to reduce emissions among remaining Kyoto countries would be roughly comparable to the U.S. commitment.[2]

Chart 5 **Reductions from Forecast Levels**

U.S. reductions from forecast levels are consistent with the average reductions in Kyoto countries.



Source: Department of Energy (Energy Information Administration) and MIT Joint Program on the Science and Policy of Global Change.

Question 6. The 18 percent emission intensity target is set to be reviewed in 2012. Given the fact that the nation has been on a voluntary system since 1992 under the United Nations Framework Convention on Climate Change, does the President plan an interim review before the 2012 date?

Answer. No formal review is planned. Yet, as with other Administration policies, there will be continuous monitoring of impacts. The President's target of reducing the greenhouse gas intensity of the American economy by 18 percent in the next decade represents an ambitious national goal, which significantly exceeds current projections and is expected to result in the avoidance of 106 million metric carbon-equivalent tons in 2012 alone. Importantly, it is also calibrated to our current level of understanding of the risk posed by human-induced climate change and current energy and carbon sequestration technologies, topics in which the Administration will be investing billions of dollars to improve in the next decade.

[2] See Energy Information Administration (EIA), *International Energy Outlook 2001,* DOE/EIA–0484 (2001) (Washington, DC, March 2001); and John Reilly, MIT Joint Program on the Science and Policy of Global Change, Snowmass Summer Workshop (August 6, 2001). The *IEO 2001* estimates that total required reductions among the Annex I countries (those required to reduce emissions under the Kyoto Protocol) would be 554 million metric tons in 2010. Of that, the United States' burden is 558 million metric tons (page 14), leaving a marginal surplus of reductions—without any further effort—among remaining participants after U.S. withdrawal from the Protocol. The MIT study provides slightly higher estimates of the burden among remaining participants (7 percent or 290 million metric tons).

Question 7. Mr. Connaughton has stated that the Kyoto Protocol would have cost the U.S. $400 billion and 4.9 million jobs. However, the U.S. is also beginning to incur damages from the effects of global warming, including fires in Arizona; drought in 40 percent of the country; and structured damages to towns and the Alaskan Pipeline in Alaska. These events will cost Americans millions of dollars. Has the Administration completed any studies of the economic damage that climate change is causing the U.S. both today and in the future?

Answer. It is extremely difficult to separate out the individual influence of factors on events such as fires and drought. Changes in temperatures can be a factor, but there still remains the question of whether the annual changes are cyclical or secular. Additionally, there are other reasons that these events may occur. For example, concerning fires, the USGCRP points out in Climate Change Impacts on the United States that "wildfires on all lands in the western U.S. increased in the 1980s after 30 years of aggressive fire suppression that had led to increase in forest biomass."[3] There is strong evidence that this is a factor in recent fires and, as you know, the President has recently announced changes in forest management practices to reduce future risks.

Because much of the discussion of climate change and its impacts centers on the use of computer models that attempt to look into the future, it may be useful to reflect for a moment on these models and how they are employed.

As Dr. Marburger noted in his testimony, "climate" is a general term for physical properties of the atmosphere, especially air temperature and pressure, wind, water vapor, and particle content. Air is a substance that obeys laws of motion that can be solved using a computer, which is what we do to predict future weather, based on current conditions. With the most powerful computers, we can predict the weather only a few days ahead, as you know. How then can we hope to predict climatic conditions far into the future? Science has developed approaches to long term climate modeling that do not attempt to give the fine detail we expect in a weather report.

Long-term climate models are sets of computer programs that attempt to simulate all the processes of nature that affect the atmosphere. The best current models average these properties over an area roughly the size of the State of Connecticut. It is not enough to model just the atmosphere, because climate is affected by the vast ocean currents, by the presence of atmospheric chemicals and light absorbing or reflecting particles, and by the interaction of all these with life processes—trees, crops, ocean organisms, and human beings. All of these processes need to be understood *quantitatively* before they can be modeled. This is the ongoing challenge of climate change research.

Once the models are constructed—a task that is by no means complete today—they have to be loaded with current conditions before they can be used for prediction. That means the state of the entire earth must be determined at a given instant of time by measurements on land, sea, and air. Satellite imagery is important but not sufficient for this. Since the output of the models depends on the input, incomplete knowledge of the state of the earth translates to uncertainty in the predictions. And the output is notoriously sensitive to the input. This is why the Intergovernmental Panel on Climate Change concluded that "Science cannot predict the climate and its impacts in Milwaukee, Mumbai, or Moscow half a century ahead very accurately, and it may never be able to do so."

Today's climate models cannot be used for definite predictions of regional or local conditions. They are typically run many times, for a range of input assumptions, and the results are assessed with statistical methods. Given our present state of knowledge, it is not surprising that the results vary widely, leading to apparently contradictory results.

That is why reports such as the *U.S. Climate Action Report 2002* do not claim to make *predictions* about future impacts. That report employs "scenarios" that are invented to capture the range of results of multiple runs of different climate models with different *ad hoc* input assumptions. The scenarios are then used to make "*projections*," a word that is carefully defined in an important footnote on page 84 of the report: ". . . *prediction* is meant to indicate forecasting of an outcome that will occur as a result of the prevailing situation and recent trends (e.g., tomorrow's weather or next winter's El Niño event), whereas *projection* is used to refer to potential outcomes that would be expected *if* some scenario of future conditions were to come about . . ."

The President believes, and I strongly concur, that responsible implementation of public policy on a scale commensurate with global climate change requires the best possible understanding of the phenomena we wish to influence. That is why the

[3] USGCRP, 2001. P. 500.

President has established a new management structure to advance and coordinate climate change science and technology research. The idea is to accelerate work in areas needed to create better tools to provide science based policy guidance, and to develop a technology base that matches the climate change challenge. To these ends, the President has established a Cabinet-level Committee on Climate Change Science and Technology Integration to oversee the entire effort. The Secretary of Commerce and Secretary of Energy will lead the effort, in close coordination with the Council of Economic Advisers (CEA), the Council on Environmental Quality (CEQ), the National Security Council (NSC), and the Office of Science and Technology Policy (OSTP), and the research program will be coordinated with existing work conducted under the Global Change Research Act of 1990. OSTP will continue to perform important coordinating functions within this new framework. I want to emphasize that the point of the new organization is to take advantage of the global change research that already exists, and focus it on the current urgent need to improve climate change analysis tools.

If you have any particular models that you would like us to examine, please feel free to contact me.

Question 8. While the Kyoto Protocol may cause short-term costs for foreign companies to come into compliance with its emissions targets, some analysts have argued that these companies may also benefit by operating more efficiently and reducing negative externalities, such as pollution. Will American companies be at a long-term competitive disadvantage as foreign companies start operating more efficiently because of the Kyoto Protocol?

Answer. A substantial body of research has examined the issue of balancing current and future emission reductions.[4] It has focused on the key features of the climate change problem—the uncertainty associated with the benefits and costs of addressing climate change; the replacement of existing energy-using equipment, structures, and other physical assets required to reduce emissions; and improvements in technology over time. These features commonly lead to two related conclusions. First, there is significant value associated with better information, suggesting a critical role for climate science. Second, the least expensive way to achieve a particular concentration target involves a gradual approach that avoids drastic changes to the capital stock.

One of the Administration's goals is to stimulate technical progress and speed up the technological learning processes so that eventually renewable energy technologies may be able to better compete with conventional technologies. The President's plan accounts for the opportunity cost inherent in any type of private technological spending—a dollar invested here leads to one less dollar invested elsewhere—by providing important flexibility that is necessary to solve the long-term problem of climate change.

As I noted in my testimony, technological innovation does not occur in a vacuum, it occurs in response to incentives. Thus using tax incentives, giving transferable credits to companies that can show real emissions reductions, funding basic scientific research, and the like will induce technological innovation. The President has begun an aggressive strategy to promote technological change without undermining the engineer of that technological advance—productivity growth.

The President's plan seeks to continue the process of developing new energy and sequestration technologies and reducing fundamental uncertainties in our current state of scientific knowledge about global change, while nurturing the growth of the economy. To this end, the President created the National Climate Change Technology Initiative, which builds upon America's leadership in technology and innovation within the area of climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

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[4] A summary of the research on this topic can be found in Michael Toman, "Moving Ahead with Climate Policy." *RFF Climate Change Issues Brief,* 2000. An additional summary of studies on this topic can be found in "Climate Change 2001: Mitigation," Intergovernmental Panel on Climate Change: Working Group Three, Third Assessment Report, pages 544–552. See http://www.ipcc.ch/pub/wg3spm.pdf.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO HON. R. GLENN HUBBARD

ECONOMIC IMPACTS TO INDUSTRY OF DELAY POLICY

Question 1. The Administration has stated that it wants to take a leadership role in addressing climate change, yet the Administration's current proposal to mitigate climate change essentially amounts to postponing the decision until 2012.

Recently, some businesses—including Honeywell International and Maytag Corp., have objected that "U.S. companies will lose out to foreign competitors that gain expertise and market share in energy-reducing technologies, and may face trade sanctions against U.S. exports that are made at higher-polluting facilities" if the U.S. does not participate in the international effort—including the trading system under Kyoto.

(a) Has the White House considered the economic effects on U.S. businesses of not participating in the international effort?

(b) Has the Administration evaluated the economic effects of NO plan to cap emissions on utility companies and the magnitude of retrofits and mitigation that will be needed down the line if there is continued delay? What about the costs or disadvantages to them if they want to be involved in international trade?

Answer. I do not view the Administration's current proposal as postponing mitigation measures until 2012. Rather, it significantly accelerates the projected reductions in the greenhouse gas intensity of the American economy. The philosophy underlying the Administration's policy was best summed up by the President on February 14, 2002: "My approach recognizes that sustained economic growth is the solution, not the problem—because a nation that grows its economy is a nation that can afford investments in efficiency, new technologies, and a cleaner environment." This philosophy, of course, represents a sharp contrast to the policy formulated by the prior Administration, which would have imposed sharp constraints on the U.S. economy in order to meet arbitrary, near term emissions reduction targets. The problem with that approach toward mitigation, which no one could accuse of "postponing" action, is that it represented a costly, unbalanced and ineffective overreaction to this long-term challenge and thus enjoyed no political report (e.g. Senate Resolution 98 passed by a 95–0 vote).

A substantial body of research has examined the issue of balancing current and future emission reductions.[5] It has focused on the key features of the climate change problem—the uncertainty associated with the benefits and costs of addressing climate change; the replacement of existing energy-using equipment, structures, and other physical assets required to reduce emissions; and improvements in technology over time. These features commonly lead to two related conclusions. First, there is significant value associated with better information, suggesting a critical role for climate science. Second, the least expensive way to achieve a particular concentration target involves a gradual approach that avoids drastic changes to the capital stock.

It is also important to note that two alternative schedules of emissions reductions can lead to different levels of emissions over time, but the same ultimate level of GHG concentrations. The choice between paths that differ in near-term versus long-term emissions reductions depends on whether we can reduce overall costs by spending more on research and less on emission reductions now, in order to achieve greater, but significantly cheaper, emission reductions in the future thanks to improved technologies, if the science justifies. It also depends on whether reductions now require early retirement of productive assets; if we have to throw away something valuable—that is a real cost. Consideration of the appropriate timing of emissions reduction is all the more important because the cost of achieving reductions over a short horizon increases dramatically with the scale of reductions. One estimate suggests that a 30 percent reduction in emissions in the near term is six times more expensive than a 15 percent reduction. That is, doubling the near-term reduction target increases costs sixfold.[6]

One of the Administration's goals is to stimulate technical progress and speed up the technological learning processes so that eventually renewable energy technologies may be able to better compete with conventional technologies. The President's plan critically accounts for the opportunity cost inherent in any type of private technological spending—a dollar invested here leads to one less dollar invested

[5] Ibid.

[6] Numerous estimates of the cost to the United States of different levels of emissions reductions are presented in John Weyant and Jennifer Hill, "Introduction and Overview," *The Energy Journal* (Special Issue, 1999).

elsewhere—by providing important flexibility that is necessary to solve the long-term problem of climate change.

As I noted in my testimony, technological innovation does not occur in a vacuum, it occurs in response to incentives. Thus using tax incentives, giving transferable credits to companies that can show real emissions reductions, funding basic scientific research, and the like will induce technological innovation. The President has begun an aggressive strategy to promote technological change without undermining the engineer of that technological advance—productivity growth.

The President's plan seeks to continue the process of developing new energy and sequestration technologies and reducing fundamental uncertainties in our current state of scientific knowledge about global change, while nurturing the growth of the economy. To this end, the President created the National Climate Change Technology Initiative, which builds upon America's leadership in technology and innovation within the area of climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

The Administration has also begun putting in place a number of programs that will lower the cost of future emission reductions. For example, we are developing a technology strategy that will make available cheaper, more effective technologies in the future. At the same time, the Administration is enhancing the U.S. scientific research program on climate to improve our understanding of precisely what emissions reductions may be necessary. In addition to aggressively pursuing voluntary reductions and commissioning an enhancement to the 1605(b) registry operated by the Energy Information Administration, the Administration is developing a technology strategy that will make available cheaper, more effective technologies in the future. GDP growth induces innovation, which leads to long term solutions.

Finally, I am unaware of any legal basis under which trade sanctions could be pursued against non-Parties to the Kyoto Protocol.

KYOTO "COSTS" AND COSTS OF NO ACTION

Question 2. Mr. Connaughton in his testimony stated that the Kyoto Protocol would have had a $400 billion economic impact on the U.S. economy, if implemented. Yet Dr. Hubbard, you testified that the U.S. greenhouse gas reductions that will result from the President's plan are "comparable to the average reductions required under the Kyoto Protocol for countries remaining in the agreement."

(a) What is the basis for the $400 billion estimate?

(b) Does it assume "command and control" or "cap and trade"? Will you share your assumptions and calculations with the Committee?

Answer. The Energy Information Administration issued a report titled *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity.* Specifically, Chapter 6—"Assessment of Economic Impacts" addresses the issue of model assumptions and development.

The macroeconomic impacts were derived by simulations of the Data Resources, Inc. (DRI) model of the U.S. economy. Two key features shape the magnitude of the macroeconomic impacts: (1) the disposition of funds collected with a permit auction run by the Federal Government; and (2) the international trading of carbon permits.

Regarding the disposition of funds, the default analysis returned collected revenues to consumers through personal income tax rebates. The alternative analysis assumed a reduction in payroll tax rates.

The role of international trading and sinks is handled through the specification of alternative targets for carbon reduction. [It should be noted that non-CO_2 gases are not addressed in the EIA Kyoto study.] The inclusion of sinks provides a 3 percent offset to the most stringent case (the 7 percent reduction relative to 1990 levels of carbon emissions). The movement to other cases (1990, 9 percent increase, 14 percent increase, and 24 percent increase) represent increasing purchases of international permits, at lower international permit price assumptions.

Pooling this information, as one proceeds from the most stringent case (7 percent decline) to the least stringent case (24 percent increase), the impacts on the economy diminish. The $400 billion figure mentioned refers specifically to the default analysis with a 7 percent decline relative to the reference case.

The 4.9 million job loss is also associated with the aforementioned default analysis with a negative 7 percent reduction relative to 1990 levels of carbon emissions. Although the EIA report, *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity,* does not explicitly calculate the employment impacts, the loss of

jobs figure can be calculated by comparing the labor force level and unemployment rate after the Kyoto Protocol relative to the base case. Given the (7 percent decline and default analysis), the level of the labor force declined and the unemployment rate rose relative to the base case. Consequently, these two effects combine for an employment loss relative to the baseline of approximately 4.9 million jobs. If you would like CEA to examine any further modeling assumptions, please let me know.

Question 2c. Will you provide this Committee with estimates of costs if the gains that were achieved with a program like the SO_2 cap and trade program (or full emissions trading) are accounted for?

Answer. A national greenhouse gas cap-and-trade system would necessarily be a far more complex, expensive, and intrusive system than the current sulfur emissions trading program, so one should be cautious about drawing conclusions from the experience of the sulfur trading program. For example, SO_2 permit trading, which gradually included plants (beginning with 263 units in 1995 and now including over 2000 units), was a natural development of existing regulations. SO_2 regulation in the 1970s and 1980s led to netting (allowing emissions reduction credits earned elsewhere in the plant to offset the increases expected from the expanded more modernized portion), banking (established procedures that allowed firms to store emission reduction credits for subsequent use in the bubble, offset, or netting programs), and bubbling (allowed existing sources to use emission reduction credits to satisfy their SIP control responsibilities); each of which provided firms with increased flexibility in reducing emissions. Greenhouse gases, which are generated from numerous sectors, rather than dominated by one sector, are not presently at this stage. Second, by 1995, SO_2 emitters had gained a wealth of experience with abatement technologies and understood the costs of these technologies well. It made sense to adopt mandatory caps on SO_2 since adding equipment to existing facilities could control these emissions. Neither is the case for greenhouse gases. Additionally, controlling emissions of other GHGs (such as methane) and carbon sequestration offer the bulk of inexpensive reduction opportunities for the U.S. right now—nearly twice as much as carbon dioxide emissions according to a recent EPA study—making it essential to include them in any cost-effective approach. This was not the case for SO_2, and many uncertainties exist about the relative cost effectiveness of the various greenhouse gas reduction opportunities.

Furthermore, GHG emissions reductions also have the same climate change benefits wherever they occur—within a company, across the country, and around the world. In sharp contrast to emissions of pollutants like sulfur dioxide that have both local and regional health consequences, GHG emissions in Asia—or anywhere else—will have exactly the same consequences for the United States as GHG emissions within the United States. Thus, any framework for any meaningful mitigation measures to achieve the long-term objective of the Framework Convention on Climate Change must entail global participation.

Question 2d. Will you please provide this Committee with a comparable estimate of the costs of No action—including costs of U.S. business of putting off decisions and having to retrofit later?

Answer. One of the Administration's goals is to stimulate technical progress and speed up the technological learning processes so that eventually renewable energy technologies may be able to better compete with conventional technologies. The President's plan accounts for the opportunity cost inherent in any type of private technological spending—a dollar invested here leads to one less dollar invested elsewhere—by providing important flexibility that is necessary to solve the long-term problem of climate change.

As I noted in my testimony, technological innovation does not occur in a vacuum, it occurs because of incentives. Thus using tax incentives, giving transferable credits to companies that can show real emissions reductions, funding basic scientific research, and the like will induce technological innovation. The President has begun an aggressive strategy to promote technological change without undermining the engineer of that technological advance—productivity growth.

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A gradual approach to reducing intensity is likely to be cost-effective compared to rapid reductions over a short period of time for two reasons: (1) because of the capital turnover issue that I have already addressed, and (2) because a gradual approach allows firms to take advantage of new technologies rather than sinking resources into obsolescent methods.

Question 2e. I'd also like to see you include the cost estimates for projected impacts identified in your Report—Members of this Committee know first hand that fighting forest fires and moving coastal villages is costly. We want to know the cost of adaptation?

Because much of the discussion of climate change and its impacts centers on the use of computer models that attempt to look into the future, it is useful to reflect for a moment on these models and how they are employed.

As Dr. Marburger noted in his testimony, "climate" is a general term for physical properties of the atmosphere, especially air temperature and pressure, wind, water vapor, and particle content. Air is a substance that obeys laws of motion that can be solved using a computer, which is what we do to predict future weather, based on current conditions. With the most powerful computers, we can predict the weather only a few days ahead, as you know. How then can we hope to predict climatic conditions far into the future? Science has developed approaches to long term climate modeling that do not attempt to give the fine detail we expect in a weather report.

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Once the models are constructed—a task that is by no means complete today—they have to be loaded with current conditions before they can be used for prediction. That means the state of the entire earth must be determined at a given instant of time by measurements on land, sea, and air. Satellite imagery is important but not sufficient for this. Since the output of the models depends on the input, incomplete knowledge of the state of the earth translates to uncertainty in the predictions. And the output is notoriously sensitive to the input. This is why the Intergovernmental Panel on Climate Change concluded that "Science cannot predict the climate and its impacts in Milwaukee, Mumbai, or Moscow half a century ahead very accurately, and it may never be able to do so."

Today's climate models cannot be used for definite predictions of regional or local conditions. They are typically run many times, for a range of input assumptions, and the results are assessed with statistical methods. Given our present state of knowledge, it is not surprising that the results vary widely, leading to apparently contradictory results.

That is why reports such as the *U.S. Climate Action Report 2002* do not claim to make *predictions* about future impacts. This report employs "scenarios" that are invented to capture the range of results of multiple runs of different climate models with different ad hoc input assumptions. The scenarios are then used to make "*projections*," a word that is carefully defined in an important footnote on page 84 of the report: ". . . *prediction* is meant to indicate forecasting of an outcome that will occur as a result of the prevailing situation and recent trends (e.g., tomorrow's weather or next winter's El Niño event), whereas *projection* is used to refer to potential outcomes that would be expected *if* some scenario of future conditions were to come about. . . ."

The President believes, and I strongly concur, that responsible implementation of public policy on a scale commensurate with global climate change requires the best possible understanding of the phenomena we wish to influence. The uncertainties have to be reduced.

That is why the President has established a new management structure to advance and coordinate climate change science and technology research. The idea is

to accelerate work in areas needed to create better tools to provide science based policy guidance, and to develop a technology base that matches the climate change challenge. To these ends, the President has established a Cabinet-level Committee on Climate Change Science and Technology Integration to oversee the entire effort. The Secretary of Commerce and Secretary of Energy will lead the effort, in close coordination with the Council of Economic Advisers (CEA), the Council on Environmental Quality (CEQ), the National Security Council (NSC), and the Office of Science and Technology Policy (OSTP), and the research program will be coordinated with existing work conducted under the Global Change Research Act of 1990. OSTP will continue to perform important coordinating functions within this new framework. I want to emphasize that the point of the new organization is to take advantage of the global change research that already exists, and focus it on the current urgent need to improve climate change analysis tools.

If you have any particular models that you would like us to examine, please contact me.

COUNTING REDUCTIONS

Question 3. According to the *Climate Action Report*, greenhouse gas intensity decreased by 17 percent from 1990–1999. The President's Climate Change initiative states that the U.S. plan will reduce greenhouse gas intensity by 18 percent by 2012. Moreover, the Report states on page 5 that in the absence of additional proposed policies and measures, the greenhouse gas intensity was projected to decline by 14 percent.

While it is clear from your testimony that emissions would still increase, it seems that a program designed to achieve an 18 percent reduction over the next decade is worse than a "business as usual" scenario.

(a) Doesn't this suggest that the Administration is counting reductions in greenhouse gas intensity that were inevitable to begin with?

(b) If emissions intensity under existing policies achieved an 18 percent reduction in intensity, why do you project these same policies would only achieve a 14 percent reduction in intensity over the same period?

(c) Isn't the answer all in the assumptions and the model? We would like to know your assumptions, the type of model used, and the basis for inputs to the model.

Answer. The "business as usual" estimate predicts that emissions intensity will decrease by 14 percent by 2012. The President's plan calls for an 18 percent reduction in greenhouse gas intensity by 2012; which is a 4 percent further improvement. The performance of existing policies characteristically deteriorates over time because the low-hanging fruit is usually picked first. To achieve an additional 4 percent reduction in greenhouse gas intensity will require additional policies as outlined in the President's National Energy Policy and in his climate change initiative announced on February 14, 2002.

Why do we project a forward-looking decline in emissions intensity of only 14 percent when business-as-usual intensity declined by 18 percent over the past decade? First, recall that the 1970s and early 1980s saw extremely high and volatile energy prices. This motivated considerable research and investment in energy efficiency—of which part was likely realized during the 1990s. Second, there was a substantial shift towards less energy intensive, service-oriented activities. Third, reaching an ambitious goal tends to be more difficult the closer one gets to the target. Furthermore, we recognize that there are some sectors, such as combined heat and power, which are only beginning to realize their potential.

You are correct in stating that the projections of any model are based on the assumptions employed. This is an especially good point because the entire climate change debate is predicated on the projections of climate and economic models, whose assumptions—as we are all aware—are often challenged.

"NO REGRETS" POLICIES—TRANSPORTATION AND UTILITIES

Question 4. The *Climate Action Report 2002* states that as the largest source of U.S. greenhouse gases, CO_2 accounted for 82 percent of total U.S. greenhouse gas emission in 1999. CO_2 from fossil fuel combustion was the dominant contributor, with 31 percent of CO_2 emissions coming from transportation activities.

The Administration's proposal emphasizes the importance of technological innovation to address climate change, but is missing some great opportunities—forcing the use of technology today will spur jobs and reduce emissions right now. For example, the NAS study on corporate average fuel economy pointed to existing technologies that would accomplish multiple goals in a cost-effective way.

This is the ultimate "No Regrets" action: reducing reliance on oil imports while reducing greenhouse gas and other emissions.

(a) Given the rapid increase in greenhouse gas emissions due to transportation, what is being done to curb emissions?

(b) What action has the Administration taken on developing CAFE standards through rule making to address this source of CO_2 emissions?

(c) Will technical innovation that moves us away from a fossil fuel economy occur rapidly enough to prevent "dangerous climate change" as defined by the UNFCCC's Article II?

(d) What is the U.S. government's present investment in renewable and alternative energies and technologies relative to the last 10 years of government investments in the same categories, factoring in inflation?

Answer. The Administration does not necessarily agree that "forcing the use of technology" represents a "great opportunity." In contrast to many environmental problems that result from a specific chemical or a narrow set of activities located in a confined area, the risk of climate change depends on the combined accumulation in the atmosphere of many different GHGs emitted from all over the world. While the contribution of a given amount of each GHG to climate change varies according to its relative potency in trapping energy and how long it naturally remains in the atmosphere, emission reductions of the various gases, adjusted for these differences, are equally valuable.[7] Moreover, because atmospheric concentration of GHGs matter, not emissions, carbon sequestration (e.g., absorption into forests and soil) of gases already in the atmosphere provides additional opportunities to reduce climate change risks.

The large contribution of carbon dioxide emissions to overall increases in the atmospheric GHG concentrations implies that reducing the growth in GHG emissions will be important to any long-term strategy to address climate change. Other gases comprised only 18 percent of total U.S. GHG emissions in 1999, while land-use changes and forestry in the United States sequestered the equivalent of roughly 15 percent of total emissions.[8] However, emissions of these other gases and carbon sequestration offer the bulk of inexpensive reduction opportunities for the U.S. right now—nearly twice as much as carbon dioxide emissions according to a recent EPA study—making it essential to include them in any cost-effective approach.[9] These facts represent the genesis of the Administration's approach to climate change, which is holistic, rather than sector-specific, and stresses efficiency and cost-effectiveness.

At the sector-specific level, addressing greenhouse gas emissions in the transportation sector would include action taken on Corporate Average Fuel Economy (CAFE) standards. The Administration is taking action on developing new CAFE standards: the National Energy Policy recommended that the Department of Transportation review and provide recommendations on establishing CAFE standards with due consideration of the National Academy of Sciences 2001 study on *The Effectiveness and Impact of CAFE Standards*. The Administration believes that CAFE standards should be addressed analytically and based on sound science, considering passenger safety and utility.

In addition, the Administration is proceeding with the FreedomCAR program, moving toward a vision of a transportation sector that is not reliant on imported oil, and creates no harmful emissions, of either criteria pollutants or greenhouse gases. This public-private partnership is working to speed development and deployment of the advanced technologies needed to use hydrogen in fuel cell-powered vehicles to meet our energy service needs in the transportation sector.

Regarding technological innovation, the IPCC reports an entire family of scenarios in which technological change is sufficient to maintain CO_2 concentration levels between 550–750 ppm through 2100 (see IPCC, "Climate Change 2001, Mitigation" Report of Working Group III, p. 4). The scientific community is as yet unable to determine what level of greenhouse gas concentrations or cumulative climate change leads to a "dangerous level" and this Administration is committed to advancing our understanding of climate science. The United States will continue to be a leader in science and technology under this Administration.

Below is a table of the Office of Energy Efficiency and Renewable Energy's budget for the past 10 years, in real 2002 dollars. EERE is the Department of Energy's pri-

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[7] As a result, emissions of greenhouse gases are often measured in tons of carbon equivalent, which weights the emissions of each gas according to the combined effect of its relative potency and residence time in the atmosphere.

[8] Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–1999,* (April 2001). See http://www.epa.gov/globalwarming/publications/emissions/us2001/pdf/table-es-1.pdf.

[9] Environmental Protection Agency, *Analysis of Multi-emissions Proposals for the U.S. Electricity Sector, Requested by Senators Smith, Voinovich, and Brownback*. See http://www.epa.gov/oar/meproposalsanalysis.pdf.

mary program for research and development of energy efficiency and alternative energy sources and technologies, and as such represents the bulk of U.S. Government spending in this area. The EERE program is responsible for strengthening America's energy security, environmental quality, and economic vitality through public-private partnerships that enhance energy efficiency and productivity to bring clean, reliable and affordable energy technologies to the marketplace, and enhancing consumer's energy choices.

EERE Budget

[2002 Real Dollars in Thousands]

Year	Budget
2002	$1,298,394
2001	$1,198,448
2000	$1,087,759
1999	$1,081,546
1998	$971,667
1997	$907,355
1996	$933,186
1995	$1,262,202
1994	$1,173,037
1993	$986,025

It is also important to note that the President's FY03 budget proposal seeks $4.6 billion in clean energy tax incentives over the next 5 years. These tax credits will spur investments in renewable energies such as solar, wind, and biomass, hybrid and fuel cell vehicles, cogeneration, and landfill gas.

WHAT WILL REALLY SPUR NEW TECHNOLOGY?

Question 5. The Report indicates that both average electricity prices and prices of gasoline are now projected to be lower in 2020 than they were in 2000, even lower than previously projected, which dulls any market-based approach.

Lower energy prices means both that fewer energy-reduction options will be cost-effective and that energy efficiency will be offset by increased total use.

(a) How will low energy prices spur development and adoption of new technology?

(b) Isn't this the classic example of the time for government intervention in the market to spur innovation and lower costs?

(c) Experience has shown that incentives from government established goals can spur the development of new technologies—why not tap this power and send a strong signal to innovate over the next 20 years?

Answer. Sustained investment in scientific research and development (R&D) is critical to energy security, environmental quality, and economic growth. Because the process of R&D from basic research to technology development, and its successful commercialization in the marketplace is complex, and the results of R&D expenditures are not possible to predict in advance, it is difficult to pinpoint what spurs R&D and causes its success. In general, R&D is accelerated by: economic incentives, including taxes and subsidies; regulatory constraints, such as environmental restrictions; public/private partnerships for sharing risks and financial burdens; and public policy objectives, such as enhanced national security and environmental quality.

The Administration is committed to achieving the objectives of energy security, environmental quality and economic growth, and to this end has recommended a number of policy initiatives as put forth in the National Energy Policy. The most significant actions to support R&D include:

- Increased funding for R&D programs in renewable and energy efficiency, electric transmission reliability and superconductivity.
- Provide tax incentives and streamline permitting to accelerate the development of clean combined heat and power technology.
- Provide for alternative fuels tax incentives.
- Provide R&D funding for clean coal technology development.

The President's FY03 budget proposal seeks $4.6 billion in clean energy tax incentives over the next 5 years. These tax credits will spur investments in renewable energies such as solar, wind, and biomass, hybrid and fuel cell vehicles, cogeneration, and landfill gas.

In terms of spurring innovation and setting up incentives for technological advance, one of the Administration's goals is to stimulate technical progress and speed up the technological learning processes so that eventually renewable energy tech-

nologies may be able to better compete with conventional technologies. The President's plan critically accounts for the opportunity cost inherent in any type of private technological spending—a dollar invested here leads to one less dollar invested elsewhere—by providing important flexibility that is necessary to solve the long-term problem of climate change.

As I noted in my testimony, technological innovation does not occur in a vacuum, it occurs in response to incentives. Thus using tax incentives, giving transferable credits to companies that can show real emissions reductions, funding basic scientific research, and the like will induce technological innovation. The President has begun an aggressive strategy to promote technological change without undermining the engineer of that technological advance—productivity growth.

The President's plan seeks to continue the process of developing new technologies while nurturing the growth of the economy. Toward this end, the President is creating the National Climate Change Technology Initiative, which will confirm that the United States is a leader in technology and innovation in climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

The Administration has also begun putting in place a number of programs that will lower the cost of future emission reductions. For example, we are developing a technology strategy that will make available cheaper, more effective technologies in the future. At the same time, the Administration is enhancing the U.S. scientific research program on climate to improve our understanding of precisely what emissions reductions may be necessary. The President's program has balanced U.S. economic objectives with that of protection of the climate system.

TIME FRAME AND REDUCTIONS NEEDED FOR STABILIZATION

Question 6. At one of our hearings on climate change last year, Dr. Kevin Trenberth made a point that really resonated with me. He stated that—because of the long residence time of CO_2 in the atmosphere—achieving the Kyoto targets would only buy us 10 years of time to figure out how to effectively reduce our emissions.

His point was that achieving Kyoto targets would only slow the rate of carbon emissions loading to the atmosphere—not stabilize or even reduce greenhouse gas emissions in the atmosphere. In other words, it is only the first step, and more needs to be done to stabilize or reduce atmospheric greenhouse gases.

In your testimony before this Committee on July 11th, you said that as a scientist, you agree.

(a) If achieving Kyoto targets only buys us 10 years to plan and does not stabilize greenhouse gases, how can the President advocate taking no real action on emissions reductions for 10 years and also say he is pursuing stabilization.

(b) Won't the President's plan doom us to a costly and dangerous adaptation scenario because we have bypassed the "window of opportunity" for action—after which the growth in emissions of around 40 percent make needed reductions more steep.

Answer. A first important point that should be considered concerning Kyoto is its exemption of 134 developing countries where emissions are projected to grow exponentially in the coming decades. The fact that Kyoto would have imposed extremely high costs on the U.S., to achieve domestic emission reductions that would have been canceled out by developing world emissions growth, has been well understood.

It is crucial to emphasize that the U.S. is making headway in finding long-term solutions to reduce greenhouse gas emissions. Great efficiency improvements are available from combined heat and power, by which efficiency can double or nearly triple. Both DOE and EPA are exploring how they can best encourage adoption of this technology under existing laws. Finally, considerable improvements in greenhouse gas emissions can be realized by reducing methane emissions. Although methane is not as long-lived in the atmosphere as is carbon dioxide, it is more than 20 times as potent in its greenhouse effects. Not only is the U.S. beginning to explore how it can reduce its own methane emissions, it is also exploring how it might best help other countries reduce theirs. There is also some potential for reducing greenhouse gas emissions by capturing, rather than burning at the point of emissions, the methane that is released from oil wells, coal mines, and dump sites.

As I stressed in my testimony, a distinguishing characteristic of climate change is that any successful effort to address the potential risk of climate change from most greenhouse gases will stem from cumulative efforts over decades, not just a few years. In 2000, for example, global CO_2 emissions contributed to an increase in

atmospheric concentrations of less than 0.5 percent,[10] a small increase compared to the 20 percent to 200 percent increase in concentrations that researchers often propose as a possible long-term stabilization goal.[11] As substantial changes in concentration result only from cumulative emissions over a period of decades, the future benefits of efforts to reduce emissions will be nearly the same whether the reductions, ton for ton, occur today or years in the future.

Accordingly, the Administration's strategy has three-prongs: slowing the growth of net greenhouse gas emissions, laying important groundwork for both current and future action, and working with other nations to develop an efficient and effective global response. This strategy builds on the Administration's June 2001 commitment to improve our understanding of the causes and potential harms posed by climate change, and to develop technologies that offer promise to significantly slow the growth of emissions. It is also the first step in a longterm commitment to slow and, if the science justifies, stop and then reverse the growth of GHG emissions. Importantly, it takes advantage of our growing experience with building better and more flexible institutions to address environmental problems—a topic discussed at length in this year's *Economic Report of the President*.

Consequently, the President's plan seeks to continue the process of developing new energy and carbon sequestration technologies while nurturing the growth of the economy—which will lead to even further advances in technology since GDP growth represents an engine to technological advance. For example, the President's FY03 Budget dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of $653 million. This level of commitment is unmatched in the world. The Administration also has developed a broad range of bilateral agreements with other countries to work on climate change issues cooperatively.

FEDERAL V. STATE ACTION

Question 7. Within recent years, Congress, individual States, and a number of major industries within the United States have taken an active role in exploring methods to reduce greenhouse gas emissions. For example, Massachusetts established the first CO_2 cap and trade program, and California is leading the way on auto emissions reduction.

(a) Why have state governments, who are now more than ever concerned about economic growth and jobs, embraced emissions reductions goals and timetables, but the Bush Administration has not?

(b) Does the Administration oppose these actions? What is the Administration's view?

(c) Has the Administration underestimated the willingness and the potential of the United States to meet the challenge of Climate Change?

(d) Has the Administration ceded leadership to the States?

Answer. Although state participation is central to achieving greenhouse gas emissions reductions, the Administration still plays the crucial role of creating sound environmental policy. On February 14, 2002, President Bush announced a comprehensive new national plan to address the challenge of global climate change. The President's plan includes a specific and realistic reduction goal with a timetable—it establishes a new greenhouse gas intensity target that reduces the rate of emission intensity by 18 percent over the next 10 years (roughly the equivalent of removing 1 out of every 3 cars from the road). The plan also expands our science and technology research, develops and deploys new technologies, and strengthens domestic and international efforts to increase energy efficiency and reduce greenhouse gas emissions. It sets us on a path to slow the growth in greenhouse gas emissions, and—as the science justifies—to stop and reverse that growth. If, in 2012, we find that we are not on track toward meeting our goal, and sound science justifies further policy action, we will respond with additional measures that may include a broad, market-based program as well as additional incentives and voluntary measures designed to accelerate technology development and deployment.

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[10] Data Source: C.D. Keeling, T.P. Whorf, and the Carbon Dioxide Research Group, Scripps Institution of Oceanography (SIO), University of California, La Jolla, California. See http://cdiac.ornl.gov/ftp/ndp001/maunaloa.co2.

[11] Based on increasing from current concentration levels of approximately 370 ppmv to future stabilization targets ranging from 450 to 750 ppmv. See "Climate Change 2001: The Scientific Basis," Intergovernmental Panel on Climate Change: Working Group One, Third Assessment Report, page 14 (http://www.ipcc.ch/pub/spm22–01.pdf) and C.D. Keeling, T.P. Whorf, and the Carbon Dioxide Research Group, Scripps Institution of Oceanography (SIO), University of California, La Jolla, California. See http://cdiac.ornl.gov/ftp/ndp001/maunaloa.co2.

The Administration has not underestimated the willingness and the potential of the U.S. to meet the challenge of climate change. Rather, it has stepped forward and challenged U.S. businesses to enter into agreements with the Administration to reduce greenhouse gas emissions, building upon successful voluntary partnerships with the aluminum and semiconductor industries. For example, in February, EPA Administrator Whitman launched a new voluntary partnership program between government and industry—Climate Leaders. Through Climate Leaders, companies will work with EPA to evaluate their greenhouse gas emissions, set aggressive reduction goals, and report their progress toward meeting those goals. Twenty-one companies representing almost all of the energy intensive industry sectors have joined Climate Leaders, including Alcoa, Bethlehem Steel, BP, Cinergy, General Motors, IBM, SC Johnson, Lockheed Martin, and Miller Brewing. Although U.S. businesses continue to improve their energy efficiency and productivity, the Administration's goal is to accelerate that trend by an additional 30 percent.

Climate change must be recognized as a long-term problem, requiring a long-term solution that has broad-based country-level participation. The Bush Administration has the strongest, most well funded climate change program in American history, devoting $4.5 billion annually to climate change programs, a $653 million increase in funding from last year. The Administration also has developed a broad range of bilateral agreements with other countries to work on climate change issues cooperatively.

The California CO_2 legislation could be perceived as a CAFE bill. Federal law, not state law, appropriately sets CAFE standards, so that cars may be sold and transferred freely among all 50 states. The U.S. Senate voted on CAFE this year, and decided by an overwhelming majority (62–38) not to adopt an arbitrary and dramatic increase in CAFE standards. The Bush Administration, however, is moving forward with a sound, science-based process at the Department of Transportation to review and revise the CAFE standards.

Regarding the Massachusetts CO_2 cap and trade program, focusing only on the power sector is an inefficient, costly approach that could have a significant, adverse impact on electricity prices, and therefore consumers, if applied nationally, as recent studies by the independent Energy Information Administration have demonstrated. A more efficient approach is to recognize the relatively inexpensive greenhouse gas reduction opportunities that are available via carbon sequestration and mitigating other gases, such as methane.

ENERGY STUDIES

Question 8. Dr. Hubbard, in your testimony on July 11th, you stated that you had never seen an economic analysis showing positive economic impacts from policies that place a market value on carbon emissions. I believe that you referred to it as "shadow price." A number of such studies exist.

One such study based on a report by DOE labs, published in the Energy Journal, found that the GDP gains from energy efficiency would exceed the GDP loss of a carbon price by the year 2020 if we implement the policies contained in the Scenarios for a Clean Energy Future, an extensive report in 2000 by DOE laboratories. The analysis assumed a $50 per ton price for tradable carbon allowances.

Dr. Hubbard, could you review this article and provide me with your expert assessment of this analysis and whether you still stand by your statements?

Cites: Sandstad, Alan, Stephen DeCanio, and Gale Boyd, "Estimating Bounds on the Economy-Wide Effects of the CEF Policy Scenarios," Energy Policy 29 (2001), 1299–1311.

Interlaboratory Working Group. 2000. Scenarios for a Clean Energy Future (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON–476 and LBNL—4402.

Answer. Please allow me to direct your attention to the Stanford Energy Modeling Forum (EMF), a prestigious group of scholars who have independently produced a series of estimated marginal costs (in the United States) associated with different levels of emission reductions from forecasts levels. The proceedings are published in a 1999 special issue of the *Energy Journal*, a leading peer-reviewed academic journal. Thirteen modeling teams from around the world participated in the exercise (approximately 50 percent from the U.S.). Table 1 summarizes the various model teams while Table 2 contains specifics of the models in 5 basic categories.

Researchers found enormous variation, but the marginal costs associated with emissions reductions were always positive. Of course, the level of total cost depends on the substitution and demand elasticities, the way in which capital stock turnover/energy demand adjustments are represented, and the like.

Again, what one takes from these estimates is the extreme variability, which is not only dependent on what trading regime is imposed, but on what particular model is chosen.

In this regard, it is important to note that these cost estimates are likely to be more stable when goals are expressed in terms of intensity rather than absolute targets. In this respect, the President's initiative helps reduce uncertainty.

With such uncertainty surrounding estimates, it is possible to find isolated efforts that support most any claim. For this reason it is necessary to rely on the most rigorous models available, as many studies are flawed in either the assumptions, or in the ways benefits are calculated.

The Clean Energy Futures Report was prepared by Oak Ridge, Lawrence Berkeley, National Renewable Energy, Argonnne, and Pacific Northwest National Laboratories and was published in November, 2000. The Report examines costs and benefits of alternative sets of policies to accelerate clean energy technology. Three scenarios were examined (1) business as usual—continuation of current policies (most closely aligned to DOE's EIA forecasts), (2) moderate, and (3) advanced. The latter two assume increasingly aggressive public commitments to R&D, tax credits, and regulatory approaches to clean energy technology development and deployment.

The report describes the various benefits that accrue from the wide range of energy policy interventions. The report makes some very ambitious assumptions about the rate at which energy efficiency advances, and about the availability of new technology even under the generous investment levels assumed. These assumptions are crucial to the conclusions that emissions and energy use can all be reduced without harm to the nation's economic growth. In addition, we find the report provides an inadequate economic analysis on how many of the policies would impact industry adjustments and consumer behavior.

While the report provides an assessment of the potential for energy-efficient and clean-energy technologies to play a greater role in meeting the country's energy challenges, it is not an accurate prediction of future energy needs, nor a credible examination of the full costs of implementing a market for carbon.

The conclusions of the CEF study should be taken in context with the assumptions made and uncertainty surrounding them as well as in comparison to the previous studies:

Overly Optimistic Assumptions Regarding Policy Implementation.

• Many of the policies indicated in the CEF analysis require legislative and regulatory actions, many of which have little chance of being implemented. It thus makes sense to conclude that the positive effects of the CEF analysis could significantly fall if the proposed policies fail to be implemented.

Overly Optimistic Regarding the Efficacy of Some Policy Instruments.

• One must also take into consideration how likely the policies hypothesized would accomplish the predicted results. As stated by the EIA, the effects on technology cost and quality of research and development funding for new technologies are notoriously difficult to quantify. For example, "some of the proposed R&D funding may achieve benefits only in a long time frame or may not achieve success at all, and predicting which developments will succeed is highly speculative."[12] Furthermore, the analysis makes the assumption that all policies will work seamlessly with one another to encourage reductions in CO_2.

• Another potential criticism of the study is that it does not separate the costs and effects of individual policies, so it is nearly impossible to distinguish the relative merits of specific policies.

• Many of the gains, which are ascribed to the effect of voluntary programs, would probably have occurred even in the absence of those programs. These gains are typically captured in "business-as-usual" baseline emissions forecasts. Including such gains in the impacts of proposed policies is therefore double-counting efficiency improvements.

• CEF projects that voluntary programs, state market transformation programs, and regulations (such as a commercial transformer standard) will reduce the growth rates for miscellaneous electricity uses in both the residential and commercial sectors—a significant and growing source of demand. In the residential sector, miscellaneous electricity uses include small heating elements, motors, and electronic devices, while in the commercial sector it includes a multitude of devices such as transformers, ATMS, traffic lights, telecommunications equipment, and medical equipment. EIA found that these reductions in growth rates appear unrealistic because it is unlikely that the use of these categories of equipment will be greatly re-

[12] EIA, DOE. "Analysis of Strategies for Reducing Multi-Emissions from Electric Power Plants with Advanced Technology Scenarios." Washington, DC: DOE, 2001, p. 14.

duced.[13] Although there is some potential for efficiency improvements, EIA found it unlikely that efficiencies could improve enough to reach the consumption levels predicted in the CEF.[14]

Overly Optimistic Regarding the Cost of Adopting New Technology.

• The costs for higher-efficiency equipment included in CEF in fact come largely from underlying engineering costs studies conducted by the DOE laboratories for the "Five Labs Study" and other analyses. These cost estimates focus on equipment purchase costs and ignore costs and uncertainties associated with transitions to new technologies, such as installation, adjustment, maintenance, and personnel training costs.

Concerning the study that you cite in *Energy Policy*, one should recognize that the authors' model takes estimates from two different strains of research, which may result in double counting—and, it is understood that there is no manner in which one can sign the direction of elasticity bias in this case. A model that integrates the concepts of technical efficiency and price would be preferable.

Table 1.—Summary of Models Analyzing Post-Kyoto EMF Scenarios

Model Acronym (Full Model Name)	Home Institution(s)
ABARE–GTEM (Global Trade and Environment Model)	Australian Bureau of Agriculture and Resource Economics (ABARE, Australia)
AIM (Asian-Pacific Integrated Model)	National Institute for Environmental Studies (NIES Japan) Kyoto University
CETA (Carbon Emissions Trajectory Assessment)	Electric Power Research Institute Teisberg Associates
FUND (Climate Framework for Uncertainty, Negotiation, and Distribution).	Vrije Universiteit Amsterdam (Netherlands)
G-Cubed (Global General Equilibrium Growth Model)	Australian National University University of Texas U.S. Environmental Protection Agency
GRAPE (Global Relationship Assessment to Protect the Environment).	Institute for Applied Energy (Japan) Research Institute of Innovative Technology for Earth (Japan) University of Tokyo
MERGE 3.0 (Model for Evaluating Regional and Global Effects of GHG Reductions Policies).	Stanford University Electric Power Research Institute
MIT–EPPA (EPPA—Emissions Projection and Policy Analysis Model).	Massachusetts Institute of Technology (MIT)
MS–MRT (Multi-Sector—Multi-Region Trade Model)	Charles River Associates University of Colorado
Oxford Model (Oxford Economic Forecasting)	Oxford Economic Forecasting
RICE (Regional Integrated Climate and Economy Model)	Yale University
SGM (Second Generation Model)	Batelle Pacific Northwest National Laboratory
WorldScan	Central Planning Bureau/Rijksinstituut voor Volksgezondheid en Milieuhygiene (RIVM) (Netherlands)

Table 2.—Some Summary Characteristics

Energy/Carbon Model			
Economy Model	Fuel Supplies & Demands By Sector	Energy Technology Detail	Carbon Coefficients
Aggregate		CETA	
Production/Cost		MERGE3	FUND
Function		GRAPE	RICE
Multisector	MIT-EPPA	ABARE-GTEM	
General	WorldScan	AIM	
		MS-MRT	
Equilibrium	G-Cubed	SGM	
Multisector Macroeconometric	Oxford		

[13] Ibid. p. 15.
[14] Ibid. p. 15.

DECISIONMAKING BASED ON MODEL PROJECTIONS

Question 9. Dr. Marburger took great pains at our hearing to assert that impact assessments contained in the U.S. Climate Action Report were only "projections" and not "predictions" of outcomes, and thus attempted—unsuccessfully I might add—to downplay concerns about the threats posed by likely scenarios of climate change that are likely to flow from our current actions. I'd like to note that the NAS Report that Dr. Marburger lauded at the hearing specifically referred to the outcomes as "predictions."

(a) Do the economic models you utilized in advising the President on domestic policy decisions make projections or predictions of outcomes?

(b) How about the modeling you did of emissions intensity reductions and associated estimates of "emissions reductions?" What is your level of certainty for these projections, and the assumptions you used?

(c) In the market, don't you have to assume certain unquantifiables in running your models, for example, the response of investors?

(d) What is more certain—the emotional behavior of investors in the marketplace, or the physics of climate science?

(e) Are you and the President comfortable making important decisions based on projected outcomes using these sorts of assumptions? What level of certainty do you require of your model projections in other contexts?

Answer. As Dr. Marburger noted in his testimony, long-term climate models are sets of computer programs that attempt to simulate all the processes of nature that affect the atmosphere. The best current models average these properties over an area roughly the size of the State of Connecticut. Once the models are constructed—a task that is by no means complete today—they have to be loaded with current conditions before they can be used for prediction. That means the state of the entire earth must be determined at a given instant of time by measurements on land, sea, and air. Today's climate models cannot be used for definite predictions of regional or local conditions. They are typically run many times, for a range of input assumptions, and the results are assessed with statistical methods. Given our present state of knowledge, it is not surprising that the results vary widely, leading to apparently contradictory results.

That is why reports such as the *U.S. Climate Action Report 2002* do not claim to make *predictions* about future impacts. That report employs "scenarios" that are invented to capture the range of results of multiple runs of different climate models with different ad hoc input assumptions. The scenarios are then used to make "*projections*," a word that is carefully defined in an important footnote on page 84 of the report: ". . . *prediction* is meant to indicate forecasting of an outcome that will occur as a result of the prevailing situation and recent trends (e.g., tomorrow's weather or next winter's El Niño event), whereas *projection* is used to refer to potential outcomes that would be expected *if* some scenario of future conditions were to come about. . . ."

The President believes, and I strongly concur, that responsible implementation of public policy on a scale commensurate with global climate change requires the best possible understanding of the phenomena we wish to influence. That is the reason for the use of both predictions and projections by economists.

When measuring uncertainty, it is important to factor in whether we have experienced the situation previously or if the situation is novel. This point is highlighted in the NAS study, which calls into attention a very salient aspect of climate change: the possibility of unexpected, rapid, and dramatic changes in the climate. Since many of the "abrupt changes of the past have not been fully explained yet, and [current] climate models typically underestimate the size, speed, and extent of those changes," the ability to predict future climate changes is largely stifled. Consequently, the NAS recommends research initiatives that fall into two broad categories: (1) implementation of targeted research to expand instrumental and paleoclimatic observations, and (2) implementation of modeling and associate analysis of abrupt climate change and its potential ecological, economic, and social impacts.[15]

Specifically, the NAS study reinforces the Administration's policy on climate change. Recommendation 5 of the *Abrupt Climate Change* report states "Research should be undertaken to identify "no-regrets" measures to reduce vulnerabilities and increase adaptive capacity at a little or no cost." Of course, the same intuition holds for investor behavior: consider the vast uncertainty facing securities investors when securities markets re-opened after September 11, 2001.

[15] The National Academy of Sciences, "Abrupt Climate Change: Inevitable Surprises," (2002), p. 2.

ECONOMIC IMPACTS OF CAP AND TRADE & PREVIOUS CLIMATE STUDIES

Question 10. Dr. Hubbard, in your testimony on July 11th, you stated that you had never seen an economic analysis showing positive economic impacts from policies that place a market value on carbon emissions. Additionally, you commented that the U.S. does not currently have the proper infrastructure in place for managing a "cap and trade" program. Therefore, the President's approach of a voluntary registry offered a first step.

However, I am aware of a number of studies that show positive economic benefits from an innovation-led climate strategy. One specific analysis of a strategy for reducing multi-emissions, including carbon, from electric power plants carried out by EPA at the request of Senators Jeffords and Lieberman last October, shows that GDP will actually increase compared to the reference case for two of the technology scenarios modeled on DOE's Clean Energy Future study. Furthermore, the EIA and EPA studies done at the request of Senators Smith, Voinovich, and Brownback, also from last October, analyzed a binding carbon cap on the electric sector and also showed no negative impacts on the economy.

(a) Therefore, I must ask what is the basis for your testimony?

(b) Were you not aware of these studies, or of the previous requests of Congress for this information? I am attaching a list of studies for your consideration.

(c) Did your assessment include the consideration of any of these studies?

(d) Based on this extensive evidence, would you alter your assessment in any way?

Answer. The EIA report, *Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants with Advanced Technology Scenarios*, prepared for Senators Jeffords and Lieberman, analyzed the impacts of imposing caps on power sector emissions of nitrogen oxides, sulfur dioxide, mercury and carbon dioxide in cases with alternative technology assumptions. The results in each case are driven by the combination of the emission limits and technology assumptions used. To estimate the impacts of imposing the emission caps, EIA compared cases that shared the same underlying technology assumptions—with and without the emission limits. By doing this, EIA separated the impacts of the technology assumptions from the impacts of imposing the emission caps.

EIA found that imposing the emission caps always led to negative economic impacts as the market responded to the higher energy prices that result. For example, in cases using reference case technology assumptions, imposing power sector emission caps were found to lead to 0.8 percent lower GDP and 32 percent higher electricity prices in 2007. Similarly, in cases using advanced technology assumptions, imposing power sector emission caps were found to lead to 0.7 percent lower GDP and 30 percent higher electricity prices in 2007. It is true that projected GDP in the case using advanced technology assumptions with power sector emission caps is higher than in cases using reference technology assumptions. However, using this as a measure of the economic impact of imposing the emission caps is inappropriate because it is driven by the different technology assumptions in the cases rather than the effects of the emission caps.

The EIA report, *Reducing Emissions of Sulfur Dioxide, Nitrogen Oxides, and Mercury from Electric Power Plants*, prepared for Senators Smith, Voinovich and Brownback, analyzed the impacts of imposing alternative caps on power sector emissions of nitrogen oxides, sulfur dioxide, and mercury. The impacts of an explicit cap on power sector carbon dioxide emissions were not addressed in this study. This analysis also projected higher energy prices when power sector emission caps were imposed, but the impacts are much smaller than when a carbon dioxide emission cap is also required. For example, in 2020, projected average electricity prices were between 1 and 6 percent higher than reference case levels in the different cap cases examined.

I also considered numerous studies to arrive at my policy recommendation (see Table 1). Let me direct your attention to the Stanford Energy Modeling Forum (EMF), a prestigious group of scholars who have independently produced a series of estimated marginal costs (in the United States) associated with different levels of emission reductions from forecasts levels. The proceeds are published in a special 1999 issue of the highly-respected *Energy Journal.* Thirteen modeling teams from around the world participated in the exercise (~ 50 percent from the U.S.).

These researchers found enormous variation, with the marginal costs associated with emissions reductions always being positive. Of course, the level of total cost depends on the substitution and demand elasticities, the way in which capital stock turnover/energy demand adjustments are represented, and the like.

Again, what one takes from these estimates is the extreme variability. Not only dependent on what trading regime is imposed, but on what particular model is cho-

sen. In this regard, it is important to note that these cost estimates are likely to be more stable when goals are expressed in terms of intensity rather than absolute targets. In this respect, the President's initiative helps reduce uncertainty.

Of course, it is possible to find isolated efforts that support most any claim. For this reason it is necessary to rely on the most rigorous models available, as many studies are flawed in either the assumptions, or in the ways benefits are calculated.

TRANSFERABLE CREDITS

Question 11. Dr. Hubbard, you testified before the Committee that the U.S. greenhouse gas reductions that will result from the President's plan are "comparable to the average reductions required under the Kyoto Protocol for countries remaining in the agreement." I understand that your assessment is based on the notion that countries would buy the credits they need through international trading.

(a) What statutory authority does the President have to recognize or give value to "transferable credits" obtained through emissions reductions?

(b) How would such reductions be made permanent, so that we're not providing credits for actions in one year that are overwhelmed by increases in the following year?

Answer. Section 1605(b) of the Energy Policy Act of 1992, Public Law 102–486, contemplates a program whereby voluntary efforts to reduce greenhouse gas emissions can be recorded, with the specific purpose that this record could be used "by the reporting entity to demonstrate achieved reductions of greenhouse gases." (42 U.S.C. 13385(b)(4)). In February, President Bush directed the Secretary of Energy, in consultation with the Secretary of Commerce, the Secretary of Agriculture and the Administrator of the Environmental Protection Agency, to propose improvements to the current voluntary emission reduction registration program under section 1605(b) of the Energy Policy Act to enhance the measurement accuracy, reliability, and verifiability of reported reductions. The President directed the Secretary of Energy to give transferable credits to companies that can show real emissions reductions under the improved standards for measurement and reporting. The details of these new standards are currently the subject of a broad stakeholder process that has been convened by the Department of Energy. See, e.g., Notice of Inquiry and Request for Comment, Department of Energy, "Voluntary Reporting of Greenhouse Gas Emissions, Reductions, and Carbon Sequestration," 67 Federal Register 30370 (May 6, 2002). Issues related to the "permanence" of credited reductions will be addressed in this process.

COST AND BENEFITS

Question 12. Dr. Hubbard, in your written testimony, you said, "the future benefits of efforts to reduce emissions will be nearly the same whether the reductions, ton for ton, occur today or years in the future." That statement seems contrary to growing evidence, considering the National Academy of Sciences has pointed out the potentially severe impacts of abrupt climate change. As the Administration's report and testimony before this Committee verify, increasing concentrations of greenhouse gases are a problem, and the risks increase with growing concentrations of those gases.

(a) How can you suggest that benefits accrue in a linear fashion with reductions regardless of the time frame?

(b) How can you reconcile the finding of the NAS study on abrupt climate change with your assessment of the costs and benefits of the President's plan?

(c) Were the costs of those potentially severe impacts as identified in this NAS report considered in the development of the President's plan? Or in your assessment reflected by your testimony?

The essential economic logic behind my statements can be found in my response to questions #6 and #9 above. My statement was meant to emphasize that greenhouse gases are *just* one parameter in a very complex system that determines how the climate changes. The degree to which our actions influence greenhouse gas concentration is subject to considerable debate. Furthermore, it is important to highlight that the "individual components" (whether firms or organisms involved in economic and ecological systems) interact in ways where "everything depends on everything else."[16] Thus, at this stage, it is prudent to act in a manner that will maximize the long-term benefits—continue the process of developing new technologies while nurturing the growth of the economy. This growth will be the engineer to long term climate change solutions. To this end, the President created the National Climate Change Technology Initiative, which builds upon America's leadership in tech-

[16] Ibid., p. 149.

nology and innovation within the area of climate change. Furthermore, the President's FY03 budget proposal dedicates $1.7 billion to fund basic scientific research on climate change and $1.3 billion to fund research on advanced energy and carbon sequestration technologies. Overall, the President's FY03 budget seeks $4.5 billion in total climate spending—an increase of nearly $700 million. This level of commitment is unmatched in the world.

The NAS study calls attention to a very salient aspect of climate change, the possibility of unexpected, rapid, and dramatic changes in the climate. Since many of the "abrupt changes of the past have not yet been fully explained, and [current] climate models typically underestimate the size, speed, and extent of those changes," the ability to predict future climate changes is largely stifled. Consequently, the NAS recommends research initiatives that fall into two broad categories: (1) implementation of targeted research to expand instrumental and paleoclimatic observations, and (2) implementation of modeling and associate analysis of abrupt climate change and its potential ecological, economic, and social impacts.[17] Specifically, the NAS study reinforces the Administration's policy on climate change. Recommendation 5 of the *Abrupt Climate Change* report states "Research should be undertaken to identify 'no-regrets' measures to reduce vulnerabilities and increase adaptive capacity at a little or no cost."

Generally, the NAS reports have identified projections of possible impacts of climate change based on varying scenarios—primarily due to the lack of certainty about the causes of climate change. Specifically, the NAS study on abrupt climate change states, "Climate models that are used to test leading hypotheses for abrupt climate change, such as altered deep-ocean circulation, can only partially simulate the size, speed, and extent of the large climatic changes that have occurred."[18] Given the fact that we do not have a reliable predictor or what *will* happen, but rather what *may* happen under a wide range of unstable conditions, to put costs to a situation(s) in which the time frame, region, location, and other characteristics are unknown is not a reliable and sound way to formulate and base policy.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ERNEST F. HOLLINGS TO JOHN H. MARBURGER III

CLIMATE CHANGE RESEARCH INITIATIVE (CCRI)

Question 1. Congress has strongly supported global climate change research through the federally coordinated U.S. Global Climate Research Program established in the Global Change Research Act of 1990. However, the Administration has initiated a new Climate Change Research Initiative (CCRI) outside of this authorization, which appears ill-defined as to how it will function in relation to the U.S. Global Change Research Program.

Would you explain how the CCRI proposes to enmesh the USGCRP into its proposed framework on a functional level?

How do these two structures functionally fit together and operate to produce a workable and sensible climate research initiative?

How does the CCRI differ from the USGCRP? Who makes decisions about research priorities? How are decisions reached?

Answer. The USGCRP and the CCRI are managed together within the Climate Change Science Program Office (CCSPO). This office, led by a representative from the Department of Commerce, is the interagency coordinating mechanism for climate change science. The CCRI will provide a focused program aimed at reducing key uncertainties in our understanding of climate change and providing tools for decision and policy makers, while the USGCRP will continue to provide a broad base of scientific investigation related to global change. The CCSPO is currently coordinating a complete review of climate change science with all of the relevant federal agencies in order to ensure key priorities are being met and clear goals are being established. The initial plan will be the result of an interagency effort; in December, a larger workshop is planned that will involve additional stakeholders. The coordinated plans of the CCSPO will be presented to and approved by the Cabinet-level Committee on Climate Change Science and Technology Integration through the Interagency Working Group on Climate Change Science and Technology.

Question 2. Why does the President's 2003 budget proposal request new funds for the CCRI only, when you declare that our understanding of climate change and its impacts are limited by the existing level of scientific knowledge?

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[17] Ibid., p. 2.
[18] Ibid., p. 4.

Answer. The President's fiscal year 2003 budget request includes a $44 million increase for the USGCRP and an additional $40 million dedicated to the CCRI. In addition to these increases, the Administration is undertaking a comprehensive review of the current climate change science portfolio, in order to ensure that key scientific uncertainties are being addressed. In the past, the federal climate change research portfolio was not designed or managed to focus on key uncertainties or to provide tools for decision and policy makers. Thus an important part of the Administration's research plan is to provide this focused approach under CCRI while continuing and strengthening the broader basic science foundations provided by USGCRP.

Question 3. The CCRI also entails several layers or filters through which all new research information must pass before being disseminated more broadly to the general public.

How long will it take for new information to hit the streets under this framework?

Answer. The question includes an incorrect statement. All the research performed under CCRI is expected to be published in the open scientific literature. It will not be censored or restricted in any way. Official reports produced by CCRI will be subject to review by the various federal management entities, just as for any U.S. Government agency report.

Question 4. Who ultimately decides what information goes out the door and in what form, for public consumption?

Answer. See the answer above. All research reports are expected to be published immediately through the normal mechanisms of scholarly publication (which include peer review by the scientific journals.)

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO HON. JOHN H. MARBURGER III

Question 1a. In your statement, you say that "With the most powerful computers, we can forecast the weather reliably only a few days ahead, as you know. How then can we hope to predict climatic conditions far into the future?" You also state that today's climate models cannot be used for definite predictions of regional or local conditions.

As the Director of the Office of Science and Technology Policy, are you suggesting that the government's investment in modeling is not a reasonable one?

Answer. No. The aim of climate modeling is not to make definite predictions of regional or local conditions; it is to understand the impacts of various natural and anthropogenic mechanisms on the overall climate system. These mechanisms are complicated and depend upon basic scientific knowledge, computer capabilities, and extensive observational data, all of which currently have major gaps and shortcomings that undermine confidence in the model projections. The purpose of government investments is to improve the capabilities of the models, which is reasonable given the magnitude of the potential consequences of climate change.

Question 1b. What are your thoughts on the millions of dollars already invested in this area? Was it useful or not?

Answer. The funds invested to date in this area have indeed been useful, and have made the U.S. the world's leader in climate change research overall. However, the Climate Research Council of the National Research Council issued a report in 1998, *Capacity of United States Climate Modeling to Support Climate Change Assessment Activities*, which found that the United States "lags behind other countries in its ability to monitor long term climate change. Those deficiencies limit the ability of the United States to predict future climate states. . . ."

Question 2. You have noted the distinction between "prediction" and "projection" in your statement. What would you say the President's 18 percent greenhouse gas emissions intensity is based upon, prediction or projection?

Answer. The President's 18 percent intensity reduction figure is based on neither a prediction nor a projection. It is a target based upon reasonable estimates of economic growth and what accelerated improvements in and deployment of technology may produce in the immediate future. The target significantly exceeds analyses of greenhouse gas intensity reductions for 2012 that have been provided by the U.S. Department of Energy's Energy Information Agency.

Question 3. You have mentioned that the President's fiscal year 2003 budget request includes $1.7 billion for fundamental scientific research on climate change which includes $40 million for the new Climate Change Research Initiative. Is the remainder of that ($1.66 billion) for the existing U.S. Global Change Research Program?

Answer. Not exactly. Fundamental scientific research on climate change and global change is occurring under the USGCRP and the CCRI. In the President's fiscal year 2003 budget, the request for the USGCRP is $1.714 billion. There is an additional $40 million requested for CCRI. A more detailed enumeration of these and related expenditures can be found in the *Federal Climate Change Expenditures Report to Congress, July 2002.*

Question 4a. The National Research Council recently issued a report entitled "Abrupt Climate Change: Inevitable Surprises." The report states that "because climate change will likely continue in the coming decades, denying the likelihood or downplaying the relevance of past abrupt events could be costly."

Do you agree with that statement?

Answer. Yes.

Question 4b. What plans does your office have in response to this report?

Answer. OSTP does not plan to respond formally to this report. However, reports such as the one from the National Research Council provide useful input into the process of designing a robust and complete research portfolio and of setting research priorities. My office will continue to use and consider such reports in our role of advising the President and coordinating the federal research effort.

Question 5. The U.S. Climate Action Report 2002 states that evidence is emerging that black carbon aerosols (soot), which are formed by incomplete combustion, may be a significant anthropogenic agent. What are the implications if these carbon aerosols are found to be a significant contributor to climate change?

Answer. The role of black carbon aerosols, and aerosols in general, on climate change in both the global and regional scales is not well understood. As you note, there is emerging evidence that these aerosols may play a more profound role than has been previously realized. Clearly there is a need for more research in this area, which was also recognized by the National Academy as a key uncertainty in its 2001 report, "Climate Change Science: An Analysis of Some Key Questions." Climate change response strategies will have to address black carbon production. Methane is another significant agent that may be subject to human management. The most recent research indicates that black carbon and methane together are comparable to CO_2 in their contribution to climate forcing. The global climate is forced by a number of other variables, some anthropogenic and some not. Climate change response strategies require a significantly improved understanding of the response of the climate system to each of these variables.

Question 6. The U.S. Climate Action Report 2002 identifies one of the weakest links in our knowledge about climate science as the connection between global and regional projections of climate change. Can you comment on what the Administration is doing to address this weak link?

Answer. Regional projections of climate change consist of a wide range of scenarios based upon experience with global climate change models and additional knowledge of the impact of global variables upon local conditions. The ultimate objective of research on regional climate change is to narrow the range of future scenarios, if possible, for a particular region. The range of projected alternatives may be narrowed by improvements in global climate modeling, and by studies of mechanisms affecting regional conditions such as water and soil management, urbanization, and local weather systems. Research on regional conditions is currently sponsored by federal science agencies, including NOAA and USDA.

Question 7. Your testimony emphasizes the distinction between a projection of what could happen and a prediction of what will happen. Isn't it true that the more heat-trapping gases are released into the atmosphere, the more likely that projections of harmful effects on the United States will become a reality?

Answer. When looking at statistical probabilities in complex systems like the climate, it is highly unreliable to try and isolate one parameter, such as heat trapping gases, and draw a general conclusion. Because of this, the best answer to your question in this case is "not necessarily." At the present time, science has only partial answers to this question. Recall that the actual global average surface temperature increases from all sources are projected to be rather small. Many "harmful effects" occur regionally, and come from extreme events that occur randomly about a global average. We do not understand how the statistics of these extreme events are affected by average climate parameters that our models attempt to calculate based on known forcings, including "heat-trapping gas" releases. Some harmful effects, such as those of sea level rise, are directly attributable to global parameters, such as mean surface temperature, which are known to be linked to a number of factors. Even for these effects, the relative contribution of anthropogenic mechanisms to natural variation remains unknown.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN F. KERRY TO HON. JOHN H. MARBURGER III

ADMINISTRATION VIEW OF IPCC

Question 1. I understand the Administration recently sent representatives to Bonn to participate in technical negotiations under the Framework Convention.

I was shocked to hear from observers that the Administration worked, together with developing countries, led by Saudi Arabia—to strongly dilute the role played by IPCC scientists and their latest "state of the science" report (the Third Assessment)—including its role in helping policymakers consider if concentrations are trending toward stabilization.

A U.S. negotiator even objected to the use of the word "robust" to characterize this IPCC Assessment, even though our own NAS characterized it this way.

What is the Administration's position on the role of the IPCC under the UNFCCC—to which I remind you, the U.S. is a Party?

Answer. The Administration regards IPCC as an essential organization for coordinating international work on climate change.

Question 2. Does this Administration support the IPCC as the appropriate body to assess available information on the science, the impacts, and the economics of—and the options for mitigating and/or adapting to climate—change; and to provide scientific, technical and socio-economic advice to the Parties to the UNFCCC?

Answer. The Administration does regard the IPCC as an appropriate body for these functions.

Question 3. As discussed during the July 11th hearing, I would like a full account of these negotiations as soon as possible.

Answer. OSTP will continue to keep the committee apprised of its involvement with ongoing scientific and technical discussions in the international arena.

DANGERS OF MISSING THE "WINDOW OF OPPORTUNITY"

Question 4. A recent article in *Science* features an article by Dr. Michael Oppenheimer, of Princeton University, an authority on climate change and a member of the IPCC. Dr. Oppenheimer and his coauthor Dr. Brian O'Neill of Brown University show that in order to prevent "dangerous anthropogenic interference in the climate system"—or "dangerous climate change" (ranging from elimination of all coral reef systems to disintegration of the West Antarctic Ice Sheet)—it is necessary to begin reducing total *actual* emissions within the next two decades or so.

According to these scientists, any delay beyond that timeframe will have irreversible effects on our climate system. Furthermore, these scientists say that the sooner emissions drop, the easier it will be to achieve the concentrations necessary to prevent dangerous climate change. If we wait until 2020, we will have to make such drastic emissions reductions that it may not be economically feasible to prevent dangerous climate change.

What implication does this latest research have with respect to potential impacts of the President's proposal, which has emissions rising indefinitely into the future?

Answer. The paper by Oppenheimer and O'Neill does not in fact "show" that immediate reduction of emissions is a necessary condition for avoiding "dangerous climate change." The authors of this article raise interesting points worthy of discussion, but they are also very clear in the inherent uncertainties and assumptions within their analysis:

> "Dangerous interference can be viewed from a variety of perspectives, and the choice will ultimately involve a mixture of scientific, economic, political, ethical, and cultural considerations, among others. In addition, the link among emissions, greenhouse gases concentrations, climate change, and impacts are uncertain. Furthermore, what might be considered dangerous could change over time."

The authors do not present new scientific data in this article, but rather use existing impact scenarios and attempt to correlate them with atmospheric CO_2 levels. This is not possible to do with any assurance of accuracy with today's modeling capabilities, but the methodology of the authors' approach is interesting and could be useful in the future. The authors' discussion of optimal timing for mitigation is specifically conditioned by the statement that "our ability to identify this point is constrained by our incomplete understanding of the carbon cycle." It is precisely this kind of uncertainty that leads to the multi-stage approach to mitigation proposed by the President, which preserves flexibility to respond to an improved scientific understanding of global climate change and the development of advanced energy and sequestration technologies. Such flexibility will preserve our ability to pursue the most cost-effective trajectory toward formulating and achieving long term goals.

Question 5. How do you reconcile the President's proposal for steadily increasing GHG emissions with the reality that emissions must drop in the next few decades in order for GHG to be stabilized?

Answer. Significant reductions in GHG emissions while maintaining current levels of economic activity require substantially different technologies for producing and using energy than those commonly in use today, and they require broad international participation in a coherent program. The President's proposal logically slows the projected growth in domestic greenhouse gas emissions in the next decade. The President's proposal focuses on the means to achieve the reductions necessary for long term stabilization, while maintaining the economic growth required to fuel technological innovations, which remain the key to successfully addressing this long term issue.

TIME FRAME AND REDUCTIONS NEEDED FOR STABILIZATION

Question 6. At one of our hearings on climate change last year, Dr. Kevin Trenberth made a point that really resonated with me. He stated that—because of the long residence time of CO_2 in the atmosphere—achieving the Kyoto targets *would only buy us 10 years of time* to figure out how to effectively reduce our emissions.

His point was that achieving Kyoto targets would only slow the rate of carbon emissions loading to the atmosphere—not stabilize or even reduce greenhouse gas emissions in the atmosphere. In other words, it is only a first step, and more needs to be done to stabilize or reduce atmospheric greenhouse gases.

In your testimony before this Committee on July 11th, you said that as a scientist you agree.

If achieving Kyoto targets only buys us 10 years to plan and does not stabilize greenhouse gases, how can the President advocate taking no real action on emissions reductions for 10 years and also say he is pursuing stabilization?

Answer. The President's plan is more likely to achieve the necessary stabilization of greenhouse gases than the Kyoto targets because it focuses on increasing knowledge that will inform reduction strategies, it funds research that supports and provides incentives for necessary technological change, and it seeks broader international collaborations. All these steps are necessary for real change.

Question 7. Won't the President's plan doom us to a costly and dangerous adaptation scenario because we have bypassed the "window of opportunity" for action—after which the growth in emissions of around 40 percent make needed reductions more steep?

Answer. No. Immediate substantial reduction of GHG emissions is not currently possible, and therefore there is no "window of opportunity." The window of opportunity will exist when major changes in technology are introduced and widely adopted throughout the world to achieve stabilization. Substantial reductions of GHG emissions are in fact possible with different technologies such as nuclear power. The President's plan to develop these technologies is an important part of the pathway to GHG stabilization.

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY HON. ERNEST F. HOLLINGS TO HON. JAMES R. MAHONEY

Question 1. You said that you are testifying today as the Director of the Climate Change Science Program. How does this program differ from the U.S. Global Change Research Program?

Answer. The Climate Change Science Program is responsible for the consolidated interagency management of the U.S. Global Change Research Program (USGCRP) and the President's Climate Change Research Initiative (CCRI). This consolidation ensures internal consistency of the focused CCRI research within the larger body of global change research conducted by the USGCRP and other supporting programs. The interagency Climate Change Science Program retains the responsibility for compliance with the requirements of the Global Change Research Act (GCRA) of 1990, including its provisions for annual reporting of findings and short-term plans, scientific reviews by the National Academy of Sciences/National Research Council, and periodic publication of a 10-year strategic plan for the program.

Question 2. In your development of the strategic plan for the U.S. Global Change Research Program and the Climate Change Research Initiative, will abrupt climate change research be included as part of the plan?

Answer. Abrupt climate change research has been identified and will be incorporated in the plan. A report recently published by the National Academy's National Research Council highlights the need for attention to the possibility of abrupt cli-

mate change. This report, as well as other Academy reports, will be used as a resource in the development of the strategic plan for the U.S. Global Change Research Program and the Climate Change Research Initiative.

Question 3. Can you discuss the value of observation and monitoring systems to the verification of computer modeling? Do you feel that a National Climate Service within the Department of Commerce, as recommended by the National Research Council, is necessary to provide the required observations and monitoring?

Answer. Observing systems provide the ground truth against which all model forecasts are measured. Observations from multiple sources (land, sea, air, and satellite based) must be combined using sophisticated methods to match the time and space scales of interest to any particular model. Analyses can also help identify and correct for limitations in observing systems, to some degree. (For example, combining the wide coverage of satellites with more precise in situ observations.) But ultimately observations from reliable, continuous (spatially and temporally) observing systems are vital to verification and validation of every model. NOAA and other U.S. agencies must maintain and upgrade observing systems to serve the needs of the climate community and assure data record continuity. We must also work with other countries effectively to cover the globe.

The recent report of the National Research Council did not specifically recommend a National Climate Service. The report did, however, recommend: effective use of the nation's weather and climate observation systems; improved capabilities for research, technology infusion, modeling and prediction; and regional interdisciplinary approaches to climate services.

NOAA's recently established Climate Observations and Services Program (COSP) is already leveraging the existing infrastructures and know-how of NOAA's National Weather Service, National Environmental Satellite, Data and Information Service, and Office of Oceanic and Atmospheric Research in a way consistent with the NRC's vision. The study emphasized a user-centric service to develop regional activities, attributes that are already part of NOAA's COSP. Effective national climate services can only be delivered through the pooled talents of federal, state, local, and private partners.

The Academy's first recommendation for "the effective use of . . . climate observation systems" follows earlier National Research Council (NRC) reports that identified shortcomings in NOAA observing systems built for purposes other than climate monitoring. Such improvements as higher measurement accuracy and long-term stability are needed to meet climate requirements. NOAA is working to implement the recommendations of the NRC articulated in the report *Adequacy of Climate Observation Systems*. NOAA has implemented a U.S. Climate Reference Network, which is following the climate monitoring guidelines and principles from the NRC report. These guidelines and principles are being integrated into that report and the observing systems, as appropriate. In addition, coordination among the various observing systems operated by NOAA, as well as other federal agencies, is providing more complete data sets for coupled climate models and modeling the Earth's climate system, including ocean, atmosphere and land processes. Finally, existing international partnerships are being leveraged through programs such as the Global Climate Observing System. NOAA's COSP is pursuing these tasks.

Question 4. You have identified a number of scientific uncertainties that need further research. You have also noted that we have spent over $20 billion over the past 13 years on research on climate change science. Do you have any idea of how much more will be needed to address the many uncertainties you have identified?

Answer. The research community has made significant contributions to our knowledge of climate change issues since the passage of the Global Change Research Act. However, substantial uncertainties in our knowledge continue to limit our ability to project future climate in response to technological (energy use and environmental) scenarios. My written testimony contains a list of the key uncertainties.

While "more research is always better," we believe that effective management and research prioritization and sequencing of GCRP/CCRI should allow significant reduction of uncertainty at approximately stable funding levels. Because of the importance of global climate change issues, long-term (5–10 years and beyond) significant funding will be needed for all three principal categories of interest: science, observations and decision support.

Question 5. In his written testimony, Dr. Marburger states that the U.S. Climate Action Report 2002 employs scenarios based on "ad hoc input assumptions." When NOAA scientists run climate modeling experiments, how do they generate their assumptions?

Answer. Two categories of input assumptions have been used by NOAA scientists in their future climate projections. For internationally coordinated assessment ac-

tivities, i.e., IPCC, the climate model inputs are based on scenarios of future economic growth, population trends, and technological change that have been generated and agreed upon by the international scientific community. Not surprisingly, there is considerable uncertainty, especially beyond a few decades, in projecting future economic growth, population trends, and technological change. Hence the scenarios are intended to bracket the range of possible outcomes. Most climate modeling centers, including NOAA Geophysical Fluid Dynamics Laboratory, have made climate projections based on at least two of these scenarios. NOAA scientists also use simpler approximations of future trends in greenhouse gases and other trace constituents of the atmosphere (e.g., CO_2 increase of 1 percent per year) in studies designed to improve their understanding of fundamental climate change processes.

In addition to these "standard" types of scenarios, specialized scenarios will be run in the future to explore various options for reducing the short-lived greenhouse species, such as tropospheric ozone and aerosols, where impacts currently are uncertain but progress in reducing the uncertainties can be made, as well as emissions strategies which are more closely linked to plausible technological advances in moving towards cleaner energy sources.

Question 6. The wider climate research community uses tools, such as the Community Climate System Model, to conduct groundbreaking research in studying the climate. What steps has NOAA and other agencies in the Climate Change Science Program taken to coordinate research efforts with the outside community?

Answer. The Community Climate System Model is a University-based effort which is funded by agencies under the Climate Change Science Program (or Global Change Research Program), primarily the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Energy (DOE). This is the U.S. Government effort to integrate the climate research community. Similarly, NOAA's effort is focused at its Geophysical Fluid Dynamics Laboratory, which collaborates with and solicits input from Princeton University scientists as well as through close collaboration and interaction with CCSM scientists. CCSM is increasingly focusing on modeling research while GFDL has an evolving focus on applications of climate models.

Question 7. In April 2002, the Earth Simulator computer displaced several U.S. military supercomputers as the world's fastest computer. Currently, federal agencies are not allowed to buy Japanese supercomputers, because of the "Buy America Act." Some scientists have alleged that this prohibition has restricted American research in the field of climate science. What barriers, if any, has this prohibition on foreign supercomputers had on NOAA's climate modeling program?

Answer. For its most recent supercomputer acquisition, NOAA held a full and open competition for which all supercomputer manufacturers (both U.S. and international) were eligible to compete. NOAA chose the best available offer. Decision criteria include cost-performance on NOAA weather and climate models, risk, and past performance, among others.

NOAA models have been programmed over the last several years to run on all major computer architectures, including the massively parallel architectures using commodity processors from U.S. vendors, and the vector architectures of NEC and Cray. This has led to a highly competitive procurement process that has, in turn, led to the best value for the taxpayer.

For comparison, although they have different missions, the Japanese Earth Simulator has a peak performance of 40 trillion instructions/second for an initial capital cost of $400M plus an unknown operating cost. The most recent NOAA supercomputer acquisition from IBM will cost $224 million over 9 years, including operating costs, and provide a 400–500 percent increase in computing speed over NOAA's current capabilities. In 3 years, it will have a peak speed of 11.4 trillion instructions/second.

It is unlikely that purchase restrictions will have any significant impact on future NOAA climate modeling programs.

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN KERRY TO HON. JAMES R. MAHONEY

Question 1a. The U.S. has advocated and supported voluntary actions to reduce emissions—including under the Clinton Administration. Yet after a decade of such voluntary actions, emissions continue to increase rapidly both for the United States and the rest of the world. Even those who are supporters of voluntary emissions reductions point to the record and observe that in the aggregate, voluntary actions have not succeeded at curbing the overall growth in U.S. emissions. And the data in the Report support that view.

Dr. Mahoney, does it make sense to spend another 10 years proving what the record already tells us?

Answer. The Climate Change Science Program focuses on the development of scientific analyses, measurements and projections that deal with climate science, together with ecosystem and human forcings and feedbacks. To maintain scientific credibility, the Program does not develop findings or recommendations on policy questions. The likely effectiveness of a voluntary emissions reduction program will be principally determined by several policy considerations, including the long term nature of the challenge of global climate change and the need to sustain a strong economy that can continue to develop the energy and sequestration technologies that will deliver the most cost-effective trajectory toward meeting the long term stabilization objective of the Framework Convention on Climate Change. Approaches that disregard the expressed and unanimous guidance of the U.S. Senate, such as that embodied in Senate Resolution 98, will not likely succeed.

The Climate Change Science Program is not able to offer recommendations on these possible policy outcomes.

Question 1b. What data does the Administration have to support the effectiveness of voluntary measures in reducing *actual* emissions?

Answer. In the case of voluntary CO_2 and other greenhouse gas emissions measures, their effect will be determined principally by policy influences rather that scientific findings. Comments on such policy influences are beyond the scope of the Climate Change Science Program.

Question 1c. What kinds of "voluntary measures" and verifiable emissions reductions will be implemented over the next 10 years with the two largest sources of emissions and growth in emissions: transportation and utilities?

Answer. The CCSP is unable to comment on these potential measures.

DANGERS OF MISSING THE "WINDOW OF OPPORTUNITY"

Question 2a. A recent article in Science features an article by Dr. Michael Oppenheimer, of Princeton University, an authority on climate change and a member of the IPCC. Dr. Oppenheimer and his co-author Dr. Brian O'Neill of Brown University show that in order to prevent "dangerous anthropogenic interference in the climate system"—or "dangerous climate change" (ranging from elimination of all coral reef systems to disintegration of the West Antarctic Ice Sheet)—it is necessary to begin reducing total actual emissions within the next two decades or so.

According to these scientists, any delay beyond that timeframe will have irreversible effects on our climate system. Furthermore, these scientists say that the sooner emissions drop, the easier it will be to achieve the concentrations necessary to prevent dangerous climate change. If we wait until 2020, we will have to make such drastic emissions reductions that it may not be economically feasible to prevent dangerous climate change.

What implication does this latest research have with respect to potential impacts of the President's proposal, which has emissions rising indefinitely into the future?

Answer. The National Academy of Sciences was asked to provide the most up-to-date information about what is known and about what is not known on the science of climate change. They reported that the most likely scenario in the next century is that the climate will continue to warm, but that there is considerable uncertainty in current understanding of how the climate system both varies naturally and also reacts to emissions of greenhouse gases and aerosols. Current estimates of the magnitude of warming (1.5 to 4.5 degrees C by the end of the 21st Century) should be regarded as tentative and subject to future adjustments (either upward or downward). The President has reaffirmed America's commitment to the United Nations Framework Convention and its central long term goal to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate. Our immediate goal is to reduce America's greenhouse gas emissions relative to the size of our economy.

Global climate change presents a long term challenge with alternative trajectories for achieving long term goals, each of which has cost implications. Near term, dramatic reductions in emissions such as those embodied in the Kyoto Protocol, in the view of most Members of Congress and the Bush Administration, represents an unwise and unnecessarily costly alternative. Instead, the promise of advances in the future development and application of energy and sequestration technologies, coupled with our greenhouse gas intensity goal for the next decade, represents a more cost-effective approach toward achieving our long-term objective, (and one that allows us to reduce the scientific uncertainties, with flexibility to assure that our responses are appropriately directed.)

Question 2b. How do you reconcile the President's proposal for steadily increasing GHG emissions with the reality that emissions must drop in the next few decades in order for GHG to be stabilized?

Answer. The President has declared his commitment to cutting the U.S. greenhouse gas intensity by 18 percent over the next 10 years. He has also noted that more stringent greenhouse gas controls can be implemented in the future, as the science justifies.

Responses to the following questions were not available at the time this hearing went to press.

QUESTIONS FROM HON. JOHN MCCAIN TO HON. JAMES R. MAHONEY

Question 1. You said that you are testifying today as the Director of the Climate Change Science Program. How does this program differ from the U.S. Global Change Research Program?

Question 2. In your development of the strategic plan for the U.S. Global Change Research Program and the Climate Change Research Initiative, will abrupt climate change research be included as part of the plan?

Question 3. Can you discuss the value of observation and monitoring systems to the verification and validation of computer modeling? Do you feel that a National Climate Service within the Department of Commerce, as recommended by the National Research Council, is necessary to provide the required observations and monitoring?

Question 4. You have identified a number of scientific uncertainties that need further research. You have also noted that we have spent over $20 billion over the past 13 years on research on climate change science. Do you have any idea of how much more will be needed to address the many uncertainties you have identified?

Question 5. In his written testimony, Dr. Marburger states that the *US. Climate Action Report 2002* employs scenarios based on "ad hoc input assumptions." When NOAA scientists run climate modeling experiments, how do they generate their assumptions?

Question 6. The wider climate research community uses tools, such as the Community Climate System Model, to conduct groundbreaking research in studying the climate. What steps has NOAA and other agencies in the Climate Change Science Program taken to coordinate research efforts with the outside community?

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