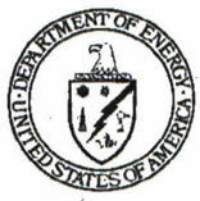


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*cabinet -
Energy*



DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

U.S. DEPARTMENT OF ENERGY

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DEPARTMENT OF ENERGY
Washington, DC 20585

October 29, 1997

OFFICE OF THE SECRETARY

MEMORANDUM FOR TODD STERN

STEVE SILVERMAN

FROM:

LIZ MONTOYA *LM*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

SUBJECT:

RECENT DOE CLIMATE CHANGE EVENTS

Selected Secretarial Activities – August - October

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DOE Office:	Policy and International Affairs
Location:	Prague, Czech Republic
Event/Action:	The Policy Office participated in an international workshop on greenhouse gas emissions trading. The workshop was designed to build support for the U.S. position on international emissions trading systems by explaining the benefits to potential trading countries.

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Location:	Paris, France
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Location: D.C.
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Location: Seattle, Washington
Event/Activity: Office of Biological and Environmental Research hosted the joint science team meetings with the Chinese Academy of Sciences (CAS) and the China Meteorological Administration (CMA). This was the ninth science team meeting with the CAS and the third with the CMA. The objective of the meetings was to outline ongoing, joint research activities for the next 12-15 months. Bilateral actions include: developing and validating climate models; investigating climate observations for evidence of climate change; and developing new data sets on methane emissions (an important greenhouse gas).

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DOE Office: Fossil Energy
Location: Pittsburgh
Event/Action: Issued a call for proposals to the nation's scientific community, asking for novel concepts on ways to sequester, store or recycle greenhouse gases. Secretary Peña highlighted the new research effort in his speech to business and academic leaders in Pittsburgh. DOE is prepared to provide up to \$50,000 for each new concept selected for study, and funding levels would increase if the concepts warrant further development.

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Location: Chicago, Illinois
Event/Action: The Chicago Operations Office selected nine firms to receive financial assistance awards for development and implementation of international projects that reduce, avoid, or sequester greenhouse gas emissions for submission under the U.S. Initiative on Joint Implementation (USII). The total awarded is \$250,000.

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Event/Activity: The DOE Southern Great Plains Atmospheric Radiation Measurement Program site near Lamont, Oklahoma, is hosting six highly coordinated intensive scientific observation periods to collect data essential for improving climate models. These sessions are focused on studying some of the largest uncertainties in climate change prediction: the effects of clouds, aerosols, and water vapor.

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10/30

Todd Stern
Jonathan Adashek
Natalie Wymer

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cabinet - energy

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STABILIZING CARBON EMISSIONS IN 2010 AT LOW COST

The U.S. can meet a goal of stabilizing carbon emissions at 1990 levels by 2010 at low cost (about \$25 per ton of carbon) by investing in technological innovation; by applying intelligent policies here at home to encourage markets to adopt new technologies; and by taking advantage of opportunities to purchase or obtain low cost carbon credits internationally through trading and joint implementation.

Using this approach, we would cut U.S. domestic emissions by 260 MMT relative to forecast levels for 2010, and obtain another 130 MMTs from international transactions.

All sectors of the U.S. economy would be able to make use of technological advances to reduce carbon emissions. What follows is just a sketch of the technological possibilities available.

ELECTRIC UTILITY SECTOR SAVINGS

We can cut carbon emissions from the utility sector by between 75 to 91 MMTs in 2010, at \$25 per ton by using the energy we now waste, by using cleaner fuels, by using more efficient generating technologies, and by increasing the efficiency of our existing systems. Some of the technologies and strategies to accomplish this are:

Using "Wasted" Energy: The efficiency of the US utility sector stands at about 34%, meaning that about 3 units of fossil fuel energy we had to produce 1 unit of electrical energy. The U.S. throws away about 21 quadrillion BTUs of energy each year -- that's an amount equal to the energy used by Japan's entire economy. We can use this heat energy in combined heat and power (CHP) systems. Overall, by developing a comprehensive CHP initiative, the US could cut carbon emissions by 20- 30 MMT in 2010.

Increasing the Use of Efficient, Natural Gas Power Plants: Converting existing coal based power plants to efficient combined cycle natural gas systems can double the efficiency with which we generate electricity, and reduce carbon emissions by nearly 70% per unit of electricity. Nationally, this would enable us to cut carbon emissions in 2010 by 9-15 MMT produced.

Using More Renewable Energy: Federal investments in renewable energy technologies are paying off in steadily declining prices for wind, solar and biomass combustion. The "Five Lab Study" scenario where carbon is priced at \$25 per ton, indicates that these clean energy alternatives could cut carbon by 9 MMT.

Increasing Plant Efficiencies: Southern Utility set out to increase their plant efficiency and saved \$108 million and reduced their emissions 35 million tons of carbon over a ten year period. Nationally, such approaches could cut emissions by 8 MMT in 2010 in a competitive marketplace.

INDUSTRY SECTOR SAVINGS

The industrial sector is projected to produce 548 MMTs of carbon emissions in 2010 under a business as usual scenario. We can cut emissions between 64 to 74 MMTs by 2010, by increasing energy efficiency in the industrial sector and using low carbon technologies. The right mix of tax incentives, utility deregulation, and environmental regulatory reinvention would enable us achieve such reductions.

Increasing Energy Efficiency: Expanding successful programs in energy audits, motor efficiency, and manufacturing extension centers could result in a 5-10 MMT annual cut in carbon emissions by 2010.

- *Energy audits* encourage systematic approaches to energy efficiency that typically have high yields. For example, Southwire Corporation, a large manufacturers of wire, rod, and cable, cut their use of natural gas by 60% and cut electricity use by 40% per pound of product produced.

- *Motors* consume 70% of industrial electricity used, and there is room for improving their efficiency. The Greenville Tube Company, for example increased productivity by 15%, increased energy efficiency by 30%, reduced scrap by 15%, and achieved a \$77,000 per year savings by improving the efficiency of their motors.

Cogeneration and Combined Heat and Power: New technologies available in the industrial sector will allow us to capture the waste heat the U.S. now throws away. The right kinds of environmental regulations and other supporting policies could allow us to cut annual carbon emissions 20 to 30 MMTs by 2010 by using industrial cogeneration of natural gas or biomass

- *Advanced turbines* developed by DOE in conjunction with industry will be available in three years (orders are already being taken). They have an overall efficiency of 80% to 90%, produce steam together with low-cost electricity and significantly reduce NOx emissions. These turbines can run on natural gas or biomass.

- Some industries have their own low-cost biomass feedstocks (for example, black liquor gasification in the pulp and paper industry), which makes possible cogeneration with nearly zero net carbon emissions.

Expanding Industries of The Future: An aggressive expansion of the Industries of the Future program sponsored by DOE could enable the U.S. to cut carbon emissions in 2010 by 44 MMTs by itself. The seven most energy-intensive industries—steel, aluminum, petroleum refining, chemicals, pulp and paper products, glass, and metal casting—account for about 80% of the carbon emissions in U.S. manufacturing and more than 90% of the hazardous waste. The Department of Energy has formed partnerships with each of these industries in which the industry takes the lead in developing visions of energy-efficient, low-polluting, highly competitive "Industries of the Future" as well as technology roadmaps to identify an R&D and deployment pathway to achieving the vision. These industry visions typically foresee annual energy efficiency improvements of 1.0% to 1.5% for two decades.

BUILDINGS SECTOR SAVINGS

The buildings sector is projected to produce 571 MMTs of carbon emissions in 2010 assuming business as usual. The 5-lab study projects emissions reductions of 47 to 52 MMTs in 2010. Of that, 42 MMTs are from energy efficiency and 5 to 10 MMTs comes from expanded use of combined heat and power. Almost all of these savings come from deploying existing technology.

Energy Efficiency: There is substantial opportunity to improve the energy efficiency of our buildings and the appliances in them. Many of these technologies improve the quality of service delivered (i.e., higher quality lighting) and have been documented in a number of cases to improve productivity.

Standards: About half of the 42 MMTs of carbon emissions reductions in 2010 can be achieved through existing authority of DOE to establish efficiency standards for appliances, such as refrigerators and air conditioners. DOE uses a consensus-based approach in which manufacturers, environmentalists, consumer advocates, and the states work together to develop applicable standards.

Voluntary Programs: The other half of the 42 MMTs of carbon emissions reductions in 2010 will be achieved primarily by the expansion of voluntary programs, such as the joint EPA-DOE Energy Star program. The Energy Star labeling program has already transformed a number of markets, for instance cutting the energy used by computers, monitors, and printers by 50% at virtually no incremental cost and is being to dozens of other products.

Plugging Leaking Electricity: Electronic equipment consumes electricity in stand-by mode (even when not being used) generating 12 MMTs of carbon emissions each year. Preliminary analysis suggests that up to 90% of that could be saved through adopting best engineering practices without reducing service.

Research And Development: Designing new buildings with advanced technology can reduce energy consumption by 25% to 50% without increasing the building's initial cost. The extra cost of some of the energy-efficient equipment is paid for by the smaller required heating and cooling

system. A partnership for 21st Century Housing can achieve 2 to 3 MMT of carbon emissions reductions in 2010 (and far more in later years as more new buildings are constructed).

Combined Heat And Power: As in the case of industry, we can reduce the carbon intensity of the buildings sector by accelerating the use of combined heat and power. Two CHP technologies -- small turbines and proton-exchange membrane (PEM) fuel cells -- have the potential to cut carbon dramatically in this sector. With accelerated R&D, these technologies have the potential to cut 2-3 MMT of carbon emissions by 2010 (with substantially larger savings in subsequent years).

TRANSPORTATION SECTOR SAVINGS

The transportation sector is projected to produce 616 MMTs of carbon emissions in 2010 assuming business as usual. The 5-lab study projects emissions reductions of 88 MMTs. Of that, 74 MMTs results from energy efficiency (greater fuel efficiency) and 14 MMTs results from increased use of low-carbon fuels (primarily ethanol).

High Efficiency Cars And Light Trucks: The President's Partnership for a New Generation of Vehicles is aiming at cars that are three times more efficient than current vehicles with no compromises in size, safety, comfort or cost. The goal is a production prototype 80 mpg vehicle in 2004 and commercial availability soon after. A variety of efficient technologies such as hybrid vehicle design, advanced engines, regenerative braking, and lightweight materials are under development. These technologies are also applicable to light trucks and sport utility vehicles, so that a PNGV for these heavier passenger vehicles is quite possible with an expanded research effort. If the efficiency of new autos is 40 mpg and the efficiency of new light trucks and sport utility vehicles is 29 mpg in 2010, carbon emissions would be reduced by about 46 MMTs in 2010.

High Efficiency Heavy Trucks: Ongoing Federal R&D on advanced diesel engines and lightweight materials could substantially reduce carbon emissions from heavy trucks. These technologies are projected to be available by about 2003 and be quickly adopted by trucking manufacturers since energy is a major cost component of freight transportation (a truck typically gets 7 to 8 miles per gallon while traveling over 50,000 miles a year). The 5-lab study estimates carbon emission reductions of about 12 MMTs in 2010.

Advanced Efficient Aircraft and Rail: Ongoing Federal research on advanced aircraft engines lightweight materials, and improved aerodynamics have the potential to improve aircraft engine energy efficiency by 40%, and reduce carbon emissions by 12 MMTs in 2010, with an additional 4 MMT of carbon emissions reductions achieved by increasing the efficiency of trains.

Low-carbon Fuel: Government-industry R&D partnerships have brought the cost of ethanol from cellulosic waste (such as waste paper or crop waste) and dedicated crops such as switchgrass or hybrid poplar trees—from \$3.60 per gallon in 1980 to \$1.20 per gallon today. Such fuels are carbon neutral

because the crops capture carbon dioxide when they grow and release it during combustion. Continued R&D in bio-engineered organisms and fast-growing crops is expected to produce ethanol for under 70 cents a gallon by 2005, competitive with oil-based fuels at current prices. By using ethanol to replace 5% of gasoline in 2010 (e.g., through blending) 14 MMTs in carbon reductions can be achieved.

Summary of Potential Carbon Emissions Reductions in 2010
(Needed for stabilization: 390 MMT)

	Emissions Reductions (MMT)
5-Lab Study at \$25/ton	234
Additional Reductions from Electricity Restructuring and Other Policies	40-71
International Trading and JI	130
Total	404 - 435

Cabinet -
Energy

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Washington, DC 20585

October 29, 1997

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PAGES: 5 (including cover)

COMMENTS:



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DOE Office:	Energy Research
Location:	Seattle, Washington
Event/Activity:	Office of Biological and Environmental Research hosted the joint science team meetings with the Chinese Academy of Sciences (CAS) and the China Meteorological Administration (CMA). This was the ninth science team meeting with the CAS and the third with the CMA. The objective of the meetings was to outline ongoing, joint research activities for the next 12-15 months. Bilateral actions include: developing and validating climate models; investigating climate observations for evidence of climate change; and developing new data sets on methane emissions (an important greenhouse gas).

Selected Subcabinet Activities (continued)

Date: September 15, 1997
DOE Office: Fossil Energy
Location: Pittsburgh
Event/Action: Issued a call for proposals to the nation's scientific community, asking for novel concepts on ways to sequester, store or recycle greenhouse gases. Secretary Peña highlighted the new research effort in his speech to business and academic leaders in Pittsburgh. DOE is prepared to provide up to \$50,000 for each new concept selected for study, and funding levels would increase if the concepts warrant further development.

Date: September 17, 1997
DOE Office: Field Management
Location: Chicago, Illinois
Event/Action: The Chicago Operations Office selected nine firms to receive financial assistance awards for development and implementation of international projects that reduce, avoid, or sequester greenhouse gas emissions for submission under the U.S. Initiative on Joint Implementation (USIJI). The total awarded is \$250,000.

Date: September 15-October 4, 1997
DOE Office: Energy Research
Location: Lamont, Oklahoma
Event/Activity: The DOE Southern Great Plains Atmospheric Radiation Measurement Program site near Lamont, Oklahoma, is hosting six highly coordinated intensive scientific observation periods to collect data essential for improving climate models. These sessions are focused on studying some of the largest uncertainties in climate change prediction: the effects of clouds, aerosols, and water vapor.

Date: September 22-28, 1997
DOE Office: Policy and International Affairs
Location: The Maldives
Event/Action: Policy Office staff attended the Plenary Meeting of the International Panel on Climate Change (IPCC). This meeting helped establish the analytical framework of the IPCC's next review (its third assessment of climate change). Policy Office staff were able to influence the structure of the upcoming review and will a role in determining the contents of the final report.

'97 OCT 29 PM 5:34

Cabinet -
Energy



DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

U.S. DEPARTMENT OF ENERGY

PHONE: 586-7700

FAX: 586-9626

TO:

Todd Stern

Phone:

456-2702

Fax:

456-2215

FROM:

Mark M.

Phone:

Fax:

PAGES:

5 (including cover)

COMMENTS:



DEPARTMENT OF ENERGY
Washington, DC 20585

October 29, 1997

OFFICE OF THE SECRETARY

MEMORANDUM FOR TODD STERN

STEVE SILVERMAN

FROM:

LIZ MONTOYA *LM*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

SUBJECT:

RECENT DOE CLIMATE CHANGE EVENTS

Selected Secretarial Activities – August - October

On August 8, Secretary Peña addressed the Colorado Oil and Gas Producer Association and discussed the industry's challenges and opportunities in light of the compelling science regarding the effects of greenhouse gas emissions.

On August 27, Secretary Peña addressed the Northwest Alliance for Transportation Technologies in Seattle, Washington regarding the Partnership for a New Generation of Vehicles (PNGV). The Secretary stressed that PNGV is part of the Administration's efforts to leverage technological resources toward reducing greenhouse gas emissions.

On September 10, Secretary Peña addressed the Hispanic Business Magazine CEO Roundtable and talked about the important role that businesses play in global climate change policy decisions.

On September 11, Secretary Peña spoke on climate change issues to a group of Lawrence Livermore Laboratory employees in Livermore, California. He highlighted the role that new technologies can play in reducing greenhouse gas emissions.

On September 15, Secretary Peña visited Carnegie-Mellon University in Pittsburgh, Pennsylvania, with Secretary Daley. Secretary Peña and Secretary Daley co-hosted a Regional Roundtable Lunch with CEOs from major corporations in the Pittsburgh region and local elected officials. This was followed by a public forum where Secretary Peña and Secretary Daley made remarks on climate change and then took questions from the audience. The trip generated favorable local and regional media coverage.

On September 15, Secretary Peña attended a dinner for senior business executives hosted by Secretary Daley. This provided an opportunity to listen to these executives and to address their concerns that the Administration will propose very stringent emissions reduction plans.

Selected Secretarial Events (Continued)

On September 16, Secretary Peña spoke to the Alliance to Save Energy in Washington, DC about the contributions that the energy efficiency industry can make to the Administration's efforts to reduce greenhouse gas emissions.

On September 17, Secretary Peña discussed climate change in a speech to the Hispanic Caucus in Washington, DC, focusing on the challenge the climate change poses to future generations.

On October 1, Secretary Peña addressed the American Chamber of Commerce in Vienna, Austria regarding the need for partnership in solving the problems posed by climate change.

On October 6, Secretary Peña led a panel discussion on technology at the White House Global Climate Change Conference.

On October 7, Secretary Peña delivered an all-hands speech to DOE employees on the 20th Anniversary of DOE's creation; global climate change figured prominently in the remarks.

Departmental Events:

On September 25, DOE released the "Five Lab" study, showing how faster development, diffusion, and adoption of new technologies can significantly reduce greenhouse gas emissions without hurting the economy.

Selected Subcabinet Activities

Date:	September 4-5, 1997
DOE Office:	Policy and International Affairs
Location:	Prague, Czech Republic
Event/Action:	The Policy Office participated in an international workshop on greenhouse gas emissions trading. The workshop was designed to build support for the U.S. position on international emissions trading systems by explaining the benefits to potential trading countries.

Date:	September 7-8, 1997
DOE Office:	Policy and International Affairs
Location:	Paris, France
Event/Action:	Policy Office staff participated in a Joint Implementation Additionality Workshop, attended by several countries. The workshop was intended to build support for the U.S. negotiating position on joint implementation by showing developing countries how they could benefit from access to low-emissions technology.

Selected Subcabinet Activities (continued)

Date: September 7-8, 1997
DOE Office: Policy and International Affairs
Location: Palo Alto, CA
Event/Action: Stanford University hosted an Energy Modeling Forum meeting, focused on climate change modeling issues. Policy Office staff participated in the two-day forum, which was designed to advance modeling techniques used in evaluating the economic effects of climate change policies.

Date: September 8-11, 1997
DOE Office: Fossil Energy
Location: D.C.
Event/Action: Fossil Energy participated in the Executive Committee Meeting of the IEA Greenhouse Gas Program. One purpose of this group is to advance the goals of the Climate Technology Initiative under the auspices of the Framework Convention on Climate Change.

Date: September 9-10, 1997
DOE Office: Policy and International Affairs
Location: Tokyo, Japan
Event/Action: Policy Office staff formed part of the U.S. delegation to a meeting of the Group of 12 (made up of developed countries). The focus of the meeting was to see if there was agreement on key items of the climate change protocol. This meeting allowed the various countries to explore common interests and to educate each other about (and lobby each other on) the subtleties of their individual proposals.

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DEPARTMENT OF ENERGY
Washington, DC 20585

October 29, 1997

OFFICE OF THE SECRETARY

MEMORANDUM FOR TODD STERN

STEVE SILVERMAN

FROM:

LIZ MONTOYA *LM*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

197 OCT 30 PM 1:05

SUBJECT:

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DEPARTMENT OF ENERGY
Washington, DC 20585

97 AUG 6 4:31

OFFICE OF THE SECRETARY

URGENT

OFFICE OF THE SECRETARY

FACSIMILE TRANSMISSION SHEET

To	Todd Stern	From	Dan Reicher
Office		Date	8/6/97
Fax Number	456-2215	Fax Number	202/ 586-0148
Office Number		Office Number	202/ 586-9500

Comments:

Proposed Roll-Out Strategy
for Fire Lab Study. Let's discuss
ASAP

Regards,

Dan Reicher

586-7701

301-891-3625 (#)

Pages: 3, including this cover sheet.

IF TRANSMITTAL IS INCOMPLETE, PLEASE PHONE Doreen at 202/ 586-9500.

Proposed Media Roll Out for Five Laboratory Climate Change Study

THE NEWS

Peer-reviewed study demonstrates ability of U.S. industry to meet range of possible climate change commitments through development and deployment of technologies that increase efficiency and reduce emissions. The study's conclusions are clear: Clean energy technology can prevent climate change and contribute to economic growth. Industry can remain strong and competitive -- even with the challenges of reducing global pollution.

To illustrate study results -- and demonstrate that the technology solution is viable -- DOE has a set of additional, newsworthy announcements. For example:

- Clean diesel grant to Caterpillar and Cummins, reducing exhaust fumes
- Air conditioning standards for low-cost cooling -- less electricity means reduced emissions from power plants
- Climate technology grants to communities
- A call for proposals to develop technologies that recycle or isolate greenhouse gases, such as carbon emissions released by power plants.
- As many as 10 of DOE's 36 R&D 100 awards are technologies that contribute to reducing global warming. For example, Lawrence Berkely Laboratory's innovation reduces costs for applying energy efficient film on building windows.

ANNOUNCEMENT OPTIONS

1. Event or announcement by the Vice President with Secretary Peña

- DOE issues press release

2. New York Times exclusive on study only; broader announcement via press release

- Include presidential/vice presidential quote in release
- Media conference call with Secretary Peña and WH principals
- Follow up media by DOE, CEQ

3. New York Times exclusive on study only; broader announcement via Secretarial event

- President's quote in release
- Follow up media by DOE, CEQ
- Delay until September

FOLLOW UP MEDIA

Opinion editorial: Secretary Peña's byline

Editorial boards: Provide top 25 papers with release and studies...Calls by DOE/CEQ to Washington Post, New York Times...Mailings to Business Week, Automotive Week...

Columnists: Robert Samuelson...(add'l TBD)

Broadcast: Seek opportunities to discuss study on CNBC programs, Talk of the Nation (weekly or Friday science show), Diane Rehm, TechnoPolitics, etc.

Regional: Participating laboratories promote to regional media (New Mexico, Chicago, Tennessee, Denver, Washington State) -- via statements by lab directors, mailings/calls to editorial boards

Draft: 7/18/97

TO: John Angell
FROM: Sam Rodriguez
TOPIC: DOE's Role in Education

The Department of Energy, under the leadership of Secretary Peña, recognizes the importance of education in the Nation's economic and scientific viability and the vital role the Department plays in its mathematics and science education infrastructure due to the unique resources that are available at its facilities. Teaching and life long learning is, and will continue to be, an integral part of our research and technology programs. The universities and laboratories funded by DOE are encouraged to include the participation of student investigators in their research efforts, thereby providing enhanced learning opportunities through hands-on research experiences.

We also believe that one of the best ways the Department can contribute to the scientific knowledge and skills of pre-college teachers is to provide hands-on research opportunities in our National Laboratories. There the teachers can work with a scientist mentor, be part of a research team, and develop transferable activities to take back to the classroom. The National laboratories have also developed partnerships with local and regional school districts to provide scientific and technical resources for teachers at the local level.

The Department through its research programs and its Laboratories is actively engaged in bringing the wonders of science to the earliest stages of learning. Innovative distance learning systems developed by DOE laboratory staff are providing Internet based curriculum modules for middle and high school students on the World Wide Web. For example, the Interactive Plasma Physics Educational Experience (IPPEX) curriculum was designed by a Princeton Plasma Physics Laboratory team comprised of a Physicist, Computer Scientist, and Science Education specialist. Lawrence Berkeley National Laboratory developed a high school astronomy education program that enables students from all over the world to request observations from an automated telescope, download images from a large image data archive, display the images using image processing software and learn math, physics, and astronomy from a comprehensive set of well-tested curriculum activities.

At the Department of Energy, we recognize that supporting education is one of the most important activities we can do to realize the success for future generations, for our agency and for society as a whole. I see educating our children as a human and social imperative. After all, the young faces we see today are the faces of the workforce and leaders of tomorrow.

Student achievement in mathematics and science is unacceptable low, especially compared with that of our international counterparts. Too many young -- particularly female and minority students who represent a largely untapped resource -- lack the preparation they need to advance to higher education and to careers in scientific and technical fields. Too few teachers receive training of the depth and magnitude required to deliver mathematics and science instruction in a way that sparks student interest. Public knowledge of scientific and technical subjects is alarmingly inadequate in light of the complex issues our Nation faces.

The Department of Energy has a direct stake in the quality and distribution of math and science education in the Nation. Working collaboratively with other federal agencies the Department can make unique contribution of facilities and human resources to this national concern.

We believe that the Department of Energy, with its unparalleled collection of scientific laboratories, facilities and experts has the potential to set a highly visible and creative example of educational collaboration for the Federal Government and the private sector. The Department has excellent resources and program models that have been little known for too long.

The Department will initiate and support a series of vigorous and immediate steps to use the Department's resources to help strengthen science, technology, engineering and math education in the Nation. We are asking the Department's laboratories and facilities to:

- Develop internet based education technologies for elementary through college students
- Expand undergraduate and faculty research opportunities
- Help support minority institutional development
- Enhance community outreach activities in science, technology, engineering and math education at all facilities
- Sustain graduate and post doctoral fellowships

As a steward of billions of dollars of taxpayer's money invested in facilities and infrastructure, the Department has a responsibility to utilize those resources productively, including the education and training of the next generation of scientists and engineers.



DEPARTMENT OF ENERGY
Washington, DC 20585

Energy
97 AUG 18 PM 1:50

OFFICE OF THE SECRETARY

OFFICE OF THE SECRETARY

FACSIMILE TRANSMISSION SHEET

To	Todd Stern	From	Dan Reicher
Office		Date	8/13/97
Fax Number	456-2215	Fax Number	202/ 586-0148
Office Number		Office Number	202/ 586-9500

Comments:

Pages: 2, including this cover sheet.

IF TRANSMITTAL IS INCOMPLETE, PLEASE PHONE Vernellia AT 202/ 586-9500.

Memorandum

To: Todd Stern

From: Dan Reicher *DR*
Department of Energy

Date: August 12, 1997

Re: Media Roll Out for Climate Change Study

In response to the meeting Monday, below is our approach for releasing the Department of Energy's climate change study. We will coordinate with Natalie Wymer and Paul Risley at the WH Climate Change Task Force.

- **Approach Jack Cushman, *New York Times*, for an exclusive.** Arrange on-the-record interview with Secretary Peña and background interviews with Joe Romm, DOE's Acting Assistant Secretary for Energy Efficiency and Renewable Technologies. Offer additional interviews with peer reviewers, e.g. Monsanto executive, and/or lab scientists.

If Cushman is not interested, approach Joby Warrick, *Washington Post*.

- On the day of the article, send **news release on study AND ancillary announcements** (diesel grant, air conditioning standards, climate technology grants). Quote from President Clinton or Vice President Gore in news release. Media conference call with Secretary Peña. ***We will speak with Jack Gibbons and Katie McGinty about participating in call.***
- Day of release, **participating laboratories would promote news** to their regional media (New Mexico, Chicago, Tennessee, Denver, Washington State) -- via statements by lab directors, mailings/calls to editorial boards.
- Place **opinion editorial** by Secretary Peña.
- Mail materials to approximately **40 editorial boards at major dailies nationwide**. Arrange informal visit and/or phone calls by Joe Romm and Dan Reicher to review study with Fred Hiatt, *Washington Post* (already has written editorial supporting technological solutions to global warming), *New York Times*, *Los Angeles Times*. ***We will speak with Jack Gibbons and Katie McGinty about calling selected ed boards.***
- Seek opportunities to discuss study on CNBC programs, Talk of the Nation (weekly or Friday science show), Diane Rehm, TechnoPolitics, etc.
- Stakeholder briefings would be ongoing.

The News

- Peer-reviewed study demonstrates ability of U.S. to meet range of possible climate change commitments through development and deployment of clean energy technologies coupled with market-based strategies. The study indicates that U.S. industry can remain strong and competitive -- even with the challenges of reducing global pollution.
- To illustrate study results -- and demonstrate that the technology solution is viable -- DOE has a set of additional, newsworthy announcements. For example:
 - ▶ Clean diesel grant to Caterpillar and Cummins, reducing exhaust fumes
 - ▶ Air conditioning standards for low-cost cooling -- less electricity means reduced emissions from power plants
 - ▶ Climate technology grants to communities nationwide -- encouraging alternative fuel vehicles and other approaches that reduce emissions
 - ▶ A call for proposals to develop technologies that recycle or isolate greenhouse gases, such as carbon emissions released by power plants
 - ▶ As many as 10 of DOE's 36 R&D 100 awards are technologies that contribute to reducing global warming. For example, Lawrence Berkeley Laboratory's innovation reduces costs of applying energy efficient film on building windows.

Materials

- Study: complete or executive summary
- Press release (study + ancillary announcements)
- Quotes on technology and climate change, including Gingrich, BP, *Business Week*, etc.

Sensitivities: Argonne Study

On the issue of "duelling studies," we will develop Q&As that respond to specific concerns relating to the studies. Generally, we would explain:

The Argonne report -- which provided industry perspectives on price scenarios that do not reflect key Clinton Administration policies -- confirms the wisdom of U.S. direction in formulating climate change strategy. This new analysis -- which models Administration policy outlined in the President's UN speech -- demonstrates how to meet possible pollution reduction proposals and grow our economy.

Timing

The best opportunity for high-profile coverage of the study would require release in August.

Secretary of Energy Advisory Board

1000 Independence Ave., SW
Washington, DC 20585-0108
Fax: (202) 586-6279

97 AUG 4 PM 5:52

Facsimile Transmission



To: Todd Stern

From: Shela Harris

Date: 8/4/97

Number of Pages (Including Cover): 3

GREETINGS FROM DOE!!!

Notes:

Todd:

Arlic Schardt called me about this. I shared my concerns with him and Katie. Please let me know if I can help you deal with this.

ice
Hatched

Shela

let me know when you talk to Arlic Todd

Fax Number of Recipient:

Natalie

Katie ...

I don't know if you have heard about Arlie's idea but I thought you should.

Basically, he wants the VP to stimulate donations to EMS so he can do a big media campaign in support of the climate change initiative. My first reaction was NO WAY but actually there might be some merit to a modified version of his idea.

Great press from Lake Tahoe.

Skila

ENVIRONMENTAL
MEDIA SERVICES

July 23, 1997

ARLIE SCHARDT
Executive DirectorMr. Todd Stern
Staff Secretary
Ground Floor, West Wing
The White House
1600 Pennsylvania Avenue, NW
Washington, DC 20503

Dear Todd:

I am founder and Executive Director of Environmental Media Services, a non-profit communications group that works to generate increased coverage of environment and public health issues. For the past three years EMS has run a highly effective, broad-based campaign to educate U.S. media and the general public on the science, economics and politics of global climate change. I served as National Press Secretary in Vice President Gore's 1988 presidential campaign, and I know how committed both he and President Clinton are to addressing this critical issue.

I am writing to ask your help in unlocking the resources necessary for EMS to implement a public information campaign to ensure support for the Administration's goal of achieving meaningful greenhouse reduction commitments in Kyoto.

The President is absolutely correct that American public opinion will make or break his efforts on climate change. But it is clear that neither the White House nor the federal agencies alone can create the necessary level of public education and support. Nor do any of the national environmental organizations have the capacity to wage a sustained, professional climate change media campaign on their own.

A few major foundations have already recognized this problem, and it is their generous support that makes the existing efforts by EMS and a handful of other organizations possible. But much more support is needed to lift public understanding of climate issues to a level sufficient to achieve the President's objectives.

I believe the White House could help bring this about by calling a meeting of selected foundation heads with the President and/or the Vice President, and urging them to expand their support of media and public education efforts during this critical period. Such a request would not be without recent precedent:

Before the population summit in Cairo, for example, Mrs. Clinton contacted foundations to urge their support for related media and public education efforts. Foundations and the NGO community responded resoundingly.

1320 18th Street NW
Suite 500
Washington DC 20036
Tel 202/463-6670
Fax 202/463-6671
E-mail ems@ems.org
Website www.ems.orgRegional Office
203 N LaSalle Street
Suite 1390
Chicago IL 60601
Tel 312/759-3420
Fax 312/332-1580

U.S. DEPARTMENT OF ENERGY

OFFICE OF THE SECRETARY

586-7700

FAX: 586-9626

TO:

Todd Stern 456-2215
Steve Silverman 456-6704

Phone:

Fax:

FROM:

Mark Marur ~~586-7700~~

Phone:

586-7700

Fax:

PAGES:

2

(including cover)



DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

August 15, 1997

MEMORANDUM FOR STEVE SILVERMAN
TODD STERN

FROM: LIZ MONTOYA *lm*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

SUBJECT: SECRETARY PEÑA'S SEPTEMBER CLIMATE CHANGE EVENTS

In response to your request, we have the following climate change events tentatively scheduled for September.

September 11-12: Secretary Peña will be in California and will visit the Lawrence Livermore Laboratory where he will speak on climate change, highlighting the role that new technologies can play in reducing greenhouse gas emissions.

September 15: Secretary Peña participates in a dinner for CEOs hosted by Secretary Daley.

September 17 or 18: Secretary Peña and Secretary Daley tour the Bethlehem Steel plant in Burns Harbor, IN (just south of Chicago). This plant has installed many advanced efficiency technologies in the past few years, enabling it to compete effectively in world steel markets. After the tour, they host a roundtable discussion with local business leaders on the opportunities presented by possible climate change strategies.

We also note that the Department of Energy plans to release a study showing how technologies can significantly lower the costs of reducing greenhouse gas emissions (*Scenarios of U.S. Carbon Reductions*) once concerns raised by the economic agencies can be addressed. This release should occur sometime in August.

Please call me at 586-6003 if you wish to discuss this further.

FAX MEMO**August 15, 1997****TO: Todd Stern****FROM: Dirk Forrister**

Per your instruction, I spoke with Rich and Kevin about their ideas for White House outreach. I spent a few minutes with Cherri Carter to get her ideas, and the attached draft benefits from her initial views. However, she did not have time yesterday or today to discuss it at length. She is reviewing the draft over the weekend. She and I are scheduled to meet on Monday morning to discuss and revise. I know she will have some helpful suggestions on specific companies, plus other ideas.

At this time, I am leaning against the WWF suggestion of another major CEO meeting with the President -- although it runs counter to my instincts to turn away the chance to use our best advocate with industry. (For example, we could try to use it as a carrot for those who are close to ready to offer a commitment.) I think you discussed this in person with Rich and Kevin, so you know their views against it. I'd like to test that with a couple of other folks before giving you a final recommendation.

I'm heading to the mountains for the weekend. I can be reached at 304/897-6077.

DRAFT *DRAFT*DRAFT**(8/15/97)****White House Climate Change Outreach Plan****Background:**

- The President's meeting with the 10 CEO's of "Fortune 500" companies created a new spark of interest in industry toward becoming part of the solution to climate change -- so long as the Administration's proposed policy framework is achieved (combining binding emissions budgets with reasonable timing, emissions trading and joint implementation).
- One CEO proposed an intriguing possibility: in exchange for a "reasonable target" (such as 2010 - 2020), industry would step forward to enter voluntary agreements "with real teeth" in the period leading up to the binding regime.
- Other CEO's stressed the importance of a stronger public-private commitment to an effort to research, develop and deploy climate-friendly technologies.

Objectives:

- Build positive momentum from CEO meeting.
- Develop enhanced voluntary CEO commitments that could be unveiled at October White House Conference.
- Follow-up on other suggestions from CEO meeting through more focused, sectorally-focused discussions on how best to deliver:
 - technology strategies and other market-based domestic policies;
 - international policy framework (binding emissions budget alternatives, II, international emissions trading, developing country commitments);
- Begin to create the coalition of supporters for an American position for Kyoto.

1. The Electric Power Sector

Desired Outcome: Companies could agree to rally other electric utilities for new, improved commitments for the October conference. The President could assure credit for early action. In addition, these companies could be expected to support and participate in a "climate technology for the future" drive. Later, when the President reinforces his commitment to U.S. policy framework and announces the terms of the "realistic, achievable and binding target," these commitments (and tonnes pledged) would serve as a show of force in American resolve to combat climate change.

Guests:

(Illustrative list)

1. Linn Draper, AEP
2. Fred Buckman, PacifiCorp
3. Craven Crowell, TVA
4. William Dahlberg, Southern Co.
5. William Davis, Niagra Mohawk
6. Charles Bayliss, Tuscon Electric Co.
7. Roger Sant, AES Corp.
8. Thomas Casten, Trigen Energy

9. Gregory Boyce, Kennecott Energy Co.
10. Irl Englehardt, Peabody Coal

- WH/Cabinet:
1. Todd Stern (Chairs meeting)
 2. Secretary Pena (alternative: Dep. Sec. Moler)
 3. Secretary Daley
 4. Gene Sperling/Tarullo
 5. Katie McGinty
 6. Jack Gibbons
 7. Janet Yellin
 8. Secretary Rubin

2. Oil & Gas

Desired Outcome: These companies have yet to pledge voluntary commitments. Building on the utility model, these CEO's could develop an industry-wide voluntary reduction framework. This would set up the parameters for compacts for voluntary reductions from companies that take action prior to the binding target by assuring credits for early reductions.

- Guests:
(Illustrative list)
1. Ken Lay, Enron
 2. Steve Percy, BP
 3. Phil Carroll, Shell
 4. Larry Fuller, Amoco
 5. Ken Derr, Chevron
 6. Mike Bowlin, Arco
 7. Bob Catelle, Brooklyn Union
 8. Richard Farmer, Pacific Enterprises
 9. Wayne Allen, Phillips Petroleum
 10. Layton Stewart, _____ (Big LA independent oil producer)

- WH/Cabinet:
1. Todd Stern (Chairs meeting)
 2. Secretary Pena (alternative: Dep. Sec. Moler)
 3. Secretary Slater
 4. Gene Sperling/Dan Tarullo
 5. Katie McGinty
 6. Jack Gibbons
 7. Janet Yellin

3. Manufacturing

Desired Outcomes: These companies have yet to pledge voluntary commitments. Building on the utility model, these CEO's could develop an industry-wide voluntary reduction framework. This would set up the parameters for compacts for voluntary reductions from companies that take action prior to the binding target by assuring credits for early reductions. This effort could benefit from the strong public-private R&D partnerships (DOE's "Industries of the Future")

- Guests:
(Illustrative list)
1. Robert Burt, FMC
 2. Michael Bonsignore, Honeywell
 3. Hank Barnett, Bethlehem Steel
 4. Pete Corell, Georgia-Pacific
 5. Paul O'Neil, Alcoa
 6. George David, United Technologies

7. William Stavropoulos, Dow
8. Paul Yhouse, Holnam
9. John Krol, DuPont
10. Joseph Cannon, Geneva Steel
11. Glen Hiver, Owens-Corning
12. Amstead?(A foundry?)
13. [Norm Augustine][successor?], Lockheed-Martin
14. Gary Tooker (or Chris Galvin?), Motorola
15. Harold Wagner, Air Products and Chemicals
16. Jack Creighton, Weyerhaeuser
17. DiSimone, 3M

- WH/Cabinet:
1. Todd Stern (Chairs meeting)
 2. Secretary Pena (alternative: Dep. Sec. Moler)
 3. Secretary Daley
 4. Administrator Browner (alternative: Dep. Adm. Hanson)
 5. Gene Sperling/Dan Tarullo
 6. Katie McGinty
 7. Jack Gibbons
 8. Janet Yellin

Additional Steps with Other Industries: The sectors noted above cover the bulk of U.S. greenhouse gas emissions, but other sectors are important.

- The President will meet in early October with CEO's of the **"Big 3" automobile manufacturers**.
- Secretary of Transportation Slater, NASA Administrator Goldin and Undersecretary of State Wirth or Eisenstadt could be helpful in meeting in September with CEO's of leading **airlines** (Northwest, American, United, Delta, etc.) and **aircraft manufacturers** (Boeing) on some specific proposals that could garner their support (relating to international standards and enhanced air traffic control proposals).
- Secretary Daley and Administrator Browner could be helpful in meeting with the **electronics and telecommunications industries** (Intel, Microsoft, AT&T, US West, Ameritech) that use modest amounts of CFC substitutes and are participating now in voluntary efforts to reduce. They could possibly expand their commitments to continually improve post 2000.



DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

August 15, 1997

MEMORANDUM FOR STEVE SILVERMAN
TODD STERN

FROM: LIZ MONTOYA *lm*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

SUBJECT: SECRETARY PEÑA'S SEPTEMBER CLIMATE CHANGE EVENTS

In response to your request, we have the following climate change events tentatively scheduled for September.

September 11-12: Secretary Peña will be in California and will visit the Lawrence Livermore Laboratory where he will speak on climate change, highlighting the role that new technologies can play in reducing greenhouse gas emissions.

September 15: Secretary Peña participates in a dinner for CEOs hosted by Secretary Daley.

September 17 or 18: Secretary Peña and Secretary Daley tour the Bethlehem Steel plant in Burns Harbor, IN (just south of Chicago). This plant has installed many advanced efficiency technologies in the past few years, enabling it to compete effectively in world steel markets. After the tour, they host a roundtable discussion with local business leaders on the opportunities presented by possible climate change strategies.

We also note that the Department of Energy plans to release a study showing how technologies can significantly lower the costs of reducing greenhouse gas emissions (*Scenarios of U.S. Carbon Reductions*) once concerns raised by the economic agencies can be addressed. This release should occur sometime in August.

Please call me at 586-6003 if you wish to discuss this further.

Jonathan
Cabinet plans
Energy

THE WHITE HOUSE
WASHINGTON

To: Gene
Don
Shulley
Date 8-7
Peter D. Jeff Smith
Bob B.
From: The Staff Secretary

Here's summary
of a study to be
released report from
DOE. Please take a look
so we can decide
best way to put it out.

WDS

Proposed Media Roll Out for Five Laboratory Climate Change Study

THE NEWS

Peer-reviewed study demonstrates ability of U.S. industry to meet range of possible climate change commitments through development and deployment of technologies that increase efficiency and reduce emissions. The study's conclusions are clear: Clean energy technology can prevent climate change and contribute to economic growth. Industry can remain strong and competitive -- even with the challenges of reducing global pollution.

To illustrate study results -- and demonstrate that the technology solution is viable -- DOE has a set of additional, newsworthy announcements. For example:

- Clean diesel grant to Caterpillar and Cummins, reducing exhaust fumes
- Air conditioning standards for low-cost cooling -- less electricity means reduced emissions from power plants
- Climate technology grants to communities
- A call for proposals to develop technologies that recycle or isolate greenhouse gases, such as carbon emissions released by power plants.
- As many as 10 of DOE's 36 R&D 100 awards are technologies that contribute to reducing global warming. For example, Lawrence Berkely Laboratory's innovation reduces costs for applying energy efficient film on building windows.

ANNOUNCEMENT OPTIONS

1. Event or announcement by the Vice President with Secretary Peña

- DOE issues press release

2. New York Times exclusive on study only; broader announcement via press release

- Include presidential/vice presidential quote in release
- Media conference call with Secretary Peña and WH principals
- Follow up media by DOE, CEQ

3. New York Times exclusive on study only; broader announcement via Secretarial event

- President's quote in release
- Follow up media by DOE, CEQ
- Delay until September

FOLLOW UP MEDIA

Opinion editorial: Secretary Peña's byline

Editorial boards: Provide top 25 papers with release and studies...Calls by DOE/CEQ to Washington Post, New York Times...Mailings to Business Week, Automotive Week...

Columnists: Robert Samuelson...(add'l TBD)

Broadcast: Seek opportunities to discuss study on CNBC programs, Talk of the Nation (weekly or Friday science show), Diane Rehm, TechnoPolitics, etc.

Regional: Participating laboratories promote to regional media (New Mexico, Chicago, Tennessee, Denver, Washington State) -- via statements by lab directors, mailings/calls to editorial boards

SCENARIOS OF U.S. CARBON REDUCTIONS

*Potential Impacts of Energy-Efficient and Low-Carbon Technologies
by 2010 and Beyond*

Prepared by the
Interlaboratory Working Group on
Energy-Efficient and Low-Carbon Technologies

Oak Ridge
National Laboratory



Lawrence Berkeley
National Laboratory*

Pacific Northwest
National Laboratory

Operated by Battelle for the
U.S. Department of Energy

Pacific Northwest
National Laboratory



National Renewable
Energy Laboratory



Argonne National
Laboratory

DRAFT - August 1, 1997

Prepared for
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

*Coordinating laboratories for this study

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U.S. Department of Energy

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EXECUTIVE SUMMARY

This report presents the results of a study conducted by five U.S. Department of Energy national laboratories that quantifies the potential for energy-efficient and low-carbon technologies to reduce carbon emissions in the United States.¹ The study documents in detail how four key sectors of the economy – buildings, transportation, industry, and electric utilities – could respond to directed policies to expand adoption of energy-efficiency and low-carbon technologies, an increase in the relative price of carbon-based fuels by \$25 or \$50/tonne (e.g., as a result of a cap on domestic carbon emissions and a market for carbon "permits"), and an aggressive program of research, development, and deployment of clean technologies. Current projections suggest that a carbon emissions reduction of 380 million metric tons (MtC) is required to stabilize U.S. emissions in 2010 at 1990 levels.

The study, which has been peer-reviewed by industry and academic experts, uses a technology-by-technology assessment as well as an engineering-economic modeling approach. It draws upon a wide variety of technology cost and performance information to assess potential impacts. Analysis of the buildings, industry, and transportation sectors quantifies the impacts of end-use energy-efficiency improvements on carbon emissions. The utility sector analysis estimates the impacts of those improvements on utility carbon emissions, and quantifies additional emissions reductions through conversion of a number of coal power plants to natural gas, dispatching of the utility grid with \$25 and \$50/tonne carbon permit prices, the accelerated use of biomass cofiring and wind energy, and other low-carbon electricity supply options. Finally, a number of other promising low-carbon technologies are examined to determine their potential for reducing emissions in the end-use sectors, including advanced gas turbines in industry, transportation biofuels, and fuel cells in buildings.

Three overarching conclusions emerge from the analysis of alternative carbon scenarios. First, a vigorous national commitment to develop and deploy cost-effective energy-efficient and low-carbon technologies has the potential to restrain the growth in U.S. energy consumption and carbon emissions such that levels in 2010 are close to those in 1997 (for energy) and 1990 (for carbon). We analyze a case in which energy efficiency alone can reduce carbon emissions by 120 MtC by 2010. Under more aggressive assumptions motivated in part by a \$25/tonne carbon permit price, a combination of energy-efficient and low-carbon technologies can reduce 2010 emissions by a total of 230 MtC. Under a \$50/tonne carbon permit price, technology investments reduce 2010 emissions by about 380 MtC. The analysis also suggests that substantial additional savings are available if permit prices were to begin to rise above the \$50/tonne level.

The second conclusion is that, if feasible ways are found to implement the carbon reductions as described above, all the cases (with reductions varying between 120 and 380 MtC/year by 2010) can produce benefits that exceed costs, counting as benefits only the energy savings to the nation. We estimate net benefits of \$6 to \$38 billion per year in 2010. Such net benefits, not generally observed in macroeconomic models requiring structural change in the economy to accommodate reductions in carbon emissions, result from the application of cost-saving energy technologies at the sectoral level.

The third conclusion is that a next generation of energy-efficient and low-carbon technologies promises to enable the continuation of an aggressive pace of cost-effective carbon reductions over the next quarter century. This report documents a wide array of advanced technology options that could be cost-competitive by the year 2020, assuming a vigorous and sustained program of energy R&D beginning now and extending beyond 2010.

¹ The five national laboratories participating in the study were: Argonne National Laboratory (ANL), Lawrence Berkeley National Laboratory (LBNL), National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). LBNL and ORNL were the co-leaders of the effort.

AUTHORSHIP

Marilyn A. Brown (Oak Ridge National Laboratory) and Mark D. Levine (Lawrence Berkeley National Laboratory) were responsible for the overall leadership of the project. They jointly authored the Executive Summary, Chapter 1 (Analysis Results), and Chapter 2 (Introduction and Background).

Chapter 3 (Buildings) authorship is best described in terms of the analysis for 2010 (Sections 3.2 and 3.3 and associated appendices) and R&D potential in 2020 (Section 3.4). Jonathan Koomey (Lawrence Berkeley National Laboratory) was the lead author for the 2010 analysis. Nathan Martin, Lynn Price, and Mark Levine (LBNL) were co-authors. Marilyn Brown was the lead author for the R&D section, with support from staff at Oak Ridge National Laboratory and Lawrence Berkeley National Laboratory.

Gale Boyd (Argonne National Laboratory), Joseph M. Roop, and Madeline G. Woodruff (Pacific Northwest National Laboratory) were the lead authors of Chapter 4 (Industry) with the exception of Section 4.3 (Low-Carbon Technologies), which was prepared by Helena Chum and Ralph Overend (National Renewable Energy Laboratory), Tony Schaffhauser and Marilyn Brown (Oak Ridge National Laboratory), and Tina Kaarsberg (Vista Technologies).

David Greene (Oak Ridge National Laboratory) and Steve Plotkin (Argonne National Laboratory) were responsible for Chapter 5 (Transportation).

Stanton Hadley and Eric Hirst (Oak Ridge National Laboratory) were the authors of Chapter 6 (The Electricity Sector's Response to End-Use Efficiency Changes).

Chapter 7, Electricity Supply Technologies, consists of a variety of topics: Conversion of Coal-Based Power Plants to Natural Gas (Section 7.2) was prepared by David South and Jack Siegel (Energy Resources, Inc.); Renewable Electricity Technologies (Section 7.3) was written by Eldon Boes and Erik Ness with contributions from National Renewable Energy Laboratory staff; the section on Advanced Coal Technologies (Section 7.6) was written by Stanton Hadley (Oak Ridge National Laboratory); and the sections on Efficiency Improvements in Generation and T&D (Section 7.4) and Nuclear Plant Life Extension (Section 7.5) were written by Marilyn Brown (Oak Ridge National Laboratory). Other sections of this chapter are summaries of published materials.

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The completion of this study was guided by a committee of experts from industry, universities, and utility research organizations. The committee was chaired by Bill Fulkerson (University of Tennessee) and included: Morton H. Blatt (Electric Power Research Institute), Daniel E. Steinmeyer (Monsanto Chemical Company), Robert A. Frosch (Kennedy School, Harvard University), Douglas C. Bauer (National Academy of Sciences), Hillard G. Huntington (Energy Modeling Forum, Stanford University) and Thomas Roose (Gas Research Institute).

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Chapter 1 (Summary): Jonathan Koomey.

Chapter 3 (Buildings): George Courville, Mike MacDonald, Jeff Muhs, John Tomlinson, Jim Van Coevering, Robert Wendt (ORNL); Steve Selkowitz, Joe Huang and Steve Johnson (LBNL).

Chapter 4 (Industry): Jim Chang, Hann Huang, Zhuoxiong Mao, John Molburg, Ken Natesan, Leslie Nieves, and Mike Petrick (ANL), Scott L. Freeman, Gary B. Josephson, and Mark J. Niefer (PNNL), Wayne Hayden (ORNL), Keith Davidson and Bill Major (OnSite Energy, Inc.), and Nancy Margolis (Energetics, Inc.).

Chapter 5 (Transportation): K. G. Duleep (Energy and Environmental Analysis, Inc.).

Chapter 7 (Electricity Supply Technologies): Helena Chum, David Kline and Ralph Overend (NREL), Jack Siegel (Energy Resources International, Inc.), Claud Pugh and Mike Sale (ORNL). Ronald Wolk contributed to Appendix G-1 and Ronald Fisher contributed to Appendix G-4.

Staff members of DOE's Energy Information Administration (EIA) participated in the planning process for this report, provided advice and assistance with the modelling described in the report, and offered insightful comments on previous drafts. Leading this group were Mary Hutzler, Andy Kydes, and Barry Cohen. Sector-specific assistance and feedback was provided by EIA's Erin Boedecker and John Cymbalsky (buildings), Crawford Honeycutt (industry); David Chien and Mark Friedman (transportation); and Art Holland and Dave Schoeberlein (electricity).

Non-participating DOE laboratories were asked to comment on various draft materials. This group of reviewers included Jerome LaMontagne (Brookhaven National Laboratory) and Dan Arvizu (Sandia National Laboratory). Additional valuable comments on earlier drafts of this report were received from John Sheffield (ORNL), Jay Braitsch and Doug Carter (DOE's Office of Fossil Energy), and several staff of the American Council for an Energy-Efficient Economy.

By acknowledging the involvement of the above individuals and the extensive review process in which they participated, we do not mean to imply their endorsement of the report. Final responsibility for the content of this report lies solely with the authors.

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Chapter 1

ANALYSIS RESULTS

This report presents the results of a study conducted by five U.S. Department of Energy national laboratories that quantifies the potential for energy-efficient and low-carbon technologies to reduce carbon emissions in the United States.¹ The stimulus for this study derives from a growing recognition that any national effort to reduce the growth of greenhouse gas emissions must consider ways of increasing the productivity of energy use. To add greater definition to this view, we quantify the reductions in carbon emissions that can be attained through the improved performance and increased penetration of efficient and low-carbon technologies by the year 2010. We also take a longer-term perspective by characterizing the potential for future research and development to lead to further carbon reductions over the next quarter century. As such, this report underscores the value of energy technology research, development, demonstration, and diffusion as a public response to global climate change.

Two overarching conclusions emerge from the analysis of alternative carbon scenarios. First, a vigorous national commitment to develop and deploy cost-effective energy-efficient and low-carbon technologies, along with utility sector investments, has the potential to restrain the growth in U.S. energy consumption and carbon emissions such that levels in 2010 are close to those in 1997 (for energy) and 1990 (for carbon). It must be noted that such a vigorous national commitment would have to go far beyond current efforts.

Second, a next generation of energy-efficient and low-carbon technologies promises to enable the continuation of an aggressive pace of carbon reductions over the next quarter century. This report documents a wide array of advanced technology options that could be cost-effective by the year 2020, assuming a vigorous and sustained program of energy R&D beginning now and extending beyond 2010.

1.1 OBJECTIVES OF THE REPORT

The purposes of this study are threefold:

1. To provide a quantitative assessment of the reduction in energy consumption and carbon emissions that could result by the year 2010 from a vigorous national commitment to accelerate the development and deployment of cost-effective energy-efficient and low-carbon technologies;
2. To document the costs and performance of the technologies that underpin a year 2010 scenario in which substantial energy savings and carbon emissions reductions are achieved;
3. To illustrate the potential for energy-efficiency and renewable energy R&D to lead to further reductions in energy use and carbon emissions by the year 2020.

1.2 METHODOLOGY

To achieve these objectives, we started with the *Annual Energy Outlook 1997* (AEO97) reference case forecasts for the year 2010 (Energy Information Administration, 1996). After thoroughly reviewing these forecasts on a sector-by-sector basis, and working with EIA staff, we chose to accept

the EIA "business-as-usual" (BAU) scenario as is for buildings and industry and to modify some of the assumptions and data to produce a new BAU case – not greatly different from the EIA case – for the transportation and the electric utility sectors.

We then assembled existing information on the performance and costs of technologies to increase energy efficiency or, for selected end-uses, to switch from one fuel to another (e.g., from electricity to natural gas for residential end-uses or from gasoline to biofuels for transportation). For the buildings sector, the technology performance and cost data base are extensive. For transportation, the data base – although less fully developed than for buildings – is sufficient for our purposes. For industry, only partial information on technologies and costs is presently available. As a result, the analysis for industry relies primarily on historical relations between energy use and economic activity and much less on explicit technological opportunities. The industrial analysis also includes some examples of industrial low-carbon technologies. The analysis of low-carbon supply technologies in the electricity sector is based on a review of the literature including detailed technology characterizations prepared by DOE in conjunction with its national laboratories and industry.

Next we created scenarios of increased energy efficiency and lower carbon emissions using the technology data (or, in the industrial sector, historical relations) as a key input. We chose to run three scenarios other than the BAU case. We have termed the first the "efficiency" (EFF) case. It assumes that the United States increases its emphasis on energy efficiency through enhanced public- and private-sector efforts. The general philosophy of the efficiency case is that it reduces, but does not eliminate, various market barriers and lags to the adoption of cost-effective energy-efficient technology.

The other two cases, dubbed the "high-efficiency/low-carbon" (HE/LC) cases, describe a world in which, as a result of commitments made on a climate treaty or other factors, the nation has embarked on a path to reduce carbon emissions. These two cases assume a major effort to reduce carbon emissions through federal policies and programs (including environmental regulatory reform), strengthened state programs, and very active private sector involvement. They include a focused national R&D effort to develop and transform markets for low-carbon energy options (e.g., fuel cells for microcogeneration in buildings and advanced turbine systems for combined heat and power in industry). The difference between the two HE/LC cases is in the assumption of a carbon permit price resulting from a domestic trading scheme for carbon emissions with a cap on U.S. emissions (or from equivalent policy measures that increase the price of carbon-based fuels relative to those with less carbon). We assume a domestic permit price of \$25 and \$50 per tonne of carbon for the two cases. Both of these HE/LC cases include a program of research, development, demonstration and diffusion that is more vigorous than in the efficiency case. In some sectors (buildings and industry), the carbon price signal, combined with policies promoting energy efficiency, is believed to trigger the bulk of the additional carbon reductions portrayed in the HE/LC cases. In the transportation sector, it is the R&D-driven technology breakthroughs that generate the bulk of the carbon reductions beyond the efficiency case. For the electricity sector, higher prices for carbon-based fuels cause larger shifts from coal to natural gas; for this sector, these same higher relative prices combined with federal and private research, development, and demonstration can bring advanced low-carbon technologies to market.

Although the work focuses on 2010, we also look beyond this date. Here we describe new technologies, materials, processes, manufacturing methods, and other R&D advances that promise to offer significant energy benefits by the year 2020; for this time period, we make no effort to forecast specific levels of market penetration, energy savings, or carbon reductions. Thus, instead of creating scenarios we describe the technological innovations that could enable the continuation of an aggressive pace of decarbonization well into the next quarter century, if appropriate investments in R&D were made.

1.3 BACKGROUND

The decade of gains in energy productivity achieved by the U.S. following the 1973-74 Arab oil embargo represents a period of economic growth that was decoupled from increases in energy consumption, resulting in substantial economic benefits. Between 1973 and 1986, the nation's consumption of primary energy froze at about 74 quads – while the GNP grew by 35%. Starting in 1986, energy prices began a descent in real terms that has continued to the present. As a result, energy demand grew from 74 quads in 1986 to 91 quads in 1995, and carbon emissions have been increasing at a similar pace.

Despite the growth in energy consumption since 1986, the U.S. economy today remains more energy productive than it was 25 years ago. In 1970, 19.6 thousand Btu of energy were consumed for each (1992) dollar of GDP. By 1995, the energy intensity of the economy had dropped to 13.4 thousand Btu of energy per (1992) dollar of GDP. The U.S. Department of Energy (DOE) estimates that the country is saving \$150 to \$200 billion annually as a result of these improvements.

Nevertheless, many cost-effective energy-efficient technologies remain underutilized. A host of market barriers account for these lost opportunities. And declining energy R&D expenditures may cause promising technology options to be foregone.

The rationale for government support of energy-efficiency R&D is strong. Much energy-efficiency research is both long-term and high-risk and therefore is not adequately funded by the private sector – despite the possibility of sizable gains in the long run. Furthermore, advances in energy efficiency offer substantial public benefits (such as carbon reductions and improved national security through greater oil independence) that cannot be fully captured in the private marketplace.

The benefits of past public investments in energy-efficiency R&D have been well documented. Between 1978 and 1996, DOE spent approximately \$8 billion on energy-efficiency research, development and demonstration (RD&D). Just five of the technologies that were developed or demonstrated with a fraction of this DOE support have resulted in net benefits of \$28 billion through 1996. Many other R&D successes have produced technologies yielding substantial energy and cost savings in the market. The DOE RD&D portfolio has also led to significant environmental, health, productivity, and economic competitiveness benefits, as well.

The HE/LC scenario with \$50/tonne carbon charge has the potential to reduce carbon emissions by approximately 380 million tonnes, thereby achieving 1990 carbon emission levels in 2010. Of this 380 million tonne reduction, about 190 million tonnes are from supply technologies. The largest of these technologies involves increased use of natural gas for electricity generation (including repowering existing coal-fired power plants and dispatching natural gas-fired power plants in preference to coal plants). Other electricity-supply technologies include renewables (wind, co-firing coal-based power plants with biofuels, expansion of hydropower capacity, mixing ethanol fuel with gasoline), power plant efficiency improvements, and nuclear power plant extensions. The remaining 40 million tonnes comes from deploying other low-carbon technologies. The largest of these – deploying advanced combustion turbines in industry – also involves increased use of natural gas. Other technologies in this category include fuel cell cogenerators in large industrial buildings, ethanol from cellulose, biomass and black liquor gasification, and low carbon industrial process technologies. Figure 1.3 (below) illustrates this breakout of carbon emissions reductions by type of technology.

Approximately 140 MtC of the increase in carbon emissions between 1990 and 2010 will have occurred by the end of 1997; thus, it is useful to look at the 13-year forecast starting with 1997. The

carbon reductions incorporated in the efficiency case cut the overall growth in carbon emissions between 1997 and 2010 from 240 million tonnes (as forecast in the BAU case) to 120. The HE/LC scenario with \$50/tonne carbon charge reduces carbon emissions in 2010 by about 130 million tonnes (compared with the 1997 level).

1.4 RESULTS

1.4.1 Prospects for Improved Efficiencies by the Year 2010

Table 1.1 and Figure 1.1 compare the nation's primary energy use in quads for the years 1990 and 1997 (projected) with the results of the three scenarios for 2010. (We have included only the high-efficiency/low-carbon case at \$50/tonne in the table and figure for simplicity.) In addition, the HE/LC case shown below does not reflect the energy impacts of the selected low-carbon technologies described later in this summary (e.g., stationary fuel cells for buildings, advanced turbine systems and biomass gasification in industry) or the supply-side options shown in Table 1.4.

Table 1.1 Primary Energy Use in Quads: 1990-2010

	1990	1997	2010		
			Business-as-Usual Case	Efficiency Case	High-Efficiency/Low-Carbon Case (\$50/tonne C)
Buildings	29.4	33.7	36.0	34.1	32.0
Industry	32.1	32.6	37.4	35.4	33.6
Transportation	22.6	25.5	32.3	29.2	27.8
Total	84.2	91.8	105.7	98.7	93.4

Source: Energy use estimates for 1990 come from EIA (1996a, Table 2.1, p. 39).

Energy use estimates for 1997 come from forecasts conducted for EIA (1996b).

Numbers may not add to the totals due to rounding.

The major observations are as follows:

- In the business-as-usual case, energy use increases by 22 quads (26%) between 1990 and 2010; 8 quads of this increase have occurred during the first seven years of this 20-year period. The fastest growing sector during these initial seven years has been buildings (4.3 quads) followed by transportation (2.9 quads) and industry (0.5 quads). In the BAU case, the fastest growing sector during the remaining 13 years is transportation (6.8 quads). This is followed by industry (4.8 quads) and then buildings (2.3 quads). The rapid projected growth in the energy consumed for transportation is driven by estimates of increased per capita travel and minimal fuel efficiency gains.
- The efficiency scenario cuts the overall growth between 1990 and 2010 from 22 to 15 quads. This is a 17% increase over the level of energy consumption in 1990, down from a 26% increase in the BAU case. Relative to the BAU case, the efficiency scenario for transportation delivers slightly more energy savings (3.1 quads) than do the same scenarios for the industrial (2.0) or buildings (1.9) sectors. Compared with 1997 levels, the smallest increase in energy growth for this case is in buildings (0.4 quads), followed by industry (2.8 quads), and transportation (3.7 quads).

- The high-efficiency/low-carbon scenario with \$50/tonne carbon charge further decreases the overall growth between 1990 and 2010, reducing it from 22 to 9 quads. This is an 11% increase over the level of energy consumption in 1990. Relative to the BAU case, the high-efficiency/low-carbon scenario for buildings, industry, and transportation delivers energy savings ranging from 3.8 to 4.5 quads for each sector. Compared with 1997 levels, the buildings sector is down about 2 quads and industry and transportation are up 1 and 2 quads, respectively.

Figure 1.1 Primary Energy Use in Quads: 1990-2010

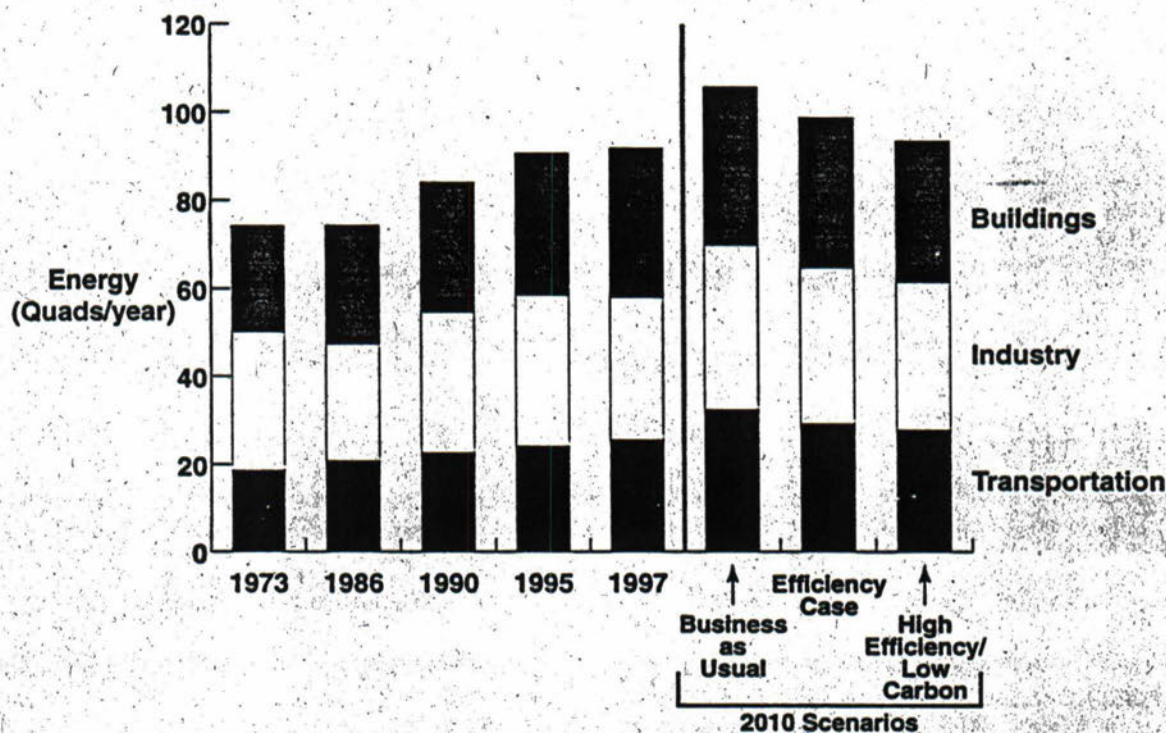


Table 1.2 documents the impact of these projected energy savings in 2010 on carbon emissions in that same year. It also presents the results of the HE/LC scenarios with both \$25 and \$50 per tonne carbon charges. These scenarios show significant carbon reductions from the combination of greater efficiency improvements and increased use of advanced low-carbon technologies.² In these cases, a number of low-carbon technologies have high rates of adoption (e.g., advanced turbine systems and biomass gasification in industry), the utility grid is dispatched to reduce carbon emissions (by using many coal plants for intermediate power and by running more natural gas plants as base load), a set of coal-based power plants are repowered, nuclear plant lifetimes are extended, and key renewable energy technologies are deployed. In all cases, these technologies and measures are estimated to be cost-effective with a differential carbon fee of \$50/tonne.

Table 1.2 Carbon Emissions (MtC): 1990-2010

	1990	1997	2010			
			Business-as-Usual (BAU) Case	Efficiency Case	High-Efficiency/Low-Carbon ^a	
					\$25/tonne	\$50/tonne
Buildings	460	511	571	546	527	509
Industry	452	482	534	512	488	452
Transportation	432	486	616	543	528	513
Utilities ^b	-	-	-	-	-48	-136
Total (rounded)	1340	1480	1720	1600	1490	1340
Change from 1990		140	380	260	150	0
Change from BAU	-	-	-	-120	-230	-380

^aThis scenario includes the carbon emission reductions resulting from a carbon permit price of \$25 or \$50/tonne: (1) dispatch of power plants in which natural gas is favored relative to coal, (2) repowering and partial repowering of coal-based power plants to convert to natural gas, and (3) introduction of selected low-carbon technologies to replace conventional ones, primarily in the industrial and utility sectors.

^bThe entries in the last two columns are negative as they correspond to reductions in carbon emissions resulting from the increased use of natural gas in power plants as a result of the \$50/tonne carbon permit price in this scenario.

Figures 1.2 and 1.3 complement the above table by illustrating the carbon emissions reductions from each scenario. The major observations are:

- In the BAU case, carbon emissions are forecast to increase by approximately 380 million tonnes.
- The energy-efficiency gains incorporated in the efficiency case cut overall growth between 1990 and 2010 by one-third (from 380 to 260 million tonnes). This represents a carbon increase of 19% above 1990 emissions.
- The HE/LC scenario with \$25/tonne carbon charge has the potential to reduce carbon emissions by 230 million tonnes from the BAU case in 2010. The largest part of these carbon reductions are from increased efficiency, but major changes in electricity supply (carbon-based dispatching and repowering) contribute nearly 35 million tonnes, and other low-carbon technology, particularly renewables and advanced turbine systems, produce approximately another 25 million tonnes.
- The HE/LC scenario with \$50/tonne carbon charge has the potential to reduce carbon emissions by approximately 380 million tonnes, thereby achieving 1990 carbon emission levels in 2010. Of this 380 million tonne carbon reduction, about 190 million tonnes are from increased energy efficiency, 140 million tonnes results from increases in the use of low-carbon fuels and technologies in the utility sector, and 50 million tonnes results from the use of low-carbon technology in industry and transportation.

100 million of the 140 million tonnes of carbon reductions in the utility sector comes from redispatching the utility system (favoring the use of low-carbon fuels) and from repowering coal plants with natural gas. Both are cost-effective with a \$50/tonne carbon charge. The remaining 40 million tonnes are from renewables (wind, co-firing coal-based power plants with

biofuels, expansion of hydropower capacity), nuclear power plant life extensions, and power plant efficiency improvements.

The remaining 50 million tonnes of carbon reductions in industry and transportation are about equally divided among three sets of fuels/technologies: (1) advanced combustion turbine cogenerators in industry, (2) biomass and black liquor gasification and low-carbon industrial processes, and (3) cellulosic ethanol/gasoline blends for automobiles.

- Approximately 140 MtC of the increase in carbon emissions between 1990 and 2010 will have occurred by the end of 1997; thus, it is useful to look at the 13-year forecast starting with 1997. The carbon reductions incorporated in the efficiency case cut the overall *growth* in carbon emissions between 1997 and 2010 from 240 million tonnes (as forecast in the BAU case) to 120. The HE/LC scenario with \$50/tonne carbon charge *reduces* carbon emissions in 2010 by about 130 million tonnes (compared with the 1997 level).

Figure 1.2 Reductions in Carbon Emissions from Each Scenario

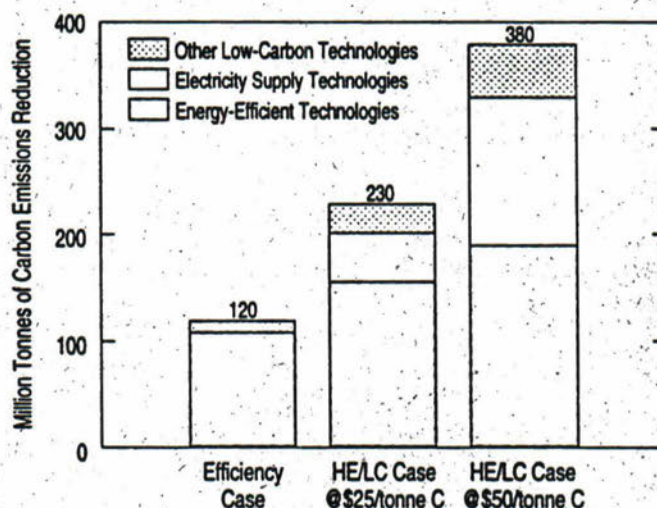


Figure 1.3 Reductions in Carbon Emissions from Each Type of Technology

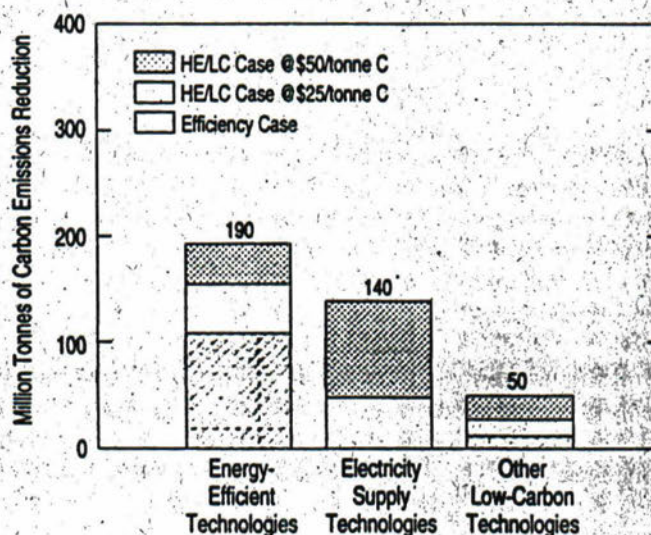


Table 1.3 provides a comparison of the growth rate in energy and in carbon emissions for the four cases, from 1990 to 2010. For the BAU and efficiency cases, the growth in carbon emissions is slightly more rapid than the increase in energy demand. For the HE/LC cases, carbon emissions decline while energy consumption rises. The carbon reduction reflects the increased deployment of low-carbon fuels and technologies as a consequence of the relative increase in price of carbon-based fuels precipitated by the \$50/tonne incentive.

Table 1.3 Average Annual Energy and Carbon Growth Rates, 1997 to 2010, for Four Cases

	Business-As-Usual (BAU)	Efficiency Case	High Efficiency/ Low Carbon Case (\$25/tonne)	High Efficiency/ Low Carbon Case (\$50/tonne)
Gross Domestic Product (GDP) ^a	1.88%	1.88%	1.88%	1.88%
Energy Demand	1.09%	0.56%	0.34%	0.13%
Carbon Emissions	1.16%	0.60%	0.05%	-0.76%
Energy Consumption Per GDP (E/GDP)	-0.77%	-1.30%	-1.51%	-1.71%
Carbon Emissions Per GDP (C/GDP) ^b	-0.70%	-1.25%	-1.79%	-2.59%

^a The Gross Domestic Product in 1995 was \$6,739 billion chained 1992 dollars.

^b The carbon decrease per unit GDP growth for 1990 to 2010 is 0.7%, 1.1%, 1.4% and 1.9% per year for the reference, efficiency, \$25/tonne HE/LC, and \$50/tonne HE/LC cases, respectively.

It is useful to compare the scenarios in this study to those of other studies. The 1991 report by the Office of Technology Assessment (OTA) titled *Changing by Degrees* (U.S. Congress, 1991) analyzed the potential for energy efficiency to reduce carbon emissions by the year 2015, starting with the base year of 1987. Its "moderate" scenario results in a 15% rise in carbon emissions, from 1300 MtC/year of carbon in 1987 to 1500 MtC/year of carbon in 2015 (compared to a BAU forecast of 1900 MtC/year). Its "tough" scenario results in a 20% to 35% emissions reduction relative to 1987 levels, or emissions levels of 850 to 1000 MtC/year of carbon in 2015. Our efficiency and HE/LC cases ranging from 1.3 to 1.6 billion tonnes of carbon emissions in 2010 are comparable to OTA's "moderate" case and show considerably higher emissions than OTA's "tough" case.

Another benchmark is provided by the 1992 National Academy of Sciences (NAS) report on *Policy Implications of Greenhouse Warming* (National Academy of Sciences, 1992). This study identified a set of energy conservation technologies that had either a positive economic return or that had a cost of less than \$2.50 per tonne of carbon. Altogether, NAS concluded that these technologies offer the potential to reduce carbon emissions by 463 million tonnes, with more than half of these reductions arising from cost-effective investments in building energy efficiency. Our efficiency and HE/LC cases suggest the potential for reducing carbon emissions by between 120 and 380 million tonnes by the year 2010. One reason that the NAS estimate is higher is because it is not limited to the 2010 time frame, but rather characterizes the full potential for carbon reductions. Thus, it did not take into account the replacement rates for equipment and processes, and other factors that prevent the instantaneous, full market penetration of cost-effective energy-efficient and low-carbon technologies.

1.4.2 R&D's Potential for Further Benefits by 2020

If carbon reductions in 2010 and beyond are to be sustained at reasonable cost, vigorous R&D efforts are needed to fill the pipeline of next-generation energy technologies. It is difficult to estimate the carbon savings that will accrue from these technologies; however, our effort to characterize their features suggests that an aggressive pace of carbon reductions over the next quarter century can be sustained, with a sufficient investment in R&D. Our analysis of R&D potential for the year 2020 focuses on opportunities for improved energy-efficiency and renewable energy technologies. The potential long-term contributions of carbon sequestration, advanced coal technologies, and nuclear power may also be significant. However, the treatment of vigorous R&D initiatives to improve these supply options beyond 2010 is beyond the scope of this report.

Renewable energy technologies will likely play a crucial role in limiting carbon emissions over the long term. Low-carbon energy supply options are needed to fuel domestic and international economic development without stimulating further global warming. Although renewable resources account for only 7% of the nation's total energy consumption at present, many believe that they are at the beginning of a long-term growth trajectory. With continuing technological development and cost reductions, renewables could become preferred energy resources some time within the next several decades. Early evidence of this transition is seen in the continuing adoption of renewable power systems, including especially wind farms and biomass power systems, even in the face of low gas-fired power generation costs and considerable uncertainty in today's electric energy sector.

With a vigorous and sustained program of research, development and deployment, biomass, wind, photovoltaics, geothermal, and solar thermal technologies could deliver significant quantities of electricity in 2020, thereby substantially displacing carbon emissions. For example, while the use of forestry and agricultural residues in biomass power systems continues to be an attractive power option where those residues exist, the successful development of higher-efficiency biomass gasification systems would make this technology competitive in a wider range of applications, including for power systems using dedicated feed stock supply systems. At the same time, biological and agricultural research on biomass production will lead both to higher biomass yields and better species for energy conversion purposes in the future.

A second area in which a vigorous and sustained R&D effort could spawn a range of key improvements is in wind power systems. Potential improvements include advanced blade shapes that increase wind power capture while reducing stress loads, elimination of gearboxes through development of direct-drive generators, variable speed turbines, and better resource prediction that will increase the value of wind power to power systems operators.

A third area of renewables development that is at the beginning of a long-term growth path is the use of renewables in buildings. Solar daylighting, passive solar designs, solar water heating, and geothermal heat pumps already are cost-competitive in many applications, but are not yet widely used. R&D advances could substantially accelerate their market penetration. In addition, building-integrated photovoltaic products will benefit directly from advances in materials research. The ultimate vision is that many buildings will become "net energy generators" through a combination of renewable energy and energy-efficiency technologies.

In the next quarter century, improved energy-efficiency technologies will result from a combination of incremental advances and fundamental breakthroughs. Incremental improvements in all sectors can be achieved by the greater reliance on more precise and reliable sensors and controls or on lower-cost sensors and controls, often integrated into industrial processes, transportation systems, and buildings. Advanced manufacturing technologies, including rapid prototyping and ultraprecision fabrication, also offer broad opportunities for continuous incremental improvements in energy

efficiency and renewable energy. Breakthroughs in bioprocessing, separations, superconductivity, catalysts, and materials can have wide-ranging impacts on energy efficiency and carbon emissions by the year 2020. Examples of specific technology opportunities are described in this report, by sector.

Six R&D areas are forecast to offer great promise to reduce significantly the energy requirements of our nation's buildings in 2020: advanced construction methods and materials; adaptive building envelopes; multi-functional equipment; integrated, advanced lighting systems, controls and communications; and self-powered buildings.

In addition to the broad application of better process modeling, sensors, and controls in industry, many process/industry-specific opportunities for efficiency gains exist. These are described for each of DOE's targeted industries of the future: pulp and paper, chemicals, petroleum refining, glass, aluminum, iron and steel, and metal casting.

Many of the advanced technologies that have the potential to significantly improve the energy efficiency of transportation after 2010 need considerable R&D investment before they can become commercially available in the year 2020. For example, to achieve fuel economies in the 60-80 miles per gallon (MPG) range and remain affordable and safe, light-duty vehicles will need breakthroughs in manufacturing processes for composite materials; large reduction in fuel cell costs and/or cost reductions and performance gains in batteries; ultra-low rolling resistance tires; high-efficiency accessories; and highly aerodynamic designs. Opportunities for R&D to lead to improvements in the energy efficiency of other transportation modes are also described.

In all, the continued adoption of energy efficient and renewable energy technologies and a steady flow of technology improvements from collaborative R&D programs with industry could make such environmentally friendly technology an attractive option for domestic and global energy economies in the future. With strong public-private partnerships to support the necessary R&D and market transformation activities, ample cost-effective energy products and practices will be available in 2020.

1.5 ASSESSMENT OF COSTS AND SOURCES OF CARBON REDUCTIONS

The business-as-usual scenario projects an increase of 380 MtC/year between 1990 and 2010. In our efficiency scenario, in which the nation actively pursues policies and programs to promote market acceptance of energy efficiency while expanding commitments to research and development, energy-efficient technologies reduce this growth in carbon emissions by 120 MtC/year. Under a carbon cap and trading system, in which permits for carbon sell for \$25 and \$50/tonne C for the two cases considered, very substantial carbon reductions appear possible. Detailed results for these cases, showing the sources of the carbon reductions, are contained in Table 1.4. (Summaries of these results were presented in Figures 1.2 and 1.3.) Results indicate that, for the HE/LC case, there is a potential to roughly return to 1990 levels of carbon emissions in 2010 at a cost of approximately \$50/tonne carbon. About two-thirds of the increase in carbon emissions is eliminated in the case with \$25/tonne carbon charge.

The estimates in Table 1.4 include ranges for most of the electricity supply options and the other low-carbon technologies. There are no ranges for the efficiency technologies because the models used to estimate their penetration are nonstochastic. When selecting a single estimate for the \$50/tonne case, numbers from the low end of the ranges were generally selected in order to be cautious. Because we did not conduct an integrating analysis in which supply options compete against one another, we felt it important to minimize potential overlap by entering the supply options in conservative

quantities. Also note that several renewable resources that could play a significantly greater role by 2010 are omitted from Table 1.4; these resources include photovoltaics, geothermal, solar thermal, and landfill gas.

It is important to recognize that there are significant uncertainties in the analysis and in many of the factors that will determine the feasibility and the costs of achieving the carbon reductions shown in Table 1.4. We present below a summary of the expected technology costs in 2010, as well as the cost of implementing a carbon permit system. While these costs are necessarily uncertain, they are our best estimates and, in our view, as likely to be high as to be low. We note, however, that we have focused our analysis on technology costs, and have not assessed policies or programs to achieve market acceptance.

Table 1.4 Potential Annual Reductions in Carbon Emissions in 2010, Compared to the Business-As-Usual Forecast for 2010 (MtC)

	Efficiency Case	High-Efficiency/Low-Carbon Case	
		\$25/tonne	\$50/tonne*
Buildings			
Energy efficiency	25	42	59
Fuel cells		2	3
	25	44	62
Industry			
Energy efficiency	22	36	51
Advanced turbine systems		5	17 (15-26)
Biomass and black liquor gasification, cement clinker replacement, and aluminum technologies		5	14 (13-16)
	22	46	82
Transportation			
Energy efficiency	61	74	87
Ethanol	12	14	16
	73	88	103
Utility Supply Options			
Carbon-ordered dispatching		25	55
Converting coal-based power plants to natural gas		9	40 (25-66)
Co-firing coal with biomass		5	17 (16-24)
Wind		2	7 (6-20)
Extending the life of existing nuclear plants		3	5 (4-7)
Hydropower expansions		2	4 (3-5)
Power plant efficiency		2	8 (7-13)
		48	136
Total (rounded)	120	226	383

*Numbers in parenthesis are ranges, as documented in the text of the report.

We have analyzed the economics of carbon emissions reductions from two different perspectives. In the first, which we label "best estimate," we evaluate all costs and benefits with a real discount rate that approximates the cost of capital for efficiency investments for the different end-use sectors: 7% for buildings, 10% for transportation, and 12.5% for industry. The lowest cost, for buildings, is based on the fact that the money for residential buildings is derived from home mortgages or home improvement loans. The higher cost for industry reflects the fact that energy-efficiency investments have to compete with investments for other projects. These discount rates are not those that describe current market behavior, but rather are reflective of costs of capital if the market did invest in the energy-efficiency measures. One could argue that a lower discount rate should be used for the "best estimate" case – namely, a social discount rate which might be between 3 and 7% real – but we have made a more conservative assumption on discount rates. For the "best estimate" case, we assume costs for efficiency measures brought about by utility, federal programs, and state programs (e.g., demand-side management programs by utilities, federal market transformation programs) to be 15% of technology costs. We also assume that at least half of the efficiency occurs as a result of federal policies (e.g., standards or carbon permit charges) which add very little direct program costs. The electric supply-side technologies are assumed to add an incremental cost of \$30/tonne carbon in 2010, based on an average estimate of the incremental costs of the technologies from the appropriate sections of this report.

The second perspective, which we label "alternative view," assumes that there are hidden costs associated with achieving widespread market acceptance of many of the efficiency and low-carbon technologies, even after the imposition of a carbon charge and the implementation of major policies and programs to promote a low-carbon future. In this perspective, we evaluate costs and benefits at a real discount rate of 15% for buildings and 20% for transportation and industry. Program costs are increased to 15% of the cost of efficiency measures. Other data and assumptions in this case are the same as for the "best estimate" case.

The results of the economic analysis are presented in Table 1.5. We show results for two of our scenarios (efficiency case and HE/LC at \$50/tonne carbon) and for both the "best estimate" and "alternative view" perspectives. Also, we have grouped the results into just four categories of energy technologies. For more detail, both on the results and methodology, the reader is referred to Appendix A-2.

The "best estimate" for the efficiency scenario shows annual net benefits of \$26 billion in 2010 (\$26 billion in costs and \$52 billion in benefits). This value reflects the fact that, even after accounting for energy-efficiency investment, the annual energy savings (without including the benefits of reduced carbon emissions) are \$26 billion greater than the required investment. The "best estimate" for the HE/LC scenario with \$50/tonne carbon charge produces an annual net benefit of \$38 billion in 2010 (\$50 billion in costs and \$87 billion in benefits).

The "alternative view" shows annual net direct benefits for the efficiency scenario of \$7 billion in 2010 (\$45 billion in costs and \$52 billion in benefits). For the HE/LC (\$50/tonne carbon) scenario, the "alternative view" indicates annual net benefits of \$6 billion in 2010 (\$81 billion in costs and \$87 billion in benefits).

Table 1.5 Costs and Benefits of the Efficiency and High-Efficiency/Low-Carbon Scenarios : Best Case and Alternative View Estimates (billions of 1995\$, annualized)

	Efficiency Case		High-Efficiency/Low-Carbon Case ^b	
	Net Benefits ^c (billion 1995\$)	Carbon Savings MtC	Net Benefits ^c (billion 1995\$)	Carbon Savings MtC
Best Estimate				
Energy Efficiency ^a	26	120	43	213
Electricity Dispatch	0	0	(1.8)	55
Electricity Repowering	0	0	(1.8)	45
Other Low-Carbon Technologies	0	0	(1.6)	72
Total	26	120	38	385
Alternative View				
Energy Efficiency ^a	7	120	12.5	213
Electricity Dispatch	0	0	(2.8)	55
Electricity Repowering	0	0	(1.9)	45
Other Low-Carbon Technologies	0	0	(1.8)	72
Total	7	120	6	385

^a Energy efficiency category includes ethanol in transportation.

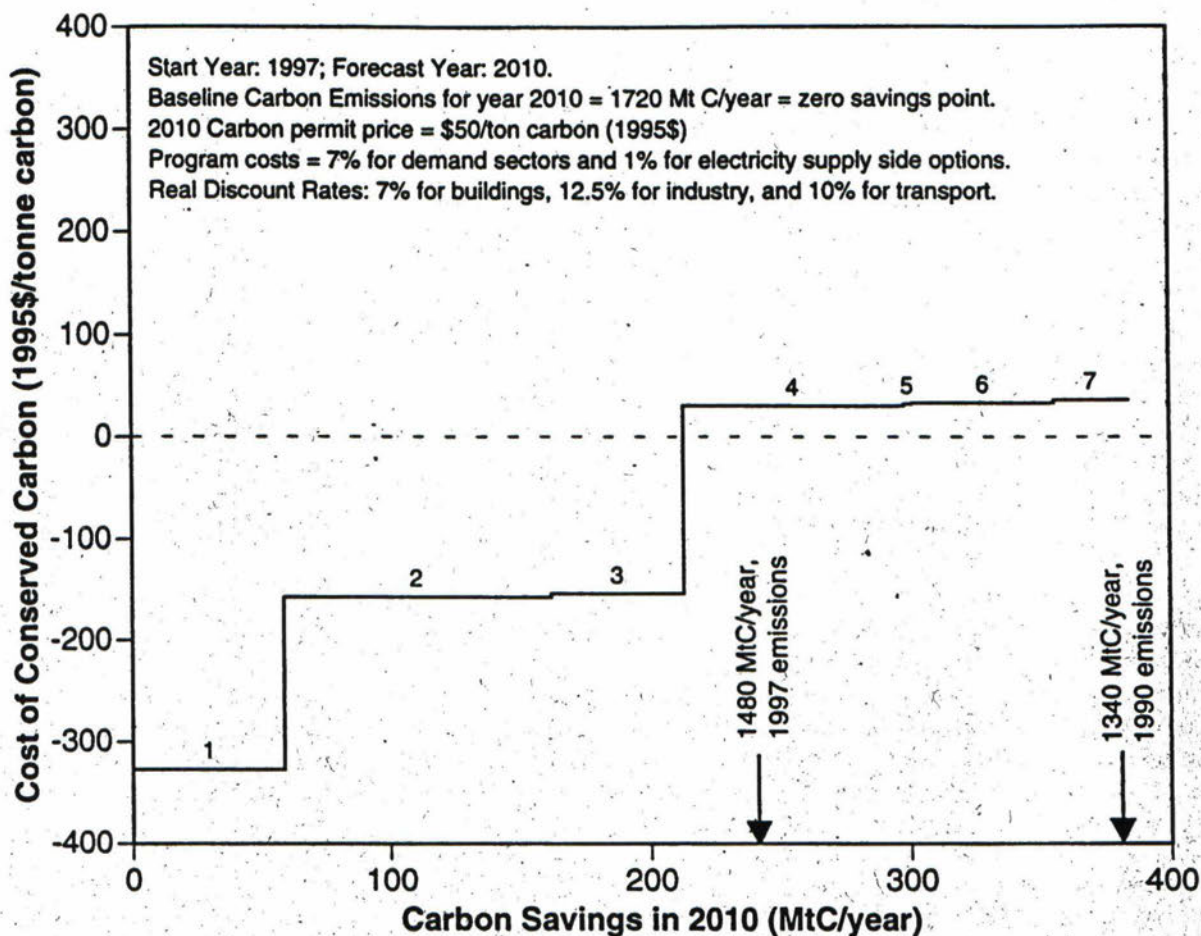
^b Benefits and carbon savings in the HE/LC case are relative to BAU case.

^c Net benefits are calculated as annual energy savings minus annualized capital costs (energy savings equal zero for supply-side technologies and advanced low-carbon technologies).

Another way to present these results is in the form of a conservation supply curve, as shown for the HE/LC scenario in Figure 1.4. This figure has the cost of conserved carbon on the y-axis (1995\$/tonne C) and carbon savings in 2010 (MtC/year) on the x-axis. Carbon savings from buildings sector efficiency are least expensive, followed by industrial and transport sector efficiency. All three of these sectors reduce carbon emissions and save money at the same time. More than 200 MtC of carbon reductions can be achieved in these three sectors. The remaining 180 MtC of carbon reductions in 2010 are in electricity supply side and advanced carbon saving options. These savings are achieved at a cost of \$30-37/tonne C, but the added cost of these options is more than outweighed by the benefits captured by the money-saving options, resulting in the net benefit of \$38 billion per year.

In addition to these costs, one needs to calculate the impact of the cases on natural gas demand. In all of these cases, natural gas replaces very large quantities of coal. Higher natural gas demand would result in higher natural gas prices, which in turn would increase the cost of substituting natural gas for coal in power production, etc. As it turns out, our scenarios have *reduced* gas demand compared with the BAU case (or with AEO97 baseline for 2010, on which the price of natural gas in our work is based). Specifically, demand for natural gas in the HE/LC (\$50/tonne) case declines in 2010 by 2 quads compared with the business-as-usual case. This is the result of declines of 0.5 quads for buildings, 1.0 quads for industry, and 0.5 quads for electricity. The latter occurs because of the balance among three factors: (1) increase in gas demand because of the large-scale substitution of natural gas for coal, (2) decrease of gas demand because of the use of many low-carbon technologies that do not use natural gas (wind, nuclear power plant extensions, power plant efficiency upgrades, hydropower expansion, co-firing with biofuels), and (3) the large increase in cogeneration, which reduces demand for natural gas for heating applications. The sum of the second and third effects are somewhat greater than the first, and thus total natural gas demand associated with electricity generation declines. This will reduce the cost of natural gas, a benefit that we have not included in Table 1.5.

Figure 1.4 Cost of Carbon Savings in 2010, High Efficiency/Low Carbon Case (Best Estimate)



	Annual Savings		Annual Costs
1. Buildings Efficiency	\$19.3B	4. Electric Repowering/Other	\$2.6B
2. Transport Efficiency	\$16.2B	5. Fuel Cells in Commercial Bldgs.	\$0.1B
3. Industry Efficiency	\$7.9B	6. Electricity Dispatch	\$1.8B
		7. Industry Other	\$1.1B
Total Savings	\$43.4B	Total Costs	\$5.6B

Total Annual Net Savings (Items 1 through 7) = \$38 B/year

The \$50/tonne carbon charge, while not constituting a direct cost, does represent a potentially large transfer payment. The magnitude of the transfer payment, as well as the losers and winners from the transfers, depends on the nature of policy and its implementation as a cap and trade system or some alternative. The amount of money that could be in play is very large: \$50/tonne times 1.3 billion tonnes per year equals annual revenues of \$65 billion.

In short, while there will surely be winners and losers for these energy-efficiency and low-carbon scenarios, our analysis shows that their net economic costs – under a range of assumptions and alternative methods of cost analysis – are favorable: from \$6 billion to \$38 billion per year in 2010.

This analysis counts the benefits of reduced expenditures on energy but does not explicitly value the benefits of reducing carbon dioxide emissions.

The achievability of the cases depends on many factors. In all cases, carbon reductions require the nation to embark on an aggressive set of policies and programs, presumably in response to an international agreement on climate change or other events that result in a national determination to reduce the growth of carbon emissions. In the high-efficiency/low-carbon case, we assume a vigorous national program of research, development, demonstration, and diffusion, and a trading regime for carbon with a domestic permit price of \$50/tonne carbon. Without some scheme that provides an incentive of this nature for switching from coal to natural gas, and for deploying other low-carbon technologies, much of the carbon reductions in our case would not be possible.

Government policies and programs that encourage and/or require the adoption of energy-efficiency and low-carbon technologies will be needed, along with incentives for industry to invest more in these technologies. Additional private and public investments are necessary, not only to accelerate the introduction of new technologies into the market before 2010 but also to ensure technology for the period after 2010. The transportation and utility sectors are especially dependent on early technological advances to achieve the scenario results in 2010.

There is no assurance that these and other driving forces will cause the scenarios we have described to take place. Our major conclusion is that the cost-effective technology can be deployed to achieve major reductions in carbon emissions by 2010. Cost-effective energy efficiency alone can take the nation 30 to 50% of the way to 1990 levels (from our expected base case results). An important finding is that two additional utility sector measures can reduce carbon emissions by another 30% at an estimated cost of \$50/tonne carbon: carbon-based dispatch and conversion of existing power plants from coal to natural gas.³ Finally, we identify additional technologies that can contribute up to 20% of the carbon reductions, also for less than \$50/tonne. A next generation of advanced energy-efficiency and renewable energy technologies promises to enable the continuation of an aggressive pace of energy and carbon reductions over the next quarter century.

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ENDNOTES

¹ The five national laboratories participating in the study were: Argonne National Laboratory (ANL), Lawrence Berkeley National Laboratory (LBNL), National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). LBNL and ORNL were the co-leaders of the effort.

² \$50 per tonne of carbon corresponds to 12.5 cents per gallon of gasoline or 0.5 cents per kilowatt-hour for electricity produced from natural gas at 53% efficiency (or 1.3 cents per kilowatt-hour for coal at 34% efficiency). \$25 per tonne would cut these gasoline and electricity price increments in half.

³ The cost curve for repowering is relatively flat; as such, considerable additional reductions are possible at a cost not too different from \$50/tonne. The results are highly sensitive to the price differential between coal and natural gas; at a lower (higher) price differential, a higher (lower) permit price of carbon is needed.

Chapter 2

INTRODUCTION AND BACKGROUND

This report presents the results of a multi-laboratory study aimed at quantifying the potential for energy-efficient and low-carbon technologies to reduce carbon emissions in the United States. The stimulus for this study derives from a growing recognition of the link between energy-efficiency R&D and the nation's ability to respond to international calls to reduce the growth of greenhouse gas emissions. According to a recent report of the Intergovernmental Panel on Climate Change (IPCC), the earth's surface temperature has increased about 0.2 degrees Celsius per decade since 1975. Further, the IPCC report concluded that "the balance of evidence suggests that there is a discernible human influence on global climate" as the result of activities that contribute to the production of greenhouse gases (IPCC, 1996, p. 5). By preventing heat radiated from the sun-warmed earth from escaping into space, the increased concentration of greenhouse gases in the atmosphere contributes to global warming.

The major greenhouse gases are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_2O), and a host of engineered chemicals such as chlorofluorocarbons (CFCs). CO_2 accounts for a majority of recent increases in the heat-trapping capacity of the atmosphere, with worldwide atmospheric concentrations of CO_2 increasing at about 0.5% annually. Of all the human activities that contribute to these increases, fossil fuel combustion is by far the largest, accounting for almost 60% of the greenhouse warming resulting from anthropogenic sources in recent years (NAS, 1992, Table 2.2, p. 8). Energy-efficient technologies reduce CO_2 emissions by displacing the need for fossil fuel combustion; this report focuses on this single greenhouse gas. This report quantifies the climate benefits of energy-efficient and low-carbon technologies in terms of reductions in millions of metric tons of carbon (MtC) emitted.¹

Analysis by a number of key climate and energy modelers indicates that significant research and development on greenhouse-friendly technologies is essential to achieving meaningful targets at affordable costs. As a result, climate change is becoming a major impetus for energy R&D programs and is likely to grow in importance in the future. By documenting the emissions reductions that past energy-efficiency R&D can deliver by the year 2010, and by describing the potential for future research to reduce carbon emissions even farther, this report is intended to inform a broad public about technology-based approaches to reduce greenhouse gas emissions.

2.1 OBJECTIVES OF THE STUDY

The purposes of this study are threefold:

1. To provide a quantitative assessment of the reduction in energy consumption and carbon emissions that could result by the year 2010 from a vigorous national commitment to accelerate the development and deployment of cost-effective energy-efficient and low-carbon technologies;
2. To document the costs and performance of the technologies that underpin a year 2010 scenario in which substantial energy savings and carbon emissions reductions are achieved;
3. To illustrate the potential for energy-efficiency and renewable energy R&D to lead to further reductions in energy use and carbon emissions by the year 2020.

The report focuses on energy-efficiency and renewable energy R&D. The coverage of additional selected low-carbon end-use and electricity supply options was based in large measure on their perceived potential to contribute significantly to stabilizing carbon emissions by 2010 at their 1990 level, which is one possible national target under discussion.

2.2 METHODOLOGY

2.2.1 Overview

To achieve these objectives, we started with the *Annual Energy Outlook 1997* (AEO97) reference case forecasts for the year 2010 (Energy Information Administration, 1996). After thoroughly reviewing these forecasts on a sector-by-sector basis, and working with EIA staff, we chose to accept the EIA "business-as-usual" (BAU) scenario as is for buildings and industry and to modify some of the assumptions and data and produce a new BAU case – not greatly different from the EIA case – for the transportation and the electric utility sectors.

We then assembled existing information on the performance and costs of technologies to increase energy efficiency or, for selected end-uses, to switch from one fuel to another (e.g., from electricity to natural gas for residential end-uses or from gasoline to biofuels for transportation). For the buildings sector, the technology performance and cost data base are extensive. For transportation, the data base – although less fully developed than for buildings – is sufficient for our purposes. For industry, only partial information on technologies and costs is presently available. As a result, the analysis for industry relies primarily on historical relations between energy use and economic activity and much less on explicit technological opportunities. The industrial analysis also includes some examples of industrial low-carbon technologies. The analysis of low-carbon supply technologies in the electricity sector is based on a review of the literature including detailed technology characterizations prepared by DOE in conjunction with its national laboratories and industry.

Next we created scenarios of increased energy efficiency and lower-carbon emissions using the technology data (or, in the industrial sector, historical relations) as a key input. We chose to run three scenarios other than the BAU case. We have termed the first the "efficiency" case. It assumes that the United States increases its emphasis on energy efficiency through enhanced public- and private-sector efforts. The general philosophy of the efficiency case is that it reduces, but does not eliminate, various market barriers and lags to the adoption of cost-effective energy-efficient technology.

The other two cases, dubbed the "high efficiency/low carbon" (HE/LC) cases, describe a world in which, as a result of commitments made on a climate treaty or other factors, the nation has embarked on a path to reduce carbon emissions. They assume a major effort to reduce carbon emissions through federal policies and programs (including environmental regulatory reform), strengthened state programs, and very active private sector involvement. They include a focused national R&D effort to develop and transform markets for low-carbon energy options (e.g., fuel cells for microcogeneration in buildings and advanced turbine systems for combined heat and power in industry). The difference between the two HE/LC cases is in the assumption of a carbon permit price resulting from a domestic trading scheme for carbon emissions with a cap on U.S. emissions (or from equivalent policy measures that increase the price of carbon-based fuels relative to those with less carbon). We assume a domestic permit price of \$25 and \$50 per tonne of carbon for the two cases. Both of these HE/LC cases include a program of research, development, demonstration and diffusion that is more vigorous than in the efficiency case. In some sectors (buildings and industry), the carbon price signal, combined with policies promoting energy efficiency, is believed to trigger the bulk of the additional carbon reductions portrayed in the HE/LC cases. In the transportation sector, it is

the R&D-driven technology breakthroughs that generate the bulk of the carbon reductions beyond the efficiency case. For the electricity sector, higher prices for carbon based fuels cause larger shifts from coal to natural gas; for this sector, these same higher relative prices combined with federal and private research, development, and demonstration can bring advanced low-carbon technologies to market.

Although the work focuses on 2010, we also look beyond this date. Here we describe new technologies, materials, processes, manufacturing methods, and other R&D advances that promise to offer significant energy benefits by the year 2020; for this time period, we make no effort to forecast specific levels of market penetration, energy savings, or carbon reductions. Thus, instead of creating scenarios we describe the technological innovations that could enable the continuation of an aggressive pace of decarbonization well into the next quarter century, if appropriate investments in R&D were made.

2.2.2 Time Frame

Analysis for all sectors focuses on two base years (1990 and 1997) against which future progress is benchmarked, and a target year of 2010 for assessing emissions reduction potential. Energy use and emissions for 1990 and 1997 are reported as base years against which we compare future energy consumption and carbon emissions.

The report examines a "snapshot" of energy use and carbon emissions, by sector, in 2010. The increased use of energy-efficient technologies combined with the development of new technologies based on past R&D plus an invigorated R&D effort initiated in 1998 are needed to achieve our 2010 scenarios.

We also highlight the likely post-2010 benefits of an intensified investment in energy R&D. This captures the effects of technologies that may not be widely commercial for some years but that could deliver cost-effective energy savings and emissions reductions, if public and privately supported R&D were to accelerate their proof of concept and reduce their developmental risks.

2.2.3 End-Use Efficiency Scenarios

Each of the three end-use sector chapters is consistent in terms of overall approach, scope, and time frame. They each analyze three scenarios for the year 2010: a business-as-usual case, an efficiency case, and a high-efficiency/low-carbon case. (In the integration of this work, we later assess two different HE/LC cases – one with a \$25/tonne carbon charge and the other with a \$50/tonne carbon charge. The buildings sector also presents a "frozen efficiency" baseline, for additional comparison purposes. While there is variation in the methodologies used to estimate the energy savings and emission reductions potential of each sector, the three sector chapters are similar in using a combination of technology analysis and model-based forecasting. Specifically, the buildings and transportation sectors use stock models with technology characteristics and other parameters taken from assessments of individual technologies. The industrial sector forecasts conservation investment behavior based on econometric modeling with industry-specific conservation supply curves as inputs.

All of the scenarios described in this report use the AEO97 forecasts of national economic output as measured by gross domestic product (GDP), which is projected to increase by 1.9% per year through 2015. Similarly, the buildings sector uses the AEO97 forecast of growth in residential and commercial floorspace; the industrial sector uses the AEO97 assumption of a 2.1% annual growth rate for manufacturing production; and the transportation sector uses the AEO97 forecast of a 3.7% annual increase in air travel.

The scenarios for each sector also use the AEO97 energy price forecasts. World oil prices are assumed to rise from \$17 per barrel in 1995 to \$20.4 per barrel (in 1995\$) in 2010. In AEO97, natural gas prices in the industrial, electricity, and transportation sectors increase throughout the forecast period; natural gas prices for the residential and commercial sectors decrease significantly. Between 1995 and 2010, the average price of electricity is projected to decline by 0.6% a year as a result of competition among electricity suppliers. Electricity prices are forecast to decrease the most for industrial customers and the least for residential customers.

Such macroeconomic and fuel price assumptions strongly influence the rate of penetration of energy-efficient technologies in each sector. Further details regarding these assumptions can be found in EIA (1996c).

Frozen Efficiency Baseline. This case, which is analyzed only for the buildings sector, assumes that energy-consuming equipment and systems existing in the year 1997 remain at the same efficiency until they are retired. This equipment and these systems retire over the 1997-2010 period at a rate based on standard equipment lifetimes. It assumes that all new equipment employed after 1997 remains at the efficiency of new devices in the year 1997. The frozen efficiency baseline provides an upper bound to likely energy demand (under the economic assumptions applied to all the cases), because it ignores all forces leading to higher efficiency of new equipment in the business-as-usual case. It also ignores any retrofits that might take place if there were economic reasons for early retirement of equipment.

This case is presented primarily for heuristic reasons: it describes an easily-understood case in which technology does not change. This is useful for exploring the impacts of technology change. Also, the case is not necessarily divorced from reality: in the era of low energy prices preceding the oil embargo of 1973-74, the energy efficiency of many household, transportation, and industrial technologies changed very little.

Business-as-Usual Case. The business-as-usual (BAU) case represents the best estimate of future energy use given current trends in service demand, stock turnover, and natural progress in the efficiency of new equipment. It assumes that R&D and implementation programs at DOE and EPA continue at more or less current levels, without a significant influx of new funding. It captures likely changes in efficiencies of new equipment over the analysis period. It also allows for some early retirement of equipment where cost savings from new energy-efficient products are high relative to purchase and installation costs, as in some industrial motor and drive systems and commercial lighting retrofits.

To create this scenario, the buildings and industry sectors adopted the AEO97 reference case as their BAU cases. For the transportation sector, we modified AEO97 somewhat. Specifically, the AEO97 reference case forecasts that the efficiency of passenger cars will increase from 27.5 MPG in 1997 to 31.5 MPG in 2010. We believe such improvements are unlikely in the absence of increases in real gasoline prices and hence our BAU case for transportation leaves the MPG performance of light-duty vehicles in 2010 unchanged from 1997 performance.

Efficiency Case. The efficiency case describes the potential for cost-effective, energy-efficient technologies to penetrate the market by the year 2010, given an invigorated public- and private-sector effort to promote energy efficiency through enhanced R&D and market transformation activities. This case assumes that national policy, possibly in combination with exogenous events, leads to an increase in the cost-effectiveness and deployment of energy-efficient technologies. Cost-effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies or exogenous events that could precipitate

such changes. Instead, we examine the potential for technology-based energy and carbon reductions, assuming that significant efforts are undertaken to enhance the attractiveness of these technologies.

To be attractive to these manufacturers and consumers, a technology must be cost-effective. Thus, this scenario limits itself to describing the potential for cost-effective technologies to reduce energy use and carbon emissions. A technology is defined as "cost-effective" if it delivers a good or service at equal or lower life-cycle costs relative to current practice.² Externalities are not internalized in this definition of cost-effective. An energy-efficient technology may be societally cost-effective, for instance by taking into account its air quality or safety benefits, but not be judged cost-effective by our narrower economic criteria. This scenario reflects the view that "policy options exist that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run" (Arrow et al., 1997).

Compared to the business-as-usual case, the efficiency case assumes (1) better technology and (2) higher penetration rates for energy-efficient and low-carbon technologies.

1. "Better technology" results from an invigorated public- and private-sector investment in R&D such that energy-efficient technologies become more cost-competitive based on current fuel prices. Performance improvements between 1997 and 2010 are mostly incremental in this scenario, but by 2020 they could be revolutionary.
2. "Higher penetration rates" result from an invigorated set of policies and market transformation programs that remove or reduce market failures which inhibit the use of energy-efficient and low-carbon systems. Through improved information and risk reduction, capital markets for energy-efficiency investments could be strengthened and consumer investment hurdle rates for the purchase of high-efficiency equipment could be lowered.

Despite its assumption of an aggressive public commitment to energy efficiency, this scenario also takes into account real-world experience and program implementation constraints which suggest that it is not reasonable to assume that every consumer will purchase the least-cost, high-efficiency technology option. There are many reasons to expect a shortfall from such a maximum case: capital rationing, imperfect information, misplaced incentives, and the unevenness of supply, installation, and maintenance networks (DOE, 1996b).

High-Efficiency/Low-Carbon Case. The high-efficiency/low-carbon (HE/LC) case assumes a greater commitment to reducing carbon emissions through federal policies and programs, strengthened state programs, and very active private sector involvement. One way to view this case is to see it as an attempt to model a world where an international global warming treaty is negotiated over the next few years and where the outcome for the United States (and other Annex I nations) is to stabilize carbon and other greenhouse gas emissions in 2010 at 1990 levels. The United States pursues those reductions by (1) aggressively instituting federal policies to develop and deploy energy-efficiency and low-carbon technologies, such as increased funding for market transformation and R&D efforts and (2) by issuing tradable emission permits.

In this rendition of the HE/LC case, policies are put into place by 2000 and progressively phased in until they are fully in place by 2010. The permit price for carbon would presumably rise steadily through 2010. Thus, we have multiple factors affecting consumer and business behavior, including the following:

- The recognition that policies to reduce carbon emissions will necessarily follow the signing of an international agreement, including an anticipation of higher relative prices for carbon-based fuels;

- The actual increases over time in the permit price of carbon (which we model as averaging either \$25 or \$50 per tonne for much of this period);
- Increased federal effort to accelerate R&D and diffusion of low-carbon technologies;
- The development and introduction by other countries of advanced low-carbon technologies; and
- The change in consumer preferences and behavior that would result from an international treaty and national commitment to stabilize greenhouse gases, much like changes in consumer behavior in the aftermath of the oil embargo of 1973-74.

In summary, this scenario for 2010 describes a combination of better technology, "readier" markets, and a price of carbon that results in a significantly increased willingness to manufacture, purchase, and use low-carbon technologies.

2.2.4 Methodological Differences Across Sectors

The operational definitions used to model these scenarios for the individual end-use sectors reflect the above conceptual definitions, but are nevertheless distinct (Table 2.1). These differences are due partly to the modeling approaches used for each sector. They also reflect the authors' sense of what could "drive" significant increases in energy efficiency in each sector. For instance, to achieve a high-efficiency/low-carbon scenario, the transportation analysis postulates a set of technology breakthroughs. The industrial analysis, on the other hand, achieves its high-efficiency/low-carbon scenario by doubling market penetration rates and assuming that energy-efficiency decisions are treated as strategic investments with correspondingly lower hurdle rates.

The sectors also differ in the way that life-cycle costs and benefits are calculated to determine the cost-effectiveness of technologies in their efficiency scenarios.

- The buildings sector employs a 7% real discount rate to value the stream of benefits accruing from an investment. These benefits accumulate throughout the specific operational lifetimes assumed for individual technologies. The efficiency case assumes market penetration of about one-third of the technologies that are cost-effective at a 7% real discount but not adopted in the business-as-usual case. The HE/LC case doubles this penetration.
- The industrial sector assumes a capital recovery factor (CRF) of 15%, rather than 33% (which is the BAU assumption). Thus, to be considered cost-effective in this sector, an investment must pay back in no more than approximately seven years.
- The transportation sector uses a 7% discount rate, but it is applied only to the first five years of operation, even though the expected lifetime of a vehicle may be much longer. This five-year period is meant to reflect the realities of purchase behavior in this sector, and results in decisions that are based on considerably less than the full life-cycle of benefits.

Table 2.1 Conceptual and Operational Definitions of Scenarios for 2010

Scenario/ Definition	Business-as-Usual (BAU)	Efficiency (EFF)	High-Efficiency/ Low-Carbon (HE/LC)
Conceptual Definition	Best estimate of future energy use given current trends in service demand, stock turnover, and natural progress in the efficiency of new equipment, including advances supported by current public-sector programs; assumes no changes in federal energy or environmental policies.	Potential for cost-effective, energy-efficient technologies to penetrate the market given an invigorated effort to promote energy efficiency through enhanced public and private-sector R&D and market transformation activities.	Optimistic but feasible potential for energy efficiency and low-carbon technology based on a greater commitment to reduce carbon emissions resulting from actions that might include the creation of a market value for carbon of \$25 and \$50 per tonne.
Operational Definitions:			
Buildings	AEO97 reference case developed using the NEMS model. ^a	35% of the difference in total energy savings between the BAU and cost-effective energy savings potential. ^b	65% of the difference in total energy savings between the BAU and cost-effective energy savings potential.
Industry	AEO97 reference case; LIEF is calibrated to this case and then is modified to produce the two efficiency scenarios.	The capital recovery factor (CRF) for energy-efficiency investment used in LIEF is lowered from 33% to 15%. ^c	The CRF is lowered to 15% and the penetration rates for energy-efficient technology used in the BAU are doubled.
Transportation	AEO97 reference case modified to hold new light-duty vehicle fuel economy constant at current levels.	Assumes earlier introduction of advanced fuel economy technology and adds certain key technologies that are not in the BAU.	Postulates breakthroughs in hybrid vehicle technology, major aerodynamic and engine efficiency gains for commercial aircraft, and other technological achievements.

^a NEMS = National Energy Modeling System developed by DOE's Energy Information Administration.

^b The cost-effective energy savings potential is defined as the difference between the energy demand that results from using the most energy-efficient of the cost-effective technology currently available or forecasted to be available by 2010, and the energy demand in 2010 assuming business-as-usual rates of technology change and use in the economy.

^c LIEF = Long-Term Industrial Energy Forecasting model developed by Argonne National Laboratory and Lawrence Berkeley National Laboratory.

2.2.5 What the Study Does Not Do

This report does not describe the policies that might be implemented to achieve higher penetrations of energy-efficient and low-carbon technologies. (Reviews of a wide range of possible policy options can be found in several recent publications, including OTA (1991), NAS (1992), and DOE (1996b)). Rather, this report highlights the potential performance and impacts of technological developments and transformed markets. The existence of cost-effective technologies is a prerequisite for public policies to work. Without the technologies, policies to reduce greenhouse gas emissions will be very costly. Indeed, this analysis suggests that carbon stabilization could produce net benefits if the nation invests significantly in cost-effective energy-efficiency and low-carbon technologies.

Thus, we believe it is critical to understand the availability of technologies, their performance, and their costs for as many end-uses of energy as possible. Armed with this knowledge, discussion of policies becomes much more meaningful. Without it, such discussion is less likely to lead to good decisions. Thus, we choose to focus this report on the more narrow topic of technologies in the belief that doing a credible job in this area will ultimately further the policy dialogue.

A second reason for focusing on technologies is our belief that the role of R&D on energy-efficient and low-carbon technologies as a means to deal with climate change and other environmental impacts has been inadequately recognized. If effective energy technologies are not developed, then the cost of reducing greenhouse gas emissions (and other environmental impacts of energy) will be very high.

As in the AEO97 reference case, each of the scenarios is completed at the national level. Thus, regional variations in population and economic activity are not considered, nor are regional differences in fuel price, weather, or air quality and environmental conditions that might create regional niche markets for particular technologies. As a result, our analyses have undoubtedly overlooked the possible development of regional markets for advanced energy technologies. A valuable next step would be to conduct analyses at a finer geographic scale to produce national estimates that reflect such regional variations.

2.3 OVERVIEW OF THE REPORT

The rest of Chapter 2 sets the stage for the remainder of this report. It describes historical energy and carbon trends, both at the national level and by sector, as a backdrop for assessing energy consumption and carbon emission forecasts. It also discusses the government's role in energy R&D, including the rationale for government support and some evidence of past energy-efficiency technology successes that benefited from government sponsorship.

Chapters 3 through 5 address each of the major energy end-use sectors: buildings (Chapter 3), industry (Chapter 4), and transportation (Chapter 5). Four tasks are completed for each sector:

1. Energy scenarios with and without a strong efficiency push, focusing on the year 2010, and including comparisons with the AEO97 projections from the National Energy Modeling System;
2. Documentation of the cost and performance assumptions for individual energy-efficient and low-carbon technologies;
3. Development of three scenarios (business-as-usual, efficiency, and high-efficiency/low-carbon cases) for the year 2010 and an explanation of how the scenarios were developed; and

4. Descriptions of new technologies that could become available in the 2010 to 2020 time period, as the result of R&D over the next two decades.

Each of these chapters is accompanied by appendices that provide detailed documentation of the technology assumptions and the forecasting methodologies used. These are labeled Appendices C (buildings), D (industry), and E (transportation).

Chapter 6 analyzes the electricity sector to forecast the effect of electricity and demand savings in the year 2010 on CO₂ emissions from power plants. It also assesses the impact of a \$25/tonne and \$50/tonne permit price for carbon on the generation mix used by the electricity sector in 2010. The results of these analyses are used in the buildings and industry sector chapters to convert electricity savings into carbon reductions. Results from this chapter reveal the importance of fuel choice for new power plants and fuel switching for existing power plants as determinants of carbon emissions in 2010. Specifically, the cost and magnitude of fuel switching from coal to natural gas for power generation, the possible early retirement of some coal-fired plants, and the upgrading/repowering of existing plants were identified as key issues for Chapter 7.

The possible conversion of coal plants to natural gas combined cycle technologies is analyzed in Chapter 7, as one of many electricity supply-side options for reducing carbon emissions by 2010. Other options are addressed in Chapter 7, albeit more briefly, including cofiring coal with biomass, efficiency improvements in generation and T&D, advanced coal technologies, and nuclear plant life extension. The chapter also characterizes the carbon reduction benefits that could accrue by the year 2020 from a sustained renewable energy R&D effort.

2.4 HISTORICAL ENERGY TRENDS

2.4.1 National Trends

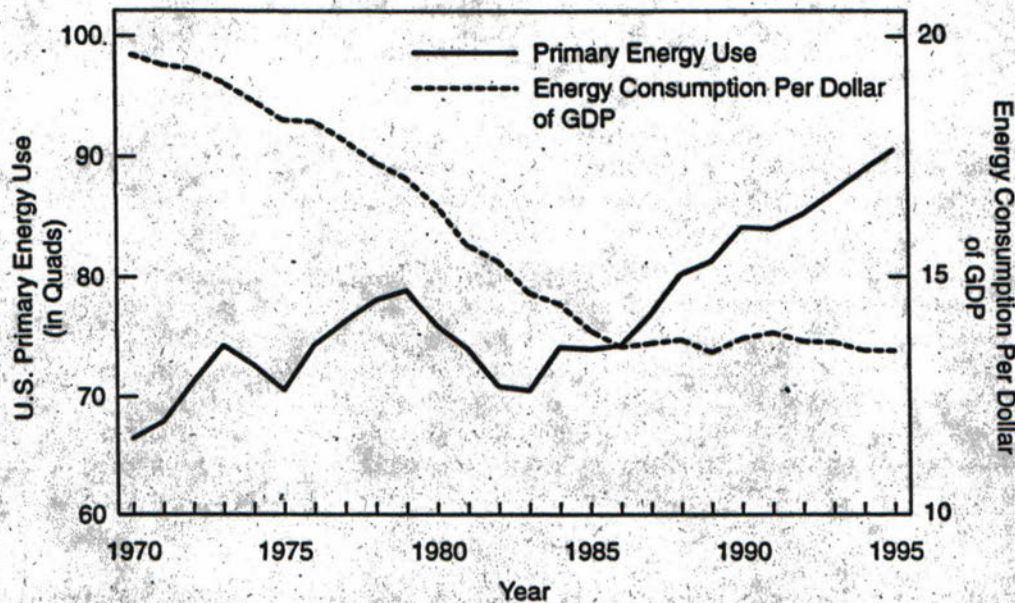
In studying historical trends in energy use and carbon emissions, we have chosen to highlight the years 1973, the beginning of rising energy prices to the nation; 1986, the year in which energy prices began a ten-year decline in real terms; 1990, the year generally used as a reference for carbon emissions; and 1997, the first year of our forecast period.

Between 1973 and 1986, the nation's consumption of primary energy froze at about 74 quads – while the GNP grew by 35%.³ People purchased more fuel-efficient cars and appliances, insulated and caulked their homes, and adjusted thermostats. Businesses retrofitted their buildings with more efficient heating and cooling equipment and installed energy management and control systems. Factories adopted more efficient manufacturing processes and purchased more efficient motors for conveyors, pumps, fans, and compressors. These investments in more efficient technologies were facilitated by higher energy prices and by federal and state policies that were enacted and implemented to promote energy efficiency. About one-third of the freeze in energy use during this period was the result of structural changes such as declines in energy-intensive industry and increases in the service sector; two-thirds was due to increases in energy efficiency (DOE, 1995).

The gains in energy productivity achieved by the U.S. in the two decades following the 1973-74 Arab oil embargo represent one of the great economic success stories of this century. The extent to which the U.S. economy improved its energy productivity can be quantified by examining the relationship between total energy consumption and gross domestic product (GDP), as depicted in Figure 2.1. In Figure 2.1, primary energy use is measured in quads and energy consumption per dollar of GDP is measured in thousands of Btus per 1992\$. In 1970, 19.6 thousand Btu of energy were consumed for each dollar of GDP (1992\$). By 1995, the energy intensity of the economy had dropped

to 13.4 thousand Btu of energy per dollar of GDP (1992\$) (EIA, 1996a, p. 17). DOE estimates that the country is saving \$150 to \$200 billion annually as a result of these improvements.

Figure 2.1 Energy Consumption Per Dollar of Gross Domestic Product: 1973-1995



Starting in 1986, energy prices began their descent in real terms that has continued to the present. As a result, energy demand grew from 74 quads in 1986 to 91 quads in 1995, and it continues to increase. One of the major lessons of the period since 1973 is that the economy will and can respond to energy price changes. In addition to prices, other factors are also important and can slow the decline in conservation activity that otherwise would be expected with declining energy prices. Federal policies, as well as federal, state, and utility programs and consumer preferences for energy-efficient appliances, houses, and cars can increase the purchase and use of energy-efficient products. Technological developments can improve the energy efficiency, reduce the carbon emissions, and often improve the performance of the product. Demand for energy-efficient products and low-carbon energy technologies is also strengthened by factors such as environmental concerns.

2.4.2 Sectoral Trends

Each end-use sector functions differently in the U.S. energy marketplace. One of the reasons for these differences is the differing market structure for delivering new technologies and products in each sector. Residential and commercial building technology is shaped by thousands of building contractors and architectural and engineering firms, whereas transportation technology is in the hands of a few manufacturers.

The principal causes of energy inefficiencies in manufacturing and transportation are not the same as the causes of inefficiencies in homes and office buildings, although there are some similarities (Hirst and Brown, 1990). For example, in the manufacturing sector, energy-efficiency investments are hindered by a preference for investments that increase output compared with investments that reduce operating costs. The cost and relative difficulty of obtaining reliable information often prevents energy-efficient features of buildings from being capitalized into real estate prices. This is

partly due to the lack of widely accepted building energy rating systems. These same information gaps do not characterize the transportation sector, which has a well understood labeling system for vehicles, in the form of miles per gallon. Misplaced incentives inhibit energy-efficient investments in each of the sectors. Consumers often must use the energy technologies selected by others. Specialists write product specifications for military purchases that limit access to alternatives. Fleet managers select the vehicles to be used by others. And architects, engineers, and builders have great control over the energy integrity of buildings, even though they do not pay the energy bills. The involvement of intermediaries in the purchase of energy technologies limits the ultimate consumer's role in decision making and leads to an emphasis on first cost rather than life-cycle cost (DOE, 1996b).

The end-use sectors also differ in terms of their ability to respond to changing energy prices. The transportation and residential sectors can respond relatively rapidly to price spikes, through reduced driving and by adjusting thermostat settings, respectively.

The vast differences in the R&D capability of the various sectors also influence their ability to respond quickly to changing energy prices and market signals. The private sector as a whole spends more than \$100 billion per year on R&D, dwarfing the government expenditure on all non-defense technology R&D. Of this R&D expenditure, the automobile manufacturers stand out – Ford alone spends more than \$8 billion per year on R&D. Next comes the rest of the industrial sector. Here, manufacturers account for a majority of the R&D expenditures. Finally, in the buildings sector, the construction industry has virtually no indigenous R&D. The Council on Competitiveness in 1992 estimated that the construction industry spends less than 0.2% of its sales on R&D, far less than other industries, which average 3.5%.

Finally, each of the sectors is distinct in terms of their dynamics and primary societal benefits from improved energy efficiency. Improving the efficiency of transportation is needed to improve air quality and reduce dependence on imported oil. Improving the efficiency of the industrial sector improves economic competitiveness and is often effective in preventing pollution. Opportunities for energy-efficiency improvements are most widespread in the buildings sector because of market barriers in the form of information that is difficult to obtain, energy consumers who do not make purchase decisions on energy-using equipment, etc. Such differences make analysis by end-use sector essential for understanding the U.S. energy, carbon, and innovation picture as a whole.

Table 2.2 presents the primary energy consumed annually by the buildings, industry, and transportation sectors between 1973 and 1997. It shows significant sectoral differences in energy consumption trends. For instance, during the 1973-86 period when the country's primary energy use was steady at 74 quads, energy use in buildings and transportation increased by 2.7 quads and 2.2 quads respectively; industry experienced a compensating decline of 4.9 quads.

Table 2.2 Primary Energy Use in Quads: 1973-1997

	1973	1986	1990	1995	1997
Buildings	24.1	26.9	29.4	32.1	33.7
Industry	31.5	26.6	32.1	34.5	32.6
Transportation	18.6	20.8	22.6	24.1	25.5
Total	74.3	74.3	84.2	90.6	91.8

Source: Energy use estimates for 1973-95 come from EIA (1996a, Table 1.1, p. 39). Energy use estimates for 1997 come from EIA (1996c).

Over the entire period from 1973 to 1997, energy use increased in buildings from 24.1 to 33.7 quads (40%); in industry, from 31.5 to 32.6 quads (3.5%); and in transportation, from 18.6 to 25.5 quads (37%). As shown in Table 2.3, the growth in buildings and transportation has been relatively steady, at less than 1% per year from 1973 to 1986, and between 1.3 and 2.9% per year from 1986 to 1997. Growth in energy demand in industry has been much more volatile during the period, showing substantial declines during the period of rising prices (a negative 1.3% annual growth for the 13 years of increasing energy prices), an increase of 2.7% per year from 1986 to 1995, and a 2.9% per year decline from 1995 to 1997.

Table 2.3 Historical Energy Growth Rates: 1973-1997

	AAGR 1973-97	AAGR 1973-86	AAGR 1986-90	AAGR 1990-95	AAGR 1995-1997
Buildings	1.41%	0.85%	2.25%	1.77%	2.46%
Industry	0.14%	-1.31%	4.81%	1.45%	-2.87%
Transportation	1.32%	0.86%	2.10%	1.29%	2.86%
Total	0.89%	0.0%	3.18%	1.48%	0.66%

AAGR = Average Annual Growth Rate

The growth of carbon emissions during the period roughly follows that of energy demand growth. Table 2.4 shows estimated carbon emissions from 1973 to 1997. Like energy, carbon emissions were flat between 1973 and 1986. The increase in the fraction of coal in the final mix from 17.5% in 1973 to 23.2% in 1986 was offset by the increasing fraction of primary energy from nuclear power, from 0.1% in 1973 to 6.0% in 1986. From 1986 to 1997, carbon emissions grew more slowly than energy consumption. This was a result of an increase in the share of natural gas from 22.5% in 1987 to 25.4% in 1997 and in electricity from nuclear power from 4.5% to 7.2%, combined with a small decrease in coal (23.3% to 22.5%) and a larger decrease in petroleum (43.3% to 39.7%).

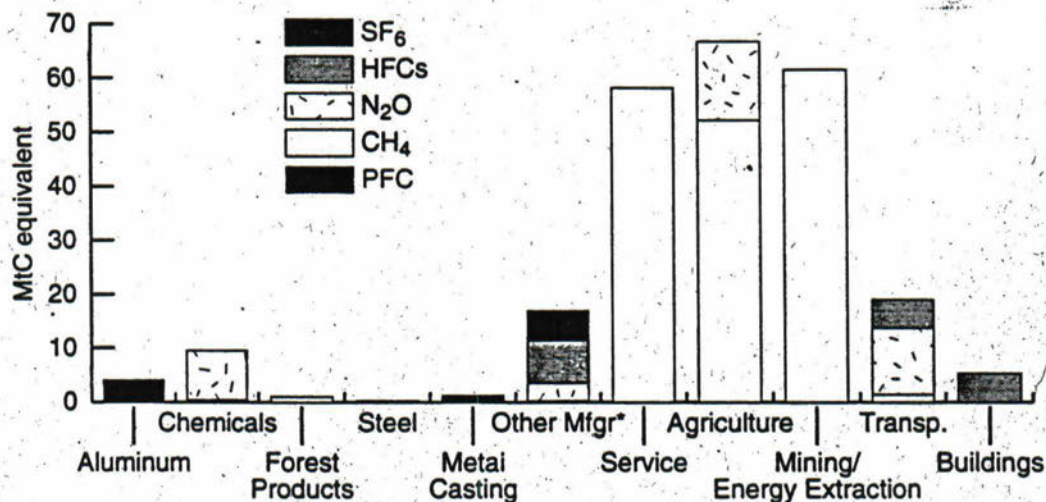
Table 2.4 Carbon Emissions from Fossil Energy Consumption: 1973 to 1997

	1973	1986	1990	1995	1997
Carbon emissions from energy in MtC	1260	1240	1344	1424	1480
	1973-97	1973-86	1986-90	1990-95	1995-97
Average annual growth rates (AAGR) for carbon emissions	0.67	-0.12%	2.03%	1.16%	1.95%

Sources: Carbon emissions estimates for 1990 are from EIA (1996b, Table 6, p. 16), and for 1995 are from EIA (1996b, Table A19, p. 120). Carbon emission estimates for 1973 and 1986 were derived using factors for carbon emissions from combustion of oil, natural gas, and coal for 1990. For 1997, they are from the end-use sector analyses described in Chapters 3 through 5 of this report.

Although non- CO_2 industrial emissions of greenhouse gases are small by weight, they have global warming potentials (GWPs) that range from 21 for methane to 23,900 for sulfur hexafluoride (SF_6). Carbon dioxide has a GWP of one by definition. Figure 2.2 shows the relative contribution of these other gases in MtC equivalent. The largest non- CO_2 greenhouse gas contribution is from methane (CH_4), which is responsible for 177.5 MtC equivalent and has a GWP of 21. Next is nitrous oxide (N_2O), which is responsible for 39.1 MtC equivalent and has a GWP of 310. Finally, in 1994, various halocarbons and other engineered chemicals amounted to 29.5 MtC equivalent. These engineered chemicals are a source of concern since their emissions are growing rapidly – and the United States is the major source. SF_6 alone is increasing at a rate of 0.5 MtC equivalent per year (EIA 1996b). Note also that many of these emissions are seen not only in energy-intensive industries but also in “high-tech” and service industries, as shown in Figure 2.2.

Figure 2.2 Non- CO_2 Greenhouse Gas Emissions by End-Use Sector and Industry



Source: EIA (1996b)

2.5 THE GOVERNMENT'S ROLE IN ENERGY R&D

2.5.1 Rationale for Government Support

Most people agree that the federal government has a clear and important role in the funding of basic research, and that it should not fund research that the private sector would conduct on its own. Between these two extremes is a wide range of applied technology development and deployment activities where the rationale for federal sponsorship is often unclear.

Economists have identified at least three situations in which the government's role in the R&D process is justified. First is the situation where the potential aggregate benefits of the research are large, but the uncertainties are simply too great for the private sector to shoulder the full research costs. Second is the case where R&D activities will result in benefits that cannot be captured by private entities. Although benefits might accrue to society at large, no single firm can realize enough economic gain to justify the research costs. A recent Council of Economic Advisors report (CEA, 1995) estimated that the private returns from R&D are 20 to 30%, while social returns (including energy and environmental benefits) are 50% or higher. This economic barrier limits the extent to which the private sector can supplant a government role in maintaining nationally beneficial R&D. The third situation occurs when the public sector is the primary consumer of the

results of the R&D. This is characteristic, for instance, of much defense and crime prevention research.

Based on these three justifications, the rationale for government support of energy-efficiency and low-carbon technology R&D is strong. Much of this research is both long-term and high-risk and therefore cannot be afforded by private companies despite the possibility of substantial gains in the long run. Examples include high temperature superconductivity, fuel cell vehicles, and building materials with switchable thermal and optical properties. Advances in energy research also offer substantial public benefits that cannot be fully captured by private entities. Specifically, energy-efficiency and low-carbon resources improve energy security by reducing the nation's reliance on foreign sources of oil; they lead to reductions in waste streams; and they reduce greenhouse gas emissions, which contribute to global warming. Finally, it is possible that governments will in the future become the principal purchaser of greenhouse gas reductions as the result of future international agreements. In this case, the third rationale for federal sponsorship of energy R&D will also apply.

Industry's R&D priorities are shifting away from basic and applied research and toward near-term product development and process enhancements. Business spending on applied research has dropped to 15% of overall company R&D spending, while basic research has dropped to just 2%. In addition, corporate investments in energy R&D, in particular, are down significantly (DOE, 1996a, p. 2).

Great potential exists for public-private R&D partnerships to produce scientific breakthroughs and incremental technology enhancements that will produce new and improved products for the marketplace. U.S. industry spends more than \$100 billion per year on all types of R&D. The top 20 R&D performing companies all have R&D budgets exceeding \$1 billion per year. These expenditures dwarf the U.S. government's energy-related R&D appropriations. If climate mitigation policies reoriented even a tiny fraction of this private-sector expenditure and capability, it could have an enormous impact. One way to reorient private-sector R&D is through industry-government R&D partnerships that involve joint technology roadmapping, collaborative priorities for the development of advanced energy-efficient and low-carbon technologies, and cost-shared R&D.

2.5.2 Past R&D Successes

Some indication of the cost-effectiveness of energy-efficiency R&D can be gleaned from the experiences to date of DOE's Office of Energy Efficiency and Renewable Energy. From fiscal year 1978 through fiscal year 1994, DOE spent a total of about \$8 billion on energy-efficiency R&D and related deployment programs. Estimates of the benefits of several dozen projects supported by this funding were published in DOE/SEAB (1995). In response to a detailed review of these estimates by the General Accounting Office in 1995/96, DOE has revised and updated the estimated benefits accruing from five technologies that were developed with DOE support. Altogether, these five technologies alone have resulted in net benefits (i.e., the value of energy saved minus annualized cost premiums for better equipment) of approximately \$28 billion (1996\$) and annual emissions reductions of 16 MtC equivalent (Table 2.5).

Thus, the value of the energy saved by these five technologies, alone, far exceeds the cost to the taxpayers of DOE's entire energy-efficiency R&D budget over the past two decades. Additional case studies and benefits are documented in Geller and McGaraghan (1996) and DOE/SEAB (1995).

Table 2.5 Cumulative Net Savings and Carbon Reductions from Five Energy-Efficient Technologies Developed with DOE Funding

Energy-Efficient Technology	Net Present Value of Savings Thru 1996 (billions of 1996\$)	Annualized Consumer Cost Savings (billions of 1996\$)	Annual Carbon Reductions in 1996 (MtC equivalent)
• Building Design Software	11.0	0.5	8
• Refrigerator Compressor	6.0	0.7	3
• Electronic Ballast	3.7	1.4	1
• Flame Retention Head Oil Burner	5.0	0.5	3
• Low-E Windows	3.0	0.3	1
Totals	28	3.4	16

Note: Savings for the refrigerator compressor and flame retention head oil burner are through 1996 only; the remainder are savings from products in place by the end of 1996 and include estimated energy savings from the product's years in operation beyond 1996.

In addition, results recently reported by Elliott et al. (1997) indicate that the total benefits – including both energy and non-energy savings – that accrue from so-called "energy-saving" projects are typically much greater than those from the energy savings alone. In fact, based on numerous case studies, the authors conclude that the average total benefits received from these "energy-saving" projects are close to two to four times the value of the energy savings alone. They also noted that costs and benefits resulting from non-energy ramifications of energy-efficiency projects are often not included in cost/benefit analysis of energy-efficiency projects. Similarly, Romm and Ervin (1996) describe public health benefits that have resulted from advances in energy-efficient and renewable energy technologies, and Romm (1994) describes productivity gains that have accompanied investments in industrial efficiency improvements.

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ENDNOTES

¹ In this report, carbon dioxide is measured in carbon units, defined as the weight of the carbon content of carbon dioxide. Carbon dioxide units at full molecular weight (typically, million tonnes of carbon (MtC)) can be converted into carbon units by dividing by 44/12, or 3.67. This approach has been adopted for two reasons: (1) carbon dioxide is most commonly measured in carbon units in the scientific community, in part because it is argued that not all carbon from combustion is, in fact, emitted in the form of carbon dioxide, and (2) carbon units are more convenient for comparisons with data on fuel consumption and carbon sequestration (EIA, 1996b). Note that, in the U.S., a "ton" (sometimes referred to as a "short ton") equals 2000 pounds; a metric ton, or "tonne," equals 1000 kilograms (approximately 2204 pounds).

² We evaluate cost-effectiveness from several viewpoints, with real discounts between 7% and 20%. Even with the high discount rates, the efficiency case is cost-effective.

³ Primary energy use is the chemical energy embodied in fossil fuels (coal, oil and natural gas) or biomass, the potential energy of a water reservoir, the electromagnetic energy of solar radiation, and the energy released in nuclear reactors. For the most part, primary energy is transformed into electricity or fuels such as gasoline, jet fuel, heating oil or charcoal – these, in turn, are referred to as secondary energy. The end-use sectors of the energy system provide energy services such as cooking, illumination, comfortable indoor climate, refrigerated storage, transportation and consumer goods using both primary and secondary energy (NAS, 1992, p. 3)

⁴ The net present value (NPV) of cost savings, cumulative through 1996

$$NPV = \sum_{t = \text{entry year}}^{1996} (E_t - P_t) e^{0.07(1996 - t)}$$

where: E_t is value in 1996\$ of energy saved in year t

P_t is annualized cost premium (1996\$) of the better product

0.07 is the 7% real interest rate recommended by the Office of Management and Budget.

'97 JUL 18 PM6:22



Department of Energy

Washington, DC 20585

OFFICE OF THE EXECUTIVE SECRETARIAT FACSIMILE TRANSMITTAL FORM

Fax Number: FTS 896-4403 Verify (Voice) FTS 896-5081 Verify (Alternate) FTS 896-5078
CML 202-586-4403 CML 202-586-5081 CML 202-586-5078

Date: 7/18/97To: Todd Steen 456-2215From: Secretary PeñaTransmittal consists of 2 pages, excluding this form.

Notes:

Revised - Please discard previous version

**The Secretary of Energy**

Washington, DC 20585

July 18, 1997

MEMORANDUM FOR JOHN GIBBONS, ASSISTANT TO THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY

THURGOOD MARSHALL, JR., ASSISTANT TO THE PRESIDENT
OFFICE OF CABINET AFFAIRS

KATIE MCGINTY, CHAIR
COUNCIL ON ENVIRONMENTAL QUALITY

GENE SPERLING, ASSISTANT TO THE PRESIDENT
NATIONAL ECONOMIC COUNCIL

TODD STERN, ASSISTANT TO THE PRESIDENT AND STAFF
SECRETARY
OFFICE OF THE PRESIDENT

DAN TARULLO, DEPUTY ASSISTANT TO THE PRESIDENT
FOR INTERNATIONAL ECONOMIC POLICY

FROM:

FEDERICO PEÑA

A handwritten signature in black ink, appearing to read "Federico Peña", is written over the typed name.

SUBJECT:

Possible Announcements for Nobel Event

Below are some possible announcements that could be made in conjunction with the President's event with the Nobel laureates on July 24.

- **Report Highlights How Technology Can Reduce Costs of Meeting Climate Change Commitments.** DOE will release *A Technology Scenario for US Carbon Reductions by 2010 and Beyond*, a peer-reviewed study by five DOE national laboratories, showing how energy-efficient and low carbon technologies can dramatically reduce the costs to the nation of stabilizing greenhouse gas emissions.
- **Launch of National Climate Change Technology Strategy.** In his recent U.N. address the President directed the Cabinet to develop technologies to combat climate change. I immediately mobilized the Directors of the National Laboratories to produce an aggressive strategy that will focus on clean power generation; energy efficiency in the transportation, building and manufacturing sectors; and basic research. The strategy draws on the best talents of the public and private sectors, including federal agencies and laboratories, private industry and universities. The President could highlight development of the Strategy in his July 24 remarks and it could be a feature of the White House Conference on Climate Change.

New Energy-Saving Standards for Room Air Conditioners. DOE will publish final standards for the manufacture of more energy-efficient air conditioners. These revised energy-efficiency standards will join new standards for energy-efficient refrigerators, which were promulgated in April 1997. Taken together, energy-efficient air conditioners and refrigerators will save 7.34 quads of energy over the next 30 years, which is equivalent to the amount of electrical energy used by 63.5 million households in one year.

\$10 million to States for Climate Change Technology. Announce the selection of more than 100 projects in 48 states, the District of Columbia, and two territories to share \$10 million to improve energy management and state building codes and standards, encourage the use of alternative fueled vehicles, foster better industrial and residential energy efficiency, and demonstrate renewable energy technologies such as biomass, photovoltaics, wind, hydrogen, and geothermal heat pumps.

\$750 Million Solicitation for Energy Savings in Federal Buildings. DOE will issue a \$750 million solicitation for energy-savings contracts to enable federal facilities in the southeastern part of the country to access private capital for energy-saving equipment. This would ultimately reduce federal energy costs (i.e., the federal deficit) by \$1.5 billion over the life of the contract. This solicitation builds on a \$750 million contract awarded in May 1997 for eight western states, and is part of a \$5 billion contracting process covering energy-saving technology for federal facilities throughout the country.

For further information, please contact me or have a member of your staff contact my Senior Policy Advisor, Dan Reicher, at 202-586-7701



DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

July 22, 1997

MEMORANDUM

TO: KRIS BALDERSTON
SPECIAL ASSISTANT TO THE PRESIDENT

FROM: ELGIE HOLSTEIN
CHIEF OF STAFF *EH/CH*
U.S. DEPARTMENT OF ENERGY

SUBJECT: CLIMATE CHANGE OUTREACH INITIATIVES

The following is a list of activities being undertaken by the Secretary and Subcabinet-level appointees to further the President's Climate Change Initiative. These outreach efforts include speaking engagements, constituency meetings and media communications.

Secretarial Events/Announcements

- 1) Date: Late July 1997
DOE Official: Secretary Peña (Possible White House Announcement)
Location: DC
Event: Report Release -- Release of "A Technology Scenario for U.S. Carbon Reductions by 2010 and Beyond", a peer reviewed study by five national laboratories commissioned by DOE, showing how energy-efficient and low-carbon technologies can reduce the cost of stabilizing greenhouse gas emissions.
- 2) Date: Late July/August 1997
DOE Official: Secretary Peña (Possible White House Announcement)
Location: DC
Event: Launch of National Climate Change Technology Strategy - DOE has produced an aggressive strategy that will focus on clean power generation; energy efficiency in transportation, building and manufacturing sectors and basic research. The strategy draws on the talents of the public and private sectors, including federal agencies, laboratories and universities.

*Need coordinate
w/ WH & policy efforts -
not solo*

*Q is how to
capitalize on DOE's
energy saving activities*

*S i.e. tech. program &
effort needs to be part of
p's ultimate proposal; but
do energy saving activities
in next few months help?*

*Probably only
if tied
to a
message that
tech. will be
part of
solution...*

- 3) Date: July 1997
DOE Official: Secretary Peña (Possible White House Event)
Energy Efficiency and Renewable Energy
Location: DC
Event: Project Selections -- announce the selection of more than 100 projects in 48 states, the District of Columbia, and two territories to share \$10 million to improve energy management and state building codes and standards, encourage the use of alternative fueled vehicles, foster better industrial and residential energy efficiency, and demonstrate the efficacy of renewable energy technologies such as biomass, photovoltaics, wind resources, hydrogen, and geothermal heat pumps.
- 4) Date: July/August 1997
DOE Official: Secretary Peña
Location: DC
Event: Rulemaking -- publication of final regulations mandating more energy-efficient air conditioners. These revised energy efficiency standards will join the new standards for energy-efficient refrigerators, which were promulgated in April 1997.
- 5) Date: Week of July 21 - 1997 (TBD)
DOE Official: Bonneville Power Administration (BPA) Officials with Secretary Peña
Event: Bonneville Power Administration is signing an agreement to purchase energy capacity from the Wyoming Wind Project - the site will test the feasibility of using wind turbines in a cold weather environment. Other utility partners in the project are PacifiCorp and the Eugene Water & Electric Board. Ultimately, wind turbines could be constructed on 62,000 acres of private, federal and state lands over a 10-12 year period. An "opening" event will occur sometime in September. This is BPA's first "green" power purchase, and the first major wind project to break ground involving Pacific Northwest utilities.
- 6) Date: August 1997 (TBD)
DOE Official: TBD
Location: San Diego, California
Event: A celebration of the "Greening the Bases" program. Nine Naval and Marine Bases in San Diego California, in conjunction with

DOE's Federal Energy Management Program and San Diego Gas and Electric, have completed a retrofit of over 500,000 lighting fixtures, saving nearly \$4 million per year and substantially reducing air pollution.

- 7) Date: August 15, 1997
 DOE Official: TBD
 Location: Willmington, Vermont
 Event: Formal dedication of Green Mountain Corporation's new wind power facility in Searsburg, Vermont -- the largest wind energy project in the Eastern U.S.

Speaking Engagements - Subcabinet:

- 1) Date: July 18, 1997
 DOE Official: Marc Chupka
 Acting Assistant Secretary for Policy
 Location: Hyatt Regency, Washington, DC
 Event: Opening Remarks -- International Federation of Industrial Energy Consumers. Remarks regarding the recent release of the Argonne National Laboratory study related to climate change effects on selected industries.
- 2) Date: July 22, 1997
 DOE Official: Joseph J. Romm, Acting Assistant Secretary for Energy Efficiency and Renewable Energy
 Marc Chupka, Acting Assistant Secretary for Policy
 Location: Washington, DC
 Event : Remarks -- Center for Strategic International Studies Roundtable on Climate Change. Remarks will focus on role of technology in meeting our obligations under a climate change treaty and decreasing economic costs of meeting those obligations.
- 3) Date: July 29, 1997
 DOE Officials: Joseph J. Romm, Acting Assistant Secretary for Energy Efficiency and Renewable Energy; Martha Krebs, Assistant Secretary for Energy Research; Pat Godley, Assistant Secretary for Fossil Energy; Jay Hakes, Energy Information Administration; and Kyle Simpson, Senior Advisor to the Secretary.
 Location: Washington, DC

Event: Workshop -- Carbon Sequestration Workshop. Discussion will focus on role of DOE technology in meeting our obligations under a climate change treaty and decreasing economic costs of meeting those obligations.

Constituency Meetings:

- 1) Date: July - August, 1997
DOE Official: Joseph J. Romm, Acting Assistant Secretary for Energy Efficiency and Renewable Energy
Location: Washington, DC
Event Type/Title: Hill Meetings -- meetings being scheduled with Congressional staff and Members to discuss climate change issues, role of DOE technology in meeting climate change objectives, and highlights of the Office of Energy Efficiency and Renewable Energy budget request for FY '98.

- 2) Date: July 30, 1997
DOE Official: Joseph J. Romm, Acting Assistant Secretary for Energy Efficiency and Renewable Energy
Location: Washington, DC
Event: Breakfast Meeting -- Alliance to Save Energy. Discussion will focus on climate change issues, including role of DOE technology in meeting our obligations under a climate change treaty and decreasing economic costs of meeting those obligations.

Other Actions:

- 1) Date: August/September (TBD by Secretary or Designee)
DOE Official: TBD
Location: Tulsa, Oklahoma; Red River Valley, South Dakota; Florida Sun Coast; Portland, Maine; Phoenix, Arizona
Event: Designation of five new "Clean Cities" to join 54 already designated. The DOE Clean Cities Program works with community leaders to advance the use of alternatively-fueled vehicles in government and private fleets, and to provide infrastructure and expertise to support this effort.

- 2) Date: September 4, 1997
 DOE Official TBD
 Location: Houston, Texas
 Event: Designation of Houston as a "Clean City" under DOE Clean Cities Program.

- 3) Date: September 1997 (TBD by POTUS or designee)
 DOE Official TBD
 Location: Washington, DC (Fort Belvoir, Anacostia Naval Air Station, Andrews Air Force Base, and Fort Myer)
 Event: Roll-out of a swap of compact florescent floor lamps for hazardous and energy inefficient halogens at military housing throughout the United States.

- 4) Date: October 7-9, 1997
 DOE Official TBD
 Location: Denver, Colorado
 Event: Clean Airport Summit. Topic: Powering airport ground vehicle operations with alternative fuels. Participants will include representatives from 100 airports across the U. S., vehicle manufacturers and fuel providers, rental car companies, airlines, state and federal air quality regulators.

- 5.) Date: October 1997
 DOE Official: TBD
 Location: DC
 Event: Solicitation — Issue a \$750 million solicitation for energy-savings contracts (FREE Savings Contracts) to enable federal facilities in southeastern part of U.S. to invest in energy-saving equipment and in energy-efficient renovations without paying any up-front costs, ultimately reducing federal energy costs (i.e., the federal deficit) by \$1.5 billion over the life of the contract.

DEPARTMENT OF ENERGY
Washington, DC 20585Cabinet - energy

'97 SEP 24 AM 8:51

OFFICE OF THE SECRETARY

OFFICE OF THE SECRETARY**FACSIMILE TRANSMISSION SHEET**

To	Todd Stern	From	Dan Reicher
Office	456-2215	Date	
Fax Number		Fax Number	202/ 586-0148
Office Number		Office Number	202/ 586-9500

Comments:

Pages: _____, including this cover sheet.

IF TRANSMITTAL IS INCOMPLETE, PLEASE PHONE _____ AT 202/ 586-9500.

FRAMER

Secretary Peña

TRANSPORTATION

John McTeague

Vice President of Research
Ford Motor Company

313/222/7105

BUILDINGS

Bill McDonough

Dean of Architecture
University of Virginia

804/979-1111

INDUSTRIAL

Tom Kasten

CEO, Trigen Corp.

**TECHNOLOGY FOR
DEVELOPING
NATIONS**

Mae Jemison

Dartmouth College
Jemison Group, Inc.603/646-1282
281/486-7918**RENEWABLES**Rose McKinney
JamesCorporation for Solar
Technology and
Renewable Resources

702/869-3610

Steve Percy

President
B.P. America

212-207-7600

FOSSIL/NUCLEAR

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President & CEO
U.S. Generating, Inc.,
Senior Vice President,
Pacific Gas & Electric

415-973-7540

R&D

Maxine Savitz

General Manager, Allied
Signal Aerospace Ceramic
Components

310-512-5678

Larry Papay

Senior Vice President &
Manager of Research &
Development, Bechtel, Inc.

415-768-0275

39/24/97 18:07 202 586 7222 ET-32 001
1044 Will Davi with Washington - HYTER 8-30,
He's @ 301-891-3625. Press conf is @ 11am. Dep X
Energy
Thanks.

DRAFT * DRAFT * DRAFT * DRAFT * DRAFT
(7pm Wed.)

MEDIA CONTACTS:

Amber Jones, 202/586-5806

Carmen MacDougall, 202/586-4940

FOR IMMEDIATE RELEASE

September xx, 1997

24 PM 7:30

**Clean Technology Can Achieve
Significant Greenhouse Gas Reductions**

Peer-Reviewed Energy Study: What's Good for Environment is Good for Economy

National investment in energy-efficiency and clean energy technologies can reduce U.S. emissions of global warming gases and produce energy savings that roughly equal or exceed the costs to implement them, Energy Department experts predict. A study conducted by five Department of Energy laboratories and peer-reviewed by industry and academic experts demonstrates that the United States could hold down the costs of meeting climate change goals through technological solutions such as advanced natural gas turbines, biomass and biofuels, and energy-saving appliances. Many consumers and businesses could actually save money through reduced energy use and lower overall energy bills.

"This analysis provides strong evidence that progress on climate change can be achieved without increasing the nation's energy bill. What's good for the environment also can be good for the economy," said Energy Secretary Federico Peña. "President Clinton's plan to make technology a cornerstone for reducing greenhouse gas emissions can achieve these results. From the Partnership for a New Generation of Vehicles that's creating the super-efficient car of the future to expanded use of renewable energy sources, the technology solution is already creating environmental benefits and savings in energy costs."

Current projections suggest that a carbon emissions reduction of 390 million metric tons (MMT) would be required to reduce U.S. emissions in 2010 to 1990 levels. The study models a scenario that combines a vigorous national technology program with a domestic system of carbon trading to achieve the reduction. The study concludes that such an approach could reduce emissions by up to 390 MMT. A new generation of technologies and international carbon emission trading could result in further reductions over the next quarter century.

This study estimated the potential costs of the reductions at \$50 to \$90 billion per year. Costs in the study include incremental investments to deploy clean energy or energy efficient technologies by consumers and industry as well as those associated with hypothetical increases in energy prices. In addition, Energy Department experts reviewed energy cost savings resulting from the use of these technologies; these estimated savings through 2010 total \$70 to \$90 billion per year. This indicates that the clean energy investments could produce energy cost savings roughly equal to or greater than the costs of implementation, on a life-cycle basis.

The "bottoms-up" approach in the study examines 200 specific technologies in four major sectors of the economy -- buildings, industry, transportation and electric utilities -- and analyzes the possible advances in each sector. For the buildings, industry and transportation sectors, the study analyzes the impacts of end-use energy-efficiency improvements and low-carbon technologies on carbon emissions. The utility sector analysis estimates the impacts of clean energy activities, such as increased use of natural gas and renewable energy. While no one measure can address the entire problem, technologies already in development could contribute substantially to the reductions. For example:

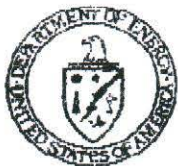
- **Transportation:** The Partnership for a New Generation of Vehicles is developing advanced automobiles that will be three times more fuel-efficient than today's vehicles but still safe and affordable. In the biofuels area, cellulosic ethanol, a promising biofuel made from agricultural and forestry wastes, produces no net carbon emissions; the Energy Department projects cutting the cost of ethanol to under 70 cents/gallon by 2010.
- **Buildings:** The study projects promising carbon reductions from energy-efficient appliances supported by the Energy Department, including a 1 kilowatt-hour/day refrigerator and advanced lighting. Advanced fuel cells powered by natural gas will produce electricity and provide heating at 80-percent efficiency, while lowering the current cost of power.
- **Utilities:** Wind turbines are expected to produce power at less than 3 cents/kilowatt-hour by 2010. Biomass co-firing with coal at some plants could produce significant emissions reductions.
- **Industry:** Advanced turbines are expected to achieve 80 percent system efficiency, producing electricity and steam in industrial plants at less than today's costs. Advanced motor systems and clean industrial technologies can cut emissions and costs while increasing productivity.

The Department of Energy's Oak Ridge and Lawrence Berkeley National Laboratories led the comprehensive one-year analysis, with contributions by the National Renewable Energy Laboratory and Pacific Northwest and Argonne National Laboratories. The findings, which were reviewed extensively by representatives from industry and academia, are consistent with those of two previous studies. Those studies, released by the National Academy of Sciences and Office of Technology Assessment in 1991, also concluded that technology could play a prominent role in reducing U.S. greenhouse gas emissions.

To request a summary or full copy of the study, titled *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficiency and Low-Carbon Technologies by 2010 and Beyond*, media can call the Department of Energy Press Office at 202/586-5806; others can call Public Inquiries at 202/586-5575.

- DOE -

END FAX



DEPARTMENT OF ENERGY
Washington, DC 20585

97JUL 11 PM8:10

OFFICE OF THE SECRETARY

OFFICE OF THE SECRETARY

FACSIMILE TRANSMISSION SHEET

KATIE MCGINTY

To	DAVID SANDALOW GENE SPERLING	From	ELGIE HOLSTEIN
Office →	TODD STERN	Date	JULY 11, 1997
Fax Number		Fax Number	202/ 586-7644
Office Number		Office Number	202/ 586-6210

Comments:

Pages: 3 , including this cover sheet.

IF TRANSMITTAL IS INCOMPLETE, PLEASE PHONE CAROLYN AT 202/586-6210.

Cabinet

CLIMATE CHANGE PRINCIPLES

- ▶ **WE BELIEVE THE SCIENCE IS SUFFICIENTLY COMPELLING TO REQUIRE PRUDENT ACTION NOW:** The balance of evidence suggests a discernible human influence on the climate system. While significant scientific uncertainties remain, the potential threat to human activities and natural systems is large. The world community must begin prudent action to limit our emissions of greenhouse gases.
- ▶ **WE BELIEVE THAT EXISTING COMMITMENTS ARE INADEQUATE:** The United States and other nations have agreed that the existing commitments under the Framework Convention on Climate Change to "aim" to reduce greenhouse gas emissions to their 1990 levels by the year 2000 are not adequate to address the threat of climate change.
- ▶ **WE BELIEVE VERIFIABLE, LEGALLY-BINDING COMMITMENTS ARE NEEDED:** Developed nations must adopt legally-binding emissions reduction obligations now. Commitments should be expressed in terms of multi-year emissions budgets. Measurement and reporting are essential to assure verifiability and compliance.
- ▶ **WE BELIEVE ALL COUNTRIES MUST HAVE LEGALLY-BINDING COMMITMENTS IN THE NEAR FUTURE:** While developed countries will lead the way, the level and timing of obligations for key developing countries must be settled by a date certain. In the meantime, developing countries should continue to advance their current commitments, including undertaking "no regrets" measures and preparing annual emissions inventories.
- ▶ **WE BELIEVE OUR GOALS MUST BE REALISTIC:** While we must start to act now, our goals must be realistic and achievable. Realism involves both the level of the goals and their timing. Timing must provide opportunity for capital stock turnover and for new technology to enter the marketplace.
- ▶ **WE BELIEVE PARTIES MUST HAVE MAXIMUM FLEXIBILITY IN MEETING THEIR COMMITMENTS:** International emissions trading and joint implementation with credit are necessary options to assure cost-effective reductions.
- ▶ **WE DO NOT BELIEVE THAT POLICIES AND MEASURES SHOULD BE HARMONIZED:** We reject the notion of harmonized policies and measures among parties-- each country must be free to identify and pursue emissions reductions appropriate to its national circumstance to meet its obligation.
- ▶ **WE BELIEVE TECHNOLOGY IS AN IMPORTANT PART OF THE SOLUTION:** Advanced energy technology is the key to successfully addressing the threat of climate change. Aggressive research and development efforts can reduce the cost of low- and no-emission energy systems, allowing us to reduce emissions of greenhouse gases and other pollutants while enhancing long-run economic prospects.

- ▶ **WE BELIEVE OUR APPROACH TO SOLVING CLIMATE CHANGE MUST BE COMPREHENSIVE:** All greenhouse gases must be included in any agreement. All sources and sinks of greenhouse gases must be included in any agreement. We should not purposely limit the tools and opportunities at our disposal to address climate change.
- ▶ **FOR THE LONG TERM, WE BELIEVE A LONG TERM GOAL MUST BE ESTABLISHED:** The stabilization of greenhouse gas emission concentrations, not simply stabilization of emissions levels, is needed.-

7-11-97

THE WHITE HOUSE
WASHINGTON

OFFICE OF THE STAFF SECRETARY

Fax Transmittal Sheet

TO:

Todd Stern

Fax Number:

337-4104

Phone Number:

FROM:

Barbara

SUBJECT:

DOE fax

DATE:

7-11-97

NUMBER OF PAGES (including cover sheet):

MESSAGE:

*Sorry for the delay - I was out
when you called, just saw the audit light.*

If all pages are not received, please call 202/456-2702

Barbara

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DEPARTMENT OF ENERGY
Washington, DC 20585

OFFICE OF THE SECRETARY

August 15, 1997

MEMORANDUM FOR STEVE SILVERMAN
TODD STERN

FROM: LIZ MONTOYA *LM*
DEPUTY CHIEF OF STAFF
DEPARTMENT OF ENERGY

'97 AUG 21 AM 9:01

SUBJECT: SECRETARY PEÑA'S SEPTEMBER CLIMATE CHANGE EVENTS

In response to your request, we have the following climate change events tentatively scheduled for September.

September 11-12: Secretary Peña will be in California and will visit the Lawrence Livermore Laboratory where he will speak on climate change, highlighting the role that new technologies can play in reducing greenhouse gas emissions.

September 15: Secretary Peña participates in a dinner for CEOs hosted by Secretary Daley.

September 17 or 18: Secretary Peña and Secretary Daley tour the Bethlehem Steel plant in Burns Harbor, IN (just south of Chicago). This plant has installed many advanced efficiency technologies in the past few years, enabling it to compete effectively in world steel markets. After the tour, they host a roundtable discussion with local business leaders on the opportunities presented by possible climate change strategies.

We also note that the Department of Energy plans to release a study showing how technologies can significantly lower the costs of reducing greenhouse gas emissions (*Scenarios of U.S. Carbon Reductions*) once concerns raised by the economic agencies can be addressed. This release should occur sometime in August.

Please call me at 586-6003 if you wish to discuss this further.

OFFICE OF THE SECRETARY

DEPARTMENT OF ENERGY
Washington, DC 20585



UNITED STATES DEPARTMENT OF ENERGY
OFFICE OF THE SECRETARY
WASHINGTON, DC 20585-1000

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L. Montoya

Mr. Todd Stearn
White House - G West Wing
1600 Pennsylvania Ave.
Washington, DC 20500

FIRST CLASS



20500-0005 01





Department of Energy

Washington, DC 20585

Cabinet Energy

July 2, 1997

MEMORANDUM TO DISTRIBUTION

FROM:

Marc W. Chupka *Marc W. Chupka*
Acting Assistant Secretary
Office of Policy and International Affairs

1997 JUL 8 08:57

SUBJECT:

*The Impact of High Energy Price Scenarios on Energy-Intensive Sectors:
Perspectives from Industry Workshops*
Compiled by Argonne National Laboratory

Attached is a report based on a series of workshops conducted in June and July of 1996 by Argonne National Laboratory under contract with the Department of Energy. The views contained in this report are those of the workshop participants and do not reflect the position of the Department of Energy.

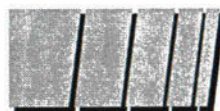
The workshops explored the possible effects of new climate change commitments on six energy-intensive industries (basic chemicals, iron and steel, petroleum refining, paper and allied products, aluminum and cement) that are subject to significant foreign competition. For each sector, Argonne selected a panel of industry representatives, experts from academia, environmental groups, organized labor, the financial community and government. These panels were then asked to assume a projection of energy price increases that incorporated specific assumptions about the energy price effects of a postulated climate change agreement, and to reflect on the possible industry responses. Participants in each sector met for separate half-day workshops to discuss the impacts these energy price scenarios would have on industry output, employment, energy usage, industry costs, industry prices, imports and exports.

Overall, the participants reported negative impacts on the six industries under the assumed price increases. Under the given scenarios, panelists predicted the industries would experience reductions in output and employment from projected baseline levels. Less-developed countries -- which were assumed in the workshops not to adopt binding commitments to lower greenhouse gas (GHG) emissions in the timeframe considered -- would capture an increasing share of the respective markets. Some industry representatives reported that it would be necessary to relocate under the hypothetical situation, and some reported that industry composition would change.



It is important to emphasize, however, that the negative conclusions expressed by the participants and summarized in this report are predicated on the specific restrictive energy price scenarios assumed in mid-1996, which were based upon interagency analyses of proposals advanced by other countries at that time. As such, these price scenarios do not reflect key policies advocated in international negotiations by the U.S. government in the intervening year. For example, the assumed fuel price scenarios do not take into account the impact of multi-year emission budgets, international emission trading and joint implementation. If adopted, these provisions would lower the costs of achieving emission reductions in the U.S. and other developed countries, and would significantly lower the energy price increases assumed in the workshop scenarios. Nor did the workshop participants consider the acceleration of energy efficient and low-carbon technology development from expanded R&D efforts by the public and private sector, which could cushion the impact of energy price increases. Finally, the Administration has argued that developing countries should assume additional obligations in the near future to reduce their projected rapid growth of GHG emissions. No such actions are reflected in the workshop scenarios.

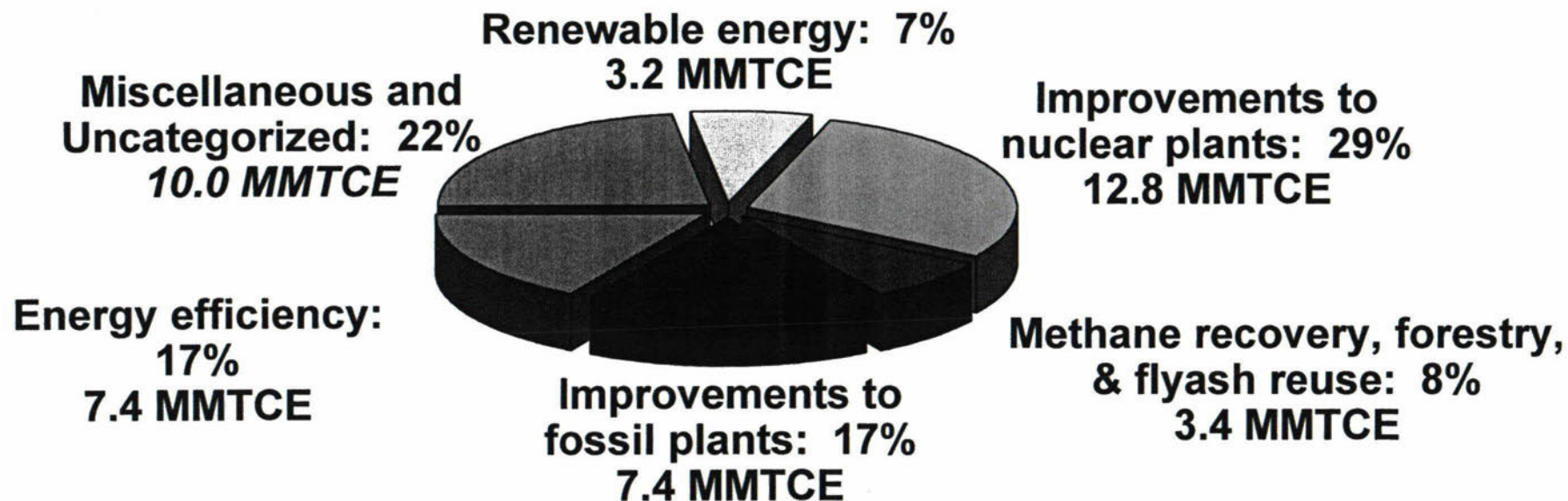
Despite these limitations, and taken in context, the workshops provided valuable information that has reinforced the need to pursue sensible climate change policies. The environmental and socio-economic issues surrounding the stabilization of GHG emissions have been the subject of considerable debate, but are especially sensitive now as participating nations are engaged in a new round of negotiations for further commitments within the Framework Convention on Climate Change that will conclude in December of 1997 in Kyoto, Japan. The U.S. position taken in these negotiations stresses that international agreements to combat the threat of climate change must be flexible, cost-effective, realistic, achievable, and ultimately global in scope. By examining scenarios that do not reflect such policies, the workshop papers have identified important economic risks in key industrial sectors that reaffirm the wisdom of the U.S. approach.



U.S. Electric Utilities Have Shown Leadership in Pledging GHG Reductions

- ✦ 120 signed agreements
- ✦ over 600 utilities participating
- ✦ 69% of industry
- ✦ over 45 MMTCE pledged

Pledged Reductions (normalized)



Source: Climate Challenge Participation Accords, DOE estimates. Note: Estimates are normalized and include international actions and trace gases., and are based on pre-March 1997 data.

1 MMTCE= 1 million metric tons of carbon equivalent emissions = average annual emissions from electricity consumed by 600,000 homes.

U.S. Department of Energy Climate Challenge Program

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CLIMATE CHALLENGE

Summer 1997

Volume 2, Number 3

A Partnership of the U.S. Electric Industry and the U.S. Department of Energy

HL&P AND RICE UNIVERSITY WORK TO REDUCE AGRICULTURAL METHANE EMISSIONS

Researchers at Rice University in Houston have discovered that by draining rice fields as many as three times during the growing cycle the methane emissions—a potent greenhouse gas—can be virtually eliminated. During a 20-year period the global warming potential of methane is 56 times greater than that of carbon dioxide. For nearly a decade now, research on trace-gas emissions from natural and agricultural wetlands has been conducted at the Wetland Center for Biogeochemical Research at Rice University. Much of the research has been funded by Climate Challenge participant Houston Lighting & Power Co. (HL&P).

According to the Center, the global concentration of atmospheric methane is increasing at a rate of about 1% per year. Much of this increase can be attributed to emissions from flooded rice fields. In

addition, to meet the rice demand of growing populations, rice cultivation will have to increase by about 47% between 1990 and 2020 just to maintain current nutritional levels.

Because of variations in the natural and cultural components of rice-growing systems, methane emission rates vary widely, making it extremely difficult to accurately calculate a total for annual global methane emissions. Researchers estimate that about 20% of methane emissions come from rice agriculture worldwide. Rice University researchers believe that if methane from rice fields can be reduced to a negligible amount, we can stop the growth in methane concentrations. They have found that methane emissions from soil bacterial activity in agricultural wetlands is influenced by floodwaters.

(Continued on pg. 3)



Rice University

Researchers from Rice University, with assistance from Houston Lighting and Power, are working in Rosenberg, Texas, to investigate methane production associated with rice agriculture.

Issue Analysis

MARKET-BASED TRADING IN GREENHOUSE GASES FACES MANY HURDLES

At a July 1996 meeting of international climate change negotiators in Geneva, the U.S. delegation first announced a shift in policy toward endorsing binding targets and away from voluntary limits or reductions for greenhouse gases such as carbon dioxide (CO₂). While calling for binding targets, U.S. negotiators stressed the need for maximum flexibility in achieving any agreed upon goal. Flexibility in reaching targets was also emphasized by President Clinton in his speech to a United Nations (UN) meeting in June 1997. At the earlier meeting, the United States specifically called for "the inclusion of activities implemented jointly on a global basis," and said international emissions trading must be part of any future regime.

If "activities implemented jointly" means parties from two or more countries reducing emissions in a partnership arrangement, then U.S. utilities, leaders in developing such projects, will be in an excellent position to take advantage of any opportunities written into any future protocol or legally binding document.

However, the call for international emissions trading will give pause to those familiar with the intricacies of setting up such programs. At the same time, the flexibility of market-based approaches does have wide appeal in the electric utility industry.

(Continued on pg. 3)

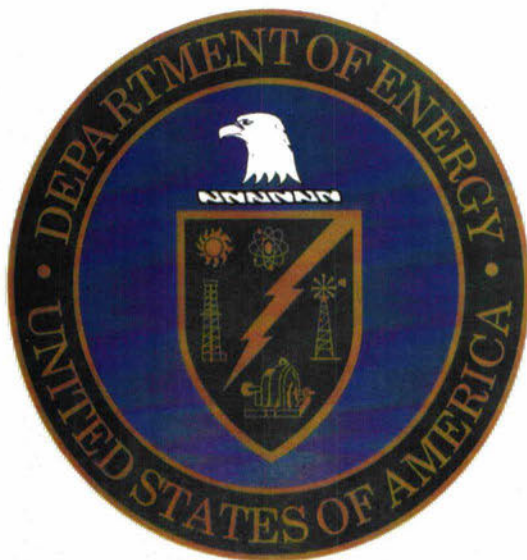
The Climate Challenge Accord

The Climate Challenge Program is a joint, voluntary effort of the U.S. Department of Energy and the electric utility industry to reduce, avoid or sequester greenhouse gas emissions.

It reflects the intention of the parties to play a leadership role in pursuit of the President's goals for reducing greenhouse gas emissions.

The parties by today's Memorandum of Understanding form the Climate Challenge Program. As representatives of the Department of Energy and the electric utility industry, we, the undersigned, do hereby execute the Climate Challenge Memorandum of Understanding, as of this 20th day of April, 1994.

Harold R. Kury
Secretary,
United States Department of Energy



Thomas R. Kline
President,
Edison Electric Institute

Royce Syle
President,
American Public Power Association

John E. ...
Executive Vice President,
National Rural Electric Cooperative Association

Ronald W. Walker
Chairman,
Large Public Power Council

Liam ...
Chairman,
Tennessee Valley Authority



Tracy - The [initials]
JIM DORSKIND: 8/21

Please coordinate
the reply.

August 14, 1997

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

I want to thank you for the opportunity to meet with you, the Vice President, and others from your Administration on the critical issue of climate change.

At our meeting, you outlined principles that the Administration plans to use to guide U.S. participation in international negotiations.

You also graciously invited the meeting participants to participate in the policy process as your Administration develops and asserts the United States' position prior to and at the Third Conference of the Parties in Kyoto later this year. PacifiCorp stands ready and eager to work with you on this profoundly important matter.

As we discussed, while there is disagreement over the issue of complete scientific certainty, it appears an international set of binding emissions targets and timetables is a global political inevitability. If such targets and timetables are truly reasonable, I believe much of the business community will work diligently to find cost-effective ways to implement them.

Reasonable targets and timetables must:

- ◆ include all countries and not harm U.S. economic interests relative to our international competitors;
- ◆ cover all sectors of the economy so that each sector contributes its proportionate share to the solution;
- ◆ include all important carbon-based greenhouse gases to ensure achievement of environmental goals;
- ◆ provide an adequate timetable for compliance to allow for the orderly depreciation of our capital assets and those of our customers; and,

The President
August 14, 1997
Page Two

- ◆ allow all forms of flexibility to lower the cost of compliance as much as possible. For PacifiCorp, flexibility means there must be credit for all legitimate efforts to reduce emissions or sequester carbon, trading across borders, credit for international projects (i.e., Joint Implementation), and credit for early emission reductions or sequestration projects.

Without a reasonable timetable and all necessary flexibility, a climate change protocol will find little public support. With flexible implementation, achievement of the target goals becomes increasingly possible at lower economic cost.

In the interim, voluntary measures can create a glidepath toward more formal targets to address climate change. Both Dr. Draper and I pointed to the many successes of the utility industry which has already begun implementing emission reductions and offset projects on a voluntary basis.

The successes of our voluntary efforts to date suggest there is more we and others can do to address climate change concerns. The Administration can assist us in this regard in two tangible ways.

First, we have undertaken these voluntary efforts with no clear policy to provide emissions credits. We are risking our investments of time and resources not only to begin efforts to reduce greenhouse gases now, but also with the expectation that PacifiCorp will receive tangible credit for these at a later time. A governmental commitment to credit for early reductions will provide a strong incentive for PacifiCorp and others to increase voluntary actions.

Second, the voluntary effort must be broadened beyond utilities. As is evident by the statements of other participants in the August 5 meeting, industry leaders are willing to take action if asked. Your leadership in seeking voluntary reductions from all US emitters would significantly advance this cause.

There are important initiatives underway within the business community and among some environmentalists to explore methods of stepping up voluntary efforts and to pool credits all in advance of a mandatory program. I commend this effort to you in hopes that the administration gives it full support. PacifiCorp will aggressively pursue these voluntary actions if assured that appropriate credit is ultimately provided.

The President
August 14, 1997
Page Three

There are also efforts ongoing to give substance to the type of framework the US can advocate which allows for the type of flexible implementation I previously described as absolutely essential to any acceptable protocol. You also have my commitment that PacifiCorp will work with your Administration and other interests to help shape that framework.

Once again, I sincerely thank you for the opportunity to meet with you and am encouraged that you are taking a very personal interest in this issue. I hope, through this letter and subsequent discussions, PacifiCorp can remain fully engaged in your difficult deliberations regarding our country's position at Kyoto. I personally pledge our support in your efforts and very much look forward to our continuing dialogue.

Sincerely,

A handwritten signature in dark ink, appearing to read "Fred Lusk", with a long horizontal flourish extending to the right.

cc: The Vice President
Mr. Dirk Forrister
✓ Mr. Todd Stern



Climate Challenge Participation Accord

DOE's Energy Partnerships for a Strong Economy

Climate Challenge Participation

Accord Between The Southern Company

and the

United States Department of Energy

This Accord describes the commitments that The Southern Company and the U.S. Department of Energy (DOE) have made to participate in the Climate Challenge Program in pursuit of the President's goals for reducing greenhouse gas emissions. The Climate Challenge Program is a joint, voluntary effort of DOE and the electric utility industry to reduce, avoid, or sequester greenhouse gas emissions. The framework of the Climate Challenge Program was established in the Climate Challenge Program Memorandum of Understanding (MOU) and exhibits thereto dated April 20, 1994 (the Climate Challenge Program MOU.) (See Attachment B to this Participation Accord.)

The Southern Company is the parent firm of one of the nation's largest investor-owned electric utility groups. The company includes five operating utilities - Alabama Power, Georgia Power, Gulf Power, Mississippi Power, and Savannah Electric - as well as Southern Nuclear and Southern Electric International.

I. Utility Commitments

A.

Consistent with paragraph II.B.1 of the Climate Challenge Program MOU,

The Southern Company will participate in the following industry

initiatives:

- 1) National Earth Comfort Program
- 2) Electric and Renewable Energy Investment Pool
- 3) Utility Forest Carbon Management Program, and
- 4) EV America

The Southern Company will also undertake projects in the following areas:

- 1) Transportation
- 2) Forestry
- 3) End-Use
- 4) Supply-Side
- 5) Transmission
- 6) Distribution
- 7) Recycling, and
- 8) Other government/industry initiatives

A description of these programs is provided in Attachment A.

B.

The Southern Company will report annually on activities and achievements under the Climate Challenge Program. Results achieved during each year shall be reported in a clear and understandable manner that is consistent with the guidelines adopted pursuant to subsection 1605(b) Energy Policy Act and the Climate Challenge accounting protocols in Exhibit B of the Climate Challenge Program MOU. The first such report may include a description of the activities and achievements of The Southern Company prior to its becoming a participant in the Program, expressed on an annual basis to the extent possible.

C.

The Southern Company will confer with DOE on or before July 1, 1996, to evaluate jointly the progress of the company in achieving its Climate

Challenge Programs goals and to discuss possible adjustments to its voluntary commitments.

D.

The Climate Challenge Program representative for The Southern Company will be Charles H. Goodman, Vice President, Southern Company Services, Post Office Box 2625, Birmingham, Alabama 35202. The Southern Company agrees to notify DOE prior to or, in any event, no later than 30 days after any change in liaison responsibilities or personnel.

II. DOE Commitments

A.

DOE's commitments to The Southern Company are those set out in section III of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

DOE will consider requests by The Southern Company to intervene in regulatory proceedings of federal, state, and local commissions and boards on issues pertinent to the Climate Challenge Program. Before DOE intervenes in regulatory and other proceedings pertaining to The Southern Company and/or its operating subsidiaries for purposes of addressing Climate Challenge Program issues, it will provide notice to The Southern Company.

C.

DOE will provide an annual report to The Southern Company describing the actions that it has

taken to fulfill its commitments under section III and Exhibit C of the Climate Challenge Program MOU and the results of those actions.

D.

The Climate Challenge Program representative for DOE, who will serve as liaison to The Southern Company, will be Allan Hoffman, Department of Energy, Room 6B-128 (EE-10), 1000 Independence Avenue, S.W., Washington, DC 20585; Telephone: (202)586-1786. DOE agrees to notify The Southern Company prior to or, in any event, no later than 30 days after any change in liaison responsibilities or personnel.

III. General Provisions

A.

Use of DOE-developed materials by The Southern Company will be governed by the provisions of section IV of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

In addition to the foregoing provisions, DOE and The Southern Company agree to act in accordance with the principles set out in section I of the Climate Challenge Program MOU and the general provisions set out in subsections V.A-V.D, V.F, and V.G of the Climate Challenge Program MOU, which are hereby incorporated by reference.

C.

Either party may withdraw from this Participation Accord or any of its activities under the Climate Challenge Program without penalty and without being subject to remedies at law or equity.

A.W. Dahlberg
President
The Southern Company

February 3, 1995

Hazel R. O'Leary
Secretary
U.S. Department of Energy

February 3, 1995

Attachments:

Attachment A -- Commitments of The Southern Company under the Climate Challenge Program

Attachment B -- Climate Challenge Program Memorandum of Understanding and Exhibits

(Attachment A)

Commitments of The Southern Company

under the

Climate Challenge Program.

.....

Attachment A.

The Climate Challenge Program

Commitments of The Southern Company

INDUSTRY INITIATIVES

1. National Earth Comfort Program

The Southern Company will participate in this program to increase the market penetration of ground source heat pump technology. Present financial requirements for participation are \$50,000 per year from 1995 through the year 2000 for a total investment of \$300,000.

2. Electric and Renewable Energy Investment Pool

This fund will provide venture capital for companies to produce and introduce into the market electric and renewable energy technologies that will reduce emissions of greenhouse gases. The Southern Company will invest up to \$5 million into the fund for the years 1995 through 1999. If additional funding pools are created as part of this initiative, The Southern Company will consider additional investments in those funding pools.

3. Utility Forest Carbon Management Program

This initiative will leverage the resources of numerous utilities to undertake carbon sequestration projects. The Southern Company plans to commit \$200,000 for the years 1994 through 2000 upon satisfactory development of the program.

4. EV America

This program is designed to enhance the development and demonstration of electric vehicles by having utilities introduce them into their fleets. Alabama Power Company and Georgia Power Company are founding members of this program. The Southern Company will introduce 100 electric vehicles into its fleet operations by the year 2000 under the EV America program.

COMPANY SPECIFIC INITIATIVES

1. Transportation

Between the years 1995 and 2000, The Southern Company will expend \$63 million in programs to place electric vehicles into the transportation marketplace. This will include the introduction of some 1,400 electric vehicles into the fleets of The Southern Company's operating subsidiaries. (This commitment does not include the EV America commitment of 100 vehicles.)

2. Forestry

The Southern Company will expend the following on programs to address sequestration of carbon from the atmosphere over the years 1994 through 2000:

\$300,000	Smithsonian Tropical Research Institute
\$700,000	Improvements on existing Company lands
\$3,800,000	Development and implementation of programs not on Company lands

The allocation between company and non-company land may be revised based on further evaluation of the available opportunities. These programs will be long term with results extending beyond the year 2000.

3. End Use Programs

Demand Side Management (DSM)

1991 - 1994

The DSM programs in place include the promotion of new energy efficient homes, low-income housing energy efficiency kits, technical assistance to businesses, time-of-use and pricing incentives, and additional programs.

1995 - 2000

The operating subsidiaries of The Southern Company will continue to implement and improve programs to help electric customers use energy in the most efficient manner. These programs will continue to be refined, based on market conditions and Integrated Resource Plan requirements. The Southern Company is committed to undertake a portfolio of DSM programs during this time period. A description of the plans is provided in the current Integrated Resource Plan of The Southern Company. The activities are projected to reduce energy consumption by more than 2 million MWh annually in 2000. Southern Company anticipates aggregate expenditures of approximately \$25 million on DSM over the next 5 years.

In addition, as part of The Southern Company's overall commitment to DSM programs we plan to: 1. Seek appropriate regulatory solutions to overcome economic barriers;

2. Continue to investigate additional economic programs; 3. Continue to sponsor, participate in, and seek out appropriate government-sponsored programs; and 4. Support the passage and enforcement of cost effective and energy efficient building codes and appliance and equipment standards.

Electrotechnology Development

Over the next 5 years, The Southern Company will operate the Technical Application Center for the promotion and development of electrotechnologies and will support the research of viable electrotechnologies. Electrotechnologies allow the substitution of electric equipment for manufacturing and other applications where other fuels or less efficient electric equipment are presently used. Their use may result in a net reduction of greenhouse gas emissions. The Company anticipates that operating expenditures for the Center will total \$5 million over the next 5 years. In addition, The Southern Company will invest over \$1 million over the next 5 years for additional research into electrotechnologies.

4. Supply Side Programs

The Southern Company will implement programs to continue and enhance past gains in efficiency at its electric generating plants. This focus on efficiency lowers the amount of fuel needed to provide each unit of energy from the plants.

1991 - 1994

Fossil Efficiency Improvements

From 1990 to 1993, fossil fuel fired plants in The Southern Company improved their average net heat rate from 9,810 Btu/kWH to 9,721 Btu/kWH.

Heat Rejection Improvements

Since 1990, cooling tower system upgrades have included 1800 MW and 3300 MW of fossil and nuclear-fueled generation, respectively. Upgrades have been achieved through media replacement, helper cooling towers, redesign, and chemical additives. These upgrades improve the condenser heat exchange of a generating unit and thus its operating efficiency.

Nuclear

The Southern Company owns 100 percent of Plant Farley, 50.1 percent of Plant Hatch, and 45.7 percent of Plant Vogtle. Nuclear generating plants do not emit greenhouse gases, and they reduce overall emissions by displacing generation from coal-fired baseload plants.

Between 1991 and 1994, the total annual generation of these three nuclear plants (including the co-owned portions) rose from 38,167,229 MWh to 42,134,134 MWh, an increase of more than 10 percent. Several factors have contributed to this increase: the total rated capacity of Plant Vogtle was increased by about 100 MW, routine refueling outages were completed in less time, and plant reliability and availability between refuelings were improved.

1995 - 2000

Heat Rejection Improvements

The Southern Company will improve the steam cycle heat rejection equipment at several system generating plants prior to 2000. These improvements will result in more efficient production of electricity. The Company anticipates aggregate expenditures of approximately \$10 million over the next 5 years as outlined in current capital budgets.

Other Efficiency Improvements

The Southern Company will implement other efficiency measures at system generating plants between 1995 and 2000. Plans for these improvements are described in the current capital budget of The Southern Company. The Company anticipates aggregate expenditures on these efficiency measures on the order of \$170 million over the next 5 years.

Biomass

The Southern Company burns more than a thousand tons of wood waste each month to displace coal. This represents an increase above the pre-1990 levels. The Company will also investigate committing to further uses of biomass based on economics and tax treatment.

Nuclear

The total rated capacity of Plant Hatch will be increased by approximately 80 MW during this time period, at a cost of about \$15 million (including co-owner shares). It is also expected that the reductions in refueling outage times that have been achieved will be sustained during this period, and improved levels of plant reliability and availability between refuelings will continue. Together, these factors will allow current high levels of nuclear production to be maintained or increased during the 1995 to 2000

period, decreasing the need for fossil-fueled generation.

Cogeneration

The Southern Company subsidiary Mississippi Power Company upgraded the cogeneration facility at the Chevron refinery in Pascagoula, Mississippi to include a new 80 MW unit in 1994. This natural gas-fired facility produces electricity and process steam for a significant industrial customer and provides The Southern Company system with less CO₂ emissions as compared to coal-fired baseload capacity.

Solar

The Southern Company will continue to implement programs to enhance the development and performance of solar generated energy including:

Georgia Institute of Technology Aquatic Center

Georgia Power Company, The U.S. Department of Energy, and the Georgia Institute of Technology are finalizing plans to fund and construct a photovoltaic array on the roof of the Aquatic Center at the university for the 1996 Olympics. Georgia Power's investment in the 300-kW facility will be \$1.8 million.

Research

The Southern Company will invest \$8.2 million prior to 1998 in the Power Systems Development Facility (PSDF) located in Wilsonville, Alabama. In addition to The Southern Company, project partners include the U.S. Department of Energy, the Electric Power Research Institute, and others. The \$158 million project will develop and test advanced gasifier systems, advanced pressurized bed combustion, hot gas cleanup systems and fuel cells. This research will lead to technologies that increase the efficiency and environmental performance of electric generation.

5. Transmission

The Southern Company is committed to undertake a portfolio of projects to maintain, improve and enhance the efficiency of existing transmission systems. The Company's plans are described in the current Integrated Resource Plan of The Southern Company. For instance, the Company will operate some of the transmission systems at a higher voltage profile, add new capacitors on the transmission grid, and substitute more efficient transformers. These projects are expected to reduce transmission losses by over 420,000 MWh per year by the year 2000. Over the next 5 years, the Company anticipates aggregate expenditures of approximately \$505 million on transmission system improvements that will maintain, improve, and enhance efficiency.

6. Distribution

The Southern Company is committed to a portfolio of projects to maintain, improve and enhance the efficiency of the existing electric distribution system. The Company's plans are described in the current capital budget of The Southern Company. For example, The Southern Company will install lower loss transformers, improve distribution system automation, enhance system voltage optimization and improve phase current balancing and dispersed energy storage. These projects are expected to reduce distribution losses by about 15,000 MWh per year by the year 2000. Over the next 5 years, the Company anticipates aggregate expenditures of approximately \$374 million on distribution system improvements that will maintain, improve, and enhance efficiency.

7. Recycling

1991- 1994

Over the period from 1991 through 1994, The Southern Company reused almost 15 percent of total ash, totaling over 2.5 million tons of ash. During this same period, approximately 2,400 tons of paper were recycled. This represents an increase above the pre-1990 levels.

The Southern Company will continue and enhance existing programs to increase the recycling of waste material from its facilities and the specification of recycled material in product and supply purchases. For the period 1995 through 2000 these include:

\$ 2,100,000	Development and testing of coal ash use in concrete
\$ 2,000,000	Purchase products made with recycled materials
\$46,000,000	Installation of dry coal ash collection systems which recycling

Recycled ash reduces the amount of raw materials needed in the manufacture of concrete and in roadbed construction, reducing the energy consumption necessary for their manufacture.

8. Other Government/Industry Initiatives

The Southern Company will continue to be a partner in other government/industry programs which will lead to reductions in greenhouse gas emissions. These include:

Green Lights (EPA) - Joined in May, 1993

Waste Wise (EPA) - Charter Member, July, 1994

Cool Communities (EPA, DOE, American Forests) - Georgia Power is a member of this program.

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Return to the EREN Home Page



Climate Challenge Participation Letter

DOE's Energy Partnerships for a Strong Economy

CLIMATE CHALLENGE PARTICIPATION ACCORD

BETWEEN NIAGARA MOHAWK POWER CORPORATION AND

THE UNITED STATES DEPARTMENT OF ENERGY

This Participation Accord describes the commitments that Niagara Mohawk Power Corporation ("NMPC") and the United States Department of Energy (DOE) have made to participate in the Climate Challenge program in pursuit of the President's goals for reducing greenhouse gas emissions. The Climate Challenge Program is a joint, voluntary effort of DOE and the electric utility industry to reduce, avoid or sequester greenhouse gas emissions. The framework of the Climate Challenge Program was established in the Climate Challenge Program Memorandum of Understanding and exhibits thereto dated April 20, 1994 (the Climate Challenge Program MOU). See Attachment A hereto.

LNMP C Commitments

A.

Consistent with paragraph II.B.1. of the Climate Challenge Program MOU, NMPC commits to limit Company carbon dioxide (CO₂) emissions (in tons) to its 1990 baseline level. NMPC also commits to maintain its CO₂ emissions at or below that level each year through the year 2000. The Company's 1990 baseline emissions and business activities included in the baseline will be documented in accordance with provision I.E. below.

B.

In support of the commitments in I.A., NMPC commits to undertake and will continue to undertake a variety of measures to limit its total greenhouse gas emissions. Examples of such measures which have been undertaken since 1990 or are expected to be undertaken in the future are attached as Attachment B.

C.

If in any year NMPC's baseline commitment level is not met, CO₂ reductions which are available from the cumulative total reductions achieved below the baseline level since 1990 through greenhouse gas reduction measures undertaken by NMPC, and which have not been transferred to any other party, will be applied to offset the exceedance (in tons) above the 1990 baseline CO₂ emissions level. If sufficient offsets are unavailable in any year, NMPC will determine the shortfall in tons of CO₂ and will investigate with DOE's assistance additional measures to limit or reduce such emissions.

- D. NMPC will report annually on activities and achievements under the Climate Challenge Program. Results achieved during each year will be reported in a clear and understandable manner that is consistent with the guidelines adopted pursuant to subsection 1605(b) Energy Policy Act and the Climate Challenge accounting protocols in Supplemental Guidance on Commitment Definitions and Reporting of the Climate Challenge Program MOU ("Exhibit B").
- E. Within 90 days of the signing of this Accord, NMPC will submit to DOE an initial annual report (1) identifying company business activities and the corresponding CO₂ emissions total included in its 1990 baseline level, (2) documenting annual CO₂ emissions beginning in 1990, (3) listing measures undertaken since 1990 which reduce, limit, or avoid emissions of CO₂ and other greenhouse gases, and (4) reporting results achieved versus the 1990 baseline commitment on an annual and cumulative basis. NMPC will also include in this report for informational purposes estimates of CO₂ emissions resulting from other energy purchase commitments. The initial report will serve as the model under this Accord for future annual reporting by NMPC that is in addition to reporting under 1605(b).
- F. The commitments specified above will apply through the year 2000. NMPC and DOE agree to reopen or revisit this Accord by December 31, 1998, to address NMPC's continued participation in the Climate Challenge Program and the nature of NMPC's commitments after the year 2000.
- G. NMPC will confer with DOE on or before December 31, 1996 to evaluate jointly the progress of NMPC in achieving its Climate Challenge goals and to discuss possible adjustments to its voluntary commitments.
- H. The Climate Challenge representative for NMPC will be Dr. Martin Smith, Chief Environmental Scientist, NMPC, 300 Erie Boulevard West, Syracuse, New York 13202. NMPC will notify DOE prior to or, in any event, no later than 30 days after any change in the representative.

II. Cooperation between NMPC, DOE and Other Utilities for Meeting Climate Challenge Program Objectives

- A. DOE, as outlined in the Climate Challenge MOU, and NMPC agree that the Climate Challenge should provide utilities with maximum flexibility to pursue cost-effective, customized strategies including but not limited to demand-side management, electrotechnologies, increased use of

renewable energy sources, forestry and other CO₂ sequestration activities, fuel switching, efficiency improvement, and international projects.

B.

DOE, as outlined in the Climate Challenge MOU, and NMPC agree that the Climate Challenge should promote the development and demonstration of innovative methods to promote cooperative, joint utility efforts designed to support both national objectives related to global warming mitigation and individual utility environmental goals in an economically-efficient manner, including emissions reduction agreements between Climate Challenge participants to allow the participants to meet their Climate Challenge commitments in the most cost-effective manner.

C.

NMPC may transfer greenhouse gas emission reductions to other Climate Challenge participants, provided that the transferred emission reductions are below the baseline level and are:

1. The result of measures undertaken by NMPC; and
2. Not applied to offset NMPC emissions in another year in which NMPC emissions are in excess of the Company's 1990 baseline.

D.

NMPC agrees to provide DOE with a copy of any agreements covering transactions described in paragraph II.C. of this Accord.

III. DOE Commitments

A.

DOE's commitments to NMPC are those set out in section III of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

DOE will consider NMPC requests to intervene in regulatory proceedings of federal, state and local commissions and boards on issues pertinent to the Climate Challenge Program. Before DOE intervenes in regulatory and other proceedings pertaining to NMPC for purposes of addressing Climate Challenge Program issues, it will provide notice to NMPC.

C.

DOE will provide an annual report to NMPC describing the actions that it has taken to fulfill its commitments under section III and Exhibit C of the Climate Challenge Program MOU and the results of those actions.

D.

The Climate Challenge Program representative for DOE, who will serve as liaison to NMPC, will be Allan Hoffman, U.S. Department of Energy, 1000 Independence Ave., S.W., Washington, D.C. 20585 --(202)586-1786. DOE will notify DOE prior to or, in any event, no later than 30 days after any change in liaison responsibilities or personnel.

- E. DOE will consider request to assist NMPC its interactions with other regulatory agencies or governmental authorities (including but not limited to IRS, EPA, NYS Public Service Commission) in furtherance of the goals or commitments set forth herein, including the implementation of any cooperative action with another utility for purpose of achieving Climate Challenge objectives.
- F. In a manner and to an extent consistent with Department policy, DOE will support recognition of greenhouse gas emissions reductions achieved through voluntary efforts in any future national programs to mitigate climate change.

IV. General Provisions

- A. Use of DOE-developed materials by NMPC will be governed by the provisions of section IV of the Utility Climate Challenge MOU.
- B. In addition to the foregoing provisions, DOE and NMPC agree to act in accordance with the following principles, statements and actions contained in the Utility Climate Challenge MOU, which are hereby incorporated by reference:
1. Principles - section 1.
 2. General Provisions - section V.A-V.D, V.F and V.G.
- C. Either party may withdraw from this Participation Accord or any of its activities under the Climate Challenge Program without penalty and without being subject to remedies at law or equity.

NIAGARA MOHAWK POWER CORPORATION

BY: _____

DATE: February 2, 1995

U.S. DEPARTMENT OF ENERGY

BY: _____

DATE: February 3, 1995

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Climate Challenge Participation Accord

DOE's Energy Partnerships for a Strong Economy

Climate Challenge Participation Accord Between Tennessee Valley Authority And U.S. Department of Energy

This **Participation Accord** describes the commitments that the Tennessee Valley Authority (TVA) and the U.S. Department of Energy (DOE) have made to participate in the Climate Challenge Program in pursuit of the President's goals for reducing greenhouse gas emissions. The Climate Challenge Program is a joint, voluntary effort of DOE and the electric utility industry to reduce, avoid or sequester greenhouse gas emissions. The framework of the Climate Challenge Program was established in the Climate Challenge Program Memorandum of Understanding and exhibits thereto dated April 20, 1994 (the Climate Challenge Program MOU), which is hereby incorporated by reference.

1. TVA's Commitments

A. Consistent with paragraph 11.B.1 of the Climate Challenge Program MOU, TVA commits to reduce its annual emissions of greenhouse gases by the equivalent of 22.7 million tons of CO₂ by Year 2000. Most of these reductions are relative to Year 2000 greenhouse gas emission levels for a modified reference case that was projected from the average of TVA's 1987-1990 baseline of approximately 92.7 million tons of CO₂ emissions by excluding the specific reduction activities identified in Attachment A from the production model of the TVA power system. The reference case and the business operations involved in the reference case are more fully described in Attachment B. TVA's commitment applies to all of the agency's activities including its power system program and appropriated-funded programs. This commitment and all other commitments established by this Accord are subject to the conditions stated in the Climate Challenge MOU, the results of TVA's integrated planning process activities, and satisfactory completion of any environmental reviews.

B. TVA will report annually on its activities and achievements under the Climate Challenge Program. Results achieved during each year shall be reported in a clear and understandable manner that is consistent with the guidelines adopted pursuant to subsection 1605(b) of the Energy Policy Act and the Climate Challenge accounting protocols in Exhibit B of the Climate Challenge Program MOU. The first such report may include a description of TVA's greenhouse gas reduction activities and achievements prior to execution of this Accord.

C. TVA will confer with DOE on or before January 30, 1996 to evaluate jointly TVA's progress in achieving its Climate Challenge Program goals and to discuss possible adjustments to its voluntary commitments.

D. TVA's Climate Challenge Program representative shall be:

Mr. Jerry L. Golden
Manager, Clean Air Program and Generation Technology
Tennessee Valley Authority
Chattanooga, Tennessee 37402-2801

TVA agrees to notify DOE prior to or, in any event, no later than 30-days after any change of its representative.

DOE's Commitments

A. DOE's commitments to TVA are those set out in section III of the Climate Challenge Program MOU, which are hereby incorporated in this Accord by reference.

B. DOE will provide an annual report to TVA describing the actions that it has taken to fulfill its commitments under section III and Exhibit C of the Climate Challenge Program MOU and the results of those actions.

C. DOE's Climate Challenge Program representative, who will serve as liaison to TVA will be:

Mr. Allan Hoffman
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington D.C. 20585
(202) 586-1786

DOE agrees to notify TVA prior to or, in any event, no later than 30 days after any change of its representative.

III. General Provisions

A. Use of DOE-developed materials by TVA will be governed by provisions of section IV of the Climate Challenge Program MOU, which are hereby incorporated in this Accord by reference.

B. In addition to the foregoing provisions, DOE and TVA agree to act in accordance with the principles set out in section I of the Climate Challenge Program MOU and the general provisions set out in subsections V.A - V.D, V.F, and V.G of the Climate Challenge Program MOU, which are hereby incorporated in this Accord by reference.

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C. Either party may withdraw from this Accord or any of its activities under the Climate Challenge Program without penalty and without being subject to remedies at law or equity.

D. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this MOU or to any benefit that may arise therefrom, but this provision shall not be construed to extend to any corporation or unit of Government contracting for its or the public's general benefit.

Director

Tennessee Valley Authority

Secretary
U.S. Department of Energy

ATTACHMENT A
CO₂ Reduction Activities Undertaken by TVA

The CO₂ reduction estimates identified below are generally derived through the use of a modified reference case that compares the CO₂ equivalent emissions generated by TVA's activities with and without the identified reduction activity.

1. **Nuclear Unit Operation:** TVA restarted its Browns Ferry Nuclear Unit 2 in August 1991. It plans to restart its Browns Ferry Nuclear Unit 3 and start Watts Bar Nuclear Unit 1 prior to the Year 2000. Operation of these nuclear units is expected to result in annual CO₂ emissions reductions in the Year 2000 of 15,898,000 tons.
2. **Biomass Cofiring:** TVA has initiated a biomass cofiring test program at its fossil fueled units. The biomass used is wood waste from the wood products industry in the TVA region. Based on these tests, TVA will initiate commercial cofiring projects at various fossil plants that will result in annual greenhouse gas reductions in the Year 2000 equivalent to 2,422,000 tons of CO₂. In addition to the avoided CO₂ emissions associated with combusting coal, this reduction includes the CO₂ equivalent of avoided methane emissions (approximately 75,000 tons) due to wood waste carbon conversion to CO₂ by combustion rather than conversion to CO₂ and methane by decomposition. A global warming potential of 21 was used for the avoided methane emissions.
3. **Demand Side Management (DSM) Programs:** TVA has identified a number of DSM programs that may be implemented as a result of its ongoing integrated resource planning (IRP) process. TVA expects to initiate cost-effective DSM programs that will result in estimated annual CO₂ emissions reductions in the Year 2000 of up to 1,383,000 tons.
4. **Fossil Fueled Unit Efficiency Improvements:** TVA expects to continue to initiate activities to offset thermal performance degradation and to improve the efficiency of its fossil fueled generating units. These activities include improved operation and maintenance, upgrading plant equipment, and upgrading plant instrumentation and controls. The activities TVA completed in 1991 through 1994 to improve unit efficiency are expected to result in annual CO₂ emissions reductions of approximately 1,018,000 tons in the Year 2000. Additional unit efficiency improvement activities TVA plans to initiate in 1995 through 2000 are expected to result in additional annual CO₂ emissions reductions of approximately 459,000 tons in the Year 2000.
5. **Transmission System Efficiency Improvements:** TVA expects to continue to improve the efficiency of its transmission system and thereby reduce power generation requirements. Such improvements include reconductoring existing transmission lines, constructing new transmission lines, constructing new substations, and replacing transformers. The activities TVA completed in 1991 through 1994 to improve transmission system efficiency are expected to result in annual CO₂ emissions reductions of

approximately 183,000 tons in the Year 2000. Additional transmission system efficiency improvement activities TVA plans to initiate in 1995 through 2000 are expected to result in additional annual CO₂ emissions reductions of approximately 545,000 tons in the Year 2000.

6. Hydro Modernization Activities: TVA expects to continue to initiate activities to improve the performance of its hydroelectric generating units such as modernizing and upgrading the turbines and generators to increase their efficiencies. The activities TVA completed in 1991 through 1994 to modernize its hydro facilities are expected to result in annual CO₂ emissions reductions of approximately 20,000 tons in the Year 2000. Additional hydro modernization activities TVA plans to initiate in 1995 through 2000 are expected to result in additional annual CO₂ emissions reductions of approximately 375,000 tons in the Year 2000.

7. Fossil Fueled Unit Flyash Sales: Sales of flyash from fossil fueled units to the cement manufacturing industry result in CO₂ reductions due to lower energy consumption and reduced calcination in the manufacturing process. TVA plans to increase its marketing of flyash to the cement industry from approximately 140,000 tons in 1990 to 290,000 tons in the Year 2000. The increased TVA flyash sales are expected to result in additional annual CO₂ emissions reductions in the Year 2000 of 155,000 tons.

8. Heat Pump Program Activities: TVA intends to continue to encourage its customers to install efficient heat pumps through such activities as providing low-cost loans and heat pump inspections. The heat pump program activities TVA completed in 1991 through 1994 are expected to result in annual CO₂ emissions reductions of approximately 40,000 tons in the Year 2000. Additional heat pump program activities TVA plans to initiate in 1995 through 2000 are expected to result in additional annual CO₂ emissions reductions of approximately 97,000 tons in the Year 2000.

9. Utility Forest Carbon Management Program (UFCMP): TVA is a participant in the UFCMP in which a portfolio of greenhouse gas reduction and carbon sequestration projects will be funded and has committed to provide \$75,000 annually for five years to this effort. The greenhouse gas emissions reductions and carbon sequestration that will result from this program have not yet been identified but TVA's proportionate share is estimated to be equivalent to 50,000 tons of CO₂ annually in the Year 2000.

10. CFC Management Activities: TVA expects to continue its activities to manage and phase-out the use of chlorofluorocarbons (CFCs) in TVA-owned equipment. CFC management activities include elimination of venting during equipment maintenance and replacement of high global warming potential CFCs with lower global warming potential materials. The CFC management activities TVA completed in 1991 through 1994 are expected to result in annual greenhouse gas emissions reductions of approximately 8,000 tons CO₂ equivalent in the Year 2000. Additional CFC management activities TVA plans to initiate in 1995 through 2000 are expected to result in additional annual greenhouse gas

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emissions reductions of approximately 1,000 tons CO₂ equivalent in the Year 2000. Global warming potentials ranging from 310 to 8,000 were used for the various affected CFCs to derive CO₂ equivalent tons.

11. Internal Energy Management Activities: TVA expects to continue to reduce its internal consumption of energy. This will be done through such activities as the installation of high efficiency electric motors,

building heating and air conditioning efficiency upgrades, and water heating efficiency upgrades. These efficiency improvement activities are expected to result in annual CO₂ emissions reductions of approximately 26,000 tons in the Year 2000.

12. Transportation Efficiency Improvement: TVA expects to continue to improve the efficiency of its transportation fleet. For example, TVA's automobile fleet fuel efficiency was increased 0.4 miles per gallon from 1990 to 1993 by replacing less efficient automobiles with more efficient models. The TVA truck fleet fuel efficiency improved by 5.7 miles per gallon from 1990 to 1993. The activities TVA completed in 1991 through 1994 to improve its transportation fleet efficiency are expected to result in annual CO₂ emissions reductions of approximately 5,000 tons in the Year 2000. Additional activities TVA plans to initiate in 1995 through 2000 to improve its transportation fleet are expected to result in additional annual CO₂ emissions reductions of approximately 1,000 tons in the Year 2000.

13. Forest Management Activities: TVA expects to continue reforestation and active forest management activities on TVA-owned lands. These activities are planned for approximately 150 acres per year. The activities completed from 1990 to 1994 and planned for 1995-2000 are expected to result in CO₂ sequestration in the Year 2000 of 3,000 tons.

14. Office Waste Paper Recycling: Paper recycling results in reduced greenhouse gas emissions from the paper manufacturing industry due to lower energy consumption relative to paper manufacturing using raw materials. Paper recycling from TVA offices is expected to reach 1,700 tons in the Year 2000 resulting in annual CO₂ reductions of 3,000 tons.

15. Cogeneration: In 1995, TVA will begin supplying steam in addition to electricity to an industrial customer near TVA's Johnsonville Fossil Plant. This energy supply arrangement will result in an annual CO₂ reduction in the Year 2000 of 23,000 tons compared to previous energy supply arrangements.

16. Animal Waste Methane Recovery: TVA expects to implement several animal waste methane recovery and utilization demonstration projects over the next five years. The annual CO₂ equivalent in the Year 2000 of the avoided methane emissions from these projects is expected to be 8,000 tons. A global warming potential of 21 was used to calculate the CO₂ equivalency of avoided methane emissions.

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17. NOX Emission Reductions: TVA plans to achieve an approximate annual reduction of 225,000 tons of NOX emissions from its fossil-fueled units by the Year 2000 and intends to begin reporting these in 1997 as part of its Climate Challenge efforts, consistent with DOE's Section 1605(b) Reporting guidelines. These expected reductions would be in addition to the greenhouse emission reduction tonnage commitment made by TVA.

18. Public Power Initiatives: TVA is participating with public power industry groups and other public power utilities in the development of industry initiatives for greenhouse gas reductions. TVA commits to continue this effort to develop such reductions and initiatives and to consider participating in appropriate initiatives. Any reductions associated with this activity would be in addition to the greenhouse emission reduction tonnage commitment made by TVA.

ATTACHMENT B

Description of Reference Case

The greenhouse gas (GHG) emissions reductions resulting from many of the actions described in Attachment A are relative to GHG emissions for a **modified reference case** for the Year 2000. The modified reference case emissions are projected using widely accepted electric utility planning techniques and mathematical models. In summary, the models were used to determine the difference between the modified reference case emissions assuming no GHG-reduction activities had been taken and the level of emissions with reduction actions.

The modified reference case emissions for the power system related actions are the result of power system production modeling. The modified reference case model runs were configured to meet the predicted Year 2000 system load with power system resources and performance characteristics that were in service in 1990. An output of the model is predicted CO₂ emissions. Low GHG emitting supply side additions to the system completed or planned for completion since 1990, such as nuclear units and hydroelectric generation facility upgrades, were excluded from the system resources modeled for the modified reference case. Generation load reductions resulting from transmission system upgrades and DSM programs implemented or planned for implementation since 1990 were excluded from the modified reference case model runs. Fossil unit heat rate performance improvements completed or planned for completion since 1990 were excluded from the modified reference case CO₂ emissions predictions. The total system load growth from 1990 to 2000 is expected to be about 34 %. In the modified reference case, the additional load and the absence of new nuclear unit generation is met by combustion turbine capacity additions, pulverized coal fired capacity additions, additional generation from the existing pulverized coal fired capacity, and additional off-system power purchases.

TVA has included the CO₂ emissions associated with the generation of purchased power in its emissions total. Based on historical purchases, it is assumed that the off-system purchased power would be generated by coal fired facilities. In turn, CO₂ emissions associated with the generation of power sold off-system were deducted from total emissions.

The modified reference case emissions from the transportation fleet were predicted by calculating the emissions from a fleet with the average fuel efficiency of the 1990 fleet traveling the vehicle miles predicted for 2000.

The modified reference case emissions for chlorofluorocarbons (CFCs) were predicted by calculating the CO₂ equivalent of CFC emissions based on CFC consumption rates and the types of CFCs in service in 1990.

The emissions reductions resulting from the remaining actions described in Attachment A are relative to the baseline period of 1987-1990, i.e., a **basic reference case**. For example, TVA had no biomass cofiring activities, no animal waste methane recovery activities, and no participation in the Utility Forest Carbon Management Program during the baseline period. For other reduction actions such as flyash sales to the cement manufacturing industry and forest management activities on TVA owned lands, TVA had ongoing activities during the baseline period. For these actions, the reductions are based only on the activities initiated since 1990.

The TVA total modified reference case GHG emissions for the Year 2000 are equivalent to 127.3 million tons of CO₂. The total GHG emissions reductions, including reductions relative to modified and basic reference cases, are equivalent to 22.7 million tons of CO₂.



Climate Challenge Participation Accord

DOE's Energy Partnerships for a Strong Economy

Climate Challenge Participation Accord

This Participation Accord describes the commitments that PacifiCorp and the U.S. Department of Energy (DOE) have made to participate in the Climate Challenge Program in pursuit of the President's goals for reducing greenhouse gas emissions. The Climate challenge Program is a joint, voluntary effort of DOE and the electric utility industry to reduce, avoid or sequester greenhouse gas emissions. The framework of the Climate Challenge Program was established in the Climate Challenge Program Memorandum of Understanding and exhibits thereto dated April 20, 1994 (the Climate Challenge Program MOU) (see Attachment A to this Participation Accord).

I. Utility Commitments

A.

Consistent with paragraph II.B.1 (a, e and f) of the Climate Challenge Program MOU, PacifiCorp will:

1.

Reduce its emissions rate (in lbs. of CO₂ per MWh) by ten percent between 1990 and 2000. In handling the emissions from the sale and purchase of power, emissions are added to our total when we purchase and subtracted when we sell power. Emissions are assumed, for both sale and purchase, to be from gas resources unless we know specifically otherwise (e.g., purchase from hydroelectric or coal facilities). Emissions rate will change from 2123 lbs/MWh 1911 lbs/Mwh. The company will include the following activities in order to achieve the commitment:

a.

Changes in generation mix - Actions that change the mix of resources used to supply energy to our customers.

b.

Offset activities - Actions that offset generation emissions through forestry projects and non-forestry projects (e.g., coal ash recycling, ethanol production, methane

capture, etc.)

2.

Pursue projects to cost-effectively reduce, sequester and avoid CO₂ emissions.

Project-by-project descriptions will be provided for projects in the following areas:

a.

Customer demand-side programs

b.

Transmission and distribution efficiencies

c.

Other projects

3.

Participate in the Utility Forest Carbon Management Program.

In order to achieve the commitment under section 1(A)(1):

- **Changes in generation mix** - PacifiCorp intends to take actions necessary to have 200 MWa of renewable resources on line by 2001, if cost-effective. These actions taken alone will reduce emissions by approximately 600,000 tons of CO₂ in 2000 (when modeled against our "base case" resource selection). The company's rate commitment will primarily be achieved through this aggressive acquisition of renewables as well as the use of gas resources and the retention of existing renewable resources (through relicensing hydroelectric facilities).
- **Current forestry projects to sequester emissions** - Since 1992, PacifiCorp has initiated a series of pilot-scale greenhouse gas emissions offset projects. To date the company has invested \$425,000 in four forestry offset projects. These projects are expected to offset a total of 23,928 in the year 2000 and 638,670 tons of CO₂ over the life of the projects. These ongoing projects are described in detail in attachment B.
- **New projects to avoid and sequester CO₂** - The company intends to spend approximately \$1 million on pilot efforts between 1995 and 2000. Based on our current assumptions, this investment must accrue approximately 700,000 tons of CO₂ in 2000 to accomplish our rate reduction goal. This offset requirement calculation may change with variations in the company's integrated resource plan or market changes. These investments represent a long-term effort to sequester and avoid carbon emissions as well as our effort to find sequestration opportunities that may be expanded in the future if the need arises. The company is exploring a wide variety of projects to pursue as pilots including: reductions in the transportation sector, methane capture at wastewater facilities, applications of lower CO₂ technologies at customer locations.
- **Coal ash recycling** - The company is increasing its effort to recycle coal ash. When used to produce cement, coal ash recycling significantly reduces the amount of energy consumed during cement production and thus results in CO₂ emissions being avoided. PacifiCorp recycled over 390,000 tons of coal ash in the baseline year of 1990. PacifiCorp intends to recycle over 85,000 tons of ash annually (over and above the 1990 baseline amount), so will offset 85,000 tons of CO₂ in the year 2000.

In order to achieve the commitment under section 1(A)(2):

- **Customer demand side programs** - PacifiCorp has displaced 34.9 MWa of generation between January 1, 1992 and 1994 through demand side programs. Based on the company's resource mix, the company has avoided 240,000 tons of CO₂ emissions during this time. For 1995-2000, the company intends, through investment in cost-effective demand side resources, to displace an additional 211 MWa of generation. This estimate is based on our current assumptions and modeling effort and may change as technologies and assumptions vary. Based on the company's resource mix, the company intends to avoid (between 1995- 2000) an additional 1,465,000 tons of CO₂. In the year 2000, our demand-side activities are expected to displace 40.5 MWa and avoid 283,800 tons of CO₂. PacifiCorp is committed to developing a diversified portfolio of DSM programs during 1995 -2000 to achieve this goal such as:

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Commercial FinAnswer Program - Through the Energy FinAnswer program, PacifiCorp provides up-front prime rate financing for cost-effective energy conservation measures installed in new commercial buildings. Measures may include: lighting, insulation, HVAC systems, controls or other measures that save electricity beyond code requirements. Repayment of the loan is added to the customer's electric bill as an Energy Service Charge (ESC). Energy cost savings are greater than the monthly ESC, so most customers experience a positive cash flow.

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Industrial FinAnswer Program - The program offers industrial customers opportunity to decrease their energy consumptions by promoting energy efficient design and providing funding for installation of energy conservation measures. Thus far the program has focused on four major technologies: lighting, motors, air compressors systems, and refrigeration.

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Home Comfort - PacifiCorp's Home Comfort program is a retrofit weatherization effort designed to achieve higher rates of customer participation than are typically achieved. The program offers a free home energy check-up, using high-tech diagnostic equipment and the installation of "instant savings measures." These items include: a low-flow showerhead, water heater wrap, faucet aerators, and fluorescent light bulbs.

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New Residential Buildings - The company influences adoption of Model Conservation Standards (MCS) through capturing cost

effective lost opportunities beyond the current code, while working with state and local agencies to promote adoption of MCS.

- **Transmission and distribution efficiencies** - PacifiCorp intends to avoid transmission and distribution system loss through aggressive development of transmission and distribution (T&D) efficiencies. Between 1991 and the present, the company has accomplished approximately 14 aMW of savings through T&D projects and intends to save an additional 16 aMW through additional efforts. These efforts will offset approximately 205,000 tons of CO₂ in 2000. The company's efficiency efforts include:

Implementation of conservation voltage reduction (CVR) on specific lines.

Efficiency improvements at company sub-stations including capacitor installations, use of larger wire on transmission circuits, and conversion of low voltage systems to higher levels.

Efficiency improvements through the purchase of more expensive transformers, larger conductors and additional capacitors.

- **Additional projects** - The company is exploring additional projects in the area of forestry on company lands and conversion of fleet vehicles. If these projects are pursued on a larger scale, the company will quantify the relevant 1990 baseline to calculate incremental benefits of these projects. These projects are listed in attachment C.

In order to achieve the commitment under section 1(A)(3):

- **Utility Forest Carbon Management Program** - PacifiCorp has invested \$5,000 in November, 1994 to join the utility carbon management program. We will explore further investment in the program once the cost-effectiveness of this investment has been determined. Any share of our investment that accrues credible and countable carbon benefits in the year 2000 will be counted towards the company's rate commitment in 1(A)(1) and this investment will go towards our \$1 million investment in off-system emission reduction programs.

B.

PacifiCorp will report annually on activities and achievements under the Climate Challenge Program. Results achieved during each year shall be reported in a clear and understandable manner that is

consistent with the guidelines adopted pursuant to subsection 1605 (b) Energy Policy Act and the Climate Challenge accounting protocols in Exhibit B of the Climate Challenge Program MOU. The first such report may include a description of the activities and achievements of PacifiCorp prior to its becoming a participant in the Program, expressed on an annual basis to the extent possible.

C.

PacifiCorp will confer with DOE on or before June 30, 1996 to evaluate jointly the progress of the company in achieving its Climate Challenge Program goals and to discuss possible adjustments to its voluntary commitments.

D.

The Climate Challenge Program representative for PacifiCorp will be Tom Imeson, 700 NE Multnomah, Suite 1600 Portland, OR 97232. PacifiCorp agrees to notify DOE prior to or, in any event, no later than 30 days after any change in the contract

II. DOE Commitments

A.

DOE's commitments to PacifiCorp are those set out in section III of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

DOE will consider PacifiCorp requests to intervene in regulatory proceedings of federal, state and local commissions and boards on issues pertinent to the Climate Challenge Program. Before DOE intervenes in regulatory and other proceedings pertaining to PacifiCorp for purposes of addressing Climate Challenge Program issues, it will provide notice to the company.

C.

DOE will provide an annual report to PacifiCorp describing the actions that it has taken to fulfill its commitments under section III and Exhibit C of the Climate Challenge Program MOU and the results of those actions.

D.

The Climate Challenge Program representative for DOE, who will serve as liaison to the company, will be Allan Hoffman, Department of Energy, Room 6B-128 (EE-10), 1000 Independence Avenue SW, Washington DC 20585 (202)586-1786. DOE agrees to notify PacifiCorp prior to or, in any event, no later than 30 days after any change in liaison responsibilities or personnel.

III. General Provisions

A.

Use of DOE-developed materials by PacifiCorp will be governed by the provisions of section IV of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

In addition to the foregoing provisions, DOE and PacifiCorp agree to act in accordance with the principles set out in section I of the Climate Challenge Program MOU and the general provisions set out in subsections V.A-V.D, V.F and V.G of the Climate Challenge Program MOU, which are hereby incorporated by reference.

C.

Either party may withdraw from this Participation Accord or any activities under the Climate Challenge Program without penalty without being subject to remedies at law or equity.

(Original signed by)

President and Chief Executive Officer
PacifiCorp

(Original signed by)

Secretary of Energy
U.S. Department of Energy

Attachments:

Attachment A - Climate Challenge Program MOU and exhibits

Attachment B - Ongoing Forestry Projects

Attachment C -- Additional Projects

Attachment B - Ongoing Forestry Offset Projects

The company had developed four ongoing efforts to test cost-effective way to offset emissions through forestry. These projects are as follows:

- Reforestation of privately unforested private lands in cooperation with the Oregon Department of Forestry. This project resulted in over 600 acres planted.
- Shade tree planting around ten different Utah neighborhoods and individual sites. Conducted in partnership with nonprofit organization TreeUtah.
- Reforestation effort in eastern Washington to replant privately-owned lands that were devastated by fire. Organized in cooperation with the Upper Columbia Resource Conservation and Development Council.
- Investment in the Oregon Forest Resource Trust that funds planting on unforested and understocked lands. By combining company's \$75,000 investment with state funds, Trust can reforest 5,250 acres in the near term. Long-term goal is to plant 250,000 acres in 15 years.

Attachment C - Additional Projects

PacifiCorp will explore proceeding with a variety of other projects. They are as follows:

- **Management of Company Lands** - The company owns approximately 13,000 acres of forested land managed in association with our hydroelectric facilities. Much of the land is intensively managed through aggressive reforestation and careful land management. These practices yield CO₂ benefits when compared with either natural regeneration or with reforestation practices required under state forest practices acts. Within the next year, the company will develop methods to quantify these carbon benefits. Only post-1992 carbon benefits in excess of those achieved during the 1990 baseline would be counted towards a project-by-project commitment.
- **Fleet Conversions** - PacifiCorp currently owns three converted electric vehicles and six vehicles fueled by natural gas as part of our fleet. Our number of alternative fueled vehicles will be increasing steadily (to approximately 200 vehicles by 2000) and these purchases will accrue CO₂ benefits when compared to internal combustion vehicles. PacifiCorp also is exploring a variety of larger-scale business opportunities that would allow us to have a significant impact on CO₂ emissions through alternative fueled vehicles.

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Climate Challenge Participation Accord

DOE's Energy Partnerships for a Strong Economy

Climate Challenge Participation Accord

This Participation Accord describes the commitments that the American Electric Power System (AEP) and the U.S. Department of Energy (DOE) have made to participate in the Climate Challenge Program in pursuit of the President's goal for reducing greenhouse gas emissions. The Climate Challenge Program is a joint, voluntary effort of DOE and the electric utility industry to reduce, avoid or sequester greenhouse gas emissions. The framework of the Climate Challenge Program was established in the Climate Challenge Program Memorandum of Understanding and exhibits thereto dated April 20, 1994 (the Climate Challenge Program MOU) (see Attachment A to this Participation Accord).

I. AEP Commitments

A.

Consistent with paragraph II.B.1 (a and f) of the Climate Challenge Program MOU, AEP will undertake the following programs, projects and actions to reduce, avoid or sequester greenhouse gas emissions:

- Fossil power plant efficiency improvement program
- Adjustable speed drive motor pilot program
- Transmission & distribution system efficiency improvement program
- 415 MW coal to natural gas conversion project
- Hydroelectric facilities refurbishment program
- Nuclear plant availability and capacity increase
- Demand side management program
- Green Lights program participant
- Enhanced forest management and tree planting program
- Increase sales of fly ash to cementitious products markets

In addition, AEP will actively promote to its customers the use of electrotechnologies that can result in an improvement in energy efficiency and a reduction in emissions.

Finally, AEP will participate in the following industry-wide Climate Challenge initiatives:

- The Utility Forest Carbon Management Program

\$5,000 initial commitment in 1994

- The Earth Comfort Geothermal Heat Pump Program
\$50,000/year for 5 years initial commitment in 1995
- Envirotech - The Electrotechnology and Renewable Energy Investment Pool
Up to \$5,000,000 initial commitment in 1995
- EV America
Commitment to purchase EVs, number and cost unknown at this time

A more complete description of these programs, projects and actions is included in Attachment B.

B.

AEP will report annually on activities and achievements under the Climate Challenge Program. Results achieved during each year will be reported in a clear and understandable manner that is consistent with the guidelines adopted pursuant to subsection 1605(b) of the Energy Policy Act and the climate program accounting protocols in Exhibit B of the Climate Challenge Program MOU. The first such report may include a description of the activities and achievements of AEP prior to its becoming a participant in the Program, expressed on an annual basis to the extent possible.

C.

AEP will confer with DOE on or before January 1, 1998 to evaluate jointly AEP's progress in achieving its Climate Challenge Program goals and to discuss possible adjustments to its voluntary commitments.

D.

The Climate Challenge Program representative for AEP will be:

Dale E. Heydlauff, Vice President - Environmental Affairs
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

AEP agrees to notify DOE prior to or, in any event, no later than 30 days after any change in the contact.

II. DOE Commitments

A.

DOE's commitments to AEP are those set out in section III of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

DOE will consider AEP's requests to intervene in regulatory proceedings of federal, state and local commissions and boards on issues pertinent to the Climate Challenge Program. Before DOE intervenes in regulatory and other proceedings pertaining to AEP for purposes of addressing Climate Challenge Program issues, it will provide notice to AEP.

C.

DOE will provide an annual report to AEP describing the actions that it has taken to fulfill its commitments under section III and Exhibit C of the Climate Challenge Program MOU and the results of those actions.

D.

The Climate Challenge Program representative for DOE, who will serve as liaison to AEP, will be:

Allan Hoffman
U.S. Department of Energy
Room 6B-128 (EE-10)
1000 Independence Avenue SW
Washington, DC 20585
202-586-1786

DOE agrees to notify DOE prior to or, in any event, no later than 30 days after any change in liaison responsibilities or personnel.

III. General Provisions

A.

Use of DOE-developed materials by AEP will be governed by the provisions of section IV of the Climate Challenge Program MOU, which are hereby incorporated in this Participation Accord by reference.

B.

In addition to the foregoing provisions, DOE and AEP agree to act in accordance with the principles set out in section I of the Climate Challenge Program MOU and the general provisions set out in subsections V.A-V.D, V.F. and V.G. of the Climate Challenge Program MOU, which are hereby incorporated by reference.

C.

Either party may withdraw from this Participation Accord or any of its activities under the Climate Challenge Program without penalty and without being subject to remedies at law or equity.

Dr. E. Linn Draper, Jr. Date
Chairman of the Board, President and
Chief Executive Officer
American Electric Power Company, Inc.

Secretary of Energy or designee Date
U.S. Department of Energy

Attachment:

Attachment A - Climate Challenge Program MOU and exhibits

Attachment B - Description of AEP Climate Challenge Plan

Attachment B - AEP's Climate Challenge Plan

The programs and initiatives included in the AEP Climate Challenge Plan fall into five areas: supply-side, demand-side, land management, industry initiatives and miscellaneous. A description of the components of each of these areas follows:

Supply-side Activities. The evaluation of on-going and potential future programs and activities in the supply-side area determined that emissions savings were occurring and would continue to occur in the areas of fossil plant heat rate improvements, use of natural gas in place of coal, hydroelectric generation life extension and efficiency improvements, nuclear plant availability and capacity increases and transmission and distribution system energy loss reductions. In the area of **fossil plant heat rate improvement**, a significant number of capital improvements or operational changes were identified that have already been undertaken since 1/1/91 or could potentially lead to improvements in individual unit heat rates. Examples of these activities include the use of **adjustable speed drive motors** for certain applications in the power plants, operating fossil units within a load range that optimizes heat rate while maintaining economic dispatch, reblading steam turbines to improve turbine efficiency, taking auxiliary equipment out of operation to reduce auxiliary power losses, and others. In addition, a target heat rate improvement level was established for the AEP System to be achieved by 2000. While many of these activities were occurring already, AEP will investigate other innovative ideas for improving fossil plant efficiency due to the attention given to the Climate Challenge program and the potential benefits of reducing CO₂ emissions.

AEP is **converting three small coal units to natural gas-burning capability** in 1995 in what is referred to as a "dual-firing" mode as an acid rain compliance measure. AEP will operate these units on natural gas when it is cost-effective to do so, factoring in the value of SO₂ allowances. Based on projections in the compliance plan of the amount of generation expected from these units when on gas and the differential CO₂ emission rate of natural gas compared to coal, an estimate of emissions savings is included in the Climate plan.

The operation of AEP's **conventional hydroelectric generation** (16 facilities totaling 271 MW) avoided roughly 1 million tons of CO₂ in 1990. Many of these units are nearing the end of their expected operating lives. In addition, the turbines in many of the units are outdated and not as efficient as turbines available today. In the late 1980s and early 1990s, AEP undertook a program to increase the efficiency and extend the lives of its hydroelectric facilities. The program was expanded in 1994 due in part to the Climate Challenge. Without this program, much of the capacity would likely have been taken out of service before the year 2000. With the program, these units will remain in service, in some cases with increased capability. These measures have been included in the Climate Challenge plan, with a generation projection from the units based on a normal hydrological year and an emissions projection based on the assumption that the generation would come from coal-fired units on the AEP System if it does not come from the non-CO₂ emitting hydroelectric units.

AEP has two nuclear units as part of its system, totaling 2,110 MW. Since the early 1990s, an intensive program has been established to **increase the availability of the AEP nuclear units** by reducing the forced outage rates and decreasing the lengths of refueling outages. This program is consistent with efforts being undertaken throughout the industry to improve nuclear plant operations. AEP will continue to implement its strategic plan for the 2,110 MW nuclear plant. If the AEP program is successful, projected electric generation from the plant may increase as much as 40% compared to levels seen in 1990 and during many years in the 1980s. In addition, AEP's Nuclear Engineering Department is undertaking a project to **increase the capability**

of one of the nuclear units by 60 MWe. Similar to the hydroelectric units, the emissions savings that will result from increased output from these units is based on the assumption that the generation would instead come from coal-fired units on the AEP System.

Potential emissions savings from **activities on the transmission and distribution system** fall into two categories. AEP has an active program of transmission line construction to meet the needs of its customers and to maintain the reliability of the transmission system in its geographical region of the country. In many cases, the addition of a new transmission line will allow energy to flow through the system more efficiently, thus reducing line losses. This directly translates to emissions savings as it results in less electricity being generated to meet a given customer demand. AEP's T&D Services Department also continually evaluates programs to reduce line losses for the existing transmission system. The combined effect of planned additions to the system and planned improvements in the system in the 1990-2000 timeframe have been included in the Climate plan and form part of AEP's commitments.

On the distribution side, AEP has an on-going program to upgrade the electrical equipment in its distribution system. A portion of this activity is planned maintenance to insure reliability of the system and a portion is unplanned in response to equipment failures. Much of the equipment being replaced has been in operation for many years. The replacement equipment tends to be more efficient due to improvements in technology, which will automatically result in a reduction in distribution losses. This translates into emissions savings on the same basis as for the transmission system. AEP will continue its distribution system maintenance program. The emissions savings calculation for the transmission and distribution system energy loss savings is based on an average CO₂ emission rate for the AEP System that factors in non-fossil generation with fossil-based generation.

Demand-side Activities. Like many utilities, AEP has a demand side management (DSM) program aimed at altering the amounts and patterns of its customers' electricity use. To the extent that such a program results in a reduction in the amount of electricity generated to meet customer demand, emissions savings will occur. AEP has implemented and will continue to implement a diversified portfolio of DSM projects, examples of which include:

- Project Good Turn refrigerator recycling program
- Targeted Energy Efficiency residential weatherization program
- Neighborhood Energy Watch residential weatherization program
- SMART Financing Program (commercial & industrial)
- TranstexT residential energy management system

The CO₂ emissions savings projected for the year 2000 from this level of effort were included in the final Climate Challenge plan. The emissions calculation is based on the assumption that the reduction in generation associated with the end-use energy efficiency improvement occurs at AEP fossil plants.

Land Management Activities. AEP has a long history of tree planting and land management programs. CO₂ savings can occur both from planting new trees and increasing forest stand productivity through aggressive land management techniques. Such efforts would continue even without the Climate Challenge program. However, the emphasis on CO₂ emissions brought about from participation in the Climate Challenge has resulted in a renewed focus on AEP's land management activities. As a result, both the tree planting and land management programs will be expanded between 1994 and 2000. Ultimately, AEP will plant up to 15 million new trees during this period, and bring 15,000 additional acres of existing forest lands under more aggressive management. All of these activities have been included in the Climate Challenge plan.

Miscellaneous. The AEP Climate Challenge plan includes three additional areas that hold the potential for CO₂ emissions savings. The first, U.S. EPA's Green Lights program, is in some respects a DSM program, but on AEP's side of the electric meter. AEP became a Green Lights utility ally in 1992, and is in the process of conducting lighting retrofits in its facilities. Under the current schedule, AEP will complete the lighting retrofit program in 1997. The energy savings projected to occur from this effort, reaching a peak of 47 million kwh/year in 1997, have been included in the plan. AEP is also an aggressive marketer of coal ash for use in commercial products. One of these uses, fly ash in place of cement in the manufacture of concrete products, can result in significant energy and emissions savings. AEP will continue to aggressively market coal by-products, and a fly ash utilization program has been included in the plan. Finally, AEP, as well as many other utilities, is developing an electrotechnologies marketing program to identify and promote the use of electric technologies to replace the direct use of fossil fuels. Many such technologies can result in an overall improvement in energy efficiency and reduction in emissions even though the generation of electricity increases. While the AEP Climate Challenge plan recognizes the role of electrotechnologies, an emission savings projection was not developed at this time.

Industry-wide Initiatives. The electric utility industry recognized early in the Climate Challenge development process that the combined resources of many companies could be an effective approach to achieving emissions savings in a cost-effective manner. Through the efforts of the Edison Electric Institute, five industry-wide initiatives were developed during 1994. AEP will participate in four of these initiatives as part of its Climate Challenge plan:

- The Utility Forest Carbon Management Program
\$5,000 initial commitment in 1994
- The Earth Comfort Geothermal Heat Pump Program
\$50,000/year for 5 years initial commitment in 1995
- Envirotech - The Electrotechnology and Renewable Energy Investment Pool
Up to \$5,000,000 initial commitment in 1995
- EV America
Commitment to purchase EVs, number and cost unknown at this time

As these initiatives are still in a developmental stage, an emissions savings projection was not included in the AEP plan. However, as the initiatives are implemented and emissions savings occur, a share of these savings will be credited to AEP.

Emissions Savings Projection. The CO₂ emissions savings projection for the year 2000 from each of these program areas is:

Supply-side activities	8.31 million tons
Demand-side activities	0.78 million tons
Land management & Misc.	0.46 million tons
Total	9.55 million tons

Considerations. It is important to note the programs included in this Climate Challenge Participation Accord and the emissions savings projected to occur from implementation of these programs are based on the best projections available at the time the Accord goes into affect. Changing circumstances either within AEP or external to AEP could materially affect the actual emissions savings that will be achieved under this Climate Challenge Participation Accord.