CONF-9706180--Summ

CLIMATE CHANGE

Evolving Technologies, U.S. Business, & The World Economy in the 21st Century

A report based on a conference at the
U.S. Department of State, Washington DC
June 18, 1996

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The conference was sponsored by
The U.S. Department of State,
The U.S. Environmental Protection Agency,
The U.S. Agency for International Development,
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This report was sponsored by
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CLIMATE CHANGE: What the Scientists Tell Us *Comments by John H. Gibbons*

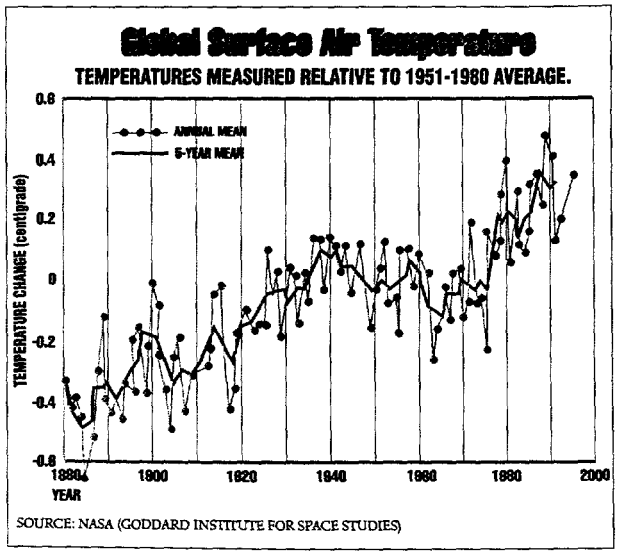
Over the last decade the world's governments have taken unprecedented steps to assess and describe current scientific understanding of climate change. More than 2,000 of the world's most prominent climate researchers from over 50 countries participated in the U.N. Intergovernmental Panel on Climate Change (IPCC), which announced in December 1995 its conclusion that "the balance of evidence" suggests a discernible human influence on global climate[1]. This is principally because human activities are increasing the atmospheric concentrations of carbon dioxide and other greenhouse gases that cause global atmospheric warming. The IPCC also said human activities are raising the concentration of sulfate aerosols that may cool the atmosphere and are contributing significantly to acid rain in some regions, especially in the northern hemisphere. The carbon dioxide content of the atmosphere is nearly 30 percent greater than it was at the onset of the industrial revolution in the eighteenth century. Methane has more than doubled and nitrous oxide has gone up by 15 percent.

To put it plainly, we're just beginning to understand that the earth's climate has changed over the millennia due to "natural" phenomena–but it is now changing in new and comparatively sudden ways because of human activities. For example:

- The earth's surface temperature in the twentieth century is as warm or warmer than it was during any earlier century, going back to at least 1400 A.D.;
- The global average surface temperature has increased by 0.3 to 0.6 degrees centigrade (about 0.5 to 1 degree Fahrenheit) over the last century;
- The last few decades have been the warmest in this century;
- The sea level has risen 10 to 25 centimeters (about 4 to 10 inches) since the year 1900;
- Mountain glaciers around the world are measurably retreating; and
- 1995 was the warmest year on record.

It is also important to note that U.S. emissions of greenhouse gases currently account for about 20 percent of the world total; and that the developing countries are the largest and fastest-growing source of greenhouse gas emissions.

The long atmospheric lifetime of many greenhouse gases–decades to centuries–coupled with the centuries-long lag time required for the oceans to equilibrate to changes in temperature and carbon dioxide concentrations, means that the warming effect of anthropogenic emissions will be long-lived. Even after a hypothetical stabilization of the atmospheric concentrations of greenhouse gases, temperatures would continue to increase for several decades, and the sea level would continue to rise for centuries. Reversing the effects, therefore, would also take centuries. Some impacts, such as species loss, are irreversible.



SOURCE: NASA (GODDARD INSTITUTE FOR SPACE STUDIES)

1 See excerpts from the IPCC report on p. i.

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With additional financial support from
The Alliance to Save Energy, ARCO, BP America, BHP Minerals, Cargill, Edison Electric Institute, Electric Power Research Institute, The Environmental Working Group, Gas Research Institute, Gillette, Honda North America, Monsanto, Motive Power, National BioEnergy Industries Association, Shell, Solar Energy Industries Association, UNOCAL, The Project for the Integrated Study of Global Change at the University of Michigan, and The Bureau of Intelligence and Research, U.S. Department of State

Human Activities Influence Global Climate *Excerpts from a UN Report*[2]

"Human activities are increasing the atmospheric concentrations of greenhouse gases–which tend to warm the atmosphere–and, in some regions, aerosols–which tend to cool the atmosphere. These changes, taken together, are projected to lead to regional and global changes in climate and climate-related parameters such as temperature, precipitation, soil moisture and sea level...

"Climate models, taking greenhouse gases and aerosols into account, project an increase in global mean surface temperature of about 1–3.5 degrees centigrade by 2100 and an associated increase in sea level of about 15–95 centimeters... [P]otentially serious changes have been identified, including an increase in some regions in the incidence of extreme high-temperature events, floods, and droughts, with resultant consequences for fires, pest outbreaks, and ecosystem composition, structure and functioning...

"Significant reductions in net greenhouse gas emissions are technically possible and can be economically feasible. These reductions can be achieved by utilizing an extensive array of technologies and policy measures that accelerate technology development, diffusion and transfer in all sectors, including the energy, industry, transportation, residential/commercial and agricultural/forestry sectors...

"Many of the policies and decisions to reduce emissions of greenhouse gases and enhance their sinks–and eventually stabilize their atmospheric concentration–would provide opportunities and challenges for the private and public sectors. A carefully selected portfolio of national and international responses of actions aimed at mitigation, adaptation and improvement of knowledge can reduce the risks posed by climate change to ecosystems, food security, water resources, human health, and other natural and socio-economic systems. There are large differences in the cost of reducing greenhouse gas emissions and enhancing sinks, among countries due to their state of economic development, infrastructure choices and natural resource base.

"International cooperation in a framework of bilateral, regional or international agreements could significantly reduce the global costs of reducing emissions and lessening emission leakages. If carried out with care, these responses would help to meet the challenge of climate change and enhance the prospects for sustainable economic development for all peoples and nations..."

2 The United Nations Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP) in 1988 to (1) assess available scientific information on climate change and the environmental and socio-economic impacts of climate change and (2) formulate response strategies. The IPCC First Assessment Report, completed in 1990, served as the basis for negotiating the U.N. Framework Convention on Climate Change. These excerpts were taken from the report of an IPCC subcommittee ("Working Group 2"), which was published as part of the Second IPCC Assessment Report in December 1995.

Weather-Related Disasters with Damages Exceeding Three Billion Dollars, 1982-1995*

DISASTER	LOCATION	YEAR	DEATHS	ESTIMATED DAMAGES (billion dollars)
Cyclone Iniki	N. America	1992	4	3.0
Winter Storms	N. America	1993	246	5.0
Mississippi floods	N. America	1993	41	12.0
Winter storms	N. America	1994	170	4.0
Spring floods	China	1994	1,846	7.8
Flood	Italy	1994	64	9.3
Winter floods	Europe	1995	28	3.5
Floods	China	1995	1,390	6.7
Storm, flood	N. Korea	1995	68	15.0

SOURCE: GREENPEACE INTERNATIONAL, *THE CLIMATE TIME BOMB: SIGNS OF CLIMATE CHANGE* AMSTERDAM, 1994

* Losses from weather-related disasters in recent years illustrate the potential vulnerability of human society to extreme weather events, which may be aggravated by climate change.

Foreword

We often hear about the expenses entailed in protecting the environment. Unfortunately, we hear less about the economic benefits that may be associated with prudent actions to counter environmental threats.

That's why the conference on climate change reflected in this report was particularly useful: It focused attention on profitable business opportunities in the United States and elsewhere that arise from practical efforts to mitigate the risks of climate change.

Specifically, the conference enabled leading policy-makers and experts from government, business, academia, and non-governmental organizations to exchange views regarding the importance of technologies aimed at improving efficiency in producing electric power, transporting people and freight, fabricating manufactured goods, and enhancing agricultural yields while curtailing greenhouse gas emissions.

The participants noted that government and private-sector R&D increasingly make it possible to produce more heat, light, motor power, and transportation with less (and cleaner) energy inputs, less waste, and fewer pollutants, including greenhouse gases.

Conference participants noted, for example, that although industrial nations discharged a disproportionate share of greenhouse gases into the atmosphere in the past, such emissions are likely to increase more rapidly in developing nations and economies in transition in the future. At the same time, these expanding economies will have the option of importing climate-friendly technologies as they modernize their economies.

The sponsors hope the insights reflected in this report will contribute to continuing dialogue and cooperation among those seeking viable solutions to the problems posed by climate change and the market opportunities for technologies designed to solve those problems.

The International Climate Change Partnership is pleased to present this report as one of its efforts to present current information on climate change to the public.

KEVIN J. FAY
EXECUTIVE DIRECTOR
INTERNATIONAL CLIMATE CHANGE PARTNERSHIP

PARTICIPANTS IN THE CONFERENCE FINAL PLENARY WERE (LEFT TO RIGHT): JONATHAN LASH, DARIUS GASKINS, JAMES WOLF, DAVID HALES, FRANKLIN NUTTER, AND ROBBIN JOHNSON. PAUL PORTNEY ALSO PARTICIPATED IN THE FINAL PLENARY PANEL. THESE INDIVIDUALS ALSO MODERATED THE OTHER CONFERENCE PANELS.

Conference Speakers

JULIE BELAGA
Director
Export-Import Bank

NANCY BIRDSALL
Executive Vice President
Inter-American Development Bank

JOHN B. CARBERRY
Director of Environmental Technology
DuPont

GILBERT E. CARMICHAEL
Vice Chairman
Motive Power

PIERRE CROSSON
Senior Fellow
Resources for the Future

CHESTER T. DICKERSON, JR.
Director, Agricultural Affairs
Monsanto Company

ANTHONY DOWNS
Senior Fellow
Brookings Institution

ANTHONY S. EARL
Chair
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Environmental Attorney
Lucent Technologies

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President
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Cargill, Inc.

RICHARD L. KLIMISCH
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American Automobile Manufacturers Association

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Professor of Economics
Carnegie Mellon University

JAMES MACKENZIE
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Climate, Energy, and Pollution Program
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JERRY B. MARTIN
Vice President, Environment, Health, and Safety Regulatory Affairs
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Executive Director
Business Council for Sustainable Energy

RICH MORRISON
Senior Vice President
Bank of America

DAVID M. NEMTZOW
President
Alliance to Save Energy
and
Chairman
Export Council for Energy Efficiency

FRANKLIN W. NUTTER
President
Reinsurance Association of America

PAUL R. PORTNEY
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Resources for the Future

JOHN REILLY
Deputy Director for Research
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Department of Agriculture

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Department of Energy

R. NEIL SAMPSON
Senior Fellow
American Forests

THOMAS R. SCHNEIDER
Executive Scientist, Strategic Research and Development
Electric Power Research Institute

SCOTT SKLAR
Executive Director
Solar Energy Industries Association

JOAN E. SPERO
Under Secretary for Economic, Business, and Agricultural Affairs
Department of State

ROBERT C. STEMPEL
Chairman and Executive Director
Energy Conversion Devices, Inc.

MICHAEL A. TOMAN
Senior Fellow
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ROBERT WATSON
Environment Department
The World Bank

MASON WILLRICH
Chairman
EnergyWorks

TIMOTHY E. WIRTH
Under Secretary for Global Affairs
Department of State

JAMES L. WOLF
Vice President, Energy and Environmental Markets
Honeywell Inc.

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~ Former Secretary of State Warren Christopher
Stanford University, April 9, 1996

"American businesses know that a healthy global environment is essential to our prosperity. Increasingly, they recognize that pitting economic growth against environmental protection is what President Clinton has called 'a false choice.' Both are necessary, and both are closely linked. Protecting the environment also opens new business opportunities. We are committed to helping U.S. companies expand their already commanding share of a $400 billion market for environmental technologies."

Climate Change Risks and Technologies to Mitigate the Risks

Climate change may increase stress on ecological and social systems already threatened by population growth, pollution, and various non-sustainable economic activities. Environmental technologies now being developed can mitigate the threat of climate change and the costs of responding.

Specific consequences of climate change may include the following[3]:

More Extreme Weather Events.

Droughts and floods may become more frequent. Since 1992, tornados, heat waves, blizzards, and hail storms, etc. in the United States have cost $70 billion in damages and several hundred deaths. Damages from Mississippi River flooding in 1993 cost some $12 billion.

Pressure on Water Resources.

Changes in precipitation and increased evaporation from higher temperatures may affect water supplies and water quality, posing threats to hydropower, irrigation, fisheries, and drinking water. This could add to the stress in U.S. river basins in several states, including Arkansas, California, Colorado, Missouri, and Texas.

Effects on Agriculture and Forestry.

Large areas of the eastern and central United States may face moderate to severe drying. Food supplies may be threatened in the tropics and subtropics. Climate change may also shift the favorable range for some North American forests by some 300 miles to the north, potentially exceeding the ability of forests to migrate. Forest damage from fire, driven by drought, insects, and disease, could increase.

Loss of Human Habitat.

A slight rise in the sea level (20 inches, within the range predicted by the IPCC) could inundate more than 5,000 square miles of dry land and an additional 4,000 square miles of wetlands in the United States, especially in the Atlantic and Gulf coastal areas. Sea-level rise and storm surges could also create 50 million environmental refugees in China.

Threat to Human Health.

The incidence of such vector-borne diseases as malaria, dengue fever, yellow fever, and encephalitis and such non-vector-borne diseases as cholera and salmonellosis may increase. Heat-stress mortality, particularly in the very young and very old, may also increase.

~ Joseph Romm
(Dept. of Energy)

"Continuing technological advances will be critical to the mitigation of climate change risks. The Department of Energy fosters a number of programs designed to facilitate the development of those technologies, such as, for example, our Partnership for a New Generation of Vehicles (PNGV) initiative, which has the goal of developing new automobile technologies that can triple the fuel efficiency of a typical family sedan while meeting stringent emissions and safety standards and maintaining affordability and performance. Unfortunately, resources available to the Department for supporting such technologies have been drastically reduced in recent years. In fact, federal government expenditures on energy R&D now amount to only one-half of one percent of our national energy bill."

3 SOURCE: EPA

~ Timothy Wirth (Dept. of State)

"Countless success stories demonstrate that the public and private sectors can work together to achieve simultaneous economic and environmental progress. Tremendous strides have been made in developing more efficient means of generating power and transporting people. Ingenious new systems of production have been developed to reduce resource inputs and the generation of waste. Sophisticated means of capturing, handling, and disposing of pollutants have been created. These developments have made the air in our cities cleaner, our water safer, and our health better. These successes prove that public dollars, wisely invested, can bring a significant return and that a great deal of money can be made from technological innovation and the need for a clean environment. And they form the foundation for the resolve and determination that must be summoned to face the challenge of climate change."

~ Jonathan Lash (WRI)

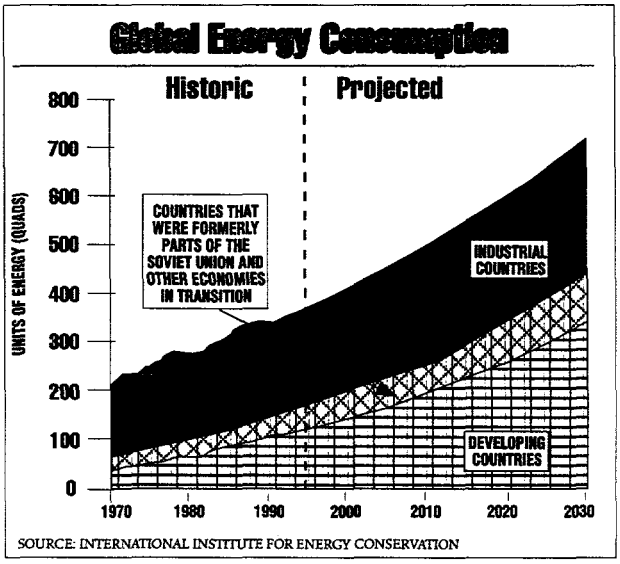
"Some time in the coming years, human society will probably decide to slow down global atmospheric pollution. That will require policy intervention on an unprecedented scale. At that point, governments must set clear goals, allow flexibility in the achievement of those goals, and provide incentives for reaching them. A practical international agreement to limit greenhouse gases will require a transfer of resources from the industrialized countries that have been putting carbon dioxide into the atmosphere for a century and a half to the developing countries, which are not likely to sacrifice their development to achieve climate goals. There will be hard bargaining over those goals–and we must remember that the developing countries have leverage over those decisions. Once we reach agreement, however, there will be enormous business opportunities for U.S. companies that produce the technologies that will facilitate the transition."

~ Julie Belaga (Ex-Im Bank)

"Being concerned about the competitiveness of American companies, U.S. negotiators are trying to develop common environmental standards among member countries of the OECD. We want to level the playing field internationally, but it's not easy."

~ Scott Sklar (Solar Energy)

"American industry leads the world technologically, because we have tough environmental laws, a free market, and the best know-how. And by expanding our exports of environmental technologies, we create jobs in the United States. Multilateral limitations on greenhouse gas emissions are therefore clearly in our economic interest–they will drive demand for our technologies and create thousands of new U.S. jobs."



The Complex Nature of the Challenge

The challenge of climate change has many components, including potential injury to human health, ecological systems, economic structures, and energy supplies. Better public understanding that people everywhere will be affected by climate change will strengthen public support for the short-term and long-term actions that will be required.

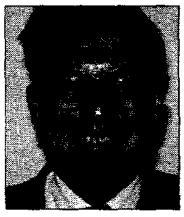
The Challenge is Complex

~ Paul R. Portney (RFF)

"The earth has warmed and cooled at various times, and it will continue to do so. But anthropogenic activities now have the potential to affect significantly the climate balance. By the same token, poorly designed policies to deal with this problem could do much economic harm. This is a public policy issue rich in scientific, economic, political, legal, ethical, and diplomatic complexity."

~ Robert Watson (World Bank)

"While we cannot accurately predict the impact that climate change will have on human health, ecological systems, or socio-economic sectors at a particular place or at a particular time, we believe climate change represents an important additional stress. We expect that there will be an increase in periods of high temperatures and heavy precipitation events that will lead to more floods and droughts, and regardless of climate change there will be an increasing stress on water supplies in many parts of the world as population expands. In addition, since we expect sea level to rise between 15 and 95 centimeters, new coastal infrastructure will be required."



~ Jeffrey Hunker (Dept. of Commerce)

"The challenge of global climate change is only one of many forces dramatically transforming the U.S. and global economies. Technological innovations and globalization will transform our economy in ways that we haven't seen since the shift from farm to factory that took place a century ago—and not always smoothly. There have been striking economic discontinuities, such as downsizing and leveraged buy-outs. The economy of the future will not be just a bigger and more efficient version of today's economy; it will be different in ways we cannot discern today. Our discussion about the economic agenda for climate change should keep that in mind."

~ James MacKenzie (WRI)

"There's plenty of fossil carbon in the world; but cheap and accessible $30-a-barrel crude oil is definitely a finite resource. This finiteness is very clear in the United States. Between 1973 and 1986, in response to higher oil prices, U.S. oil exploration quadrupled, while our domestic production and reserves both continued to decline. Worldwide, no major new oil fields were found during this period. (Oil was found on the north slope of Alaska and in the North Sea in the late 1960s.) Increased reserves came mostly from more drilling in existing fields. While the amount of conventional crude oil that will ultimately be pumped from the earth is uncertain, there is strong evidence that global production will probably peak within the next twenty years. There will be tremendous pressures to develop alternative energy sources and more efficient technologies for using fossil fuels. The price of oil is certain to rise, although transportation will probably continue to take a large share of oil supplies. Factories and homes

have more options than transport and will probably begin the switch to renewably based energy sources sooner."

~ Scott Sklar (Solar Energy)

"Since the extraction, conversion, and use of energy are the single largest contributor to global greenhouse gas emissions, we must move to more efficient and cleaner sources of energy. But measuring energy efficiency is not simple. Besides, even when new technologies quickly pay for themselves–and many do–it's not always easy to finance them. That's why government and multilateral institutions should support entrepreneurial companies that offer innovative solutions to problems in this area."

The Rationale for Early Action

~ R. Neil Sampson (American Forests)

"Trends don't matter as much as individual episodes. You only have to freeze to death once. It's the events that fall outside historic tendencies that cause ecosystems to go into stress. It's uncertainty about what climate change will bring rather than a model based on average conditions that concerns us. Averages can be made up of high and low extremes that are moving farther apart. When that happens, farm and forest ecosystems can be seriously affected by extreme climate events, even when the average change is modest or nonexistent."

~ Joseph Romm (Dept. of Energy)

"The production and use of energy do more environmental damage than any other human activity–and the world's energy consumption may double over the next two decades. We must become more efficient in our use of energy, whether derived from coal, oil, natural gas, or renewables. The Department of Energy gives top priority to the development of small combined-cycle gas turbines and fuel cells, which can help move the world toward greater use of natural gas and smaller-scale utility systems."

The Need for Better Public Understanding

~ Anthony Downs (Brookings)

"Climate change, as perceived by most people, is discounted to a present value of zero, because, first of all, there's tremendous uncertainty in the public mind as to whether there will be any climate change; and secondly, even if climate change should be huge, it is sufficiently far in the future that it doesn't affect the present conduct of most people. That's why the average citizen pays little attention to the threat of climate change–and most politicians ignore the whole issue. The fact is, we continue to discover new sources of oil, and technologies for exploiting it are still evolving. That doesn't mean we can continue to increase our oil consumption indefinitely for an infinite amount of time, but the world supply of oil will not be drastically reduced in the foreseeable future."

~ Robert L. Hirsch (E-Tec)

"Everyone would like an environmentally benign and sustainable society–but we must deal with the real world as it is. Americans enjoy low energy prices with modest environmental impacts, and the public is generally satisfied with that situation. To make the rapid changes that some environmentalists favor would cost an enormous amount of money–and dramatically raise energy prices. The public would not stand for that unless and until there is persuasive evidence of the need for it."

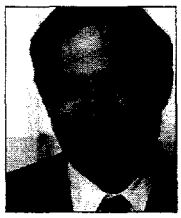
Responding to the Challenge

New technologies aimed at improving energy efficiency will be crucial to a successful strategy for coping with the threat of climate change.

The "Big Picture" vs. an Incremental Approach

~ THOMAS J. GROSS (DEPT. OF ENERGY)

"Oil required for transportation needs is growing in the United States–and even more rapidly worldwide. Our current course is costing the country a bundle and increasing our economic vulnerability. Our oil imports continue to increase. U.S. consumers now pay a billion dollars a week–and rising–for imported oil. At some point, the whole system will rupture if these trends continue. The question is whether we can engineer a controlled explosion or whether there will be catastrophic economic results. The similarities to the years leading up to the oil embargo in the 1970s are striking. We should be doing more to inform consumers about the current situation, the environmental impacts, and the potential repercussions of continued growth. Meanwhile, since the track we're on is not sustainable, we at the Department of Energy are supporting work on new technological approaches that will improve fuel efficiency while reducing greenhouse gas emissions."



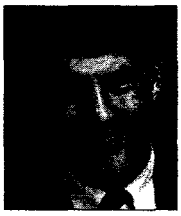
~ THOMAS R. SCHNEIDER (EPRI)

"We need to address the ancient problem of the 'commons'– problems we face together–whose resolution will benefit the public at large. Sometimes an individual firm will benefit from innovations that also benefit society. More generally, this is not the case. Many of the most valuable contributions to society do not lead to significant private gain. Examples are the theories of relativity and quantum mechanics, which, having spread throughout the world, are available to everyone. Ideas, once published, can spread at the speed of light as bit strings over the Internet. The creators of these ideas seldom capture economic rents equivalent to the benefit to society. As a consequence of an inadequate return, the private sector has been withdrawing from investment in R&D that produces public goods. For our own benefit, as members of society, we need to provide for the creation of new ideas without restricting the spread of new knowledge throughout society. That is why the government should fund basic research and adopt policies to encourage private sector collaborative R&D that both provides industry-wide profit and benefit to society at large. Fiscal and tax policies are especially relevant here."

~ Pierre Crosson (RFF)

"Too many people are looking for a silver bullet that will immediately solve the problem of global climate change. We should instead focus on more dependable one or two percent positive contributions. If you find several of them, they will make a big difference. Preparing to reduce dependence on fossil fuels before their prices rise makes all kinds of economic sense."

Focus on New Technologies



~ David Gardiner (EPA)

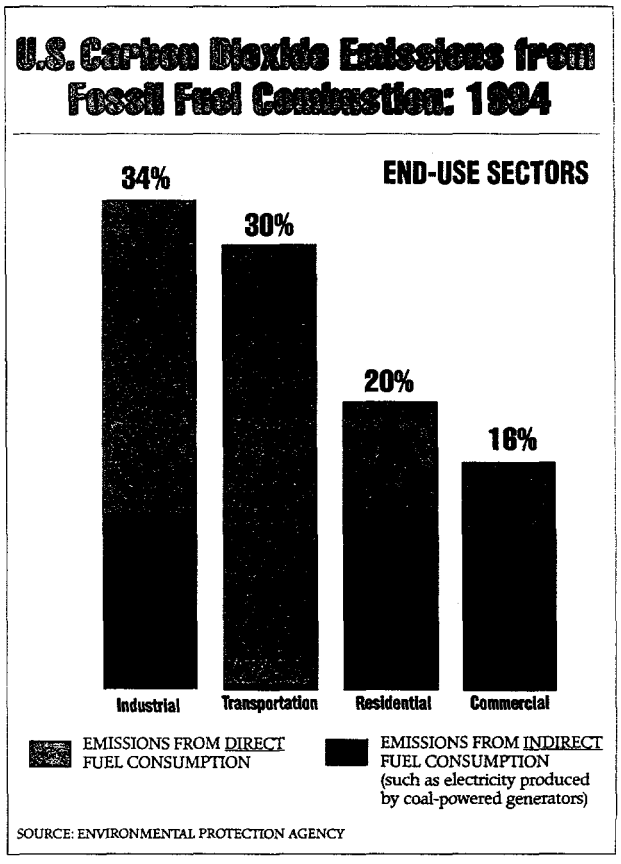
"Sustainable energy technologies are an important key to preventing climate change. Sustainable energy technologies can also help avoid other environmental problems–such as air and water pollution–that are caused by burning fossil fuels. As the adverse consequences of climate change become increasingly apparent, progressively larger premiums will be paid for clean energy, and climate change-related business opportunities will expand."

~ Robert L. Hirsch (E-Tec)

"As renewable energy costs decline, renewables will be applied to more niche uses. For instance, photovoltaics (PVs) with batteries already offer an ideal source of electricity in remote locations, especially in some developing countries. However, just because the quoted costs of renewables are approaching the costs of existing electric power generation options does not mean we can look to renewables to supply a large share of U.S. energy needs in the near future, because the costs are not comparable. Those quoted costs apply when the cells operate under ideal, sunny conditions. In fact, consumers require electricity on demand, 24 hours a day, and the cost of reliable, dispatchable, stand-alone PV power to meet that demand can reach 10 or more times the quoted PV power costs."

~ James MacKenzie (WRI)

"The two major sectors of the world economy that contribute most heavily to global climate change are transportation–which is growing rapidly in many developing countries–and the production of electric power. Government and industry are actively searching for new technologies to reduce the traditional dependence of these two sectors on fossil fuels."



Electric Power

Population growth and rising living standards inexorably drive an increasing global demand for electric power to turn the motors of industry, pump water, produce light and heat, and cool homes and offices. More efficient generation and distribution of electricity will reduce costs and the release of greenhouse gases into the air while creating new business opportunities.

Renovating a Traditional Industry

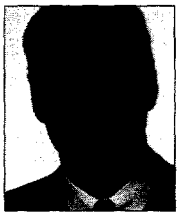
~ Mason Willrich (EnergyWorks)

"Many people believe the highest priority for the U.S. electric utility industry is to operate its aging plants more efficiently. The real need is to accelerate innovation, replacing these plants with much more efficient facilities. This will happen as we open the industry to competition by spinning off utility-owned generation assets, adopting performance-based regulations, and providing consumers with choices regarding their electricity suppliers. The resulting business environment would attract venture capital and accelerate innovation in electricity supply. In a disaggregated system, small modular power units located close to customers could account for much of the new capacity."

~ Michael L. Marvin (BCSE)

"The U.S. electric utility industry has been undergoing reform for more than three decades. Its traditional mantra was 'Bigger is better.' We can now see that sometimes 'Smaller is smarter.' We'll probably continue to build some conventional power plants in the 500 to 1,000 megawatt range; but newer technologies are becoming competitive. Small wind turbines, combined-cycle natural gas turbines, photovoltaic arrays, and fuel cells that are a fraction the size of traditional facilities are increasingly appropriate for utilities, small companies, and single residences."

Opportunities for U.S. Business



~ John J. Easton, Jr. (EEI)

"By the year 2010 the world will consume one-third more energy than it did in 1992—and fossil fuels will still account for about 90 percent of the energy consumed worldwide. Global energy-related carbon dioxide emissions may reach 30 to 40 percent above 1990 levels. No region of the world is likely to stabilize emissions at 1990 levels by that year. Meanwhile, the two billion people in the world who don't have electricity today will drive international markets; and people who can't be reached by traditional power lines today will represent huge opportunities for U.S. firms."

~ Joseph Romm (Dept. of Energy)

"There are significant possibilities for making U.S. homes, buildings, and industry more energy efficient. Technologies that do that are available, their costs are coming down, and within three decades renewable sources of power could perhaps comprise one-third of all new power generation. Some renewable energy technologies are already competitive with fossil fuels. Since the exact technologies that will be most efficient cannot be accurately forecast today, the government should bet on all of them. When we get serious about responding to the threat of global warming, we will start investing heavily in energy efficiency, which is the most cost-effective resource available to us. The National Academy of Sciences concluded in 1991 that a 25 percent decrease in carbon dioxide emissions could be realized while $80 billion could be saved each year by improving

energy efficiency. However, unfortunately, we are seeing less R&D in the utility industry and related energy sectors. If, at the same time, Congress continues to cut R&D funds available to the government, fewer technologies will be developed, and in ten years, we will be left at a competitive disadvantage."

~ Scott Sklar (Solar Energy)

"We're all trying to figure out what the rules will be after energy deregulation. If the taxpayer must pick up the costs of deregulation, as by paying for environmental clean-ups or by financing additional energy subsidies to compensate for higher electricity costs, deregulation will probably not drive us to develop more cost-effective processes. But if deregulation works as it should, the U.S. economy will benefit from the expansion of private power."

Visions of the Future

~ Thomas R. Schneider (EPRI)

"I would like to present a vision of an economically and environmentally sustainable future linked to electrification. This involves looking at electricity as a modern tool for adapting industrial ecology to society as a whole. This concept goes back to Thomas Edison, who promoted both production and use of electricity by developing innovations on both sides of the meter. In the 1890s, the production of electricity to power a light bulb was very inefficient, and electric lighting cost more than candles or gas lamps. Today electric lighting is 200 to 300 times more efficient than lighting was before Edison. The history of electricity and energy use underscores the role of innovation: There is usually a steady increase in intensity of energy use in the early stages of development until a peak is reached, after which there is a decline, as new innovative technologies lead to increased efficiency. This presents us with a vision of entrepreneurial opportunity to leapfrog intermediate stages of development by developed countries transferring advanced technologies that meet the needs of developing countries seeking to modernize their economies."

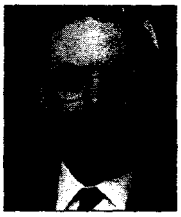
~ Robert Hirsch (E-Tec)

"In our zeal to reduce greenhouse gas emissions, we would do well to pragmatically address worldwide physical, technological, and economic realities. For example, coal will be used in increasing amounts around the world no matter what the United States decides to do. Let us recognize that much can be done to improve coal utilization. For example, a coal-burning plant in Kalundborg, Denmark operates at 90 percent thermal efficiency, because it produces all of the heating for the local town plus 40 percent of the heat for a nearby refinery and a pharmaceutical manufacturing complex. In addition, its flue gas desulfurization sludge meets two-thirds of the needs of a local wallboard plant, and its ash is used for roads and in a cement plant. The Kalundborg plant is thus well integrated into its community because the local regulatory structure encouraged it. However, if climate change comes to be perceived as a serious threat and we decide to phase out fossil fuels for electric power production, our primary existing alternative will be nuclear power. Renewables as we know them now can probably provide no more than ten to twenty percent of our U.S. needs. Eventually, fusion power will provide a clean and attractive energy source--but not for a long time."

Transportation

The U.S. government is seeking to stimulate major advances in transportation technologies, looking to heavier reliance on lightweight materials, mass transit, intermodal operations, greater fuel efficiency, and advanced propulsion systems. Effective partnerships and interaction between government and business will accelerate the pace of progress toward these objectives.

The Challenge of Transportation



~ THOMAS J. GROSS (DEPT. OF ENERGY)

"As the world economy grows, as communications become more instantaneous, and as the desire for mobility increases, there will be ever greater pressure on all existing modes of transportation. The Department of Energy sponsors programs that are aimed at encouraging greater energy efficiency and more reliance on renewable energy supplies in transportation; but frankly, there is little realistic prospect that we can do more than reduce the rate of growth in the overall consumption of energy by transportation over the next few years. But from an energy security vantage point—and from an environmental standpoint—our ultimate goal should be to bring about a revolution in our transportation systems. If we don't, we risk a head-on collision between the demand for mobility and our ability to provide a sustainable response. If we do, we will require major advances in transportation and energy technologies. That's a major focus of the Office of Transportation Technologies at the Department—and our specific goal is to develop technologies that will stimulate a radical improvement in fuel efficiency. If we can go several times the distance with the same amount of fuel, we'll need much less fuel and we'll sharply reduce greenhouse gas emissions. To satisfy the reduced needs, we're looking for fuels that will be inexpensive, domestic, and clean."

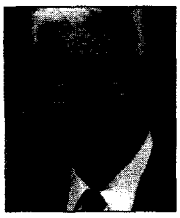
~ JAMES MACKENZIE (WRI)

"It has taken us some fifty years to build ourselves into a society where we have few travel alternatives to our present heavy reliance on the automobile. It will probably take us another fifty years to evolve a more sensible transportation system. Providing the options of walking, bicycling, and public transit on a large scale will be a difficult task. The problem is not so much that people are driving more or taking much longer trips. It is that there are more people and more drivers. Half of the new drivers over the past few decades arise from simple population growth and the other half from women entering the work force. There is no simple technological fix to congestion, but increasing population density lends itself to greater reliance on various forms of transit, such as the new personal rapid transit (PRT) system being tested by Raytheon Corporation. Small PRT vehicles run on their own electrified guideways and will take you non-stop to a station close to your final destination. Parking problems would be reduced and PRT technology would provide transportation for those now unable to drive: the elderly, the young, and the disabled. PRT looks now to be a cost-effective alternative to many trips now taken in cars."

~ RICHARD L. KLIMISCH (AUTOMOBILE MANUFACTURERS)

"It's not clear that a major expansion of mass transit would significantly reduce carbon dioxide emissions. Ridership would have to increase a great deal for that to happen—and that doesn't seem to be in the cards."

The Promise of an Intermodal Approach



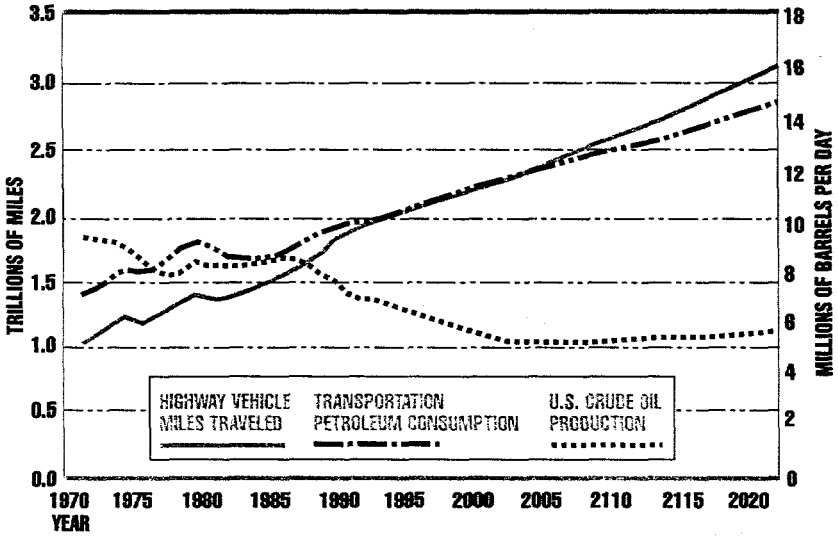
~ Gilbert E. Carmichael (Motive Power)

"Since Congress enacted the Intermodal Surface Transportation Efficiency Act in 1991, a revolution has been taking place in U.S. transportation. New technologies are radically changing intermodal operations, safety, and train control. Ships now carry freight containers to the dock, where rail cars pick up 280 of them and carry them over the long distance that 280 trucks used to cover. That's many times more fuel efficient. Similar things are happening on the passenger side, with high-speed inter-city and commuter rail systems. These high-speed rail systems are extremely fuel efficient: They can use solar or hydroelectric power, for example. But instead of taking advantage of their potential–our rail system is operating at only about 25 percent of its capacity–we're spending billions of dollars trying to get a one or two percent increase in capacity out of our saturated highway system. The volume carried by our railroad system could be doubled or trebled just by improving signals, eliminating at-grade crossings, and adding a second track."

~ Darius W. Gaskins, Jr. (High Street Associates)

"The only privately funded railroad construction of any substantial magnitude that has taken place anywhere in the world in the last two decades has been built to transport coal. Where there has been new railroad construction, it has been subsidized by government. I conclude that a substantial increase in the use of rail transportation will only occur if we dramatically change relative prices or directly subsidize rail transport."

Reducing Petroleum Consumption Through Advanced Transportation Technologies



New technologies supported by the Department of Energy will increase the efficiency of transportation systems. Lightweight materials, advanced propulsion systems, emission controls, thermal management, and advanced energy storage, for example–combined with greater reliance on such alternative fuels as natural gas, ethanol, methanol, and propane–will make it possible to move significantly more passengers and cargo with less consumption of petroleum. Other benefits will include a lower trade deficit, enhanced energy security, improved competitiveness, economic growth, additional jobs, savings to taxpayers, and improved human health.

SOURCE: DEPARTMENT OF ENERGY

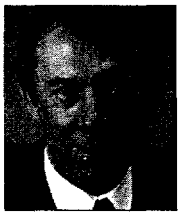
The Need to Cope with Vehicle Growth

The number of automobiles worldwide increased from 70 million in 1950 to more than 600 million in 1993—a trend that will continue for at least the next twenty years. However, increased reliance on more efficient lightweight vehicles running on cleaner fuels could reduce the growth of greenhouse gas emissions.

The Continuing Dominance of the Automobile

~ Thomas J. Gross (Dept. of Energy)

"Asia, Latin America, and Eastern Europe have less than one car per 100 people, compared with 72 per 100 people in the United States. The number of automobiles in those regions will increase rapidly in the coming years. In theory, government action could slow down this rate of growth; but in practice, getting agreement by those governed will be difficult indeed."



~ Richard L. Klimisch (Automobile Manufacturers)

"Private vehicles affect virtually every aspect of modern life. My anthropologist friends tell me our popular obsession with private vehicles is a cultural trait that will be incredibly difficult to change. We establish our identity by the cars we own—and we equate this with the freedom and autonomy that we prize. There is no realistic alternative to our reliance on automobiles, especially in the short run, either in the United States or anywhere else around the world. I recently visited China, which looks like the United States in the 1950s: They're building freeways everywhere."

~ Anthony Downs (Brookings)

"As their incomes rise, individuals throughout the developing world express their rising living standards by the automobiles they own, vigorously encouraged by the rich and influential automobile industry and the upper-middle-income officials who determine government policies. And since it will be impossible to build enough roads to accommodate all those cars, worldwide traffic congestion will get worse and worse, especially in rapidly developing countries. To illustrate, there was a tremendous explosion of vehicle ownership in Eastern Germany after the fall of Communism, far exceeding the capacity of parking facilities and roads."

~ James MacKenzie (WRI)

"Motor vehicles create problems relating to climate, air pollution, and security as well as problems relating to congestion. The introduction of electric-drive zero-emission vehicles powered by batteries or hydrogen fuel cells would pretty much solve the first set of problems, at least when the primary energy is supplied by renewable sources. Ending congestion is harder. The United States is a major part of the global transport problem: With only 4.5 percent of the world's population, we buy about a third of all new motor vehicles—about 16 million of 48 million manufactured each year."

Climate-Friendly Electric Automobiles

~ Robert C. Stempel[4] (Energy Conversion Devices)

"One hundred years ago, we replaced the horse with a motor and the automobile industry was born. We're now introducing electric vehicles (EVs) that will compete with gasoline-powered cars in the 21st century.

"Although EVs have been around for a long time, they received new impetus in September

4 Mr. Stempel was a conference keynote speaker.

1993, when President Clinton and industry executives announced a Partnership for a New Generation of Vehicles (PNGV) to pursue three goals: To improve our national competitiveness in manufacturing; to move commercially viable innovation from research into commercialization; and to develop vehicles that will achieve three times the fuel efficiency of 1994 sedans.

"The PNGV encourages joint R&D among competitors, which was previously barred under our antitrust laws. The automobile industry formed its first research consortium in 1988, after an involved legal process established that it did not violate antitrust laws. This was a breakthrough, recalling that under the Clean Air Act of 1970 the industry was forbidden from working together to reduce emissions.

"The PNGV started as a U.S. project, but it is now a worldwide effort. We don't expect to find another silver bullet like the catalytic converter, but we do expect the synergy from the many shared research projects now under way to yield fruitful results.

"I became especially interested in EVs in 1987, when one crossed Australia—almost 2,000 miles—at an average speed of 42 miles per hour, powered only by photovoltaics that captured the energy from the sun. This stimulated us to develop and introduce the first GM electric car in the fall of 1996.

"An electric vehicle is not just a car. It operates quietly and efficiently; it's easy to use; it requires little maintenance; it's reliable and durable. We get good results in city traffic and on hilly roads; and recharge capability is rapidly improving. EVs will be practical for driving across the United States in any season. Many battery-powered cars have been driven with lights and air conditioning on in the desert southwest in temperatures exceeding 100 degrees Fahrenheit—and also in cold winter weather. An EV recently set a new distance record of 373 miles on a single charge, powered by a nickel hydride battery—or about 85 watt-hours per mile. These batteries represent an excellent example of industry, government, and scientific cooperation.

"GM, Ford, and Chrysler are already marketing EVs, and Honda and Toyota are not far behind. American consumers will be able to drive them soon. There will be a premium for the first vehicles, but as is the case with all electronic devices, the prices will come down as volume increases."

The Partnership for a New Generation of Vehicles:* A Transportation Revolution

1) MATERIALS
- Lightweight
- Recyclable/reusable

2) ALTERNATIVE FUELS

3) EMISSIONS CONTROLS
- Sensors
- On-board diagnostics

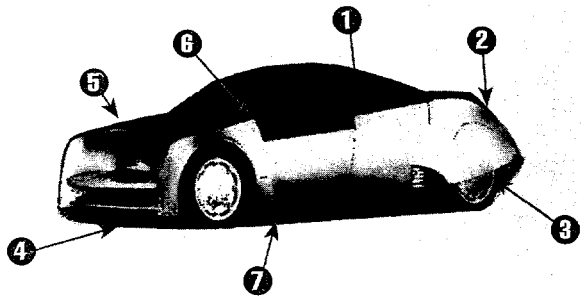
4) STORAGE SYSTEMS
- Batteries
- Ultracapacitors
- Flywheels

5) ENERGY EFFICIENT PROPULSION SYSTEMS
- Advanced heat engines
- Electric motors
- Fuel cells
- Hybrid systems

6) THERMAL MANAGEMENT
- Smart glazing
- Efficient heating and cooling

7) ELECTRONICS
- Programmable electronic control of energy distribution

SOURCE: DEPARTMENT OF ENERGY



* The Partnership for a New Generation of Vehicles (PNGV) is an undertaking of government, industry, and universities that seeks to triple automobile fuel efficiency by the year 2004. The objective is to create an automobile that will get 80 miles per gallon while otherwise comparable to current vehicles in terms of cost, performance, safety, and comfort.

Industrial Technologies

Recycling, improved product design (lengthening the life and enlarging the capacity of appliances, for example), robotization, nanotechnology, and countless other means of avoiding pollution and other forms of waste are rapidly transforming industrial processes around the world. Firms that weigh environmental factors in reaching strategic decisions involving new technologies will likely benefit in the long run.

The Environment and Management Decision-Making

~ KEVIN J. FAY (ICCP)

"Climate change is not the only factor businessmen must consider when they allocate their scarce investment resources. They must always weigh alternatives when they determine the priority of their investments, including: compliance with environmental and safety regulations; expansion of manufacturing capacity; improvement of product quality; reduction of operating costs by redesigning production processes; construction of additional facilities to manufacture new products; and acquisition of outside entities to meet long-term strategic goals. Each of these activities requires financial resources, and a corporation has only a finite amount of capital to invest at any point in time. The corporation must therefore ascertain which investments are most likely to achieve the objectives it deems most important."

~ JAMES L. WOLF (HONEYWELL)

"Honeywell does a lot of business with other companies by installing new energy management systems and other equipment in their facilities. We save them energy and money. The Energy Star voluntary programs sponsored by the U.S. Department of Energy and EPA[5] have encouraged that by elevating the importance of energy efficiency in the eyes of the companies. Government endorsement of the objective has been critically important in changing the market, both domestically and overseas."

~ DEBRA SABATINI HENNELLY (LUCENT)

"We need to embed environmental considerations in the mainstream of business decision-making. Regulations alone do not sufficiently inspire optimal business responses to environmental challenges. Until our senior executives consider specific issues as *business* propositions, they are not likely to approve and effectively implement the sustainable policies and programs needed to curtail greenhouse gas emissions. But when company decisions and long-term commitments affecting the environment are taken with sufficient lead time, they may, in fact, be financially advantageous to the companies. In such circumstances, effective methodologies and quantitative metrics will be devised, because what gets measured gets managed. EPA's Project XL [an experimental program in which EPA works with companies and communities to find more effective approaches to environmental protection, as compared with those taken merely to comply with existing regulations] and ISO 14001 [a quality-based international environmental management systems standard developed to encourage commitments to compliance, prevention of pollution, and continuous improvement] certification efforts provide excellent opportunities for making voluntary, innovative, and sustainable improvements. Companies need to be responsibly proactive, because if we wait for regulators to tell us what to worry about, we may not end up with the best possible environmental *and* business impacts."

5 See Gardiner quote, p. 28.

The Role of Technology

~ JEFFREY HUNKER (DEPT. OF COMMERCE)

"Unfortunately, it may be rational for corporations to underinvest systematically in long-term technologies, because no single company is likely to gain an adequate return from investment in basic research. That's why private-sector R&D has been significantly cut in recent years, even while some of our leading competitors in other countries have been raising their R&D investment. That's why the Clinton Administration wants to work with industry to develop the new technologies that we see as critical to our economic growth and our strategy for responding to climate change."

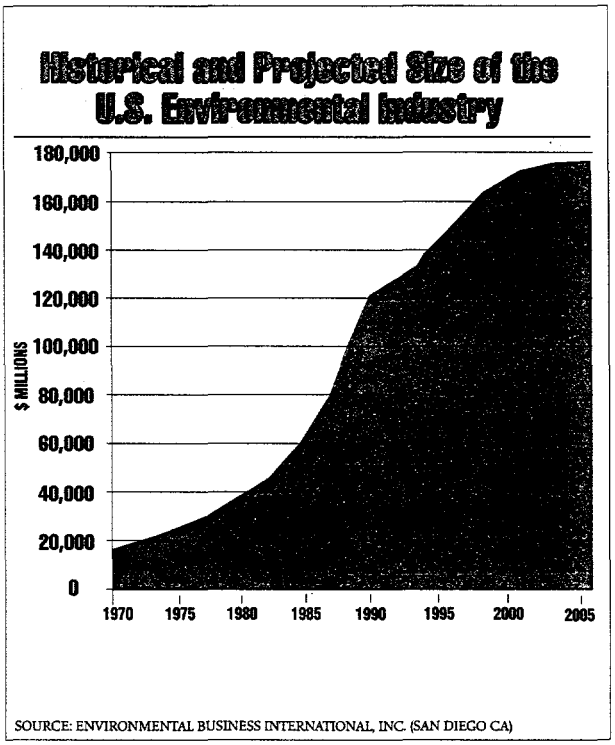
~ JERRY B. MARTIN (DOW)

"Our waste reduction program at Dow has helped us identify cost-effective projects that reduce waste, energy consumption, and emissions. Three elements of this program are critical: public dialogue, performance measurement, and employee recognition. First, we have established an environmental advisory council of outside experts to help us formulate viable environmental policies and goals, which include the specific objective of reducing our energy consumption by 20 percent by the year 2005. Second, we have developed a global emissions inventory based on precise internal and external measurements as a basis for gauging our environmental performance. And third, we recognize the contributions of individual employees by giving them 'environmental care awards' in public ceremonies. A good example of our achievement has been our steady move toward cogeneration [the simultaneous production of both electrical or mechanical power and thermal energy from a single energy source]: Over 90 percent of Dow's production around the world now relies on cogeneration--and the energy we thus save each year would meet the annual needs of one million U.S. households."

The U.S. Environmental Industry

The environmental industry has its roots in water delivery (going back to the aqueducts of Rome), sanitation engineering (sewage infrastructure), and waste management (early refuse collection). With the adoption of environmental legislation, regulations, and enforcement in the early 1970s, new forms of business emerged, including air pollution control equipment, environmental consulting and engineering services, sophisticated environmental instrument and testing services, hazardous waste management, and remediation (or cleanup) services. The U.S. environmental industry, thus defined, is in the mid-1990s a growing industry that accounted for almost three percent of the U.S. gross national product and employed more than 1.2 million people in 1995.

SOURCE: ENVIRONMENTAL BUSINESS INTERNATIONAL, INC. (SAN DIEGO CA)

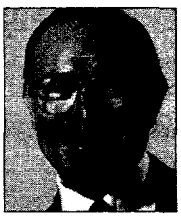


SOURCE: ENVIRONMENTAL BUSINESS INTERNATIONAL, INC. (SAN DIEGO CA)

Agriculture and Forestry

Soil erosion in North America, soil acidification in Europe, deforestation and desertification in Asia, Africa, and Latin America, and widespread waste and pollution of water supplies must be reversed if the needs of an expanding world population for food, fiber, and forest products are to be met in the climate-changed world of the 21st century. Further progress toward an open international trading system will be essential so that agricultural production can adjust effectively to changing conditions. More extensive agricultural research can also help.

Agricultural Technology and Research



~ Chester T. Dickerson, Jr. (Monsanto)

"The world's population will double over the next fifty years from about five billion to about ten billion, and people everywhere will want to improve their diets. That means we'll have to triple the world's food supply. To do that, we'll need to make better use of the world's most productive land; and we'll also need to make less productive land more productive. Three technologies can help: biotechnology, precision farming, and conservation tillage. First, eleven crops that have been bioengineered are already being planted in some three to five million acres in the United States. Monsanto has introduced, for example, insect-resistant cotton—and remember that cotton growers account for about half of the insecticides used in this country. We have a similar product to combat the Colorado potato beetle. Such products will sharply reduce consumption of chemical insecticides. Precision farming enables us to put yield monitors on harvesting equipment. This technology will also allow us to vary the seed we put in the ground and the fertilizer and the pesticides that are applied. And finally, with conservation tillage, we only disturb the soil in the very narrow planting band. The biomass from the last crop remains on the surface of the soil, greatly reducing the potential for erosion. When we harvest the crop, more biomass stays in and on the soil, which increases the storage of carbon in soils. All this amounts to a revolution in agriculture: We now use materials that are low in toxicity and persistence, while allowing more accumulation of organic matter or biomass. Companies are finding it profitable to introduce these environmentally friendly concepts."

~ Pierre Crosson (RFF)

"Agricultural producers will probably face more serious problems over the next five decades than those associated with climate change. Population growth will drive a great increase in demand for food, and increasing food production to the extent required at environmentally and economically acceptable costs will be a great challenge. Meanwhile, more research regarding the agricultural implications of climate change is certainly warranted. We should breed crops with increased resistance to drought, pests, insects, and weeds, for example. Unfortunately, investment in agricultural research is diminishing around the world precisely at a time when it should be increased. Furthermore, most of that research today is oriented toward increasing productivity; whereas the problems more likely to arise in the future will be environmental, such as those associated with increased sediment in ground water and water pollution resulting from pesticides and nitrogen fertilizers."

A Vital Role for International Trade

~ Robbin S. Johnson (Cargill)

"The effects of climate change on agriculture and forestry are more likely to show up in regional variability of production than in fundamental erosion in overall productivity trends. An open international trading system can enable regions adversely affected by climate irregularities to import commodities they need. Trade can provide this critical and flexible balancing mechanism by tapping into natural resource endowments and efficiency on a global basis. The policy implications are that we should create better infrastructure in poor countries, which means developing markets, marketing institutions, and trading capabilities and integrating isolated pockets of poor people and poor countries more fully into the global trading system. This should especially include the development of transportation and storage infrastructure. Here there are appropriate roles for public funding (such as roads, bridges, ports, and basic sanitation) and private capital (including warehouses, elevators, mills, and transfer facilities)."

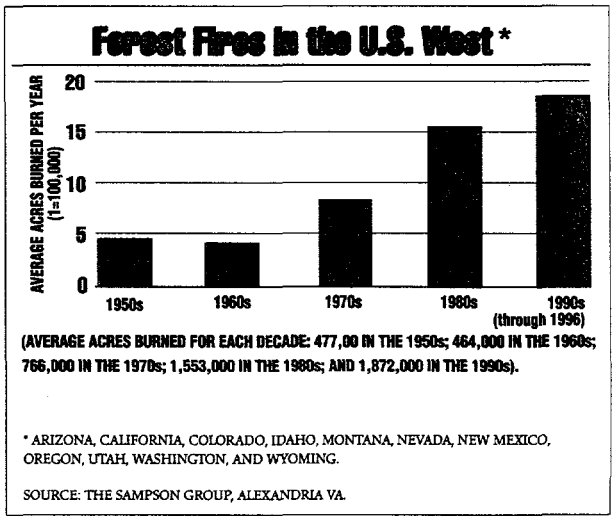
~ John Reilly (Dept. of Agriculture)

"We can't predict which regions will lack overall food security in the future. Some areas will suffer more than others from climate change, so the issue is how they will adjust. The vulnerability of individuals will depend on their socioeconomic status: The affluent will not starve, wherever they are. It's the poor people—even those who live in agriculturally productive areas—that may go hungry when agricultural products fetch good prices in world markets. To address the hunger and malnutrition that could result from climate change, we need to look at the overall economic system. Trade alone won't bring hungry people food because even when a country trades, its internal distribution system may not put imported food into the hands of the needy."

Forests and Climate Change

~ R. Neil Sampson (American Forests)

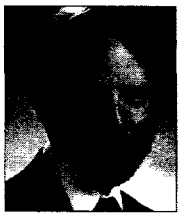
"U.S. forests contain about sixty billion tons of carbon. A little over half of that is in the soil, and the remainder is in the trees and other vegetation. We could add some 300 to 600 million tons of carbon a year by expanding forests into marginal crop and pasture lands and by improving forest management. We could, in fact, grow forest crops for energy production. However, wildfires in our western states are killing trees that survived dozens of wildfires in the past. We may lose some 15 to 20 million acres of forest to lethal wildfires in those states in the next decade. We'll spend $4 to $5 billion fighting those fires in the coming years. In the 1990s, wildfires in the West are emitting an average of 50-60 million tons of carbon dioxide each year, up significantly from earlier decades. A warmer, drier climate will increase the number and extent of wildfires, and the additional carbon dioxide emissions will significantly exacerbate the greenhouse effect. If forests are going to burn, we should decide whether we'll have clean, controlled fires that produce usable energy or dirty, uncontrolled fires that cause great damage. It would make a lot more economic and environmental sense to dispose of large quantities of waste material in forests by burning it in specially constructed power plants, rather than by creating great environmental damage from burning it in open air."



Developing Countries and Economies in Transition

Greenhouse gas emissions in developing countries and economies in transition can be curtailed without jeopardizing their continuing economic growth. Modernization of their utilities, transportation systems, industry, and agriculture will present substantial opportunities for expanding international trade.

Climate Change and Developing Countries



~ MICHAEL A. TOMAN (RFF)

"Climate change is not the most immediate issue confronting the developing countries, although they may ultimately be more vulnerable to its adverse effects than the wealthier countries. Many problems posed for developing countries by climate change reflect existing challenges of development, such as needs for better health care, infrastructure, water supply, and sanitation. As for policy responses, among the most urgent needs are to get energy and other prices right, stabilize the macro economy, develop an outward-oriented trade policy, improve natural resource management, and increase needed investments in public infrastructure. Such measures will help enhance productivity, reduce waste, and replace outmoded energy and industrial plants; and they are useful regardless of concerns about climate change."

~ MASON WILLRICH (ENERGYWORKS)

"Each developing country has its own resource base, environmental constraints, and government policies, but there are common threads. Electricity demand outstrips supply in most of them, often because their electricity prices are below cost. Many depend on bankrupt state-owned utilities valued by political leaders because of the jobs they offer. Being capital constrained, they avoid investments in new technologies that could reduce emissions. In short, some of these countries can leapfrog ahead by installing gas turbines or other small power systems and modern equipment using renewable energy sources."

~ ROBBIN S. JOHNSON (CARGILL)

"Improved economic performance in many developing countries requires getting prices right. Water, for example, is almost universally underpriced, which does not encourage its efficient use. India and China, with a combined population exceeding two billion people, have a serious imbalance in their pricing strategies for nitrogen as opposed to phosphorous and potassium, and that means their agricultural practices have adverse effects on productivity and on the environment. Simple policy corrections can therefore help to increase food production while limiting environmental harm."

~ DAVID HALES (USAID)

"The climate change strategy of the Agency for International Development is tied to its overall goal of promoting sustainable development. We try to anticipate and help mitigate the threat of climate change through our energy program, for example, which promotes energy efficiency and fosters the use of renewable sources of energy. Our forestry program similarly helps to limit deforestation and improve forest management; and our health program responds to emerging diseases associated with climate change. We support climate change action planning in Mexico, Indonesia, and the Philippines. And finally, we help developing countries identify technologies that will effectively decrease emissions."

Private Sector Opportunities

~ Nancy Birdsall (IDB)

"Developing countries cannot rely solely in the medium term future on official development assistance to ensure a desirable level of technology transfer, because traditional mechanisms of support are declining. Private-sector trade and investment can help fill the need. Major shifts in technology are not required—incremental improvements will suffice. They will come faster when rational prices provide better incentives for decision-makers to adopt economically optimal policies. We would get to greater reliance on solar energy, for example, some five to ten years sooner if we eliminated or at least reduced the direct and indirect subsidies that distort markets. Contrary to the assumptions of some experts, economic growth itself can bring about environmentally benign economic practices. Meanwhile, the 'joint implementation' program[6] is a good example of economically prudent technological cooperation between private companies in developed and developing countries."

~ John J. Easton, Jr. (EEI)

"Some two billion people in the world do not use electricity today, although they could benefit substantially from more efficient and less polluting sources of energy than the fossil fuels they commonly rely on. These countries will need to import technologies from the developed countries as they modernize their economies. Public/private sector cooperative partnerships have proved to be effective instruments for fostering technological cooperation between developed and developing countries. Partnerships between the Edison Electric Institute and utilities in developing countries, for example, are bringing appropriate technologies to the developing world in a way that ensures sustainable development."

~ Kathryn Jackson (TVA)

"TVA is well known internationally as an integrated resource system that has provided multiple benefits for its region for 60 years. It is thus a useful model for some developing countries. We have found, on the basis of long-term partnerships with public utilities in several developing countries, that a spectrum of solutions, from high-tech to low-tech, can respond to any technical assistance challenge. In advance of expert assessment, one can never be certain which specific technologies will best fit any particular situation."

Economies in Transition

~ Anthony S. Earl (Center for Clean Air)

"A low-technology emphasis sometimes makes sense. For example, the Center for Clean Air Policy has supported a low-cost project in the Czech Republic that simply brought in new boilers and a new fuel. The benefits are significant: Toxics, sulfur dioxide, and nitrous oxide were drastically curbed, and there was an enormous public health benefit. Literally thousands of simple projects like that could be mounted in Central and Eastern Europe—and throughout the developing world."

Participants in the conference panel on developing countries were (left to right): David Hales, Kathryn Jackson, John J. Easton, Jr., Nancy Birdsall, and Michael A. Toman.

6 At the first conference of the parties to the UN Framework Convention on Climate Change (FCCC) in 1995, governments agreed that two or more countries may cooperate in "jointly implementing" (JI) pilot projects that reduce, avoid, or sequester greenhouse gas emissions.

The Financial Community

Substantial financial resources will be required to develop and market technologies that will improve energy efficiency and facilitate increasing reliance on renewable sources of energy. Most of the capital needed will be supplied by corporations, governments, and multilateral financial institutions. However, commercial banks and the insurance industry can support these developments by financing and otherwise encouraging investment in R&D, new capital stock, urban development that is environmentally sound, and new energy-efficient building codes.

Private Sector Financial Institutions

~ David M. Nemtzow
(The Alliance to Save Energy)

"The financial community has a clear interest in climate change. Insurance companies write checks every day to cover the costs of natural disasters, and the checks are going up and up. Half of the damages paid by insurance companies because of climatic events over the past eighty years have been paid since 1992[7]. Banks and insurance companies can take various steps in this area: (1) They can sponsor research, building on scientific studies that have already been done, as reflected in the IPCC report. Our financial institutions are largely unfamiliar with that work, so they should do their own homework, as by funding special research to identify the implications of climate change for their own industry. (2) That research may well show that funding energy efficiency can be profitable if the high transaction costs associated with their own unfamiliarity with these matters can be reduced. (3) The industry could also support demonstration projects. Mobil, for example, found that by spending $270,000 for a major efficiency upgrade, it saves $52,600 a year in energy costs. (4) The insurance industry should support energy-efficiency building codes to safeguard the properties it underwrites, as the property insurance industry did nearly a century ago."

~ Rich Morrison
(Bank of America)

"Many entrepreneurs believe the technologies they possess would be profitable if only they could finance their initial production and introduction into the market. They often propose imaginative arrangements through which commercial banks could help them get started. The banks are inherently skeptical about such proposals: What matters to them are, first, cash flow, and second, the balance sheet. Banks also want to be sure that a secondary source of repayment will be there if the primary source—that is, the cash flow—does not materialize as projected. A loan proposal accompanied by cash flow projections that amply cover the need will be favorably reviewed; and a would-be borrower who lacks a strong cash position is usually rejected. The loan officer makes his best judgment regarding in-between cases, including those related to new technologies. Banks don't pretend to project the commercial viability of new technologies in the marketplace. In theory, one expects venture capitalists to support innovative technologies, but they seem to find the present regulatory regime inimical to environmental technologies. They also remember the 1970s, when some companies that received government support to experiment with solar energy totally collapsed when the government suddenly withdrew its support."

7 See chart on p. i.

~ Mason Willrich (EnergyWorks)

"I think the venture capital industry will soon start moving into energy efficiency and renewables. Look at what happened in telecommunications: Very little venture capital was available in that industry until Judge Green's decision broke things open. And when venture capital comes in, the rate of change in the industry will accelerate sharply."

~ Jonathan Lash (WRI)

"The technical opportunities for improving energy efficiency are plentiful, significant, practical, and available--but the financial support required for the private sector to take advantage of these opportunities is limited and ineffective. Current markets do not provide incentives for venture capital to invest in the technologies that are available, and public policy has not intervened to strengthen those incentives."

Government and Intergovernmental Institutions

~ Julie Belaga (Ex-Im Bank)

"Over the last three years, the Export-Import Bank has sharply raised the priority it assigns to environmental projects. We now have a director on our board explicitly charged with concern for environmental issues, including climate change. We have adopted procedures and guidelines to ensure special attention to loan applications. Projects involving $10 million or more or proposals for which our support might be critical are assessed for environmental impact against those guidelines. Furthermore, we proactively seek to support American companies looking to export environmental technologies, such as those concerned with clean air, water pollution, wastewater treatment, toxic waste and cleanup, renewable energy, forestry, and ecological management."

~ Robert Watson (World Bank)

"The World Bank has lent over $10 billion for projects specifically designed to protect the environment, e.g., conservation of biodiversity and reduction of urban pollution. Beyond that, most of the Bank's loans require an environment assessment that identifies the environmental implications and costs that might result from the project. The World Bank is also undertaking a study to assess the economic and environmental implications that a shadow price for carbon would have had on most of its energy and transportation loans over the last five years. In the long run, the World Bank believes that social and global environmental issues need to be mainstreamed into traditional sector lending, i.e., issues such as climate change and biodiversity need to be mainstreamed into our lending for agriculture, forestry, etc."

~ Nancy Birdsall (IDB)

"Two aspects of the $2 billion GEF[8] make it a particularly interesting financing mechanism. First, rich countries have greater demand for environmental services than poor countries: The greater a country's income, the more it cares about clean air, greenhouse gas emissions, and biodiversity. Second, the cost of greenhouse gas emissions is not sufficiently charged to the emitters--and not even to the country that produces the emissions. When you put these two points together, you see that GEF 'grants' should be considered as *purchases* of better environmental services that consumers in developed countries make in their own self-interest."

The Insurance Industry

~ Franklin W. Nutter (Reinsurance Association)

"The property casualty insurance companies have been severely affected by significant losses from recent hurricanes and tornadoes. The U.S. industry is struggling with the whole question of its role in climate change. Generally speaking, the industry also struggles with insuring high-risk structures in areas susceptible to weather extremes. Its impulse is to shorten its margin of risk by raising rates and deductibles for high-risk structures--and that changes incentives and disincentives throughout the economy. The industry is also evaluating building codes and their enforcement across the country, and the resulting evaluations will be factored directly into insurance premiums."

8 The Global Environmental Facility, implemented by the World Bank, the UN Development Program, and the UN Environmental program, finances projects in developing countries aimed at protecting the global environment, including projects relating to energy efficiency and renewable energy.

The Role of Government

Many economists believe a primary role for government in coping with the threat of climate change is "to get the prices right" by internalizing "externalities[9]" through the use of taxes and other measures, on the ground that "correct" prices will strengthen market incentives for accomplishing the desired public good. A second government role is to support R&D aimed at developing new materials, processes, and products that will foster rising living standards while moderating reliance on fuels and processes that cause greenhouse gas emissions. Innovative partnerships between the federal government and the private sector have proved to be particularly effective tools for improving such R&D and spurring the development and use of new energy-saving technologies[10].

The Need for Clear Signals from the Government

~ JERRY B. MARTIN (DOW)

"The threat of command and control by government may be more effective than actual command and control. Although most environmental improvements over the past 25 years have resulted from government mandates and regulatory requirements, we have recently seen better approaches. After regulations are promulgated, companies don't have time to consider alternative solutions; they must simply comply with the new requirements, whatever the cost. Some new voluntary programs have been quite successful. If we look at our emissions and waste as *opportunities,* we may see the business advantages of cost-effectively reducing waste and emissions. We can in that way spend fewer dollars and still stay ahead of the regulatory process. Nevertheless, in today's world, we can't totally do away with regulatory minimums: The threat has to be there."

~ DARIUS W. GASKINS, JR. (HIGH STREET ASSOCIATES)

"If we're going to curtail carbon dioxide emissions, our actions must be international in scope and cooperative among many nations. But today the average American citizen knows little about this issue. Token unilateral actions will not have any significant effect on world-wide emissions, much less the concentration of carbon dioxide in the atmosphere."

~ KEVIN J. FAY (ICCP)

"If the government wants the private sector to increase investment in R&D aimed at the threat of climate change, it should explain its rationale forcefully and clearly, because businessmen need a realistic and stable framework within which they can plan their own operations. Policymakers should keep in mind that the limited capital available for investment will be put to best use when entrepreneurs understand and support clearly enunciated government objectives. Unfortunately, government perspectives tend to be short-term, whereas in order to meet the threat of climate change, we need to encourage the private sector to invest in R&D for a longer term push."

9 Economists use the term "externalities" to refer to the "failure" of markets when the prices of certain goods and services do not reflect all the benefits and costs associated with their production and consumption.
10 See "Federal Government Expenditures on Environmental R&D (1994)," outside back cover.

Research and Development

~ Lester B. Lave (Carnegie Mellon)

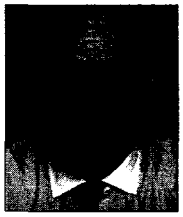
"The government can influence the economy, but we often overstate what it can do. When it intervenes in the market, the government should make every effort to adopt prudent policies, because heading off in the wrong direction can squander a lot of resources. Good intentions don't guarantee success. The government can do three things to stimulate the development and adoption of new technologies: (1) It can sponsor basic research, which is especially important when it's trying to encourage technological innovation. It's too bad that government R&D hasn't expanded to meet these challenges. (2) Recognizing that consumers do respond to economic incentives, it can affect prices through taxes and subsidies, especially investment tax credits for private-sector R&D. Unfortunately, the political system often presses for the wrong incentives. And (3) It should do its best to ensure easy public access to current knowledge."

~ John B. Carberry (DuPont)

"Two national treasures can be invaluable assets to the government in coping with the threat of climate change: The U.S. university system and the federal laboratory system. Fortunately, federal funding for university research through the National Science Foundation and the National Institutes of Health has not suffered from the same severe budget reductions that have recently struck other domestic programs. We need to be careful to maintain that alignment of budgeting and priorities."

~ Thomas J. Gross (Dept. of Energy)

"The government should not try to pick and choose among technologies or technological policies. It's not a question of either R&D or tax policy; we should consider how different policies can be effectively linked. If we're going to move new energy technologies into the market, we will likely need to provide a combination of incentives and disincentives."



~ Paul R. Portney (RFF)

"Perhaps the most important role of government, in the case of climate change, is to foster R&D, especially where the private sector cannot capture all the benefits from R&D because of 'free riding.' The government should certainly spend more on research relating to energy efficiency, and it should increase its support for the social science component of research related to climate change."

Specific Government Actions

~ Anthony Downs (Brookings)

"We should raise the tax on gasoline. Virtually all countries that do not produce oil impose high taxes on gasoline. But I don't think we'll do that, because few U.S. politicians will advocate higher fuel taxes. Instead, they want to reduce the tax on gasoline."

~ Michael L. Marvin (BCSE)

"The federal government remains this nation's largest purchaser of electricity. Direct and indirect pressure it exerts on local utilities to purchase cleaner electric generation sources sends a powerful, necessary, and appropriate market signal."

~ Scott Sklar (Solar Energy)

"The *threat* of government regulation can be very effective. When industry perceives that the international community may impose mandatory rules on national performance, it is more likely to adopt clean technologies on its own. The private sector is thereby encouraged to invest its resources accordingly, not only for new capital stock, but also for innovation. This avoids the command-and-control danger that raises hackles. That is, the specter of a government club can create incentives for companies to figure out how they can best integrate energy efficiency into their investment portfolios before they are forced to do so."

The Role of Business

Business investment in environmentally friendly technologies will probably be the most efficient means of bringing about a cleaner and more efficient global economy. Climate change will be accompanied by profit opportunities for enterprises as well as costs.

Watch Both the Waves and the Tide

~ LESTER B. LAVE (CARNEGIE MELLON)

"Businessmen should distinguish between the waves and the tide. If you're piloting a ship, you must keep your eye on the waves: You're not likely to sink because of the tide. In making investments, businessmen need to figure out what is going on in the current marketplace—what consumers desire and the available technologies. They also need to consider underlying forces. Markets change very quickly. To confront the future, businessmen should lean down their organizations so their companies are flexible enough to react quickly and survive the waves. They must also figure out which way the tide is running. If energy efficiency is increasing around the world—as energy becomes more expensive—then the tide will lead those who are alert to new opportunities. Small companies often spot these changes more quickly than large companies, and they can more quickly assimilate new technologies. Large companies may accordingly find it useful to turn to small companies for particular services or modules."

Energy-Saving Investment Is Cost-Saving Investment

~ JAMES L. WOLF (HONEYWELL)

"With surfing, you start paddling before the wave reaches you. If you paddle too early, you'll be tired when the wave hits, and you may get wiped out. If you paddle too late, you'll miss the wave. It's a question of timing. Industry faces the same problem when it develops new products. Honeywell finds this is a good time to sell process and energy management controls to such industries as chemicals, pulp and paper, and others that are trying to improve product quality and output while also cutting waste and energy costs. Process control equipment brings a variety of benefits. And we are much more successful when we sell process controls and energy-saving systems to a senior financial official than we are when we try to sell them to an engineer or energy manager, who, having no budget, has little leverage. When a financial manager sees the multiple benefits and cost savings that will result from improved efficiency, he usually supports it, whether it's a hospital, an industrial plant, or any other large project."

~ JERRY B. MARTIN (DOW)

"In 1994 Dow replaced a number of old plants with new facilities, and in each case we scored a 20 percent energy improvement. Over a 14-year period, we improved our energy efficiency by 32 percent. But when we compare the new facilities we installed on our own initiative with those that responded to government mandate, we invariably find a positive return at least 50 percent greater on the voluntary projects."

~ THOMAS R. SCHNEIDER (EPRI)

"It's innovation that drives energy efficiency, either through the adoption of technologies or new inventions. Innovation leads to greater productivity, meaning the production of the same output with less input of energy, materials, labor, or capital. Innovation produces endogenous efficiency improvements and de-materializes and de-carbonizes the economy. Some experts believe that more than half of the growth of the

U.S. economy has been due to technological innovation, and that means human ingenuity is the ultimate renewable resource. That's why we should encourage R&D and innovation today on solutions to issues like climate change."

Opportunities Abroad

~ KEVIN FAY (ICCP)

"In the long run, it is the private sector that must provide the investment required to develop and market the technologies needed to meet the threat of climate change–and there are many opportunities for that. A few years ago, developing countries looked mainly to the World Bank to finance their infrastructural development, especially for energy and transportation, the two economic sectors most closely related to climate change. In the mid-1990s, they look more to the private sector to support their development in those areas. In fact, private-sector investment in energy and transportation in developing countries may double by the year 2000."

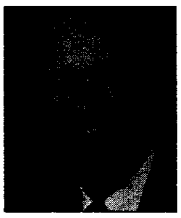
~ NANCY BIRDSALL (IDB)

"The best single vehicle for transferring technologies to developing countries is new private-sector investment. It's expensive to retrofit old technologies and plants, but new investment almost automatically embodies clean technology. And new investments obviously go into developing countries more quickly when those countries are growing. That's why Chile has some of the cleanest technology in Latin America."

The Value of a Cooperative Approach

~ DEBRA SABATINI HENNELLY (LUCENT)

"We may now be at the point where some industries no longer need to be regulated under the 'command-and-control' approach to improve their environmental performance. For 25 years, the enforcement 'stick' successfully encouraged compliance, but this paternalistic approach may no longer be necessary, at least for some proactive companies. The collective learning we have gained from government-industry-community partnerships may move us along alternate paths to go beyond compliance. That's why Project XL and ISO 14001[11] are valuable tools for achieving sustainable environmental improvements. To use Project XL language, these voluntary initiatives help us find 'cleaner, cheaper, smarter' approaches to pollution prevention and environmental performance improvements than the traditional regulatory scheme would inspire."



~ JOHN B. CARBERRY (DUPONT)

"In the United States–and throughout the world–the R&D budgets of large companies are under pressure. Many of the new environmental technologies offer opportunities for cooperation, if we can get our act together. The automobile companies are working together on batteries for electric cars, for example; and the chemical industry is looking at recycling hydrochloric acid into chlorine, through *in situ* remediation technologies, such as facilitated dechlorination, electro-osmosis, optimization of biological wastewater treatment, and management of biosolids resulting from wastewater biotreatment, for example. We'll see more of that in the future."

~ JOHN J. EASTON, JR. (EEI)

"Members of the Edison Electric Institute are pursuing a variety of public/private-sector partnership arrangements aimed at reducing greenhouse gas emissions. The government has helped to facilitate those partnerships by providing seed financing for the private sector. For example, it gave a small grant to set up a World Wide Web site for joint implementation, which we call JI[12] On-Line. We're also negotiating with the Department of Energy regarding prefeasibility funding for some proposed projects around the world designed to increase energy efficiency and the use of renewable energy."

11 See Hennelly comments on p. 14.
12 See n. 6, p. 19.

A View from Capitol Hill

Comments by Wayne T. Gilchrest

Martin Luther once said: "We are all weak, ignorant creatures trying to probe and understand the incomprehensible majesty of the unfathomable light and wonder of God." To me this captures the essence of the issues of climate change and sustainable development. Our planet's moderate climate and abundant natural resources are treasures which have allowed our species to flourish in what would otherwise be a cold and hostile universe. Too often, however, with our lack of understanding or lack of political will in the face of uncertainty, we thwart our own best interests by choosing short-term economic gain over long-term sustainability.

Once upon a time in our nation's history the was a great frontier for which brave men and women gave up the security of their lives in hopes of a better future for their children. On the frontier, they worked with their neighbors when they needed to build a barn to protect their livestock, knowing that winter was coming with its winds and cold and snow. So they worked together with the understanding that the individuals benefited when the community worked together to stave off a hostile environment.

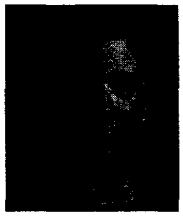
That frontier no longer exists. Our world is becoming crowded; experts say that one hundred years from now, there will be ten billion people on the planet. It is hard to maintain that feeling of community when some of your neighbors are so far removed.

Our new frontier is an intellectual frontier. How can humans continue to survive on Planet Earth? How can we stretch and reallocate our resources to feed and clothe 5 billion new inhabitants? How do we get together to develop solutions to problems that haven't even cropped up yet? How do we persuade elected officials to set aside partisan agendas to agree as a community on a common approach to the problems that confront us all today?

The U.S. environmental movement became a vital political force during the Nixon Administration, and many Republican Members of Congress deal with environmental issues pragmatically. Most people, left, right, and center, want more objective information about climate change. They want public debate on how and to what extent we should address the problems associated with a changing climate. I am confident that the number of people in public life who will support action to mitigate the threat of climate change will grow as that information and debate proceed.

In the end, our reverence for God's gifts will inspire us to overcome our weakness and ignorance to care for that which was so graciously bestowed. I am optimistic that in the next two years we will see a more practical, rational approach to environmental issues in general, and the climate in particular.

U.S. Firms Lead in Environmental Technologies *Comments by Joan E. Spero*



All of us at the Department of State are working to develop a new foreign policy for the 21st century. Unquestionably, issues of national security, war, and peace will remain central. But we are also bringing to the forefront other concerns such as economics and environmental issues that are vital to our national interest. We are committed to pursue our security, economic, and environmental interests in tandem, in the belief that they are compatible and reinforcing goals.

[Former] Secretary of State Warren Christopher[13] made clear the importance he attached to addressing environmental and other global issues. In his speech at Stanford University in April 1996, he explained how global environmental issues affect our national interests and charted a strategy for employing multilateral and bilateral initiatives as well as greater partnerships with business and non-government organizations to deal with global environmental challenges.

Our objective here is to lead in safeguarding the environment, on which prosperity and peace ultimately depend. We have also set our sights on capturing the burgeoning business opportunities overseas for U.S. environmental technologies and services.

One of our principal activities at the Department of State is to build a new economic architecture for the post-Cold War world. We are working at all levels–globally, regionally, and bilaterally–to strengthen international economic institutions, open markets, and promote sustainable development.

We believe trade liberalization and a high level of environmental protection are mutually supportive goals. That is why we played the leading role in the establishment of the Committee on Trade and Environment in the World Trade Organization. We have also emphasized the central importance of environmental issues in specialized regional bodies in Europe, Asia, and Latin America.

With the long tradition of environmentalism in the United States, American firms are well positioned to supply the technological needs of other countries as they move to implement their environmental priorities. The United States leads the world in most environmental technology fields. Indeed, the great majority of innovations in environmental technology goods and services have come from small and medium-sized enterprises in this country.

13 Warren Christopher was Secretary of State at the time Ambassador Spero made these comments.

The U.S. Climate Change Action Plan

The Climate Change Action Plan announced by President Clinton on April 21, 1993 was designed to respond to the threat of global warming, while strengthening the U.S. economy.

The U.S. Climate Change Action Plan:

- Includes measures to reduce *all* significant greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, and other gases);
- Embraces measures in all sectors of the economy that emit greenhouse gases, from energy production and use to forest fires;
- Fosters partnerships between government and business where focused government guidance and flexible approaches can produce cost-effective emission reductions;
- Encourages investments in technologies of the future, thus strengthening U.S. competitiveness in the global environmental technology marketplace;
- Provides support from federal resources, including significant levels of government funds;
- Creates new jobs in the sectors and industries that produce, market, and install technologies that save energy or reduce greenhouse gas emissions;
- Calls for the coordination and strengthening of multiple programs involving relationships between the federal government and electric and gas utilities, state and local governments, and industry;
- Is monitored to ensure progress toward meeting the Plan's objective of limiting greenhouse gas emissions; and
- Established a White House team to develop strategies for long-term emission reductions.

~ David Gardiner (EPA)

"The Energy Star labeling program, part of the Climate Change Action Plan, identifies products and services that save energy and money while protecting the environment. More than 500 manufacturers offer some 13,000 products now authorized to use the Energy Star label. It was first awarded to energy-efficient computer equipment in 1993. Since then, Energy Star labels have been extended to cover office equipment, heating and cooling equipment, appliances, lighting, and building technologies. The Energy Star program provides consumers with clear information about energy-efficient products and services.

"Climate Wise, another program of the Action Plan, targets the industrial sector, encouraging comprehensive, cost-effective industrial energy-efficiency and pollution prevention actions. There are currently more than one hundred partners in the Climate Wise program, accounting for more than six percent of U.S. industrial energy consumption."

~ Joseph Romm (Dept. of Energy)

"The Department of Energy sponsors several programs in support of the U.S. Climate Change Action Plan, including, for example, the Department's Motor Challenge initiative, which has encouraged more than 1,600 partners to promote the adoption of energy-efficient motors and practices for operating them. We estimate that by the year 2010 the Department's investments in energy technologies in the transportation, buildings, industrial, and utility sectors will have prevented one billion tons of carbon equivalent emissions from entering the atmosphere."

The U.S. Position in International Climate Negotiations *Comments by Timothy E. Wirth*[14]

The 1992 Framework Convention on Climate Change[15] has not achieved the results that its negotiators anticipated. Few nations in either the developed or developing world have fully met their commitments under the Convention. We have to do better.

The United States will be guided by the following principles as it considers various proposals regarding our continuing multilateral negotiations relating to the convention:

First, our negotiations should focus on outcomes that are real and achievable. Sound policies pursued in the near term will allow us to avoid truly draconian and economically disruptive policies in the future.

Second, the United States will continue to seek market-based solutions that are flexible and cost-effective. We will not accept proposals that are offered for competitive, not environmental, reasons. Serious proposals in the future must not be thinly veiled attempts to gain economic advantage. Since this is a global problem with global impacts, it requires fair solutions that will ensure prosperity–now and in the future–for all the world's people.

And third, we believe the agreement should lay the foundation for continuing progress by all nations in the future. We further believe that international cooperation in responding to this challenge remains critical and *all* nations–developed and developing–will have to make more ambitious contributions to the solution. While this is a long-term challenge, we must start making progress now and we must engage the public and private sectors over the medium term as well. Climate change is a serious problem that will require sustained long-term investment and the full creativity of the marketplace.

Based on these principles–encompassing environmental protection, realism and achievability, economic prosperity, flexibility, fairness, and comprehensiveness–the United States recommends that future negotiations should focus on an international agreement that sets a realistic, verifiable, and binding medium-term emissions target. We believe the medium-term target must be met through maximum flexibility in the selection of implementation measures, including the use of reliable joint implementation[16] and trading mechanisms.

President Clinton has urged all Americans and all nations to prepare their economies for the 21st century. Meeting this challenge requires that the genius of the private sector be brought to bear on the challenge of developing the technologies that are necessary to ensure our long-term environmental and economic prosperity.

14 Edited excerpts from a statement by Under Secretary Wirth at a conference of the Parties to the U.N. Framework Convention on Climate Change, July 17, 1996, Geneva.
15 See n. 2, p. i.
16 See n. 6, p. 19.

~ TIMOTHY E. WIRTH

"The issue of global climate change was first postulated more than one hundred years ago. It has been taken up through serious scientific investigations over the last twenty-five years. The workings of the global climate system are now broadly understood. This is a problem that must be addressed–and it involves opportunities for reducing emissions and enhancing efficiencies where American industry should be at the forefront. The government needs inputs and ideas from industry–and suggestions about how the United States can do a better job to capitalize on the market opportunities that are opening up all over the world."

~ WAYNE T. GILCHREST

"If people are going to understand the climate change issue, they need to be exposed to it in a very relentless way–not just once or twice. This is an issue that needs to be discussed often. You don't teach something very complicated in one session–you just begin the process!"

The U.S. government budgeted more than $4 billion to support environmental technology programs in 1994. Approximately one-half of that amount was earmarked for "pollution avoidance" R&D to promote energy efficiency and clean energy. Some $1.2 billion was aimed at financing technologies that monitor and assess the state of the environment. A relatively small level of funds has been devoted to commercialization and export promotion of environmental technologies.

The charts below indicate the allocation of funds for environmental R&D for the principal end uses among federal government agencies.