Committee on
GOVERNMENTAL AFFAIRS
The United States Senate
COMMITTEE MEMBERS
SUBCOMMITTEES
HEARINGS
KEY LEGISLATION
JURISDICTION
PRESS STATEMENTS
SPECIAL REPORTS
VIDEO OF SELECTED HEARINGS
SITES OF INTEREST

TESTIMONY

The Role of Energy Technology in
Stabilizing Greenhouse Gas Concentrations
Statement to the
Senate Committee on
Governmental Affairs

James Edmonds
Senior Staff Scientist
Pacific Northwest National Laboratory
Battelle Memorial Institute

July 18, 2001

Thank you Mr. Chairman and members of the Committee for the opportunity to testify here this morning on the potential contribution of energy technology to addressing the issue of global climate change. My presence here today is possible because the US Department of Energy, EPRI and numerous other organizations in both the public and private sectors have provided me and my team at the Pacific Northwest National Laboratory (PNNL) long-term research support. Without that support much of the knowledge base upon which I draw today would not exist. That having been said, I come here today to speak as a researcher and the views I express are mine alone. They do not necessarily reflect those of any organization.

My observations today draw upon the work that was conducted under the Global Energy Technology Strategy Program to Address Climate Change, an international, public/private sector collaboration[1] advised by an eminent Steering Group[2]. Analysis conducted at the Pacific Northwest National Laboratory as well as in collaborating institutions around the world during the first phase of research supports four general conclusions:

1. **It's concentrations of greenhouse gases that matter.** For CO_2, it is cumulative, emissions by all countries, over all time that determines the concentration—not emission by any individual country, no matter how great, or any individual year;

2. **Technology is the key to controlling the cost of stabilizing the concentration of greenhouse gases**;

3. **There's No "Silver Bullet."** That is, no single technology controls the cost of stabilizing CO_2 concentrations under all circumstances. Managing the cost of stabilizing the concentration of greenhouse gases, at any level, requires a portfolio of energy R&D investments across a wide spectrum of technology classes—from conservation to renewables to nuclear to fossil fuels, to hydrogen systems and fuel cells to biotechnology, to natural and engineered carbon capture and sequestration and advanced fossil fuel energy systems, and undertaken by both the public and private sectors.

4. **Energy Technology Development Is One Part of a Larger Comprehensive Strategy.** While technology is pivotal when it comes to controlling the cost of stabilizing the concentration of greenhouse gases, it is only one of four major elements that are needed in a comprehensive program to address climate change including:

    1. Reduction of scientific uncertainties,

    2. Adaptation to climate change, and

    3. A credible, global commitment that greenhouse gas concentrations will be limited, as well as

    4. Energy technology R&D.

1. It's Concentrations of Greenhouse Gases That

Matter. The United States is a party to the Framework Convention on Climate Change (FCCC). The FCCC has as its objective the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (Article 2) This is not the same as stabilizing emissions. Because emissions accumulate in the atmosphere, the concentration of carbon dioxide will continue to rise indefinitely even if emissions are held at current levels or even at some reduced level. Limiting the concentration of CO_2, the most important greenhouse gas, means that the global energy system must be fundamentally transformed by the end of the 21st century. Given the long life of energy infrastructure, preparations for that transformation must start today.

A popular myth is that the world is running out of fossil fuels and will therefore make a natural transition to an energy system based on renewables and conservation during this century, thus leading to a natural limit on cumulative carbon emissions. The reality is that while the most attractive grades of fossil fuel resources may be limited, fossil fuels as a class are abundant and hold the potential of remaining the core of the global energy system throughout the century ahead.

Growth in population and incomes can be expected to require a concurrent growth in the demand for energy services. It is this growth in demand for energy services coupled with the abundance and usefulness of fossil fuels that is anticipated to lead a continued growth in cumulative global emissions of carbon to the atmosphere throughout the 21st century. Given these two facts, research designed to enable the continued use of fossil fuels while simultaneously addressing the climate issue is particularly attractive.

Limiting cumulative global emissions implies that the global energy system, not just the United States energy system, must undergo a transition from one in which emissions continue to grow throughout this century into one in which emissions peak and then decline. Coupled with significant global population and economic growth, this transition represents a daunting task even if an atmospheric CO_2 concentration as high as 750 ppmv is eventually determined to meet the goal of the Framework Convention—though the concentration that will prevent "dangerous" interference with the climate system is not yet known.

2. Technology is the key to controlling the cost of stabilizing the concentration of greenhouse gases. Stabilizing the concentration of greenhouse gases in the atmosphere will require a credible commitment to limit cumulative global emissions of CO_2. Such a limit is unlikely to be achieved without cost but that cost will in large measure be shaped by the character of the energy technology options available to limit cumulative global emissions of CO_2.

It is not well recognized that most long-term future projections of global energy and greenhouse gas emissions and hence, most estimates of the cost of emission reductions, assume dramatic successes in the development and deployment of advanced energy technologies that occur for free. For example, the Intergovernmental Panel on Climate Change developed a set of scenarios based on the assumption that no actions were implemented to mitigate greenhouse gas emissions. The central reference case that assumes "technological change as usual" is called IS92a. This central reference scenario assumes that by the year 2100 three-quarters of all electric power would be generated by non-carbon emitting energy technologies such as nuclear, solar, wind, and hydro, and that the growth of crops for energy (commercial biomass) would account for more energy than the entire world's oil and gas production in 1985. Yet with all these assumptions of technological success, the need to provide for the growth in population and living standards around the world drive fossil fuel emissions well beyond 1997 levels of 6.6 billion metric tons of carbon per year to approximately 20 billion metric tons of carbon per year. Subsequent analysis by the IPCC as well as independent researchers serves to buttress the conclusion that even with optimistic assumptions about the development of conventional energy technologies that the concentration of CO_2 in the atmosphere can be expected to continue rise throughout the century. Thus, achieving stabilization of greenhouse gas concentrations will require an investment in basic research and new technology development well above these assumptions.

Technology development is critical to controlling the cost of stabilizing CO_2 concentrations. Improved technology can both reduce the amount of energy needed to produce a unit of economic output and lower the carbon emissions per unit of energy used. Analysis conducted under the Global Energy Technology Strategy Program showed that the availability of cost effective renewable, nuclear, hydrogen systems and fuel cells, and a variety of mechanisms to capture and sequester carbon in addition to improved conservation and fossil fuel technologies, could dramatically reduce the cost of limiting cumulative global net carbon emissions.

3. There's No "Silver Bullet." No single technology controls the cost of stabilizing CO_2 concentrations under all circumstances. The portfolio of energy technologies that is employed varies across the world's regions and over time. Regional differences in such factors as resource endowments, institutions, demographics and economics, inevitably lead to different technology mixes in different nations, while changes in technology options inevitably lead to different technology mixes across time.

Technologies that are potentially important in stabilizing the concentration of CO_2 include energy efficiency and renewable energy forms, non-carbon energy sources such as nuclear power and fusion, improved applications of fossil fuels, and technologies such as terrestrial carbon capture by plants and soils, carbon capture and geologic sequestration, fuel cells and advanced energy storage systems, and commercial biomass and biotechnology. The latter holds the promise of revolutionary change for a wide range of energy technologies. Many of these technologies are undeveloped or play only a minor role in their present state of development. Research and development by both the public and private sectors will be needed to provide the scientific foundations needed to achieve improved economic and technical performance, establish reliable mechanisms for monitoring and verifying the disposition of carbon, and to develop and market competitive carbon management technologies. For example, advances in the biological sciences and biotechnology hold the promise of dramatically improving the competitiveness of commercial biomass as an energy form and potentially opening up new pathways for revolutionary breakthroughs in other technologies such as carbon capture and sequestration.

4. Energy Technology Development Is One Part of a Larger Comprehensive Strategy. While technology is pivotal when it comes to controlling the cost of stabilizing the concentration of greenhouse gases, it is only one of four major elements that are needed in a comprehensive program to address climate change. The four elements are:

1. Reduction of scientific uncertainties,
2. Adaptation to climate change,
3. A credible, global commitment that greenhouse gas concentrations will be limited; and
4. Energy technology R&D.

In summary, stabilizing the concentration of greenhouse gases at levels ranging up to 750 ppmv represents a daunting challenge to the world community. Energy related emissions of CO_2 must peak and begin a permanent decline during this century. Both a credible global commitment to limit cumulative emissions and a portfolio of technologies will be needed to minimize the cost of achieving that end, including technologies that are not presently a significant part of the global energy system. While important, energy technology development alone will not be enough. It must be complemented by a commitment to resolve scientific uncertainties, facilitate adaptation to climate change that cannot be avoided, and a credible, global commitment that greenhouse gas concentrations will be limited.

Mr. Chairman, thank you for this opportunity to testify. I will be happy to answer your and the committee's questions.

---

[1] Sponsors of the program were: Battelle Memorial Institute, BP, EPRI, ExxonMobil, Kansai Electric Power, National Institute for Environmental Studies (Japan), New Economic and Development Organization (Japan), North American Free Trade Agreement–Commission for Environmental Cooperation, PEMEX (Mexico), Tokyo Electric Power, Toyota Motor Company, and the US Department of Energy. Collaborating research institutions were: The Autonomous National University of Mexico, Centre International de Recherche sur l'Environnment et le Developpement (France), China Energy Research Institute, Council on Agricultural Science and Technology, Council on Energy and Environment (Korea), Council on Foreign Relations, Indian Institute of Management, International Institute for Applied Systems Analysis (Austria), Japan Science and Technology Corporation, National Renewable Energy Laboratory, Potsdam Institute for Climate Impact Research (Germany), Stanford China Project, Stanford Energy Modeling Forum, and Tata Energy Research Institute (India).

[2] Richard Balzhiser, President Emeritus, EPRI; Richard Benedick, Former US Ambassador to the Montreal Protocol; Ralph Cavanagh, Co-director, Energy Program, Natural Resources Defense Council; Charles Curtis, Executive Vice President, United Nations Foundation; Zhou Dadi, Director, China Energy Research Institute; E. Linn Draper, Chairman, President and CEO, American Electric Power; Daniel Dudek, Senior Economist, Environmental Defense Fund; John H. Gibbons, Former Director, Office of Science and Technology

Policy, Executive Office of the President; José Goldemberg, Former Environment Minister, Brazil; Jim Katzer, Strategic Planning and Programs Manager, ExxonMobil; Yoichi Kaya, Director, Research Institute of Innovative Technology for the Earth, Government of Japan; Hoesung Lee, President, Korean Council on Energy and Environment; Robert McNamara, Former President, World Bank; John Mogford, Group Vice President, Health, Safety and Environment BP; Granger Morgan, Professor, Carnegie-Mellon University; Hazel O'Leary, Former Secretary, US Department of Energy; Rajendra K. Pachauri, Director, Tata Energy Research Institute; Thomas Schelling, Distinguished University Professor of Economics, University of Maryland; Hans-Joachim Schellnhuber, Director, Potsdam Institute for Climate Impact Research; Pryadarshi R. Shukla, Professor, Indian Institute of Management; Gerald Stokes, Assistant Laboratory Director, Pacific Northwest National Laboratory; John Weyant, Director, Stanford Energy Modeling Forum; and Robert White, Former Director, National Academy of Engineering.

Committee Members | Subcommittees | Hearings | Key Legislation | Jurisdiction
Press Statements | Current Issues | 1997 Special Investigation | Video of Select Hearings | Sites of Interest