Project 88

Harnessing Market Forces To Protect Our Environment:

Initiatives For The New President

A Public Policy Study

sponsored by

Senator Timothy E. Wirth, Colorado
Senator John Heinz, Pennsylvania

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FOREWORD
by
Senator Timothy E. Wirth and Senator John Heinz

Timeless folk wisdom tells us there is more than one way to skin a cat. Common sense and this report tell us that there are also many ways to a cleaner environment. Among them are innovative measures to enlist the forces of the marketplace and the ingenuity of entrepreneurs to help deter pollution and to change the conduct that wastes and degrades nature's resources.

Project 88 is a nonpartisan effort to find innovative solutions to major environmental and natural resource problems. This report offers 36 specific recommendations resulting from that effort. In many instances, the recommendations are multipurpose ones that address the common causes of interrelated environmental problems. Where the report is most inventive, however, is in its emphasis on the practical employment of economic forces to achieve heightened protection of the environment at lower cost to society. Such approaches, properly implemented, can enlist the everyday economic decisions of individuals and businesses as powerful forces for environmental protection; reduce the costs of meeting our environmental goals; and engage the innovative capacity of our entrepreneurial system in our environmental enterprise.

We are not proposing a free market in the environment -- far from it. This report is not about putting a price on our environment, assigning dollar values to environmental amenities or auctioning public lands to the highest bidder. What we are proposing is that once tough environmental goals are set, we should design mechanisms for achieving those goals which take advantage of the forces of the marketplace in our economy. In order to concentrate on that design task, Project 88 steps away from ongoing debates over specific environmental goals, to focus instead on finding better mechanisms for achieving whatever standards are set.

Our current array of environmental laws and regulations has done much over the past 25 years to check and even reverse spreading threats to air, water, land, wildlife, and health. But much remains to be done. Many problems are unsolved. The air in many of our cities is getting worse, not better. We have barely begun cleanup of toxic wastes from the past. And now new challenges are emerging, some of them -- climate change and ozone loss -- so enormous that previous policies hardly begin to comprehend them. New directions are needed in the ways we think about managing our environment and natural resources and the ways we allocate responsibility for progress.

Especially now, as a new Administration and a new Congress organize for action, the rising dangers to our environment and our heightened awareness of these threats call for new thinking, new inquiry, and, above all, new approaches. Project 88 is a response to that need. Its proposals are presented neither as panaceas nor, in many cases, as definitive answers. Although we do not necessarily endorse each and every idea presented, and might take exception to some,

we believe that they deserve serious and timely consideration. The quality of life that our children and grandchildren will inherit may, in large part, hinge on the choices we make now and in the near future.

This report is the product of a staff effort led by Dr. Robert Stavins, an economist and professor of public policy at Harvard University's John F. Kennedy School of Government, and an associate of its Energy and Environmental Policy Center. Dr. Stavins, a specialist in natural resource and environmental policy, with broad experience at the Giannini Foundation, the Environmental Defense Fund, and as a Peace Corps volunteer, worked with a team of experts on environmental and natural resource policy from across the country. More than fifty persons from academia, private industry, environmental organizations, and government contributed to or reviewed drafts of the report. We owe a substantial debt to all of these participants, but none should be held responsible for any remaining errors or omissions. We thank the reviewers and contributors, particularly Dr. Stavins, for their work. We are proud to have sponsored this effort and to put this report before the public.

CONTENTS

CHAPTER 1
INTRODUCTION AND SUMMARY

This study faces a broad challenge: to find the best, most cost-effective, new approaches to the mounting environmental hazards which face Americans and the world at large. Our environmental and natural resource policies have evolved over the past two decades in response to an array of perceived threats. Now, new and greater dangers have arisen, the cost of enforcing even existing policies has escalated, and the issue of how to share that burden has become a brake on urgently needed action.

In the face of historically unprecedented Federal budget deficits, it is less and less likely that we can increase environmental protection simply by spending more money on programs and policies already in place.[1] Our concerns are much broader than budgetary issues: the costs of environmental compliance to our economy are high.[2] We need to ensure that investment in environmental protection is cost-effective if we are to build international competitive strength along with a better environment.

The approach that seems most promising -- most effective in selecting the means of protection, most efficient in keeping its costs low, and most productive in resolving a wide range of overlapping problems simultaneously -- is one of harnessing market forces to spur both technological advance and sustainable management of national and global natural resources.[3] Indeed, a more economically efficient approach will allow more ambitious policies. In light of the escalating threats posed by environmental degradation, it is imperative that new thinking be brought into public and private decision-making.

This report looks at ways to engineer the forces of the marketplace into our environmental programs, using economic incentives (and disincentives) to make the everyday economic decisions of individuals, businesses, and the government work effectively for the environment. The mechanisms can be as simple as the elimination of subsidies for environmentally destructive timber sales or as intricate as a system of auctioned, tradeable pollution permits to control acid rain.

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[1]Federal expenditures for all environmental and natural resource programs in 1985 were about $13.4 billion (1.4% of all Federal outlays). See: (1) U.S. Office of Management and Budget. *Budget of the U.S. Government, Historical Tables, Fiscal Year 1987.* Washington, D.C.: U.S. Government Printing Office, 1986. (2) U.S. Council of Economic Advisors. *Economic Report of the President.* Washington, D.C.: U.S. Government Printing Office, 1986.

[2]In 1984, total U.S. expenditures on pollution control amounted to about $65 billion -- 63% by businesses, 21% by all levels of government, and 16% by consumers. Total pollution control expenditures were about 1.8% of GNP. See: (1) Farber, Kit D. and Gary L. Rutledge. "Pollution Abatement and Control Expenditures." *Survey of Current Business* 66(1986):100-103. (2) U.S. Council of Economic Advisors 1986.

[3]A "new environmentalism" which embraces such approaches has already emerged. See: Krupp, Frederic D. "New Environmentalism Factors in Economic Needs." *Wall Street Journal*, November 20, 1986, p. 34.

This study is not about setting environmental goals by the use of economic criteria. It does not recommend the use of benefit-cost analysis, or setting dollar values on environmental amenities or human health. Indeed, for the most part, the report eschews judgement on goals and standards. It does not suggest how much air pollution is acceptable, how many acres of wilderness are needed, or how to balance the need for controlling emissions of toxic chemicals with the costs of such controls. These are important -- even crucial -- questions. But there is a need to set aside ongoing debates over specific environmental standards, in order to carry out a separate examination of effective mechanisms for environmental protection.

Where mechanisms can be developed to make environmental goals part of economic decisions, the strong forces of the marketplace can work to reduce the costs of compliance and enlist the innovative capacity of American entrepreneurs in our environmental enterprise. The study does not suggest that less regulation, freer markets, or privatization of government assets automatically result in a better environment. Instead, this report proposes new ways of thinking about how regulations could work, and new ways in which we can apply economic common sense to some of our most vexing environmental problems. The report's recommendations are designed to increase environmental protection and economic productivity by providing incentives for business and individuals to go beyond what regulators can require. This same focus on economic forces also calls for recognizing and reforming ongoing government programs that impose market barriers or provide direct or indirect subsidies which create market forces that contribute to environmental problems.

Developing such proposals in detail and putting them into action will be a complicated and difficult enterprise, but this is a challenge that must be met. We face a huge Federal deficit, growing costs for each new increment of pollution control, and the challenges of new and even more daunting problems in the coming decades. Public demand for a quality environment is strong and deep.[4] Yet it is unlikely that either the Federal government or our economy as a whole will be able to afford higher environmental standards unless we seek out those means that get us the most protection possible for every dollar. The forces of the marketplace, in which reduced costs are a plus on the bottom line, can help us do this. At the same time, market forces can supplement the regulatory power of the government and create a setting for private sector innovation and initiative in the pursuit of environmental quality.

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[4]Public opinion polls consistently show that public concern over environmental quality has remained firm during energy crises, economic downturns, and tax revolts. See: (1) Dunlap, Riley E. "Polls, Pollution, and Politics Revisited: Public Opinion on the Environment in the Reagan Era." *Environment* 29(1987):7-37. (2) Ladd, E. C. "Clearing the Air: Public Opinion and Public Policy on the Environment." *Public Opinion*, February/March 1982, pp. 16-20. (3) Lamm, Richard D. and Thomas A. Barron. "The Environmental Agenda for the Next Administration." *Environment* 30(1988):17-29.

Identifying Innovative Solutions to Major Environmental Problems

For each of 13 major environmental and natural resource problems addressed in this report, we considered a variety of possible policy responses, and assessed them according to nine major criteria:[5]

- Will the policy effectively achieve our environmental goals?
- Will the policy approach be cost-effective, that is, will it achieve the environmental goals at the least cost (to society at large)? This is essential if we are to maximize the environmental protection we get for each dollar we spend.
- Will the strategy provide relevant government agencies with the information they need?
- How easy (or costly) will monitoring and enforcement be?
- Will the policy be flexible in the face of change? When changes occur in tastes, technology, or resource use, will the policy accommodate these changes and remain effective, or will it be in danger of becoming ineffective (or even counter-productive)?
- Will the policy give industry positive, dynamic incentives? For example, will it encourage firms to develop new, environment-saving technologies, or encourage firms to retain existing, inefficient plants?
- Will the economic effects of the policy be equitably distributed?
- Will the purpose and nature of the policy be broadly understandable to the general public?
- Will the policy be truly feasible, both in terms of enactment by the Congress and in terms of implementation by the appropriate departments or agencies?

We used these criteria to select what we believe to be effective new approaches to the problems we examined.

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[5]This set of criteria is partly based upon a similar set of criteria described by: Bohm, Peter and Clifford S. Russell. "Comparative Analysis of Alternative Policy Instruments." *Handbook of Natural Resource and Energy Economics, Volume I*, eds. Allen V. Kneese and James L. Sweeney, pp. 395-460. Amsterdam: North-Holland, 1985.

Common Threads and Implications for Environmental Policy

Our consideration of the problem areas addressed in this report led us not only to specific recommendations but also to more general policy conclusions.

The first is the startling degree to which many environmental problems are interrelated and how some of the most effective policies can help solve several problems simultaneously. For example, the comprehensive energy-efficiency program we advocate will help fight global warming, acid rain, and local air pollution, while strengthening U.S. energy security and international competitiveness.

The second is that while conventional regulatory approaches have been effective, they need to be supplemented. Setting uniform standards or requiring specific control technologies is increasingly a difficult and expensive method to achieve environmental improvements.

A basic underpinning of Project 88 is the notion that a key to reducing inefficient natural resource use and environmental degradation is to ensure that consumers and producers face the true costs of their decisions -- not just their direct costs, but the full social costs of the consequences of their actions. Economic-incentive systems provide various ways to do this: tradeable permits for industrial pollutants;[6] pollution charges; deposit-refund systems for containerized hazardous wastes; least-cost bidding at utilities for greater energy efficiency; removal of market barriers which promote inefficient resource use; and removal of unwarranted subsidies of environmentally destructive activities. With incentive-based systems, the tens of thousands of decisions of individual firms can bolster scarce public-sector resources.

Charge systems impose a fee or tax on pollution, while tradeable permit systems set a total allowable level of pollution and authorize firms to buy, sell, and trade permits within that overall limit. The workings of a pollution charge are simple -- when the polluter pays, it is to the polluter's advantage to clean up. With fees, however, it is necessary to guess how large a fee will result in how much clean-up. Permits are preferable in many cases, as they can start with a firm decision as to how much pollution is the limit, and then issue permits for only that amount. Permit systems do not have to begin or stay at the status quo. They can begin by issuing permits for some fraction of current emissions and give permit holders a deadline to get there. They can also be designed to ratchet down toward stricter standards.

At a time of concern about our economy's international competitiveness, incentive-based approaches can provide huge savings and increases in productivity. For example, a market-based approach to acid rain reduction could save us $3 billion per year, compared with the cost of a dictated technological solution.[7] And, incentive-based approaches need not be any more expensive

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[6]Some environmental groups have expressed concerns regarding emission permit trading and similar incentive-based approaches. In Chapters 2 through 7, we address the major concerns which have been expressed. For responses to a broader set of criticisms, see: Stewart, Richard B. "Controlling Environmental Risks Through Economic Incentives." *Columbia Journal of Environmental Law* 13(1988):153-169.

[7]See: (1) ICF, Inc. *Analysis of Six and Eight Million Ton 30-Year/NSPS and 30-Year/1.2 Pound Sulfur Dioxide Emission Reduction Cases.* Washington, D.C., February 1986. (2) U.S. Congress, Congressional Budget Office. *Curbing Acid Rain: Cost, Budget and Coal-Market Effects.* Washington: U.S. Government Printing Office, 1986. (3) Raufer, Roger K. and Stephen L. Feldman. *Acid Rain and Emissions Trading: Implementing a Market Approach to Pollution Control.* Totowa, New Jersey: Rowman & Littlefield, 1987.

for the government to administer than conventional, regulatory methods. In fact, funds from tradeable-permit auctions could be used to help finance an expanded EPA budget.[8] No one, however, should be deceived into believing that environmental protection can be achieved without significant costs, since no program of environmental controls can be effective without a strong commitment to monitoring and enforcement.

Most importantly, economic-incentive approaches allow greater levels of protection for any given aggregate cost of control. Rather than dictating to enterprises how they should manufacture their products, incentive-based systems impose a cost on pollution-causing activities, leaving it to individual firms to decide among themselves how to achieve the required level of environmental protection. Market forces will drive these decisions toward least-cost solutions and toward the development of new pollution-control technologies and expertise by the private sector.

Incentive-based approaches have an added benefit; they can make the environmental debate more understandable to the general public. Because they do not dictate a particular technology, these approaches can focus attention directly on what our environmental goals should be, rather than on difficult technical questions concerning technological alternatives for reaching those goals.

Utilizing market forces and economic common sense to achieve environmental goals also entails removing market barriers and government subsidies which promote economically inefficient and environmentally unsound practices. Dropping these obstacles, we can simultaneously foster environmental protection; promote a stronger, more competitive economy; and reduce government budget deficits.

Removing unwarranted subsidies does not mean that the Federal government should abandon to the marketplace all provision of goods and services. Not just a regulator, the government is an important owner of public lands, buyer of wetlands, and steward of the Strategic Petroleum Reserve; and the government obviously has broad responsibilities outside the field of environmental protection.

To design and implement such economic-incentive programs, it will be necessary to adapt, not abandon, present programs and build step-by-step on our own and other industrialized nations' initiatives with market-based policies. We know, too, that market-oriented policies will not fit every problem. For example, there may be no more effective way to reduce air pollution from automobiles than to set more stringent emission standards for motor vehicles. As the report spells out, the best set of policies will almost certainly involve a mix of market and more conventional regulatory processes.

The policies we recommend are practical and politically feasible. New policies which deliver improved environmental quality at reasonable cost and which are consistent with American traditions favoring voluntarism over government coercion should have a promising future.

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[8]For further discussion of such possibilities, see: Ackerman, Bruce A. and Richard B. Stewart. "Reforming Environmental Law: The Democratic Case for Market Incentives." *Columbia Journal of Environmental Law* 13(1988):171-199.

Major Recommendations

We make 36 individual recommendations for the environmental and natural resource problems investigated. While Chapters 2 through 7 provide detailed descriptions of the various problems and our specific recommendations for each, we outline our proposals below.

Global Air Pollution Problems

THE GREENHOUSE EFFECT AND CLIMATE CHANGE

Recommendations:

- Fund research on causes and consequences and on adaptation and prevention strategies
- Promote energy efficiency and development of alternative fuels
- Offset new sources of greenhouse gases through trading
- Prevent deforestation through debt-forest swaps
- Set up international trading in greenhouse gases
- Improve population policies

STRATOSPHERIC OZONE DEPLETION

Recommendations:

- Phase out potential ozone depletors (PODs) with tradeable permits
- Provide incentives for recovery of PODs from products
- Support overseas marketing of alternative technologies
- Label POD-containing products

Air Quality Issues

LOCAL AIR POLLUTION

Recommendations:

- Implement tradeable permits for stationary sources
- Strengthen mobile-source regulations and incentives

ACID RAIN

Recommendation:

- Initiate an Acid Rain Reduction Credit program

INDOOR RADON POLLUTION

Recommendation:

- Consider several Federal actions, including tax incentives, subsidized loans, construction codes, soil tests, testing requirements for real estate transactions, and accelerated information dissemination

Energy Policy and the Environment

THREATS TO ENERGY SECURITY AND ENVIRONMENTAL QUALITY

Recommendations:

- Increase motor vehicle fuel-efficiency standards
- Provide incentives for vehicle efficiency and alternative fuels
- Expand the strategic petroleum reserve
- Increase energy efficiency through comprehensive least-cost bidding at electrical utilities
- Fund research on alternatives to fossil fuels

Federal Water Policy

INEFFICIENT USE AND ALLOCATION OF WATER SUPPLIES

Recommendation:

- Remove barriers to water markets

DEGRADATION OF SURFACE AND GROUND WATER QUALITY

Recommendations:

- Implement a combination of regulatory and market programs for nonpoint sources
- Reform Federal water programs to protect wildlife refuges
- Focus the Conservation Reserve Program on water quality problems
- Provide incentives for adoption of integrated pest management
- Implement tradeable discharge permit systems for point sources

Public Land Management and Other Land Use Issues

MANAGEMENT OF THE PUBLIC LANDS

Recommendations:

- Implement a public stewardship mandate
- Reduce government subsidies
- Invest government revenue from non-renewable resources in recreational and environmental assets

DEPLETION OF AMERICAN WETLAND RESOURCES

Recommendations:

- Institute market incentives to reflect wetland values
- Improve use of environmental impact statements
- Restructure the Federal aid in fish restoration fund
- Develop a sport fishing conservation stamp
- Reform wetland regulation

SOLID WASTE MANAGEMENT

Recommendation: • Implement policies which allow recycling to compete

PRESENCE OF TOXIC SUBSTANCES IN THE ENVIRONMENT

Recommendation: • Provide incentives for source reduction

MANAGEMENT OF TOXIC AND INFECTIOUS WASTE

Recommendation: • Implement a deposit-refund system for containerized wastes

Toward a New Era of Environmental Protection

Americans are partners in a broad national consensus for effective environmental protection. In many cases, our environmental goals are clear -- the question is how to get there. The policy tools used do make a difference.

Although conventional regulatory policies have often worked well, they have also tended to pit economic and environmental goals against each other, when these goals should complement one another in the long run if either is to be achieved. Project 88 bridges this gap by applying economic-incentives to the work of environmental protection.

Private-sector innovation, which market-oriented environmental policies will encourage, is essential if the U.S. is to maintain both economic growth and environmental quality. In fairness to future generations, we must begin now to deal with our long-term problems, both economic and environmental. Sustainable solutions to today's problems are required, because the debts we incur today -- whether economic or environmental -- are ones which some day must be paid.

If Theodore Roosevelt's conservation ethic at the beginning of this century represented the first important era of environmental concern in the United States, then the decade of important new laws and regulations following Earth Day was the second era. Our challenge now is to move aggressively into a third era -- a period when practical and economically sensible policies will provide more effective and efficient management of natural resources and protection of the environment.

CHAPTER 2
GLOBAL AIR POLLUTION PROBLEMS

Global climate change due to the greenhouse effect and stratospheric ozone depletion due to the release of chlorofluorocarbons and related chemicals are world-wide problems with potentially enormous consequences. Both are air pollution problems. The greenhouse effect could dramatically alter Earth's weather, geography, and economy. Ozone loss, resulting in higher levels of ultraviolet radiation, can endanger not only human health and longevity but the survival of plant and animal life.

This chapter looks at both dangers and proposes measures to deal with them. Examining the greenhouse effect first, we recommend six specific policies:

(1) immediate research on major strategies of prevention and adaptation;

(2) promote energy efficiency and alternatives to fossil fuels;

(3) offsets of new sources of greenhouse gases through trading;

(4) prevention of tropical deforestation through debt-forest swaps with less developed countries;

(5) international trading in greenhouse gases; and

(6) improved population policies.

In the second part of the chapter, we examine stratospheric ozone depletion, endorsing EPA's proposed market-based approach to implementing the Montreal Protocol standards in this country. We advocate the adoption of a system of tradeable permits and recommend three complementary policies:

(1) a marketable-permit approach to encourage the recovery of PODs from products;

(2) Federal support for research and development of alternative technologies and for the marketing of these technologies overseas; and

(3) labelling products which contain potential ozone depletors.

The Greenhouse Effect and Climate Change

The single most important environmental threat our planet has faced since the beginning of the industrial revolution may be global climate change due to the greenhouse effect. Gases such as carbon dioxide (CO_2), methane, nitrous oxide, and chlorofluorocarbons (CFCs) transmit the sun's visible radiation, which warms the earth's surface, but these same gases absorb infrared radiation, thus preventing the escape of atmospheric heat into space. The process is similar to that which occurs in an ordinary greenhouse or in a closed automobile left in the sun.

Man's burning of fuels -- particularly of fossil fuels -- has doubled the concentration of CO_2 in the atmosphere since the industrial revolution. A doubling of today's concentrations may occur in the next 30 to 50 years. The resulting global temperature increases may produce climate changes at unprecedented speed. Scientists expect that by the middle of the next century, temperatures may rise in the range of 5-10 degrees Fahrenheit, an increase over 60 years equivalent to the warming since the last Ice Age, 18,000 years ago.[1] These temperature increases will cause massive changes in global precipitation patterns, storm intensities, and ocean levels.

The Nature and Magnitude of the Problem

Short of nuclear war, it is difficult to imagine a more sweeping transformation of the earth as we know it than that forecast to result from global warming. All aspects of human and natural existence will be affected; and attempts to stabilize greenhouse gases (GHGs) in the atmosphere will require significant lead times before they take effect. Many scientists believe that the speed of change will outstrip the capacity of many natural ecosystems to adjust, causing widespread loss of forests and wildlife.

Agriculture is probably the most weather-sensitive sector of our economy. While the 1988 drought cannot be definitively attributed to the greenhouse effect, the terrible buffeting that some farm communities suffered is a reminder of agriculture's vulnerability to weather. Furthermore, drought conditions in the Great Plains and Midwest were consistent with predictions of climate changes due to the greenhouse effect.[2] Some experts have gone even further. Dr. James E. Hansen, Director of NASA's Goddard Institute for Space Studies stated in testimony before the U.S. Senate Energy and Natural Resources Committee: "It is time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here."[3]

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[1]For an examination of "scientific issues" surrounding the greenhouse effect and global warming, see: Schneider, Stephen H. "The Greenhouse Effect: What We Can or Should Do About It." *Preparing for Climate Change*, pp. 18-34, Proceedings of the First North American Conference on Preparing for Climate Change: A Cooperative Approach, Washington, D.C., October 27-29, 1987. Rockville, Maryland: Government Institutes, Inc., 1987.

[2]Manabe, S. and R.T. Wetherald. "Reduction in Summer Soil Wetness Induced by an Increase in Carbon Dioxide." *Science* 232(1986):626-627.

[3]Shabecoff, Philip. "Global Warming Has Begun, Expert Tells Senate." *New York Times*, June 24, 1988, p.1.

For three major crops alone, the 1988 drought has been estimated to cost farmers and others more than $3 billion.[4] This contrasts with estimates of annual agricultural losses of up to $14 billion in the U.S. as a consequence of climate change due to global warming.[5] Potential changes in precipitation patterns due to a greenhouse warming are being taken seriously by an increasing number of major corporations, such as Weyerhaeuser, the forest products company, which is concerned about possible consequences for its extensive holdings in Oklahoma and Arkansas.[6] More widely in the U.S., global warming raises the likelihood of forest fires and threatens a tremendous decrease in water supplies west of the Continental Divide.

Climate change will redistribute climate resources in ways which will not necessarily be bad for all parts of the globe. While U.S. farming is likely to suffer, Canadian or Soviet agriculture could benefit, with a consequent loss of competitive advantage for American agricultural exports. On balance, it appears that negative consequences will greatly outweigh positive ones, particularly if climate change occurs with the rapidity most scientists predict.[7]

In addition to climatic impacts on agriculture and forestry, an expected sea level rise holds high risks. Partly because water expands as it is heated, temperature increases associated with the greenhouse effect will cause many coastal areas to be inundated. If the polar ice caps partially melt, the effects will be even more dramatic, endangering extensive coastal infrastructure and investment, as well as such environmental resources as coastal wetlands, estuaries, and beaches.

A third major category of greenhouse impacts is associated with the potential for increased tropical storm intensity. Increased surface temperature of the oceans under a doubled CO_2 atmosphere could cause a 40% to 50% increase in the destructive power of storms.[8] Higher storm intensities could produce significantly worse coastal damages -- as much as $1.4 billion annually in Charleston, South Carolina, for example, and up to $500 million in Galveston, Texas. The most serious human suffering would probably hit the densely inhabited, low-lying, deltaic regions of nations such as Egypt and Bangladesh.

Finally, in the temperate, industrial nations, the direct effects of global warming on electrical power demand during the summer months (for air-conditioning) may constitute a fourth category of major impacts. These could come in a vicious cycle of energy consumption-CO_2 emission-warming-growing energy demand.

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[4]Associated Press. "Middle West Showers Tease But Are Too Little, Too Late." *New York Times*, June 17, 1988, p. A15.

[5]Dudek, Daniel J. "Assessing the Implications of Changes in Carbon Dioxide Concentrations and Climate for Agriculture in the United States." *Preparing for Climate Change*, pp. 428-450. Proceedings of the First North American Conference on Preparing for Climate Change: A Cooperative Approach. Government Institutes, Inc., April 1988.

[6]Ramirez, Anthony. "A Warming World." *Fortune*, July 4, 1988, pp. 102-107. For further discussion of the business community's perspective on global warming, see: Wald, Matthew L. "Fighting the Greenhouse Effect." *New York Times*, August 28, 1988, Section 3, pp. 1, 18.

[7]Schneider, Stephen H. *The Greenhouse Effect: Do We Need Major Federal Action Now?* Testimony before the U.S. Senate Committee on Energy and Natural Resources, Washington, D.C., August 11, 1988.

[8]Emmanuel, Kerry A. "The Dependence of Hurricane Intensity on Climate." *Nature* 326(1987):483-485.

Whereas the consequences of global warming will be felt worldwide, it is emissions from sources in the industrialized nations that are primarily causing the buildup of greenhouse gases in the atmosphere. CO_2 is the most common of the greenhouse gases, currently increasing in the atmosphere by 0.5% per year; it is expected to account for over 50% of total global warming. The major man-made source of atmospheric CO_2 is fossil fuel combustion, accounting for 98% of all industrial CO_2 emissions (one-fifth from U.S. sources). Forests play an important mitigating role, since trees naturally remove CO_2 from the atmosphere, transforming it into biomass. Deforestation, principally in tropical regions of the globe, however, is causing about 20% of current CO_2 increases.[9]

CFCs, manufactured chemicals in widespread use in developed economies, constitute another important set of greenhouse gases and a link between the problem of climate change and that of ozone depletion. Despite their lower atmospheric concentrations, CFCs currently account for perhaps 15% of global warming, because they are very strong absorbers of infrared radiation.

Lastly, methane, tropospheric ozone, and nitrous oxides collectively account for about 35% of current global warming. Methane sources include livestock, rice paddies, termites, fossil fuel combustion, including natural gas flaring, and landfill decomposition. About 80% of the methane comes from biological sources.[10] Tropospheric ozone, a major component of smog, is produced from the reaction of hydrocarbon and nitrogen oxide emissions in the presence of ultraviolet radiation. Nitrous oxide sources include fertilizers, cement producers, biomass burning, fossil fuel combustion, and various natural sources, this last category accounting for half of all nitrous oxide emissions.[11]

Current Federal Policy

Although the U.S. has yet to formulate an explicit policy regarding the greenhouse effect and global warming, an enormous number of policies affect the rates at which greenhouse gases are produced and emitted. Policies which affect energy use decisions -- especially, efficiency and the use of fossil fuels -- provide the most obvious example.[12] Current (fossil fuel) energy production and consumption may well be inefficient for two reasons: first, because of widespread subsidization of energy consumption in general; and second, because of the failure of market prices for energy to reflect the true social costs of use (including environmental costs associated with global warming).

Policies which affect the maintenance of forests also merit attention. Deforestation, particularly of tropical forests, has been estimated to be responsible for as much as 20% of CO_2 production traceable to human activity. Conversely, planting trees -- which convert CO_2 in the atmosphere to biomass -- can cut some of the increase in CO_2 emissions. Thus, it is likely that the

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[9]Whittaker, R.H. and G.E. Likens. "Carbon in the Biota." *Carbon and the Biosphere*, ed. G. M. Woodwell, and E. V. Pecan, pp. 281-302. AEC Symposium Series No. 30. Springfield, Virginia: National Technical Information Service, 1973.

[10]*Chemical and Engineering News*, November 24, 1986, p. 23.

[11]*Electric Power Research Institute Journal* 13(1988):12.

[12]See Chapter 4 of this report for further discussion of energy policy and environmental impacts.

best defensive strategies against global warming will include both positive policies to increase energy efficiency and policies to encourage forest protection and reforestation.

Recommended Policies for Managing the Global Atmosphere

Effective action against global atmospheric pollution problems such as climate change due to greenhouse gases will require an assortment of policies, some of them new and unconventional. Because international cooperation is essential to solve this global problem, realistic policies must accommodate a diversity of governments, cultures, values, and economic systems. Policies must be designed to encourage participation, not repel it.

Potential measures to manage the greenhouse effect fall into three general categories: (1) those which will prevent or retard climate change; (2) those which will expedite and ease adaptation to a changing climate; and (3) those which will facilitate research to identify the appropriate mix of prevention and adaptation strategies.

Since some climate change is inevitable, given past and current emissions to the atmosphere, eventually we will probably need to pursue all three lines of attack and are likely to find market-based polices particularly attractive. They can simultaneously promote prevention and facilitate adaptation, while allowing decentralized decisions to identify the best mix of strategies. Our own six recommended policies follow.

Recommendation 1: Research on Prevention and Adaptation Strategies

While the scientific community has given little attention to means of adapting to climate change, scientific, economic, and policy research have focused even less on methods of prevention. Basic scientific research into the underlying causes and consequences of global warming is certainly the first priority. Second, research on specific methods of prevention and adaptation is needed. Third, because eventual decisions on strategies to adapt will likely be based mainly on economic considerations, economic and policy research will also be important. The causes of the greenhouse effect are essentially economic in nature; market interactions are largely responsible for the overall level of energy generation and the particular mix of energy sources used. Likewise, the consequences of global warming include extremely important economic dimensions, in regard both to shifting patterns of precipitation and to sea level increases. Thus, there will inevitably be important economic dimensions to any "solutions" to the problem, whether they be prevention strategies that limit the buildup of GHG concentrations or strategies of adaptation to climate change.

Until recently, there appeared to be something of a consensus among both economists and physical and biological scientists that adaptation is the "best strategy."[13] This apparent consensus -- no longer operative -- emerged despite the fact that very little research had examined the feasibility of alternative prevention approaches such as increasing (production and use) efficiency to limit GHG emissions through reduced burning of fossil fuels and/or increased reliance on non-fossil, renewable energy resources. Moreover, no studies have compared the relative feasibility of

[13]See: National Research Council. *Changing Climate: Report of the Carbon Dioxide Assessment Committee.* Washington, D.C.: National Academy Press, 1983; and Seidel and Keyes 1983.

prevention and adaptation strategies. Given this dearth of research on these fundamental questions, it is obviously premature to focus exclusively on adaptation.

While the Federal government has supported some work on global carbon cycle models and general circulation (climate) models, relatively few Federal research dollars have gone to long-term analyses of preventing climate change. This imbalance is not surprising; the National Research Council in 1983 indicated that because "even very forceful policies adopted soon with regard to energy and land use are unlikely to prevent some modification of climate as a result of human activities, the major emphasis of economic research should be on strategies of adaptation, not prevention."[14] Yet that conclusion, and similar ones in other studies, did not emerge as a result of analyses of the relative costs of prevention versus adaptation.

Our first recommendation, therefore, is that the responsible Federal agencies, such as EPA and the Departments of Energy, Agriculture, and Interior, increase their support of basic scientific research on atmospheric and global systems and research on alternative strategies to deal with this critical global problem. We need to compare the costs of specific means of prevention with the expected benefits of prevention (the avoided costs of adapting to climate change). Research on prevention strategies should examine: (1) improved energy efficiency and demand management; (2) renewable energy resources; (3) more efficient generation technologies, including clean coal and improved natural gas technologies; (4) safe nuclear power; and (5) factors affecting forest depletion worldwide, including population growth.[15]

Adaptation strategies which should be assessed include: (1) development of drought-resistant strains of agricultural crops; (2) increased efficiency of irrigation methods; (3) mapping sea-level rises; (4) methods of protecting major urban areas and other shorelines from heightened sea levels and increased storm intensities; and (5) other methods of mitigating anticipated impacts in the major climate-sensitive sectors (agriculture, energy, water resources, commercial fisheries, construction, transportation, recreation/tourism, and social services). Such parallel research efforts can begin to identify the best strategies -- whether based upon prevention, adaptation or, more likely, some combination of the two approaches.

Recommendation 2: Promote Energy Efficiency and Alternatives to Fossil Fuels

The cornerstone of any program to fight global warming is likely to be the promotion of energy efficiency and non-fossil fuel alternatives for energy generation. Chapter 4 of this report examines these critical issues in detail. It proposes ways to create greater incentives for energy efficiency, including the development of non-fossil energy sources. Non-fossil alternatives can allow the industrialized world to expand its energy supply without generating additional CO_2.

Unless the developed world can offer developing nations reasonable alternatives to the burning of fossil fuels for their industrialization, energy growth in those countries will more than outweigh gains made through efficiency and alternatives in the developed world. China, for

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[14]National Research Council 1983, p. 3.

[15]See our discussion later in this chapter of linkages between population growth and global warming (and other environmental problems).

example, has large reserves of low-grade coal. If its plans for industrialization include reliance on coal burning, the result will be the addition of huge amounts of CO_2 to the atmosphere.

In addition to the measures examined in Chapter 4, other potential means exist to slow the growth of greenhouse gases, including increased use of natural gas (which produces about half the CO_2 per unit of energy as conventional coal), and utilization of more efficient coal combustion technologies which produce more energy for each unit of CO_2 they generate.

Dramatic improvements can come from changes in some existing policies. One example of a policy change which would factor social -- especially environmental -- costs into the calculations used in the Public Utility Regulatory Policies Act (PURPA) of 1978. That legislation was written to encourage the use of alternative sources of energy at a time when oil and gas prices were rising rapidly. It based the incentives it offered on a calculation of market prices of fossil fuels on the one hand and an administrative determination of the costs that could be avoided by shifting to alternative energy sources, on the other. Because the oil glut caused energy prices to tumble, the formula has not had the expected impact on creating attractive incentives for the adoption of energy alternatives.

An important problem lies in the fact that the market sets coal, oil, and natural gas prices without reference to the environmental consequences (costs) associated with their extraction and use. PURPA, too, makes no calculation of these costs, and thus does not guide administrators to measure accurately the costs avoided by switching to alternative energy sources. Amending PURPA to fill this accounting gap would enable administrators to factor in the true costs of fossil-fuel energy when they evaluate bids to meet energy demands. It would give utilities accurate signals of the price of competing energy sources, and provide a consistent and comprehensive framework for weighing the costs and benefits of energy investments and for setting effective incentives for the development of alternative sources.

Recommendation 3: Offset New Sources of Greenhouse Gases

We recommend that new sources of greenhouse gases, particularly stationary sources of carbon dioxide, be required to compensate for their proposed emissions. No priority is higher than slowing the accumulation of greenhouses gases. Compensation can be achieved by any available means that creates offsetting emissions reductions, an approach which has already been used by EPA to protect local air quality.

This offset concept can easily be extended to the management of greenhouse gases. For example, proposed sources of new CO_2 emissions could be required to offset their emissions so as to produce no net increase in CO_2. Offsets could be generated by: investing in energy conservation; retiring older, more CO_2-intensive facilities; investing in mass transit; or carrying out collaborative investments in tree plantations with forest product firms. Other possibilities are offered by the Conservation Reserve Program (CRP) of the 1985 Food Security Act, designed to remove highly erodible land from agricultural production.[16] A national market for CO_2 offsets could provide a much needed additional source of revenue for landowners participating in the conservation program, a market mechanism that would not require increased Federal support payments.

[16]See our discussion of nonpoint source water pollution in Chapter 5.

Since requiring offsets for new CO_2 sources would increase the cost of constructing new power plants, for example, utilities and others would be spurred by a powerful incentive to make greater investments in increased energy efficiency and other conservation methods. An offset program that expanded the incentives for CRP participation could reduce CO_2 emissions, stimulate energy conservation, expand forested acreage, and reduce soil erosion -- all without increasing Federal outlays. In general, the offset approach would stimulate the search for new and cheaper ways of eliminating CO_2 emissions, an important national goal.

Since the greenhouse problem is concerned with a suite of gases, the offset concept could be expanded beyond one-to-one trading in a single gas. The domestic program to manage CFCs provides an immediate opportunity. EPA is expected to implement a program of marketable permits to control production and trade in the fully halogenated chlorofluorocarbons, notoriously strong greenhouse gases. Since transferable permits will exist, offsets could easily take the form of buying up and shelving appropriate CFC production entitlements. Other such opportunities for trading diverse emissions among various sources exist. The challenge is to engage creative entrepreneurial energies in the pursuit and discovery of these opportunities.

Recommendation 4: Preventing Tropical Deforestation through Debt-Forest Swaps

Because forests are important reservoirs of carbon, there is a close link between deforestation (particularly by burning) and CO_2 increases in the atmosphere. Thus, tropical deforestation raises at least two significant environmental issues: the role of forests in the biosphere; and biological diversity. Whereas considerable attention has been devoted to species diversity and the role of rain forests as critical habitat, substantially less thought has been given to the role of these forests in the maintenance of climate.

Many of the world's developed economies are both important GHG emitters and major financiers of economic development in the LDCs, the main repositories of the world's tropical forest resources. Much has been written about the Third World debt crisis; in essence, for a variety of reasons, many LDCs have found that they can no longer meet their massive debt obligations and invest adequately in growth at home. Their dilemma has threatened the solvency of major banking institutions in the developed world. Their debt burden has also created additional pressures on them to exploit natural resources for quick, high returns -- even at long-term economic and environmental costs. Surely there is a better way.

The developed and less developed nations share common interests in the tropical forests, a nexus between climate change problems and debt problems. These common interests could be furthered by expanding the offset concept into the international arena -- debt-for-forest swaps, several of which have already been arranged by the World Wildlife Fund and other organizations.[17] On the one hand, maintaining, rather than burning tropical forests, could

[17]Developing and developed nations are already cooperating on international approaches to deforestation issues. A tropical forest action plan has been co-sponsored by the World Bank, the United National Development Program, the Food and Agricultural Organization, and other agencies. See: World Resources Institute. *Tropical Forests: A Call for Action*. Washington, D.C., 1985. Nearly 50 developing nations are currently developing national plans for increased forestry investment, to be supported by international assistance. Also, a "global biodiversity action plan" is now being developed by several development agencies and non-governmental organizations, including the World Resources Institute, the International Union for Conserving Nature, and the World Wildlife Fund/Conservation Foundation.

significantly cut additional greenhouse gas output; while, on the other hand, voluntary debt-forest swaps would, almost by definition, benefit debt-burdened LDCs.[18]

Recommendation 5: International Trading in Greenhouse Gases

In the long term, the global nature of the greenhouse problem will require truly international efforts. It is likely that negotiations to produce an international agreement will be convened under the auspices of the United Nations Environment Program. Possible forms for such an agreement range from a "Law of the Atmosphere" to a "Convention on Greenhouse Gases," modeled on the protocol for stratospheric ozone protection.[19] In the latter case, some elements of the Montreal ozone agreement offer promise in managing the greenhouse effect as well, particularly flexibility in national implementation, ease of verification, and separate "equity provisions" for less developed countries (LDCs).

The Montreal agreement sets an important precedent by providing that nations can trade in emission entitlements. The rationale for this approach derives chiefly from the fact that market-oriented flexibility in meeting standards will mean achieving those standards at the least possible overall cost.

As an alternative to an emissions permit system, emission fees (taxes) have also been suggested, both for CO_2[20] and for CFCs[21]. The problems associated with implementing such an international fee system, however, would be awesome: collection, certification, and the ultimate disbursement of revenues pose major institutional problems. From the recent stratospheric ozone negotiations, it is clear that any effective and practical cooperative control strategy must allow for separate national implementation. In effect, this reality means that signatories would be given targets and goals, but not specific mechanisms for attaining them. Although it is conceivable that individual nations could use fees to meet their reduction quotas, this process would create problems of verifying compliance with the international schedule, uncertainty among firms while the "correct" fee level was being identified, and trade distortions reflecting differences in national control strategies or fee levels.[22]

Our recommendation, therefore, is for a system of international emissions trading in greenhouse gases. Given the intimate link between greenhouse gas emissions and energy use, a

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[18]Debt-forest swaps carried out between the U.S. government (directly or through commercial banks) and LDCs can produce intended, beneficial environmental effects only if LDCs are able to monitor and enforce the local execution of forest-saving plans. Related local administrative costs should therefore be included in designs of debt-forest swaps. See: Hultkrans, Andrew N. "Greenbacks for Greenery." *Sierra*, December 1988, p. 43.

[19]See the discussion later in this chapter of the Montreal Protocol for international reductions in the emissions of CFCs.

[20]Nordhaus, William D. "How Fast Should We Graze the Global Commons?" *American Economic Review* 72(1982):242-246.

[21]Miller, Alan S. and Irving M. Mintzer. *The Sky is the Limit: Strategies for Protecting the Ozone Layer.* Research Report #3. Washington, D.C.: World Resources Institute, 1986.

[22]Dudek, Daniel J. *Chlorofluorocarbon Policy: Choices and Consequences.* New York: Environmental Defense Fund, April 1987.

system of transferable emission permits would be particularly desirable because: (1) it would handle distributional problems (i.e. LDC participation) explicitly while allowing for efficient allocations to emerge; and (2) it would provide incentives for efficient GHG management, including the use of forests as "carbon reservoirs" to generate valuable credits and offset the growth of atmospheric concentrations of GHGs. The latter factor creates the possibility of linking another global commons problem, tropical deforestation, to the problem of climate change with positive net benefits.

It is unlikely that governments, including the United States, would be willing to adopt trading schemes without the benefit of practical experience in implementation. Credible experience with emissions trading for GHG can begin by extrapolating from our domestic offset proposal, above, which allows for economic growth to proceed while emissions reductions are achieved.

Recommendation 6: Improved Population Policies

It is important to recognize that rapid global population expansion seriously affects both the rate of fossil fuel (and fuelwood) burning and the rate of deforestation. The highest rates of population growth are concentrated in the world's developing nations, where up to 95% of population growth is expected to occur over the next 70 years.[23] Rural populations in these countries are depleting remaining forests in their search for land to farm and fuel to burn. The massive increases which are expected to boost world population above its current level of 5 billion are not inevitable, however. According to United Nations projections, world population in the year 2100 will grow to only half (7.2 billion) of what it will otherwise reach (14.9 billion) if major new investments are made in family planning information and services, particularly in the less developed countries. Therefore, we recommend that a fundamental element of any comprehensive approach to the problem of global climate change should include policies aimed at moderating world population growth. Restraining the population explosion is essential to restrain increases in the demand for energy and the rate of tropical deforestation.

Conclusions

Several of our recommendations in this chapter for the greenhouse effect have dealt with encouraging a more energy efficient economy. Those recommendations and the proposals we present in Chapter 4 on explicit energy-environment policies would have immediate benefits, in addition to their contributions to preventing and mitigating global warming. Increased energy efficiency will also go some way toward reducing problems the country is experiencing with local air pollution and acid rain (as we discuss in the next chapter).

Other such complementarities are also important. As we indicated earlier, one important set of greenhouse gases are the so-called CFCs, major contributors to another global environmental problem, the depletion of stratospheric ozone. It is to that problem that we turn next.

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[23]For a recent description of the social and environmental effects of intense population pressures, see: Mydans, Seth. "Experts See a Time Bomb in the Rapidly Exploding Philippine Population." *New York Times*, July 31, 1988, p.12.

Stratospheric Ozone Depletion

Recent assessments confirm what many have feared for some time -- that chlorofluorocarbons (CFCs) and related chemicals are depleting stratospheric ozone.[24] This loss is of concern because stratospheric ozone screens out ultraviolet (UV) radiation before it reaches the earth's surface. Ozone depletion will thus increase UV radiation, potentially increasing human skin-cancer incidence, promoting cataracts, suppressing immune responses, and causing other adverse effects to animals, plants, and materials.

The Nature of the Problem

The most important potential ozone depletors (PODs) are CFC-11, 12, and 113, carbon tetrachloride, methyl chloroform, and Halon 1301 and 1211.[25] All are artificially synthesized compounds used in a wide variety of industrial processes and consumer products. Annual worldwide sales of CFCs alone are currently on the order of $2.2 billion,[26] and are continuing to grow at more than 5% annually. Ironically, PODs' chemical stability, which makes them generally nonflammable, non-toxic, and among the safest of industrial chemicals, is also the characteristic which allows them to survive long enough in the atmosphere to reach the stratosphere where they are decomposed by intense UV radiation.[27]

The CFCs of concern are used to produce rigid insulating foams and flexible cushioning foams; as refrigerants in industrial, mobile, and home air-conditioning systems and refrigerators; as aerosol propellants except in the few countries (including the United States) which have prohibited all but "essential" aerosol applications;[28] for degreasing, metal cleaning, and other industrial applications; and in dry cleaning. Additionally, Halons are used as fire extinguishants.

The possibility that CFCs could deplete ozone was first recognized in 1974;[29] but recent assessments of trends in satellite and ground-station measurements suggest that depletion is occurring more rapidly than previously anticipated. The discovery that ozone has been severely

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[24]National Aeronautics and Space Administration. *Executive Summary, Ozone Trends Panel.* Washington, D.C., March 15, 1988.

[25]Although the term CFC is often used to indicate the class of potential ozone depleting substances, it is misleading. Only three of the seven most important PODs are CFCs, and several of the proposed POD substitutes are CFCs, e.g. CFCs 134a, 141b, 142b, 143a, and 152a.

[26]Shabecoff, Philip. "The Race to Find CFC Substitutes." *The New York Times*, March 31, 1988, p. 25.

[27]Most of these chemicals are expected to survive in the atmosphere for 75 years or more.

[28]In 1978, the U.S. government banned all "non-essential" aerosol uses of CFC-11 and CFC-12, at that time the major application of these compounds. Canada, Sweden, and Norway enacted similar controls; and in the early 1980s, the European Economic Community capped CFC production at current capacity, a level well in excess of current production.

[29]Molina, M. J., and F. S. Rowland. "Stratospheric Sink for Chlorofluoromethanes: Chlorine Catalyzed Destruction of Ozone." *Nature* 249(1974):810-812.

and increasingly depleted (since the late 1970s) in the Antarctic springtime has heightened international concern. The consequences of stratospheric ozone depletion are even more uncertain than its extent, but they could be dramatic. UV exposure has been linked to non-melanoma skin cancers, a relatively easily treated, rarely lethal condition; and increased UV doses could also increase lethal melanoma skin cancer incidence, suppress immune responses, contribute to cataract formation and other ocular damage, and damage plants, aquatic organisms, outdoor plastics, and protective coatings (paints).

Federal Policy

Like the greenhouse effect, stratospheric ozone depletion is a true global commons problem: POD emissions from any nation eventually affect the ozone layer everywhere. International cooperation in limiting ozone depletion is therefore essential. Since the United States accounts for about one-third of current POD emissions -- more than any other nation -- it must play an important role in limiting ozone depletion.

Significant progress has been made in the last few years. The Vienna Convention for the Protection of the Ozone Layer, negotiated in 1985, provides a framework for international negotiations and cooperative research; the Montreal Protocol to the Convention was signed by 31 countries in September, 1987. If a sufficient number of countries ratify it, signatories will be committed to freezing and subsequently reducing production and consumption of most of the major PODs. The Protocol calls for periodic assessments of the current understanding of scientific and economic factors. There are exemptions allowing increased POD production for export to developing countries which consume less than a specified per capita level; and, if offset by reductions in another country, to "rationalize" production and thus lower costs. The Protocol establishes a flexible, effective framework for world-wide reduction of POD emissions. It allows countries significant flexibility to accommodate national needs while limiting each country's contribution to ozone depletion (in proportion to its 1986 contribution).

The United States has ratified the Protocol, and EPA has proposed regulations to implement its restrictions. EPA envisions a system of production and import permits allowing permit holders to produce and/or import a specified quantity of PODs in a twelve-month period.[30] As the quantities of PODs available are restricted, prices are expected to rise, providing an incentive for POD users to: (1) develop non-POD-dependent products or manufacturing processes and substitute chemicals; (2) reduce the quantity of PODs required per unit product; and (3) recover PODs from the production process and reuse them. Permits will be allocated to producers and importers in accordance with their 1986 levels of these activities, but can be freely traded among firms; market forces will determine not only the applications in which PODs are used, but also the division of the allowed quantity among specific PODs.[31]

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[30]U.S. Environmental Protection Agency. "Protection of Stratospheric Ozone." *Federal Register* 52 (239), 47486-47523, December 14, 1987.

[31]Permits apply to specific PODs, weighted by their relative ozone-depletion efficiencies. For example, the same permit may allow a firm to use either 1 kg of CFC-11 or 0.8 kg of CFC-113. This feature permits efficient substitution among PODs at no cost to the environment. A similar scheme may be appropriate for control of greenhouse gases, acid-rain precursors, and other pollutants.

Recommendation 7: Phase-Out POD Emissions through EPA's Tradeable Permit System

A number of factors must be considered when designing a strategy for addressing ozone depletion. Although annual production and import permits now proposed allow for adjustments, a conservative bias (erring on the side of preserving stratospheric ozone) is appropriate for setting control levels. Because PODs survive in the atmosphere for 75 years or more, today's emissions will affect ozone levels a century from now. The most recent evidence demonstrates that an 85% reduction in POD production is needed just to stabilize ozone at present levels.[32] We propose moving to a 100% phase-out of selected PODs.

Either a conventional regulatory approach or the tradeable permit approach could be used to move toward that zero level. The advantage of the incentive-based approach is that it is likely to be more effective (for any given level of aggregate control) and should certainly be less costly. Given the extensive variety of commercial POD applications and the wide-ranging nature of potential alternatives, conventional command-and-control regulatory approaches would be difficult for the government to implement and unnecessarily expensive for industry. Developing specific requirements for the hundreds of POD applications and enforcing these requirements on the thousands of firms which use PODs would be an administrative nightmare. In contrast, market-based approaches like EPA's marketable permits will provide economic incentives for firms to reserve PODs for their most valued uses, thereby minimizing the costs of reducing POD use.

The market-based approach offers several additional benefits over command-and-control regulations. First, it is likely to be far more effective in stimulating firms to adopt measures which require changed work practices, such as recovering PODs from a production line or when servicing refrigeration equipment. Although conventional regulations can require firms to pursue technological solutions, like installing emission-control equipment, it is difficult to ensure that the equipment is properly maintained and operated, and even more difficult to enforce restrictions on the shop floor. Second, this approach provides industry with incentives to develop substitute chemicals, industrial processes, and consumer products. As we note in our examination of local and regional air pollution problems in the next chapter, command-and-control regulations provide little incentive for innovation. Such rules give firms little incentive to develop methods to reduce emissions more than needed to meet requirements.

One potential difficulty with the marketable-permit approach is that PODs represent a very small cost share in many applications. For example, in refrigeration and air-conditioning equipment, the cost of the refrigerant is only a few dollars out of a total price of hundreds or thousands of dollars. In these cases, firms may have less incentive to develop substitute products, since consumers may not be sensitive to the proportionately small price increase which would be needed to pay the increased cost of the refrigerant. To offset this possible effect, EPA may wish to impose engineering controls or product bans in a limited number of cases. Finally, consideration should be given to the auctioning of initial permits, an idea which is consistent with EPA's request for comments on August 25, 1988.

In summary, EPA's proposed use of marketable permits is an admirable use of market mechanisms to achieve environmental goals at minimum economic cost. Preventing further

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[32]Hoffman, John S. and Michael J. Gibbs. *Future Concentrations of Stratospheric Chlorine and Bromine.* EPA 400/1-88/005. Washington, D.C.: U.S. Environmental Protection Agency, August 1988.

stratospheric ozone depletion may well be the first environmental-policy context in which such an approach is adopted on a wide scale. Several additional and complementary approaches may also be valuable.

Recommendation 8: Recovery of PODs from Products

A significant share of POD production is "banked" in products from which it is emitted slowly over time, or at product disposal. Examples include refrigeration and air-conditioning systems, rigid insulating foams, and fire-extinguishing systems. The current bank may contain an amount equal to two or three years of current CFC-11 and 12 production and perhaps 10 years of Halon production; methods to recover PODs before they are released to the atmosphere could become valuable. The marketable-permit approach could stimulate demand for POD recovery and reuse. The increased price of PODs that is expected to result from regulatory constraints on their supply will constitute, in effect, a bounty for POD recovery (similar to the deposit-refund system sometimes used for soft-drink and other containers). Government grants or other assistance to stimulate development of recovery methods and centers could facilitate the process.

Recommendation 9: Marketing Alternative Technologies Overseas

Development of competitive alternatives to POD-using products and processes will substantially reduce POD demand and emissions. Global POD emissions will be much smaller if developing countries which have not yet invested in POD-dependent infrastructure (refrigeration and air-conditioning systems, for example) can be induced to adopt alternative technologies. Federal support to develop and market these technologies would not only contribute to an efficient global response to ozone depletion, but it would also put U.S. firms in a strong position to supply new markets for alternative technologies. Market-based regulations in the United States will provide a strong incentive to develop alternative products for U.S. consumption, products which may also be exported; and to the extent that other countries can be persuaded not to use PODs, will mitigate damage to the United States from ozone depletion.

Recommendation 10: Labelling POD-Containing Products

Labelling requirements may also be effective if some consumers are willing to pay slightly higher prices or purchase slightly "inferior" products if they know that by doing so they are protecting the ozone layer. In that case, firms can reap economic and public-relations benefits by marketing non-depleting products. Recall that this approach contributed to a dramatic decline (50%) in CFC use in aerosol products during the 1970s, even before the EPA and FDA bans became effective. Recognition of these same advantages was probably a significant factor in recent decisions by the food-tray manufacturers' association to stop using CFC-12 in its products by the end of the year and by E.I. du Pont de Nemours to phase out all POD production.

In the future, some firms are likely to voluntarily label their products and advertise the fact that their use does not deplete ozone. The effectiveness of such efforts might be increased by a requirement that products containing PODs or that emitted PODs in their manufacture be labelled to indicate this fact to potential buyers. Although the effectiveness of a labelling requirement is uncertain, this approach may be a useful supplement in some cases.

Conclusions

Stratospheric ozone depletion is a global problem: POD releases from any nation have similar effects on ozone. An efficient response must coordinate action across frontiers and across the several potential ozone-depleting substances and their diverse industrial applications. In order to minimize the economic costs of limiting ozone depletion, it is important to stimulate development of alternative chemicals to replace PODs and alternative industrial processes and consumer products which are not POD-dependent.

These multiple goals are best served by market-based mechanisms, such as EPA's marketable permits approach. In this case, quantity regulation through permits is preferred to price regulation through fees because of the need to support and comply with the Montreal Protocol in order to advance international cooperation. By allowing permits to be used for any combination of PODs, weighted by their relative ozone depletion efficiencies, efficient substitution among PODs and alternative technologies will be encouraged.[33]

Actual experience in implementing policies is certainly the best possible test of their practicality and effectiveness. In the recent protocol for the protection of the stratospheric ozone layer, we now have the essential ingredients to begin learning. The United States can initiate this effort by adopting a national marketable permit system for CFCs, a guide to how such policies can operate in diverse political and economic settings. The same approach can then be extended to the climate change problem through offsets for new sources of greenhouse gas emissions.

The global environmental challenges confronting us demand a greater degree of coordination in our policy making. As we learn and move ahead, we are likely to find that economic-incentive approaches to these problems provide least-cost solutions by allowing maximum freedom of individual choice in practice.

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[33]For further reading, see: Hammitt, J. K. *Timing Regulations to Prevent Stratospheric-Ozone Depletion*, R-3495-JMO/RC. Santa Monica: The RAND Corporation, April 1987. Hammitt, J. K., K. A. Wolf, F. Camm, W. E. Mooz, T. H. Quinn, and A. Bamezai. *Product Uses and Market Trends for Potential Ozone-Depleting Substances, 1985-2000*. Santa Monica: The RAND Corporation, May 1986. Miller, A. S., and I. M. Mintzer. *The Sky is the Limit: Strategies for Protecting the Ozone Layer*, Research Report #3. Washington, D.C.: World Resources Institute, November 1986.

CHAPTER 3
AIR QUALITY ISSUES

As a result of 20 years of Federal attention to local air pollution problems, there have been substantial improvements in air quality in most parts of the country. Nevertheless, more than 100 million Americans remain exposed to excessive smog levels, and some 70 urban areas still lack adequate local plans to reduce them. In the first part of this chapter, we examine why current policies cannot finish the job, and we endorse an added approach to solving local, stationary-source air quality problems -- a comprehensive system of marketable emission permits. This approach can be highly effective for major stationary sources of air pollution, but in many of the most troubled areas, small mobile sources (motor vehicles) are a major source of emissions.

Clearly, innovative means of reducing vehicular emissions and/or vehicle miles traveled are needed. While various incentive-based approaches may eventually hold some promise, our major recommendations for mobile-source control are for enforcement of stricter vehicle-emission standards and for positive incentives for alternative fuel use.

Because Federal air pollution legislation has been targeted exclusively at local air quality problems, two major environmental threats have largely been ignored -- transported air pollution in the form of acid rain, and indoor air pollution from radon gas. Despite the fact that the Clean Air Act has helped to reduce sulfur dioxide emissions in most parts of the country, attempts by the Federal government to develop an explicit policy for the reduction of acid rain have not been successful.

In the second part of this chapter, we describe an innovative approach to this seemingly intractable problem -- an "acid rain reduction credit" program. Finally, we examine the threat posed in many parts of the country by indoor air pollution from radon gas, and we describe six varying approaches which merit consideration.

Local Air Quality

The Clean Air Act of 1970 established ambient air quality standards for several pollutants, including sulphur dioxide, particulates, carbon monoxide, and ozone. The general approach of the Act was to require the U.S. EPA and the states to establish plans to achieve standards for these pollutants by specified deadlines. These deadlines have been extended repeatedly, and today, almost 20 years after the passage of the Act, ambient air quality standards for ozone and carbon monoxide have not been met in numerous regions of the country.[1]

[1]In the case of ground-level ozone, instead of progressing toward statutory goals, the country may actually be losing ground. The number of violation-days for ozone increased by 46% from 1986 to 1987, and further deterioration

Current Federal Policy

Under the law, EPA can impose stiff sanctions, including cutting off Federal highway funds, for a state's failure to require emission reductions. EPA, however, has been reluctant to take such steps, partly because they would require reductions in emissions from smaller sources and tighter standards on automobile (tailpipe) emissions. Thus, progress toward reducing local air pollution is at an impasse. Further improvements in local air quality depend on tougher enforcement or new approaches or both.

The basic regulatory framework for local air pollution has combined the Federal vehicle emission-control program with the establishment by the states of State Implementation Plans (SIPS) under the supervision of EPA. The SIPS are specific strategies designed to meet air quality standards established by the Act. For the most part, they adopt a "command and control" approach, whereby specific pollution sources are required to achieve specified emission levels. In many cases, particular pollution control technologies or methods are also specified, based on available control devices.[2]

This "command and control" approach has brought significant emission reductions, particularly from large plants and automobiles (controlled directly by EPA under the Clean Air Act), which could be subjected to standardized engineering solutions and for which technologically feasible solutions already existed. Other pollution sources were ultimately controlled by the development of new technologies or new applications of existing control methods.[3] Further emission reductions are needed, however, and it may be difficult and expensive in many cases to achieve them through more intense application of current methods, except on automobiles.

In some cases, additional emission reductions are going to have to be made by smaller, more dispersed sources, and by innovative emission control methods at large sources. Since it is very difficult to "command" innovation, it is unlikely that these reductions can be achieved by exclusive reliance on traditional regulatory approaches. The historical approach of "technology forcing" that has been effective mainly with large industries may be difficult to apply to smaller sources with limited resources to invest in research and development. To obtain reductions from them, new strategies should supplement conventional regulatory methods.

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appears to have occurred in 1988. See: Shabecoff, Philip. "Ozone Pollution is Found at Peak in Summer Heat." *New York Times*, July 31, 1988, pp. 1, 24.

[2]In the early 1970s, many SIPs contained emission reduction requirements for which control devices had not been devised, but for which such devices were later developed by industry in the face of enforcement pressure.

[3]Major advances in the development of flue gas desulfurization for power plants, sulfuric acid technology for smelters, and catalysts for automobiles resulted from "technology forcing." Emission standards were defined which exceeded the capability of known technology. The threat of aggressive enforcement, including potential shutdowns, established strong incentives for plant operators and automobile manufacturers to invest in the development of new control methods.

Fortunately, there is a substantial track record of using a less conventional approach to controlling local air pollution.[4] In 1974, EPA began to implement "emissions trading," allowing firms that reduced emissions below the level required by law to receive "credits" usable against higher emissions elsewhere. Under programs of "netting" and "bubbles," firms have been allowed to "trade" emissions reductions among sources within the firm, so long as total, combined emissions comply with an aggregate limit.

Firms have also traded emissions credits. Under the "offset" program, begun in 1976, firms that wish to establish new sources in areas which are not in compliance with ambient standards have been required to offset their new emissions by reducing existing emissions by a greater amount. This can be done with their own sources or through agreements with other firms. Finally, under the "banking" program, firms may store earned emission credits for future use, to allow either for internal expansion or for a sale of credits to other firms.

These programs were codified in EPA's Final Policy Statement on Emissions Trading in 1986, but their use to date has not been extensive.[5] States are not required to use them, and uncertainties about the future course of the programs have made firms reluctant to participate, except where their wish to establish new sources in non-attainment areas left them no choice. Nevertheless, the programs have resulted in more than $4 billion in savings in control costs, with no adverse effect on air quality.[6]

We now have an opportunity to build on this experience in two ways. First, emissions trading should be built into the Clean Air Act itself, to reduce the uncertainty about continued operation of these programs. Second, the time is ripe to make emissions trading an affirmative tool to achieve environmental objectives, building on the experience gained using it to reduce control costs. If we are to go further in meeting our air quality goals, we must harness the powerful effects of economic incentives to work toward those goals.

Recommendation 11: Marketable Emissions Permits for Stationary-Source Air Pollution

A logical extension of the emissions trading initiatives already implemented by EPA is a comprehensive system of Marketable Emissions Permits.[7] Under such a system, all major pollution sources would be required to have permits specifying their allowed amount of pollution discharge. Firms which can reduce discharges below their permit levels could sell their surplus to

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[4]See: Levin, Michael H. "New Directions in Environmental Policy: The Case for Environmental Incentives." *Proceedings of Annual Midwinter Meeting, American Bar Association, Section of Natural Resources Law.* Keystone, Colorado, March 18-20, 1988.

[5]Shortcomings in EPA's original emission trading rules have largely been remedied. For further discussion of the lessons to be learned from EPA's experiences with emissions trading, see: Dudek, Daniel J. and John Palmisano. "Emissions Trading: Why is This Thoroughbred Hobbled?" *Columbia Journal of Environmental Law* 13(1988):217-256.

[6]Hahn, Robert W. and G. L. Hester. "The Market for Bads: EPA's Experience with Emissions Trading." *Regulation* (1987), nos. 3/4, pp. 48-53.

[7]For further discussion, see: Hahn, Robert W. "Innovative Approaches for Revising the Clean Air Act." *Natural Resources Journal* 28(1988):171-188.

other firms; firms for whom compliance is relatively costly could choose instead to buy additional permits. Once such a system is established, systematic reduction of permit amounts would bring progress towards ambient goals. If strictly enforced, this approach could be substantially more efficient than the current regulatory approach, both because its inherent flexibility takes advantage of differences in control costs ranging from, for example, $500/ton of emissions (fuel-volatility sources) to $39,000/ton (methanol-conversion sources) and because it allows individual firms to decide where and how to make desired reductions.[8] An emissions permit market can achieve the same degree of air quality protection at lower cost, as well as bring about even greater levels of pollution reduction without increasing overall control costs.

Three major steps will be involved in implementing a marketable permit system. First, an accurate emissions baseline must be established to form the basis for initial permits. The simplest approach will be to use existing emissions for firms that are complying with all current requirements and to use current legal limits for firms that are not in compliance. States should be given the flexibility, however, to deal with local situations in ways that avoid punishing firms that have aggressively reduced emissions, and any credits established under existing programs should be recognized.

Second, once the baseline permit levels are established, states should be required to institute systems for evaluating, carrying out, recording, and monitoring exchanges and sales of permits among firms. Again, local discretion will be necessary.

Third, the permitted emissions level will not constitute a "right" to pollute. State implementation plans for areas where air quality does not meet the standards set should be based on systematic scheduled reductions of aggregate permitted emission levels. That is, once the inventory is complete, a schedule should be issued that sets fixed annual percentage reductions in permitted levels until standards are met. A plant which currently (legally) emits ten tons of hydrocarbons will begin with ten permits. But it will know that those ten permits will become, for example, eight the next year, six in 1990, and five in 1992.[9]

Each pollution source will then face a choice. It can either reduce its emissions in accord with the schedule, or it can seek to purchase additional permits from firms which manage to reduce their emissions faster than required.[10] Any firm wishing to establish a new source will have to acquire the necessary permits from existing sources, and in severely polluted areas the price of emissions permits will be high. Firms which do not reduce their emissions (or wish to increase them) will have to pay for the privilege. Even firms which reduce their emissions on schedule will be "paying," in the sense that they will know that faster reductions would generate credits which could be sold for cash. This convertibility of cleanup into revenue will give firms a powerful

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[8]Tietenberg, Tom H. "Transferable Discharge Permits and the Control of Stationary Source Air Pollution: A Survey and Synthesis." *Land Economics* 56(1980):391-416.

[9]We recognize that differences in source location and seasonal factors mean that not all emissions reductions are of equal value in terms of improving air quality, a problem which also applies to command and control approaches. While it is, of course, theoretically desirable to take account of such differences, we also recognize that in some cases it may not be practical to do so.

[10]It is possible that firms would choose to retain their own credits unless and until a secure, long-term and liquid secondary market is established. A government regulated brokerage exchange might provide such needed security and liquidity.

incentive to find cleaner (cheaper) ways of doing business and will put to work resources far greater than those currently commanded by regulators in a hunt for ways to reduce emissions. What conventional regulatory methods cannot achieve in cleaning the air, this approach can.

Assessment

The main attractions of a Marketable Emissions Permits system are: (1) it holds the promise of achieving objectives which cannot be met otherwise; (2) whatever level of reductions are achieved, they will likely come at lower cost; and (3) the system has great flexibility over time. Regulators need not anticipate the emergence of new industries or the growth of existing ones. Emission levels will be predictable over time regardless of economic developments.

One potential difficulty with the approach is that it will require regulators to change the way they think about their jobs.[11] No longer will regulators be in the business of evaluating different pollution control technologies and strategies. Firms will do that for themselves, driven by the price of continued pollution.

What regulators will have to do is manage the permit system. They will need to keep track of each source's current permit level, monitor all emissions trading, and review proposed sales of permits to insure that emissions to be increased are environmentally comparable to those being reduced. Regulators may at first feel that they have less control over the system, because actual pollution control decisions will be made by polluters, not by the government.

This, of course, is the whole point of the marketable permit approach. The system will be effective only if this decentralization of decision making is allowed to work. Regulators must resist temptations to restrict the ways in which emissions are reduced to produce tradeable permits. For example, a utility which reduces loads via a conservation program must be permitted to sell the resulting pollution reductions, just as one that switched to a cleaner fuel or installed a new control technology would.

It should be noted that experience to date in those states with relatively comprehensive emissions trading systems has been only modestly successful.[12] To a large degree, plant managers have been reluctant to get involved in lines of business with which they are uncomfortable.[13] Thus, just as regulators will have to change the way they think about their jobs, so too will plant managers need to take on new roles. What the government can do to facilitate this process is to reduce risk and uncertainty by ensuring the long-term continuity of the trading system, thus fostering security and liquidity of the market. An additional problem with this and

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[11]For further discussion of likely resistance to local air quality emissions trading schemes, see: Dudek, Daniel J., and John Palmisano. "Emissions Trading: Why is This Thoroughbred Hobbled?" *Columbia Journal of Environmental Law* 13(1988):217-256.

[12]Various shortcomings in EPA's original emission trading rules, which allowed practices such as "paper trades" to take place, have been remedied. See *ibid.*

[13]See: Liroff, Richard A. *Reforming Air Pollution Regulations: The Toil and Trouble of EPA's Bubble.* Washington, D.C.: The Conservation Foundation, 1986. Liroff, Richard A. *Air Pollution Offsets: Trading, Selling, and Banking.* Washington, D.C.: The Conservation Foundation, 1980.

other trading proposals which must be addressed, if they are to be implemented successfully, is the fact that adequate baseline emissions data are currently unavailable.

Finally, enforcement will be key to the success of the program. Strict monitoring and emission-reporting requirements will be essential for timely enforcement. Fines for permit violation must be steep. The system will collapse if fines for permit violations are less than costs of acquiring needed permits from other firms, or if firms believe they can violate permit levels with impunity. Because compliance will mean meeting (possibly changing) emissions levels, rather than installing a particular technology, determining compliance may be more difficult, and hence enforcement may be more costly. On the other hand, firms will have a strong incentive to inform regulators of violations by others, since they will be paying for their own pollution permits.

Recommendation 12: Strengthened Regulatory and Incentive Approaches for Mobile-Source Air Pollution

Mobile sources play a major role in the air pollution problems of many cities. In areas such as Los Angeles and Houston, ozone standards would not be met even if industrial sources reduced emissions to zero. Most mobile and nonpoint sources probably cannot be controlled directly via the market approach outlined above, although implementation should be flexible enough that, for example, a firm which needs permits could generate them by agreeing to pay for retrofitting local gas stations to reduce hydrocarbon emissions or by facilitating increased reliance on mass transit instead of automobile commuting.

In areas where mobile sources play a very important role, air cleanup progress will probably require stricter emission standards for vehicles. The stricter-than-national standards now in place in California have been shown to be practical and cost-effective and could result in immediate help for many areas if they were put into place nationally. Other short-term approaches which merit consideration include: installation of controls on gas pumps to capture and recycle vapors which escape during refueling; reduction of gasoline volatility; use of van pools and other approaches which make more efficient use of existing vehicles; and fleet conversion to cleaner fuels, such as alcohol or natural gas. Long-run measures include increasing use of mass transit and better land-use planning.

Certain incentive-based systems also merit consideration. These include EPA's current practice of allowing use of emission-reduction credits from mobile sources to meet stationary-source requirements and fleetwide averaging and "bubbles" to comply with truck emission standards. Lastly, carefully designed emission charges offer the possibility of eventually being more cost-effective than the uniform standards approach. All of these approaches to reducing mobile-source air pollution -- both regulatory and incentive-based -- will also have important benefits for our nation's energy security and for combatting global warming.

Conclusions

For the control of stationary-source local air pollution, the time has come to move toward a more comprehensive mix of both incentive-based and conventional regulatory methods. EPA's experience with "bubbles" and offsets provides a springboard for a more comprehensive program. Such incentive-based approaches, however, will not provide a complete answer to local air

pollution problems. These approaches are subject to some of the same limitations and uncertainties which characterize conventional regulatory approaches -- namely, lack of information regarding the time and location of discharges into the environment and the effects of such discharges on human health and other receptors. Furthermore, incentive approaches are even more limited in the case of mobile sources. Because of the importance of such sources of local air pollution in some major cities, we recommend that consideration be given to enacting and enforcing stricter vehicle-emission standards.

Acid Rain

The environmental consequences of acid rain appear to be increasing year by year,[14] but there is as yet no explicit, comprehensive policy response on either the national or international level. Cost considerations and attendant social disruptions, especially for communities that mine and burn high-sulfur coal in the Appalachians and the Midwest, are one reason for the policy gap.

A program utilizing "Acid Rain Reduction Credits" can provide an innovative approach, which has already demonstrated its cost-effectiveness in the protection of local air quality. It offers the possibility of forging a politically feasible, environmentally desirable, and economically rational response to the acid rain problem.

The Nature of the Problem

Acid rain, the popular term for both wet and dry atmospheric deposition of acidic substances, has become a major environmental threat in many parts of the United States, Canada, and Europe. Industrialized areas and their neighbors downwind commonly receive precipitation with acid concentrations well in excess of natural, background levels. Rainfall in eastern North America has increased in acidity, and specific localities within this region have experienced acute problems.

Though there are natural sources of acid deposition, the evidence has increased that human sources dominate production of the two primary pollutants, sulfates and nitrates. Man-made emissions of sulfur dioxide (SO_2), the primary target of most acid-rain legislative proposals, totalled about 27 million tons nationwide in 1985, of which 15.8 million tons came from electric utilities.

Of the many forms of damage inflicted by acid rain, the acidification of aquatic ecosystems is perhaps the best documented. The most studied acidified waters are in the Northeastern United States, Canada, and Western Europe, but evidence is accumulating that the damage is much more widespread. When lake surface waters become moderately acidic, fish reproduction and health are impaired, not only by the direct effects of the acidity, but also by the toxicity of metals (such as aluminum) released by acids. Affected lakes and streams are scattered throughout the eastern

[14]For a recent description of increasing impacts on forests in the eastern U.S., see: Shabecoff, Philip. "Deadly Combination Felling Trees in East." *New York Times*, July 24, 1988, p.1.

United States and across the Canadian border in the path of emissions transported from the U.S. Their spread has generated considerable controversy between the two traditionally close allies.

Aquatic life is not the only casualty of acid rain. Another significant form of damage results from the degrading effects of airborne pollutants on natural and man-made materials. The discoloration of paint, corrosion of metals and deterioration of surface stone are well-documented examples. Other adverse effects include visibility reduction and potential damage to forest growth.

Current Federal Policy

Most of the Federal approach to controlling pollution, as embodied in the Clean Air Act, focuses on local pollution problems, rather than on continental problems such as acid rain. Therefore, while both nitrogen and sulfur oxides come within the purview of that law, the chief concern of local control authorities has been controlling ground-level concentrations within approximately 50 miles of discharge. While this objective was partly met by increasing the height of smoke stacks, one result has been an increase in the long-range transport of pollutants.

Legislation aimed directly at the acid rain problem has provided for funding of the Clean Coal Technology program, a research effort to develop technologies to reduce sulfur dioxide emissions in the burning of high-sulfur coals. Likewise, Congress has authorized funds for research and development of technologies for retrofitting older boilers to minimize sulfur emissions.

Under the provisions of the Clean Air Act of 1970, newly constructed, large industrial and electric utility emitters of sulfur dioxide were required to meet especially stringent emission standards. Because only the newest plants are subject to the stringent regulations, older plants contribute the largest proportion of total remaining emissions. By 1995, over 90% of utility discharges of sulfur oxides will be accounted for by older plants. Controlling them is thus the key issue in designing acid rain legislation.

Several obstacles lie in the way of simply requiring stringent control devices to be installed on older sources. First, it would be unnecessarily expensive. Second, it would not target the reductions in the most effective way. In the normal course of events, some electrical generating units will be retired in the near future as they outlive their useful economic lives. It would be wasteful in the extreme to force such plants to install very expensive pollution control equipment which would be used only a short time. Third, some sources are in a financially precarious position and therefore may choose to use the court system to avoid meeting standards. To the extent they succeed, the amount of reduction actually achieved will fall short of the legislative goals.

Recommendation 13: The Acid Rain Reduction Credit Program

We propose an innovative way to overcome these obstacles: the "Acid Rain Reduction Credit" (ARRC) program. Patterned after EPA's emissions trading program,[15] this economic incentive approach to acid rain control offers the possibility for achieving the emission reduction targets at a lower cost, while dealing realistically and fairly with units that are about to be replaced or are in financial trouble. Our program would function much like the "Marketable Emissions Permits" system recommended above for dealing with some local air pollution problems, except that trading would occur on a national or regional basis, rather than a local basis.[16] The source-receptor relationship must be considered, since reducing acid rain precursors in California, for example, will not reduce acid rain on the East Coast.

The ARRC program would work in tandem with other efforts to control emissions. The innovation would be to allow any sources of emissions contributing to acid rain to have "excess" reductions -- over and above a target level -- certified by EPA as acid rain reduction credits. These credits could then be used by the owners of the reducing source to meet a portion of the acid rain emission standards on some other source under their control; or they could be transferred (sold or leased) to another source. The key aspect of these credits is that they would be transferable, allowing market forces to govern their ultimate disposition.

The advantage of this approach is that individual sources will decide what methods of control to utilize. Some electrical utilities, for example, may find it cost-effective -- hence, in their interest -- to adopt retrofit programs involving coal preparation or duct injection. If initial permits are auctioned, the revenues can finance both the installation of retrofit and clean coal technology through a Federal cost-sharing arrangement and research and development efforts on these and other such technologies. Communities which currently utilize high-sulfur coal could qualify for these cost-sharing arrangements, and those sources which adopt scrubbers and similar technologies will have salable excess reductions, generating revenue in the process.

This approach combines the important efficiency properties of the ARRC program with equitable protection for communities which are economically dependent upon the high-sulfur coal industry. Furthermore, the cost-sharing arrangements for retrofitting and clean coal technology have the advantage of enhancing the competitiveness of coal, the nation's most abundant domestic energy resource.

Assessment of the ARRC Program

Adopting this innovative approach would offer many advantages. First, higher acid rain reduction goals could be met at a much lower cost than would otherwise be possible. Firms that could afford to reduce their emissions relatively cheaply would do so, selling or leasing any excess reduction to those for whom further reductions would be much more expensive; both firms would

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[15]This EPA program is described above in our examination of local air quality protection policy. A detailed evaluation of the program can be found in: Tietenberg, Tom. *Emissions Trading: An Exercise in Reforming Pollution Policy*. Washington: Resources for the Future, 1985.

[16]In some cases, firms may be subject to both programs. EPA would have to insure coordination between them.

be better off as a result. The credits would flow to their best use, minimizing the overall cost of control in the process, while meeting the legislatively mandated total emission reduction.

The cost savings could be considerable. The Congressional Budget Office has estimated that the cost of achieving a ten-million-ton reduction of sulfur oxides could be $330 million less with the ARRC approach than with conventional methods.[17] Another study, examining the cost savings that could be achieved within a single state (Illinois), concluded that the cost of control would be approximately one-third lower if an ARRC type approach were instituted.[18] An EPA analysis, based on updated coal market data, indicated that an ARRC type system could cut the costs of achieving SO_2 reductions by up to 50% (an annual savings of $3 billion) after 1995.[19]

The sources of these lower costs are not difficult to understand. Achieving emission reductions of the magnitude considered by Congress will require some utilities to adopt "scrubbers," devices which remove pollutants from stack gases prior to discharge. To force all older plants to adopt scrubbers would not only be very expensive but also unnecessary to achieve the reduction target. Yet it is politically and legally difficult under conventional approaches to isolate a few utilities to bear this additional burden for the greater good. The ARRC program solves this problem by allowing utilities to voluntarily accept greater control and by providing the proper incentive to assure that some do. While all utilities would face similar, if not identical, allowable emissions standards, some utilities, presumably those for whom adopting scrubbers was the cheapest alternative, would voluntarily choose that course, and, doing so, gain for them a performance excess above their emission control requirements.

EPA, in turn, would certify them for acid rain reduction credits, which could be sold or leased to other utilities. By buying some or all of these credits to satisfy their own emission standards, the purchasing firms would eliminate their need to install scrubbers. The process would result in sufficient control and would provide a market means of selecting those utilities that would install scrubbers while distributing the costs of scrubber installation among all utilities. Those purchasing the acid rain reduction credits would, in effect, be subsidizing a portion of the selling firm's installation of the pollution control device.

The policy would also allow tapping non-utility sources of control. Sources with tall stacks could choose to overcontrol. They would then sell the accumulated credits to the utilities, finding a ready market among those utilities that for one reason or another would prefer not to overcontrol. By using this market to open the door to other sources of reduction, many of which could be cheaper than those tapped under the traditional approach, the ARRC policy offers an additional possibility of reduced costs.

The capability to lease credits is another advantage of an acid rain reduction credit approach. Leasing offers an enormous degree of flexibility, not available with other approaches to

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[17]U.S. Congress, Congressional Budget Office. *Curbing Acid Rain: Cost, Budget and Coal-Market Effects.* Washington: U.S. Government Printing Office, 1986.

[18]Raufer, Roger K. and Stephen L. Feldman. *Acid Rain and Emissions Trading: Implementing a Market Approach to Pollution Control.* Totowa, New Jersey: Rowman & Littlefield, 1987.

[19]ICF, Inc. *Analysis of Six and Eight Million Ton 30-Year/NSPS and 30-Year/1.2 Pound Sulfur Dioxide Emission Reduction Cases.* Washington, D.C., February 1986.

pollution control. The usefulness of leasing derives from the fact that utilities and other sources have patterns of emission which vary over time, while allowable emission levels remain constant. When plants are operating at reduced levels of output (electrical or otherwise), emissions fall below allowable levels. Such plants could lease their excess emission credits to other firms, recalling them as their own needs rose. Leasing also provides a way for the oldest electrical generating units (which may shortly be retired) to participate in the reduction program. Under the traditional approach, once the deadline for compliance is reached, the utility must either retire the unit early or install expensive control equipment, useless once the unit is retired. By leasing credits for the limited period before retirement, the unit could remain in compliance without taking either of those drastic steps; it would, however, be sharing in the cost of installing the extra equipment in the leasing utility. Leased credits facilitate an efficient transition into the new regime of more stringent controls.

The ARRC approach also offers flexibility in meeting specified emissions levels for plants which are not near the end of their useful lives. Under conventional regulatory approaches, although deadlines are essential, they are also troublesome. The absence of a deadline invites procrastination, but the presence of a deadline causes its own set of problems. A single deadline uniformly applied to all sources is rarely efficient.

The ARRC approach creates an incentive for a sufficient number of sources to meet the deadline early to compensate for firms which should be allowed to meet it later. Incentives to procrastinate are eliminated by providing rewards to those who advance the schedule, while greater flexibility cuts the inefficiencies of a single deadline. An optional feature should allow firms which meet the deadline early to transfer their "early reduction credits" (defined in terms of both quantity and timing of emissions reductions) to other firms which find it particularly difficult (costly) to meet the compliance timetable.

Early reduction credits have already been successfully used in U.S. environmental policy in another context. As part of the program to reduce lead in gasoline, EPA imposed stringent deadlines for meeting standards. It was known, however, that refiners differed greatly in their ability to meet them by the mandated time. To provide flexibility while preserving the incentive to comply quickly, EPA allowed early compliers to bank their accumulated early reduction credits for ultimate sale to others. This program provided a smoother transition into the regime of more stringent controls than otherwise would have been possible.

Conclusions

Acid Rain Reduction Credits would facilitate the achievement of the nation's environmental goals for acid rain reduction at lower cost than would otherwise be possible, while providing a greater degree of flexibility to individual firms and sources. By including cost-sharing arrangements for retrofitting and clean coal technology in the ARRC plan, the program can be both relatively cost-effective and equitable, providing an important measure of protection for areas currently dependent upon the high-sulfur coal industry. The basic tradeable permit approach is not revolutionary; it has been applied successfully by EPA as a component of its local air quality protection program. What is new is the application of marketable permits to the acid rain problem, which is particularly well suited to this approach.

Indoor Radon Pollution

In 1984, an engineer at the Limerick Nuclear Power Plant in southeastern Pennsylvania set off radiation detectors as he arrived at work in the morning. The cause was found to be radioactive contamination from radon gas within his own home.[20] EPA has now identified radon as one of the most serious environmental risks facing the nation.

The Problem

The radioactive gas radon-222 is a natural decay product of radium, which is found, to varying degrees, in virtually all soil and rock. High human exposures occur when radon gas from soil with a high radium content enters a building through cracks or openings in the foundation. If the building has inadequate ventilation, radon concentrations can accumulate to unhealthy levels. Various radioactive "daughters" attach to dust particles in the air or enter the lungs directly and expose sensitive tissue to alpha radiation. Such exposure over a period of ten to thirty years can cause lung cancer. EPA has identified radon as one of the most serious environmental risks facing the nation, causing 5,000 to 20,000 lung cancer deaths each year. In 1987, EPA found elevated radon levels in 21% of a sample of 10,000 homes tested in ten states. Alabama had the lowest incidence at 5%, and Colorado had the highest at 40%; but Alabama had the highest single reading at 45 times the EPA action level.

Current Policy

EPA and state health departments have tried to inform the public of potential risks and have encouraged voluntary testing and some measures to reduce indoor radon exposure, but there is very little statutory authority for government involvement in the radon problem. EPA's initial program was based on general language in the Clean Air Act, and the Department of Energy implemented a research program because of the relationship between elevated radon levels and energy conservation. The Superfund Amendments and Reauthorization Act (SARA) of 1986 subsequently assigned responsibility (and $7.6 million in appropriations) to EPA for a national survey of radon exposure and determination of what radon level poses a threat to human health. Only five states -- Florida, New Jersey, Pennsylvania, Maine, and New York -- have extensive radon programs. Total state funding in 18 states has reached $20 million, with Pennsylvania, New York, and New Jersey accounting for nearly 90% of that amount. In contrast, EPA is requiring industry to spend some $300 million to reduce radon exposure from commercial uranium mill tailings, although health risks from such sources represent only a small fraction of the total risk of radon to the general population.

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[20]Additional sources of information on indoor radon pollution include: (1) U.S. Environmental Protection Agency, Office of Air and Radiation, U.S. Department of Health and Human Services, and Centers for Disease Control. "A Citizen's Guide to Radon: What It Is and What to Do About It," OPA-86-004, Washington, 1986. (2) U.S. General Accounting Office. "Indoor Radon: Limited Federal Response to Reduce Contamination in Housing," GAO/RCED-88-103, Washington, 1988. (3) Johnson, F. Reed and Ralph A. Luken. "Radon Risk Information and Voluntary Protection: Evidence from a Natural Experiment." *Risk Analysis* 7(1987):97-107. (4) Smith, V. Kerry, William H. Desvousges, Ann Fisher, and F. Reed Johnson. "Communicating Radon Risk Effectively: A Mid-Course Evaluation," U.S. Environmental Protection Agency, EPA-230-07-87-029, Washington, 1987.

The current approach focuses primarily on the technical and health dimensions of the radon problem: developing consistent testing methods, demonstrating radon reduction techniques on a variety of building types, and confirming the connection between exposure and disease. There has been little progress in actually reducing indoor radon concentrations in homes, schools, and work places. Because radon exposure occurs largely in private homes, it has appeared neither feasible nor appropriate to use the conventional regulatory approach of setting and enforcing health-based exposure standards. Instead, EPA, the Department of Health and Human Services, and the Center for Disease Control issued "action guidelines" to advise homeowners about steps to take to reduce high exposure levels. EPA identified an exposure level of 4 picocuries per liter (pCi/l) as a level above which people should attempt to reduce exposures "within a few years;" sooner if levels were above 20 pCi/l. It is important to emphasize that the 4 pCi/l level is based on technical feasibility, not on public health criteria. EPA typically regulates toxic pollutants if the risk of death is about one per million. The risk of lung cancer for a lifetime exposure of 4 pCi/l is between one and five per hundred (between ten thousand and fifty thousand per million), about the same as smoking half a pack of cigarettes a day.

The existing policy for reducing radon risks relies on homeowners' access to information provided by state agencies and their ability to make informed judgments about appropriate actions, but available evidence on the success of such an approach is not encouraging. Fewer than half of the homeowners living in known high-risk areas of Pennsylvania have carried out tests for radon, despite the availability of free test kits and extensive publicity.

Desirable characteristics of an effective radon-reduction program include: (1) the policy should enable homeowners to understand the risks to which they are exposed and to make informed decisions about alternatives; (2) the policy should encourage cost-effective risk reduction (i.e., encourage people at high risk to mitigate it and assure people at low risk that mitigation is unnecessary); and (3) the policy should impose a minimum burden on scarce public resources.

Recommendation 14: Give Consideration to a Variety of Federal Actions

Numerous policies have been suggested for the radon problem, but there are important problems with each. For that reason, rather than endorsing a single policy at this time, we recommend that consideration be given to a number of possible approaches to the radon problem.

a. Tax Incentives and Subsidized Loans

First, tax incentives and subsidized loans have been suggested because radon mitigation imposes an economic burden. Radon mitigation could be encouraged by reducing its effective cost to homeowners through tax credits, rebates, or reduced interest rates on loans, and a means test could restrict such benefits to lower income households. Radon mitigation requires modifications to structures which are generally no more complicated or costly than those associated with energy conservation measures. The relative success of tax credits for energy conservation may indicate their appropriateness for radon mitigation as well. Disadvantages of this approach, however, include the following: (1) tax incentives obviously increase budgetary deficits; (2) the public's understanding of the risks of radon would not be improved; (3) cost-effective mitigation would not be induced; and (4) at least one state, Pennsylvania, found little citizen interest in a subsidized loan program and abandoned it.

b. Development of Model Construction Codes

Construction codes could be tightened to prevent leakage of soil gas into homes. EPA estimates that the cost of radon-proofing a house during construction ranges from $400 to $600, while retrofitting an existing house with the same equipment costs from $1,600 to $3,000. Relatively simple modifications of construction practices could therefore greatly reduce radon mitigation costs. The Federal government could sponsor the development of a model building code for preventing radon intrusion and encourage its adoption by local governments.

Although this approach has the advantages of avoiding problems of judgment on the part of homeowners and imposing no significant burden on the public purse, some substantial problems remain. Requiring all new construction to be radon-proof would be inefficient in the extreme, since only a small share of new homes are likely to have elevated radon levels. Yet all new home buyers would pay higher costs. If the average cost of retrofitting is about four times greater than radon-proofing new construction, then this policy would be cost-effective only in areas where more than 25% of new homes are likely to have elevated radon levels.

c. Soil Testing and Land Use Planning

New Jersey now tests soil samples in various parts of the state to determine areas where radon problems may be predicted in future construction. This information will be used in land-use planning to restrict development in known radon hot spots or to require radon-proof construction techniques in such areas. Such a policy could be encouraged by the Federal government and supported by assisting states to develop soil testing and evaluation programs.

Particularly when combined with appropriate building code requirements, this approach could reduce the disadvantages of the previous proposal by targeting problem areas. Unfortunately, however, soil tests have not proven to be reliable in predicting actual indoor radon concentrations. Exposures depend upon a large number of variables, in addition to radon content in soil gases.

d. Improved Certification of Testing and Mitigation Services

The private sector has responded quickly to the new demand for radon testing and mitigation services: EPA's list of approved testing companies has increased from a handful to over a thousand in less than two years. Inevitably, some unscrupulous radon companies have exploited homeowners with deceptive and fraudulent practices, and the lack of known reliable radon firms has probably deterred some homeowners from taking appropriate action. The government could stimulate more effective private market activity by improving certification of radon-service providers, expanding existing training programs for private contractors, providing better enforcement of anti-fraud laws, and helping to establish a clearing house to match homeowners and firms.

Certification reduces some of the burden of information gathering and processing on the part of homeowners and therefore works to reduce mitigation costs. Eager for such a program,

industry has cooperated with Federal and state agencies. On the other hand, one reason why existing firms are so eager for this type of regulation is that it would impose barriers to entry and competition. Certification may also stifle innovation and generally raise costs to consumers. An alternative to certification might be for the government to provide easily accessible information on firms' services, prices, and customer complaints.

e. Testing Requirements for Real Estate Transactions

The delayed effects of radon exposure make it easy for individuals to put off radon mitigation, even though the risks are serious indeed. In many cases, concern for real estate values may provide a more immediate and tangible motive for homeowners to reduce radon levels. The single Federal action likely to have the greatest effect on reducing radon exposure would be to require that homes be certified "radon free" in order to qualify for FHA financing, just as they must currently be certified free of termite infestation. Some banks already have begun to require such certification before approving mortgage financing.

Alternatively, local real estate regulations could require merely that buyers be informed of radon concentrations prior to sale. Possible mitigation costs could then become one more element to be negotiated between buyers and sellers. Some buyers have already begun requesting such information and some real estate associations now recommend inclusion of a radon clause in standard sales contracts. Government intervention would accelerate this process.

The attraction of this pair of approaches is that neither requires expenditure of government funds nor establishment of new programs. Only minor modifications of existing rules would be necessary. The perceptual problems associated with delayed, low probability risks are avoided, and existing market forces and self-interest are harnessed to achieve positive public health benefits. The second (information only) alternative allows people to seek outcomes consistent with their own preferences and circumstances.

A problem with the FHA requirement is that it could enshrine a basically arbitrary standard and reinforce perceptions that a specific radon level is "safe." More important, unlike termite inspections, it may be difficult to obtain an unbiased short-term test. Current tests involve exposing testing devices to indoor air for three to five days. A minimum of ventilation before and during the test is required; otherwise the reading will be inaccurately low. A seller has an incentive to influence the test in that direction, an easily accomplished distortion. Furthermore, because radon levels can vary considerably over time, short-term monitoring can give poor indications of average annual exposures, the basis for most risk estimates. Alternatively, of course, tests could be performed after the buyer moves in, but that eliminates the possibility of certifying acceptable radon levels before sale and would require, at the least, a substantial escrow deposit to cover mitigation costs. The real estate industry has resisted such requirements because they could increase transaction costs of real estate sales.

f. Improved Information and Voluntary Compliance

Finally, greater public resources could be used to disseminate information to current and prospective homeowners, because radon risks have characteristics which make it difficult for people to make appropriate decisions. Although mailing an informational brochure to citizens in affected areas might be appropriate, the use of local elected officials to disseminate the message, sharing information among neighbors, and making inexpensive test kits available in grocery stores may prove more effective than national or statewide programs.

As unreliable as voluntary compliance often seems, most of the alternative approaches have serious deficiencies. Until we can achieve significant breakthroughs in increasing the effectiveness and reducing the costs of testing and mitigation methods, one possibility is to continue to rely on risk communication as the primary means of reducing radon health risks. A relatively modest investment of resources in radon risk communication can be effective in developing better methods of informing homeowners and motivating appropriate decisions. Compared to conventional regulatory procedures, information programs are inexpensive and effective ways to let homeowners and buyers make informed decisions which reflect their own preferences and circumstances.

CHAPTER 4
ENERGY POLICY AND THE ENVIRONMENT

Since the Arab oil embargoes of the 1970s, Federal energy policy debate has focused on the security of our energy supplies and on conflicts between increasing domestic energy production and environmental protection. In this chapter, we examine emerging complementarities between means to increase our energy security and ways to protect our environment. After examining the major energy security and environmental problems associated with energy production and use, we recognize that a highly effective strategy for dealing with both sets of problems is to increase energy efficiency throughout the economy.

We make three sets of recommendations to achieve that goal:

(1) higher vehicle fuel-efficiency standards;

(2) a series of incentives to encourage consumers to switch to alternative fuels; and

(3) systems of comprehensive least-cost bidding for electrical utilities

Next, we propose a policy which focuses exclusively on energy security concerns: an expansion of the Strategic Petroleum Reserve. Finally, we recognize that environmental and energy concerns regarding fossil fuel use may lead to renewed interest in alternatives to generating electricity by burning fossil fuels. We consider the problems this will present and we recommend that the government fund research on non-fossil fuel energy sources, including solar, other renewable sources, and passively safe nuclear power.

The Problem

Crude petroleum is among the most critical of all resources to the U.S. economy, accounting for more than 40% of the nation's energy needs. Over the past 20 years, imports have provided an increasing share of the crude oil used in this country. In the early 1970s, we imported about 25% of our crude oil; today, the total is over 37%. The increased dependence on imported oil is cause for concern, since the overall supply of oil on the world market is very much influenced by production from the Persian Gulf, a region of chronic political instability. Since a cutback of oil supplies from the Middle East could cause substantial economic losses to the U.S. and other oil-consuming nations, efforts to find low-cost domestic sources of crude oil and to reduce dependence on imports have intensified.

Energy security is not a simple matter of physically securing supplies of energy to prevent their disruption. While the U.S. has vast energy supplies, the almost total dependence of our transportation sector on oil and its derivatives makes us dependent on imports. Our oil supplies are not only limited, but also, compared to production costs in other producer nations, expensive.

Vulnerable to fluctuations in world oil prices, our economy risks both the huge costs of high oil prices and the failure of domestic producers when prices fall. In that case, imports increase, and so does our vulnerability to subsequent price rises. In either case, oil imports burden our balance of trade. Even at today's comparatively low oil prices, the U.S. is spending over $40 billion annually to import oil, about 25% of our total trade deficit.[1]

Because oil prices are set on a world market, the U.S. cannot simply produce its way out of these risks. A cutback in oil supplies from the Persian Gulf would raise the price from wells in Texas as well as in Saudi Arabia. Furthermore, an attempt to buy security through higher and higher domestic oil production could run up against serious environmental considerations, such as the risks of exploration and drilling offshore along the Outer Continental Shelf (OCS). Yet another conflict between increased domestic oil production and environmental protection has been raised by the Department of the Interior's proposal to open up sections of the Arctic National Wildlife Refuge in Alaska to oil drilling. This area is the only part of the U.S. Arctic coast now protected from oil development, and a key site for the survival of polar bear, caribou, and musk oxen on the Alaskan North Slope.

Significant gains in domestic oil production can be made through research and development of enhanced oil recovery, as well as continued exploration and development in the U.S. -- which in many areas is not environmentally problematic. The United States can also make significant gains in cutting dependence on oil by pursuing increased efficiency in our use of oil and by encouraging the use of alternative fuels.

Recommendation 15: Increase Motor Vehicle Fuel-Efficiency Standards

Increasing the efficiency of motor vehicles should receive very high priority. Vehicles account for 63% of oil demand in the U.S. and 27% of our total energy use. Current law requires automobile manufacturers to achieve a "fleet average" efficiency of at least 26 miles per gallon (mpg). We can do considerably better than that with current technologies, and it is reasonable to target a standard of at least 38 mpg by the end of the century. While the current standards apply to a manufacturer's entire spectrum of models taken as a whole, it may be possible to achieve greater progress by providing a more flexible system.

Recommendation 16: Provide Incentives for Greater Efficiency in the Motor Vehicle Sector

The regulatory initiative described above could be coupled with a program to increase the tax on "gas guzzlers" and use revenues from this tax (and perhaps from gasoline taxes) to provide rebates to purchasers of very efficient vehicles -- "gas sippers." Currently, cars which get less than 22.5 mpg are taxed as "guzzlers," and the tax gets higher for cars that are even less efficient. We should index the tax so that its threshold rises as new car requirements get stricter.

Another incentive which merits some consideration is an increase in current Federal excise taxes on gasoline. Revenues from gasoline taxes currently go into the Federal Highway Trust Fund to be spent ultimately on highway construction and repair. Under this arrangement, gasoline

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[1]U.S. Department of Commerce. *U.S. Merchandise Trade*. Circular FT-900. Washington, D.C.: U.S. Government Printing Office, 1987.

taxes are essentially user fees: highway users pay the taxes necessary to construct and maintain our highways. But the serious air quality costs of gasoline marketing and consumption, as well as energy security risks, justify additional taxes on gasoline. Increased gasoline taxes can encourage people to cut down on driving and gasoline consumption.[2] Phased in by three or more increments over a number of years, gas tax increases would cause purchasers to take future costs into account as they make investment decisions on new cars, while holding down the immediate impact on consumers. Revenues could be used to fund research on renewable energy sources, support for mass transit, and various methods of protecting and improving air quality.

Finally, encouraging the use of alternative vehicle fuels is essential to dealing with energy security and will be an important part of fighting urban air pollution. One means of doing this is lowering Federal excise taxes on fuels such as natural gas and alcohols in recognition of their value to society, not only in improving energy security, but also in reducing air pollution and the production of greenhouse gases. The Federal government has an important leadership role to play in promoting alternative fuels. Where the government owns or supports short-range vehicle fleets (such as the majority of vehicles used by the postal service), it can and should be the first to switch to alternative fuels. Where fuel availability is a serious constraint, the Federal government should actively pursue flexible-fuel vehicles -- those which can use either gasoline or alternative fuels -- and it should provide for a base supply of alternative fuels for those vehicles.

Natural gas, which is an alternative vehicle fuel itself and is also the primary feed stock for methanol production, is relatively abundant. But the Federal government must plan now for increasing use of natural gas. The Federal Energy Regulatory Commission must give greater priority to policy options on natural gas pipeline regulation which will enable greater amounts of natural gas to reach growing markets where pursuits of alternative-fuel vehicles will likely increase demand.

A key feature of all of these proposals is that they have multiple benefits which are not included in oil cost calculations. Increasing vehicle efficiency and switching from gasoline and diesel to cleaner fuels not only reduces oil imports; it also decreases the production of greenhouse gases and in many cases reduces the total production of local air pollutants.

Recommendation 17: Expand the Strategic Petroleum Reserve

The Strategic Petroleum Reserve (SPR) program is a crucial element in the effort to reduce the nation's vulnerability to a cutback in oil supplies on the world market. The SPR provides a buffer stock of oil to be used in the event of a cutback in world oil supplies. If a serious disruption were to occur, oil from the SPR would be made available to refiners and thereby lessen economic damages.[3] Studies indicate that the national security benefits of expanding the Reserve to one

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[2]A problem which needs to be addressed is that environmental damages, and hence the social costs of gasoline use, vary widely by geographic area.

[3]There would be no need for government stockpiling if all of the potential economic losses from a supply cutback would be suffered by the firms that import oil: if this were the case, the oil importing firms would have incentives to stockpile oil in sufficient volumes to "internalize" the risks associated with imported oil. Many of the economic losses from a disruption, however, would be suffered by other firms and individuals, and consequently government stockpiling becomes necessary. For a detailed discussion of the justifications for government involvement in oil stockpiling, see: Hogan, William W. "Oil Stockpiling: Help Thy Neighbor." *The Energy Journal* 4(1983):49-71.