Order Code 98-738

CRS Report for Congress

Global Climate Change: Three Policy Perspectives

Updated February 7, 2008

Larry Parker and John Blodgett
Specialists in Energy and Environmental Policy
Resources, Science, and Industry Division

Prepared for Members and
Committees of Congress

Global Climate Change: Three Policy Perspectives

Summary

The 1992 U.N. Framework Convention on Climate Change requires that signatories, including the United States, establish policies for constraining future emission levels of greenhouse gases, including carbon dioxide (CO_2). The George H. W. Bush, Clinton, and George W. Bush Administrations each drafted action plans in response to requirements of the convention. These plans have raised significant controversy and debate.

This debate intensified following the 1997 Kyoto Agreement, which, had it been ratified by the United States, would have committed the United States to reduce greenhouse gases by 7% over a five-year period (2008-2012) from specified baseline years. Controversy is inherent, in part, because of uncertainties about the likelihood and magnitude of possible future climate change, the consequences for human well-being, and the costs and benefits of minimizing or adapting to possible climate change. Controversy also is driven by differences in how competing policy communities view the assumptions underlying approaches to this complex issue.

This paper examines three starting points from which a U.S. response to the convention is being framed. These starting points, or policy "lenses," lead to divergent perceptions of the issue with respect to uncertainty, cost and benefit accounting, and urgency. They also imply differing but overlapping processes and actions for possible implementation, thus shaping recommendations of policy advocates concerning the federal government's role in reducing greenhouse gases.

A *technological lens* views environmental problems as the result of inappropriate or misused technologies. The solutions to the problems lie in improving or correcting technology. The implied governmental role would be to provide leadership and incentives for technological development.

An *economic lens* views environmental problems as the result of inappropriate or misleading market signals (prices). The solutions to the problems lie in ensuring that the prices of goods and services reflect their total costs, including environmental damages. The implied governmental role would be to improve the functions of the market to include environmental costs, so the private sector can respond efficiently.

An *ecological lens* views environmental problems as the result of indifference to or disregard for the planet's ecosystem on which all life depends. The solutions to the problems lie in developing an understanding of and a respect for that ecosystem, and providing people with mechanisms to express that understanding in their daily choices. The implied governmental role would be to support ecologically based education and values, as well as to promote "green" products and processes, for example through procurement policies and labeling requirements.

Some initiatives are underway; all the perspectives are relevant in evaluating them and possible further policies. The purpose here is not to suggest that one lens is "better" than another, but rather to articulate the implications of the differing perspectives in order to clarify terms of debate among diverse policy communities.

Contents

List of Tables

Global Climate Change: Three Policy Perspectives

Introduction

Even as the possible role of human activities affecting global climate is being actively debated, national and international climate change policy actions are underway.[1] As a party to the United Nations Framework Convention on Climate Change, the United States committed to the objective of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"; and to preparing "national action plans" to address emissions of greenhouse gases.[2]

The domestic debate intensified with the negotiations relating to the Kyoto Protocol, agreed to in December, 1997.[3] Specifically, under the terms of the Kyoto Protocol, the United States would have committed to reducing its average annual net carbon-equivalent emissions of six gases — carbon dioxide (CO_2), nitrous oxide, methane, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride — by 7% below 1990 levels (1995 for the fluorinated gases) over the five-year period 2008-2012. If it had been ratified by the Senate, the Kyoto Agreement would have moved

---

[1] This paper discusses policy perspectives on the issue and potential actions, but not the underlying controversy concerning the reality and urgency of global climate change — sometimes more narrowly termed "global warming." For background, see CRS Report RL33849, *Climate Change: Science and Policy Implications*, by Jane A. Leggett.

[2] The Senate consented to ratification of the U.N. Framework Convention on Climate Change on October 7, 1992, with a two-thirds majority division vote; President H. W. Bush signed the instrument of ratification of the Convention on October 13, 1992.

[3] On the agreement, see CRS Report RL33826, *Climate Change: The Kyoto Protocol, Bali "Action Plan," and International Actions*, by Susan R. Fletcher and Larry Parker.

the debate beyond the mix of "study,"[4] "no regrets,"[5] and "voluntary actions"[6] policies of the George H. W. Bush, Clinton, and George W. Bush Administrations.

The Clinton Administration, however, never submitted the Kyoto Protocol to the Senate,[7] and subsequently President George W. Bush rejected it outright. In lieu of the approach of the Kyoto Protocol, featuring binding commitments to reduce emissions by developed and transitional nations, President George W. Bush proposed a two-pronged approach: one to focus on further research and development to better characterize global climate change and its causes, the other to reduce the amount of greenhouse gases emitted per unit of economic activity through voluntary actions.[8] In addition, on July 27, 2005, the Bush Administration announced formation of a six-nation Asia-Pacific Partnership on Clean Development and Climate (APP),[9] with the goal of meeting "national pollution reduction, energy security and climate change concerns, consistent with the principles of the U.N. Framework Convention on Climate Change (UNFCCC)" through "a voluntary, non-legally binding framework

---

[4] Focusing on the study of global climate processes, with particular attention to the potential human role in causing change, this approach implies that taking action to regulate human activities on the basis of possible impacts of global warming should await further information verifying the need. This is not simply to ignore the problem, because it implies focused research with additional resources. Arguably, too, such research would be necessary to support decisions when and if action were deemed necessary. For a review of federal investments in climate change-related research, see CRS Report RL33817, *Climate Change: Federal Expenditures*, by Jane Leggett.

[5] Adopting a "no regrets" policy can be summarized as assessing policy options across the range of federal activities for their potential impact on global climate change, and where alternative policies to achieve a goal otherwise appear similar, adopt the one most consistent with protecting against the risk of global climate change. The idea of "no regrets" derives from the presumption that even if global climate change proves a false alarm, one would not regret adopting policies that are protective if there were no additional (or at most minimal) costs and the policies were justified on other grounds (e.g., have other environmental benefits or energy security benefits).

[6] These steps included longer-term research and development and incentives focused primarily on more energy-efficient buildings, industrial cogeneration and control of minor greenhouse gases, fuel efficient vehicles, and reducing carbon emissions in electricity generation. These actions could be classed as consistent with a "no regrets" approach, the Framework Convention, and U.S. energy policy as articulated in the Energy Policy Act of 1992.

[7] In July, 1997, prior to Kyoto, the Senate agreed by a unanimous vote 95-0 to S.Res. 98, stating that the Clinton Administration should not accept an agreement that would seriously harm the economy or that did not require developing countries to meet appropriate reduction requirements. The Clinton Administration signed the agreement, saying that costs would not be excessive (particularly because it included emissions trading and joint implementation provisions), and said it would be encouraging developing nations to participate. But the Clinton Administration never submitted the Agreement to the Senate.

[8] See [http://www.whitehouse.gov/news/releases/2002/02/climatechange.html].

[9] The other members are China, India, Japan, Australia, and South Korea.

for international cooperation."[10] Additionally, in May 2007, the President announced that the United States would convene a meeting of the world's "major economies" that are responsible for most greenhouse gas emissions. Held in September 2007, the final statements of the "Major Economies Meeting on Energy Security and Climate Change" emphasized the need to integrate such meetings into the overall UNFCCC negotiations. The U.S. summary of the meeting focused on the "aspirational" nature of reduction goals, reflecting the Administration's rejection of mandatory reduction targets.[11] A second meeting was held in January 2008.

Because of the uncertainties associated with global climate change — the extent to which global climate change is occurring, what the effects might be and their magnitude, the economic and social consequences that would follow from actions to reduce emissions of greenhouse gases, the relationships between emissions and economic activity, the costs of actions or of taking no action, the time frame of impacts, etc. — each individual's perception of what, if anything, to do is strongly influenced by personal and community values, perceptions of human progress and adaptability, experience, education and training, and outlook in how to cope with risks and uncertainty.[12]

These differing perspectives of persons affect their observations and interpretations of the issue, influencing their decisions on whether policy interventions are necessary and, if so, what kinds of intervention. At the same time, personal perspectives can change; new knowledge, education, and/or moral suasion may impact on policymaking and individual and corporate behavior, and may also be necessary to create conditions for successfully implementing initiatives relating to climate change.

---

[10] Charter for the Asia-Pacific Partnership on Clean Development and Climate (January 12, 2006), "Purposes," 2.1.1. For additional information on APP, see [http://www.asiapacificpartnership.org/] and "Asia-Pacific Partnership on Clean Development and Climate: New Vision Statement of Australia, China, India, Japan, the Republic of Korea, and the United States of America" [http://www.state.gov/g/oes/climate/app/75320.htm].

[11] "Final Chairman's Summary: First Major Economies Meeting On Energy Security and Climate Change,"White House Council on Environmental Quality (September 27-28, 2007), at [http://www.state.gov/g/oes/climate/mem/93021.htm].

[12] Implications of differing perceptions are discussed in, for example, Steven Kelman, *What Price Incentives: Economists and the Environment* (Boston: Auburn Publishing Co., 1981); Lester B. Lave and Hadi Dowlatabadi, "Climate Change: The Effects of Personal Beliefs and Scientific Uncertainty," *Environmental Science and Technology*, Vol. 27, no. 10 (1993), 1962-1972; Richard B. Norgaard and Richard B. Howarth, "Climate Rights of Future Generations, Economic Analysis, and the Policy Process," in U.S. Congress, House, Committee on Science, Space, and Technology, *Technologies and Strategies for Addressing Global Climate Change*, Hearings, 17 July 1991 (Washington, D.C.: U.S. Govt. Print. Off., 1992), pp. 160-173; and "Science and Nonsense in the Global Warming Debate," *ENDS Report* 233 (June 1993), 21-23.

Three Lenses for Viewing Solutions

The many personal proclivities and professional constructs that help shape an individual's perspectives on environmental issues in general, and global climate change in particular, can be grouped into three perspectives that affect proposed policies. These perspectives, which can intertwine and overlap, are:

- that environmental problems are the result of inappropriate or misused technologies, and that the solutions to the problems lie in improving or correcting technology;

- that environmental problems are the result of market failures, and that the solutions to the problems lie in ensuring that market decisions take into account all costs, including environmental damages; and

- that environmental problems result from a combination of ignorance of, indifference to, and even disregard for, the ecosystem on which human life ultimately depends, as well as for the other living creatures that share the planet; and that the solutions to environmental problems lie in developing an understanding of and a respect for that ecosystem and in providing mechanisms for people to express the priority they place on the environment in their daily choices.

Each of these perspectives can be considered a "lens" through which individuals and policy communities view the issue — a lens that provides a particular focus on the nature of the problem and for the kinds of actions to solve it.[13] For shorthand, they might be termed the *technological lens*, the *economic lens*, and the *ecological lens*, respectively.

Each perspective and its associated policy approaches generally are sufficiently distinct that a dominating tendency in policy options can be discerned. As policy frameworks, these lenses incorporate terminology and methods associated with diverse academic disciplines and professions, including not only engineering, economics, and ecological sciences, but also various social sciences, jurisprudence, theology, and others. As policy frameworks, they should not be confused with any one academic discipline or profession;[14] rather, they are perspectives on policymaking, on how to focus on a policy issue.

---

[13] No further action on global climate change, or setting a policy of no federal government role are options, as well.

[14] Hence, the economic lens should not be confused with the academic discipline of economics, nor the ecological lens with ecological science. The frameworks are broader than any single discipline, incorporating a range of policy-relevant perspectives, depending on the personal experiences and knowledge of the policymaker.

While the lenses can be analyzed as distinct perspectives, most of the time for most people they represent predilections rather than conscious alternatives.[15] The lenses differ primarily in what aspects of the issue come into focus, resulting in some being magnified, others obscured, or even distorted. The appropriateness of this focusing is dependent on the characteristics of the specific issue and the orientation of the policymaker. Thus, a policymaker viewing global climate change through one lens — say, the technological lens — is not necessarily disregarding economic or ecological factors, although these factors tend to lie outside, and may be less discernible, than the more clear focus on technological options.

Ultimately, given the diversity of policymakers and the potential overlapping of viewpoints, any global climate policy considered will likely involve a mix of initiatives representing all of the perspectives. Such a mix may reflect mutual accommodation as much as conscious agreement that a combination of approaches better ensures progress toward mitigation goals. The purpose here is not to suggest that one lens is superior to another, but rather to articulate the differing perspectives in order to facilitate communication among different parties and interests.

Technological Lens

Background. Viewed through the technological lens, an environmental problem is an "opportunity" for ingenuity, for a technical "fix." This technologically driven philosophy focuses on research, development, and demonstration of technologies that ameliorate or eliminate the problem. Many uncertainties can be ignored if technology is available to render them irrelevant (a presumption underlying the "pollution prevention" concept, for example). From this perspective, policy entails the development and commercialization of new technologies; government's role can include basic research, technical support, financial subsidies, economic mechanisms, or the imposition of requirements or standards that stimulate technological development and that create markets for such technologies.

The relationship between environmental protection and technological development was recognized early in the environmental debates and policymaking of the 1960s and 1970s. Particularly in the area of mobile source pollution control, standards anticipated technological development to achieve emissions reductions — commonly called "technology-forcing." Although some in industry argued that this was not an efficient means of encouraging technology (particularly when the deadlines for compliance were short), the process undoubtedly stimulated development.

A "technology-forcing" approach to environmental policy is generally associated with pushing private sector research and development in a socially desired direction (for example, forcing the automobile industry to meet more stringent emission standards than technologically feasible at the time the standards were set). Technology-forcing requirements have also been imposed on public sector programs. For example, the Solid Waste Disposal Act was amended in 1992 to subject the

---

[15] See Marco Janssen and Bert de Vries, "The Battle of Perspectives: A Multi-Agent Model with Adaptive Responses to Climate Change," *Ecological Economics* 26 (1998), 43-65.

Department of Energy (DOE), which is responsible for generating the bulk of the Nation's mixed waste,[16] to penalties for violating the Act's requirements with respect to handling and disposing of such waste. Because of inadequate treatment technology available at the time, DOE was required to submit a plan to develop such treatment capacities and technologies to treat all DOE mixed wastes by 1995 (sec. 3021(b)). Failure to comply was subject to penalties against DOE by EPA.[17]

Regulatory mandates can directly stimulate the commercialization of technology by creating market opportunities. These mandates can be performance-based (meet an emissions level), or technology-based (specify the performance of the technology used). For example, California and 14 other states have enacted legislation or regulations mandating that greenhouse gas emissions from new passenger vehicles be reduced by 22% in model year (MY) 2012 and 30% in MY2016.[18] The degree to which these sorts of mandates have forced technologies has depended on the perceived seriousness of problems (resulting in accelerated time frames for development, and in very high levels of required performance), the ease of developing the needed technology, and the impact of anticipated costs on consumers.[19]

Along with the use of a regulatory approach to forcing technology, the federal government has also taken an active role in assisting private industry in developing pollution control technology. Some environmentally important industries did not have strong research and development sectors in the late 1960s and 1970s, or did not have ones that could easily be redirected toward pollution control. This led to governmentally directed research and developmental efforts toward pollution control technology. For example, the EPA spent approximately $2 billion supporting development of a feasible flue gas desulfurization (FGD) device for electric utility use to control sulfur oxides. At that time (late 1960s), the utility industry had no central research effort (the Electric Power Research Institute (EPRI) was not started until 1972), and individual utilities devoted their engineering efforts to improving mechanical efficiency of generation, not the chemical engineering necessary for desulfurization. Many utilities also were opposed to adding a chemical process on their plants, preferring other control techniques, such as tall stacks and low sulfur coal. The success of the Government's efforts is indicated by the fact that the FGD

---

[16] Mixed waste consists of both radioactive and hazardous materials. The radioactive material in DOE mixed waste may be low-level, transuranic, or high-level, depending on the activity that generated the waste. The radioactive material is subject to the Atomic Energy Act (AEA), and the hazardous material is subject to the Resource Conservation and Recovery Act (RCRA). Although both statutes are generally consistent, Section 1006(a) of RCRA grants precedence to the AEA for certain provisions that may differ.

[17] DOE proposed treatment plans for its mixed waste sites to EPA and relevant states in 1995, most of which were approved later that year. For information on the status of the remaining plans and site locations, see EPA's website at [http://www.epa.gov/radiation/mixed-waste/mw_pg12.htm].

[18] See CRS Report RS22788, *Regulation of Vehicle Greenhouse Gas Emissions: State and Federal Standards*, by Brent Yacobucci.

[19] For more information, see CRS Report RL34099, *California Waiver Request to Control Greenhouse Gases Under the Clean Air Act*, by James E. McCarthy and Robert Meltz.

device is now the performance and reliability standard by which new, emerging control devices are measured. The federal government has also promoted the development of hybrid electric and fuel cell vehicles in the United States through joint government-industry research and development aimed at the introduction of high efficiency cars and trucks, as well as tax incentives for the purchase of new advanced technology vehicles.[20]

The technological lens reflects a traditional American "can-do" faith in technology, and in the country's ability to find a "technology-fix" to meet the needs of most problems. Such an approach attempts to increase the effectiveness of technology so that social problems can be solved at little or no additional cost. Consumers' desires and needs are taken as a given. The technological response is an effort to achieve an acceptable level of environmental protection without unduly restricting the choices available to those consumers. For example, consumers want to drive. Viewed through the technological lens, policymakers see their role as making that activity less environmentally harmful at minimal cost to consumers, not as restricting that desire or even necessarily as offering alternatives to driving such as mass transit. Efforts to diminish consumer use of the automobile would be seen as a last resort. *The technological lens provides a view of the economy in which technology permits consumers to continue their preferred behaviors while concomitantly achieving environmental goals. It is not necessary for consumers to change their behavior significantly to adjust to the "new reality" of an environmental problem.*

Application to Global Climate Change. Viewed through the technological lens, global climate change is seen as a problem requiring a reorientation of the energy sector from carbon-based fossil fuels to a more "environmentally friendly" energy system based on renewables and conservation. As stated by Worldwatch Institute:

> The end of the fossil fuel age is now in sight. As the world lurches from one energy crisis to another, fossil fuel dependence threatens at every turn to derail the global economy or disrupt its environmental support systems. If we are to ensure a healthy and prosperous world for future generations, only a few decades remain to redirect the energy economy.[21]

This view was reflected in a speech of President Clinton on April 21, 1993: the challenge of global climate change "must be a clarion call, not for more bureaucracy or regulation or unnecessary costs, but instead for American ingenuity and creativity, to produce the best and most energy-efficient technology." The focus on technology was evident in the Clinton Administration's 1993 Climate Change Action Plan:

> These [long-term] policies must address technologies of energy supply and use, and condition markets for the long-term transition away from activities, fuels, and technologies that generate large emissions of greenhouse gases.

---

[20] See CRS Report RL33654, *Alternative Fuels and Advanced Technology Vehicles: Issues in Congress*, by Brent Yacobucci.

[21] Christopher Flavin and Nicholas Lenssen, *Beyond the Petroleum Age: Designing a Solar Economy* (Washington D.C.: Worldwatch Institute, December 1990), p. 5.

> The policies contained in the Action Plan are directed primarily at creating effective markets for investments in existing or nearly commercially available technology that reduce greenhouse gas emissions. The core of a long term strategy must ensure that a constant stream of improved technology is available and that market conditions are favorable to their adoption. The Action Plan is likely to stimulate a modest acceleration in technological development.... Such gains will lay the foundation for the development of technologies that could contribute to significant reductions in greenhouse gas emissions in both the United States and abroad....
>
> Research and development into the technologies that could contribute to greenhouse gas emission reductions will be a critical part of the long term effort.[22]

These views were reiterated in President Clinton's 1998 $6 billion Climate Change Technology Initiative. As stated by then National Economic Council Chair Gene Sperling:

> We think that this [Climate Change Initiative] package is a very good example of what we spoke about when we said that there were win-win opportunities for positive incentives that would clearly show how we can address the issue of climate change and strengthen our economy at the same time.[23]

This "win-win" perspective on climate change policy also represents the core of the George W. Bush Administration's approach. The President stated that his alternative could "grow our economy and, at the same time, through technologies, improve our environment."[24] In supporting his new National Climate Change Technology Initiative, he stated:

> America's the leader in technology and innovation. We all believe technology offers great promise to significantly reduce emissions — especially carbon capture, storage and sequestration technologies.
>
> So we're creating the National Climate Change Technology Initiative to strengthen research at universities and national labs, to enhance partnerships in applied research, to develop improved technology for measuring and monitoring gross and net greenhouse gas emissions, and to fund demonstration projects for cutting-edge technologies, such as bioreactors and fuel cells.[25]

---

[22] William J. Clinton and Albert Gore, Jr., *The Climate Change Action Plan* (October 1993), p. 29.

[23] As reported in *Daily Environment Report*, "Administration Announces $6.3 Billion Plan of Spending, Tax Credits to Curb Emissions," February 2, 1998, p. AA-1.

[24] Response to Questions by President George W. Bush at the National Security Agency's Operations Center, Fort Meade, Md (June 4, 2002). Reported in "Bush Defends Voluntary Policy to Slow Emissions Rather Than Mandating Cuts," *Daily Environment Report* (June 5, 2002) p. A-13.

[25] Statement of President George W. Bush on Global Change (June 11, 2001) [http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html].

This technology focus also is the central element of the Asia-Pacific Partnership: "to facilitate the development, diffusion, deployment, and transfer of existing, emerging and longer term cost- effective, cleaner, more efficient technologies and practices among the Partners through concrete and substantial cooperation so as to achieve practical results."[26]

Looking through the technological lens, policymakers may see technological development as cost-effective, thus improving the economy, not penalizing it. This "win-win" perspective appeared clearly in the George W. Bush Administration's 2002 *Climate Action Report*: "President [George W.] Bush said last year [2001] that technology offers great promise to significantly and cost-effectively reduce emissions in the long term. Our national circumstances — our prosperity and our diversity — may shape our response to climate change, but our commitment to invest in innovative technologies and research will ensure the success of our response."[27] According to proponents, the cost of a technological approach to the climate change issue appears to net out to zero, or even to save money, depending on how the benefits from increased efficiency are estimated.

The technological lens tends to focus cost-benefit analysis on a "bottom-up" methodology that evaluates the relative costs of projected compliance techniques. As summarized by National Academy of Sciences, "technological costing develops estimates on the basis of a variety of assumptions about the technical aspects, together with estimates — often no more than guesses — of the costs of implementing the required technology."[28] Assumptions are technological, in terms of technological performance; economic, in terms of cost-effectiveness; and behavioral, in terms of penetration rates.

In 1991, the Congressional Office of Technology Assessment (OTA) conducted a "bottom-up" analysis using two CO_2 control scenarios: (1) a moderate scenario focused on available technical options that are cost-effective on a life-cycle basis and seen as presenting no massive problems in terms of market penetration; and (2) a tough scenario focused on the best-available technical options with less concern about difficulties in market penetration. OTA estimated the moderate scenario would reduce a projected 50% increase in CO_2 emissions from 1987 to 2015 to about 22%. In contrast, OTA estimated that the tough scenario would reduce CO_2 emissions to about half their projected 2015 levels, or 29% below their 1987 levels in the year 2015.

OTA estimated that the moderate scenario would be achievable at a net savings to the economy; overall fuel savings (such as oil, assumed in the year 2015 to cost about $50 a barrel) would exceed annual operating costs of the control measures.

---

[26] Charter for the Asia-Pacific Partnership on Clean Development and Climate (January 12, 2006), "Purposes," 2.1.1 at [http://www.asiapacificpartnership.org/].

[27] Department of State, *Climate Action Report: 2002 Submission of the United States of America Under the United Nations Framework Convention on Climate Change*, Department of State, November 2002, p. 5.

[28] National Academy of Sciences, *Policy Implications of Greenhouse Warming* (Washington, D.C.: National Academy Press, 1991), p. 48.

With cost estimates for the tough scenario reflecting more uncertainty about the annualized capital and operating costs of proposed control measures,[29] OTA estimated a range for the tough scenario from a net savings of $22 billion to a net cost of $150 billion annually in the year 2015.

DOE's five National Laboratories — Oak Ridge, Lawrence Berkeley, Argonne, National Renewable Energy, and Pacific Northwest — estimated the benefits of a technological approach for reducing carbon emission in the year 2000.[30] The five laboratories analyzed scenarios for technologies to reduce carbon emissions in a cost-effective manner (see **Table 1**). In discussing their results, the National Laboratories concluded:

> In both the Moderate and Advanced scenarios and in both timeframes (2010 and 2020), the estimated annual energy bill savings exceed the sum of the annualized policy implementation costs and the incremental technology investments. This finding is consistent with many economic-engineering studies and with the views of many economists.[31]

Table 1. Results of 2000 Interlaboratory Working Group Study

(Results for the year 2010)

Scenario	Direct Costs (billion 1997$)	Energy Savings (billion 1997$)	Carbon Savings (MtC)
Moderate Case	$16.0	$55.3	85-90
Advanced Cases	$41.5	$89.2	230-332

Source: Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, November 2000.

Such a conclusion immediately raises the question: "If technological fixes such as enhanced energy efficiency could actually save money, why aren't people voluntarily doing it now?" One possible answer is that the projections are wrong: the technological fixes are mirages, and the market has correctly ignored them. An alternative answer, the one focused on by the technology lens, is that widespread commercialization of these technologies is blocked by technological, economic, or institutional barriers. For example, a barrier might be that the initial cost of an energy efficient appliance is higher than a lower efficiency alternative, even though the lifetime cost is less; this can be a barrier to a purchaser who is not aware of the comparative life time costs and/or who cannot afford the upfront cost despite the

---

[29] OTA estimated the annualized costs of the tough scenario in a range of $350-$570 billion annually; net costs subtract fuel savings. See Congressional Office of Technology Assessment, *Changing by Degrees* (Washington, DC: U.S. Govt. Print. Off., 1991), p. 321.

[30] Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, ORNL/CON-476, November 2000.

[31] Ibid., p. 1.28.

long-term savings. An activist viewing the problem through the technology lens would look to methods for overcoming that barrier, such as providing information on lifetime costs and/or financial help.

Technology proponents tend to look favorably on governmental assistance in overcoming such barriers. This assistance can include public sector research, development, and demonstration efforts; incentives to private enterprise through direct funding, beneficial tax treatment for research expenditures, and cost-sharing programs to help overcome technical barriers and to improve the conditions for commercialization; governmental subsidies to technology; indirect incentives that make existing technologies less attractive than new ones (such as a carbon tax); regulatory interventions that create markets for new technologies; and regulations to address institutional and market barriers, such as energy efficiency labeling requirements. Some of these incentives (e.g., hybrid and fuel cell vehicles tax credits) were enacted as part of the Energy Policy Act of 2005, and increased energy-related research and development funding was authorized by the Energy Independence and Security Act of 2007.

The technology lens focuses attention on two basic issues: what drives technological development, and what barriers impede it. From this perspective, government can help stimulate the former and help remove the latter. For those who envision technological fixes that can achieve environmental goals with minimal economic costs, governmental intervention may be a necessary antidote to market failures and unnecessary barriers. But even for those who would rely primarily on markets and minimize the role of government, the technological perspective is considered optimistic, dynamic, and oriented toward the future.

Economic Lens

Background. Viewing environmental issues through an economic lens focuses attention on markets, price signals, and market imperfections. In this view, the recognition of environmental problems should lead to adjustments in market signals, changing producers' inputs and handling of wastes, as well as the composition and level of consumer demand, so as to maximize net social welfare. Cleaning the environment entails costs, which can be weighed against benefits.

The government's role in this scenario is to ensure the correct market signals. To ensure correct signals, the government can:

- make consumers and producers aware of information on economic costs and benefits;
- adjust prices through taxes or fees; and
- affect supply through tradeable permits for products (as with leaded gasoline in the early 1980s) or for production-related emissions (as with sulfur dioxide emissions), or through other market-oriented devices.

Viewed through the economic lens, the marketplace, with the correct signals, can operate to find the optimal solution.

Economic considerations have been an explicit or implicit part of environmental policymaking since environmental quality became a federal issue in the 1960s. The use of economic mechanisms to implement environmental goals was debated in the 1960s and early 1970s, but usually rejected on various grounds.[32] Excluding economic considerations from environmental protection proved difficult, however. As laws began to be implemented, economic costs became increasingly consequential, although generally masked under "practical" or "feasibility" concerns, as achievement of some environmental standards within specified deadlines proved impossible. Automobile standards were delayed; ozone compliance was postponed; and other issues were litigated. Economic concepts began to re-emerge in the debate over the environment with the need to extend deadlines and to provide more flexibility to polluters to achieve mandated standards.[33]

The preferred economic approach to environmental problems traditionally is the pollution tax. Economists observe that pollution imposes costs on society that are not incorporated in the price of the goods or services responsible for the pollution; these are called "external" costs. An ideal pollution tax "internalizes" these external costs by making the beneficiary of the polluting activity pay for the socially borne costs (polluter pays). As long as polluters find it cost-effective to reduce their emissions to avoid paying the tax, they would add pollution controls until further controls would have higher incremental costs than the tax. Likewise, innovators would be encouraged to develop new technology that reduce emissions at a cost less than the pollution tax. When the tax is set at the level at which the marginal costs of more control would equal the marginal benefits society gains by future reductions, society's net welfare is maximized.

Despite the theoretical benefits of the pollution tax methodology, environmental taxes have received limited practical use in the United States, for technical as well as political reasons.[34] Problems of implementation have loomed large, particularly because of a lack of data, especially on benefits. Estimates of the benefits of a specific environmental action can be uncertain and can vary greatly. There are no existing U.S. models of an emissions tax, although five European countries[35] have carbon-based taxes. The closest U.S. example is a tax on chemicals that deplete stratospheric ozone. To facilitate the phaseout of ozone-depleting chemicals (required under the Montreal Protocol and subsequent amendments), the United States imposed a tax on the production or importation of certain chemicals (including chlorofluorocarbons, or CFCs) in 1990. This tax was designed to supplement the

---

[32] See, for example, Steven Kelman, *What Price Incentives: Economists and the Environment* (Boston: Auburn Publishing Co., 1981).

[33] For background, see CRS Report 94-213, *Market-Based Environmental Management: Issues in Implementation*, by John L. Moore et al.

[34] Steven Kelman, *What Price Incentives: Economists and the Environment* (Boston: Auburn Publishing Co., 1981).

[35] Finland, the Netherlands, Sweden, Denmark, and Norway.

allowance trading program that the EPA had designed to implement the international agreements. Also, inventories of certain CFCs held on January 1 of each year are subjected to a "floor stocks tax."[36]

With the economists' favor for pollution taxes not gaining policymakers' adherence, attention shifted to other economic mechanisms to increase polluters' flexibility in achieving environmental standards based upon regulation. Unlike a tax that focuses on the price (demand) for a pollutant, these mechanisms focus on the quantity (supply) of the pollutant permitted.

The tradeable allowance system for sulfur dioxide control in the acid rain program (Title IV of the Clean Air Act Amendments of 1990) represented a significant step in the evolution of economic mechanisms. Commonly called a "cap and trade" system, the acid rain control program's success has led to calls for use of a similar system with other pollutants, including carbon dioxide.[37]

A cap and trade program like Title IV's is based on two premises. First, a set amount of a pollutant, such as SO_2, emitted by human activities can be assimilated by the ecological system without undue harm. Thus the goal of the program is to put a ceiling, or cap, on the total emissions of the pollutant rather than limit ambient concentrations. Second, a market in pollution rights between polluters is the most cost-effective means of achieving a given reduction. This market in pollution rights (or allowances, each of which in the acid rain program is equal to one ton of SO_2) is designed so that owners of allowances can trade those allowances with other emitters who need them or retain (bank) them for future use or sale. During the first years of implementation of Title IV, compliance has been near 100%.

While market-based mechanisms such as cap and trade are sometimes regarded as the private market's alternative to a regulatory command-and-control program, the interactions are more complex. The so-called "market for pollution rights" would not exist if not for a governmental role in altering what the market would do in the absence of governmental action. If governmental regulations did not restrict SO_2 emissions, there would be no need for SO_2 allowances. Government creates the market and defines the boundaries of acceptable market responses. Under the SO_2 trading program, facilities may buy allowances to meet necessary reductions instead of installing equipment to control pollution.[38] The choice depends on cost.

By allowing polluters to choose their lowest cost abatement actions, implementing environmental goals through market mechanisms represents a general elevation of economic "efficiency" as the *sine qua non* of decision-making.

---

[36] For CFC-11 and 12, the 2007 tax was $10.75 per pound, and the floor stocks tax was $0.45 per pound. For more specifics on the current tax level, see IRS Form 6627, Environmental Taxes.

[37] See CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program*, by Larry Parker.

[38] However, emissions may not cause ambient levels to exceed the National Ambient Air Quality Standard for SO_2 regardless of how many allowances the owners of emitting facilities hold.

Pragmatically achieving this efficiency presumes substantially complete knowledge by producers and consumers of costs, abatement alternatives, and product substitutions as well as substantial flexibility in achieving compliance. The market approach simultaneously maintains the general principle of "polluter pays" as the underlying ethical rationale for the distribution of costs among parties. Through the market, the "polluter who pays" includes not only the producer, but also labor, stockholders, and the consumer (who demands the product and who pays somewhat more for the embedded costs to control pollution).

Those viewing environmental policy through the economic lens generally presume that governmental interference, whether through subsidies or regulation, should be minimal. In reality, the distribution of impacts through the market often leads to calls for political interventions that compromise efficiency and the "polluter pays" principle. The political process tends to weigh relevant differences between various groups affected by an environmental mandate, and special treatment may be deemed necessary to promote justice or fairness. For example, the sulfur dioxide allowance system contains numerous "special" allocations of allowances to various groups that argued for special consideration due to past, current, or future situations. These special allocations represent subsidies to these groups that a strict "polluter-pays" principle would not allow. Thus the "polluter-pays" principle is not a distributional principle that policymakers will necessarily treat independently of other concerns and criteria.

The economic lens reflects a traditional American belief in individual choice and private markets — given the correct price signals, producers and consumers will adjust their behavior accordingly. This adjustment will be done in the most cost-efficient manner, and with a minimum of governmental involvement. Consumers' desires are seen as responsive to price. The issue then is for the price to reflect the costs of relevant externalities. With the right price, supply and demand will find the level that maximizes social welfare.[39] *Policymakers using the economic lens see consumers and producers adjusting their behaviors to the "new reality" of an environmental problem by responding to the price signals that take into account a particular environmental goal.* But this approach creates clear winners and losers in terms of who will profit and who will pay the tab. As a result, policymakers adjust governmental intervention to achieve change at a pace and impact that are socially and politically acceptable.

Application to Global Climate Change. The economic lens focuses policymakers on market-based approaches to address global climate change; these include marketable permit (allowance) programs and various taxes, fees, and rebates, as well as research and development, education, and market-related information. Current proposals for controlling carbon dioxide and other greenhouse gas emissions center on either marketable permits programs (loosely based on the current sulfur dioxide program) or on a carbon tax (the closest domestic analogy is the

---

[39] As American Enterprise Institute scholar Kenneth P. Green says, "The right thing to do is to ... tax the environmental harms that energy demonstrably creates and let the market sort it out." "The Best Policy on Subsidies Is to Simply Ditch Them" AEI Short Publications, posted January 29, 2007 at [http://www.aei.org/publications/pubID.25532/pub_detail.asp].

chlorofluorocarbon tax although there are substantial differences between the two schemes.).[40] Meanwhile, the members of the European Union, in addressing their obligations under the Kyoto Protocol, have established a CO_2 trading program that covers about half their total CO_2 emissions.[41] In addition, Finland, the Netherlands, Sweden, Denmark, and Norway have imposed carbon taxes.

Debate in the United States about implementing carbon reductions has focused on tradeable permits — though occasionally a voice for carbon taxes is heard.[42] A key element of the Clinton Administration's negotiating position at Kyoto was the inclusion of domestic and international emissions trading systems and international joint implementation programs to implement any emission reduction requirements. While rejecting the Kyoto Protocol, the George W. Bush Administration's Climate Change Initiative acknowledges the potential use for trading programs to address climate change. The Initiative directs the Secretary of Energy to recommend ways to ensure that entities that register reductions under current voluntary initiatives are not penalized under a future climate policy, and to give transferable credits to companies that achieve real reductions. In addition, the Administration states: "If, in 2012, we find that we are not on track toward meeting our goal, and sound science justifies further policy action, the United States will respond with additional measures that may include a broad, market-based program...."[43]

Numerous bills have been introduced in Congress to mandate substantial reductions in CO_2 emissions implemented through a nationwide tradeable permit program, and twice the Senate has voted on proposals. In the 108th Congress, S. 139, which would have imposed a mandatory cap-and-trade greenhouse gas reduction program, failed in 2003 on a 43-55 vote. In 2005, a similar initiative was considered as an amendment during the Senate debate on the Energy Policy Act of 2005 and defeated on a 38-60 vote. These proposals would have capped U.S. greenhouse gas emissions, with the cap being implemented through a tradeable permit program to encourage efficient reductions. Although these initiatives failed, 13 Senators introduced S.Amdt. 866 during the debate on the Energy Policy Act of 2005; it stated that it is the Sense of the Senate that the Congress should enact a comprehensive and effective national program of mandatory, *market-based* limits and incentives on greenhouse gases that slow, stop, and reverse the growth of such emissions. The resolution passed by voice vote after a motion to table it failed on a 43-54 vote.

Subsequently, in the 110th Congress, S. 2191, which would also impose a mandatory cap-and-trade greenhouse gas reduction program, has been reported out of the Senate Environment and Public Works Committee on a 11-8 vote.

---

[40] See CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program*, by Larry Parker.

[41] See CRS Report RL34150, *Climate Change: The EU Emissions Trading Scheme (ETS) Enters Kyoto Compliance Phase*, by Larry Parker.

[42] Anne Applebaum, "Global Warming's Simple Remedy," *The Washington Post* (February 6, 2007), p. A17.

[43] White House, *Global Climate Change Policy Book*, February 2002. Available at [http://www.whitehouse.gov/news/releases/2002/02/climatechange.html].

The generally acclaimed success of the sulfur dioxide program notwithstanding, it may not translate easily to a marketable permit program for carbon dioxide. Fundamental differences exist: for example, the acid rain program involves over 2,000 new and existing electric generating facilities that contribute two-thirds of the country's sulfur dioxide and one-third of its nitrogen oxide emissions (the two primary precursors of acid rain). This concentration of sources makes the logistics of allowance trading administratively manageable and enforceable. However, carbon dioxide emission sources are not so concentrated. Although over 95% of the CO_2 generated from human activities comes from fossil fuel combustion, only about 40% comes from generating electricity. Transportation accounts for about 33%, direct residential and commercial use for about 12%, and direct industrial use for about 15%. Small dispersed sources in transportation, residential/commercial, and the industrial sectors are far more important in controlling CO_2 emissions than they are in controlling SO_2 emissions. This would create significant problems in administering and enforcing a tradeable permit program that attempts to be comprehensive or equitable.[44] These concerns multiply as the global nature of the climate change issue is considered, along with other potential greenhouse gases, such as methane and nitrous oxide.[45]

In the view of most economists, a carbon tax would be the most efficient approach to controlling CO_2 emissions.[46] The approach is generally conceived as a levy on natural gas, petroleum, and coal according to their carbon content, in the approximate ratio of 0.6 to 0.8 to 1.0, respectively. With the millions of emitters involved in controlling CO_2, the advantages of a tax are self-evident. Imposed on an input basis, administrative burdens such as stack monitoring to determine compliance would be reduced. Also, a carbon tax would have the broad effect across the economy that some feel is necessary to achieve long-term reductions in emissions.

In other ways, a tax system merely changes the forum, rather than the substance of the policy debate. Because paying an emissions tax becomes an alternative to controlling emissions, the debate over the amount of reductions necessarily becomes a debate over the level of tax imposed. Those wanting large reductions quickly would want a high tax imposed over a short period of time. Those more concerned with the potential economic burden of a carbon tax would want a low tax imposed at a later time with possible exceptions for various events. Taxing emissions basically would remain an implementation strategy; policy determinations such as tax levels would require political/regulatory decisions. Also, a tax would raise revenues;

---

[44] On distributional effects of carbon trading, see Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs*, June 2000.

[45] For a discussion of the emerging international market for greenhouse gas credits, see Richard Rosenzweig, Matthew Varilek, and Josef Janssen, *The Emerging International Greenhouse Gas Market*, Pew Center on Global Climate Change, March 2002.

[46] "It is an open and shut case that the most economic way to constrain carbon dioxide (CO_2) emissions is a flat-rate tax based on the carbon content of fuels — across the board, no exceptions." David Cope, "Environment, Economics and Science," *UK CEED Bulletin*, No. 53 (Spring 1998), 18.

the disposition of these revenues would significantly affect the economic and distributional impacts of the tax.

The difficulties in crafting a carbon tax or a multi-national trading program should not be underestimated. With the 1997 Kyoto Protocol now in force, many countries that ratified the protocol have developed appropriate implementation strategies to begin reducing their emissions of greenhouse gases. In particular, the European Union (EU) decided to establish an emission trading scheme as a cornerstone of its efforts to meet its obligation under the Kyoto Protocol. In deciding on this scheme, the European Commission (EC) adopted an initial "learning-by-doing" trial period (2005-2007) to prepare the EU for Kyoto Protocol's emissions limitations that began in 2008. The results from 2005-2006 suggested a rocky start for the program as over-allocation of allowances, thin trading volumes, and other issues resulted in a very volatile market. From a high of about 30 euro per allowance in 2005, the allowance price dropped to less than 1 euro by mid-2007. The 2008-2012 Kyoto compliance phase of the European Trading System has been adjusted to address some of the problems identified in the first phase, but its functionality remains to be proved.[47]

The choice between a tradeable permit approach and a tax approach depends in part on one's sensitivity to the uncertainty in the benefits of reductions in greenhouse gases versus the uncertainty in the costs of the program. Those confident of the benefits to be received from reducing greenhouse gases tend to focus on the quantity of pollutants emitted and to argue for a specific, mandated emission level. For example, the Kyoto agreement mandates a specific allowable emission level based on a historical baseline (1990/1995, depending on the gas) for a specific compliance period (2008-2012). While a ceiling is placed on emissions, no ceiling is placed on control costs. Implementing such a reduction program through a market-based scheme, such as a tradeable permit program, would probably assure that the costs would be dealt with efficiently through the marketplace; however, those costs are not capped. This is the approach used under the current SO_2 control program. After a decade, results indicate that control costs under the SO_2 program are considerably less than they would have been under an alternative "command and control" scheme. However, there is no lid on the costs, which may rise in the future as growth in electricity generation pushes against the cap on emissions.

Alternatively, a tax in effect places a ceiling on control costs, although the actual reductions achieved are subject to some uncertainty. For example, if a carbon tax of $100 a ton were levied, no polluter would pay more than $100 a ton to reduce carbon emissions. Thus, under worst-case conditions, the program costs would be $100 a ton. However, the actual reductions that such a tax might achieve would have to be estimated, based on economic simulations or actual monitoring. Reductions would not be guaranteed as any polluter could choose to pay the tax rather than to reduce emissions. Reductions could also vary over time as new technology or other events raise or lower the cost of reducing emissions.

---

[47] For more information, see CRS Report RL34150, *Climate Change: The EU Emissions Trading Scheme (ETS) Enters Kyoto Compliance Phase*, by Larry Parker.

A carbon tax or tradeable permit program would affect economic behavior in at least three ways: (1) effectively reduce real income through higher prices and therefore reduce overall consumption of goods (particularly in the short-term); (2) encourage manufacturers and consumers to substitute less carbon-intensive (or carbon free) energy sources for current carbon-intensive (i.e., fossil fuel) energy sources; and (3) encourage research and development of innovative, less carbon intensive or more energy efficient technologies and their penetration into the marketplace. The ability and efficiency of the economy in making these adjustments over a specified period of time would largely determine the impact of a market-induced rise in the costs of energy generated from fossil fuels either through a carbon tax or a marketable permit program.

Depending on the reduction achieved and the model employed, annual gross domestic product (GDP) losses resulting from carbon control are estimated to range from less than 1% to more than 4%, with most falling into a range of 1% to 3%. If a carbon tax were chosen, that tax would generate revenues — revenues sufficiently large to affect aggregate consumer demand. It is the contractionary pressure of these tax revenues that the Congressional Budget Office (CBO) cites as the major reason for a projected loss of 2% in U.S. GDP from a $100 per ton carbon tax phased in over 10 years.[48] The disposition of those tax revenues would greatly affect the impact of the carbon tax on the economy. Thus the impact of a carbon tax on the economy would depend on a combination of policies beyond just the level of the tax.

The tax level necessary to achieve a given reduction is also subject to a wide range of estimates. The Stanford Energy Modeling Forum compared 13 models under a series of control scenarios with common assumptions (where possible), including one that would have stabilized carbon emissions at 1990 levels by the year 2000.[49] About half of the models studied estimated the carbon tax necessary to meet the stabilization target in the year 2000 to be about $30 per ton or less, while the other half estimated the necessary carbon tax to be about $100 or more. Further studies by the Stanford Energy Modeling Forum on the cost to comply with the Kyoto Protocol, and on the global compliance cost of various stabilization scenarios, resulted in a similarly wide range of estimated tax levels.[50]

Because the problem of greenhouse gas emissions is seen in terms of internalizing a currently external cost, the economic lens implies that the marketplace is the most efficient means of controlling undesirable pollutants. The private sector can solve the problem if given sufficient incentive with minimal governmental

---

[48] Congressional Budget Office, *Carbon Charges as a Response to Global Warming: The Effects of Taxing Fossil Fuels* (August 1990), pp. 35-37.

[49] Energy Information Administration, *Energy Modeling Forum Study 12 — Global Climate Change: Energy Sector Impact of Greenhouse Gas Control Strategies.* Response to request by the House Committee on Energy and Commerce (May 4, 1992).

[50] On Kyoto Protocol compliance costs, see John Weyant and Jennifer Hill, "Introduction and Overview," *The Energy Journal*, (Special Issue, 1999), pp. vii-xliv; on global compliance costs of various stabilization scenarios, see John P. Weyant, Francisco C. de la Chesnaye, and Geoff J. Blanford, "Overview of EMF-21: Multigas Mitigation and Climate Policy," *The Energy Journal* (Special Issue, 2006), pp. 1-32.

interference. The Government's role primarily consists of providing a market-based signal to private industry about the external cost (e.g., emission taxes, tradeable permits, etc.). In reality, the Government's role is more involved. For taxes, this includes determining the tax level, any phasing-in period, escalation, and recycling of revenues received. For permits, this includes the total numbers of permits allowed, initial allocation formulas, any phasing in period, penalties, transaction procedures, and tax liability. While an economic approach would supplement the policy process in implementing a greenhouse gas reduction program, it would not be a substitute for basic policy decisions and oversight.

A limited or supporting governmental role is consistent with the overall perspective of the economic lens: private initiative, economic cost-effectiveness, concern about impact of environmental policy on economic policy, cost aversion, and reliance on market forces.

Ecological Approach

Background. The development of environmental protection as a national policy concern reflects three factors: (1) the development of an environmental consciousness among the electorate, (2) a change in the climate of decision-making among individuals, businesses, and government at all levels, (3) the availability of opportunities to make concrete decisions based on environmental grounds (either in addition to or in opposition to other criteria, including economic ones).

The underlying basis of an environmental consciousness is an understanding of the interconnectedness of the planet's biological processes, and a recognition that changes caused by humans may have ecological effects beyond those intended or foreseen. From this perspective, it is in humanity's self-interest (as well as in the interests of non-human life) to protect the basic biological processes that are the foundation of all life; humans can protect those processes by being conscious of humanity's environmental impact and by avoiding or mitigating that impact to the greatest extent necessary (accepting that some impact is unavoidable, and that ecological science has a crucial role in discovering the effects of human activities).

A seminal characterization of the ecological perspective is *A Sand County Almanac*, by Aldo Leopold.[51] He suggested that humankind has developed two ethical dimensions — the first dealing with the relation between individuals and the second with the relation between the individual and society. But, said Leopold:

> There is as yet no ethic dealing with man's relation to land and to the animals and plants which grow upon it.... The extension of ethics to this third element in human environment is, if I read the evidence correctly, an evolutionary possibility and an ecological necessity.[52]

---

[51] Aldo Leopold, *A Sand County Almanac, with Essays on Conservation from Round River* (New York: Ballantine Books, 1970), pp. 237-264.

[52] Ibid., p. 239.

Describing the need for an "ecological conscience," Leopold concluded that the environmental problem "is one of attitudes and implements"; the development of a "land ethic" requires "an internal change in our intellectual emphasis, loyalties, affections, and convictions."[53]

The challenge of the ecological approach was given global scope by the "Brundtland Report" of the World Commission on Environment and Development. Articulating the goal of "sustainable development," its forward described the challenge this way:

> If we do not succeed in putting our message of urgency through to today's parents and decision makers, we risk undermining our children's fundamental right to a healthy, life-enhancing environment. Unless we are able to translate our words into a language that can reach the minds and hearts of people young and old, we shall not be able to undertake the extensive social changes needed to correct the course of development.
>
> .... We call for a common endeavor and for new norms of behavior at all levels and in the interests of all. The changes in attitudes, in social values, and in aspirations that the report urges will depend on vast campaigns of education, debate, and public participation.[54]

The idea of "sustainable development" suggests future generations should enjoy the same opportunities for meaningful and fulfilling lives as the current generation. A sustainable society has been defined as "one that satisfies its needs without jeopardizing the prospects of future generations."[55] The concept thus serves as an umbrella to encourage development of renewable resources and conservation of non-renewable resources.[56]

The emergence of the ecological perspective (or the "land ethic" or "sustainable development") is manifest in new values and practices of individuals, businesses, and Government.

Within the federal government, the National Environmental Policy Act of 1969 represented a watershed in establishing the principle that major federal decisions should publically disclose and take into account environmental impacts. Originally

---

[53] Ibid., pp. 263, 246. Some, viewing global climate change through the ecological lens, see in the long-term risks an indictment of the lifestyle and economic structure of Western society — a viewpoint profoundly disturbing to others who do not look through the same lens. As noted by Leopold, an environmental ethic imposes new obligations, calls for sacrifice, and changes existing values.

[54] *Our Common Future* (New York: Oxford University Press, 1987), p. xiv.

[55] Lester R. Brown, et al. *State of the World, 1990* (New York: W.W. Norton & Company, 1990), p. 171.

[56] See, for example, Richard B. Norgaard and Richard B. Howarth, "Climate Rights of Future Generations, Economic Analysis, and the Policy Process," in U.S. Congress, House, Committee on Science, Space, and Technology, *Technologies and Strategies for Addressing Global Climate Change*, Hearings, 17 July 1991 (Washington, D.C.: U.S. Govt. Print. Off., 1992), pp. 160-173.

resisted by many agencies, the idea of assessing the environmental consequences of decisions through "Environmental Impact Statements" has now become routine. Also, over the past two decades, the federal government has taken steps to foster public awareness of environmental values through support for environmental education. In addition, the federal government has used procurement policies to support environmental goals; for example, by requiring purchases of paper of specified recycling content and authorizing payment of a premium for it, and has revised statutes to make federal facilities subject to these requirements.

The change in societal values resulting from an increased ecological consciousness also affects the perspectives of corporate decision-makers. Despite the often confrontational relationship between federal environmental policymakers and industry, a consequence often attributable to the command-and-control regulatory approach to environmental policy, industry itself has increasingly recognized that community environmental values are part of the social milieu in which industrial production occurs.

A 1994 article in the chemical industry publication *Chemical Week* reviewed the industry's perceptions of pollution control. It noted that, in the early 1970s, most corporations viewed environmental management as a "threat" and that pollution control expenditures were "nonrecoverable investments."[57] The article observed that, in 1970, "economist Milton Friedman described the actions of any company making pollution control expenditures beyond that 'required by law in order to contribute to the social objective of improving the environment' as 'pure and unadulterated socialism'." In contrast, the article said that major corporations currently are espousing the benefits of proactive environmental management, stewardship, and environmental leadership. The chemical industry, which was suffering from poor public perceptions, particularly after the Bhopal incident, was at the forefront of this shift, as indicated by remarks of Robert Luft, Senior Vice President of Du Pont Chemicals: "Our continued existence requires that we *excel* in safety and environmental performance.... We must shift our mindset from 'meeting regulations' to 'meeting public expectations'."[58]

This new attitude, or climate, of decision-making is providing many businesses and individuals with new alternatives and opportunities to choose environmentally preferred options either in concert with more traditionally based economic criteria or in opposition to such "self-interest"-based criteria. For example, the chemical industry today sponsors an international "Responsible Care" campaign[59]; and prodded by environmental groups and EPA, the American Chemistry Council (ACC)

---

[57] "34 Years of Environmental Strategy," *Chemical Week* (August 24, 1994), 27.

[58] Robert v.d. Luft, "Protecting the Environment: It's Good Business," Remarks, at the National Petroleum Refiners Association International Conference, San Antonio, Texas (March 26, 1991), p. 9.

[59] See [http://www.responsiblecare.org/] and, domestically, [http://www.americanchemistry.com/s_acc/index.asp].

has committed the industry to testing of high-use chemicals.[60] An independent but related ACC initiative is the Green Chemistry Institute, a nonprofit organization with the mission of promoting pollution prevention using "economically sustainable clean production technologies."[61] In addition, EPA and the American Chemical Society jointly sponsor annual "Green Chemistry Challenge Awards" to recognize pollution prevention through innovative chemistry; the first Green Chemistry Award was presented in 1996.

Individuals, as consumers and citizens, are also exercising options to express an environmental consciousness that extends beyond immediate economic self-interest. Consumers' responses to such environmental problems as solid waste disposal indicate that individual behavior and community programs can and will reflect environmental values. For example, recycling programs have increased in recent years, despite questionable economics and the significant consumer inconveniences involved. Such a trend suggests the power of aesthetics and the perceived intrinsic value of the environment as a force which influences people's preferences and priorities. Likewise, driven by public demand, several states offer electricity consumers the opportunity to purchase "green power" (i.e., electricity produced from renewable energy and other low-polluting sources), rather than power produced from conventional, more polluting sources.[62]

The ecological lens magnifies elements that are psychological, philosophical, and theological.[63] A policy decision to address a pollution problem generally involves a sophisticated and sometimes lengthy educational process of which economics and technological availability are only components. In this view, environmental education, Smokey the Bear, and environmental interest groups from the Audubon Society to Greenpeace to Population Connection represent efforts to inculcate the sense of moral obligation toward the environment — to acculturate people to the importance of the environment as essential to long-term human health and welfare. Such efforts can promote a climate of opinion in which environmentally responsible decisions are socially endorsed and environmentally irresponsible decisions are stigmatized as not socially acceptable. Pollution protection gets on the national agenda not on the basis of affordability or whether control technology exists, but because an environmental problem is recognized as a threat to human health or welfare. *The ecological approach views the problem of environmental policy implementation to be the moral education of individuals and institutions to the dimensions of the ecological crisis, changing the climate in which decisions are made, and providing opportunities for individuals and institutions to make decisions based on ecological concerns, rather than having those choices limited to alternatives dictated solely by economic criteria.*

---

[60] See [http://www.uslri.org/].

[61] See [http://chemistry.org/greenchemistryinstitute].

[62] For more information on green electricity markets, see the DOE website at [http://www.eere.energy.gov/greenpower/markets/index.shtml].

[63] Leopold noted that Ezekiel and Isaiah decried the despoliation of the land.

Application to Global Climate Change. In some ways, global climate change is the quintessential issue for an ecological lens, as it so clearly involves far-reaching dimensions including the standing of future generations, non-human life, and distributional justice around the globe. The ecological lens provides a decision criterion in the face of uncertainty or of competing preferences. Aldo Leopold observed that the land ethic "may be regarded as a mode of guidance for meeting ecological situations so new or intricate, or involving such deferred reactions, that the path of social expediency is not discernible to the average individual."[64] No situation is better described as "so new and intricate" or as having "such deferred reactions" than global climate change.

An ecological perspective on global climate change focuses attention on an enlightened public to implement stewardship through a changed value system. Numerous international and domestic entities are supporting activities to foster governmental, corporate, and public awareness of the global climate change issue and to encourage remedial actions. (Other entities provide "neutral" information and analysis on the issue, and still others actively lobby against the viewpoint that action is justified at this time.) These organizations support activities that translate into concrete actions through a variety of mechanisms, including voluntary programs for businesses and alternative "green" options that allow for individual consumers to make ecologically responsible decisions even when they cost more than do traditional choices.

The current umbrella for activities to foster action is the U.N. Framework Convention on Climate Change, under which a range of activities, from research and development to education, are sponsored. Manifesting the ecological perspective, the Framework Convention defines the signatories' objective to be the protection of ecosystems from "dangerous anthropogenic interference with the climate system ... to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."[65] Economic and human concerns are seen as interdependent with ecological processes. The potential policy agenda could include virtually all human endeavors and relationships, from industrial policy to North-South equity, from population policy to energy policy, from domestic concerns to the restructuring of international institutions.

From the ecological perspective, achieving such a broad policy agenda would require an active federal governmental role that involves educating the citizenry about the need to act on the risk of global climate change, providing the public with a role model in terms of government's own decisions and priorities, and developing opportunities for individuals to make ecologically responsible decisions even if those decisions are not economic in a traditional sense. At this stage of the climate change debate, the federal role has included four kinds of activities that reflect environmental stewardship.

---

[64] Leopold, p. 239.

[65] United Nations Framework Convention on Climate Change, article 2. The United States is a Party to the Framework Convention on Climate Change.

- First, making decisions that take into account potential consequences for global climate change and taking actions that support and promote environmentally "friendly" products or processes (for example, through procurement policies or through product labeling).

- Second, internationally exploring the possibilities of achieving consensus on further greenhouse gas emissions reductions and on inter-related economic and human issues.

- Third, supporting education of the public on environmental concerns generally and about global climate change specifically, and fostering the inculcation of environmental values in educational programs.

- Fourth, fostering mechanisms that permit the public to express their environmental values in everyday decision-making.

Similar activities are being promoted through various corporate and nonprofit initiatives, as well. For example, a 1998 corporate initiative under the auspices of The Pew Center On Global Climate Change[66] was created to engage business in developing efficient, effective solutions to the climate problem. Accepting "the views of most scientists that enough is known about the science and environmental impacts of climate change for us to take actions to address its consequences," the Center believes "businesses can and should take concrete steps now in the U.S. and abroad to assess their opportunities for emission reductions, establish and meet their emission reduction objectives, and invest in new, more efficient products, practices and technologies." Besides this commitment to stewardship, "major companies and other organizations are working together through the Center to educate the public on the risks, challenges and solutions to climate change"; undertaking "studies and policy analyses that will add new facts and perspectives to the climate change debate in key areas such as economic and environmental impacts, and equity issues"; and engaging in an international effort designed to increase the global understanding of market mechanisms, and to work with developing countries to assess emission reduction opportunities."

The ecological perspective emerges from individual actions both in terms of support for educational endeavors — as in support for environmental interest groups — as well as through market choices based on ecological impacts rather than on pure economic costs. Indeed, these actions can go against prevailing economic or technological trends. For example, people may choose to pay more for a product or a service because it is perceived as being more "green" or "climate friendly" than alternatives based on traditional economic or technological considerations. In a sense, customer preferences can outrun the marketplace by creating a demand for a

---

[66] The efforts are spearheaded by the Center's Business Environmental Leadership Council with 44 member companies, including Alcoa, American Electric Power, Bank of America, Boeing Company, BP, Duke Energy, Exelon, GE, Georgia-Pacific, IBM, Intel, Lockheed Martin, Sunoco, Toyota, United Technologies, Whirlpool Corporation. The quotations in this paragraph are from the Pew Center on Global Climate Change's website, at [http://www.pewclimate.org/companies_leading_the_way_belc].

product that producers did not anticipate. In such cases, economic and technological mechanisms follow the ecological imperative, rather than defining limits to it. As noted earlier, some states now offer consumers a "green electricity" alternative to conventionally produced electricity in response to consumer demand.

Many actions to reduce emissions of greenhouse gases can serve multiple social ends — such as energy conservation and pollution prevention that are thought to improve the economic efficiency with which human needs are met. Governments and corporations have taken a lead in fostering energy conservation and efficiency in use, particularly in developed countries. In the U.S., EPA and DOE sponsor a range of energy efficiency programs under the rubric, "Energy Star," to promote energy-efficient lighting, buildings, and office equipment.[67] DOE funds research and demonstration, pursuing energy efficiency in transportation, industry, utility, and buildings sectors.[68] There is also an Alliance to Save Energy, a nonprofit coalition of prominent business, government, environmental, and consumer leaders who promote the efficient and clean use of energy worldwide, arguing benefits for the environment, the economy, and national security.[69]

These EPA and DOE activities fall within the Administration's Global Climate Change Initiative. While technological in thrust, a key element of many of these programs involves education of prospective consumers to persuade them not only of potential cost savings but also of social benefits to be gained. Thus technology (and markets) can be the tool for meeting the "moral imperative" associated with by the ecological perspective.[70] Internationally, the Administration's Asia-Pacific Partnership on Clean Development and Climate has parallels. It involves encouraging the partners, including the developing China, India, and South Korea, to adopt more sustainable environmental policies, especially in using energy sources and technologies that constrain greenhouse gas emissions.

Similarly, government and corporate initiatives for pollution prevention, through, for example, source reduction and product stewardship, foster systematic changes that have the potential to reduce global climate change risks. EPA estimates that its WasteWise program — a voluntary partnership between EPA and businesses to prevent waste, recycle, and buy and manufacture products with recycled materials. EPA has estimated that, through waste reduction and recycling activities in 2004, WasteWise partners reduced greenhouse gas emissions by more than 8 million metric tons of carbon equivalent.[71]

---

[67] See [http://www.energystar.gov/].

[68] See CRS Report RL33599, *Energy Efficiency Policy: Budget, Electricity Conservation, and Fuel Conservation Issues*, by Fred Sissine.

[69] For more information, see [http://www.ase.org].

[70] However, some "deep ecologists" reject technological fixes and the use of market mechanisms on the grounds that they merely further a nonsustainable system that needs to be replaced.

[71] EPA, *WasteWise Annual Report 2005*, p. 4.

Thus, from the ecological perspective, with a public more aware of the problem of global climate change and with the availability of relevant technological and/or economic alternatives, the implementation of the broader agenda through appropriate measures becomes possible: making available options that permit people to exercise their moral obligation.

The Three Lenses and Policy Approaches

Each of the three lenses implies fundamentally different ways of assessing policy actions to address global climate change. Crucial variations emerge in perspectives on cost analysis, scientific uncertainty, and the role of government.

Cost Analysis as Viewed Through the Lenses

The technological lens focuses attention on the outcome of the innovation; actions are justified if they resolve the pollution problem, and costs and benefits should be weighed in terms of the outcome, not in terms of the transitional costs. In contrast, those viewing the issue through the economic lens tend to focus on costs and benefits as the critical metric for evaluating policies; actions are justified when the benefits outweigh the costs, but not otherwise. The ecological perspective basically suggests that policy choices can be based on a recognition of "rights" rather than costs and benefits; the principles of protecting life and of preserving the ecosystem for future generations govern choices.

These differing viewpoints have implications for the timing and focus of invested resources. Looking through the technological lens, a policymaker would focus on investing resources directly in technical options. Some investment in understanding the problem may be necessary to delineate technical options, but new technologies may make extensive research in understanding the problem moot (as when a process change eliminates use of a chemical of concern). Looking through the economic lens, a policymaker would typically first invest resources in understanding the problem and the costs and benefits of alternatives. That assessment would reveal whether society would be better off adopting policies and committing resources to action (e.g., to reduce carbon dioxide emissions). Looking through the ecological lens, a policymaker who perceives a risk to health and/or ecological systems would tend to promote immediate action. Investments in understanding the problem and the costs and benefits would be undertaken only to the extent appropriate to ensure cost-effectiveness of those actions. Because the ecological lens portrays benefits largely in non-economic terms (sustainability, equity), efforts to quantify and monetize those benefits may be viewed as inappropriate — even immoral. Instead, people are provided with alternatives to act on the problem, allowing them to choose a "responsible" option, even if it costs more than a traditionally defined "economic" option.

Technological Lens. Those using the technological lens see it as a "far-sighted," economically justifiable approach to global climate change. Technology is seen as the impetus for improved efficiency in the economy, concomitant with improved environmental protection. Although the development of technology may

be encouraged for a variety of reasons, its commercialization is ultimately based on cost-effectiveness. In terms of the substance of the environmental issue, the user of the technological lens is typically agnostic or indifferent. The current economic system is viewed as inefficient since it does not consider decisions on a "life-cycle" basis. When considered on this broader perspective, reductions in carbon emissions may be possible at no net costs to the economy — even at net savings.

Under the technological lens, the parameters of cost analysis change. Concepts like "life-cycle" costs are pivotal in making the cost-effectiveness case for new technology. Existing barriers (institutional or financial) to the rapid and widespread commercialization of new technologies are seen as artificial constraints to be overcome by government and individuals. The focus of analysis is on cost-effectiveness of solutions, not so much on the benefits of the policy.

Economic Lens. The view through the economic lens fits the global climate change issue within the boundary of market economics. The motivations of people in reducing pollution is unimportant; the critical assumption is that people will act in their own self-interest as dictated by price signals. The global climate change issue becomes another consideration in setting prices — an externality that needs to be internalized. If that price increment does not result in significant reductions, it is because none is economically justified.

Under the economic lens, the potential impacts of controlling greenhouse gases on the economy versus expected benefits is a central variable in determining the degree and time frame of reductions. Economic efficiency is the primary criterion for assessing emission reduction programs. Any existing inefficiencies in the economic system are assumed to reflect market reality and to be difficult to eliminate (and eliminating them may be undesirable). Uncertainty about the potential benefits is understood to be a factor in determining the stringency of any reduction program and a potential reason for stretching out compliance. For this lens, cost-benefit analysis is very important in assessing potential control programs. To the extent that new technologies are projected to be cost-effective and to overcome any existing market barriers or distortions, they are included in the cost-benefit analysis as viable alternatives to existing control options.

Ecological lens. Those looking through the ecological lens are suspicious of attempts to measure the economic effects of global climate change options. Most efforts to measure economic effect involve comparing a carbon control scenario with a "baseline" projection. The baseline generally is defined as the path the economy would take assuming no changes attributable to adoption of climate change policies. However, the baseline also tends to connote a path with no distortion; it is the path from which distortions are measured. This conveys some normative legitimacy on the baseline. If global climate change arguments are correct, then the current path is not sustainable in the long run, and the baseline means little — a concern reflected in proposals to incorporate "green accounting" into major economic indicators, such as the Gross Domestic Product (GDP).[72] Arguably, if an ecological perspective

---

[72] Carol S. Caron, "Integrated Economic and Environmental Satellite Accounts," *Survey of* (continued...)

returned the actual path to long-term sustainability, that scenario would represent the more reasonable baseline. Discussions of economic "growth" and "distortions" are relative to one's perspective on the long-term potential for economic growth in a world with increasing carbon dioxide concentrations.

Commonly, those looking through the ecological lens tend to dismiss economic cost analysis, and particularly cost-benefit analysis, as being of limited usefulness in the overall debate on global climate change, while acknowledging that they can have utility in developing and choosing specific options. From the ecological perspective, people should respond to the global climate change crisis because of its threat to important values, such as the fate of future generations, not because action can be justified on the basis of some narrowly defined cost-benefit analysis. Traditionally, such analysis tends to place value only on those benefits that can be easily quantified, while dismissing or ignoring many values that would be seen as governing through the ecological lens. Viewed through the ecological lens, lives and such values as intergenerational equity should not be quantified as a commodity.[73] In this view, treating the fate of future generations in terms of cost-benefit analysis and market forces should be accorded the same social condemnation allotted those who "prostitute" themselves by selling something for money that should not be sold. What people need are alternatives to many of the choices that the marketplace provides based on traditionally defined economic considerations.[74]

At the same time, a burgeoning area of study is ecological economics, and in particular analyses to determine the economic benefits of ecosystems services, which include climate regulation.[75] Such studies may serve to defend environmental values that are rarely accounted for in traditional economic analyses; they also provide another example of the intertwining of the viewpoints.

The Role of Science as Viewed Through the Lenses

Although some would prefer that science dictate the timing and magnitude of environmental policymaking, the nature of environmental science (and environmental policymaking) is not such that definitive guidelines are likely in any significant issue. Scientific knowledge represents a continuum of knowledge and uncertainty; policy

---

[72] (...continued)
Current Business (April 1994), 33-49.

[73] The ecological view was shown in the negative response to an economic analysis prepared for the U.N.'s Intergovernmental Panel on Climate Change; "The Social Costs of Climate Change: Greenhouse Damage and Benefits of Control" valued projected deaths of persons in OECD nations at $1.5 million each while deaths of persons from China, India, and Africa were valued at $150,000 each. From an ecological or human rights standpoint the discrepancy surfaced ethical concerns. See John Adams, "Cost-Benefit Analysis: The Problem, Not the Solution," *The Ecologist*, 26 (January/February 1996), 3.

[74] Peter G. Brown, "Toward an Economics of Stewardship: the Case of Climate," *Ecological Economics* 26 (1998), 11-21.

[75] Robert Constanza et al., The Value of the World's Ecosystem Services and Natural Capital," *Ecological Economics* 25 (1998), 3-15 [originally published in *Nature*, 387 (May 15, 1997), 253-260]; the issue contains a number of comments on the article as well.

initiatives go forward when a sufficient majority of the society concludes that what is known about the problem outweighs the uncertainties, or that the risks of delay despite uncertainty are not acceptable. In some cases, increases in knowledge about an environmental problem lead to more uncertainty, not less. In other cases, increased knowledge about a problem leads to widening the issue, not narrowing it.

In the case of global climate change, at least three parameters help determine how one is willing to balance the knowledge-uncertainty aspect of science. These three parameters involve one's perception of the potential risk of the problem, the potential effectiveness of any reduction program, and the potential cost of the solution. If one perceives the potential risk of the problem to be slight, the potential effectiveness of any response to be questionable, and/or the potential cost to be high, one will tend to require a high threshold with respect to scientific certainty before one is willing to act. Conversely, if one perceives the potential risk to be high, the potential effectiveness of any response to be reasonable, and the potential cost to be low, one will likely be willing to act at a substantially lower threshold with respect to scientific certainty.

Each of the three lenses contributes to differing views on these parameters and on different courses of action. For example, being optimistic that energy efficiency can be gained at low cost, the technology lens can accept a somewhat lower threshold with respect to scientific certainty because the risk of high cost is discounted. Likewise, the ecological lens' concern about unintended consequences and the protection of future generations lends itself to accepting a lower threshold with respect to scientific certainty because of the precautionary need to protect the biosphere regardless of cost. In contrast, the economic lens leads one toward a cost aversion response, because the uncertainty may mean fewer benefits, a less effective response, and potentially high cost. Those viewing the issue through this lens seek more certainty before any significant investment is made in any solution.

In a study of the effects of personal beliefs and scientific uncertainty on climate change policy,[76] two researchers, Lave and Dowlatabadi, concluded that uncertainty and the degree of optimism of the decisionmaker were both important, but less so than whether the policymaker's decision criterion hinged on minimizing expected costs or on being as precautionary as possible. The former criterion, focused on costs, essentially reflects the economic lens; the latter, focused on the "precautionary principle," essentially derives from the ecological lens. In a mix of scenarios, Lave and Dowlatabadi found that those focused on minimizing expected costs would most often support moderate abatement given existing uncertainties, while those focused on being precautionary would more often support stringent abatement despite costs.

This interplay of uncertainty, information, and costs is summarized in **Table 2**. The perspective on uncertainty can have tangible policy implications — as evidenced by the ongoing debate between those who believe action to address global climate change is justified and those who do not.

---

[76] Lester B. Lave and Hadi Dowlatabadi, "Climate Change: The Effects of Personal Beliefs and Scientific Uncertainty," *Environmental Science and Technology*, Vol. 27, no. 10 (1993), pp. 1968, 1972.

Federal Policy As Viewed through the Lenses

Faced with a fundamental problem, such as the potential for global climate change, a policymaker who is looking through the technological lens and focusing on technical fixes tends to take an activist view of the government's role — to support innovation and commercialization. In the same situation, a policymaker who is looking through the economic lens and focusing on the costs and benefits of action tends to view the government's role as limited — to ensuring that any misfunctioning of the market is corrected. And a policymaker who is looking through the ecological lens and focusing on the need for action to solve the problem tends to see the government actively playing crucial roles — to inform public understanding, to seek public commitment, and to make available options for solving the problem.

These differing propensities on the role of government among the three perspectives are summarized in **Table 3**. As described in this report, these differences have consequences for one's expectations for government action, depending on the lens one views global climate change through. At the same time, these differing expectations can have consequences for how one views the lenses themselves: that is, persons with a predisposition for limited government are likely to find the economic lens a more appropriate way to approach the issue than the other two lenses, whereas persons with a predisposition for activist government may be more comfortable with the technology and/or ecological lenses.

Table 2. Influence of the Lenses on Policy Parameters

Approach	Seriousness of Problem	Risk in Developing Mitigation Program	Costs
Technological	By itself, the lens is agnostic on the problem. The focus of the lens is on developing new technology that can be justified from multiple criteria, including economic, environmental and social perspectives.	Believes any reduction program should be designed to maximize opportunities for new technology. Risk lies in not developing technology by the appropriate time. Focus on research, development, and demonstration; and on removing barriers to commercialization of new technology.	Viewed from the bottom-up. Tends to see significant energy inefficiencies in the current economic system that currently (or projected) available technologies can eliminate at little or no overall cost to the overall economy.
Economic	Understands issue in terms of quantifiable cost-benefit analysis. Generally assumes the status quo is the baseline from which costs and benefits are measured. Unquantifiable uncertainty tends to be ignored.	Believes that economic costs should be examined against economic benefits in determining any specific reduction program. Risk lies in imposing costs in excess of benefits. Any chosen reduction goal should be implemented through economic measures such as tradeable permits or emission taxes.	Viewed from the top-down. Tends to see a gradual improvement in energy efficiency in the economy, but significant costs (quantified in terms of GDP loss) resulting from global climate change control programs. Typical loss estimates range from 1% to 2% of GDP.
Ecological	Understands issues in terms of its potential threat to basic values, including ecological viability and the well-being of future generations. Such values reflect ecological and ethical considerations; adherents see attempts to convert them into commodities to be bought and sold as trivializing the issue.	Rather than economic costs and benefits or technological opportunity, effective protection of the planet's ecosystems should be the primary criterion in determining the specifics of any reduction program. Focus of program should be on altering values and broadening consumer choices.	Views costs from an ethical perspective in terms of the ecological values that global climate change threatens. Believes that values such as intergenerational equity should not be considered commodities to be bought and sold. Costs are defined broadly to include aesthetic and environmental values that economic analysis cannot readily quantify and monetize.

Table 3. Summary of Lenses

Approach	View of the Problem	Guiding Principles	Role of Government
Technological	Problem seen as opportunity for new, more efficient technology. Country seen as on the edge of an energy transition.	Technology can solve many of the problems involved if so directed. Governmental sponsorship of and intervention in technological development can accelerate the commercialization of appropriate technology.	Create market through technological mandates. Economic assistance through research and development sponsored by the Government.
Economic	Problem seen in terms of internalizing a currently external cost.	The marketplace is the most efficient means of controlling undesirable pollutants. Private sector can solve problem given appropriate incentives with minimal governmental interference; prices are the best signal.	Provide a market-based signal to private industry about the external cost (e.g., emission taxes, tradeable permits, etc.)
Ecological	Problem seen in terms of individual and institutional behavior influenced by societal values and education.	If people have all the relevant information about choices and have the choice, they will make the responsible choice. Prices cannot signal all essential values. People do not currently fully understand the implications of their behavior. The economic system and current technologies also restrict the available choices.	Encourage a climate in which environmentally responsible decisions are more socially acceptable and less responsible decisions are stigmatized through public education and policies. Ensure availability of "green" options for consumers.

Conclusion: Balancing the Three Lenses to Develop Policy

The technological, economic, and ecological "lenses" represent ways of viewing responses to environmental problems. None is inherently more "right" or "correct" than another; rather, they overlap and to varying degrees complement and conflict with each other. Most people hold to each of the lenses in varying degrees and combinations. For example, a person who is quite concerned about the potential of global climate change from an ecological perspective, but concerned also about the economic costs and the effectiveness of a reduction program, might see a "no regrets" policy as most prudent under the circumstances. In contrast, an ecological perspective combined with a strong technological perspective would see no reason for not pushing forward with a strong reduction program without delay. A third possibility could be a risk aversion perspective deriving from cost-benefit concerns combined with a technological perspective, a combination that could lead one to a strong research and development program combined with phased-in and selective technological incentives based on potential cost-effectiveness. The combination of possibilities are many, depending on the depth of commitment to any one perspective or to any particular aspect (seriousness, effectiveness, costs) of the problem.

Table 3 summarizes the three lenses identified in this report. As indicated, they reflect differing assumptions about the nature of the problem, the means to a solution, and the governmental role in crafting that solution. The lenses are not mutually exclusive, but rather reflect differing emphases on what is a very complex issue.

These different emphases can be seen when examining the lenses according to different policymaking criteria; the governmental role differs substantially between the lenses. In actual implementation, any global climate change response would involve the government in multiple roles: promoting new technology, ensuring that the marketplace functions properly, and educating the public.

Table 4 presents other policymaking criteria. Once again, one sees conflict and complementarity across the different lenses. Eliminating non-market barriers can be a key to technological development, a removal that those peering through the economic lens would likely see as appropriate, although difficult. Similarly, those employing the technological lens have no objection to the ecological orientation of those using that lens, although they might question the need for such considerations — especially since those looking through the ecological lens might demand such thorough analysis of the implications of new technologies that its costs of development could be greatly increased or its adoption might be delayed. However, those viewing through the economic lens might object to the perspective given by the ecological lens, if it were to give weight to values or concerns that could not be justified through cost-benefit analysis (analysis to which those peering through the ecological lens might object).

Table 4. Review of Lenses Across Different Policymaking Criteria

Approach	Economic Efficiency	Effectiveness	Implementation
Technological	Depends on the cost-effectiveness of the technologies developed. Subject to considerable uncertainty during the research and development stage.	Tends to be very effective at eliminating emissions. However, the effectiveness sometimes comes at the expense of economic efficiency.	Implementation is straightforward once technology has been developed.
Economic	Depends on the functioning of the marketplace and how any economic distortions are handled.	Effectiveness depends on the level of tax/number of permits allowed and the existence of any non-market barrier to compliance.	Implementation is straightforward from a governmental perspective, providing the private sector with the maximum flexibility to respond to the market's signals.
Ecological	Depends on altered values and broadened consumer choices — economic efficiency is redefined to include ecological values (such as future generations).	Can be very effective over the long-term. However, the time-frame involved is unclear.	Implementation involves a combination of public education and public policy to provide consumers with the opportunities to act responsibly.

Elements of all three lenses can be seen in the policies promoted by the George W. Bush Administration and in the actions of the Congress — although different perspectives dominate. For the Administration, the technological (and to a lesser degree, the ecological) lens appears very important to the long-term success of its initiatives. The focus of Administration initiatives is on development and use of technology to achieve reductions without significant economic pain. That the Administration currently does not include a massive, mandatory program suggests that the economic lens is heavily influencing the design of a climate change program. Unlike the Clinton Administration, the George W. Bush views costs to be a major obstacle to reducing greenhouse gases in the near term.

For the Congress, the failure of any comprehensive climate change legislation to yet be enacted seems to reflect a focus on increasing certainty about the problem and on the costs of actions, consistent with the economic lens. While Congress did ratify the 1992 Framework Convention on Climate Change and enacted several global climate change provisions in the 1992 Energy Policy Act, a "go-slow" approach is manifest by such actions as the Senate's unanimous vote of 95-0 in support of S.Res. 98, which stated the Administration should sign no agreement that

would result in serious harm to the economy or that did not include developing countries (along with developed countries) within its control regime. In addition, the resolution stated that any agreement submitted to the Senate include a detailed and comprehensive economic impact assessment of the treaty. Yet, while similar concern about the economy was expressed in S.Amdt. 866 in 2005, that action also put the Senate on record for taking action. A subsequent step has been the report from Committee of S. 2191, which would establish a cap-and-trade program to address climate change. This approach itself is consistent with viewing the issue from an economic perspective — but the fact of action suggests either a shift toward perceived benefits outweighing costs, or, perhaps, a refocusing through other policymaking lenses.

The effort by various interests to convince the public that their perspective is correct, and that those of others reflect either wishful thinking, misinformation, or excuses, will likely continue. Such efforts will be affected by improvements in the scientific understanding of global climate change, and of the domestic and international implications for strategies for addressing it. However, the pivotal decision-making point — whether that understanding warrants action or not — will be mediated in large part by the lens through which policymakers view the new knowledge. Ultimately, it is the balance between all three perspectives that will shape policy options and eventually determine the character and timing of any policy response to the problem.