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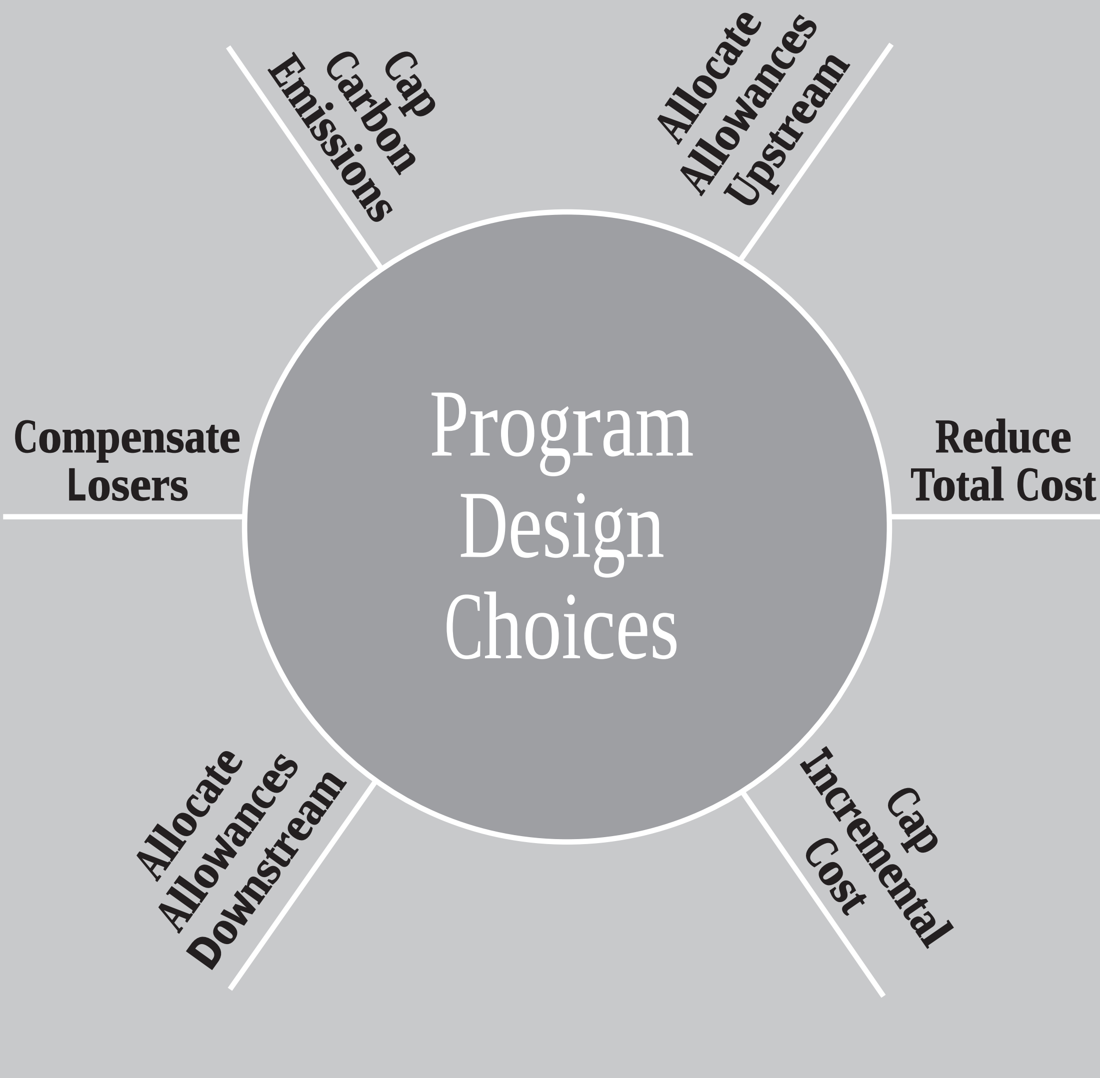
An Evaluation of Cap-and-Trade Programs for Reducing U.S. Carbon Emissions



AN EVALUATION OF CAP-AND-TRADE PROGRAMS FOR REDUCING U.S. CARBON EMISSIONS

The Congress of the United States
Congressional Budget Office

Preface

Climate change has emerged as an important public policy issue, although the prospects for an international agreement on climate policy are unclear. Several Members of Congress and public interest groups have proposed plans to encourage or require cuts in the United States' emissions of carbon dioxide, which affect the Earth's climate. This Congressional Budget Office (CBO) study—prepared at the request of the Senate Committee on Environment and Public Works—examines four proposals for reducing those emissions. Each proposal is a variant of a "cap-and-trade" program, in which policymakers would set a mandatory cap on emissions of carbon dioxide and provide companies with economic incentives to reach that cap at the lowest possible cost.

This study evaluates the four proposals using various criteria, including ease of implementation, degree of certainty about achieving the target level of emissions, cost-effectiveness, and distributional effects. The analysis shows how key decisions in the design of cap-and-trade programs affect their performance relative to those criteria. No single proposal stands out in terms of all the criteria considered. Which option policymakers might prefer, if they chose to take action at all, would depend on how they weighed the various performance criteria.

The study was written by Terry Dinan of CBO's Microeconomic and Financial Studies Division, which is directed by Roger Hitchner. Barbara Edwards, Arlene Holen, Deborah Lucas, Robert Shackleton, and Tom Woodward of CBO provided valuable comments and assistance, as did Roberton Williams III of the University of Texas at Austin, Tim Hargrave of the Center for Clean Air Policy, and Dallas Burtraw and Carolyn Fischer of Resources for the Future.

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Dan L. Crippen
Director

June 2001

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Summary

Although scientists have known since the 19th century that rising concentrations of "greenhouse gases" in the atmosphere affect the Earth's climate, climate change only recently emerged as an important public policy issue. In 1997, negotiators for the Clinton Administration and more than 80 other countries signed the Kyoto Protocol, in which most industrialized nations agreed to restrict their greenhouse gas emissions to specific levels. If the protocol is ratified, it will require the United States to cut its emissions by 7 percent from the 1990 level. However, no major industrialized nation has yet ratified the agreement, in part because of uncertainty about the potential benefits and costs of reducing emissions and the reluctance of developing countries to participate.

Several Members of Congress and public interest groups have proposed plans to encourage or require cuts in the United States' greenhouse gas emissions, either before or in the absence of implementation of the Kyoto Protocol or other international agreement. This study examines four such proposals. They focus on emissions of carbon dioxide (referred to here as carbon emissions), which make up the vast majority of greenhouse gas emissions and are the easiest to track.

The proposals are variants of a "cap-and-trade" program, in which policymakers would set a mandatory cap on carbon emissions and provide businesses with economic incentives to reach that cap at the lowest possible cost. Cap-and-trade programs have been used to limit several pollutants in recent years, including sulfur dioxide, which contributes to acid rain.

The Evaluation Criteria Used in This Study

The four proposals examined in this analysis vary greatly in terms of the ease with which they could be implemented, the certainty with which they would achieve the desired cuts in carbon emissions, their cost-effectiveness, and their distributional effects. The Congressional Budget Office (CBO) looked at some of the trade-offs inherent in the proposals by evaluating each option against the following criteria:

- *Ease of Implementation*. Would the policy be easy to carry out and enforce?

- *Carbon-Target Certainty*. Would the policy achieve the target level of carbon emissions?

- *Incremental-Cost Certainty*. Would the policy place an upper limit on the cost that the U.S. economy might bear for reducing a unit of carbon emissions? Efforts to cut carbon emissions range from low-cost strategies to high-cost ones. Incremental-cost certainty would be achieved if the policy limited reductions to those below a target cost.

- *Cost-Effectiveness*. Would the policy reduce carbon emissions at the lowest possible cost to society?

- *Distributional Effects*. How would the cost and financial benefits of the policy be distributed among U.S. households of different incomes and among U.S. producers?

No one proposal stands out in terms of all the criteria considered. Which option policymakers might prefer, if they chose to take action at all, would depend on the importance they attached to the various performance criteria.

How the four cap-and-trade proposals would measure up against the evaluation criteria would depend on basic decisions about their design. Thus, before examining the actual proposals, CBO looked at the implications of each of those design decisions.

Limitations of the Study

This analysis does not address the issue of taxing carbon emissions. However, the economic impacts of cap-and-trade programs would be similar to those of a carbon tax: both would raise the cost of using carbon-based fossil fuels, lead to higher energy prices, and impose costs on users and some suppliers of energy.

The study also does not discuss the science of climate change or the magnitude and distribution of its economic effects. Nor does it quantify the costs and benefits of each of the proposals examined. Instead, the study indicates whether each proposal could be expected to bring about emission reductions at the lowest possible cost (assuming that policymakers chose to make such reductions).

The Implications of Design Decisions for the Performance of Cap-and-Trade Programs

As usually envisioned, a cap-and-trade program would be mandatory. Policymakers would set a cap on total carbon emissions and require companies to hold rights (or allowances) to the emissions permitted under that cap. Each allowance would entitle the holder to one metric ton of carbon emissions. After an initial distribution of allowances, firms would be free to buy and sell them (the trade part of a cap-and-trade program).

Three decisions about the design of a cap-and-trade program would influence how it would measure up against CBO's evaluation criteria:

- Who would have to hold the emission allowances?
- How would policymakers allocate the allowances and distribute their value?
- Would the government set a ceiling on the price of allowances?

Who Must Hold Allowances?

A key decision in designing a cap-and-trade program is whether to implement it "upstream," where carbon enters the economy (when fossil fuels are imported or produced domestically) or farther "downstream," closer to the point where fossil fuels are combusted and the carbon enters the atmosphere.

Under an upstream program, producers and importers of fossil fuels would need to hold allowances for the fuel they sold. Their allowance requirements would be based on the carbon emissions that would be released when their fuel was combusted. Under a downstream program, some or all users of fossil fuels would be required to hold allowances. In general, an upstream program would have several major advantages over a downstream program.

Ease of Implementation. Although carbon is ultimately emitted by hundreds of millions of fossil-fuel users—including vehicles, buildings, and factories—it enters the economy through a relatively small number of fossil-fuel suppliers. By placing the allowance requirement upstream on those suppliers, policymakers could cap virtually all fossil-fuel-based carbon emissions in the United States while minimizing the government's administrative costs and the private-sector's reporting costs. Moving the allowance requirement downstream, in contrast, could require monitoring and regulating many more entities. Although a downstream trading program could theoretically cover most carbon emissions, implementing a comprehensive program could prove prohibitively expensive. A downstream program that was restricted to one sector of the economy would be cheaper, but such a program would have other limitations (discussed below).

Carbon-Target Certainty. An upstream cap-and-trade program could ensure that an economywide emission target would be met because it would cover virtually all sources of emissions. In contrast, a downstream system that was not extremely costly could cap only a subset of carbon emissions, while not limiting emissions from sources outside the cap.

Cost-Effectiveness. Ideally, a cap-and-trade program would encourage emission reductions to be made at the lowest cost throughout the economy. An upstream system would limit fossil-fuel production, leading to higher prices for those fuels and for energy-intensive goods and services. The higher prices would give the entire U.S. economy incentives to reduce carbon emissions. Those incentives would result in cost-effective emission reductions: firms and households would decrease their fossil-fuel use if the cost of doing so was less than the cost increase resulting from the higher prices. In addition, the higher prices would encourage the use of existing technologies to improve energy efficiency as well as the development of new ones. A downstream program that was limited to one sector of the economy, in contrast, would encourage reductions from only that sector, and a comprehensive downstream trading program would entail very high administrative costs.

How Would Allowances Be Allocated?

In any cap-and-trade program, policymakers would need to make three decisions about how they allocated allowances. First, would the allowances be sold or given away for free? In this analysis, CBO assumes that if allowances were sold, they would be sold through an auction, which can provide an efficient method of assigning ownership rights. Second, policymakers would need to decide who would receive the value of the allowances. (If allowances were given away, who would get them? Possibilities include consumers and suppliers of fossil fuels as well as workers in affected industries. If allowances were sold, how would the auction revenue be used?) Third, if policymakers chose to give the allowances away to businesses, they would need to decide whether to base the allocation on firms' current or past production (or emission) levels.

Selling the allowances through an auction, as opposed to giving them away, would provide an opportunity to use the auction revenue to lower the overall cost of the cap-and-trade program. However, policymakers would face a trade-off between using the allowances' value to lower that cost and using it to compensate businesses or households that were adversely affected by the policy. Using the allowances' value to compensate parties that had previously benefited from the zero price of carbon emissions (that is, from having no limit on emissions) could lessen concern that the policy would violate principles of fairness. It might also reduce political opposition to the policy.

Reducing the Program's Total Cost. The higher prices for energy and energy-intensive products that would result from a cap-and-trade program would reduce the real income that people received from working and investing, thus tending to discourage them from productive activity. That would compound the fact that existing taxes on capital and labor already discourage economic activity. The cost of that compounding—which is called the "tax-interaction effect"—could be significant. Policymakers could lower the cost of the cap-and-trade policy to the economy if they chose to sell allowances and used the revenue to cut existing taxes. Recent research has focused on the extent to which reductions in taxes on capital and labor could lower the cost of a cut in carbon emissions; it concludes that reducing taxes on capital would be the most effective approach.

Determining the Program's Distributional Effects. Policymakers would decide the ultimate distributional effects of the cap-and-trade program by choosing who would receive the allowances or the auction revenue. Theoretically, a wide variety of distributional effects could be achieved with either auctioning or free allocation.

Excluding the distribution of the allowances' value, a cap-and-trade program would be regressive

—that is, the price increases that it provoked would impose a greater relative burden on lower-income households than on higher-income households. Much of the cost of a limit on carbon emissions would be passed on to households through those higher prices. The share of costs not passed on to households would be borne by fossil-fuel suppliers and by industries that use energy intensively. Shareholders and workers in those industries would be adversely affected.

The total value of allowances under a cap-and-trade program for carbon emissions could be substantial—perhaps in the tens to hundreds of billions of dollars. Policymakers could use that value to help offset the distributional effects of a carbon restriction by giving allowances or auction revenue to households and producers in proportion to their share of the policy's cost. Such a strategy would entail giving much of the allowances' value to households, perhaps in the form of equal payments to all U.S. residents from auction revenue. Those payments would be progressive in that they would represent larger percentage increases in income for lower-income households than for higher-income households. Thus, they would tend to offset the regressivity of the policy-induced price increases.

Offsetting the distributional effects would involve giving producers only a portion of the allowances' value because they would be expected to pass a large share of the policy's cost on to consumers. A decision to give all of the allowances to a selected set of firms (such as fossil-fuel suppliers or utilities) would more than compensate them for their costs and could provide them with substantial profits. Those profits would ultimately benefit shareholders rather than consumers in general.

In essence, policymakers would face a trade-off between using the allowances' value to offset the distributional impact of the price increases and using it to offset the overall cost to the economy. For instance, making equal payments to U.S. residents would help offset the price increases but would not offset the tax-interaction effect—and thus would not lower the overall cost to the economy. Lowering existing taxes, in contrast, would reduce the tax-interaction effect, but higher-income households would benefit more than others. The allowances' value would not be sufficient to fully meet all of those goals. Thus, policymakers would have to weigh competing objectives when deciding on the appropriate combination of uses for that value.

Determining Firms' Allowance Allocations. If policymakers chose to give some of the allowances to businesses, would they base those allocations on each firm's current or historical level of production (or emissions)? Assuming that companies sell their products in competitive markets, basing allocations on historical production levels (called grandfathering) would lead to more cost-effective emission reductions. Under grandfathering, the allocation process itself would not influence firms' choices of emission-reduction strategies—instead, they would have an incentive to choose the lowest-cost strategies. In contrast, basing the number of allowances that a firm received each year on the amount that it produced in that year would subsidize production and create greater incentives for some emission strategies than for others. Such an approach would not result in the lowest-cost mix of emission-reduction strategies.

Would the Government Set a Ceiling on the Price of Allowances?

Policymakers could keep the price of allowances from rising above a certain level by agreeing to supply an unlimited quantity of allowances at that price level. The decision of whether to establish such a price ceiling highlights an important trade-off between two of CBO's evaluation criteria: carbon-target certainty and incremental-cost certainty. If policymakers set a cap on carbon emissions but not on the price of allowances, the trading program would reduce emissions to the target level, regardless of the cost to the economy. Placing a ceiling on the price of allowances would set an upper limit on the incremental cost that the United States would bear for reductions in carbon emissions (by limiting reductions to those that cost less than the ceiling), but it would leave the amount of emission reductions uncertain. Such a strategy could help prevent the U.S. economy from incurring higher-than-expected costs.

Evaluation of Four Cap-and-Trade Proposals

This study examines four specific cap-and-trade proposals in light of the evaluation criteria described earlier. Three of the four options are based on recent legislation or proposals by public interest groups. One is not similar to any current proposal but was designed to highlight certain trade-offs inherent in the actual proposals.

- *Upstream Trading Option I*. This option is similar to the "Sky Trust" proposal promoted by the groups Americans for Equitable Climate Solutions and Resources for the Future. Under this program, CBO assumes, upstream suppliers of fossil fuels would be required to hold allowances, which they would purchase in an auction. The government would set an initial ceiling of $25 per allowance. Auction revenue would be used to make equal payments to U.S. residents and to compensate consumers or companies that were adversely affected by the policy.

- *Upstream Trading Option II*. This option was designed to resemble the previous proposal, with two important differences. First, no ceiling would be set on the price of allowances. Second, auction revenue would be used to reduce corporate income taxes.

- *Downstream Trading Option I*. This option is similar to a proposal by the Progressive Policy Institute. It would initially cap emissions at the current level and then decrease that cap by 1 percent each year. Under this downstream design, large sources of carbon emissions would be required to hold allowances. Each large emitter would be given enough allowances to cover its own estimate of its emissions in the initial year of the program. Those allowance allocations would decline by 1 percent in each subsequent year.

- *Downstream Trading Option II: Electricity-Sector Cap*. This option, which would limit carbon emissions only from the electricity-generating sector, is similar to proposals in three bills that were introduced in the 106th Congress (H.R. 2569, H.R. 2980, and S. 1369). Under this type of program, the government would set a cap on emissions from fossil-fuel-fired electricity-generating units above a given size. Regulators would determine a generation performance standard (GPS) for each year by dividing the cap by the amount of electricity that they expected to be generated that year. Each covered generator would receive an annual allocation of allowances equal to the amount of electricity that it generated in that year multiplied by the GPS.

Both upstream trading options would be relatively easy to implement and would create incentives to bring about the lowest-cost emission reductions for the economy (see Summary Table 1). Upstream Trading Option I would limit the incremental cost to the economy of achieving such reductions by capping the price of allowances. Upstream Trading Option II, in contrast, would ensure a given level of emission reductions but could lead to higher-than-expected costs. Option I would use the revenue generated by the allowance auction to offset the distributional impact of the policy-induced price increases, whereas Option II would use that revenue to lower corporate income taxes, thus reducing the overall cost of meeting the carbon target.

Downstream Trading Option I would cover a large and diverse set of emission sources and would therefore be costly and difficult to implement. Because producers would be given all of the allowances, this option would have a regressive distributional effect.

The electricity-sector cap (Downstream Trading Option II) would create a more limited form of downstream trading. Its implementation costs would be lower because a smaller number of entities would be involved and because the electricity sector already participates in other cap-and-trade programs. However, the method of allocating allowances to firms in this proposal—which would be based on their current production levels and a generation performance standard—would tend to increase implementation costs and could boost the cost of emission reductions in the electricity-generating sector. Further, this option would be less cost-effective than an upstream trading

Summary Table 1.
How Various Cap-and-Trade Options Measure Up Against CBO's Evaluation Criteria

Criterion	Upstream Trading		Downstream Trading	
	Option I[a]	Option II[b]	Option I[c]	Option II[d]
Is Relatively Easy to Implement	Yes	Yes	No	Yes
Provides Certainty About Meeting Carbon Target	No	Yes	Yes for large emitters, No for the economy	Yes for the electricity sector,[e] No for the economy
Places an Upper Limit on Incremental Cost	Yes	No	No	No
Cost-Effectiveness				
Creates incentives for least-cost emission reductions	Yes	Yes	Yes for capped sources, No for other sources	No
Uses revenue to offset tax-interaction effect	No	Yes	No	No
Distributional Effects				
Creates regressive price increases	Yes	Yes	Yes	Yes
Creates windfall gains for selected industries	No	No	Yes	Yes
Overall effect on households	Progressive	Regressive	Regressive	Regressive

SOURCE: Congressional Budget Office.

a. Similar to the "Sky Trust" proposal by Resources for the Future and Americans for Equitable Climate Solutions. Suppliers of fossil fuels would be required to hold emission allowances, which the government would sell by auction with the price per allowance capped. Auction revenue would be distributed evenly to all U.S. residents and to some companies hurt by the policy.

b. Similar to the previous option except that allowance prices would not be capped and auction revenue would be used to cut corporate income taxes.

c. Similar to a proposal by the Progressive Policy Institute. Large sources of carbon emissions would receive allowances free of charge on the basis of their current emissions. Their allocations would shrink by 1 percent per year.

d. Similar to three bills introduced in the 106th Congress (H.R. 2569, H.R. 2980, and S. 1369). Only carbon emissions from electricity generators would be capped. Generators would receive free allowances on the basis of their annual production multiplied by a generation performance standard.

e. Assuming that the government could adjust the generation performance standard each year to maintain the target level of emissions.

program because it would not encourage emission reductions throughout the economy.

Conclusions

This study examines some of the options that the Congress would face should it decide that the potential benefits of reducing greenhouse gases warrant their limitation. In that case, carbon dioxide would be a likely candidate for regulation, since it is both the largest component of greenhouse gases and the easiest to monitor. Cap-and-trade programs for carbon dioxide emissions would merit consideration because such programs have the potential to reduce emissions at the lowest possible cost to the economy.

Policymakers would need to take several trade-offs into account in choosing among alternative designs for a cap-and-trade program for carbon emissions. An upstream design would be relatively simple to implement and could make it easier to achieve a given carbon target at the lowest possible cost to the economy. Moving the allowance requirement downstream would either greatly increase implementation costs—if the program tried to be comprehensive—or entail limiting the program's coverage. If properly designed, a cap-and-trade program that applied only to the electricity-generating sector would be relatively easy to carry out and could minimize the cost of cutting carbon emissions from that sector—but not from the economy as a whole.

Two fundamental decisions that policymakers would have to make in either an upstream or a downstream trading program would be how to allocate the allowances and whether to set a ceiling on their price. Selling the allowances (as opposed to giving them away) would generate revenue that could be used to reduce existing taxes that discourage economic activity. Such a reduction would lower the overall cost of the policy, but it might violate principles of distributional fairness since it would not compensate firms and households that were adversely affected by the carbon cap. Alternatively, policymakers could distribute the auction revenue—or the allowances themselves—in such a way as to offset the distributional effects of the carbon restriction. Setting a ceiling on the price of allowances could ensure that the economy would not incur excessive costs for reducing carbon emissions, but it would mean that a precise level of emissions could not be targeted.

Chapter One

Introduction

Scientists have known for more than a century that rising concentrations of carbon dioxide and other gases in the atmosphere affect the Earth's climate. Human activities are increasing the atmospheric concentrations of those so-called greenhouse gases, thus raising the prospect of human-induced climate change.

The potential effects of rising emissions of greenhouse gases are still very uncertain, as are the appropriate policy responses. Nevertheless, in the 1992 Framework Convention on Climate Change, nearly all of the world's nations agreed to take measures to "prevent dangerous anthropogenic [man-made] interferences with the climate system." Furthermore, in the 1997 Kyoto Protocol to that convention, nearly all industrialized nations agreed to restrict their emissions to specific levels. The United States, for example, would have to cut its greenhouse gases by 7 percent from the 1990 level if the agreement was ratified.

The Kyoto Protocol has not been brought to the U.S. Senate for a vote, and ratification is appearing less and less likely. Nonetheless, some Members of Congress and public interest groups have proposed initiatives to reduce U.S. emissions of greenhouse gases. Those initiatives focus on cutting emissions of carbon dioxide—referred to in this study as carbon emissions—because they make up the vast majority of greenhouse gas emissions and are the easiest to track. This study examines four such proposals using a variety of criteria, including cost-effectiveness and equity considerations. Quantifying the actual costs and benefits of each proposal, however, is beyond the scope of this analysis.

The proposals are variants of "cap-and-trade" programs, which would set an overall cap on carbon emissions and allow suppliers or users of fossil fuels to trade rights (or allowances) for that level of emissions. Cap-and-trade programs have been used in the United States to reduce several air pollutants (including sulfur dioxide, which contributes to acid rain) and to lower the lead content of leaded gasoline.[1] The economic incentives created by such programs are similar to those created by a tax on emissions.

The four proposals examined in this study represent a range of designs for a cap-and-trade program for carbon emissions.

- o The first option, which is similar to a proposal by the groups Resources for the Future and Americans for Equitable Climate Solutions,

1. The concept of distributing tradable pollution rights—what this paper refers to as emission allowances—first appeared in the academic literature in 1968; see J.H. Dales, *Pollution, Property and Prices* (Toronto: University of Toronto Press, 1968). Trading programs can be attractive alternatives to command-and-control approaches because they can lower the cost of achieving an environmental goal by giving participants some flexibility; see David W. Montgomery, "Markets in Licenses and Efficient Pollution Control Programs," *Journal of Economic Theory*, vol. 5 (1972), and Tom H. Tietenberg, *Emissions Trading: An Exercise in Reforming Pollution Policy* (Washington, D.C.: Resources for the Future, 1985). For a recent overview of the use of cap-and-trade programs in the United States, see Environmental Protection Agency, *The United States' Experience with Economic Incentives for Protecting the Environment*, EPA-240-R-01-001 (January 2001).

would require fossil-fuel suppliers to hold emission allowances. They would buy those allowances in a government auction—with the maximum price capped—and the auction revenue would be distributed to U.S. residents as well as to some companies adversely affected by the policy.

- The second option, which was developed by the Congressional Budget Office (CBO) to illustrate potential policy trade-offs, would mirror the first option except that the price of allowances would not be capped and the auction revenue would be used to lower corporate income taxes.

- Another option, which resembles a proposal by the Progressive Policy Institute, would give allowances to large emitters of carbon dioxide on the basis of their current emissions and reduce that allowance allocation by 1 percent each year, thus lowering their carbon emissions by 1 percent per year.

- A final option, which is based on legislation considered in the previous Congress, would cap carbon emissions only from large electricity-generating plants that use fossil fuels. Those plants would receive an annual allocation of emission allowances.

How those proposals—or any cap-and-trade program for carbon emissions—would measure up according to the evaluation criteria used in this study would depend on basic decisions about the design of the programs. Thus, before evaluating the specific proposals in Chapter 3, this study discusses the implications of various design decisions in Chapter 2.

Climate Change and the Kyoto Protocol

Carbon dioxide in the atmosphere affects temperatures by trapping heat from the sun close to the Earth's surface. It is produced by (among other things) burning any fuel that contains carbon, such as coal, oil, or natural gas. As a result, carbon emissions from human activities increased greatly during the industrial revolution when the use of fossil fuels surged.[2]

For many years, scientists assumed that man-made carbon emissions were being absorbed by the oceans. But that assumption changed in the late 1950s when scientists took measurements in Hawaii and found that atmospheric concentrations of carbon dioxide were rising steadily. Later research revealed that other common gases, such as methane and nitrous oxide, could also affect climate.

By the late 1980s, climate change had emerged as a major political issue transcending national boundaries. In December 1988, the U.N. General Assembly established the Intergovernmental Panel on Climate Change to review scientific data on the subject. The panel's most recent report, issued in 2001, concluded that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." However, the report also highlighted the many gaps in information and understanding that remain. "Further research is required to improve the ability to detect, attribute and understand climate change, to reduce uncertainties and to project future climate change."[3] In addition, understanding of the potential severity and impact of climate change continues to evolve. Some research has focused on the possible benefits of global warming as well as the potential harm.[4]

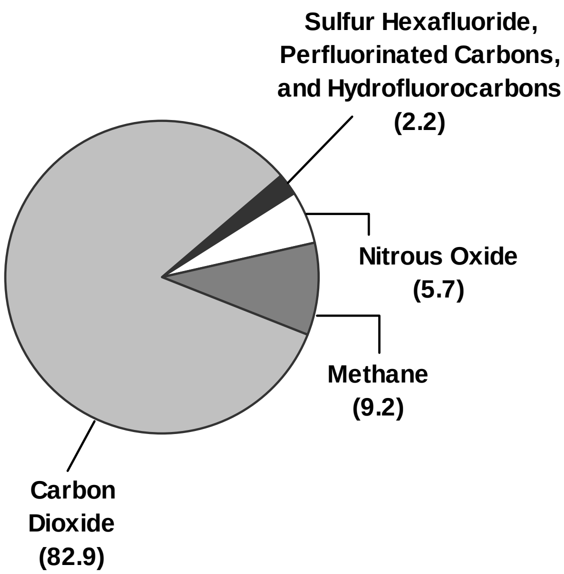
The Kyoto Protocol, negotiated in 1997, was the outcome of an attempt to develop an international strategy to address climate change. The protocol covers six greenhouse gases: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, perfluorinated carbons, and hydrofluorocarbons. Of those, carbon

2. For a more detailed discussion of the science and politics of climate change, see J.W. Anderson, *The Kyoto Protocol on Climate Change: Background, Unresolved Issues and Next Steps* (Washington, D.C.: Resources for the Future, January 1998). Much of this discussion was drawn from that report.

3. See United Nations Intergovernmental Panel on Climate Change, "Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change" (available at www.ipcc.ch/pub/spm22-01.pdf).

4. For a review of the research, see Robert Mendelsohn, *The Greening of Global Warming* (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1999).

Figure 1.
Composition of Total U.S. Emissions of Greenhouse Gases, 1998 (In percent)



SOURCE: Congressional Budget Office based on information from Department of Energy, Energy Information Administration, *Annual Energy Review 1999*.

dioxide accounted for more than four-fifths of U.S. greenhouse gas emissions in 1998 (see Figure 1).

Virtually all U.S. carbon emissions result from burning petroleum, coal, and natural gas. Of those three fossil fuels, coal emits the most carbon per amount of heat generated and natural gas the least. For example, carbon emissions would be 77 percent higher if a given amount of heat was generated by coal rather than by natural gas and 25 percent higher if it was generated by petroleum rather than by natural gas. Any attempt to achieve large reductions in U.S. emissions would require shifting from carbon-intensive fossil fuels such as coal to less-carbon-intensive ones such as natural gas. Switching to nonfossil-fuel sources of energy (such as hydropower or nuclear power) or reducing energy use would also decrease emissions.

As of May 9, 2001, the Kyoto Protocol had been signed by negotiators from the Clinton Administration and from 83 other nations and had been ratified by 34 countries.[5] However, no major industrialized country has yet ratified it. The agreement is intended to take effect 90 days after the 55th government ratifies it, assuming that those 55 countries accounted for at least 55 percent of the carbon emissions of developed nations in 1990.

The Kyoto Protocol has not been sent to the U.S. Senate for ratification, and recently, the Bush Administration announced its intention to withdraw its support for the agreement, citing concerns about the potential cost to the U.S. economy and the lack of participation by large developing countries (such as China). Reducing greenhouse gases would be relatively inexpensive in those countries, where fossil fuels are used inefficiently. Thus, the cost of meeting its own emission target would be significantly lower if the United States could do so in part by financing low-cost emission reductions in developing nations.[6] But developing countries fear that limits on emissions would impede their growth.

Although the prospects for an international agreement on climate policy are unclear, initiatives to cut U.S. emissions of greenhouse gases continue to be debated. Those initiatives could be implemented prior to, or in the absence of, an international agreement.

The Evaluation Criteria Used in This Study

Different programs to reduce carbon emissions would vary in terms of the ease with which they could be implemented, the certainty with which they would meet an emission target, the cost-effectiveness of the emission reductions, and their effects on businesses and households. This study highlights those differ-

5. See United Nations Framework Convention on Climate Change, "Kyoto Protocol Status of Ratification" (available at www.unfccc.int/resource/kpstats.pdf).

6. Global temperature levels are affected by the total amount of carbon dioxide in the atmosphere, so foreign emission reductions should be just as effective as U.S. emission reductions. If international trading of carbon allowances occurred, the United States could receive credit toward its domestic limit by purchasing low-cost foreign emission reductions.

ences by examining the performance of carbon-reducing initiatives according to five criteria:

- *Ease of Implementation*. Would the policy be easy to carry out and enforce?

- *Carbon-Target Certainty*. Would the policy achieve the target level of carbon emissions?

- *Incremental-Cost Certainty*. Would the policy place an upper limit on the cost that the U.S. economy might bear for reducing a unit of carbon emissions? Efforts to cut carbon emissions range from low-cost options to high-cost ones. Incremental-cost certainty would be achieved if the policy limited reductions to those below a target cost.

- *Cost-Effectiveness*. Would the policy achieve carbon reductions at the lowest possible cost to society? The answer depends on two more questions: would the policy provide an incentive to bring about the lowest-cost reductions in carbon emissions, and would the value of the allowances be captured by the government and used to lower existing taxes?

- *Distributional Effects*. How would the cost and financial benefits of the policy be distributed among U.S. households at different income levels and among U.S. producers?

Limits on the Scope of the Study

In focusing on cap-and-trade programs—which have been successful at reducing other pollutants in a cost-effective manner—this study does not examine the full range of policies that could be used to cut carbon emissions. For example, it does not consider command-and-control regulations, which might prescribe firm- or industry-specific technologies. This study also does not consider taxing carbon emissions; however, it points out similarities between carbon taxes and cap-and-trade programs for carbon emissions. For example, both policies would raise the cost of carbon emissions, lead to higher prices for fossil fuels, and impose costs on energy users and suppliers of carbon-intensive energy.

Further, this study does not look at how various policies might promote carbon sequestration—the absorption of carbon dioxide by trees, plants, and soils. Some policies could offset U.S. carbon emissions by encouraging changes in land use and forest management that would lead to greater levels of sequestration. To the extent that options for low-cost carbon sequestration were available, they could be relatively efficient. However, measuring baselines for carbon sequestration would be difficult, and incorporating sequestration into policy initiatives would raise the administrative and implementation costs of the policy considerably.

A primary motivation for reducing carbon emissions is to achieve positive net benefits for the United States—that is, benefits greater than costs. However, determining whether the proposals would generate positive net benefits is beyond the scope of this study. Rather, this study considers the narrower question of whether a particular program would be cost-effective—that is, would bring about carbon reductions at the lowest possible cost to the U.S. economy (given the objective of reducing carbon emissions).

Finally, this study provides qualitative but not quantitative evaluations of the cap-and-trade proposals. For example, it indicates whether a proposal would encourage the lowest-cost reductions in carbon emissions but does not estimate the proposal's actual cost. Likewise, CBO estimates whether proposals would adversely affect lower-income households but does not quantify how much various households would actually gain or lose as a result of different programs.[7]

7. For a discussion of that issue, see Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs* (June 2000).

Chapter Two

The Implications of Design Decisions for the Performance of Cap-and-Trade Programs

As generally proposed, a cap-and-trade program would be mandatory. Policymakers would set a cap on total U.S. carbon emissions and require companies to hold allowances to the emissions permitted under that cap. Each allowance would entitle the holder to one metric ton of carbon emissions. After an initial distribution of allowances, the holders would be free to buy and sell them. The allowances' value would stem from the limitation on the amount of carbon emissions. Thus, as with a tax, the production of carbon dioxide would be costly to entities affected by the regulation.

Three decisions about the design of a cap-and-trade program would influence how it would measure up against the Congressional Budget Office's evaluation criteria:

- o Who would be required to hold the carbon allowances?
- o How would the allowances be allocated? First, would they be sold or given away for free? Second, who would receive their value? (If policymakers decided to sell allowances, to whom would they distribute the resulting revenue? If they gave allowances away, who would receive them?) And third, if policymakers chose to give allowances away to businesses, would the companies' allocations be based on their past or current production (or emission) levels?
- o Would the government set a ceiling on the price of allowances?

Who Must Hold Allowances?

Carbon is a component of fossil fuels. It enters the economy when those fuels are imported or produced domestically and is emitted when they are burned. A key decision in designing a cap-and-trade program is whether to implement it "upstream," where carbon enters the economy, or farther "downstream," closer to the point where it is emitted into the atmosphere.

Under an upstream program, the producers and importers of fossil fuels would be required to hold allowances based on the carbon content of their fuel—that is, the carbon emitted when the fuel is combusted. Requiring that companies hold an allowance for each ton of carbon introduced into the economy is equivalent to requiring an allowance for each ton of carbon emitted into the atmosphere. The reason is that there are no economically viable methods (such as scrubbing emissions from smokestacks) for reducing the amount of carbon emissions per unit of fuel combusted.

A downstream program could take numerous forms, with various users of fossil fuels required to hold allowances. The choice of whether to implement a cap-and-trade program upstream or downstream has implications for three of the evaluation criteria used in this study: ease of implementation, carbon-target certainty, and cost-effectiveness. In all of those areas, an upstream design offers several advantages.

Ease of Implementation

Although carbon dioxide is emitted by hundreds of millions of fossil-fuel users (everything from power plants to automobiles), it enters the economy through a relatively small number of fossil-fuel suppliers. By placing the allowance requirement upstream on those suppliers, the government could cap virtually all fossil-fuel-based carbon emissions in the United States while minimizing both its administrative costs and the private sector's reporting costs (such as for documenting suppliers' allowance requirements and transactions). The Center for Clean Air Policy estimates that such a program would require less than 2,000 entities to hold allowances.[1] Those entities would include petroleum refineries, oil importers, natural gas pipelines, natural gas processing plants, coal preparation plants, and coal mines whose production bypasses preparation plants. Implementing such a program would be relatively easy because regulators could determine each supplier's allowance requirements on the basis of information about the amount and type of fuel that it sold in the United States.

Moving the allowance requirement downstream could require monitoring and regulating many more entities. The United States contains roughly 380,000 industrial establishments, millions of commercial buildings, and hundreds of millions of homes and automobiles.[2] The farther downstream the allowance requirement was placed, the larger the number of entities that would have to be regulated.

Although a downstream trading program could theoretically cover most sources of carbon emissions, the cost of implementing a comprehensive downstream program could be prohibitive. Alternatively, the cost of implementing a downstream program that was limited to the electricity sector would be low, but such a program would cover only about 40 percent of carbon emissions (see Table 1). Limited coverage would decrease both the likelihood that the program would meet an economywide emission target and the cost-effectiveness of the emission reductions.

Carbon-Target Certainty

An upstream cap-and-trade program could ensure that an economywide emission target would be met because it would cover virtually all carbon emissions.[3] A downstream program, in contrast, could realistically cap only a subset of carbon emissions, while not limiting emissions from sources outside the cap. Those outside emissions could increase as a result of economic growth or of unintended incentives that the program would create to shift fossil-fuel combustion to uncapped sectors. "Leakage" would occur if firms or households were able to lower their costs by shifting from regulated sources of fuel to unregulated ones.[4] For example, a cap on carbon emissions from the electricity sector that only covered utilities could lead to leakage: a facility in the industrial sector could choose to generate electricity on-site rather than purchase it from a utility that had higher costs—and higher prices—because of the cap.[5]

Cost-Effectiveness

An upstream cap-and-trade program would create price increases that would encourage reductions in carbon emissions throughout the economy. That economywide incentive to reduce carbon emissions would ensure that reductions were made at the lowest possible cost.

The carbon cap would limit production of carbon-based fossil fuels and would cause the price of those fuels to rise—with price increases reflecting

1. See Center for Clean Air Policy, *US Carbon Emissions Trading: Description of an Upstream Approach* (Washington, D.C.: Center for Clean Air Policy, March 1998), p. 7. Additional entities would be involved if policymakers wished to prevent carbon-intensive intermediate goods—such as aluminum—from being placed at a competitive disadvantage (see Chapter 3).

2. Ibid., p. 5.

3. That statement assumes that policymakers would not set a ceiling on the price of allowances (discussed later in the chapter).

4. For a discussion of leakage, see Center for Clean Air Policy, *US Carbon Emissions Trading: Some Options That Include Downstream Sources* (Washington, D.C.: Center for Clean Air Policy, April 1998), p. 14.

5. Such shifts could bring about other undesirable consequences. For instance, if the cap applied only to large electricity generators, companies might purchase more electricity from smaller, less efficient generators.

Table 1.
U.S. Fossil-Fuel-Related Emissions of Carbon Dioxide, by Sector, 1998

	Including Each Sector's Emissions Associated with Electricity		Excluding Each Sector's Emissions Associated with Electricity	
Sector	Amount of Emissions (Millions of metric tons)	Percentage of U.S. Total	Amount of Emissions (Millions of metric tons)	Percentage of U.S. Total
Residential	285	19	93	6
Commercial	238	16	60	4
Industrial	478	32	299	20
Transportation	485	33	484	33
Electricity	n.a.	n.a.	550	37
Total	1,486	100	1,486	100

SOURCE: Congressional Budget Office based on information from Department of Energy, Energy Information Administration, *Annual Energy Review 1999*.

NOTE: n.a. = not applicable.

each fuel's allowance requirements and, hence, its carbon content.[6] Those price increases would raise firms' and households' costs, encouraging them to decrease their consumption of fossil fuels and energy-intensive goods and services. (For example, households might drive less, and utilities might replace coal with lower-carbon-emitting fuels, such as natural gas or renewable sources of energy.) As a result, households and businesses throughout the economy would have an incentive to reduce all forms of carbon consumption and thus carbon emissions. Higher prices would not only encourage the use of existing technologies but would also provide an incentive for innovations to improve energy efficiency. (Similar economic incentives would result from a tax on the carbon content of fossil fuels.)

In contrast, a sector-specific (or otherwise limited) downstream trading program would confine incentives for cutting carbon emissions to one sector, although potentially lower-cost reductions could have been obtained from sources outside that sector. For example, a downstream system that was limited to electricity generators would not encourage emission reductions in the transportation sector, which accounts for roughly one-third of carbon emissions. Furthermore, as noted earlier, the cost of implementing a comprehensive downstream trading program could be prohibitive.

6. For example, the amount of carbon released per million British thermal units (MBTU) of coal is 1.8 times the amount released per MBTU of natural gas.

How Would Allowances Be Allocated?

In any cap-and-trade program, policymakers would need to make three decisions about how they allocated emission allowances. First, would allowances be sold at auction (like licenses to use the electromagnetic spectrum), given away for free (like allowances for sulfur dioxide), or some combination of the two? Second, how would the value of the allowances be distributed? If the government gave allowances away, who would receive them? If it sold allowances, who would benefit from the resulting revenue? Third, if policymakers chose to give some of the allowances to companies, how would they determine those companies' allocations?

Auction Versus Free Distribution

Auctioning off emission allowances—as opposed to giving them away—would provide policymakers with an opportunity to use the auction revenue to lower the overall cost of the cap-and-trade program. How would that work? As described above, a cap-and-trade program would cause the relative prices of energy-intensive goods to rise. Those higher prices would reduce the real income that people received from working and investing, thus tending to discourage them from productive activity. That would exacerbate the discouraging effect that existing taxes on capital and labor already have on productive activity. The exacerbation of existing tax distortions—called the tax-interaction effect—is difficult to measure but could be significant (see Box 1).

Policymakers could at least partially offset the tax-interaction effect, and thus lower the cost of the cap-and-trade program, if they sold some of the allowances and used the revenue to lower the existing taxes whose distortions the program would exacerbate. Recent research has focused on the extent to

Box 1.
How Much Would the Cost of a Cap-and-Trade Policy Decline If the Allowances' Value Was Used to Cut Taxes?

The tax-interaction effect increases the overall cost to the economy of a cap-and-trade policy by discouraging economic activity. Some recent studies conclude that the tax-interaction effect could substantially boost the cost of limiting carbon emissions. For example, one study estimates that the cost of a 15 percent decrease in carbon emissions would be 2.6 times higher if the tax-interaction effect was taken into account than if it was ignored.[1]

Policymakers could lower the overall cost of the policy by using the value of the emission allowances to offset the tax-interaction effect. One study estimates that the overall cost of a carbon limit could be cut by more than 40 percent if the value of the allowances was used to reduce individual income taxes.[2]

The results are even more dramatic when the researchers assume that the allowances' value would be used to reduce corporate income taxes. In that case, they concluded, the cost imposed on the economy would fall by more than 50 percent.[3] Another study estimates that the cost of a 15 percent decrease in carbon emissions would be more than 50 percent lower if policymakers used the allowances' value to offset existing taxes on labor (rather than giving the allowances away).[4] However, those studies do not examine how the effects of the policy would be distributed, so they neglect the fact that some people would be worse off despite the cost reduction.

Quantifying the tax-interaction effect and the extent to which it would be offset by cuts in existing taxes is difficult. The numbers discussed above are based on simplified models of the economy and on assumptions about how investment and labor would respond to changes in tax rates. Thus, they should be viewed as rough estimates.

1. See Ian H. Parry and others, "When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets," *Journal of Environmental Economics and Management*, vol. 37, no.1 (January 1999), pp. 52-84.

2. See A. Lans Bovenberg and Lawrence Goulder, *Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?* Working Paper No. 7654 (Cambridge, Mass.: National Bureau of Economic Research, April 2000). Their estimate was based on a carbon tax of $25 per metric ton (or equivalently, an auction in which the price of an allowance was $25). The gains were measured relative to the case in which the allowances' value was not used to encourage economic activity. That would occur if the government gave the allowances away or auctioned them off and made lump-sum payments to households or citizens.

3. The cost per ton of carbon emissions reduced was $102.60 in the base case, $60 when auction revenue was used to decrease individual income taxes, and $47.70 when auction revenue was used to lower corporate income taxes.

4. See Parry and others, "When Can Carbon Abatement Policies Increase Welfare?"

Box 2.
The Budgetary Treatment of Different Types of Federal Programs to Limit Carbon Emissions

The way in which the federal budget would treat programs to limit carbon emissions would depend primarily on whether the programs caused money to flow into or out of the government. Money would flow into the government if emission allowances were sold (as specified in some proposals) rather than given away (as specified in others). If allowances were sold, the revenue would show up in the budget as collections. If that revenue was spent, the expenditures would appear in the budget as outlays.

If allowances were given away, in contrast, there would be no flow of funds into the government, and the program would probably not be included in the budget. Spending on activities to monitor and enforce the program would appear in the budget, but private transactions involving the trading of allowances would not. Consistent with that approach, private trading of grandfathered allowances to emit sulfur dioxide (issued to comply with the 1990 amendments to the Clean Air Act) does not appear in the federal budget.[1]

In some cases, private financial transactions would appear in the budget because of the high degree of government control over the activity. Examples include the transactions of the health alliances that the Clinton Administration proposed in the Health Security Act of 1994 and the assessments on, and subsidies to, private telecommunications carriers under the Telecommunications Act of 1996, which seeks to provide service to customers who would otherwise be unprofitable to serve. In other cases, the government imposes regulations and mandates on private entities that result in costs and provide benefits; however, the degree of government control over the private activity falls short of the threshold necessary to classify those private transactions as federal. The budgetary treatment of a specific cap-and-trade program for carbon emissions would depend on the details of the legislation that created the program and the extent of federal involvement.[2]

1. Less than 3 percent of the sulfur dioxide allowances issued annually are auctioned. Those auctions are conducted for the Environmental Protection Agency by the Chicago Board of Trade. Auction proceeds are returned on a pro rata basis to the electricity-generating units that receive allowances through the grandfathering process. The auction revenues are held in a deposit account until they are distributed and are not counted as collections in the federal budget.

2. The Office of Management and Budget ultimately determines budgetary treatment, although CBO has an advisory role in such decisions. See Congressional Budget Office, *The Budgetary Treatment of Personal Retirement Accounts* (March 2000), for a more complete discussion of how budgetary treatment is determined.

which reductions in marginal tax rates on capital and labor income could offset the tax-interaction effect; it suggests that cuts in marginal tax rates on capital income (such as capital gains taxes and corporate income taxes) would produce the largest offsets. In contrast, no such cost reduction would be realized if the government gave the allowances away or auctioned them off and used the revenue to provide direct payments to businesses or individuals. Neither of those uses of the allowances' value would provide households with an additional incentive to work or invest.

Determining the Program's Distributional Effects

Restricting carbon emissions would impose costs on consumers and producers of some fossil fuels and energy-intensive goods and services. At the same time, the allowances (by permitting companies to produce or consume fossil fuel) would be valuable —worth tens or even hundreds of billions of dollars. Policymakers would determine the ultimate distributional effects of the cap-and-trade program by choosing whom to give the allowances or auction revenue to. Theoretically, the distribution of value could be similar under either method of allocation, since providing target groups with money from the auction or with allowances would be equivalent. (The practicality of providing different target groups with allowances or auction revenue might vary, but that issue is not addressed in this study.) However, the decision about whether to sell allowances or give them away would have varying implications for the federal budget (see Box 2 on page 9).

Distributional Effects of the Cap on Carbon Emissions. Excluding the government's distribution of the allowance value, a cap-and-trade program would be regressive—that is, it would impose a greater relative burden on lower-income households than on higher-income households. Much of the cost of the program would be borne by consumers in the form of higher prices for fossil fuels and energy-intensive goods and services. Those price increases would be regressive for two reasons. First, lower-income households generally spend a larger share of their income than higher-income households do, and second, a greater percentage of their income is spent on energy products (such as gasoline, electricity, and fuel for heating and cooking).[7]

The share of price increases that was not passed on to consumers would be borne by producers of carbon-intensive goods and services. Households would incur those costs if they owned stock in companies that suffered from reduced demand for their products because of higher fossil-fuel prices. Suppliers of high-carbon-content fuels (such as coal), for example, might retire their capital equipment early and expect lower future profits as they moved to lower levels of production. If companies could not pass those costs on to consumers, shareholders would ultimately bear them.[8] At the same time, the price increases could help other shareholders. For example, shareholders of natural gas refineries could benefit as the demand for natural gas rose because of the policy.

In addition, members of households might incur costs through their role as workers. Employees in carbon-intensive industries—such as the coal industry—could lose their jobs as a result of lower demand for those products, and wages in those industries could be temporarily depressed.

Distributional Effects of the Decision About Allocation. Policymakers could determine the ultimate distributional effects of the cap-and-trade policy by their decision about who would receive the allowances or auction revenue. First, consider a case in which the allowances were given away. The government would not need to give them to the same entities that it required to hold the allowances. For example, it could require fossil-fuel suppliers to hold allowances (to minimize implementation costs) and could give the allowances either to those suppliers, to intermediate producers that use fossil fuels, or even to households. Some recent studies indicate that the value of the allowances that fossil-fuel suppliers would receive if policymakers gave them all of the allowances would far outweigh their share of the cost of a carbon cap—creating substantial windfall gains (see Box 3).[9] Likewise, policymakers would create windfall gains for intermediate producers if they chose to give them all of the allowances. In either case, the windfall gains would ultimately benefit shareholders, who disproportionately are higher-income households. Thus, those allocation strategies would add to the regressivity of the price increases.

Alternatively, consider a case in which the government sold the allowances to fossil-fuel suppliers through an auction. The resulting revenue could be distributed to producers, consumers, or some combination in such a way as to replicate the distributional effects of giving allowances away.

7. See Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs* (June 2000), pp. 17-19.

8. One study concluded that the government could compensate coal, oil, and natural gas producers for their loss in equity values by using less than 10 percent of the total value of emission allowances; see A. Lans Bovenberg and Lawrence Goulder, *Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?* Working Paper No. 7654 (Cambridge, Mass.: National Bureau of Economic Research, April 2000). Thus, the government would need to give away only a small fraction of the allowances to compensate fossil-fuel suppliers for their losses. Some allowances could also be given to intermediate producers, such as electricity generators, that rely heavily on fossil fuels.

9. The allowances would provide each supplier with the opportunity to sell carbon-based fossil fuels, and higher fossil-fuel prices would lead to higher profits on each unit sold.

Box 3.
Estimates of Companies' Windfall Gains from Receiving Allowances for Free

If the government distributed emission allowances to companies on the basis of their past emission or production levels (a process known as grandfathering), existing firms would capture the value of the allowances. For example, suppose the government required fossil-fuel producers to hold allowances but grandfathered them. The limited number of allowances would restrict fossil-fuel production and lead to higher prices. Producers that received allowances would reap the benefits of those higher prices but would not have had to pay for the allowances. New entrants to the industry, in contrast, would have to buy allowances from existing firms. Because the existing firms' allowance allocations would be independent of their production decisions, they would not have an incentive to lower prices and pass the value of the allowances on to consumers.

The total value of the allowances under a cap-and-trade program for carbon emissions could be large. Thus, the decision to grandfather all of the allowances to a specific set of firms could provide them with substantial profits, typically referred to as windfall gains. One study estimates that the present discounted value of the allowances that coal producers would receive if the government gave away allowances to fuel suppliers would be $119.5 billion, assuming an allowance value of $25 per metric ton of emissions. The study estimated that equity values in the coal industry would rise by more than 1,000 percent as a result of that windfall gain.[1]

Another study examined a scenario for implementing the Kyoto Protocol in which the electricity sector would be allocated allowances on the basis of its 1990 emissions. Assuming an allowance price of $75 per metric ton of carbon emissions, that study estimated that the electricity sector would receive $28 billion worth of allowances annually (in 1990 dollars). By comparison, the net operating income of investor-owned utilities (which account for about 75 percent of revenue in the electricity-generating industry) was $34.6 billion in 1990.[2]

1. A. Lans Bovenberg and Lawrence Goulder, *Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?* Working Paper No. 7654 (Cambridge, Mass.: National Bureau of Economic Research, April 2000). That estimated increase in equity value is net of the adjustment costs that firms would incur as well as their increased tax payments.

2. H. John Heinz III Center for Science, Economics and the Environment, *Designs for Domestic Carbon Emissions Trading* (Washington, D.C.: Heinz Center, September 1998), p. 48.

Alternative uses of the revenue would benefit households in various income brackets differently and have disparate effects on the overall cost of the policy. In general, policymakers would face a trade-off between using the revenue to offset the distributional impact of the carbon cap and using it to offset the overall cost to the economy. For instance, to help offset the distributional impact, part of the auction revenue could be used to make equal payments to U.S. residents and part could be used to compensate affected producers.[10] Such a strategy, however, would not offset the tax-interaction effect. In contrast, policymakers could reduce that effect—and thus lower the overall cost of the policy—if they used auction revenue to cut existing taxes on capital (see Box 1). In that case, however, higher-income households would tend to reap the benefits.

Policymakers could opt to employ a combination of strategies. They might choose to give away a portion of the allowances to affected firms (to compensate them for their share of costs) and auction off the rest. They might choose to target some of the auction revenue toward lower-income households (to offset the regressivity of the policy-induced price increases) and use the remaining share to decrease existing taxes (to lower the overall economic cost of the policy).

10. Equal payments to residents could take the form of a fully refundable tax credit.

Allocating Firms' Allowances: Grandfathering Versus Using Current Production

If policymakers opted to give allowances to firms, they would need to choose a method for determining how many allowances each firm would receive. Two ways, which are included in the proposals discussed in Chapter 3, are to base those allocations on firms' past production or emission levels (called grandfathering) or on their current production levels (called output-based allocations).[11] Under grandfathering, companies could not alter the number of allowances they received by changing their current level of production; hence, the allowance allocation would not affect firms' production decisions. Under output-based allocations, in contrast, each company's annual allocation would be based on its production level in that year; thus, the allowance allocation would influence firms' current and future decisions about production.

Distributing allowances through output-based allocations instead of grandfathering would lead to higher implementation costs and could increase the economywide cost of achieving a given level of emission reductions. Further, it would reduce the windfall gains that existing firms in the industry would receive. This section compares the two allocation methods for a cap-and-trade program that is limited to the electricity sector. (An electricity-sector cap that uses output-based allocations is one of the proposals discussed in Chapter 3.)

Ease of Implementation. The government's implementation costs for reaching a given emission target for the electricity sector would be higher with output-based allocations than with grandfathering. Implementing grandfathering would require setting the cap on carbon emissions and dividing that fixed amount of emissions among existing firms on the basis of their production (or emissions) in a historical base year. In contrast, implementing a system of output-based allocations would involve dividing the carbon cap by the amount of electricity production expected —that is, determining the allowed number of emissions per unit of output, a number referred to here as a generation performance standard (GPS). The number of allowances each company received in a given year would be equal to the amount it produced in that year multiplied by the GPS. Firms would need to buy allowances if their allowance requirement (equal to the carbon emissions from the electricity they produced) was greater than their allocation. Firms with excess allowances could sell them.

To maintain a given carbon target with output-based allocations, the government would need to predict how production would vary from year to year and adjust the GPS accordingly. As described below, the allowance-allocation process itself would influence firms' production decisions, so regulators would need to account for that as well as for other factors that would affect total production.

Cost-Effectiveness. Ideally, a cap-and-trade program for the electricity sector would minimize the cost of meeting a given carbon target for that sector (in other words, it would be what this study refers to as the least-cost solution). A condition for cost minimization is that the policy must provide equal incentives for businesses and households to engage in all forms of carbon-reducing activities; it should not provide greater incentives for some activities than for others. Provided that electricity is sold in a competitive market, a cap-and-trade program in which allowances were grandfathered to existing firms would meet that condition, whereas a program in which allowance allocations were based on firms' current production would not.

Although only part of the electricity market has been deregulated—and thus has competitive pricing —the nation is moving in that direction. So far, 24 states have enacted restructuring legislation that would deregulate their electricity markets, and all but eight states are investigating restructuring.[12] The following comparison of the cost-effectiveness of grandfathering and output-based allocations assumes com-

11. Allowances could be grandfathered using many different criteria. One proposal described in Chapter 3 would base firms' allocations on their emission levels in a base year. In the current trading program for sulfur dioxide emissions, electricity generators' allowance allocations depend primarily on their heat input in a base year.

12. See Department of Energy, Energy Information Administration, "Status of State Electric Industry Restructuring Activity as of May 2001" (available at www.eia.doe.gov/electricity/chg_str/regmap.html).

petitive pricing. (Although such a comparison may be instructive, one recent study concludes that grandfathering may not be more cost-effective than output-based allocations when only part of the electricity market is deregulated.[13] Under those conditions, the cost-effectiveness of the two allocation mechanisms would be close; which one was more cost-effective would depend on the level of the carbon cap.)

Under grandfathering, the allowance requirement would cause firms' production costs to increase in proportion to the carbon emissions resulting from the electricity they produced. Firms would tend to pass those higher costs on to households in the form of higher prices. The increase in firms' costs—and resulting increase in electricity prices—would uniformly encourage all methods of reducing carbon emissions from electricity generation, including using less electricity (such as by installing more efficient lighting or turning off lights when not in use) and producing electricity from fuels with a lower carbon content (such as using more natural gas and less coal). The amount of allowances that each firm received would be independent of the electricity it produced. Thus, the allocation process would not distort choices about how to reduce carbon emissions, and the cap-and-trade program would result in the least-cost solution to the problem of cutting emissions.

Under output-based allocations, the allowance requirement would similarly tend to increase businesses' production costs. As opposed to the case with grandfathering, however, a company could increase the number of allowances it received by increasing the amount of electricity it produced—thus, the allowance allocation itself would subsidize electricity production. As a result of that subsidy, electricity prices would increase less under output-based allocations than under grandfathering. Lower electricity prices would mean that the policy would not give firms and households as much incentive to limit their electricity use. Output-based allocations would also result in a greater reliance on natural gas for electricity generation than would occur under the least-cost solution because the amount of allowances that a firm would receive from producing a unit of natural-gas-fired electricity (the output subsidy) would be greater than the amount of allowances required for such production.[14]

In summary, output-based allocations would distort choices about how to lessen carbon emissions, favoring some methods over others. Those distortions would prevent emissions from being reduced at the lowest possible cost.

Concern that grandfathering could discourage companies from cutting emissions before a cap-and-trade program took effect has prompted some legislators and groups to propose issuing early-reduction credits. Those credits have several disadvantages, however (see Box 4). Instead, disincentives for early emission reductions could be avoided by designing the allocation method carefully.

Distributional Effects. Existing companies in the electricity-generating sector would receive smaller windfall gains under output-based allocations than under grandfathering. With a GPS, the allowance allocation would lower firms' production costs (because it would be linked to their current production decisions) and would dampen the decreases in production and increases in electricity prices that would otherwise be caused by the cap on carbon emissions. As a result, consumers would tend to receive the value of the allowances in the form of lower electricity costs.[15] With grandfathering, in contrast, the allowance allocation would not affect production costs (because it would be independent of current production decisions) and would not dampen the production decreases or electricity price increases that the carbon cap would bring about. Thus, firms would tend

13. See Dallas Burtraw and others, *The Effect of Allowance Allocation on the Cost and Efficiency of Carbon Emission Trading* (Washington, D.C.: Resources for the Future, April 2001).

14. That difference would occur because the average carbon emissions from electricity produced from natural gas would be less than the generation performance standard. (If that were not the case, electricity generators would be unable to comply with a GPS for fossil-fuel-fired electricity.) In more general terms, a GPS system would tend to provide too little incentive for "output substitution" (decreasing the consumption of relatively carbon-intensive goods) and too much incentive for "input substitution" (lowering the carbon content of those goods). For a demonstration of that point in a theoretical framework, see Carolyn Fischer, *Rebating Environmental Policy Revenues: Output-Based Allocations and Tradable Performance Standards*, draft (Washington, D.C.: Resources for the Future, May 5, 2000).

15. Those electricity costs would be lower than under grandfathering but not lower than with no cap on carbon emissions.

Box 4.
Early-Reduction Crediting

Some proposals for cap-and-trade programs include the use of early-reduction crediting to reward firms that cut their emissions before the program goes into effect.[1] A company would earn a credit for each eligible metric ton of carbon emissions that it reduced voluntarily. The credit would then entitle the firm to some quantity of allowances once the cap-and-trade program was operating.

A primary advantage of early-reduction crediting is that it could keep firms from delaying capital investments to reduce their emissions. (Such delays could occur if lowering emissions would also lower their allowance allocations.) However, early-reduction crediting could create unintended distributional effects and be difficult to implement. Furthermore, a cap-and-trade program could be designed so as to avoid giving companies an incentive for delay.

Firms would be discouraged from making early emission reductions only under specific conditions: if their allowance allocations were based on their actual emissions in a current or future base year. In that case, decreases in emissions before the base year would also reduce firms' allocations of allowances. Without such a disincentive, firms would take the future cap-and-trade program into account when replacing or retiring capital equipment and would have a reason to choose less-carbon-intensive technologies (to lower their future allowance requirements).

Disincentives to reduce emissions prior to the cap-and-trade program could be avoided by altering the allowance-allocation method. Specifically, the base year could be changed to some past year (so a firm's current and future capital investments would not affect its allocations); output-based allocations could be used (although they have some disadvantages); or allowances could be auctioned. None of those allocation methods would penalize firms for cutting emissions before the start of the cap-and-trade program. Further, households and businesses would have an incentive to make early capital investments that reduced their energy use because such investments would lower their costs under the subsequent program.

1. Examples of those proposals include the Credit for Voluntary Early Actions Act (H.R. 2520) and the Credit for Early Actions Act (S. 547), which were introduced in the 106th Congress.

Early-reduction crediting would transfer the cost burden under a cap-and-trade program from companies that engaged in early reductions to ones that did not (provided that the overall cap was unaffected by the amount of early reductions made). The credits that early-reducing firms earned would entitle them to free allowances during the trading program. Thus, the credits would decrease the number of allowances that those firms would need to buy (if the government auctioned off allowances) or would provide them with additional allowances that they could sell (if the government gave allowances away). Thus, firms that did not make early reductions would bear a larger share of the cost of meeting the limit on emissions.

The shift in the cost burden away from firms that received early-reduction credits would be particularly problematic when those credits were earned for reductions that the firms would have found it profitable to make anyway, regardless of regulatory incentives. Companies would receive a credit for such reductions, even though they would not decrease emissions relative to the level that would have occurred without an early-crediting program.

In addition, the administrative costs of implementing an early-crediting program would be relatively high, as would the private sector's reporting costs. Issuing credits would require the government to document emission reductions on a case-by-case basis. Establishing baselines for the many and diverse sources of carbon emissions under early crediting could be challenging. Given the difficulty of finding one method of setting baselines that would make sense for those various sources, the Pew Center on Global Climate Change (a foundation that funds nonprofit organizations) suggests that model agreements could be established for particular industries.[2]

2. Robert R. Nordhaus and Stephen C. Fotis, *Early Action and Global Climate Change: An Analysis of Early Action Crediting Proposals* (Philadelphia: Pew Center on Global Climate Change, October 1, 1998). That study contains a useful discussion of the difficulties associated with establishing baselines for early crediting. Another good discussion of that issue can be found in Larry B. Parker and John E. Blodgett, *Global Climate Change Policy: Domestic Early Action Credits*, CRS Report for Congress RL30155 (Congressional Research Service, July 23, 1999).

not to pass the value of the allowances on to consumers; instead, they would retain that value, and it would be passed on to shareholders.

Would the Government Set a Ceiling on the Price of Allowances?

The government could establish a maximum price for allowances by agreeing to sell an unlimited quantity of them at a specified price. The decision about whether to do that highlights an important trade-off between two of the evaluation criteria in this study: carbon-target certainty and incremental-cost certainty. It could also have implications for the expected net benefits of the policy.

Previous cap-and-trade programs for pollutants, such as those for sulfur dioxide emissions, have set a limit on the level of the pollutant without setting a ceiling on the price of allowances. Without a price ceiling, the incremental cost of achieving the pollution limit could be far greater than expected. A trading program that had a price ceiling would leave the level of carbon reduction uncertain but would set an upper limit on the incremental cost that society would bear for cutting carbon emissions. The pollution target would be exceeded if the price ceiling was reached. Such a ceiling would limit carbon-reducing activities to ones that fell below the ceiling price, but it would not set a limit on the total cost to the U.S. economy.

Some research suggests that placing a ceiling on the price of carbon allowances could have advantages. Setting a carbon target at the optimal level—where the incremental cost of reducing carbon was equal to the incremental benefit—would be difficult because of the uncertainty surrounding costs and benefits. Setting a ceiling on the price of allowances instead would limit the cost that the U.S. economy would incur for incremental reductions in carbon emissions and would help avoid large losses (costs much greater than expected benefits) in the event that the cost of cutting emissions proved higher than anticipated or the carbon cap was too stringent. The price ceiling's advantages stem from the fact that both the costs and benefits of carbon reductions are uncertain and from the fact that the incremental costs can be expected to rise faster than the incremental benefits fall.[16]

16. Martin L. Weitzman first showed that government policies that set a price on pollution—such as taxes or auctions with price ceilings —would lead to higher expected net benefits than policies that limit the level of pollution. (Quantity limits would perform better if incremental benefits were expected to decline more rapidly than incremental costs rose.) See Martin L. Weitzman, "Prices vs. Quantities," *Review of Economic Studies*, vol. 41, no. 4 (1974). William A. Pizer estimated the costs and benefits of reducing carbon emissions to the 1990 level in 2010 and concluded that costs would exceed benefits by $10 billion (in 1989 dollars). In contrast, he found that benefits would be approximately $2.5 billion higher than costs if a price ceiling was set at $7 per ton (in 1989 dollars). See William A. Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change*, Discussion Paper No. 98-02 (Washington, D.C.: Resources for the Future, 1997).

Chapter Three

Evaluation of Four Cap-and-Trade Proposals

This chapter looks at four specific cap-and-trade proposals using the evaluation criteria that were described in Chapter 1. Since Chapter 2 discussed in detail the effects of various design characteristics on the evaluation of a cap-and-trade program, this chapter provides only summary evaluations of the four options (see Table 2). Three of the four are based on recent legislation or proposals by public interest groups. The other is not similar to any current proposal but was crafted by the Congressional Budget Office to highlight some of the trade-offs inherent in the actual proposals.

Upstream Trading Option I

This option is designed to resemble the "Sky Trust" proposal promoted by the groups Americans for Equitable Climate Solutions and Resources for the Future.[1] Under this proposal, domestic producers and importers of fossil fuels would be required to hold allowances equivalent to the amount of carbon dioxide that is eventually released from the fuels they sell. An emission target would be set at 1.346 billion metric tons of carbon, the amount emitted from fossil-fuel combustion in the United States in 1990. The government would sell allowances for that target through an auction and would set a price ceiling of $25 per allowance. If the demand for allowances was satisfied at a price of less than $25, the emission target would be met. If the allowance price rose to $25, however, the government would supply additional allowances at that price and the target would be exceeded.[2] The price ceiling would increase by 7 percent more than the rate of inflation each year.

1. See Americans for Equitable Climate Solutions, "Sky Trust Initiative: Economy-Wide Proposal to Reduce U.S. Carbon Emissions" (available at www.aecs-inc.org/indexn.html); and Raymond Kopp and others, "A Proposal for Credible Early Action in U.S. Climate Policy," Resources for the Future (available at www.weathervane.rff.org/features/feature060.html).

2. A similar proposal has been made by Warwick J. McKibbin and Peter J. Wilcoxen; see Warwick McKibbin and Peter J. Wilcoxen, *Designing a Realistic Climate Change Policy That Includes Developing Countries* (Washington, D.C.: Brookings Institution, October 20, 1999), and Warwick J. McKibbin, *An Early Action Climate Change Policy for All Countries*, draft (Washington, D.C.: Brookings Institution, July 28, 2000). Their proposal would establish "emission permits," which would allow holders to produce a unit of carbon in a particular year, and "emission endowments," which would entitle holders to an emission permit each year forever. The government would set a price ceiling for emission permits at $10 for 10 years and then reevaluate that ceiling. Endowment holders would buy and sell endowments on the basis of their expectation about future permit prices. Assuming that a futures market for allowances would develop under the Sky Trust proposal, the two proposals would be similar in terms of their implications for economic efficiency. Both would create downstream price signals to encourage emission reductions from all sources. Further, both would give fuel suppliers an opportunity to reduce uncertainty by contracting for rights to emit carbon in the future. The main difference between the proposals would be their distributional effects. McKibbin and Wilcoxen's would give "a significant portion" of the endowments to fossil-fuel suppliers and would issue the remainder to U.S. citizens. Thus, shareholders of fossil-fuel suppliers and U.S. households would capture some of the value of the emission endowments directly. The remaining distributional effects would depend on how the government used the revenue that it received from selling emission permits at the price ceiling. Under the Sky Trust proposal, in contrast, no allowances would be given away. The distribution of the allowances' value would be determined solely by the government's decision about how to use the auction revenue.

The government would initially use 75 percent of its auction revenue to make equal annual payments to each legal resident of the United States. The remaining 25 percent would be used to compensate regions, companies, or consumers adversely affected by the policy. For example, some of those funds could be targeted toward coal-mining regions that would suffer declines in local employment because of the policy. The portion set aside for compensation would be phased out over 10 years, after which all of the revenue would be used for lump-sum payments to U.S. residents. If the price ceiling was met, the government would collect more than $33 billion in auction revenue in the initial year of the program and would provide each U.S. resident with a payment of about $100.

Table 2.
How Various Cap-and-Trade Options Measure Up Against CBO's Evaluation Criteria

	Upstream Trading		Downstream Trading	
Criterion	Option I[a]	Option II[b]	Option I[c]	Option II[d]
Is Relatively Easy to Implement	Yes	Yes	No	Yes
Provides Certainty About Meeting Carbon Target	No	Yes	Yes for large emitters, No for the economy	Yes for the electricity sector,[e] No for the economy
Places an Upper Limit on Incremental Cost	Yes	No	No	No
Cost-Effectiveness				
Creates incentives for least-cost emission reductions	Yes	Yes	Yes for capped sources, No for other sources	No
Uses revenue to offset tax-interaction effect	No	Yes	No	No
Distributional Effects				
Creates regressive price increases	Yes	Yes	Yes	Yes
Creates windfall gains for selected industries	No	No	Yes	Yes
Overall effect on households	Progressive	Regressive	Regressive	Regressive

SOURCE: Congressional Budget Office.

a. Similar to the "Sky Trust" proposal by Resources for the Future and Americans for Equitable Climate Solutions. Suppliers of fossil fuels would be required to hold emission allowances, which the government would sell by auction with the price per allowance capped. Auction revenue would be distributed evenly to all U.S. residents and to some companies hurt by the policy.

b. Similar to the previous option except that allowance prices would not be capped and auction revenue would be used to cut corporate income taxes.

c. Similar to a proposal by the Progressive Policy Institute. Large sources of carbon emissions would receive allowances free of charge on the basis of their current emissions. Their allocations would shrink by 1 percent per year.

d. Similar to three bills introduced in the 106th Congress (H.R. 2569, H.R. 2980, and S. 1369). Only carbon emissions from electricity generators would be capped. Generators would receive free allowances on the basis of their annual production multiplied by a generation performance standard.

e. Assuming that the government could adjust the generation performance standard each year to maintain the target level of emissions.

Ease of Implementation

Because it would place the allowance requirement upstream, this proposal could be implemented at relatively low cost. However, administrative costs could increase if special provisions were adopted to prevent placing U.S. products that are highly energy-intensive (such as aluminum) at a competitive disadvantage. For example, the government could require importers of those products to pay import duties (reflecting the higher fuel costs faced by domestic producers) and could provide exporters with subsidies that would offset their higher fuel costs.[3]

Carbon-Target Certainty and Incremental-Cost Certainty

This option would not necessarily restrict U.S. emissions to 1.346 billion metric tons. The target would be met only if firms and households could do so at a cost of $25 or less per ton of reduction. However, the price ceiling would place an upper limit on that incremental cost, at least initially. Over time, the program would become increasingly restrictive—and more likely to meet the carbon target—as the price ceiling rose.

Cost-Effectiveness

The program would be cost-effective in the sense that it would encourage lowest-cost emission reductions throughout the economy through the price increases that it induced. Those price increases would provide an incentive for the development of new technologies as well as for the use of existing technologies.

Distributional Effects

Under this option, auction revenue would be used to offset the distributional effects of the price increases on households as well as the costs to producers. The lump-sum payments to U.S. residents would be progressive in that they would represent a larger percentage increase in income for lower-income households than for higher-income households. The ultimate effect on households would depend on the relative magnitude of the regressivity of the price increases and the progressivity of the payments. Overall, however, the policy would most likely be progressive.[4]

3. The particular types of adjustments that would be possible would depend on existing international agreements.

Upstream Trading Option II

This proposal is similar to Upstream Trading Option I but with two key differences that are intended to illustrate the trade-offs between competing policy goals. First, no ceiling would be set on the price of allowances. Second, auction revenue would be used to reduce marginal tax rates on corporate income.

Ease of Implementation

Implementing this policy would be similar to carrying out Upstream Trading Option I.

Carbon-Target Certainty and Incremental-Cost Certainty

In contrast to the previous option, this proposal would ensure that the limit of 1.346 billion metric tons of carbon emissions was met in the first year of the program as well as in later years. The cost to the economy of meeting that limit, however, would be uncertain.

Cost-Effectiveness

Like Upstream Trading Option I, this proposal would encourage the lowest-cost cuts in carbon emissions.

4. CBO also examined a carbon-limiting policy in which the price per allowance was assumed to be $100 and the government used auction revenue to provide equal payments to U.S. households. In that scenario, the progressive effect of equal payments outweighed the regressive effect of the policy-induced price increases, and the overall effect of the policy was progressive. See Congressional Budget Office, *Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs* (June 2000).

Unlike that option, however, it would use the auction revenue to lower corporate income tax rates, thus reducing the tax-interaction effect and giving households more incentive to save and invest. The resulting increase in economic activity could significantly decrease the cost to the economy of achieving the carbon limit.

Distributional Effects

The price increases created by this policy would be regressive because lower-income households spend relatively more on energy. Higher-income households would benefit the most from the cut in corporate income taxes because they bear more of the burden of those taxes.[5] Therefore, the overall effect on households would be regressive. Corporations as a whole would benefit from the tax cut, but some energy-intensive producers might still be worse off since they would bear a greater share of the cost than other businesses would.

Downstream Trading Option I

This option for downstream trading is similar to one being promoted by the Progressive Policy Institute (PPI).[6] The program would initially cap carbon emissions from large sources at the current level and decrease that cap by 1 percent per year. Under this downstream design, large emitters of carbon dioxide (rather than fossil-fuel suppliers) would be required to hold allowances. Those large emitters would include:

- o Electric utilities,
- o Manufacturing facilities,
- o Government facilities,
- o Commercial transportation fleets (trucks, airplanes, buses, and automobiles), and
- o Large organizations (those with more than 10,000 workers) whose employees commute to work.[7]

The government would distribute allowances to those large emitters for free. In the first year of the program, recipients would get enough allowances to cover their own estimated level of emissions. Their allowance allocations would be decreased by 1 percent per year thereafter.

Large emitters would be required to "pass through" allowances to customers who demonstrated net reductions in energy use.[8] For example, utilities would pass through allowances to companies that installed energy-efficient lighting. That pass-through requirement is designed to broaden participation in the allowance market to include companies, property owners, and others who adopt more-energy-efficient products and processes. In addition, third parties would be able to organize small entities to obtain allowances through the pass-through process. For instance, organizations that retrofitted homes to make them more energy efficient could obtain pass-through allowances from utilities (under an agreement with the homeowners). That bundling of allowances would be permitted in order to encourage small entities to participate.

Advocates of a comprehensive downstream trading program argue that placing the allowance re-

5. The corporate income tax initially falls (has an incidence) on corporate capital, but when capital used by corporations flows into the economy, part—or all—of the burden could be shifted onto capital in general or onto labor. Based on an extensive review of the literature on corporate tax incidence, this study assumes that a cut in corporate taxes is equivalent to an increase in the rate of return on capital in general. See Congressional Budget Office, *The Incidence of the Corporate Tax*, CBO Paper (March 1996).

6. See Jon Naimon and Debra Knopman, *Reframing the Climate Change Debate: The United States Should Build a Domestic Market Now for Greenhouse Gas Emissions Reductions*, Policy Report (Washington, D.C.: Progressive Policy Institute, November 1, 1999); and Debra Knopman and Jonathan Naimon, *How a Domestic Greenhouse Gas Emissions Trading Market Could Work in Practice: A Supplement to the November 1999 Policy Report "Reframing the Climate Change Debate,"* Backgrounder (Washington, D.C.: Progressive Policy Institute, March 1, 2000).

7. In an effort to limit methane emissions, the PPI proposal would also cover coal-mining companies and industrial agricultural facilities. This discussion addresses only the policies to decrease carbon emissions.

8. The PPI proposal is not explicit about how this pass-through provision would work.

quirement on the individual businesses and households that consume fossil fuel either directly or indirectly (in the form of electricity) would reduce their energy use more effectively than would the price increases resulting from an upstream approach. However, as described below, implementing such a comprehensive program would be very expensive, and the pass-through and third-party provisions would create uneven incentives that would lessen the program's cost-effectiveness.

Ease of Implementation

The administrative costs of carrying out this policy would be steep because of the large number of sources involved and the difficulty of assessing their carbon emissions. The reporting costs of the private sector would be high as well.

Implementing the cap on existing large sources of carbon emissions would entail regulating tens—if not hundreds—of thousands of companies. The program would rely on self-reported emissions data from those sources. The government's ability to verify those data (through spot-check audits) would vary widely among the sources. Moreover, sources would have an incentive to overreport their initial carbon emissions to avoid having to reduce emissions as their allowance allocations decreased over time. Reconciling the total number of carbon emissions reported from all large sources with total emissions as calculated from economywide fossil-fuel use would be difficult.

The task of administering this policy would be complicated even more by the pass-through provision and third-party involvement. Small emitters that wished to receive pass-through allowances would be required to establish baselines and document their emission reductions. The government would be responsible for seeing that large sources passed through allowances to small emitters when justified. Further, regulators would need to ensure that allowances were not counted twice. For example, if a third party installed energy-efficient lighting in small commercial establishments and obtained pass-through allowances from a utility, regulators would need to ensure that those commercial establishments did not also apply for the pass-through allowances. Implementing the pass-through and third-party provisions would greatly increase the number of entities involved, the government's administrative costs, and the private sector's reporting costs.

Carbon-Target Certainty

Assuming that this program could be enforced, it would cap carbon emissions from existing large sources. However, it would not provide an economywide limit on carbon emissions, for two reasons. First, small sources would not be capped, and second, new sources could result in additional emissions. The PPI proposal states that the government would "set aside" 5 percent of the current year's emission allowances to auction to new market entrants. But it is unclear how that provision would work if existing companies received allocations on the basis of the full amount of their current emissions, as proposed. If the allocations for existing sources were not decreased by the amount of additional emissions from new sources, the total amount of carbon emissions from large sources would rise.

Incremental-Cost Certainty

This option would not place an upper limit on the incremental cost of meeting the cap on existing large sources of carbon emissions.

Cost-Effectiveness

If the program could be implemented effectively, it would, over time, create incentives to decrease carbon emissions throughout much of the economy. The allowance requirement would encourage utilities, large industrial direct emitters, commercial transportation fleets, public agencies, and large organizations to reduce their carbon consumption in order to decrease the number of allowances they were required to hold (so they could sell excess allowances). Those large sources would cut their emissions if the cost of doing so was less than the price at which they could sell allowances. In addition, the program would lead to price increases that would encourage energy conservation farther downstream.

Although this option would cover many sources of emissions, it would not minimize the cost of reducing U.S. carbon emissions, for two reasons. First, it would not encourage reductions from some sources. For example, it would not provide many households with an incentive to drive less—only those people who work for a large organization that encouraged public transportation or carpooling as a result of the policy.[9] Second, even among covered sources, the program would create uneven incentives by overcompensating some sources for emission reductions. For instance, firms and households that used less electricity could benefit both from lower electricity costs and from selling the allowances that their utility would be required to pass through to them. Thus, the pass-through provision would overencourage carbon reductions from those sources relative to large sources, who would simply receive the value of the allowances (if they were not required to pass that value through) or receive no benefit (if they did pass the allowance value through).

Distributional Effects

The allowance requirement would increase energy prices, disproportionately affecting lower-income households. In addition, the allowance-allocation method would tend to benefit the higher-income households that were shareholders in the firms that would receive the allowances.[10]

The pass-through provision could also put large emitters at a distributional disadvantage relative to pass-through recipients. For example, households that installed energy-efficient water heaters would benefit both from saving money through reduced fuel use and from obtaining the value of the allowances associated with that lower fuel use. Utilities, in contrast, would not capture the value of the allowances (because they had to pass them through to homeowners), plus they would sell less electricity.

Downstream Trading Option II: Electricity-Sector Cap

This option, which would limit carbon emissions from the electricity-generating sector, resembles proposals in three bills that were introduced in the 106th Congress (H.R. 2569, H.R. 2980, and S. 1369). Under this option the government would set a cap on emissions from fossil-fuel-fired electricity-generating units above a given size.[11] Regulators would determine a generation performance standard (GPS) for each year by dividing the cap by the amount of electricity that they expected covered units to produce that year. Each covered unit would receive an annual allocation of allowances equal to the amount of electricity it generated in that year multiplied by the GPS.

Generating units would be required to hold an allowance for each ton of carbon they emitted. If their emissions were less than the number of allowances they received, they could sell the excess allowances or save them for a later year. Alternatively, if their emissions were greater than the number of allowances they were allocated, they would have to buy allowances from other units or use ones they had saved from previous years.

Ease of Implementation

Two factors would tend to make implementing a cap-and-trade program for the electricity-generating sector relatively easy. First, the program could build on the existing regulatory structure for trading emissions of sulfur dioxide and nitrogen oxides. Second, generators that are regulated under the acid-rain provisions of the Clean Air Act already measure their carbon emissions. (Like the upstream trading options discussed earlier, implementation would be more complicated if policymakers wanted to avoid placing

9. An exception would occur if a third party could successfully bundle carbon savings from small direct emitters. The transaction costs of doing that, however, could be sizable.

10. To a lesser extent, households could receive allowances through the pass-through and third-party provisions. In that case, the distributional effects of the policy would depend on the income levels of the households that received the pass-through allowances.

11. All three bills would have established a limit of 1.914 billion tons of carbon dioxide (or 522 million tons of carbon) for the electricity-generating sector and defined covered units as those with a generating capacity of 15 megawatts or greater.

electricity-intensive goods at a competitive disadvantage.)

Implementation costs, however, would be higher under this proposal's method of allocation than under grandfathering (basing allocations on past levels of production or emissions). The number of allowances that generators would receive in a given year—and thus their carbon emissions—would depend on their production in that year and on the government-defined GPS. As Chapter 2 discussed, setting the GPS so as to meet a specific carbon target would require successfully forecasting electricity production for the year and annually updating the GPS.

Carbon-Target Certainty

Under this proposal, the target for carbon emissions from the electricity sector would be met only if government regulators had correctly predicted electricity production for the coming year and adjusted the annual generation performance standard accordingly.[12] Even so, this program would not limit emissions from outside the electricity-generating sector—which make up more than 60 percent of all carbon emissions.

Incremental-Cost Certainty

This option would not place a limit on the per-increment cost that the U.S. economy would incur to reduce carbon emissions.

Cost-Effectiveness

Assuming competitive pricing of electricity, the cost of emission reductions would be higher under a cap-and-trade program with a GPS than under a program that met the same carbon target but in which allowances were grandfathered or sold at auction. Specifically, a GPS would result in too little reduction in electricity consumption—and too much reliance on natural gas for electricity generation—relative to the least-cost solution. In contrast, grandfathering allowances or selling them in an auction would give businesses and households an incentive to reduce carbon emissions from the electricity sector in the least costly way.

In a partially deregulated electricity market, in which some states have competitive pricing and some do not, grandfathering may not be more cost-effective than a GPS system, according to a recent study (see Chapter 2).[13] The study concludes that auctioning allowances would be the most cost-effective allocation method in such a market because electricity prices would tend to increase more with an auction than with either type of free allocation. Those higher prices would lessen the inefficiencies in pricing that occur in regulated electricity markets. Electricity is typically priced inefficiently low in such markets because regulators set prices on the basis of the average cost of production rather than the marginal cost of production (the cost of producing one more unit). An auction would tend to bring prices closer to the marginal cost of production—the real cost that society bears—than either type of free allocation would. (With competitive pricing, auctioning and grandfathering would be expected to result in similar price increases and would be equally cost-effective: both would cause the cost of allowances to be reflected in the price that consumers pay for electricity.)

A cap-and-trade program that was limited to the electricity-generating sector would not produce emission reductions at the lowest possible cost to the economy (even if it minimized the cost of reductions from electricity generators) because it would not encourage reductions—or provide incentives for innovation—in other sectors. A GPS for fossil-fuel-fired electricity-generating units could be coupled with regulatory measures for other sectors. In that case, however, the cost-effectiveness of using different regulatory approaches for different sectors of the economy should be compared with the cost-effective-

12. Alternatively, allowing the target to be exceeded could be an advantage if greater-than-expected growth in electricity generation led to higher incremental costs of emission reductions.

13. See Dallas Burtraw and others, *The Effect of Allowance Allocation on the Cost and Efficiency of Carbon Emission Trading* (Washington, D.C.: Resources for the Future, April 2001).

ness of using a comprehensive upstream cap-and-trade approach.[14]

Distributional Effects

Under this proposal, electricity prices would increase (although by less than under grandfathering or an auction), and natural gas prices would rise as well. Both of those price increases would tend to be regressive.

Existing firms in the electricity-generating sector would receive smaller windfall gains with a GPS than with grandfathering. Consumers would receive a significant share of the allowances' value in the form of smaller price increases for electricity (relative to grandfathering). To the extent that producers captured some of the allowances' value, shareholders would benefit.

Conclusions

A cap-and-trade program that regulated upstream suppliers of fossil fuels would offer several advantages over one that focused on downstream users. It would be relatively easy to implement and would create a uniform incentive throughout the economy for cutting carbon emissions—thus bringing about emission reductions in a cost-effective way.

Policymakers' decision about whether to set a ceiling on the price of allowances in an upstream trading program would depend on the relative importance they attached to two alternative goals: certainty about meeting the emission target or predictability about the cost of reducing an increment of carbon emissions. If policymakers crafted a program with a fixed target (such as Upstream Trading Option II), they would not know the program's cost until the target was met. Alternatively, they could create a program with a price ceiling (such as Upstream Trading Option I), but then the program would not necessarily meet its target. Given the uncertainty of the costs and benefits of carbon reductions—and the expectation that as more reductions were made, incremental costs would rise faster than incremental benefits would fall—a price ceiling would be advantageous.

Selling the allowances through an auction, as opposed to giving them away, would mean that the auction revenue could be used either to lower the overall cost of the program or to make it more equitable. Giving the permits away could also achieve equity goals if policymakers distributed the allowances to firms and households in proportion to their share of the cost of the cap on carbon emissions.

Policymakers could reduce the total cost of the program by using auction revenue to cut marginal tax rates on corporate income (as in Upstream Trading Option II), thereby offsetting the tax-interaction effect (the exacerbation of existing taxes that discourage work or saving). However, such a strategy would tend to benefit high-income households more than others, adding to the regressivity of the price increases caused by the carbon reductions. As a result, the cap-and-trade program would be more regressive than it would be otherwise.

Using revenue to make equal payments to U.S. residents (as in Upstream Trading Option I), by contrast, would offset the regressivity of the price increases but significantly boost the overall cost of the policy. Likewise, giving allowances or auction revenue to companies could compensate them for their share of the cost of the carbon restriction but would raise the overall cost.

With any cap-and-trade program, policymakers would be unable to fully offset the distributional effects even if they devoted all of the allowances' value to doing so. Further, such a strategy would leave no allowance value to offset the tax-interaction effect.

14. For example, a study by the H. John Heinz III Center for Science, Economics and the Environment evaluates a program that caps carbon emissions for electricity generators and large industrial combustors while setting performance standards for vehicles, appliances, buildings, and small electric motors; see H. John Heinz III Center for Science, Economics and the Environment, *Designs for Domestic Carbon Emissions Trading* (Washington, D.C.: Heinz Center, September 1998), pp. 41-52. That study assumes a tradable corporate average standard for carbon emissions from the automotive industry. Automakers that beat the standard could sell their excess allowances to other automakers or to electricity generators and large industrial combustors. A potential problem with performance standards is that they could raise the price of vehicles and thus give drivers an incentive to use older, more polluting, vehicles longer. CBO has not evaluated the pros and cons of such an approach.

Deciding what to do with the allowances' value, therefore, would entail making trade-offs among competing goals. Policymakers might choose to use a combination of strategies. For example, they could design a program in which some allowances were given to companies (as compensation for higher costs) and some were sold. They could return auction revenue to the economy through a combination of tax cuts (to offset the tax-interaction effect) and direct payments to households (or other spending programs designed to counter the regressive nature of the price increases).

A downstream trading system could, in theory, cover multiple sectors of the economy and capture a large share of carbon emissions (see Downstream Trading Option I). Advocates of such a design argue that businesses and households would be more likely to reduce their use of fossil fuels and energy-intensive goods in response to allowance requirements than in response to the incentives created by changes in fuel prices. However, because of the number of entities involved and the degree of oversight required, the cost of implementing a comprehensive downstream trading program could well be prohibitive.

A downstream program that was limited to the electricity-generating sector (such as Downstream Trading Option II) would be easier to implement than a more comprehensive design. But such a program would cover only about 40 percent of the nation's carbon emissions. The same total cut in emissions might be achieved at a lower cost if some of the reductions were made outside the electricity-generating sector.