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Carbon Tax and Greenhouse Gas Control: Options and Considerations for Congress

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Summary

Market-based mechanisms that limit greenhouse gas (GHG) emissions can be divided into two types: quantity control (e.g., cap-and-trade) and price control (e.g., carbon tax or fee). To some extent, a carbon tax and a cap-and-trade program would produce similar effects: Both are estimated to increase the price of fossil fuels, which would ultimately be borne by consumers, particularly households. Although there are multiple tools available to policymakers that could control GHG emissions—including existing statutory authorities—this report focuses on a carbon tax approach and how it compares to its more frequently discussed counterpart: cap-and-trade.

If policymakers had perfect information regarding the market, either a price (carbon tax) or quantity control (cap-and-trade system) instrument could be designed to achieve the same outcome. Because this market ideal does not exist, preference for a carbon tax or a cap-and-trade program ultimately depends on which variable one wants to control—emissions or costs. Although there are several design mechanisms that could blur the distinction, the gap between price control and quantity control can never be completely overcome.

A carbon tax has several potential advantages. With a fixed price ceiling on emissions (or their inputs—e.g., fossil fuels), a tax approach would not cause additional volatility in energy prices. A set price would provide industry with better information to guide investment decisions: e.g., efficiency improvements, equipment upgrades. Economists often highlight a relative economic efficiency advantage of a carbon tax, but this potential advantage rests on assumptions—about the expected costs and benefits of climate change mitigation—that are uncertain and controversial. Some contend that a carbon tax may provide implementation advantages: greater transparency, reduced administrative burden, and relative ease of modification.

The primary disadvantage of a carbon tax is that it would yield uncertain emission control. Some argue that the potential for irreversible climate change impacts necessitates the emissions certainty that is only available with a quantity-based instrument (e.g., cap-and-trade). Although it may present implementation challenges, policymakers could devise a tax program that allows some short-term emission fluctuations, while progressing toward a long-term emission reduction objective. Proponents argue that short-term emission fluctuations would be preferable to the price volatility that might be expected with a cap-and-trade system.

Although a carbon tax could possibly face more political obstacles than a cap-and-trade program, some of these obstacles may be based on misunderstandings of the differences between the two approaches or on assumptions that the tax would be set too low to be effective. Carbon tax proponents could possibly address these issues to some degree, but there remains considerable political momentum for a cap-and-trade program.

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Introduction

A variety of efforts that seek to reduce greenhouse gas emissions (GHG)[1] are currently underway or being developed on the international, national, and sub-national level (e.g., individual state actions or regional partnerships). One option (of many, see text box below—"Other Policy Options for Addressing GHG Emissions") for controlling GHG emissions is to apply a tax or fee on GHG emissions or the inputs that create them. This type of approach is commonly called (and referred to in this report as) a carbon tax,[2] whether it would apply to CO_2 emissions alone or to multiple GHGs, including some that may have no molecular carbon.[3] This report does not provide a comprehensive comparison and analysis of the multiple policy tools available to Congress that would address climate change. Instead, this report focuses on the policy considerations of using of a carbon tax to control GHG emissions.

Governments may impose taxes for a variety of purposes. The primary reason that governments impose taxes is to raise revenue to fund various objectives or services: e.g., national defense, public education, social security, etc. Generally, governments raise these revenue streams by placing a tax on activities that are recognized as desirable ("economic goods") such as income, employment, and investment. While this tax placement ensures a relatively steady flow of revenue (often the primary objective of the tax), economists generally describe such taxes as distortionary, because the taxes discourage the "good" activity. For example, many economists have argued that payroll and income taxes discourage employment and investment.[4] If these taxes were reduced, the incentives to increase labor and investment would be greater.

Economists maintain that levying a charge on pollution (sometimes referred to as a Pigouvian tax)[5] would be an efficient way to correct an inherent failure in a particular market. A basic economics principle is that market prices may not reflect the social cost of resource use (e.g., fossil fuel combustion) when economic activities result in pollution (e.g., CO_2 emissions). If social costs are not included, the market price of the resources will not reflect their true costs. For example, in terms of climate change policy, the price of using fossil fuels, particularly coal, does not reflect the costs—i.e., climate change-related damages—associated with CO_2 emissions.

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[1] The major GHGs discussed include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFC), and perfluorocarbons (PFC). Recent GHG reduction proposals have also included nitrogen trifluoride (NF_3).

[2] As discussed in this report, terminology is a key issue. Some proponents of the "carbon tax" approach describe the policy instrument as a user fee or user charge. There are multiple reasons that proponents may seek to change the nomenclature. Perhaps the primary concern is the political stigma associated with the word "tax." Regardless, the term "carbon tax" is the one that is most commonly associated with the GHG control policy instrument discussed in this report.

[3] Non-carbon GHGs could still be subject to the tax based on their contribution to global warming in relation to CO_2. Global warming potential (GWP) is an index of how much a GHG may contribute to global warming over a period of time, typically 100 years. GWPs are used to compare gases to carbon dioxide, which has a GWP of 1. For example, methane's GWP is 25, and is thus 25 times more potent a GHG than CO_2. The GWPs listed in this report are from: Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis* (2007), p. 212.

[4] See e.g., Gilbert Metcalf, *A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief* (2007); Nathaniel Keohane and Sheila Olmstead, *Markets and the Environment* (2007), Island Press; Ian Parry "Fiscal Interactions and the Case for Carbon Taxes over Grandfathered Carbon Permits," in *Climate Change Policy* (Dieter Helm, editor), Oxford University Press (2005).

[5] Named after A. Cecil Pigou, author of a landmark economic work, *Economics of Welfare* (1920).

In economics parlance, the social cost not reflected in the market price is called an "externality." A pollution tax would internalize the external costs by making the party who profits from the polluting activity include the external costs in the price of the good or service. Policymakers could place a pollution tax on GHG emissions or the inputs that create them. By attaching a price to GHG emissions, a carbon tax would stimulate GHG emission reduction. If the tax were placed on emissions, entities directly subject to the tax, such as power plants, would have an incentive to take actions—e.g., energy efficiency improvements or equipment upgrades—to lower tax payments. If the tax were placed on emission inputs—e.g., fossil fuels—the price of carbon-intensive energy sources, primarily coal, would increase relative to low-carbon fuels (**Table A-1** of this report—located in the **Appendix—**includes estimates of price increases to fossil fuels and motor gasoline based on different carbon tax rates). Energy consumers—e.g., power plants, industry, households, etc.—would be encouraged to (1) switch to less carbon-intensive fuels; (2) use less energy or use energy more efficiently; and (3) prefer products or services that are lower-priced by virtue of incorporating less emission tax. Each of these activities would reduce GHG emissions compared to a business-as-usual track.

These expected behavioral changes mirror the activities that are forecast for a potential cap-and-trade program. Both a carbon tax and a cap-and-trade system would place a price on carbon. Both a carbon tax and cap-and-trade system are intended (and expected) to increase the price of coal, oil, and natural gas. Under either program, these price increases would ultimately be borne by energy consumers, both businesses and households. These price increases are integral to a market-based approach to GHG emission reduction, because they send more accurate information to purchasers about the full cost of their choices.

This report begins with an overview of the fundamental choices involved between a cost (tax) and a quantity (cap) control instrument. This includes a discussion of policy tools that could be employed to bridge the gap between a carbon tax and a cap-and-trade program. Following this overview, the report analyzes the potential advantages and disadvantages of a carbon tax. In many cases, carbon tax attributes are compared with those of a cap-and-trade program. The next section discusses implementation issues for a carbon tax, including where to apply the tax, at what level to set the tax, and options for distributing the tax revenues. The final section provides conclusions.

Other Policy Options for Addressing GHG Emissions

For policymakers considering actions to address climate change, a variety of policy instruments is available. Although current attention has largely focused on market-based mechanisms, primarily cap-and-trade systems, non-market policy tools may be the most practical option to address some emission sources. Moreover, Congress may consider complementary approaches to market mechanisms to improve their effectiveness. In particular, many experts maintain that the GHG emission targets specified in recent legislation would require development and deployment of improved (low-carbon) technologies. To further this effort, some argue that Congress should address technology stimulation directly or as a supplement to the primary climate change mitigation policy. In addition, Congress has already addressed some specific sectors (cars and light trucks, and government buildings) through performance standards. These standards may be further strengthened, independent of climate change legislation.

Efforts are underway to address GHG emissions using the existing Clean Air Act (CAA) statute. The Environmental Protection Agency (EPA) has received at least eight petitions asking it to use its CAA authority to regulate GHG emissions from multiple categories of mobile sources. The agency faces lawsuits seeking GHG regulations (per CAA authority) from power plants, refineries, and other stationary sources. In 2007, the Supreme Court found (Massachusetts v. EPA) that GHG emissions are air pollutants under the CAA, and that EPA has the authority to promulgate GHG emission controls.

For more information, see CRS Report R40145, *Clean Air Issues in the 111th Congress*, by James E. McCarthy; and CRS Report RL34513, *Climate Change: Current Issues and Policy Tools*, by Jane A. Leggett.

Cost or Quantity Control: An Overview

If policymakers choose to establish a market-based mechanism to control GHG emissions, a fundamental decision would be whether to use a price instrument, such as a carbon tax, or a quantity instrument, such as an emissions cap.[6]

Economic Theory vs. Uncertainty

In an economically efficient market with perfect information, either a price (carbon tax) or quantity control instrument (cap-and-trade system) could be designed to achieve the same outcome.[7] **Figure 1** illustrates this basic economic principle. The intersection of marginal costs[8] and marginal benefits[9] would provide the point (of economic efficiency) at which to set the price or quantity limit. At this point in the figure, the abatement costs[10] equal benefits received from abatement. Per economic theory, emission abatement above or below this point would not be economically efficient.[11] The dashed lines indicate the efficient price (tax) and quantity (cap) limits. This figure illustrates that (with perfect information) if either a tax or cap is selected, both the emission abatement level and cost of abatement would be identical. For instance, if a cap were chosen, covered sources (e.g., power plants) would abate emissions until they reach the cap of Q*, at which point the marginal cost of abatement would equal P*. If a tax were chosen, sources would abate emissions until the marginal cost of abatement reached the tax level (P*), at which point the emission abatement level equals Q*. In either case, total abatement is Q*, and the total cost of the program is the shaded area under the marginal abatement cost curve.

[6] See also, CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program*, by Larry Parker; CRS Report RL34513, *Climate Change: Current Issues and Policy Tools*, by Jane A. Leggett.

[7] See e.g., William Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change* (1997), Resources for the Future Discussion Paper 98-02.

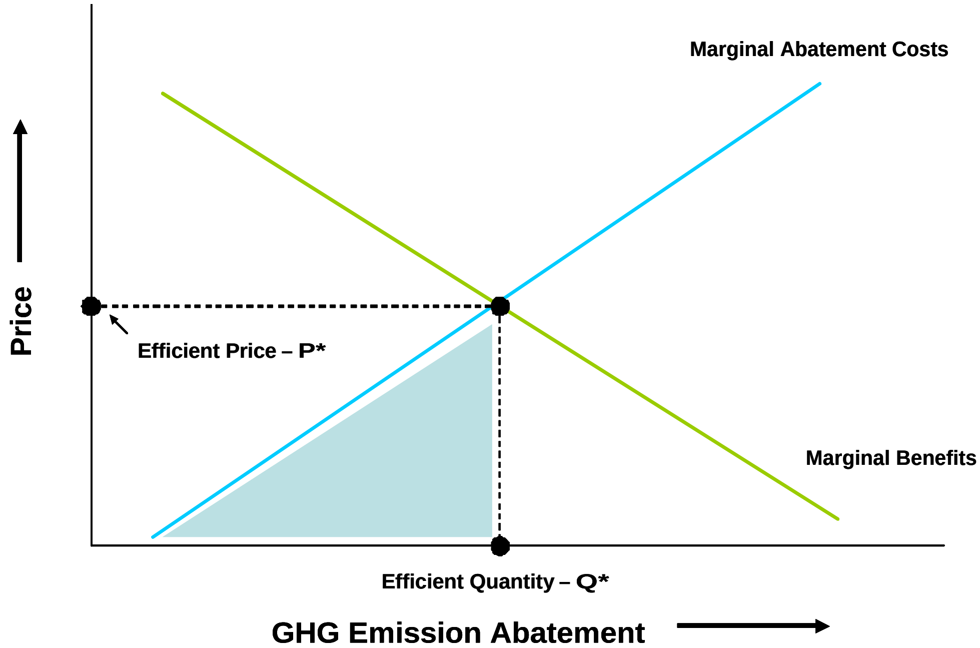
[8] The marginal cost curve indicates the cost of an *additional* unit (e.g., one ton of GHG emissions) of emission abatement at different emission levels. A rising marginal cost curve (as depicted in **Figure 1**) signals that as each incremental unit of GHG emission abatement is made, the cost of abatement (per unit) increases.

[9] The marginal benefit curve indicates the benefit of an *additional* unit (e.g., one ton of GHG emissions) of emission abatement at different emission levels. A declining benefit slope (as depicted in **Figure 1**) illustrates that with each incremental unit of abatement, the per unit benefit decreases.

[10] Abatement may include emission reductions, emissions avoided, and sequestration activities.

[11] In other words, for abatement above this level, it would cost more than the value of the benefits received. Society would be paying too much; money would be better spent for other purposes.

Figure 1. Illustration of Price Versus Quantity



Source: Prepared by CRS.

However, the illustration in **Figure 1** depicts economic theory, not economic reality: An economically efficient market with perfect information does not exist. The primary knowledge gaps are the shapes (i.e., slope) and levels (i.e., magnitude) of the marginal abatement cost and marginal benefit curves. These benefit and cost curves are influenced by multiple variables, including uncertain future emission baselines. Baseline estimates are related to projected population levels and economic growth,[12] factors that are also unknown and difficult to predict.[13] Another uncertain factor, which will have a substantial influence over mitigation costs, is the development and deployment of low-carbon technology.

Without accurate information regarding marginal costs and benefits, policymakers cannot know the efficient quantity or price from which to establish an emissions cap or carbon tax. Thus, in one sense, preference for a price (carbon tax) or a quantity limit (emissions cap) depends on one's preference for uncertainty—either uncertain emissions or uncertain program costs. A tax would set a ceiling on the marginal price of emissions (and thus the total cost of the program), but emissions would be uncertain. A cap would hold emissions to a set level, but the price of emission reductions (and thus program costs) would be uncertain.[14] However, as discussed below, the choice is not as simple as it may seem.

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[12] See CRS Report RL33970, *Greenhouse Gas Emission Drivers: Population, Economic Development and Growth, and Energy Use*, by John Blodgett and Larry Parker.

[13] For a analysis of some recent assessments, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

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

A Stark Choice or a Policy Continuum?

There are multiple design elements that can be included with a cap-and-trade program that blur the distinction between price and quantity control. Similarly, a carbon tax program could include flexible design mechanisms allowing policymakers to alter the tax rate, if they determine that emission reductions are not proceeding at a desirable pace. With these design elements available, Congress is presented with a policy continuum, rather than a stark policy dichotomy.

A Flexible Emissions Cap

Congress could enact a cap-and-trade program that includes mechanisms that provide flexibility in terms of controlling costs. **Figure 2** illustrates the options available. As the design elements in **Figure 2** (the "bridge pieces") are added to a cap-and-trade program, the program more closely resembles a carbon tax. These elements are briefly described below:

- Banking: Covered sources may save (bank) emission allowances[15] and submit them in future years. Banking reduces the absolute cost of compliance by making annual emissions caps flexible over time. In addition, banking reduces price volatility to some degree.[16]
- Borrowing: Covered sources may borrow (typically at a relatively high interest rate) emission allowances allotted to future years. The ability to borrow allowances from future years should help control price spikes.
- Market oversight: Congress could create a regulatory mechanism (e.g., an oversight board) to observe the allowance market and implement cost-relief measures if necessary. Obviously, the authority granted to the delegated entity would determine its ability to affect program costs.
- Safety valve: Generally triggered by prices in the allowance markets, safety valves may include (1) a set price alternative to making reductions or buying allowances at the market price, (2) a slowdown in tightening the emissions cap, and (3) lengthening of the time allowed for compliance. The first type would move the program closest to price control by setting a ceiling on allowance prices and limiting their volatility.
- Auctioning allowances: Auctions may be used to allocate some or all of the emission allowances. Like a carbon tax, auctions would raise revenues to support various objectives. In addition, auctions would support price discovery.[17]
- Reserve price: A reserve price is a price below which the seller refuses to part with the item for sale. A reserve price would all but guarantee a revenue stream in

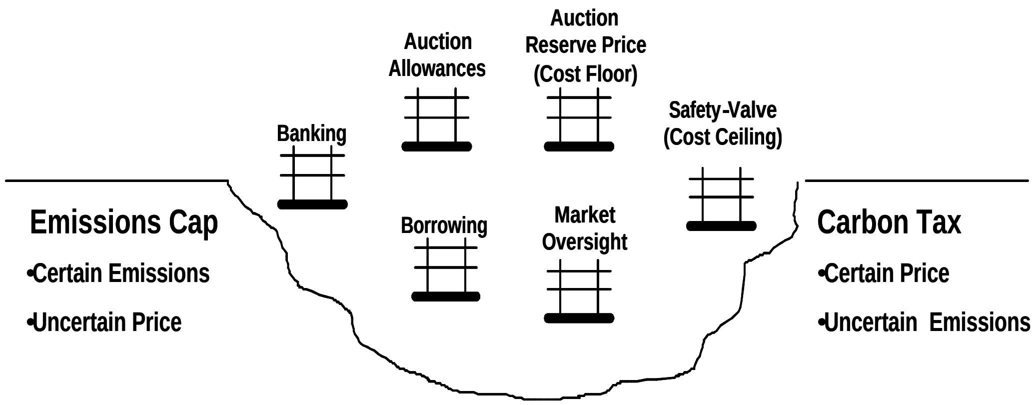
[15] Emission allowances are essentially the currency in a cap-and-trade program. An allowance is generally defined as a limited authorization by the government to emit 1 ton of pollutant. In the case of GHGs, an allowance generally refers to a metric ton of carbon dioxide equivalent (tCO_2-e).

[16] A 2008 Resources for the Future (RFF) report estimated the effects banking provisions had on price volatility. The authors concluded that banking eliminates about 20% of the cost differences between a price control (tax) system and cap-and-trade without banking provisions. Harrison Fell *et al.*, *Prices Versus Quantities Versus Bankable Quantities* (2008), Resources for the Future Discussion Paper.

[17] See CRS Report RL34502, *Emission Allowance Allocation in a Cap-and-Trade Program: Options and Considerations*, by Jonathan L. Ramseur.

an emissions allowance auction, thus operating much like a minimum tax or price floor.

Figure 2. Bridging the Gap between Price and Quantity Control



Source: Prepared by CRS.

A Flexible Carbon Tax

Policymakers could establish a carbon tax that includes mechanisms for addressing long-term emission uncertainty. For example, emission sources would be required to submit emission data periodically, so that policymakers could assess the performance of the carbon tax. If Congress determined that emission reduction was inadequate, the tax rate could be adjusted to achieve a desired emissions level. The decision authority could be retained by Congress or delegated to an existing federal agency—e.g., Department of Treasury or Environmental Protection Agency—or another entity (e.g., a newly created independent board) in order to meet pre-determined emission reduction objectives.[18]

Considering the consequences of altering a carbon tax rate, Congress may be hesitant to delegate this authority. In addition, some may question whether the federal government is nimble enough to modify the carbon tax rate on a periodic basis, particularly considering the potential size of the tax (**Table 1** below). Moreover, a flexible carbon tax approach may sacrifice long-term price certainty, depending on the authority of the entity to adjust the tax rate. To address this concern, Congress may consider providing tax rate increase parameters for the delegated entity.

Limits of the Policy Continuum

Regardless of whether policymakers employ these additional design elements, the gap between price control and quantity control can never be completely overcome: The closest resemblance would be a cap-and-trade program that employs both a price safety-valve and an emission allowance auction with a reserve price. Even if all of the above design options are part of a cap-and-trade program, the price of emission allowances would still fluctuate to some degree. Likewise, a more flexible tax system would still yield short-term emission fluctuations.

[18] See Dieter Helm *et al*., "Credible Carbon Policy," in *Climate Change Policy* (ed. Dieter Helm) (2005).

The policy continuum demonstrates that a comparison between a carbon tax and an emissions cap is not a straightforward exercise. Design details are critical for an appropriate comparison. Depending upon program design, cap-and-trade programs can vary greatly in their ability to control price fluctuations and total program costs. Some of the advantages or disadvantages (depending on one's perspective) of either system can be addressed through program design. Indeed, recent federal cap-and-trade proposals have included one or more of the design elements listed above.

Potential Advantages of a Carbon Tax

This report examines four potential advantages of a carbon tax approach to controlling GHG emissions. First, the report compares a carbon tax to cap-and-trade approach from an economics theory perspective, analyzing the assertion (of many economists) that a carbon tax would be more economically efficient than a cap-and-trade system. Second, it discusses the merits of price stability that a carbon tax would provide. The third discussion highlights the advantage of generating carbon tax revenues and examines various revenue applications and the trade-offs that would ensue. Finally, the report identifies potential implementation advantages, primarily practical considerations, of using a carbon tax approach.

Economic Efficiency

A primary argument supporting the use of a carbon tax is that in the presence of cost uncertainty—i.e., the marginal abatement cost curve (**Figure 1**)—a tax would potentially be more economically efficient than an emissions cap. However, this argument is grounded in assumptions that are the subject of considerable debate and controversy. This section outlines the basis for the argument and provides an analysis of the underlying assumptions.

Basis for the Argument

As **Figure 1** demonstrates, if the marginal cost and benefit curves are known to policymakers, either a tax or a cap instrument could be used to achieve the same result. As discussed above, both the costs and benefits of GHG emission reduction are uncertain. However, some economists argue that the *relative* slopes of the cost and benefit curves are better understood. This information—the slope of the marginal benefit curve in comparison to the slope of the marginal cost curve—is the foundation for an argument that supports a tax (price control) over an emissions cap (quantity control).

This argument was presented in Weitzman's landmark 1974 study "Prices vs. Quantities."[19] Weitzman's primary conclusion (explained in some detail below) was that price instruments (e.g., carbon tax) would be preferred when the marginal benefit curve is relatively flat; a quantity limit (e.g., emissions cap) would be preferred when the marginal cost curve is relatively flat.[20]

[19] M. L. Weitzman, "Price vs. Quantities" (1974), *Review of Economic Studies*, 41(4): 477-491.

[20] This conclusion is often referred to as the "Weitzman Rule." Nathaniel Keohane and Sheila Olmstead, *Markets and the Environment* (2007), Island Press

Intuitively, a relatively flat marginal benefits curve suggests that each additional unit of abatement provides approximately the same benefit. In contrast, a relatively steep marginal cost curve suggests that each additional unit (i.e., ton of CO_2) of emission abatement entails a greater cost than the previous unit.[21] Some economists argue that the slope of the marginal benefits curve is flat relative to the marginal cost curve.[22] This notion is the subject of intense debate, but it is grounded in the scientific processes (discussed below) through which GHG emissions generate climate change impacts.

Based on this (assumed) relationship between the expected slopes of costs and benefits, a carbon tax would be more efficient than an emissions cap. **Figure 3** and **Figure 4** below illustrate this concept. **Figure 3** provides a scenario in which the marginal benefits curve is flatter than the marginal costs curve. Without precise information regarding marginal costs and benefits, policymakers would base a tax or cap on *estimates* of the marginal cost and benefit curves. These are represented in **Figure 3** as the *expected* marginal costs and benefits of GHG emission abatement.[23] The intersection of the expected marginal abatement cost and benefit curves would be the estimated economically efficient point of regulation. From this efficient point, policymakers could apply either an emissions cap or carbon tax—at Q* or P*, respectively. Either option would produce the same outcome, if the *expected* marginal cost curve matches the *actual* marginal cost curve.[24]

However, the *actual* cost curve is unlikely to match the *expected* cost curve. Therefore, some level of economic inefficiency will exist with either a tax or an emissions cap. However, the policies are expected to yield different levels of inefficiencies. For example, consider a scenario (**Figure 3**) in which *actual* marginal abatement costs are higher than *expected*. If policymakers were to apply a carbon tax (P* in the figure) directly to emissions, emission sources would abate emissions until the marginal cost of abatement equals the carbon tax. This occurs at **Point A**, at which time covered sources would pay the tax for any additional emissions. On the other hand, if policymakers employed an emissions cap (Q*), covered sources would abate emissions until **Point B**, when the cap is met.

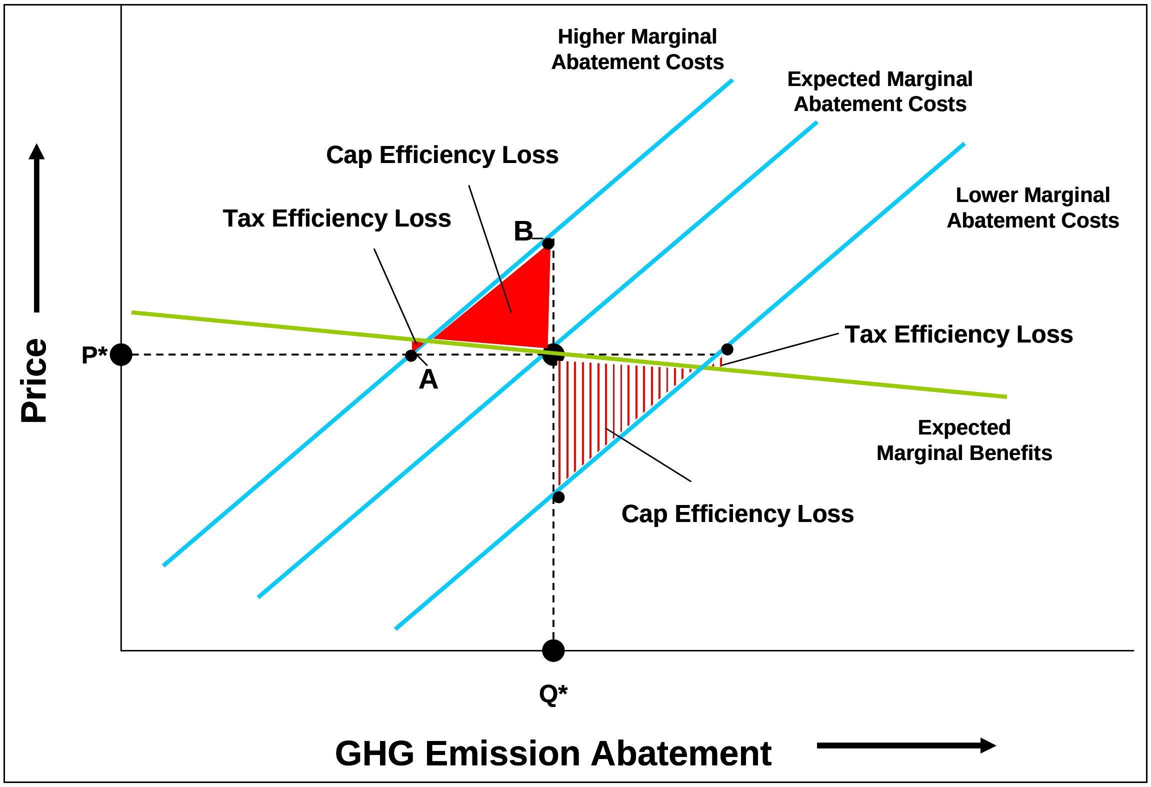
[21] In other words, not all emission reductions (or sequestration activities) are equal in terms of cost: there may be "low-hanging fruit" opportunities as well as actions that would require more substantial capital investments.

[22] Richard Newell and William Pizer, "Regulating Stock Externalities under Uncertainty," *Journal of Environmental Economics and Management* 45: 416-432 (2003); Warwick J. McKibbin and Peter J. Wilcoxen, "The Role of Economics in Climate Change Policy," (2002) *Journal of Economic Perspectives* 16(2): 107-29.

[23] The "curves" in this report's figures are depicted as straight lines for illustrative purposes.

[24] Although marginal benefit information is also uncertain, the relative-slope principle generally depends only on the marginal cost curve. The reasoning behind this approach and circumstances that may undermine this approach are discussed below.

Figure 3. Illustrative Scenario with a Relatively Flat Marginal Benefits Curve



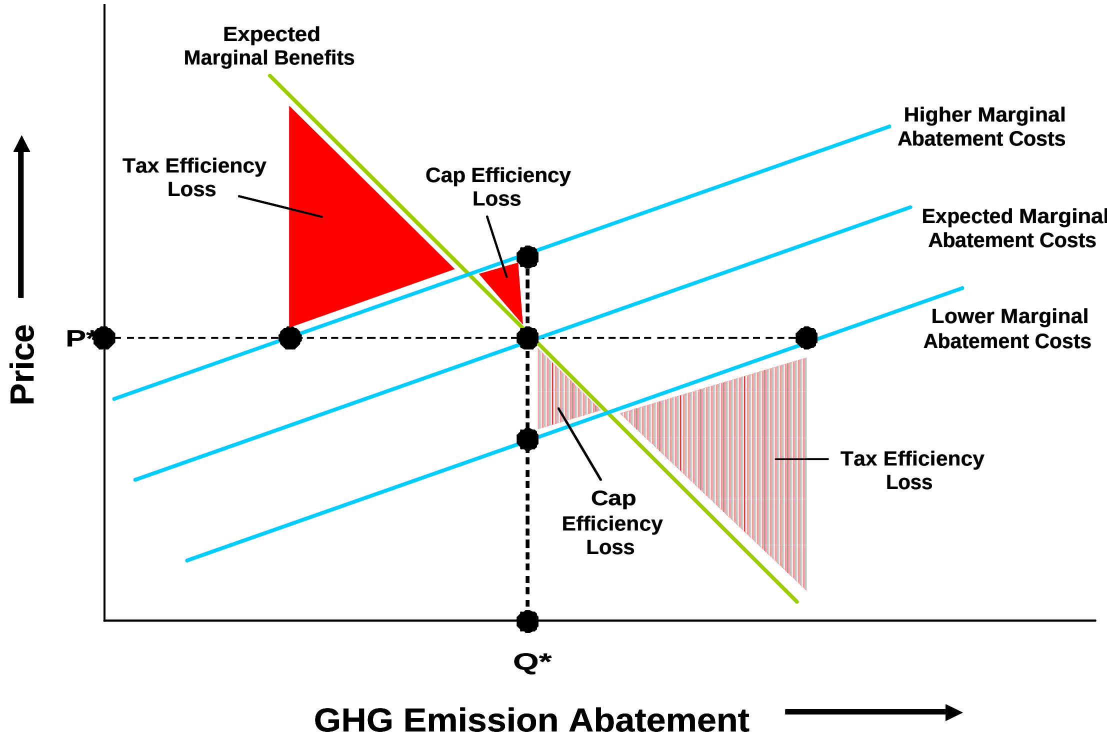
Source: Prepared by CRS.

With a tax instrument in **Figure 3**, under higher-than-expected costs, covered sources would abate less than the optimal level—the intersection of benefits and *actual* costs; with an emissions cap, sources would abate more than the optimal level. However, **Figure 3** illustrates that the difference in efficiency losses—the shaded triangles—from the two policies is substantial.

Figure 3 also illustrates the scenario of lower-than-expected marginal abatement costs. With lower-than-expected marginal abatement costs, an emissions cap would lead to abatement that is less than optimal, whereas a tax would stimulate abatement beyond the optimal level. As with higher-than-expected costs, a tax instrument would yield less inefficiency than an emissions cap. The different efficiency losses are depicted by the striped triangles in **Figure 3**.

Figure 4 illustrates the alternate scenario, in which the marginal benefits curve is relatively steep. In this situation, an emissions cap is the preferred instrument. Whether the marginal abatement costs are higher or lower than expected, the efficiency losses from a carbon tax are greater than those from an emissions cap.

Figure 4. Illustrative Scenario with a Relatively Steep Marginal Benefits Curve



Source: Prepared by CRS.

Underpinnings of the Argument

The argument that a carbon tax would minimize economic inefficiency in the face of uncertain costs contains several assumptions. A primary assumption concerns the relative steepness/flatness of the cost and benefit curves. In addition, there are other underpinnings of the argument that may be questioned. These issues are discussed below.

Relative Flatness of Benefits Curve?

At the crux of the argument that a tax would maximize efficiency is the assumption that the slope of the marginal benefits curve is flat compared to the marginal costs curve (**Figure 3**). Many would assert this is the case, based on the process by which GHG emissions generate damages. In the context of climate change, the damages related to GHG emissions are due to their concentration (referred to as "stock") in the atmosphere, as opposed to their annual flow.[25] By comparison, more traditional air pollutants (e.g., sulfur dioxide, nitrogen oxide) impose damages through their annual emission flows.

With a "stock pollutant" like CO_2, the processes involved in adding or removing the gas from the atmosphere are measured, not in years, but in decades (or centuries for some gases). The current stock of CO_2 in the atmosphere is approximately 3,000 gigatons;[26] in 2004, the entire world

[25] Other GHG emissions may yield damages unrelated to climate change impacts.

[26] 1 gigaton = 1 billion tons.

emitted roughly 30 gigatons of CO_2. Because emission quantities would have only a minor effect on the accumulation of CO_2 in the atmosphere, the benefits from controlling the stock (or the damages from business-as-usual activities) are thought to occur slowly and steadily.[27] **Figure A-1** in the **Appendix** illustrates this concept.

However, the assertion that the benefits curve is flat assumes that there are no climatic "tipping points." Some scientists maintain that at a certain stock level—concentration of GHG emissions in the atmosphere—particularly drastic events might occur.[28] By definition, a tipping point implies that when it is reached, the course of climate change is abrupt and the marginal benefits curve becomes very steep. The climate changes may even be irreversible and catastrophic, at least for some populations and environments. Examples often cited include collapse of Greenland's ice sheet; and dieback of the Amazon rainforest.[29]

If such tipping points exist, they would dramatically alter the shape of the benefits curve, because abating emissions to avoid large adverse consequences would yield large benefits. As argued by the Stern Review: "over the long term, as the stock of GHGs grows, marginal damages are likely to rise and – as the stock reaches critical levels – marginal damages may rise sharply. In other words, the damage function is likely to be strongly convex."[30] However, the Stern Review also notes that: "to the extent that damages may relate to the *rate* of climate change, the relationship is more complex, but it remains true that the damage curve is likely to respond most to cumulative emissions over several years or even decades."[31] Depending on whether the tipping points are "several years" or "decades" away, an emissions cap may be preferred.

However, scientists and policymakers have very poor information regarding the GHG concentration levels (or rates of concentration changes) at which tipping points may occur. A 2003 economic study found that emissions caps would be "optimal only when there is a well-defined threshold with clearly catastrophic consequences on the other side."[32]

Relative Steepness of the Marginal Cost Curve?

The marginal cost curve is perhaps better understood (and less controversial) than benefits estimates. Analysis of recent cap-and-trade proposals introduced in Congress suggest that with the current portfolio of technologies the marginal cost curve does not appear flat.[33] Although the first units of emission abatement opportunities may be relatively inexpensive, the costs of abatement are likely to increase with each additional unit. However, if a carbon market spurs

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[27] William Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change* (1997), Resources for the Future Discussion Paper 98-02.

[28] See e.g., James Hansen, Testimony before the House Select Committee on Energy Independence and Global Warming (June 20, 2008).

[29] See Timothy M. Lenton, *et al*., "Tipping Elements in the Earth's Climate System," *Proceedings of the National Academy of Sciences* 105:6 (February 2008).

[30] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006), p. 314 (emphasis in original).

[31] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006), p. 314, footnote 12.

[32] William Pizer, *Climate Change Catastrophes* (2003), Resources for the Future Discussion Paper. See also, CBO, *Policy Options for Reducing CO_2 Emissions* (2008).

[33] See CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

technology development, the marginal cost curve may flatten. This could reverse the relationship between costs and benefits, and make a cap the more economically efficient policy.[34]

Short-Term Time Frame

In general, Weitzman's economic principle regarding the relative slopes of the marginal cost and benefit curves applies to a static or fixed time-frame. The principle is best suited to compare the costs and benefits of controlling a "flow pollutant" (such as SO_2), which would yield short-term damages. However, as noted above, CO_2 is a stock pollutant: its potential damages are related to total accumulation in the atmosphere; one year of emissions would likely have negligible effects. Thus, the static analysis is over-simplistic, because (by definition) it assumes that activities in different time periods are unrelated.[35] However, equipment upgrades or efficiency improvements made in one time period would affect the emissions generated in future years as well. Other time-related factors need to be considered, including the discounting of future benefits and the atmospheric decay of GHGs.

Several economic studies have addressed this issue of time, expanding Weitzman's basic principle within a dynamic framework (i.e., a multi-year time-period). In general, these studies concluded that Weitzman's basic principle carries over to a dynamic setting.[36]

Only Cost Uncertainty is Considered

Although marginal benefit information is also uncertain, the relative-slope principle generally depends only on the marginal cost curve. The rationale behind this is that when covered sources make decisions regarding emission abatement—e.g., reduce onsite emissions or pay the carbon tax—benefits of abatement are not part of their economic calculation. Economists point out that if covered sources did consider benefits, there would be no externality in the first place.

However, in some circumstances an emissions cap may produce a more economically efficient outcome. As mentioned (in a footnote) by Weitzman (1974) and re-examined by Stavins in 1996,[37] if the uncertainty of costs and benefits are positively correlated—e.g., both the marginal benefit and cost curves are actually higher than expected—quantity control provides a more economically efficient result. This scenario is illustrated in **Figure 5**. The advantage for quantity control over price control under these circumstances depends on the degree of correlation and the magnitude of uncertainty with respect to the cost and benefits curves – the greater the difference between anticipated and actual cost and benefits values, the greater the advantage for quantity control measures. Stavins points out that this reversal in preference for price over quantity control could occur with plausible values for the two variables; however, he argues that "the advantage of

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[34] CBO, *Policy Options for Reducing CO_2 Emissions* (2008).

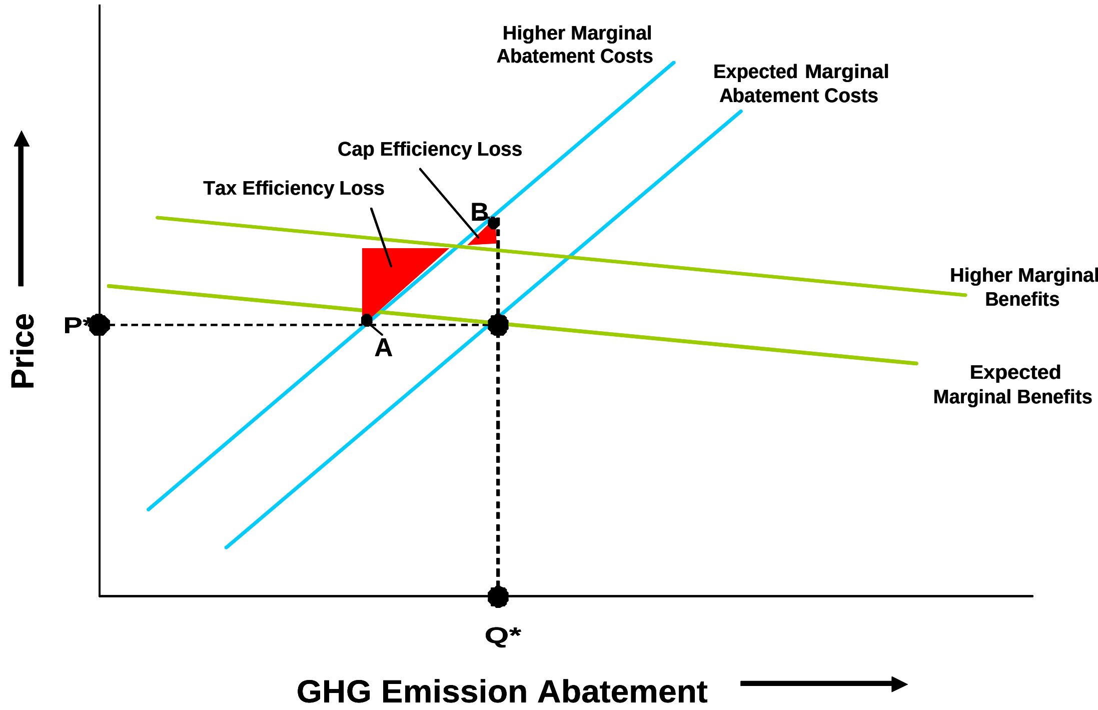
[35] William Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change* (1997), Resources for the Future Discussion Paper 98-02.

[36] Lawrence Goulder and Ian Parry, *Instrument Choice in Environmental Policy* (2008), Resources for the Future Discussion Paper, implicitly referencing: Michael Hoel and Larry Karp, "Taxes Versus Quotas for a Stock Pollutant," *Resource and Energy Economics* (2002) 24:367-84; Newell and Pizer (2003); and Larry Karp and Jiangfeng Zhang, "Regulation of Stock Externalities with Correlated Abatement Costs," *Environmental and Resource Economics* (2005) 32:273-299.

[37] Robert Stavins, "Correlated Uncertainty and Policy Instrument Choice," *Journal of Environmental Economics and Management* 30:218-232 (1996).

price over quantities remains unless the true benefits of carbon mitigation are many orders of magnitude greater than our best estimate."[38]

Figure 5. Illustrative Scenario with Marginal Costs and Marginal Benefits That Are Higher Than Expected



Source: Prepared by CRS.

Modeled Efficiency Gains

Several economic studies have examined the efficiency gains of using a carbon tax versus an emissions cap.

> While the analysis is more complicated and involves more than simply the relative slopes of marginal abatement and damage curves, *the analyses consistently find that taxes dominate cap-and-trade systems for a broad range of parameter values* consistent with scientific understanding of the global warming problem [emphasis added].[39]

For example, Pizer found that taxes are more efficient than an emissions cap by a factor of five to one.[40] Although this result is from 1997, similar estimates were made in more recent studies that

[38] Newell and Pizer (2003).

[39] Gilbert Metcalf *et al.*, *Analysis of U.S. Greenhouse Gas Tax Proposals* (2008), MIT Joint Program on the Science and Policy of Climate Change, Report No. 160.

[40] Pizer (1997).

applied different parameters.[41] The magnitude of these efficiency gains were estimated to be in hundreds of millions to several billions of dollars per year.[42]

However, a 2008 Massachusetts Institute of Technology (MIT) report points out that the modeled efficiency gains may be smaller in practice.[43] As discussed above, policymakers can design cap-and-trade programs with flexible components, such as banking and borrowing, that could alleviate some of the inefficiency loss. But a 2008 Resources for the Future (RFF) study indicates that banking may not help "as much as proponents might suggest." The study found that banking provisions in a cap-and-trade program would improve efficiency by 20% over a cap-and-trade without banking.[44]

Economic Efficiency Versus Precaution

Despite the economic efficiency argument in favor of a carbon tax, some argue that the downside risks of tipping points—i.e., irreversible climate changes—demand that economic efficiency take a backseat to precise control of GHG reductions, achievable only with a quantity-based emissions cap. This viewpoint could be described as an application of the precautionary principle: i.e., keeping one's options open in the face of uncertainty.[45] This approach argues that, while GHG emissions are held at an exact level, scientists and economists can continue to gather information regarding abatement costs and climate change benefits. As (presumably) better information is garnered, climate change policy can be amended as necessary.

Price Stability

Depending on the chosen GHG control instrument—carbon tax or cap-and-trade—either emissions or prices would fluctuate over short-term time periods (months to years). Proponents of a carbon tax often highlight the volatile price swings that have been observed in the U.S. sulfur dioxide (SO_2) emissions cap-and-trade program.[46] Between 2001 and 2006, the price of a SO_2 allowance has varied by a factor of 12.[47] The inclusion and substantial use of banking has not been sufficient to overcome other factors creating price volatility, such as uncertainty regarding proposed regulatory changes in the program (e.g., The Clean Air Interstate Rule).

Although the price volatility in the SO_2 market did not translate into electricity price spikes for consumers, CO_2 emission allowances could play a more integral role in the U.S. economy: Fossil fuels accounted for 85% of energy consumption in 2006.[48] Nordhaus states that strict quantity

[41] See, Hoel and Karp (2002); Newell and Pizer (2003); Karp and Zhang (2005).

[42] Ibid.

[43] Metcalf *et al*. (2008).

[44] Harrison Fell *et al.*, *Prices Versus Quantities Versus Bankable Quantities* (2008), Resource for the Future Discussion Paper.

[45] See Alan Ingham and Alistair Ulph, "Uncertainty and Climate Change Policy,"in *Climate Change Policy* (Dieter Helm, editor), Oxford University Press (2005).

[46] Indeed, the Carbon Tax Center lists price volatility control as one of the fundamental reasons taxes are superior to emissions caps. Carbon Tax Center, Tax vs. Cap-and-Trade, at [www.carbontax.org].

[47] William Nordhaus, "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming" (2007), *Review of Environmental Economics and Policy*, Vol. 1 (1): 26-44.

[48] Energy Information Administration, *Annual Energy Outlook 2008* (2008).

limits might have "major disruptive effects on energy markets and investment planning, as well as on the distribution of income across countries, inflation rates, energy prices, and import and export values."[49] Volatile emission allowance prices may discourage investment, because firms would have less reliable cost information upon which to plan for capital improvements.[50]

A GHG cap-and-trade program may or may not have similar price swings to those experienced with the SO_2 allowance market. The largest GHG cap-and-trade program currently operating is the European Union's Emission Trading System (EU ETS). During the four years of its existence, both Phase 1(2005-2007) and Phase 2 (2008-2012) EU ETS allowance prices have experienced significant volatility. Phase 1 allowance prices from the EU ETS are arguably not an appropriate comparison, because the fluctuations were largely related to program design issues.[51] Building on the experience gained during Phase 1, Phase 2 of the ETS began in 2008, and these emission allowance prices may provide a better example of the potential effects of market forces and the fluctuations that could occur under a U.S. cap-and-trade program.[52] **Figure 6** illustrates the market prices for Phase 2 allowances between 2005 and January 2009.

Figure 6. "Phase 2" Emission Allowance Prices in the European Union's Emission Trading System

Source: Prepared by CRS with data from European Climate Exchange, at http://www.ecxeurope.com.

Tax Revenue Applications

Carbon tax proponents often cite the generation of carbon tax revenues as a primary advantage of a carbon tax. However, policymakers could design a cap-and-trade program that could deliver

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[49] Nordhaus (2007).

[50] Ian W.H. Parry and William Pizer, *Emissions Trading Versus CO_2 Taxes Versus Standards* (2007), Resources for the Future Issue Brief.

[51] See CRS Report RL34150, *Climate Change and the EU Emissions Trading Scheme (ETS): Kyoto and Beyond*, by Larry Parker.

[52] Although Phase 2 began in 2008, the market for Phase 2 allowances was created in 2005. Unlike Phase 1 allowances, Phase 2 allowances may be banked for future use in a planned Phase 3 anticipated to begin in 2013.

similar, if not identical, results. For example, if policymakers establish a cap-and-trade program and distribute 100% of the allowances through an auction process, the auction proceeds would function as tax revenues.[53] Thus the strength of this advantage depends on the design of the cap-and-trade program to which the tax is compared.

From a public finance perspective, neither carbon tax nor auction revenues would be a reliable source of funding, because an effective carbon price (established through a tax or a cap) is expected to alter consumer behavior (e.g., demand for carbon-intensive goods). However, a carbon tax revenue stream would have a more predictable source than an allowance auction revenue stream, because the tax would be a known value, while the emission allowance price would fluctuate (as described above).

Different options for applying the tax revenue are discussed in the section "Implementation of a Carbon Tax."

Potential Implementation Advantages

Depending on the design, a carbon tax may offer several implementation advantages over a cap-and-trade program. These are discussed below.

Transparency

Arguably, the concept of a carbon tax is easier to explain and understand than a cap-and-trade program. A cap-and-trade system may have more moving parts, which may be challenging to follow, particularly the emission allowance allocation scheme. Moreover, as policymakers include more flexible design elements—primarily to improve efficiency and control price volatility—a cap-and-trade program would increase in complexity and potentially become less transparent. Some contend that the relative transparency of a carbon tax would help garner support for its enactment.[54] This argument may gain strength in the context of the recent financial climate, as many have grown more skeptical of seemingly complex financial structures.[55]

Although the concept of a carbon tax is arguably a simpler approach, many argue that the U.S. tax code is complex. Congress could establish a carbon tax framework that rivals the complexity of a cap-and-trade program. For instance, a carbon tax that only applies to CO_2 emissions from fossil fuel combustion may be more transparent than a carbon tax that address non-CO_2 GHG emissions. Moreover, policymakers could provide subsidies or exemptions to the fossil fuel industry that would run counter to a carbon tax. In addition, policymakers could allow for tax credits for carbon sequestration projects, similar to carbon offsets in a cap-and-trade regime. As with carbon offsets in a cap-and-trade program, this would require a further level of administrative responsibilities, and potentially weaken the program if the sequestration projects lack credibility.[56]

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[53] See CRS Report RL34502, *Emission Allowance Allocation in a Cap-and-Trade Program: Options and Considerations*, by Jonathan L. Ramseur.

[54] Carbon Tax Center, "Tax vs. Cap-and-Trade," at http://www.carbontax.org/issues/carbon-taxes-vs-cap-and-trade/.

[55] See CRS Report RL34488, *Regulating a Carbon Market: Issues Raised By the European Carbon and U.S. Sulfur Dioxide Allowance Markets*, by Mark Jickling and Larry Parker.

[56] See CRS Report RL34436, *The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential* (continued...)

Ironically, transparency, particularly in regards to costs, could be a political liability for a carbon tax. Although both a carbon tax and a cap-and-trade program would impose higher energy costs, the costs from a cap-and-trade program would be more difficult to estimate, because the market would determine the price of emission allowances (and thus the overall costs of the program). In other words, cap-and-trade proponents may have an advantage in promoting their approach, because they can cite studies that estimate relatively low program costs.[57]

Administrative Issues

A well-developed administrative structure for collecting taxes already exists in the United States. Moreover, fuel sales are well-documented and are currently taxed (for various reasons) to some degree.[58] Thus, a carbon tax on fossil fuels—if applied upstream in the economy (discussed below)—could utilize this existing framework. However, a carbon tax that included other GHG emissions or their inputs would not have the advantage of this existing administrative structure. Point of taxation issues are discussed later in this report.

Some argue that an emissions trading system would require the establishment of new institutions to administer the program.

> [T]he upfront costs of creating institutions to administer trading are significant and likely to produce entrenched bureaucracies that clamor for ever-tighter controls on carbon emissions.[59]

Others maintain that these concerns may be overstated. "Experience with existing trading programs, such as the U.S. SO_2 trading program, has shown that these institutions can arise quickly and for the most part inexpensively."[60] However, comparing the SO_2 trading program with a potential GHG emission trading program highlights appreciable differences. First, the scale of the SO_2 trading program is considerably smaller than the proposed cap-and-trade initiatives. Second, the SO_2 emission sources are more concentrated than GHG-emitting sources, which cut across multiple economic sectors.

As with other comparisons, the relative advantage of a carbon tax would depend on the designs of the instrument alternatives under scrutiny. For example, a cap-and-trade system with a more downstream structure may present more of a challenge, because more sources would be subject to the cap. In addition, if a cap-and-trade program were to provide emission allowances to covered sources at no cost, policymakers would need to devise a system for determining allotment. Emission allowance auctions would alleviate this responsibility, but would require an additional administrative responsibility, and some have raised concerns that auctions may impose a risk of market manipulation.

(...continued)

Benefits and Concerns, by Jonathan L. Ramseur.

57 See CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

58 Metcalf (2008).

59 AEI, 2007.

60 Parry and Pizer, 2007.

Another potential administrative advantage of a carbon tax approach is that it carries less risk of being hindered by litigation. Compared to a carbon tax, cap-and-trade legislation may delegate more authority to EPA or another government agency to implement certain components—e.g., specific allocation decisions, offset protocols, etc.—of the program.[61] Such decisions may be vulnerable to legal challenges from stakeholders.

Policy Modification

Some have argued that one of the advantages of a carbon tax is the relative ease—compared to a cap-and-trade program—in which the program's stringency could be modified.[62] In contrast, they assert that policymakers would face difficulties if they sought to adjust an emissions cap after the program's initiation.[63] The rationale for this assertion is that covered sources that made or purchased emission allowances beyond those needed in a given year would lose some of the value of these allowances if Congress raised (i.e., loosened) the cap at a later time. Similarly, a covered source may make capital investments based on the assumption of a stringent cap. If policymakers subsequently loosened the cap, these covered sources would take longer to recoup their investments.[64] However, this concern could also apply to a carbon tax. For example, energy producers and consumers may make investments based on an expected carbon tax. If the tax is subsequently altered, the value of such investments may change.

Potential Disadvantages

A GHG emission reduction program that employs a carbon tax may face several disadvantages, compared to a cap-and-trade program. As with the potential advantages, the size and/or relevancy of the disadvantages are dependent on the design of the programs being compared. The potential disadvantages are discussed below.

Uncertain Emissions

The primary disadvantage of using a carbon tax to control GHG emissions is that the level of emissions would be uncertain.[65] For some this concern may present a non-starter, precluding a carbon tax as an option to control GHG emissions. As discussed above, some argue that the potential for irreversible climate change impacts necessitates the emissions certainty that is only available with a quantity-based instrument (e.g., cap-and-trade).

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[61] As with other comparisons, this would depend upon the design of the cap-and-trade program.

[62] See Kenneth Green, *et al.*, *Climate Change: Caps vs. Taxes* (2007), American Enterprise Institute.

[63] *Ibid.*

[64] This potential problem could be alleviated by allowing covered sources to bank emission allowances.

[65] A cap-and-trade program, depending upon its design, may carry some risk of uncertain emissions as well. For example, if offsets are allowed as a compliance option, there is some concern that they would not represent real emission reductions. Emissions leakage is another threat to the certainty of the emissions cap. See CRS Report RL34436, *The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential Benefits and Concerns*, by Jonathan L. Ramseur; and CRS Report R40100, *"Carbon Leakage" and Trade: Issues and Approaches*, by Larry Parker and John Blodgett.

However, uncertain emissions do not necessarily equate with no emission control. Multiple models have estimated the carbon tax rate that would be required to achieve certain emission targets, targets that are comparable with the emission reduction goals of recent cap-and-trade proposals.[66] Regardless, these models can only provide estimates based on the best information available about the marginal costs of abatement (**Figure 1**).

Although uncertain emissions are inherent with a carbon tax approach to emission control, there are policy options available to Congress to enhance the emission control certainty of a carbon tax. In theory, policymakers could devise a carbon tax program that yields only short-term emission fluctuations, as it progresses towards its long-term emission reduction objective. To achieve this goal, Congress would need to enact a mandatory GHG emission reporting regime to act in parallel with a carbon tax. Data from such a regime could be used to track the impact and performance of a carbon tax. If policymakers determine emission reduction is not occurring at a desired pace, the tax rate could be amended.

As discussed above, carbon tax proponents would argue that short-term emission variations would not undermine efforts to control climate change. Indeed, they would assert that short-term emission fluctuations are greatly preferred to the price volatility that a cap-and-trade program would potentially impose. This argument is supported by the notion that CO_2 is a stock pollutant, which generates damages through its overall concentration in the atmosphere, not its annual flow.

Critics of such an approach may question whether modifying the carbon tax rate on a periodic basis would be a politically palatable option. For example, it may be difficult for policymakers to increase the tax rate, especially during downturns in the economy. To address these concerns, some have suggested that Congress authorize an independent board or agency with the ability to modify the tax rate, in order to meet pre-determined emission reduction objectives.[67] Although this approach would improve emission certainty, long-term price certainty would be sacrificed to some degree, depending on the authority of the delegated entity to adjust the tax rate.

Political Feasibility

A common argument against a carbon tax is that it would present more political challenges to enact than an emissions cap, and thus policymakers should focus on the latter instrument. The Council on Foreign Relations recommended a cap-and-trade system over a carbon tax, stating:

> The Task Force finds that, assessed from a domestic economic perspective, the relative advantages of cap-and-trade and carbon tax approaches are easily overstated. Either, designed with a mix of efficiency and fairness in mind, would be an acceptable approach to reducing emissions. The Task Force finds, however, that the *political momentum* behind cap-and-trade makes its near term adoption much more likely.... [emphasis added][68]

Although a carbon tax would likely face more political obstacles than a cap-and-trade program, some of these obstacles may be based on misunderstandings regarding the differences between the two approaches or on assumptions that the tax would be set too low to be effective. Carbon

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[66] See e.g., Metcalf (2008) and Shapiro (2008).

[67] See Dieter Helm *et al*., "Credible Carbon Policy," in *Climate Change Policy* (ed. Dieter Helm) (2005).

[68] Council on Foreign Relations, *Confronting Climate Change: A Strategy for U.S. Foreign Policy* (2008), Independent Task Force Report No. 161.

tax proponents may be able to address these issues to some degree, but the recent political momentum for a cap-and-trade program may trump these efforts. This section examines some of the political concerns associated with a carbon tax.

What's in a Name?

Enacting a "carbon tax" to control GHG emissions would pose a political challenge for policymakers simply due to the word "tax." In contrast, the term "cap-and-trade" does not carry the same stigma. To some degree, the terminology advantage of a cap-and-trade program is arguably unfair, because it would act very much like a carbon tax. By placing a price on carbon, both a cap-and-trade and a carbon tax would likely impose costs on the economy. Indeed, some Members have argued that a cap-and-trade approach should be labeled as a "cap and tax," because it would act effectively as a tax.[69]

Proponents of enacting a carbon tax understand the political ramifications of their instrument's name. To overcome this hurdle, some have described carbon tax programs as "user fees" or "tariffs"or if they are highlighting revenue distribution opportunities—carbon tax "swaps"[70] or "shifts." There may be procedural consequences of a name change—see the text box "The Role of Committee Jurisdiction," below. Proponents of a carbon tax could potentially make inroads in the debate by framing the debate within the larger context of tax policy, particularly tax reform.

The Role of Committee Jurisdiction

The instrument's name and function would play an important role in terms of committee jurisdiction. A carbon tax proposal would likely be referred to the House Committee on Ways and Means and/or the Senate Committee on Finance; a cap-and-trade proposal would likely be referred to a committee that covers environmental policy (e.g., the Senate Committee on Environment and Public Works, House Committee on Energy and Commerce). In general, environmental policy committees may have different perspectives, expertise, or priorities than tax committees. These differences could influence the design of a GHG control instrument that originates in a particular committee, as well as subsequent program oversight and adjustments: e.g., the use of revenue from a carbon tax or a cap-and-trade system. The committee jurisdiction factor may play some role in the conceptualization of, and the debate over GHG emission control.

Some may contend that if the policy were called a "user fee" or "user charge" then the primary committee of jurisdiction would not necessarily be a tax policy committee. Standing committees of the House, other than the Appropriations and Budget Committees, may report legislation creating or modifying user fees. However, this procedural point would likely be the subject of intense debate: A ruling on whether a policy instrument is a user fee or a tax measure may depend on the nature of the charge rather than its label. For more information on this issue see U.S. Office of Management and Budget, Analytical Perspectives, Budget of the United States Government, Fiscal Year 2009 (2008); and Congressional Budget Office, The Growth of Federal User Charges (1995).

Some Members have argued that a cap-and-trade proposal would ultimately act as a tax on GHG emissions. They question whether the potential of a cap-and-trade program to raise revenue would have implications for committee jurisdiction. See Letter from Representatives Sensenbrenner and Cantor to Representatives Conyers and Nadler (February 11, 2009), at http://republicans.globalwarming.house.gov/index.shtml.

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[69] See Letter from Representatives Sensenbrenner and Cantor to Representatives Conyers and Nadler (February 11, 2009), at http://www.eenews.net/features/documents/2009/02/11/document_pm_03.pdf. This letter also argues that if a cap-and-trade bill were to raise revenue, the bill should originate in the House of Representatives.

[70] See e.g., Gilbert Metcalf, *A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief* (2007).

Support from Industry?

Certainly the term "industry" covers a wide and diverse array of economic actors. Their motivations for support of, or opposition to, a carbon tax may vary as well. Support may depend on the anticipated design of the alternative—i.e., a cap-and-trade system. Cap-and-trade proposals have evolved in recent years. Industry stakeholders may have supported a cap-and-trade approach because, if enacted, they expected to receive some or perhaps all of the allowances at no cost.[71] This may not be an unrealistic expectation, considering the emission allocation strategies in the sulfur dioxide (SO_2) emissions cap-and-trade program and the European Union's Emissions Trading Scheme (EU ETS),[72] both of which provide almost all of their allowances to covered sources at no cost. The no-cost allowance allocation to EU emissions sources generated windfall profits for some industries**.** [73]

However, the more recent cap-and-trade proposals from the 110th Congress would have provided considerably fewer allowances to covered sources at no cost.[74] Industry stakeholders have voiced concern over the apparent evolution of allocation strategy.[75] If industry expects to receive fewer allowances at no cost than previously thought, their support of a cap-and-trade system may erode, which could increase interest in a carbon tax.

Some argue that if industry is acting in its own self-interest, taxes would be the least-preferred option, even behind auctioned allowances in a cap-and-trade system.[76] The explanation for this preference is that auctions may allow room for industry to manipulate the price, driving down the overall cost of compliance (as opposed to a tax, which would be fixed). But some industries would prefer the cost to be fixed and known in advance (as a carbon tax would do), so they can better assess investment options (e.g., equipment upgrades, efficiency improvements, etc.).[77] In addition, some industry stakeholders may lend their support to a tax, if the alternative were to resemble recent cap-and-trade proposals (from the 110th Congress), which would have applied directly to upstream entities (i.e., energy producers). This approach would resemble a tax—

[71] For example, the U.S. Climate Action Partnership (USCAP), a group of large companies (and environmental organizations) recommends that a "significant portion of allowances should be initially distributed free to capped entities and to economic sectors particularly disadvantaged by the secondary price effects of a cap.... " U.S. CAP, *A Call to Action*, at http://www.us-cap.org/.

[72] See CRS Report RL34150, *Climate Change and the EU Emissions Trading Scheme (ETS): Kyoto and Beyond*, by Larry Parker.

[73] See IPA Energy Consulting, *Implications of the EU Emissions Trading Scheme for the UK Power Generation Sector* (2005), Prepared for the United Kingdom Department of Trade and Industry; Jos Sijm et al., "CO2 Cost Pass-Through and Windfall Profits in the Power Sector," *Climate Policy* 6 (2006): 49-72; Point Carbon Advisory Services, *EU ETS Phase II—The Potential and Scale of Windfall Profits in the Power Sector* (2008), Prepared for World Wildlife Fund.

[74] See CRS Report RL33846, *Greenhouse Gas Reduction: Cap-and-Trade Bills in the 110th Congress*, by Larry Parker, Brent D. Yacobucci, and Jonathan L. Ramseur.

[75] For example, the President and CEO of Duke Energy, who initially was an advocate a cap-and-trade approach (and remains a member of USCAP), described the Lieberman-Warner bill (S. 2191) as a "bastardized" version of cap-and-trade due to its allocation scheme. See Jim Rogers, "Climate Change Legislation Should Not Be Punitive" (February 2008), *Energy Daily*.

[76] Hepburn (2006), citing P.D. Klemperer, *Auctions: Theory and Practice* (2004), Princeton University Press.

[77] In a January 2009 speech, the CEO of ExxonMobil (Rex Tillerson) spoke in favor of a carbon tax over a cap-and-trade system, stating a carbon tax would be "the most efficient means of reflecting the cost of carbon in all economic decisions—from investments made by companies to fuel their requirements, to the product choices made by consumers." This quotation was taken from a UPI news report, at [www.upi.com].

without a price certainty—for downstream energy consumers (e.g., power plants).[78] Moreover, the upstream entities subject to direct compliance—i.e., required to submit allowances—would have little or no direct emissions. The gap between compliance and emissions could pose challenges in a situation without a known price (i.e., a cap-and-trade program).

Support from Environmental Groups?

Supporters of stringent GHG emission control may oppose a carbon tax, because they assume that if Congress enacts a carbon tax, Members would set the rate too low to induce emission mitigation: e.g., energy conservation, fuel substitution, or technology development. This may be more of an argument against the tax rate, than the instrument itself.

A similar concern of stringency may exist if policymakers decide to employ a cap-and-trade system. For example, the cap might be set at undesired levels, or the program may allow for the use of questionable offsets, which could pose a risk of undermining the objective of emission reduction. Likewise, the pressure to delay the strengthening of an established cap that is considered ineffective or expensive could be considerable. Regardless, an emissions cap—at least on paper—offers more of a guarantee that a specific emission level would be met. Some environmental groups may assert that this perceived guarantee overshadows other concerns.

Consideration of International Efforts and Cooperation

It is generally recognized that mitigation of human-induced climate change will ultimately require action by all major emitting countries. Therefore, when assessing different mechanisms of GHG emission reduction, Congress may want to consider how an market-based instrument—e.g., a cap or a tax—would 1) complement existing or future international efforts and/or 2) maximize participation among major emitting nations.

For policymakers and negotiators who are attempting to create an international GHG reduction regime, establishing either instrument on an international scale would present substantial and unique challenges. A carbon tax may be at a disadvantage, primarily because the most prominent international activities currently involve cap-and-trade programs. However, some assert that a carbon tax approach may present a stronger opportunity to maximize participation between the United States and developing economies—e.g., China and India—that emit substantial portions of GHG emissions. Some of the issues are discussed below.

Coordination with Existing International Efforts

At the core of the international GHG mitigation efforts underway—e.g., the Kyoto Protocol and the EU ETS—is a cap-and-trade program among nations with quantitative commitments. If Congress enacted a cap-and-trade system in the United States, the program could be designed to allow trading between systems. In terms of overall economic efficiency, linked trading programs would be ideal, because covered sources would have access to more emission reduction

[78] There may be some industry stakeholders who support a carbon tax on the assumption that it will be politically challenging for Congress to subsequently raise carbon taxes to the level needed to stimulate the stringent emissions reductions targeted (e.g., 80% below current levels by 2050) in recent cap-and-trade proposals.

opportunities. However, linked programs could yield unintended consequences if they differ in scope and/or stringency.[79]

A U.S. carbon tax program could conceivably have a linkage of sorts with international cap-and-trade programs. For example, a carbon tax system could allow for tax credits for emission reductions made outside of the United States.[80] However, this trade would only flow in one direction: Covered sources in the EU could not purchase reductions from covered sources in the United States. Thus, this type of linkage would not equate with a union of cap-and-trade programs. Sources in the United States that were subject to the carbon tax would find this opportunity worthwhile only if the carbon tax rate were higher than the emission allowance price (EU emission allowances or EUAs) or, if eligible, offset project prices (traded as certified emission reductions or CERs) in the EU ETS. However, if policymakers were to provide tax credits for international emission abatement projects, concerns similar to those involving offsets in a cap-and-trade system would be raised. If the illegitimate projects qualify as tax credits, the primary objective of the program—GHG emission control—may be compromised.

Maximizing Participation

Some have raised the argument that encouraging maximum participation among nations should be a higher priority than instrument choice and the potential consequences of choosing a cap over a tax (e.g., loss of economic efficiency).[81] Would a carbon tax or a cap-and-trade program be the most effective approach to bring the most nations, or more precisely, emissions, under a mitigation umbrella? Neither strategy would necessarily require equal commitments between nations. For example, the United States and China could each establish unilateral carbon tax programs—as opposed to an international, harmonized system—with different tax rates. Indeed, an international carbon tax system would encounter substantial implementation challenges, particularly regarding issues of national sovereignty.

It would be (and has proven) difficult to achieve wide and diverse participation—namely, agreement from both the United States and developing nations—in a GHG control regime. Some may favor a cap-and-trade approach, because of the buildup of existing programs and the political momentum behind the cap-and-trade approach. However, this reasoning may be questioned on several counts. First, although a substantial percentage of the world's CO_2 emissions are covered under the Kyoto or EU ETS cap, an even larger percentage are not covered.[82] This latter group includes the United States, China, and India, which accounted for approximately 54% of the CO_2 emissions from the top-25 CO_2 emitting nations in 2005.[83] Second, the mere existence of a program (and its political momentum) does not indicate it is the optimal solution. Indeed, the

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[79] For example, different treatment of offsets could raise concern, particularly if covered entities in the United States gain access to questionable offset projects. See CRS Report RL34436, *The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential Benefits and Concerns*, by Jonathan L. Ramseur.

[80] Qualified credits could range from EU emission allowances (EUAs) from the EU ETS to certified emission reductions (CERs)—i.e., international offsets—issued by the Clean Development Mechanism of the Kyoto Protocol.

[81] Scott Barrett and Robert Stavins, "Increasing Participation and Compliance in International Climate Change Agreements," *International Environmental Agreements: Politics, Law and Economics*, Vol. 3:349-76 (2003).

[82] However, Kyoto participants account for the majority of 1990 emissions (the Kyoto baseline).

[83] Data from World Resources Institute, Climate Analysis Indicators Tool (CAIT), at http://cait.wri.org/.

existing international cap-and-trade systems, which are still in their early stages, have encountered substantial problems.[84]

However, a carbon tax approach would encounter obstacles similar to those observed in the cap-and-trade discussions. For example, it would be difficult to reach agreement on the equitable or fair tax rates for each nation. Not only would this agreement be difficult between developed and developing nations—for multiple reasons that are beyond the scope of this report—but it would also pose a challenge between developed nations. For example, a 2000 study found that European nations were (at the time of the study) effectively taxing carbon at a rate of approximately $27/ton of CO_2.[85] If European nations and the United States sought to establish their own carbon tax rates, pre-existing carbon taxes (and subsidies) may complicate the discussions.

International Implementation Concerns

Regardless of the chosen instrument, either would impose its own set of logistical challenges. Some assert that an international cap-and-trade system would be more susceptible to corruption.[86] However, it could be argued that monitoring and enforcement of carbon taxes in individual nations might pose similar difficulties. A primary obstacle would be determining a nation's "net carbon tax," because nations or political subdivisions could offset the carbon tax through energy subsidies or loopholes for the entities most impacted by the tax.[87] Moreover, some nations may not have transparent tax systems in place now. Adding a carbon tax to such a framework could be problematic.

Implementation of a Carbon Tax

If Congress were to use a carbon tax to control GHG emissions, policymakers would face several implementation decisions: (1) the point of taxation—where to impose the tax and what to tax; (2) the level of taxation; and (3) how to apply the tax revenue. These considerations are discussed below.

Point of Taxation

A point of taxation debate is analogous to a debate over the scope or coverage of a potential cap-and-trade program. Congress would face similar considerations of emissions coverage with either instrument. Describing coverage issues, EPA stated:

> Ideally, all sources, sectors, and emissions would be included for full coverage and maximum environmental effectiveness and economic efficiency. However, measurement

[84] See CRS Report RL34150, *Climate Change and the EU Emissions Trading Scheme (ETS): Kyoto and Beyond*, by Larry Parker; and CRS Report RL33826, *Climate Change: The Kyoto Protocol, Bali "Action Plan," and International Actions*, by Susan R. Fletcher and Larry Parker.

[85] William Nordhaus and Joseph Boyer, *Warming the World: Economic Modeling of Global Warming* (2000), MIT Press.

[86] William Nordhaus, "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming" (2007), *Review of Environmental Economics and Policy*, Vol. 1 (1): 26-44.

[87] David Victor, *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming* (2001), Princeton University Press.

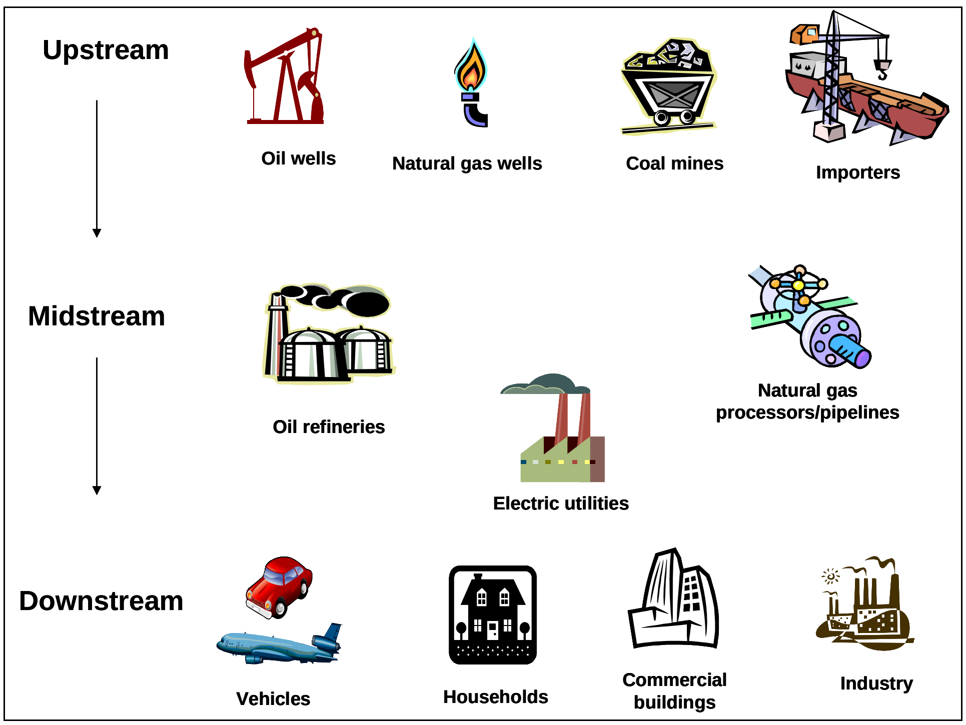
> capabilities and costs, available control options, administrative burdens, political considerations, and other constraints may limit participation to a subset of emission sources.[88]

A comprehensive discussion of these issues is beyond the scope of this report,[89] but the following sections provide options for policymakers. Note that these sections overlap to some degree.

Where to Impose a Carbon Tax?

Regarding where in the economy to impose a carbon tax, the options—at least for fossil fuel combustion-related CO_2 emissions[90]—are often couched in terms of their location in the energy production and consumption chain: upstream or downstream (**Figure 7**):

Figure 7. Illustration of Options for Points of Taxation within the Energy Production-to-Consumption Chain



Source: Prepared by CRS.

Note: Electric utilities could be listed as either downstream entities—because they are direct sources of emissions—or midstream, because their emissions are tied to the electricity consumption of their customers, the further downstream consumers.

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[88] EPA, *Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control* (2003), p. 3-5.

[89] For additional reading on these considerations, see e.g., Gilbert Metcalf and David Weisbach, *The Design of a Carbon Tax* (June 2008), Tufts University and the University of Chicago; EPA, *Tools of the Trade* (2003).

[90] Non-CO_2 GHG emissions come from a wide range of sources, most of which are outside the energy sector.

- **Upstream**—An upstream approach would apply a carbon tax to fossil fuels when they enter the U.S. economy, either at the mine, wellhead, or another practical "chokepoint" in the production chain. Imported fuels would be addressed at their point of entry into the United States (**Figure 7**). Under this approach, a carbon tax would be levied before emissions have occurred. The tax would be based upon the carbon content of the fossil fuel produced. An advantage to the upstream approach is that the number of sources directly subject to the tax would be minimized, while covering a broad spectrum of the economy.
- **Downstream—**A downstream approach would apply the tax on the emissions themselves. For example, emission sources, such as power plants or industrial facilities,[91] would pay a fee for each ton of CO_2 released into the atmosphere. In some economic sectors, there may be advantages to imposing a carbon tax downstream, even if more entities would be directly subject to the tax. For instance, Congress may consider a downstream approach for the electric utility industry, because power plants already continuously monitor their CO_2 emissions to the EPA.[92] There may be other advantages to applying the tax directly to emissions from coal-fired power plants. For example, some argue that this approach would provide a greater stimulus[93] to the development of carbon capture and sequestration (CCS) technology.[94] However, in some sectors—e.g., transportation or residential—a downstream approach may be challenging, and perhaps impractical to implement because of the comparably large number of emission sources.
- **Combined Approach**—Sometimes referred to as a hybrid strategy, this approach would cover emissions from different economic sectors in different manners. For example, transportation fuels could be taxed upstream at the point of extraction (or midstream at the refinery); coal could be taxed at the emission sources: power plants and specific industrial sectors.

Where Congress decided to impose a carbon tax would determine which entities would be required to (1) make tax payments based on emissions or emission inputs, (2) monitor emissions or emission inputs, and (3) maintain records of relevant activities and transactions.

A direct tax on emissions may be easier to understand, but considerably more difficult to implement across all economic sectors, due to the large number of emission sources. A complicating factor is that some fossil fuel uses—e.g., feedstock in asphalt production—do not generate emissions but sequester the carbon. Policymakers may consider mechanisms to exempt the fuels used for such purposes or allowing for tax credits for these activities.

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[91] Power plants may be considered midstream, because their emissions are influenced by the demand from electricity consumers: businesses and households. In addition, some carbon-intensive industries, such as steel or cement, might be categorized as midstream.

[92] Section 821 of the 1990 Clean Air Act Amendments requires electric generating facilities affected by the acid rain provisions of Title IV to monitor CO_2 in accordance with Environmental Protection Agency (EPA) regulations.

[93] Although a price signal would be sent in either case—thus (in theory) encouraging CCS development—some contend that if coal is taxed upstream at the extraction point, some of the price signal may be weakened before it reaches coal-fired emission sources.

[94] For more information on this technology, see CRS Report RL33801, *Carbon Capture and Sequestration (CCS)*, by Peter Folger.

Fossil fuels have varying levels of carbon content, thus a carbon tax would impact fossil fuels differently. For example, coal has almost twice the carbon content per unit of energy as that of natural gas (**Table 1**). Thus, a carbon tax would raise the price of coal more than the price of natural gas.

Table 1. CO_2 Emissions Per Unit of Energy for Fossil Fuels

Fossil Fuel	CO_2 Emissions Per Unit of Energy (million metric tons/quadrillion BTU)
Coal	94
Crude oil	74
Natural gas	53

Source: Prepared by CRS, based on CO2 emission factors from EIA, at http://www.eia.doe.gov/environment.html.

Note: CO2 emissions from coal vary by the type of coal being used.

The 1993 Energy or Btu Tax

A carbon tax is different from an energy consumption tax, like the British thermal unit (Btu) tax that was proposed by President Clinton in 1993. Compared to a carbon tax, a Btu tax would be a less efficient mechanism to reduce CO_2 emissions. As highlighted in , fossil fuels generate different amounts of CO_2 emissions per unit of energy. A Btu tax would treat energy sources equally, thus a Btu tax would serve different objectives than a carbon tax.

The 1993 Btu tax proposal called for a levy of 25.7 cents per million Btu, with a surcharge of 34 cents/million BTU on petroleum. The goals of the 1993 Btu tax proposal were to promote energy conservation and raise revenue. At the time, the proposed tax would have generated a new revenue stream of about $30 billion per year. The proposal was met with strong opposition and was not enacted; Congress ultimately enacted an (approximately 5-cent) increase in the motor fuels taxes.

CO_2 Emissions or All GHG Emissions?

Another point-of-taxation issue is whether a carbon tax should cover CO_2 emissions or a more comprehensive array of GHG emissions. Mitigation opportunities from non-CO_2 gases are often less expensive than other reduction options. Economic studies indicate that one advantage of including more or all GHG emissions, as opposed to only CO_2 emissions, is that the overall costs of the GHG reductions would be decreased.[95] A recent analysis of a carbon tax proposal—H.R. 3416 (Larson)—from the 110th Congress found that by adding other GHG emissions to the tax base, the overall costs of achieving the same amount of emission reduction would fall by 20%.[96] However, this finding was based on the inclusion of GHG emissions from all sources. As discussed below, the majority of the non-CO_2 GHG emissions come from sources that may present tax implementation challenges.

[95] See e.g., John Reilly *et al.*, "The Role of Non-CO_2 GHGs in Climate Policy: Analysis Using the MIT IGSM" (2006), *The Energy Journal*, Special Issue No. 3: 503-520.

[96] Metcalf *et al*. (2008). The overall costs fall, because the tax rate is decreased. By including all GHGs, the tax rate can be lowered if the cumulative target remains the same.

Which Emissions Sources to Control?

GHG emissions are spread throughout the economy and are generated by millions of discrete sources: e.g., smokestacks, exhaust pipes, households, and livestock. Although CO_2 is the primary GHG, some GHG emissions sources predominantly emit non-CO_2 GHGs. When determining which sources and gases to control through a tax, policymakers would need to balance the benefits of inclusion with administrative costs.[97] To achieve a specific emissions target, a tax applied on only a subset of economic sectors—thus covering only a percentage of U.S. GHG emissions—would need to have a higher rate than a tax applied to all GHG emissions. Numerous rationales have been put forward to justify excluding one group or sector from a reduction requirement, or to provide some other special consideration.

Table 2 lists the top emission sources of six GHGs in the United States. These sources combine to account for approximately 95% of the total (based on 2006 data).[98] **Table 2** also provides potential points of taxation that would cover the emissions from these sources.

CO_2 emissions from fossil fuel combustion yielded approximately 80% of U.S. GHG emissions in 2006.[99] Policymakers could address CO_2 emissions from fossil fuel combustion and non-energy uses—in aggregate 82% of U.S. GHG emissions—by levying an upstream carbon tax on fewer than 2,500 upstream or midstream entities (**Table 2**). A portion of these entities are already subject to environmental taxes that support other objectives.[100]

A downstream approach may be feasible for electric generating facilities powered by fossil fuels, which number approximately 3,300,[101] but impractical for other fossil fuel combustion sources—automobiles, offices, homes—which number in the millions.

One possible alternative to a complete upstream/midstream strategy would be to address coal, the most carbon-intensive fossil fuel, at its combustion location. In 2006, coal-fired power plants accounted for 92% of U.S. coal combustion.[102] As shown in **Table 2**, there are about 641 coal-fired power plants in the United States. Some argue that there would be advantages to applying a point of taxation at electric generating facilities. For example, these facilities may have a stronger incentive and/or capability to seek tax credit opportunities, such as biological sequestration projects (if allowed within the tax system). Moreover, some contend that the development of CCS would be enhanced if coal-fired facilities were directly subject to the tax. The rationale for this argument is that under an upstream approach (that indirectly taxes coal-fired emissions) the price signal may be weaker than if the tax were applied directly to emissions at coal-fired facilities. However, other sources of coal combustion would need to be covered to avoid leakage situations—i.e., increased coal (and thus emissions) use in the uncovered sectors. It may be

[97] Gilbert Metcalf and David Weisbach, *The Design of a Carbon Tax* (June 2008), Tufts University and the University of Chicago.

[98] There are additional GHGs, but they are not included in the current U.S. GHG inventory. For more information, see CRS Report RL34266, *Climate Change: Science Highlights*, by Jane A. Leggett.

[99] Based on 2006 data. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008).

[100] For example, a 5-cent-per-barrel tax on the oil industry—domestically produced oil and oil imports—supports the Oil Spill Liability Trust Fund.

[101] In 2006, there were 3,292 plants that had at least one fossil fuel-fired generator (EIA, 860 data files).

[102] EIA, *Annual Coal Report 2006* (2007).

burdensome to address the remaining sources of coal combustion at the point of emissions, particularly at residences and commercial entities.[103]

Beyond fossil fuel combustion, policymakers could cover more GHG emissions by expanding the coverage to some or all of the remaining sources listed in **Table 2**. Individually, many of these sources account for relatively small proportions of U.S. GHG emissions, but if some combination of these sources were included in the carbon tax base, the increase in emissions coverage could be appreciable.

The remaining source categories vary by (1) the number of entities that would be subject to a carbon tax, and (2) the circumstances of emission release. In general, a large number of entities subject to a carbon tax would present higher administrative costs per unit of emissions. Regardless of entity number, some emissions sources would be more difficult to cover because of logistical challenges, such as emission measurement and/or monitoring.

Although GHG emissions from the agriculture sector—farming and livestock—account for approximately 6% of total GHG emissions in the United States, agricultural emissions would be comparatively difficult to cover under a carbon tax. As indicated in **Table 2**, these emissions are generated by a large number of entities, and there are no upstream measurement points analogous to those that could cover emissions from the transportation sector. However, nitrous oxide (N_2O) emissions from the use of artificial fertilizers—as opposed to natural fertilizers like manure—might be an emission source that could be addressed through an upstream point of taxation. EPA estimates that approximately 25% of the N_2O emissions from agricultural soils are related to artificial fertilizer use.[104] This represented approximately 0.8% of U.S. GHG emissions in 2006, so it would be included in **Table 2** if counted separately. A tax on fertilizers may lead to less fertilizer use, but some argue that it could stimulate other activities—e.g., increased use of natural fertilizers—that would release N_2O emissions (a form of emissions leakage).[105] This issue is beyond the scope of this report.

In many cases, the emissions from agricultural activities may be difficult to monitor and/or measure. For practical concerns and other reasons—e.g., political considerations—the agriculture sector has thus far been excluded as a capped source in the cap-and-trade proposals that have specifically designated covered sources.[106] If not subject to a carbon tax, agriculture emissions could be addressed with other policy tools. For example, tax credits could be provided for qualifying reduction, abatement, or sequestration projects.[107]

The other emission sources listed in **Table 2** may be more amenable to a carbon tax, at least in terms of the number of entities and emission circumstances. Compared with agricultural sources, the other emission source categories—excluding HFCs (discussed below)—comprise a relatively small number of entities, at which emissions are easier to measure and monitor. In fact, certain

[103] Industry used 5% of the coal in 2006; residences and commercial entities used 3%.

[104] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008).

[105] Metcalf and Weisbach (2008).

[106] Some of the cap-and-trade proposals made in recent years would delegate coverage decisions to the implementing agency, typically EPA.

[107] Alternatively, policymakers could develop emission/sequestration standards for specific activities. This latter option would not be a market-based approach, but it was included in one of the cap-and-trade proposals from the 110th Congress—H.R. 6186 (Markey).

sources—e.g., some landfills and underground coal mines—currently control their (methane) emissions for air pollution and safety reasons.

Methane from landfills—1.8% of U.S. emissions—could be covered by including an additional 1,800 landfills in the tax base. To some degree, large municipal landfills are already required per federal air regulations to collect and combust methane emissions. Other landfills are following suit under state laws or voluntary programs.[108]

Hydrofluorocarbons (HFCs) are used as substitutes for several classes of ozone depleting substances (ODSs—hereafter, HFC-ODS).[109] HFC-ODS account for 1.6% of total U.S. GHG emissions (**Table 2**). HFC-ODS emissions occur under different circumstances than the other, "smaller" sources discussed above—landfills, coal mines, etc. Most of the HFC emissions (86% in 2006) come from air conditioning and refrigeration units—located in vehicles, buildings, and homes—during production, operation, and disposal.[110] Unlike the other "small" source categories, which emit GHGs onsite, HFC-ODS emissions enter the atmosphere from millions of locations, far away from and long after HFC production. Because of the different emission circumstances of HFC-ODS, some have proposed combining a tax at HFC production—five facilities in the United States—with a tax credit for HFCs properly recycled or disposed.[111] For example, automobile air conditioners could be sent to designated sites in order to recycle or dispose of the HFCs. Norway has an HFC rebate program in place that may be instructive for U.S. policymakers.[112] As with other carbon-intensive materials, Congress may consider applying a tax to imported HFCs as well.

By applying the tax to iron/steel production and cement manufacturing facilities—approximately 250 entities—an additional 1.3% of U.S. emissions could be covered.[113] A further 1.5% could be addressed by including methane from natural gas systems. Roughly 25% of this amount comes from field production, which may be impractical to monitor and measure accurately.[114] The remainder involves emissions from normal operations, routine maintenance, or "system upsets." Fugitive emissions (or accidental releases) are the primary source of emissions from these activities.[115] A tax on these emissions may impose administrative costs in terms setting up a process to measure and monitor these emissions.

Methane emissions from underground coal mines—0.8% of total GHG emissions—may be easier to monitor under a tax than at aboveground mines. At all underground mines, methane is ventilated for safety reasons; methane from aboveground operations is released directly to the

[108] See EPA's Landfill Methane Outreach Program, at http://www.epa.gov/lmop/overview.htm.

[109] A small amount of perfluorocarbons (PFCs) are also used as substitutes (EPA Inventory, 2008). Under the Montreal Protocol and the Clean Air Act Amendments of 1990, ODSs are being phased out. See CRS Report RL30853, *Clean Air Act: A Summary of the Act and Its Major Requirements*, by James E. McCarthy et al.

[110] EPA Inventory (2008).

[111] See e.g., Metcalf and Weisbach (2008).

[112] Intergovernmental Panel on Climate Change, *Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons* (2005).

[113] As with fossil fuels, policymakers may want to consider applying the tax to imported steel and cement. This would increase the number of entities subject to the tax.

[114] See e.g., Metcalf and Weisbach (2008).

[115] EPA Inventory (2008).

atmosphere. The 0.8% figure includes methane only from underground coal mines, which account for about 61% of methane from coal mines.[116]

Table 2. Selected Sources of U.S. GHG Emissions and Potential Applications of a Carbon Tax

GHG Emission Source	Percentage of U.S. GHG Emissions (2006 data)	Potential Carbon Tax Applications: Entity	Potential Carbon Tax Applications: Number
CO_2 from fossil fuel combustion:	79.9	Coal mines[a]	1,374
- electricity generation		or	641
- transportation		Coal-fired power plants[b]	
- industrial		Power plants[c] using imported coal[d]	26
- commercial/residential			
		Petroleum refineries[e]	150
		Petroleum importers[f]	220
		Natural gas processors[g]	530
		Natural gas importers[h]	45
N_2O from agricultural soils	3.8	Farms[i]	>2 million
CO_2 from non-energy use of fuels	2.0	Covered by the tax applied to fuels (above)[j]	
CH_4 from livestock (enteric fermentation)	1.8	Cattle operations[k]	967,440
CH_4 from landfills	1.8	Landfills[l]	1,800
HFCs from the substitution of ozone depleting substances	1.6	HFC manufacturers[m]	5
CH_4 from natural gas systems	1.5	Natural gas processors	530
CH_4 from coal mines	0.8	Coal mines[n]	1,374
CO_2 from iron/steel production	0.7	Raw steel production facilities;	116
		Integrated steel mills[o]	18
CO_2 from cement manufacturing	0.6	Cement plants[p]	118
CH_4 from manure management	0.6	Cattle operations;	967,440
		Swine operations[q]	65,640
Percentage of Total GHG Emissions	95.1		

Source: Prepared by CRS; GHG emission data from EPA, EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008); data for number of entities from multiple sources, cited in footnotes.

a. This figure accounts for mines in operation in 2007. EIA, *Coal Production and Number of Mines by State and Mine Type*, (2008).

b. In 2006, there were 641 plants with at least 1 coal-fired generator unit (EIA, 860 Database).

[116] EPA Inventory (2008).

c. Number of plants comes from EIA database, Monthly Nonutility Fuel Receipts and Fuel Quality Data (Database 423). CRS was unable to determine the number of companies that act as coal importers, analogous to petroleum importers.

d. In 2006, the United States imported approximately 36 millions short tons of coal (EIA, *Quarterly Coal Report* (2008), table 4)—3.5% of the amount to coal consumed domestically in that year (EIA, *Annual Coal Report 2006* (2007), table 26). Coal imports have increased by more than 200% since 2002.

e. This figure represents the number of "operable" refineries. EIA, *Refinery Capacity Report* (2008).

f. EIA, Company Level Imports (as of November 2008). Note that some of these companies may import only crude oil, whose emissions would be covered by the tax at the domestic refineries. Thus, this figure represents an upper bound of petroleum product importers potentially subject to a carbon tax.

g. EIA, Natural Gas Processing: The Crucial Link Between Natural Gas Production and Its Transportation to Market (2006).

h. This includes pipelines and liquefied natural gas facilities. EIA, *About U.S. Natural Gas Pipelines* (as of September 2008).

i. U.S. Department of Agriculture, *Farms, Land in Farms, and Livestock Operations: 2007 Summary* (2008). The resource defines a farm as "any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year."

j. Fossil fuels are used for a wide range of non-energy purposes. EPA estimates that of the total carbon consumed for non-energy purposes, approximately 62% is stored in products, and not released to the atmosphere (EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008), tables 3-14 and 3-15). The 2% value in Table 4 represents the emissions. In an upstream carbon tax system, fuels would be taxed before they are used. Congress may want to consider providing tax credits for the amount of carbon stored in products.

k. U.S. Department of Agriculture, Farms, Land in Farms, and Livestock Operations: 2007 Summary (2008).

l. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006 (April 2008), citing BioCycle, 15th Annual BioCycle Nationwide Survey: The State of Garbage in America (2006).

m. Intergovernmental Panel on Climate Change, Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons (2005), Figure 11.1.

n. Methane from underground mines, which accounts for about 61% of coal mine methane, is removed through ventilation systems for safety reasons. These emissions would be easier to monitor under a carbon tax than aboveground coal mine methane emissions.

o. Data from U.S. Geological Survey, Mineral Commodity Summary, Iron and Steel Production (2008), at http://minerals.usgs.gov/minerals/pubs/commodity/iron_&_steel/.

p. Cement manufacturing information from Portland Cement Association, at http://www.cement.org/basics/cementindustry.asp.

q. U.S. Department of Agriculture, *Farms, Land in Farms, and Livestock Operations: 2007 Summary* (2008). Other animals—chickens, horses, and sheep—contribute approximately 10% of the total emissions from manure (EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008), table 6-6).

Level of Taxation

If Congress were to use a carbon tax to control GHG emissions, setting the level of the carbon tax would be a subject of intense debate. Regardless of the chosen tax schedule, some parties would argue that the selected rate was either too low or too high. Although the decision would likely involve political calculations, there are economic principles that could be used to inform the debate. This section identifies and discusses two approaches that policymakers could take to set the level of a carbon tax. The first approach is based on the estimated benefits associated with avoiding climate change impacts. The second approach is based on a GHG emissions target and the tax rate needed to achieve that target. The first approach is arguably stronger from a theoretical standpoint, but the second approach is arguably (considering the uncertainty associated with the first approach) a more practical option.

To provide some context for potential carbon tax rates, **Table A-1** of this report (located in the **Appendix)** includes estimates of price increases to fossil fuels and motor gasoline based on different carbon tax rates.

Tax Based on Estimates of Costs and Benefits[117]

As noted previously, economic principles involving pollution taxes prescribe that the optimal tax should be at the intersection of the marginal costs of emission abatement with the marginal benefits of abatement. In terms of climate change, the intersection of costs and benefits is often described as the Social Cost of Carbon (SCC). The Intergovernmental Panel on Climate Change (IPCC) defines the SCC as the following:

> The discounted monetized sum (e.g. expressed as a price of carbon in $/tCO_2$) of the annual net losses from impacts triggered by an additional ton of carbon emitted today. According to usage in economic theory, the social cost of carbon establishes an economically optimal price of carbon at which the associated marginal costs of mitigation would equal the marginal benefits of mitigation.[118]

For multiple reasons, applying this economic principle to set a carbon tax currently presents monumental, if not insurmountable, challenges. These are highlighted below.

Social Cost of Carbon Estimates

Estimates of the SCC are fraught with uncertainty, thus the wide range of estimates produced should not come as a surprise. According to a 2008 meta-analysis, there are over 200 SCC estimates from 47 studies. The estimates range across several orders of magnitude, from zero to over $500 per ton of CO_2-equivalent (tCO_2-e) emissions.[119] The uncertainty and controversy of choosing a value within this range would be formidable.

The definition of SCC indicates the complexity involved in its estimation. The SCC can be defined as a monetary measure of the marginal damages (or costs)—on a global scale—of an incremental unit (e.g., one metric ton) of anthropogenic GHGs emitted to the earth's atmosphere at some point in time (e.g., now).

Estimating the SCC requires analysts to place values on goods and services that may be difficult (or controversial) to precisely measure: e.g., human health/life, water supplies, agricultural production, recreational activities. The value of these goods/services will vary from one location

[117] A comprehensive discussion and analysis of climate change costs and benefits is beyond the scope of this report. This section highlights issues associated with estimating and applying climate change cost and benefit estimates for carbon tax implementation.

[118] IPCC, *Climate Change 2007: Mitigation*, (Annex I—Glossary)Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007).

[119] Richard Tol, "The Social Cost of Carbon: Trends, Outliers, and Catastrophes," *Economics E-Journal* (August 2008). This updates a previous study: Richard Tol, "The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties," *Energy Policy* 33:2064-2074 (2005)

to the next, complicating the estimate. Moreover, the climate change processes that may impact these goods and services are not completely understood.[120]

The element of time particularly complicates an SCC estimation and application in several ways. An SCC estimate signals—per economic theory—what global society should be willing to pay *now* to avoid *future* damages due to additional emissions generated *today*. As discussed above, CO_2 and other GHGs remain in the atmosphere for decades to centuries, thus current emissions could generate damages for years to come. To take time into account—i.e., determine the cost of future damages in today's dollars (referred to as net present value)—economists employ a discount rate.[121] Discount rates are typically at the crux of cost-benefit analyses and their assignment often generates controversy. As with other public policy decisions that employ cost-benefit analysis, the chosen discount rate is a critical factor when estimating the SCC. In terms of uncertainty in evaluating damages from climate change, the Intergovernmental Panel on Climate Change (IPCC) estimates that the discount rate is the second most important factor (climate sensitivity assumptions are number one).[122]

An additional factor included in SCC estimates is the assumption of the current global emission trajectory. As stated in the Stern Review, "an SCC curve cannot be drawn, nor an SCC calculated, without specific assumptions on future paths."[123] A business-as-usual (BAU) path assumption will produce a higher SCC estimate than an assumed path of emission stabilization.[124] A higher concentration pathway yields a higher SCC estimate, because if an extra ton of GHG emissions is added to an atmosphere with a high GHG concentration, the extra ton is projected to yield more damages than if it were added to an atmosphere of lower GHG concentration.[125]

Applying Social Cost of Carbon Estimates

Using SCC estimates as a basis for a carbon tax would be consistent with economic principles, but extremely difficult in practice. The primary reason is that the estimates vary widely, based on the underlying assumptions used to generate the estimates. Selecting one estimate over another may be difficult to justify. For these reasons, economic reports often discuss the SCC in terms of a "starting place"[126] or a "good guide"[127] for setting a carbon tax level.

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[120] See e.g., Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006); Richard Tol, "The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties," *Energy Policy* 33:2064-2074 (2005); David Pearce, "The Social Cost of Carbon," in *Climate Change Policy* (Dieter Helm, editor), Oxford University Press (2005).

[121] For a more comprehensive discussion and explanation of discount rates and their applicability to climate change, see David Weisbach and Cass Sunstein, *Climate Change and Discounting the Future: A Guide for the Perplexed*, Reg-Markets Center Working Paper No. 08-19 (August 2008); and Jiehan Guo *et al*., "Discounting and the Social Cost of Carbon: A Closer Look at Uncertainty" *Environmental Science and Policy*, 9: 205-126 (2006).

[122] Intergovernmental Panel on Climate Change, *Climate Change 2007: Impacts, Adaptation, and Vulnerability* (2007), Working Group II Contribution to the Fourth Assessment Report, p. 823.

[123] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006), p. 26.

[124] Stern's business-as-usual estimate for the SCC was $95 per metric ton of CO_2-e (in $2005); the SCC estimate for a pathway that would stabilize GHG concentration at 450 parts per million was $28.

[125] Ibid., p. 301.

[126] Gilbert Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change* (2007), The Hamilton Project, Brookings Institution.

[127] Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006), p. 301.

Moreover, the estimates are snapshots for a given point in time. As conditions change, the SCC estimates change. Thus, using them as a basis for a carbon tax rate may be problematic, because policymakers would need to alter the tax schedule based on the most recent estimates. However, this concern would exist for a carbon tax system based on any economic estimates, such as marginal cost curves (as discussed below).

Regardless, the tax rates from several carbon tax proposals in economic literature[128] and one proposal from the 110th Congress—H.R. 3416 (Larson)—are close in value to the mean (average) of SCC estimates identified in a recent meta-analysis.[129] In 2007, the IPPC found that *peer-reviewed* estimates[130] of the SCC in 2005 dollars have an average of \$12/tCO_2-e.[131] However, prominent economists have generated estimates above and below this level.[132]

Tax Based on Meeting an Emissions Target

An alternative to the above approach—basing a carbon tax on expected damages (measured in net present value)—would be to determine the tax rate needed to stimulate a specific emissions reduction goal. For example, Congress would set an emissions target—e.g., 66% below 2005 levels by 2050[133]—and estimate the tax schedule—e.g., \$X/tCO_2-e in 2010, increasing Y% per year—that would encourage the reductions needed to meet the target. Using this approach, policymakers would not need an estimate of the marginal benefits of abatement in the tax rate calculation. However, the chosen emission reduction target may involve some debate over the level of climate change risks that could be tolerated by society.[134]

This approach might require estimates of the marginal costs of emission abatement. These estimates, while not as uncertain according to many economists, are similarly based on multiple assumptions, and are thus also fraught with substantial uncertainty. A comparison of the multiple cost analyses of the Lieberman-Warner cap-and-trade proposal (S. 2191/S. 3036) from the 110th Congress demonstrates the uncertainty in estimating costs.[135] These analyses forecast emission allowance prices within the narrow parameters of S. 2191. Although not the same measure, emission allowance prices provide an approximate value of marginal abatement costs for that

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[128] See Robert Shapiro *et al.*, *Addressing Climate Change Without Impairing the U.S. Economy: The Economics and Environmental Science of Combining a Carbon-Based Tax and Tax Relief* (2008), U.S. Climate Task Force; and Gilbert Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change* (2007), The Hamilton Project, Brookings Institution.

[129] Richard Tol, "The Social Cost of Carbon: Trends, Outliers, and Catastrophes," *Economics E-Journal* (August 2008).

[130] If non-peer-reviewed estimates were included, the average would be much higher, because these estimates are generally in the upper end of the range. See Richard Tol, "The Social Cost of Carbon: Trends, Outliers, and Catastrophes," *Economics E-Journal* (August 2008).

[131] Intergovernmental Panel on Climate Change, *Climate Change 2007: Impacts, Adaptation, and Vulnerability* (2007), Working Group II Contribution to the Fourth Assessment Report.

[132] For example, William Nordhaus estimates a SCC of approximately \$8/tCO_2-e (*A Question of Balance: Economic Modeling of Global Warming* (2008), prepublication version,Yale Press); Nicholas Stern's SCC estimate is approximately \$26/tCO_2-e. Both of these estimates are in \$2005 and are for different business-as-usual scenarios (Nicholas Stern, *The Economics of Climate Change: The Stern Review* (2006)).

[133] This is the projected emission reduction from the Lieberman-Warner proposal (S. 2191/S. 3036).

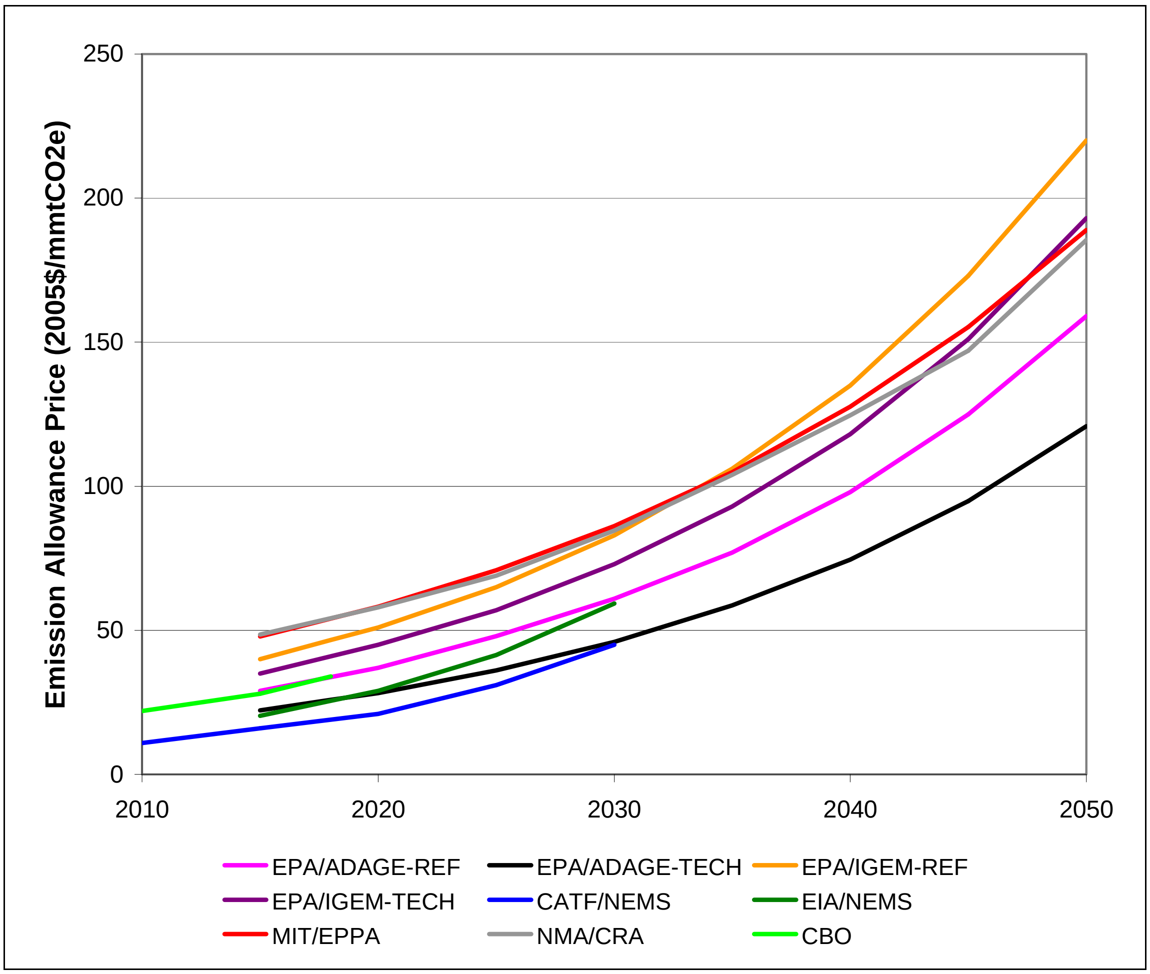
[134] Selecting a GHG reduction goal would be a complicated endeavor, involving multiple considerations. This discussion is beyond the scope of this report.

[135] For a comprehensive analysis of these issues see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

proposed strategy. As shown in **Figure 8**, emission allowance price estimates for S. 2191 varied considerably, from $16/t$CO_2$-e to $49/t$CO_2$-e in 2015. The figure indicates that the range of estimates broadens as time progresses.

The range of emission allowance prices—a proxy for marginal abatement costs—indicates that policymakers would have weak information on which to set the optimal tax rate to meet a selected emissions target. However, an uncertain emissions pathway goes hand-in-hand with a carbon tax system. As discussed above, this problem could be alleviated by annually monitoring U.S. emissions and altering the tax rate as deemed necessary—thereby requiring Congress or a delegated entity to adjust the tax rate through subsequent legislation or regulation.

Figure 8. Emission Allowance Price Estimates under S. 2191



Sources: (1) EPA/ADAGE and EPA/IGEM: "Data Annex" available on the EPA website at http://www.epa.gov/climatechange/economics/economicanalyses.html;

(2) MIT/EPPA: Sergey Paltsev, et al., "Appendix D" of Paltsev et al., Assessment of U.S. Cap-and-Trade Proposals, MIT Joint Program on the Science and Policy of Global Change (2007);

(3) EIA/NEMS: EIA, Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007 (April 2008);

(4) CATF/NEMS: Jonathan Banks, Clean Air Task Force, The Lieberman-Warner Climate Security Act—S. 2191: A Summary of Modeling Results from the National Energy Modeling System (February 2008);

(5) NMA/CRA: CRA International, Economic Analysis of the Lieberman-Warner Climate Security Act of 2007 Using CRA's MRN-NEEM Model (April 8, 2008);

(6)CBO: Congressional Budget Office, Cost Estimate: S. 2191: America's Climate Security Act of 2007 (April 10, 2008).

Notes: This figure was adapted from CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci. Estimates extrapolated by CRS from available data where necessary. Estimates converted to 2005$ using GDP implicit price deflator. The original figure included two additional estimates that are not included above, because these estimates were subsequently found to contain errors in the underlying methodology.

Tax Revenue Distribution

Carbon tax revenues would be substantial, and policymakers could apply them to further multiple objectives (not listed in any particular order): allow for reductions in other taxes; alleviate the burden of increased energy prices (brought on by the carbon tax); stimulate development of low-carbon technologies; and support other climate- or non-climate-related purposes. The redistribution of carbon tax revenues is often described as "revenue recycling."[136] After providing an estimate of potential tax revenues for context, this section discusses some of the revenue recycling options and their potential impacts.

Estimates of Tax Revenues

Table 3 provides estimates of tax revenue estimates from recent legislative proposals from the 110th Congress: H.R. 2069 (Stark) and H.R. 3416 (Larson). Both bills would have imposed a carbon tax on coal, petroleum, and natural gas, based on the CO_2 emissions[137] the fossil fuels would generate upon combustion. As indicated in **Table 3**, the bills were estimated to generate between $69 billion and $126 billion in 2015. To put these estimated tax revenues in context, consider the federal net tax revenue from the three largest revenue sources for FY2005 (in 2005 dollars):[138]

- individual income tax: $1,107 billion;
- employment taxes: $771 billion;
- corporate income taxes: $307 billion.

[136] Although some (primarily economists) may define this phrase more narrowly—i.e., only in the context of offsetting distortionary taxes—in this report, revenue recycling refers to any application of carbon tax revenue.

[137] Neither bill would address other GHG emissions.

[138] U.S. Internal Revenue Service, *Internal Revenue Service Data Book 2005* (2006)..

Table 3. Estimates of Potential Tax Revenues from Carbon Tax Proposals from the 110th Congress (in 2005 dollars)

	Proposed Tax Rates		Annual Tax Revenue Estimates	
Carbon Tax Proposals	**in 2015**	**in 2030**	**in 2015**	**in 2030**
H.R. 2069 (Stark)	$10/tCO2-e	$43/tCO2-e	$69 billion	$263 billion
H.R. 3416 (Larson)	$20/tCO2-e	$83/tCO2-e	$126 billion	$361 billion

Source: Prepared by CRS with estimates from Gilbert Metcalf *et al*., *Analysis of U.S. Greenhouse Gas Tax Proposals* (2008), MIT Joint Program on the Science and Policy of Climate Change, Report No. 160.

Note: The MIT model assumed that H.R. 2069 and H.R. 3416 would start in 2012, although both bills (as written) would have begun in 2008.

Uses of Tax Revenues

Revenues from the carbon tax could be used to promote a wide range of policy objectives, climate-related or otherwise. This section identifies different applications of the carbon tax revenues. A subsequent section discusses the policy considerations for Congress surrounding the different applications of carbon tax revenue.

Offset Reductions in Other Taxes

Carbon tax revenues could be used to replace taxes that apply to desirable activities (as noted earlier). Economic theory generally supports a tax policy that would reduce taxes on favored activities (e.g., increased employment or investment) and increase taxes on less desirable behavior (e.g., increased pollution). The rationale for this policy is that taxes on desirable activities create market distortions, discouraging increased levels of desirable actions. For example, economists argue that income taxes provide a number of distortions to the economy. "By taxing away some of the returns on working and saving, income taxes deter some people from joining the labor force and encourage others to consume too much of their income [instead of saving]."[139]

Using carbon tax revenues in this manner has been described as yielding a double-dividend: (1) reduced GHG emissions and (2) reduced market distortions from the taxes on desirable behavior. In the early 1990s, some economists suggested that the double-dividend effect would be strong enough to keep the overall costs of carbon reductions to society relatively small or even negative.[140] However, more recent economic studies indicate that the additional tax-imposed costs[141] would probably (at least in the United States)[142] exceed the economic efficiency benefits (unrelated to climate change benefits) from reducing the distortionary taxes.[143]

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139 Ian W.H. Parry and William Pizer, *Emissions Trading Versus CO_2 Taxes Versus Standards* (2007), Resources for the Future Issue Brief.

140 Ian Parry, "Fiscal Interactions and the Case for Carbon Taxes over Grandfathered Carbon Permits," in *Climate Change Policy* (Dieter Helm, editor), Oxford University Press (2005); Intergovernmental Panel on Climate Change Working Group III, *Climate Change 2001: Mitigation*, (Cambridge, UK: Cambridge University Press, 2001) Chapter 8.

141 This is referred to as the "tax-interaction effect" in economic literature. In short, a carbon tax would increase energy costs. Increased energy costs are expected to lead to some decrease in real household income and labor supply. See e.g., Ian Parry, "Fiscal Interactions and the Case for Carbon Taxes over Grandfathered Carbon Permits," in *Climate Change*
(continued...)

Direct or Indirect Payments to Households

To alleviate the carbon tax-imposed costs to households, particularly low-income households, policymakers could use the tax revenues to provide financial assistance. There are multiple mechanisms through which households could receive assistance, including lump-sum payments, payroll or income tax deductions, tax credits or rebates, or increases in existing assistance programs.

Provide Assistance to Carbon-Intensive Industries

Stakeholders in carbon-intensive industries—e.g., fossil fuel-fired electric utilities, steel producers, paper manufacturing, etc.—argue that if Congress enacts a GHG emission control program, such as a carbon tax, their industries would be adversely impacted. To alleviate potential impacts, policymakers may consider returning—directly or indirectly—a portion of the carbon tax revenues to affected industries. This would be analogous to providing a percentage of emission allowances (or auction revenues) at no cost to covered sources in a cap-and-trade program.[144]

Fund Specific Objectives

Congress may also consider using the tax revenues to provide funding to support a range of objectives related to climate change, including:

- Technology development and deployment: Promotion of emission mitigation technology is widely recognized as a vital step towards making substantial GHG emission reductions.[145]
- Energy efficiency: Improvements in energy efficiency could make considerable contributions in achieving GHG emission reductions. Although a carbon tax should stimulate energy efficiency by placing a price on carbon, Congress may consider using the tax revenues to provide additional incentives, particularly to encourage households to adopt conservation and other measures.
- Biological sequestration: Trees, plants, and soils sequester carbon, removing it from the earth's atmosphere. Tax revenues could be used to promote carbon sequestration efforts: e.g., forestry or agricultural activities.

(...continued)

Policy (Dieter Helm, editor), Oxford University Press (2005)

[142] There is some evidence that the double-dividend benefits are stronger in Europe than in the United States, because the former has a more stringent income tax system. With more stringent taxes in place, there is more "distortion" to reduce, thus strengthening the double-dividend effect. Intergovernmental Panel on Climate Change Working Group III, *Climate Change 2001: Mitigation*, (Cambridge, UK: Cambridge University Press, 2001) Chapter 8, citing several studies.

[143] For cost estimates from economic models, see Metcalf *et al.* (2008) and Robert Shapiro *et al*., *Addressing Climate Change Without Impairing the U.S. Economy: The Economics and Environmental Science of Combining a Carbon-Based Tax and Tax Relief* (2008), U.S. Climate Task Force.

[144] For more discussion, see CRS Report R40100, *"Carbon Leakage" and Trade: Issues and Approaches*, by Larry Parker and John Blodgett.

[145] See e.g., CBO, *Evaluating the Role of Prices and R&D in Reducing Carbon Dioxide Emissions*, (2006).

- Adaptation efforts: Regardless of emission reduction efforts taken today, climatic changes are expected, due to the ongoing accumulation of GHGs in the atmosphere. Therefore, some contend that investment (e.g., tax revenues) should focus on preparing communities—both domestically and internationally—to adapt to the effects of a changing climate.
- Deficit reduction: A portion of the revenues could be set aside to offset projected federal tax revenue shortfalls.[146] In addition, Congress may consider using carbon tax revenues to offset shortfalls beyond those that are related to the carbon tax.

Policy Considerations of Different Revenue Applications

Keeping in mind the potential amount of new carbon tax revenue, its use and distribution could have appreciable impacts. In general, Congress would face a zero-sum game when deciding how to apportion the tax revenues: One revenue use necessarily forgoes the opportunity to apply that level of revenue elsewhere. Analogous to emission allowance value allocation[147] in a cap-and-trade program, the distribution of tax revenue would present policymakers with a series of trade-offs. The primary options involve (1) minimizing the overall costs of the carbon tax imposed on society; (2) alleviating the costs borne by subgroups in society and economic sectors; and (3) providing funding to support other policy objectives, such as technological development. In the short-term, these options are mutually exclusive. However, in the long-term, advancements in low-carbon technology have the potential to reduce societal costs.

Overall Costs to Society

Overall costs may be referred to as macroeconomic costs and are often measured in terms of changes in projected gross domestic product (GDP) or another societal-scale metric—e.g., efficiency cost or welfare changes. Economic studies indicate that using carbon tax or auction revenues to offset reductions in distortionary taxes (labor, income) would be the most economically efficient use of the revenues and yield the greatest benefit to the economy overall. These studies show that if the revenues are used for other purposes, economic efficiency could suffer and the overall cost of the program would be higher.

A frequently cited study[148] compares the macroeconomic effects of different tax (or allowance auction) revenue applications with different emission allowance allocations in a cap-and-trade program. The study concludes that the least economically efficient method of emission allowance distribution would be to provide all of the emission allowances to covered sources at no cost. This is illustrated as the right-hand (red) column in **Figure 9**. This study finds that efficiency costs could be reduced by 21% from this scenario if policymakers were to distribute carbon tax revenues to U.S. households in "lump-sum" payments—e.g., increase the standard tax deduction or provide payments to households (represented by the middle/blue column in **Figure 9**). The

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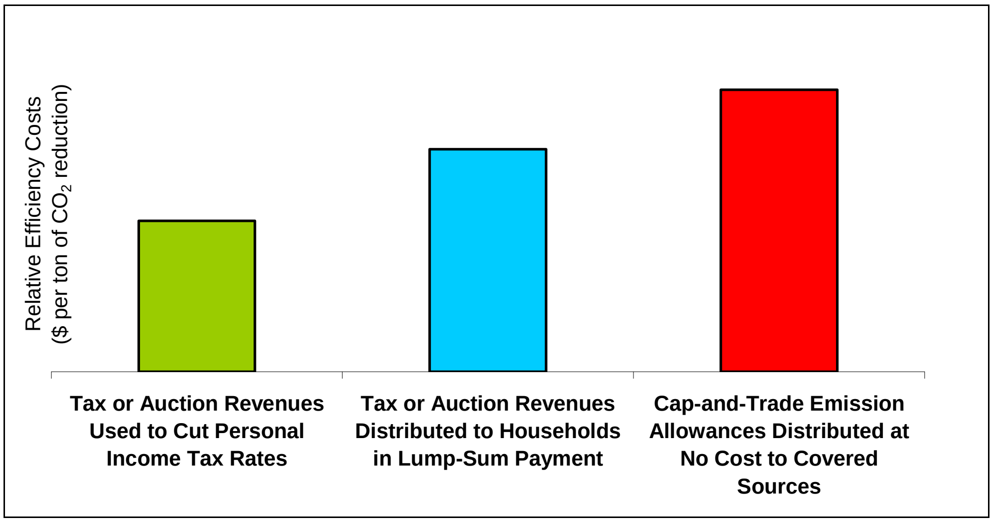
[146] A carbon tax would raise energy costs, which is expected to lead to some reduction in real household wages and labor supply. In turn, federal tax revenue may decline.

[147] Allowance value allocation includes both the use of auction revenues and distribution of allowances to entities (e.g., industry or non-covered parties) at no cost.

[148] In this study, the author applies a carbon tax of approximately \$7/tCO_2 that rises (at 7% or 9%) until it reaches \$14/tCO_2, at which point the tax is held constant in real dollars. The study also examines an emissions trading program with allowance prices that match the carbon tax paths. Lawrence H. Goulder, *Mitigating the Adverse Impacts of CO_2 Abatement Policies on Energy-Intensive Industries* (2002), Resources for the Future Discussion Paper.

lowest overall costs of those modeled would be achieved by using carbon tax revenues to reduce taxes on labor or investment. This option is shown in the left/green column. Compared to the least efficient option—no-cost distribution in a cap-and-trade program—this option would reduce societal costs by 47%. **Figure 9** indicates this option also produces substantially lower (approximately 32%) costs than lump-sum distribution. This is explained by the "double-dividend" effect, described above. However, the next section points out that the distributional impacts of these revenue applications are very different.

Figure 9. Relative Differences in Efficiency Costs between Different Applications of Tax (or Auction) Revenues and No-Cost Allowance Distribution in a Cap-and-Trade Program



Source: Prepared by CRS with data from Lawrence H. Goulder, *Mitigating the Adverse Impacts of CO_2 Abatement Policies on Energy-Intensive Industries* (2002), Resources for the Future Discussion Paper.

Distributional Impacts

In isolation, a carbon tax is regressive. This means that lower-income households would see a greater percentage increase of household income required for carbon tax-related costs—higher energy and/or electricity bills, primarily—than higher income households. A 2007 report estimated that households in the lowest income bracket could face increased costs equal to 3.4% of their household income; households in the highest bracket could see a cost increase of 0.8% (**Table 4**).[149]

If Congress were to redistribute tax revenues to households in lump-sum payments, the 2007 report estimates the impacts to household income would be more progressive: The lowest income brackets would see net gains, while higher income brackets would break even or experience relatively minor losses (**Table 4**).

[149] Gilbert Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change* (2007), The Hamilton Project, Brookings Institution.

In another scenario examined by the 2007 study, workers would receive a tax rebate equal to the payroll taxes paid—including worker and employer contributions—in a given year.[150] The rebate would be capped at the same level ($560/year) for each worker. As **Table 4** indicates, this option, while alleviating much of the regressiveness of the carbon tax, would disproportionately impact the two lowest income brackets.[151]

This disproportionate outcome would be expected, because some of the lower income households may contain unemployed or retired persons, who would not benefit from a payroll tax rebate but still experience the higher energy prices brought on by the carbon tax. The last scenario in **Table 4**, in addition to the rebates for workers, would provide equal rebates to social security recipients. This addition would generate a more progressive distribution of tax-related impacts.

Table 4. Distributional Effects of Carbon Tax with Different Applications of Carbon Tax Revenues

	Percentage Impact to Household Income by Income Bracket (1= Lowest, 10=Highest)									
Distributional Scenarios	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Carbon Tax in Isolation (before revenue recycling)	-3.4	-3.1	-2.4	-2.0	-1.8	-1.5	-1.4	-1.2	-1.1	-0.8
Carbon Tax with a Lump-Sum Distribution to Households	2.1	1.0	0.6	0.4	0.3	0.1	-0.1	-0.1	-0.2	-0.2
Carbon Tax with Payroll Tax Rebate for Workers	-0.7	-1.0	-0.2	0.1	0.1	0.3	0.2	0.2	0.0	0.0
Carbon Tax with Payroll Tax Rebate for Workers and Equivalent Rebate for Social Security Recipients	1.4	1.0	0.6	0.3	0.1	0.1	0.1	-0.1	-0.1	-0.2

Source: Prepared by CRS with data from the following: Gilbert Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change* (2007), The Hamilton Project, Brookings Institution.

Note: These results do not account for consumers' behavioral responses to the carbon tax. Metcalf points out that the results provide a "reasonable first approximation" of the different impacts to household incomes (Metcalf (2008)).

Carbon-Intensive Industries

This application of tax revenue would likely generate intense debate from industry and non-industry stakeholders alike. In general, stakeholders from all carbon-intensive industries argue that their businesses would be disproportionately affected by a carbon tax and thus should receive

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150 The Social Security payroll tax applies a constant tax rate—half of which is paid by the employee and the other half paid by the employer (the self-employed are responsible for the entire amount)—up to a certain income level. According to the Tax Policy Center, for nearly two-thirds of U.S. households, payroll taxes (if the employer portion is counted) are the single largest tax paid to the federal government at: http://www.taxpolicycenter.org/publications/url.cfm?ID=1001065.

151 Because this option effectively replaces a portion of the payroll tax (a regressive tax on an economic good) with a carbon tax (a levy on an economic bad), it has the potential to improve economic efficiency, and thus lower overall society costs. However, Metcalf asserts that the rebate is unlikely to appreciably alter labor supply, except among low-income workers. See Metcalf (2007).

a portion of the revenues to avoid financial losses or provide transition into the new carbon-constrained regime. One counter-argument is that revenues used for this purpose would be unavailable to support other objectives (some of which are described in this report), but that concern applies to any use of the tax revenues. Regardless, many would assert that providing some level of assistance to carbon-intensive industries may be a political necessity.[152]

Complicating the debate is the fact that the impacts of a carbon tax would vary across and within carbon-intensive industries. In the context of carbon tax impacts, there are two broad categories of carbon-intensive industries: industrial sectors that can more easily pass along tax-related costs and those that cannot. The first group would likely include fossil fuel producers and the electric utility sector. Fossil fuel producers and electricity generating facilities are generally expected to pass along the vast majority of their tax-related costs. Some contend that providing assistance to these industries would run counter to the principle of creating a level playing field for low-carbon energy sources. In addition, there are likely to be both winners and losers within the electricity generation sector. For instance, some facilities, such as coal-fired plants, are expected to see greater losses, while others—hydroelectric or renewable energy plants—may see financial gains under a carbon tax or cap-and-trade program.[153]

The second category of carbon-intensive industries includes economic sectors that may face a comparative disadvantage if they were subject to GHG controls (directly or indirectly) and their international competition were not.[154] Because they may be constrained in their ability to pass along tax-related costs, there may be a stronger argument for providing assistance to this subset of carbon-intensive industries. However, it may be difficult for policymakers to determine the relative capacities of different industries and companies to pass along costs, or the degree of competitive disadvantage borne.[155]

Policymakers have other options—e.g., to attach a carbon price to imported materials—that could address potential comparative disadvantages that may arise under a carbon tax system.[156]

Recent legislative proposals would have provided some assistance to carbon-intensive industries. In the 110th Congress, Representative Larson's carbon tax proposal (H.R. 3416) would have allotted to "negatively affected" industries[157] approximately 8% of the tax revenues in the first year of the tax (2008 as written), declining to zero by 2018.[158] In addition, all of the cap-and-trade bills proposed in the 110th Congress that specified an emission allowance distribution strategy (as

[152] For a further discussion of rationales for providing support to carbon-intensive industries, see CRS Report R40100, *"Carbon Leakage" and Trade: Issues and Approaches*, by Larry Parker and John Blodgett.

[153] Dallas Burtraw and Karen Palmer, *Compensation Rules for Climate Policy in the Electricity Sector* (2007), Resources for the Future Discussion Paper.

[154] Among others, the steel, paper, and aluminum industries are often cited as examples of trade-exposed industries.

[155] Department of Climate Change, Commonwealth of Australia, *Carbon Pollution Reduction Scheme: Green Paper* (July 2008), p. 310.

[156] See CRS Report R40100, *"Carbon Leakage" and Trade: Issues and Approaches*, by Larry Parker and John Blodgett.

[157] As determined by the Secretary of the Treasury in consultation with the Secretary of Labor.

[158] The other carbon tax proposal from the 110th Congress—H.R. 2069 (Stark)—does not include revenue distribution provisions.

opposed to delegating the decision to a federal agency) would have allotted some percentage of allowance value to carbon-intensive industries.[159]

Technology Development

Many experts consider government investment in technology an essential component[160] of a robust strategy to mitigate GHG emissions, because long-term emission reduction would require major restructuring of the energy economy. Moreover, the development and deployment of low-carbon technologies could have a considerable impact on the overall costs of an emissions reduction program. This is particularly the case if revenues induced technologies to be commercialized ahead of their projected schedules or if unanticipated low- or zero-carbon alternatives can be developed.

Although dispensing tax revenues for technological development could yield considerable gain, the return in terms of additional investment to promote technology improvements remains uncertain.[161] For example, some programs may be operating at full capacity, and additional funding may not provide comparable benefits. Moreover, the marketplace already provides some incentive for technological change, and a carbon tax would increase the existing incentive to develop low-carbon or zero-carbon energy alternatives.[162] In addition, using federal funds to support technology raises a number of issues for policymakers that are beyond the scope of this report.[163]

Conclusions

Market-based mechanisms that limit greenhouse gas (GHG) emissions can be divided into two types: quantity control (e.g., cap-and-trade) and price control (e.g., carbon tax). To some extent, a carbon tax and cap-and-trade program would produce similar effects: Both would place a price on carbon, and both are estimated to increase the price of fossil fuels, which would ultimately be borne by energy users, particularly households.

In an economically efficient market with perfect information, either a price (carbon tax) or quantity control instrument (cap-and-trade system) could be designed to achieve the same outcome. Because this market ideal does not exist, preference for a carbon tax or a cap-and-trade program ultimately depends on which variable one prefers to control—emissions or costs. Although there are several design mechanisms that could be included with either program that would blur the distinction, the gap between price control and quantity control can never be completely overcome.

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[159] See CRS Report RL33846, *Greenhouse Gas Reduction: Cap-and-Trade Bills in the 110th Congress*, by Larry Parker, Brent D. Yacobucci, and Jonathan L. Ramseur.

[160] Some argue that the private sector is likely to under-invest in research and development, even with a carbon price in place. See W. David Montgomery and Anne E. Smith, *Price, Quantity, and Technology Strategies for Climate Change Policy* (2005), CRA International.

[161] See Robert W. Hahn, *Greenhouse Gas Auctions and Taxes: Some Practical Considerations* (2008), AEI Center for Regulatory and Market Studies.

[162] See CRS Report RL34621, *Capturing CO2 from Coal-Fired Power Plants: Challenges for a Comprehensive Strategy*, by Larry Parker, Deborah D. Stine, and Peter Folger.

[163] See CRS Report RL34513, *Climate Change: Current Issues and Policy Tools*, by Jane A. Leggett.

Compared to a cap-and-trade system, a carbon tax may both offer several advantages as well as present several possible disadvantages. A known price on carbon would not add to the volatility of energy prices, such as electricity and household fuels, unlike what may occur under a cap-and-trade program. Moreover, with a set price, industry would have better information to guide investment decisions (e.g., energy efficiency improvements and/or equipment upgrades), unless the tax rate was subject to periodic adjustment to achieve GHG emission reduction goals. Economists often highlight the relative economic efficiency advantage of a carbon tax, but this advantage rests on assumptions about the expected costs and benefits of climate change mitigation, both of which contain considerable uncertainty and some controversy. Some contend that a carbon tax may provide implementation advantages, including greater transparency, reduced administrative burden, and relative ease of modification. In addition, some argue that a carbon tax approach may make it easier to reach a GHG reduction agreement with developing nations. However, some counter that a cap-and-trade approach is best suited to meet this objective.

The primary disadvantage of a carbon tax is that it would yield uncertain emissions. For some this concern may present a non-starter, precluding a carbon tax as an option to control GHG emissions. Some argue that the potential for irreversible climate change impacts necessitates the emissions certainty that is only available with a quantity-based instrument (e.g., cap-and-trade). However, depending upon its design, a cap-and-trade program may also include a risk of uncertain emissions. For example, if offsets are allowed as a compliance option, there is some concern that they would not represent real emission reductions. Emissions leakage offers another threat to the certainty of the emissions cap.

Although it may present implementation challenges, policymakers could devise a tax program that yields only short-term emission fluctuations, as it progresses towards its long-term emission reduction objective. Proponents argue that short-term emission fluctuations would be preferable to price fluctuations that might be expected with a cap-and-trade system.

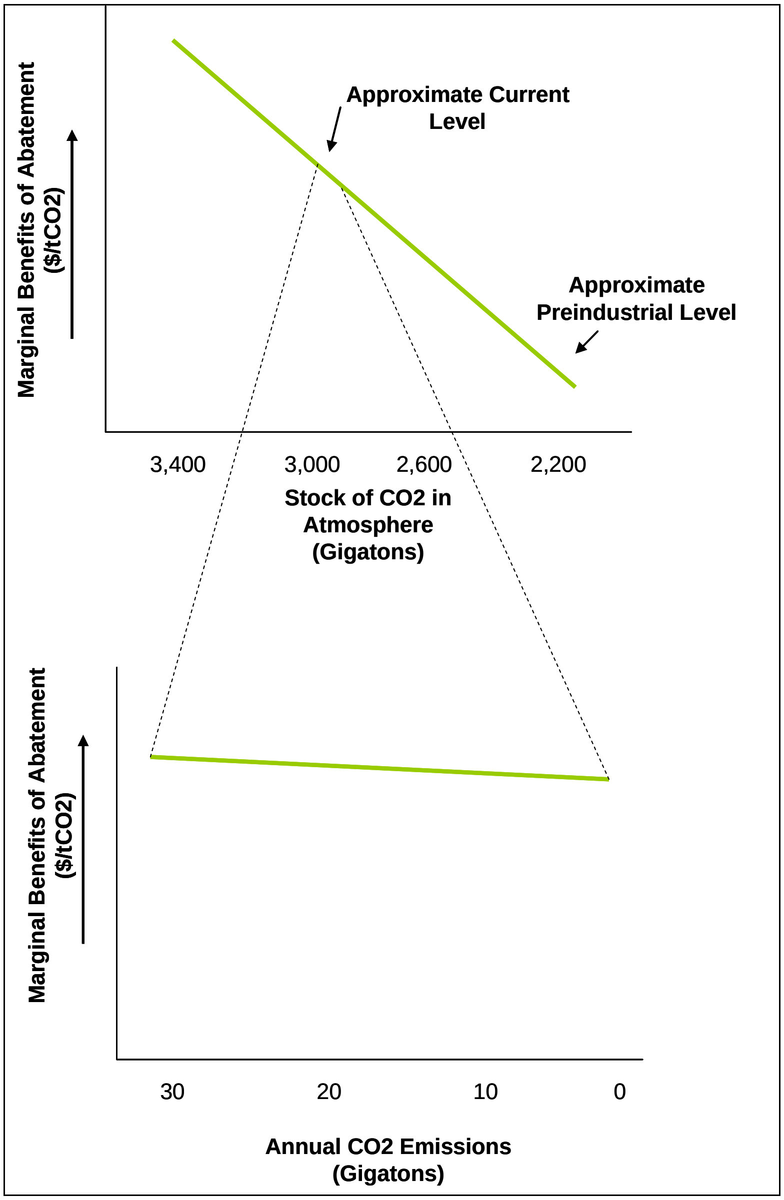
Many assert that it would be easier to garner support for a cap-and-trade system, because a tax increase policy typically carries a political stigma. To some extent, this argument may be viewed by some as based on semantics, because a cap-and-trade program would act very much like a tax, in terms of its effects on energy prices. However, a carbon tax and a cap-and-trade legislation would fall into different committee jurisdictions within Congress. The committees developing the GHG emission legislation may have Members with varying perceptions about the relative values of uncertain costs versus uncertain emission reductions. The committee jurisdiction factor may play a role in the debate over the preferred policy instrument.

In addition, some environmental groups may oppose a carbon tax, because they assume the tax rate would be set too low to be effective in controlling GHG emissions. This is more of an argument over stringency than over the instrument used to mitigate GHG emissions.

The debate over a carbon tax versus a cap-and-trade program may be instructive for policymakers because it highlights (1) the primary differences between the instruments and the (2) design elements that could be included within either instrument that would blur their distinctions. For example, Congress could devise a cap-and-trade program that controls total costs and price volatility to some degree. However, a cap-and-trade price control mechanism, such as a safety-valve and/or reserve price, would alter the character of the cap-and-trade program—the level of emissions would no longer be certain. This potential outcome reinforces the fundamental choice between a carbon tax and a cap-and-trade program: cost certainty versus emissions certainty.

Appendix. Additional Information

Figure A-1. Illustration of Relationship between the Stock of CO_2 in Atmosphere and Annual CO_2 Emissions



Source: Prepared by CRS. Adapted from William Pizer, *Prices vs. Quantities Revisited: The Case of Climate Change* (1997), Resources for the Future Discussion Paper 98-02.

Note: This figure illustrates the concept that for a stock pollutant, such as CO_2, reductions made in one year would have minimal effect on the pollutant's stock. As shown at the top of the figure, the current stock of CO_2 is approximately 3,000 gigatons (1 gigaton = 1 billion tons). Human-related activities generated approximately 27 gigatons of CO_2 emissions in 2005. If all nations were to stop emitting CO_2 emissions in one year, the effect on the stock of CO_2 would likely be minimal. Thus, the marginal benefit of abatement (for one year) is thought to be relatively flat, as depicted in the bottom of the figure. It would take multiple years of zero emissions to impact the current stock of CO_2 emissions.

Table A-1. Comparison of Estimated Carbon Tax-Related Price Impacts to Fossil Fuels and Motor Gasoline from Selected Carbon Tax Rates

	Carbon Tax-Related Price Impacts							
Carbon Tax Rate	**Coal (short ton)**		**Oil (barrel)**		**Natural Gas (thousand cubic feet, mcf)**		**Motor Gasoline (gallon)**	
\$5/ $mtCO_2$	\$9.45/ short ton	28%	\$2.15/ barrel	5%	\$0.28/ mcf	2%	\$0.05/ gallon	2%
\$15/ $mtCO_2$	\$28.35/ short ton	83%	\$6.45/ barrel	16%	\$0.83/ mcf	6%	\$0.14/ gallon	4%
\$25/ $mtCO_2$	\$47.25/ short ton	138%	\$10.75/ barrel	27%	\$1.38/ mcf	10%	\$0.23/ gallon	7%
\$50/ $mtCO_2$	\$94.50/ short ton	276%	\$21.50/ barrel	55%	\$2.75/ mcf	20%	\$0.45/ gallon	14%
	Inputs Used in Above Comparison[a]							
Metric tons of CO_2 ($mtCO_2$) per unit of fuel[b]	1.89 $mtCO_2$/ short ton[c]		0.43 $mtCO_2$/ barrel[d]		0.055 $mtCO_2$/ mcf[e]		0.009 $mtCO_2$/ gallon[f]	

a. These estimates assume that the carbon tax is applied upstream to fossil fuels. The price impacts assume that the carbon tax is passed through to end-users and not absorbed by upstream energy producers. The price effects also do not take into account behavioral changes—e.g., energy conservation, fuel substitution, etc.—in response to price increases.

b. Values derived from CO_2 coefficients (i.e., CO_2 emissions per quadrillion BTU) and thermal conversion factors (i.e., BTU per fuel unit)for each fuel. CO_2 coefficients are from EIA, *Documentation for Emissions of Greenhouse Gases in the United States 2006* (2008), table 6-1; thermal conversion factors from EIA, *Annual Energy Review 2007* (2008), Appendix A.

c. This value represents the CO_2 coefficient for coal (electric power sector) and the thermal conversion factor for coal consumption from the electric power sector (2007).

d. This value represents the CO_2 coefficient for crude oil and the thermal conversion factor for "unfinished oil."

e. This value represents CO_2 coefficient for natural gas (pipeline) and the thermal conversion factor for end-use sectors (2007).

f. This value represents the CO_2 coefficient for "motor gasoline" and the thermal conversion factor for motor gasoline (conventional).

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