AMS Policy Workshop Report

U.S. Federal Climate Policy:

Design Principles and Remaining Needs

Part 1: Emission Fees

Paul A.T. Higgins

American Meteorological Society

The American Meteorological Society's Policy Program is supported in part through a public-private partnership, which brings together corporate underwriters and Federal agencies. Sponsoring agencies include the National Oceanic and Atmospheric Administration (NOAA), The National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). Corporate partners include ITT, Lockheed Martin, Northrop Grumman, Raytheon, & SAIC.

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Preface[1]:

The American Meteorological Society's Policy Program recently initiated a series of workshops that will seek to identify key design principles for Federal climate policy along with any remaining policy needs that, if met, could help promote effective responses to climate change.

There is a great need for this series for two reasons. First, because our ongoing and increasing emissions of greenhouse gases pose substantial risks to society. Second, because large gaps remain in our consideration of potentially beneficial policy options—cap-and-trade approaches for reducing emissions being a notable and important exception. For a comprehensive and successful risk management strategy to emerge, we'll need to fill these gaps and explore a much larger set of policy options.

In the most general sense, society has three options for reducing the risks associated with climate change. We could mitigate (i.e., reduce our greenhouse gas emissions) and thereby reduce the amount that climate changes. We could build our adaptive capacity (i.e., increase our ability to cope with the climate changes that lie ahead). We could geoengineer, by which I mean that we could deliberately manipulate the earth system in the hope of counteracting the worst impacts of our emissions (critically, without triggering unintended and unpleasant side-effects). Each of these broad categories (mitigation, adaptation, and geoengineering) encompasses a wide range of more specific policy options and none is mutually exclusive—we could use them together and in a wide range of different combinations.

For the most part, these policy options simply haven't been explored at the Federal level. Until very recently, for example, the potential to mitigate through greenhouse gas emission fees (often called carbon taxes, and the focus of this report) has received relatively little attention. The same could be said of policies that could promote adaptive capacity, or that relate to geoengineering.

We offer these workshops in the belief that our policy decisions have the best chance to benefit society if we ground them in the best available knowledge and understanding. These workshops will help round out Federal climate policy discussions by focusing on those areas that haven't gotten the attention that they may need. By doing so, we hope to help society move forward in dealing with climate change.

Paul Higgins

AMS Policy Program

1. *This preface is adapted from Higgins, P.A.T., 2008,* ***Federal climate policy: design principles and remaining needs****, Bulletin of the American Meteorological Society 89(1), 102-103.*

Executive Summary:

Reducing greenhouse gas emissions almost certainly requires adding a price to those activities that cause emissions. In the broadest sense, policy makers have two cost-effective options for adding a price to climate pollution: 1) restrict the quantity of emissions through a cap-and-trade system, or 2) impose a fee on emissions.

Each approach has strengths and weaknesses and both approaches receive considerable attention from the research community. Policy makers, in contrast, have paid very little attention to emission fees and therefore may be overlooking an important risk management option for dealing with climate change. Here we identify the advantages and disadvantages of emission fees, potentially important design principles for U.S. Federal climate policy, and remaining policy needs that, if met, could help society use the approach to reduce the risks of climate change.

Key Advantages

Fees create a clear price signal to discourage emissions. Emitters know how much their activities will cost and can invest in strategies that reduce those costs (and their emissions). Fees also clarify who gains and who loses from climate policy. This helps with efforts to compensate those hardest hit by policy changes. Implementing a fee is also straightforward for regulators, discourages rent-seeking (i.e., the search for free handouts) by emitters, and avoids the potential for businesses and individuals to manipulate the market.

A clear price signal facilitates international negotiations by revealing the strength of each nation's efforts at mitigation. Fees also avoid unintended wealth transfers among nations when implemented internationally. Finally, a fee approach maximizes climate protection when rapid technological development enables easier than expected emissions reductions.

Disadvantages

Fees alone cannot ensure an upper limit on emissions the way quantity constraints can. This potential weakness is exacerbated by the fact that multiple market-failures contribute to greenhouse gas emissions, which could limit the effectiveness of a price signal. Unfavorable political framing (e.g., "It's a carbon tax") may hinder emission fee policies from moving forward or ensure that only weak measures gain traction. Emission fees remain at an early stage of policy development so moving forward with the approach may delay critically needed mitigation. If some polluters receive exemptions from the fee, then less mitigation will occur and the risk of harmful climate impacts would increase.

Policy Options and Design Principles

Key policy options include the amount of the fee at the outset, the rate it increases over time, which sources are covered, who pays, and how revenues are used. Additional provisions can encourage international cooperation, allow the use of credits and offsets, or provide "quantity containment" to ensure an upper limit on emissions.

Basic economic understanding suggests that incorporating the cost of climate damage into the price of activities that release greenhouse gases would yield considerable net economic bene-

fits. Nevertheless, raising prices on emissions will likely create political obstacles and legitimate fairness concerns.

The goal of policy design depends on subjective value judgments that may not capture the views of all societal stakeholders. This report emphasizes two potential goals for policy design: 1) to seek to address the political obstacles and fairness issues while striving for favorable societal outcomes (i.e., environmental protection and economic improvement), or 2) to focus on maximizing the advantages and minimizing the disadvantages described above.

Policies that comprehensively cover emitting activities have the best chance to maximize emission reductions and minimize cost. This implies upstream implementation (i.e., collection of fees at the mine, wellhead, or point of entry for imports) and coverage of all economic sectors.

The politics of implementing and maintaining an emission fee will likely improve if the policy can create favorable distributional consequences. For example, the revenues generated from a fee could reduce taxes or fund lump-sum payments to taxpayers. These approaches would largely ease harsh distributional burdens, build public support, and potentially allow larger fee increases.

Even the most aggressive mitigation targets currently feasible may be insufficient to avoid catastrophic climate impacts. Fees offer both upside potential (by encouraging rapid reductions when mitigation is cheap) and downside risk (by failing to ensure an upper limit on emissions). A price-quantity hybrid policy that automatically raises the fee to achieve hard targets would ensure a minimum level of climate protection (quantity containment) while creating the potential for even larger emission reductions if technology breakthroughs occur.

The timescales over which climate impacts and mitigation will happen suggest a need for mid-course policy refinement. Approaches that allow adjustments and that respond to learning will be needed.

Finally, U.S. policies that encourage international cooperation have a better chance to reduce global emissions and ease political constraints within the U.S. Border adjustments to ensure equal treatment of traded goods and conditional actions that account for international efforts could encourage cooperation and address fairness concerns.

Remaining Policy Needs

To move forward, emission fees will need wider consideration among policy makers. In the U.S. this will likely require champions in Congress who build support for them among their colleagues and constituents. More broadly, effective responses to climate change will likely depend on a better framework for translating complex scientific information into policy choices. This will occur with better integration of objective scientific understanding and subjective value judgments about risk management. Even then, the level of an emission fee (and the schedule for fee increases) that would bring maximum societal benefits will remain uncertain. Risk management choices must balance the considerable risks of climate damage with the potential impacts of increasing energy and transportation prices.

Finally, a broad family of policies focused on mitigation, adaptation, and possibly geoengineering will be needed for comprehensive management of climate change risks. Therefore, policy makers must recognize that a fee approach is one of a larger suite of tools for dealing with climate change.

Introduction:

Incorporating a price on greenhouse gas emissions is widely seen as a key component to long-term strategies for reducing the threat of climate change (Gupta *et al.*, 2007; Yang & Oppenheimer, 2007). Adding a price to emitting activities encourages both efficiency (fewer emissions from engaging in the activity) and frugality (more sparing engagement in the activity). This translates into an overall reduction in emissions. Critically, efforts to increase efficiency without increasing prices will likely fail because they lower the cost of the polluting activity, which thereby encourages more of it (Daly, 2007).

In general, there are two market-mechanisms for adding a price to emissions: 1) cap-and-trade, which sets a limit on the *quantity* of allowable emissions but leaves polluters free to buy and sell permits to pollute so that the cap is achieved at least cost (Chameides & Oppenheimer, 2007; Gupta *et al.*, 2007; Stavins, 2007a; Stavins, 2007b), or 2) emission fees, in which policy makers set the *price* polluters must pay for every ton they emit (Gupta *et al.*, 2007; Metcalf, 2007; Nordhaus, 2007). Under cap-and-trade the market determines the price emitters pay. Under an emission fee, the market determines the quantity of pollution that results.

Hybrid approaches are also possible. The *price safety valve* starts with a cap-and-trade structure but includes an upper price limit at which additional permits are always available (Pizer, 2002; Aldy *et al.*, 2003; Jacoby & Ellerman, 2004; NCEP, 2004). If permit prices reach this upper limit, then the system starts to look like a fee for all subsequent emissions: the price to emit is fixed but the quantity is unconstrained. The *climate safety valve*, in contrast, starts with a price on emissions but also includes an upper limit on the quantity of pollution. If the quantity of emissions exceeds the upper limit, then the price of emitting goes up. The approach can be implemented either by automatically increasing an emission fee if a quantity target is exceeded, or by including a price floor within a cap-and-trade system. This achieves the maximum possible emission reductions but also ensures the highest prices on emissions (Higgins, 2009).

Cap-and-trade approaches have already received enormous amounts of attention from policy makers in the U.S. and throughout the world—appropriately so given cap-and-trade's potential effectiveness for climate change mitigation. In contrast, emission fees often receive fairly cursory dismissals in policy discussions despite their considerable potential for reducing emissions.

AMS recently held a workshop on emission fees in an effort to help round out policy discussions of climate change mitigation (appendix A). We intend this to be the first in a larger workshop series that explores U.S. Federal climate policy options that have not yet received sufficient attention.

The workshop engaged a wide-range of experts—including both proponents and opponents of emission fees—in order to delve deeply into policy nuances. Among our participants, we included researchers, policy makers, leaders from the business and NGO communities, and members of executive branch agencies. This allowed a more comprehensive exploration of emission fees' potential as a tool for climate change mitigation.

This report, and the workshop on which it is based, has three overarching goals:

1) To increase understanding of what emission fees are and how they could work as a tool for mitigation. This includes a full exploration of both their advantages and their disadvantages (Figure 1).

2) To identify the options and design principles for Federal policies that would allow the U.S. to most effectively use emission fees for mitigation.

3) To identify remaining policy issues and needs that, if addressed, could help advance the use of emission fees as a risk management strategy for dealing with climate change.

ADVANTAGES

- Economically efficient
- Clear price signal
  - transparent costs
  - no price volatility
- Minimal rent-seeking & gaming
- Low administrative burden (can use already existing structures)
- Easy to deal with distributional consequences
- No emission floor (yields maximum potential mitigation)

DISADVANTAGES

- No emission ceiling
- Poor political framing (it's a tax)
- Less mature policy discussion
  - fewer proponents
  - more remaining work
  - less support internationally
- Could slow progress with cap-and-trade
- Fee exemptions weaken climate protection
- Policy makers may face political pressure to lower the fee

Figure 1. Advantages and disadvantages of emission fees as a tool for mitigation relative to command and control regulation and cap-and-trade, the alternative economically efficient option for climate change mitigation.

Advantages of Emission Fees:

Emission fees offer considerable advantages as a tool for climate change mitigation (Gupta *et al.*, 2007; Metcalf, 2007; Nordhaus, 2007). Most notably, emission fees rely on the economic efficiency of markets to ensure that a specific level of expenditure (the price of emitting) leads to the greatest possible reduction in emissions. Note that this applies equally to cap-and-trade, which ensures that a specific reduction in emissions occurs for the least cost. As a result, either approach would be expected to return the greatest environmental protection for the least cost.

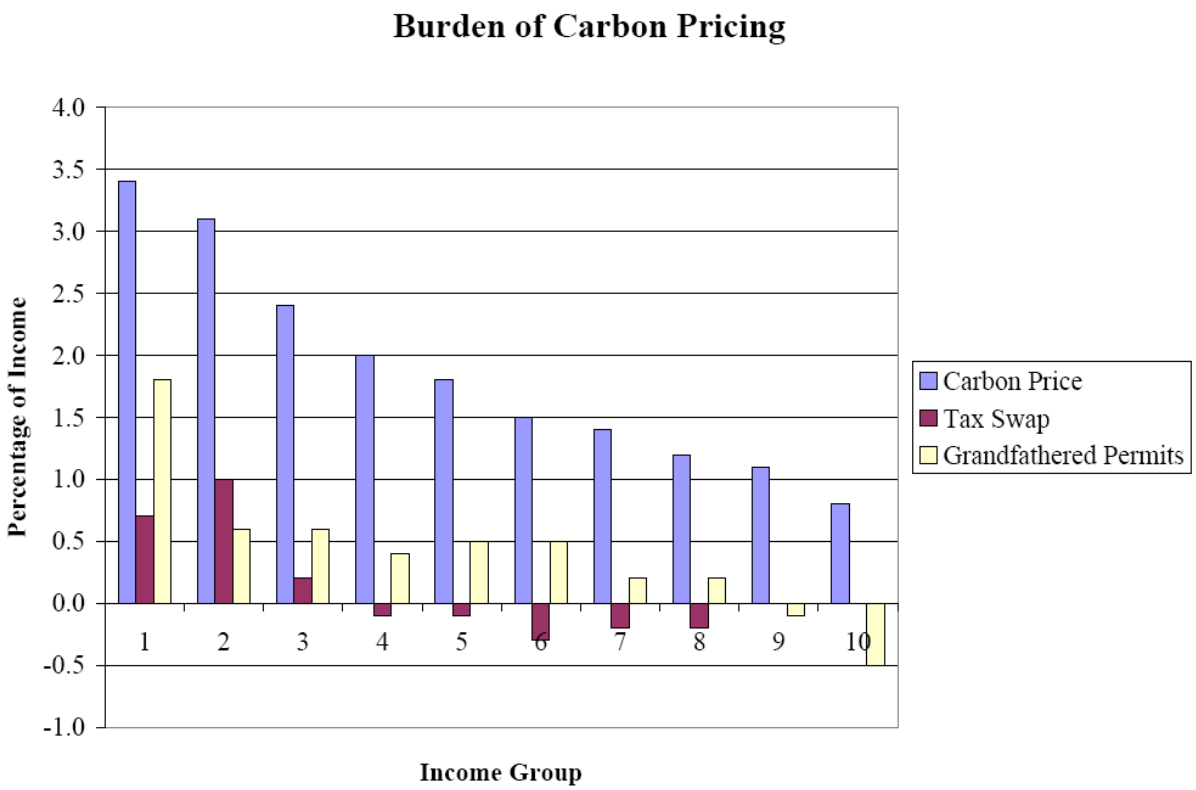

Figure 2. The burden of carbon pricing across income groups (Metcalf, 2007). A carbon price of $15 per ton CO2 is regressive in that it requires a larger fraction of income from groups with lower income. This regressivity can be eliminated for all but the first two income groups if the revenues generated go toward reducing existing pay role taxes (i.e., social security and medicare). The two lowest income groups have low pay role taxes so they still lose a larger percentage of their income. Note that lump sum return would be strongly progressive. Grandfathering permits in a cap-and-trade system reduces the percentage of income for all groups but maintains regressivity with the two highest income groups receiving more than they pay.

Emission fees also send a clear price signal to polluters because the price they must pay for their activities is explicitly specified by policy makers at the outset. This means that emitters can anticipate the costs that they will face when they pollute and adjust their decisions accordingly, most notably with long-term capital investment choices. A clear price signal also reduces the difficulties that regulated utilities (and their regulators) face in passing through legitimate production cost increases to ratepayers.

The price emitters must pay is also a direct indicator of the level of effort that a country is making toward climate change mitigation. As such fees provide a useful metric for comparing international efforts to address climate change. This can promote international cooperation because all countries easily understand their own obligations and those of every nation during negotiations, which limits any country's ability for gaming and facilitates efforts to deliberately distribute mitigation burdens fairly.

This price transparency can also circumvent misleading but effective rhetorical arguments for blocking international negotiations and unilateral action. Most notably, opponents of climate legislation in Congress often call for China to commit to "comparable" efforts as a precondition for United States action. This makes intuitive sense, but comparing effort based on the quantity of each country's emissions is highly misleading because the two countries have vastly different population sizes and levels of economic development. As a result, reducing each nation's emissions by a similar amount from their historical levels—the rhetorical foil—would actually require far greater effort from China than the United States. A quantity target based on equal per capita emissions, on the other hand, would require far greater efforts from the U.S. than from China. In contrast, equal prices on emissions generally translate into equal levels of effort to mitigate.

Emission fees also avoid unintended wealth transfers among nations, because each country would likely collect and keep the revenue from any fee. This enhances the long-term political feasibility of climate change mitigation because international payments create a strong disincentive to participation for the nations making them. Of course, wealth transfers might be considered desirable for reason of fairness or be necessary for reaching international agreements. However, they could still be selectively and explicitly included within any emission fee framework.

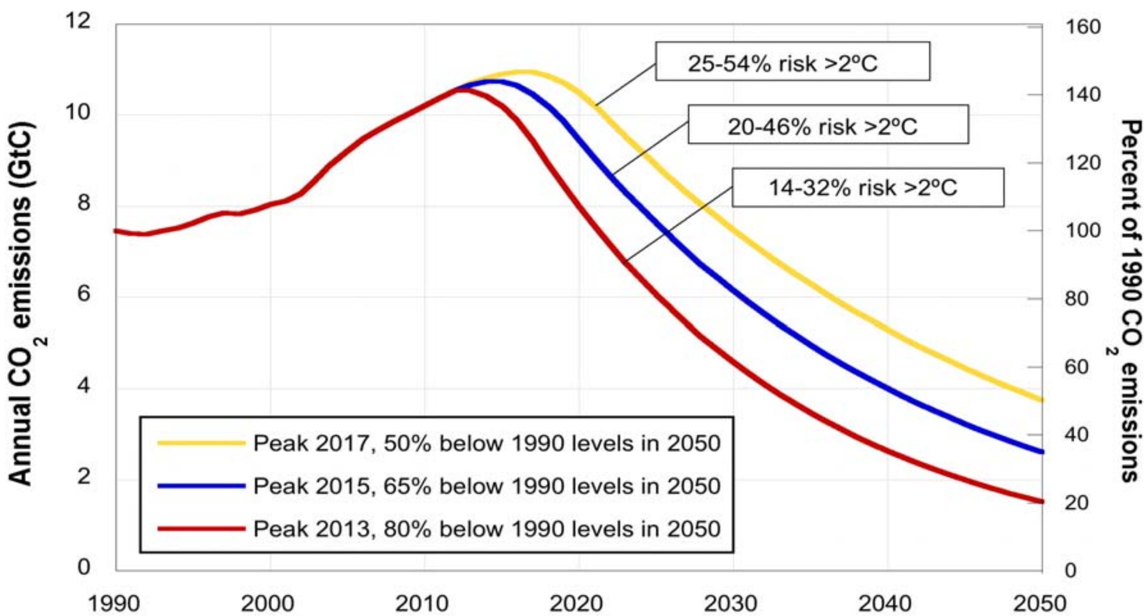

Figure 3. Plausible global emissions pathways (1990-2050) and the risk that the atmospheric greenhouse gas concentrations that result will trigger warming that exceeds 2°C (Baer *et al.*, In Press). 2°C is well outside the range that human civilization has experienced and viewed by many scientists as the upper limit for changes that could plausibly be considered "safe". Note that a 50% reduction below 1990 emissions in 2050 on per capita basis would translate into roughly a 90% reduction for the United States.

Although basic economic principles suggest that adding a price on emissions would bring net economic benefits, such efforts would almost certainly create winners and losers (Gupta *et al.*, 2007). These distributional consequences create political and fairness issues with any meaningful effort to reduce greenhouse gas emissions. For example, in the most basic form an emission fees is regressive (i.e., it would take a larger fraction of disposable income from those who earn less—Figure 2) and would be borne disproportionately by the heaviest emitters. However, these distributional consequences are relatively easy to identify and deal with when prices are transparent because policy makers can see who faces the greatest compliance burden and deploy targeted compensatory measures.

Fee based approaches are also relatively easy to administer with existing Federal institutions (e.g., current emissions monitoring and reporting systems and agencies such as the Internal Revenue Service). This helps minimize the regulatory burdens and transaction costs of efforts to mitigate climate change.

Emission fees minimize the potential for rent-seeking by polluters—efforts to receive free handouts from policy makers—because subsidies must be revealed explicitly as either exemptions from the fee or through the direct allocation of Federal revenues. Furthermore, emission fees do not enable market manipulation of consumer prices by polluters or speculators because those prices are set by policy makers.

Finally, even the most aggressive targets and timetables currently feasible given political constraints may be insufficient to avoid catastrophic climate impacts (Figure 3). Emission fees offer considerable upside potential for climate protection if mitigation proves easier than anticipated (i.e., if the marginal costs of emissions abatement are relatively low, from Higgins, 2009). The reason is that fees yield strong emissions reductions when mitigation is cheap relative to the fee. As a result, fees could lead to fast and deep emissions reductions.

Disadvantages of Emission Fees:

Emission fees also have potential disadvantages relative to command-and-control regulation. These occur because: 1) attaching a price to emissions cannot address the full suite of market failures that contribute to greenhouse gas pollution, and 2) considerations other than economic efficiency (e.g., fairness, ethical values, etc.) may be more important to society.

Greenhouse gas emissions result, in part, from as many as six market failures: 1) externalities; such as when the emitter does not pay all the costs of their activities (e.g., the damages from climate change), 2) split incentives; such as a landlord's incentive to minimize capital investments at the expense of their tenants' energy expenses, 3) imperfect information; in which those who make choices do not recognize all their options or fully understand the implications of those choices, 4) insufficient competition (monopoly power); so that consumers do not have full access to low emission options, 5) immobile factors of production; existing capital stock makes emitters less responsive to market signals and commits them to less efficient technologies, and 6) missing markets for public goods; the private sector simply cannot provide a stable climate system as a good or service.

Adding a price to emissions directly addresses the externality but is unable to address completely the other market failures that contribute to excess emissions. Therefore, including a price on emissions, whether through fees or cap-and-trade, may not fully reap the potential economic gains of mitigation. Note also that it is effectively impossible to precisely determine the magnitude of the externality (i.e., the societal damages of greenhouse gas emissions). This means that the fee policy makers impose will necessarily be too high or low for maximizing economic efficiency.

Even with overall economic improvements, including a price on emissions will create winners and losers relative to the status quo. These distributional consequences create important fairness concerns and political obstacles. For example, a simple fee (or cap-and-trade program) would burden low income emitters most heavily (Figure 2)—though less so over lifetime income than annual income (Metcalf, 2007). Policy design can address these issues (as described below) but their resolution goes beyond questions of economic efficiency and risk management to include subjective value judgments about fairness. A second distributional problem arises because heavy emitters would be disproportionately harmed by increasing prices on greenhouse gas emissions.

Furthermore, a broader range of ethical considerations permeate policy decisions for dealing with climate change. For example, the degree to which we consider climate impacts on cultural heritage, species extinctions, and the role that humans play in shaping the characteristics and functioning of the Earth system all influence policy choices without necessarily affecting market efficiency. Implicit in the choice to use a market-based mechanism is that economic efficiency is an overarching goal of the policy framework. This may, or may not, accurately reflect societal values.

Emission fees also yield uncertain levels of climate mitigation because the quantity of emissions that result is determined by the market. Therefore, there is no pre-determined upper limit on future greenhouse gas emissions for policies that rely on emission fees alone. This constitutes a primary concern among proponents of climate protection (Doniger *et al.*, 2006; Chameides & Oppenheimer, 2007; Gupta *et al.*, 2007).

Emission fees may face difficult political challenges because: 1) opponents frame them effectively as tax increases, and 2) price increases for emitting activities are explicit at the time policy makers must take action (i.e., when they enact legislation). Efforts to establish a price on emissions may be easier to adopt, at least initially, if those prices are hidden at the outset. However, emission fees may face greater long-term political viability because price increases are fully revealed at the outset rather than and left to fluctuate over time based on market forces. Thus, once enacted emission fees become relatively easy to maintain. Whether the short or long-term political considerations prove most critical for successfully implementing climate change mitigation is difficult to assess and likely depends on the effectiveness of political framing.

Although academic researchers have spent considerable effort studying policy options that use emission fees, policy makers' have barely begun to develop and vet such proposals. As a result, the approach is at an immature state in the policy process. Furthermore, emission fees have few proponents among leading policy makers and little traction in current policy discussions. Thus, implementing an emission fee may take a considerable investment of time, energy, and political capital.

Exemptions from a fee granted to individual polluters weaken emission reductions and overall climate protection because those polluters have no incentive to reduce their emissions and because such exemptions could contribute to leakage—the shifting of emissions among polluters to those exempted from the fee. In contrast, the free allocation of permits in a cap-and-trade system (an analogous political lubricant) provides a windfall profit to emitters at the public's expense but without decreasing the quantity of climate change mitigation.

Finally, policy makers may face intense political pressure to lower fees because the price of emissions is explicit whereas climate protection follows as a consequence of that price. As a result, policy makers may be more sensitive to polluters concerns than to the need for climate protection.

Policy Options and Design Principles:

Options for policy makers to consider include the initial amount of an emission fee and the rate that it increases over time. Higher fees translate into larger emission reductions but may trigger larger price increases for energy and transportation. Likewise, faster rates of increase offer more climate protection but provide less time for polluters to adjust.

The fee can be collected at several points within the economy. Upstream stream implementation—in which fees are collected at the oil well, coal mine, or point of entry for imports—helps ensure comprehensive coverage of emission sources, reduces the administrative burden placed on regulators, and minimizes transaction costs for polluters. Alternatively, fees could be collected downstream (close to the point where the emissions occur such as at the tail pipe or smoke stack), or somewhere in between (e.g., petroleum refineries). The point where regulation occurs (i.e., where the fee is collected) likely does not affect who ultimately pays the fee, because market forces generally determine the relative burden borne by producers and consumers.

Similarly, policies can be more or less comprehensive with respect to the economic sectors that get covered. An economy-wide scope that includes the energy, transportation, manufacturing, and agricultural sectors would ensure greater overall emissions reductions and may help reduce compliance costs. However, a more narrow scope of coverage might allow policy makers to target specific economic sectors in order to enhance political feasibility (e.g., by initially excluding politically sensitive sectors) or to achieve ancillary benefits (e.g., energy independence).

Of course, actual policy choices reflect a range of objectives, tradeoffs, and value judgments. In this discussion, we consider two related goals for climate policy. The first is to identify those design options that can maximize the advantages of emission fees and minimize their disadvantages. The second is to seek measures that increase the political feasibility of emission fees. A combination of these two goals likely offers the best chance for creating policies that are: 1) environmentally effective, 2) economically beneficial, and 3) politically feasible.

Revenues generated from a fee could be used to reduce unfavorable distributional consequences or promote political support. For example, using revenues to reduce existing taxes or to fund the lump sum cash payments to citizens on a per capita basis could increase the progressivity of emission fees (Figure 2). Similarly, the disproportionate impact on heavy emitters can be softened by directing some of the revenue generated by the fee to hard hit sectors. It is likely that less than 20 percent of revenues would fully compensate those businesses that will be acutely hurt by climate legislation (Burtraw *et al.*, 2002).

Such measures would also likely create more favorable political framing for climate change mitigation in general and emission fees in particular. At the same time, framing that emphasizes the potential economic, national security, and environmental benefits associated with higher prices on emitting activities could also increase political feasibility of the approach as could the use of revenues to promote research and development of low emission technologies.

Measures to ensure an upper limit on the quantity of emissions (i.e., quantity containment) may increase the effectiveness of and support for emission fees by ensuring a minimum level of climate protection. Quantity containment can be achieved by updating the level of the fee to account for emission targets and timetables through either: 1) policy-maker initiated review, or 2) automatic adjustments that are built in to legislation.

Normal legislative procedures ensure that policy-maker initiated review can occur anytime Congress or the President chooses. However, additional provisions could facilitate and speed the adjustment process. For example, Congress could grant the President fast-track authority to speed legislative review or rest authority to adjust the fee with an independent board (similar to the Federal Reserve Board) or a Presidential appointee (e.g., the administrator of the EPA).

Alternatively, legislation could include automatic updates that set an upper limit on the quantity of pollution. If the quantity of emissions exceeds the upper limit, then the price of emitting also goes up. This would require: 1) identifying quantity targets and a timetable for achieving them, 2) establishing a fee schedule expected to achieve the targets, and 3) automatic fee increases if actual emissions exceed the target. This would establish a hard limit on the quantity of emissions while maintaining many of the advantages inherent to carbon fees described above.

A fee system could include offsets or credits for emissions reductions that occur elsewhere (e.g., carbon capture and sequestration, forestry projects, and international mitigation efforts). Offsets have several advantages, most notably that they can encourage emission reductions, and reduce the costs of achieving a given level of climate protection. However, the effectiveness of offsets can be limited because the accurate accounting of offsets is extremely challenging and because seemingly legitimate reductions may not last over time.

Policy options can also help encourage international cooperation and protect the U.S. (and other nations) from uncooperative countries. For example, we could include border adjustments for imports and exports to ensure that all goods, whether manufactured in the U.S. or abroad, face similar costs for their greenhouse gas emissions. Alternatively, we could tie the level of our fee, at least partly, to the actions of other countries. For example, the fee could be adjusted up (or down) automatically if international cooperation was good (or bad). Both measures could help reduce the political, economic, and rhetorical obstacles to climate legislation while simultaneously increasing climate protection by encouraging nations to make strong efforts to mitigate.

Finally, any approach will almost certainly require midcourse corrections as we learn more about the magnitude of climate impacts and the economic consequences of climate policy. Policies that facilitate midcourse corrections will likely have greater long-term success than rigid policies that are insensitive to new information. However, care will be needed because too much flexibility may create regulatory uncertainty which could hinder long-term capital investment decisions in low emitting technologies.

Remaining Policy Needs:

Policy choices have the best chance to benefit society if they are grounded in the best available knowledge and understanding. Unfortunately, major gaps in understanding remain between the scientific and policy communities. For example, scientific understanding of the climate system is vast but complex—spanning numerous fields within the physical, natural, and social sciences (IPCC, 2007a; IPCC, 2007b; IPCC, 2007c)—and so the seriousness of risks we face from our emissions are often obscure to non-experts. As a result, climate policy choices will almost certainly require policy makers to become more informed about the risks that greenhouse gas emissions pose to society.

Even with informed policy makers, challenges will still arise because of the difficulty we face in translating what we know, based on scientific and economic understanding, into policy choices for dealing with climate change (Schneider & Lane, 2006). Scientists are often reluctant to engage fully in policy discussions like these because doing so requires moving beyond objectivity, the pursuit of which is a principle tool of scientific advancement (Higgins *et al.*, 2006). However, without input on policy choices from those experts who most understand the implications of our emissions, a widening gap develops between scientific research and society's ability to use it (ICSU, 2006). Therefore, there is a great need for improvements in translating existing knowledge into the societal decisions about managing climate risks.

Of course, policy choices depend on far more than scientific understanding. Policy makers must account for economic impacts, distributional consequences, ethical implications, and subjective values. Balancing among these factors wisely with respect to emission fees, or virtually any policy instrument, depends on a thorough vetting of options by policy makers and experts. To date, that has not occurred for emission fees. Therefore, broader discussion among leading policy makers of the emission fee approach will be necessary.

Similarly, progress with policy often depends on the individual efforts of key proponents from within the policy community. At present, only a few members of Congress have put forward emission fee approaches and none has demonstrated the level of support needed to initiate broader consideration among their colleagues. While a strong case for fees can be made, the approach will surely not progress unless leaders argue on behalf of them. Therefore, there remains a need for policy makers who champion the approach.

Policy makers also face difficult tradeoffs in selecting an emission fee schedule for reducing emissions. Higher fees and steeper increases over time promote greater climate protection but likely also imply more rapid price increases for energy and transportation. Policy makers could be risk averse with respect to either (or both). As a result, there remains a need for efforts to resolve the risk management choices that underlie the decision to set the level of an emission fee and its rate of increase.

Finally, policy discussions must recognize that incorporating a price on emissions is both necessary and insufficient for comprehensive management of climate change risks. Instead, a broad family of solutions will likely be necessary. Such a comprehensive risk management approach would likely include additional efforts to mitigate through regulation, increased research, development and deployment of new technologies, positive incentives to encourage emissions reductions, and education to raise public awareness (Gupta *et al.*, 2007). Similarly, policies that increase our adaptive capacity and that responsibly consider (and restrict) geoengineering will be needed. As a result, there is a great need to broaden and expand existing climate policy discussions.

Conclusions:

Comprehensive risk management of climate change almost certainly requires adding a price to greenhouse gas emissions and increasing that price over time. In the most general sense, policy makers have two cost-effective options for including a price on emissions: cap-and-trade, and emission fees. Each has strengths and weaknesses and each offers tremendous potential for climate change mitigation. To date, emission fees have received very little attention from the policy community, however. Therefore, policy makers may be overlooking an important option for reducing the risks of climate change.

Even with a price on greenhouse gas emissions, managing the risks of climate change will almost certainly require additional policy efforts to reduce emissions and to adapt to unavoidable changes in climate. Even desperation strategies that come with high risk, such as geoengineering, may prove necessary if our efforts at mitigation and adaptation are insufficient. Near-term policy measures can ensure that such efforts are thoughtful and restrained but these will require greater attention from policy makers. Climate change poses sufficiently serious risks to society to require a broad family of risk management solutions.

Acknowledgements:

The speakers and participants at the AMS Federal Climate Policy workshop provided critical insights through their presentations and discussion. This work was supported in part by funding from NASA (grant # NNX07AH21G).

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Appendix A: Agenda

FEDERAL CLIMATE POLICY: DESIGN PRINCIPLES & REMAINING NEEDS

TUESDAY, NOVEMBER 13

An **American Meteorological Society** Workshop
at
University of California in Washington
1608 Rhode Island Avenue, NW
Washington, DC 20005

November 13, 2007

7:30 am	Continental Breakfast
8:00 am	Welcome and Overview Paul Higgins, American Meteorological Society
8:15 am	Joseph Aldy, Resources for the Future (*Designing a Domestic Carbon Fee*)
8:45 am	Panel on obstacles to emission fees Mark MacLeod, Environmental Defense Vicki Arroyo, Pew Center for Global Climate Change Rafe Pomerance, The Climate Policy Center
9:45 am	Bruce Braine, American Electric Power Service (*Impacts of Emission Taxes on the Electricity Sector*)
10:15 am	Break
10:30 am	Bill Chameides, Nicholas School of Environment and Earth Sciences, Duke University (*C Emissions: How Much is Too Much*)
11:00 am	Scott Barrett, Johns Hopkins University
11:30 am	Richard Morgenstern, Resources for the Future (*Competitiveness Effects of Pricing CO_2: Impacts on Manufacturing and Policy Options*)

12:00 pm	*Lunch & Keynote address:* Herman E. Daly, School of Public Policy, University of Maryland, (*Climate Policy: From Know How to Do Now*)
1:15 pm	Gilbert Metcalf, Tufts University (*Distributional Considerations with Carbon Fees*)
1:45 pm	Richard Cooper, Harvard University (*International Cooperation: the Case for an Emissions Tax*)
2:15 pm	Paul Baer, EcoEquity (*Progressive Carbon Fees and the US's International Obligations*)
2:45 pm	Break
3:15 pm	Brent Yacobucci, Congressional Research Service (*Legislative Proposals and Congressional Action on Climate Change and Emissions Fees*)
3:45 pm	Chris Miller, Congressional Staff, Office of Harry Reid (*Outlook on Congressional/Federal Action on Carbon Emissions Reduction Policies – Fees, Caps, Regulations and Other Options*)
4:15 pm	Panel discussion on design principles & remaining needs Joe Aldy Gib Metcalf
5:00 pm	Summary and wrap up Paul Higgins, AMS Policy Program
5:15 pm	Reception