Using Emissions Trading to Regulate U.S. Greenhouse Gas Emissions

Part 1 of 2: Basic Policy Design and Implementation Issues

I N T E R N E T   E D I T I O N

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Introduction

In Kyoto, Japan, in 1997, the U.S. government agreed that between 2008 and 2012 it would limit average annual emissions of greenhouse gases (GHGs) to seven percent below 1990 levels. Participants in the climate policy debate are expressing considerable and growing interest in the use of an "emissions trading" policy to achieve these limits. Through the trading of emissions permits, society as a whole benefits from having environmental goals achieved at lower cost than command-and-control. Over time, GHG controls implemented by permit trading will induce investments in the development and diffusion of new technologies (such as renewables and enhanced energy efficiency) for reducing GHG emissions. Several recent experiments with emissions trading to control other pollutants, notably the phaseout of lead in gasoline and the ongoing reduction of SO_2 emissions from electric utilities under Title IV of the U.S. Clean Air Act, suggest that an emissions trading policy is very promising. However, there is still considerable debate and some confusion about how a GHG emissions trading program would be organized and operated in practice.

In this first of two issue briefs on U.S. GHG trading, we address a number of basic questions that must be considered in designing and implementing a domestic trading system. These include who and what is covered by regulation (what sources and gases); the commodity to be traded and the nature of the trading system; how rights to GHG permits are defined; and how to deal with different kinds of

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This issue brief is adapted, in part, from the longer RFF discussion paper, *Using Emissions Trading to Regulate U.S. Greenhouse Gas Emissions: An Overview of Policy Design and Implementation Issues*, by Fischer, Kerr and Toman. To download the discussion paper as a PDF file, on the internet go to http://www.rff.org/disc_papers/1998.htm. To order it in hard-copy (paper), call RFF's fulfillment office at (202) 328-5025. Reference discussion paper 98-40.

uncertainties. The second issue brief explores additional questions related to the initiation of the system, intertemporal flexibility, and interactions of permit trading with the tax system. Throughout we consider the overall cost-effectiveness of alternative approaches (including administrative costs), their distributional implications, and political economy considerations. Our focus is exclusively on domestic policy; we do not consider how emissions trading or other GHG control policies should function in an international context. (A number of these issues are addressed in an earlier issue brief by Jonathan Wiener, listed in Further Reading.) We also do not address the relative advantages of emissions trading versus carbon taxes, a topic pursued in a forthcoming issue brief.

Our fundamental conclusions are:

- The best overall economic performance will be achieved with an "upstream," "cap-and-trade" program that controls fossil fuel inputs to the economy, with other GHGs added on an ancillary basis.

- Distributing bankable carbon permits through a periodic government auction also has attractive economic and equity features, provided the government uses the resulting revenues to reduce other distorting taxes in the economy and to provide carefully targeted assistance to those most adversely affected by GHG restrictions.

- The rules for altering permit allocations should create the proper incentives for the private sector to respond to risk while also limiting opportunistic government behavior.

The Basic Economics of GHG Trading

The fundamental idea behind emissions trading is that any particular environmental target can be achieved at lower total cost to society if those responsible for achieving the environmental target can exploit "gains from trade." Here, gains from trade refers to the possibility of those with higher cost of abatement paying those with lower cost of abatement to undertake more emission control. Those with higher costs benefit by reducing their net cost of compliance – they pay others to undertake emission control, but they avoid even higher costs of controlling themselves. Those with lower costs benefit because they voluntarily enter into transactions that yield revenues at least as large as the extra control costs they assume. And society benefits by having a more cost-effective control program – fewer real resources devoted to the achievement of the environmental goal.

These concepts underlie both the SO_2 control program in the U.S. and previous programs involving more informal trading of "emission reduction credits." In the SO_2 program the government established emission limits for each covered source but made the allowed emissions tradable through the issuance of homogeneous (not source-specific) emission allowances that could be freely bought and sold.

Those with higher abatement costs buy allowances from those with lower costs, who must then undertake additional emissions control to remain in compliance. Emission reduction credits, in contrast, arise from the action of an individual emitter who reduces emissions below the required level and thereby creates a credit that can be sold to another emitter who seeks to cover excess emissions relative to its standard. Credits are not the homogeneous "emissions scrip" characteristic of a cap-and-trade program, but instead are the product of bilateral trades. As a consequence, markets for credits tend to be "thinner" and less well-developed, with more "transaction costs" associated with identifying and effectuating trading opportunities.

These examples illustrate the application of trading systems to the direct control of unwanted emissions. Generally, to be most efficient environmental policy needs to be focused directly on the unwanted "bad," the emissions. Policies that seek instead to indirectly regulate emissions through the control of inputs to production or consumption – for example, by taxing coal based on its sulfur content – are less cost-effective. The reason is that they single out some paths for control at the expense of others, whereas all options for control need to be on a level playing field to achieve the lowest costs. In the example above, a tax on the sulfur content of coal would encourage substitution of lower-sulfur fuels, but it would not make the best use of end-of-pipe controls (scrubbers).

This argument does not apply to CO_2, however, at least not until such time as technology for large-scale "scrubbing" and storage of waste CO_2 become economical. In the absence of such technology, there is a one-to-one correspondence between the carbon content of fossil fuels going into combustion and the CO_2 emitted. This means that it is possible to regulate CO_2 emissions by limiting fossil fuel use. This is the theory behind the use of a tax based on the carbon content of fossil fuels to restrict CO2 emissions. As described below, the same idea underlies an "upstream" approach to GHG trading that places quantitative restrictions on fossil fuel flows through the economy.

While there are a variety of ways that GHG trading can be implemented, it is crucial to note that *any* approaches (taxes or trading) that comparably restrict fossil fuel use or GHG reductions have essentially the same effects on energy costs, given fairly well-functioning markets (reasonable levels of competition and limited regulatory distortions). Whether there are restrictions on fossil fuel supplies or comparable restrictions on demand through limits on users' emissions, and whether permits are distributed gratis or sold by the government, the effects on energy prices are the same. In particular, even if carbon allowances are given away, firms will value them at their market price and the prices of energy will corrrespondingly adjust to reflect the increased scarcity of primary fuel inputs. In the past, regulation of the electric utility industry did result in differences in the price consequences of different systems, since regulators determined electricity prices based on formulas reflecting actual expenditures. But with progressive deregulation of the utility sector and greater reliance on market pricing, it will be the market price of carbon permits rather than the accounting value that determines the price of electricity.

The fact that different methods of restricting GHG emissions will have comparable effects on energy prices and other prices throughout the economy means that the first-order effects of GHG limits on downstream energy purchasers, including households, and the effects on employment and capital investment, are the same across different trading strategies. The principal differences among the trading approaches relate to administrative efficiency (including the inclusion of diverse energy suppliers and users), and to who obtains the "scarcity rent" – the revenues generated when final energy prices rise as a consequence of regulatory-induced scarcity. The latter issue raises questions related to both fairness and politics.

Design of a GHG Trading System

Direct regulation of all or even most GHG emissions is all but impossible in practice: looking only at CO_2 emissions from fossil fuel use, the most important GHG, there are literally scores of millions of sources. In addition, highly precise methods for directly measuring CO_2 emissions are economically practical only for large boilers that can be equipped with continuous emission monitors.

One alternative is to control fossil fuel inputs to the economy. Since the CO_2 emitted from fossil fuel is essentially perfectly correlated with the carbon content of the fuel, a reasonably accurate measure of emissions can be obtained by keeping track of quantities of fossil fuel used together with their carbon content. For example, it would be possible to control natural gas entering interstate pipelines, crude oil (domestic and imported) entering refineries, and coal sales from mines or processing plants. Such a system would require oversight of fewer than 2000 actors

One might also consider various hybrids that combine regulation of downstream CO_2 emissions from large boilers (as in the U.S. SO_2 program) with upstream regulation of other fossil fuel flows. This approach requires more complex record keeping and enforcement and has greater risks of sources "leaking" from the system. For example, it would be necessary to draw a distinction between natural gas flows to utilities (the downstream component) and gas flowing to household and commercial users for space heating (the upstream component). As noted above, this approach does not lead to a fundamentally different outcome in the economy that might justify the extra administrative burden and potential loss of efficiency. The main distinguishing feature of the hybrid approach seems to be that it could be used to allocate emission permits to large sources of emissions, as was done in the SO_2 program. This raises some challenging questions related to equity, as discussed in the next section.

A variety of adjustments additions would be needed to increase the coverage and efficiency of a CO_2 program. The basic upstream system would not capture the relatively small amount of energy used in producing and initially transporting the fossil fuels to the regulatory control points. A rough adjustment might be made for that energy by requiring permits in excess of the actual carbon content of the fuel. It would be necessary also to adjust for noncombustion uses of fossil fuel inputs (such as chemical feedstocks, taking into account that some of the carbon in these materials eventually may escape to the environment as wastes are burned). Biomass energy supplies could be included by requiring biomass supplies to be permitted for their carbon content but then providing credits for the carbon sequestered in the growing of the feedstock. Similar crediting provisions would be needed for other deliberate carbon-sequestration activities, notably reforestation. (Sequestration is an important subject in its own right and is covered in a forthcoming issue brief.)

Some arguments have been made for including producers of energy-using capital equipment in a trading system (for example, by requiring vehicle manufacturers to hold permits equal to the expected lifetime emissions of their vehicles). However, this approach controls only the performance of new equipment, has no effect on the utilization of equipment, and creates a bias that encourages uneconomic life extension of older, less efficient equipment. It also can lead to double regulation of emissions from energy using capital equipment. Over the long term, price signals provided by a fuels-based program will effectively guide both equipment purchase and utilization decisions. It is certainly possible that market failures associated with energy-using equipment (such as information unavailability, regulatory rigidities in the utility sector that limit transmission of effective price signals) need to be addressed to improve the efficiency of capital purchase decisions. But these problems are best attacked directly where they occur through targeted reforms in regulation, the provision of better information to consumers, and so forth.

A "cap-and-trade" program for CO_2 would involve issuing a quantity of homogeneous (not source or sector-specific) permits equal to the total target level of emissions. Individuals would be free to buy and sell permits subject to whatever bookkeeping requirements are needed for assuring compliance. The "commodity" traded is the opportunity to emit a unit of carbon (measured in terms of carbon content released) once, rather than defining the commodity as a stream of emissions over time. This approach to defining the commodity, which is used already to regulate U.S. utilities' SO_2 emissions, provides maximum flexibility and liquidity in the permit market. "Transaction costs"—the costs of identifying trading partners and effectuating trades—can be very low, and "derivative" transactions such as forward, futures, and options contracts can develop.

Other human-induced greenhouse gas emissions (such as methane from coal mines and landfills, or HFCs now used in lieu of CFCs in air conditioners) could be added to the cap-and-trade system (based on calculations of their relative contributions to global warming), depending on the capacity to measure or infer emission balances. Sources, sinks, and gases not included directly, because of difficulties in tracking aggregate balances, could be incorporated in ancillary project-specific efforts to create credits that could be "imported" into the core program.

Each permit can be used after a given date. For example, permits for the first budget period would be dated 2008, those for the second period, 2013. Permits could be used or banked for future use. Banking is a key feature of an efficient trading system, since it allows for efficient arbitrage of marginal costs when these are rising over time as emission targets tighten or energy demand grows. Regulators also could issue or sell permits ahead of their "use after" dates, and emitters and fuel suppliers could engage in forward contracting to assemble portfolios of permits. In particular, it may be useful to initiate provision or sale of permits for the initial commitment period (2008-2012) somewhat beforehand, so as to allow price information to develop and to build confidence in the trading and monitoring institutions themselves. Experience with the U.S. SO_2 program suggests that confidence is enhanced by establishing in advance how trading will work, and how results will be monitored.

Once a capacity for measuring or reliably estimating individual actors' CO_2 emissions or fossil fuel sales is established (a feasible but not trivial task), it is necessary only to keep track of covered sources' permits relative to fuel flows or emissions. There would be no need to keep track of specific transactions in the trading registry, other than the creation of project-specific non-CO_2 emission credits imported into the core cap-and-trade program. Any shortfall between required and actual permits would be deterred by stiff financial penalties and a requirement to cover the shortfall. Permits would be fully fungible within the five year commitment period, but each year firms would be required to show they hold permits equal to or greater than their emissions. This annual reporting would avoid the risk of large carbon debts when firms go bankrupt, and could provide useful information to the permit market.

How GHG Permits Are Allocated

Before any trading program could commence, the permits would first have to be allocated. The government could simply require prospective permit holders (and anyone else who wished to) to bid for permits in an auction. An active secondary market could and (unless foolishly prohibited by government) would evolve that would allow sources to adjust their permit holdings to changes in circumstances between auctions. Auctions could be held periodically (e.g., quarterly). The government could auction more permits than are expected to be used within the period, to allow a limited kind of "borrowing" within the commitment period. (More expansive approaches to borrowing are assessed in the sequel to this paper.)

A great deal of research and a reasonable amount of practical experience is available for designing an auction. One option with strong potential for efficiency is a sealed-bid auction with a uniform price rule. Buyers would submit bids, the auctioneer would find the price that clears the market, and those who bid at least as much as the clearing price would receive permits at that price. Uniform pricing encourages participation by small bidders, since it is strategically simple. The usual concern with market power in uniform price auctions does not arise in this competitive market. Ascending auctions are more complex approaches that can yield some efficiency improvements over sealed bids, an advantage which must be balanced against their complexity. The repeated bidding process in an ascending auction reveals information about participants' valuations of permits, which improves the bidders' own valuation estimates and hence the efficiency of the final permit allocation.

An auction would raise considerable revenue for the government. To illustrate, U.S. emissions of carbon from fossil fuel burning in 1990 were calculated to be 1374 million tonnes. Reducing this by seven percent by 2008 would imply emissions of about 1280 tons. (The U.S. is obliged only to reduce all GHGs by an average of seven percent by 2008-2012.) If the price of a GHG permit were $50/tonne of carbon emission, then 1280 million tonnes of permits in the U.S. would be worth $64 billion per annum.

This revenue could be used to mitigate the adverse effects of GHG control for certain groups of businesses or workers, to help finance innovation in technologies for GHG reduction (such as new energy sources or carbon storage technologies), for adaptation to climate change, or to benefit taxpayers as a whole through reductions in other taxes. This last use of revenues has the potential to substantially reduce the net cost of GHG control, assuming the tax cuts are broad-based and efficiency-increasing. The reason is that since leisure goes untaxed, any tax on consumption goods or income lowers the effective real wage and reduces the incentives of workers to increase the labor effort they provide. Any environmental policy which raises the cost of carbon-intensive goods exacerbates the pre-existing distortions in the labor market that result form current income taxes. (See the earlier issue brief by Ian Parry, listed in Further Reading, for further discussion of this issue.)

The alternative to an auction is some form of gratis allocation. Such an allocation could occur in a number of ways. One often-discussed strategy is a form of "grandfathering," whereby regulated emission sources or fuel suppliers are given permits in proportion to their historical emissions or fossil fuel sales. Another approach is to divide up permits in proportion to market output shares, which could be updated over time (for example, in a "rolling average"), though this approach would act as an efficiency-reducing subsidy on output.

Gratis allocation provides a tool for distributing the scarcity rents created by limits on fossil fuel use or GHG emissions. It reduces the resistance of those who would in an auction have to pay for all their carbon or emission permits. However, the beneficiaries from a political decision to allocate permits to certain parties may not correspond to those who ultimately face the most adverse economic effects from imposition of the program. As already noted, the ultimate price and allocative effects will be the same with any permit allocation or with a permit auction. This means that, for example, employees that are unable to easily change jobs in response to lower labor demand in specific sectors such as coal, or households that cannot easily reduce energy demand in response to higher energy prices will suffer such effects under any system. On the other hand, with gratis allocation the rents will flow to the shareholders of the favored firms, and there will be no capacity to reduce the direct costs of GHG control with reductions in other taxes. Gratis allocation also may reduce somewhat the incentive for technical innovation (since, if an innovator anticipates cost savings due to permit price reductions, these savings will be smaller with a gratis allocation).

Grandfathering is sometimes criticized as being biased against new sources, which must pay for their emissions permits while existing sources obtain theirs for free. However, unless there are deeper competition problems, existing firms will have neither the motivation nor the capacity to discriminate against new entrants. For their part, entrants can and should come into an industry if and only if they are more efficient than incumbents, taking into account the opportunity cost of GHG permits. It is possible that small new sources could be disadvantaged because of imperfect capital markets that limit their access to finance. But this problem is best rectified by addressing the sources of any capital market distortions. Gratis allocations other than grandfathering also create inefficiencies; for example, allocating permits based on changes in market share acts as a de facto subsidy to the output of the favored firms and distorts product purchasing decisions.

For all of these reasons, we believe auctioning is a better approach. Because it may be problematic politically to start with an auction for all GHG permits, it would be possible to start with a mixture of gratis allocation and auctions and gradually phase out the gratis allocation. In light of the argument in the previous section, the allocation should be of upstream fossil fuel carbon permits, *not* emission permits. Gratis allocation of these permits to downstream actors would then be bought back by upstream actors which directly face regulation(e.g., refineries), making the flows of rents fairly transparent. Rent transfers also could be achieved in more direct and more transparent ways than through the gratis allocation of permits — in particular, through transfers of revenues from a permit auction to whatever groups of shareholders or consumers are deemed worthy of receiving them (though again, care is needed to avoid inventing new forms of output subsidies).

Dealing with Uncertainties

A GHG trading program also must deal with various uncertainties over time. "External" factors reflect changes in aggregate national GHG emissions ceilings due to such international influences as changes over time in the perceptions of the risks of climate change, and the ongoing process of negotiation of global emissions targets and national obligations under the Framework Convention. For example, a discovery that climate change is more threatening than it seems today could cause national GHG budgets to be reduced to phase down emissions more quickly. "Internal" uncertainties reflect the government's own political or revenue-based motivations for changing the allocation of permits. The time inconsistency problem is one major source of uncertainty. Other sources arise even if the Kyoto targets are met. One is reallocations of gratis quota among sectors, for example reductions in downstream sectoral quotas when a sector has shown particular capacity to reduce costs. Another is unannounced movements from gratis allocations to auctioned allocations to increase government revenue.

These uncertainties call for responses that are to some extent at cross purposes. Putting the external risk on the private sector creates uncertainties in their investment planning. However, these risks are unavoidable and emitters, not the government, are in the best position to bear them through a portfolio of investments in existing and new technologies that provide flexibility if quotas fall (and options to emit more if they should happen to rise). On the other hand, internal risks unnecessarily increase investment uncertainty, and they can undercut the incentives for permit market participants to undertake desirable investments in lowering the cost of emissions control. By their nature, hybrid upstream/downstream programs with gratis allocation seem more prone to internal risks than an upstream auctioned approach, since the government has more control over the initial allocations of permits. Policy needs to spell out carefully the circumstances under which emissions allocations can be altered, in order to limit opportunistic regulatory behavior, while recognizing the sovereignty of the government over GHG emissions and its need to respond to ongoing international discussions on GHG reductions.

Concluding Remarks

Our conclusions that the permit system should be upstream, auctioned, and that auction revenue should be recycled are still controversial. However, if one assumes a longer-term national commitment to potentially costly GHG emissions control there is both a fair amount of time for regulatory institutions to evolve and gain public acceptance, and a pressing need to choose the best institutions possible. Without such a commitment, which is currently lacking in the political arena, any discussion of regulatory options is somewhat beside the point. Only time will tell if our proposal gains currency in the 10 years between now and the start of binding commitments under the Kyoto Protocol. Many important practical questions need to be addressed before a GHG trading system in the United States can be constructed and implemented. However, the deployment of a relatively efficient and transparent system seems within our grasp, especially once key issues related to who benefits from the revenues created by such a system are resolved. A well-developed domestic trading system in turn would provide a good foundation for taking advantage of the potential opportunities afforded by GHG trading on an international scale.

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