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JOHN F. KENNEDY SCHOOL OF GOVERNMENT

Designing Domestic Carbon Trading Systems: Key Considerations

Henry Lee

Environment and Natural Resources Program

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EXECUTIVE SUMMARY

In the fall of 1998, the US government was divided between those who believed that the nation should agree to substantial reductions in greenhouse gas emissions and those who believed the price tag was too high and the scientific evidence too uncertain. Amidst the debate loomed a larger and more difficult question: if the US does commit to making carbon reductions, how should it do so? Ideally it would like to purchase a large percentage of its reductions obligation from other countries where the cost of reductions are lower, but the international community is not apt to allow the US to meet all its obligations in this manner. Voluntary programs are inexpensive and domestic approval easy to win, but not sufficient to achieve international targets. Command and control regulations are very expensive and lack political and public support. In short, the US will have little choice, but to rely on market incentives. This paper focuses on one such incentive, tradable permits, and assesses some of the major design problems that will have to be overcome.

A tradable permit program could take many forms, but the basic idea is to establish a cap on carbon dioxide emissions. Those sources that find it inexpensive to reduce below their cap can sell their surplus permits to those that find it more costly. Total emissions must remain below the cap, but the sources are free to find their least expensive way to meet that cap.

This paper outlines four possible tradable permit program designs: 1) an "upstream" program in which fossil fuel producers face a cap on the amount of embedded carbon that the products they sell can contain; 2) a "downstream" program in which the users of fossil fuel face a cap on the amount of carbon dioxide they can emit; 3) a midstream program that places the permit obligations on key intermediary entities in the fuel cycle such as refineries, gas pipelines and coal processing plants; and 4) a "hybrid" program that combines elements from both an "upstream" and "downstream" program.

Any form of tradable permit program will face daunting design and implementation problems. Some are common to all options. For example, all options will require significant investments to establish an effective monitoring and enforcement program. There are also differences. An upstream system must address the question of what to do about fossil fuels that are used for non-energy purposes, and include a way to control the carbon embedded in the enormous volume of fossil fuels that are imported and exported. A downstream system must manage competition and trade issues as countries place different restrictions on similar industries. A downstream system will provide incentives to spur the development of new technologies to strip and sequester carbon at the point of emissions, but with an upstream system, these incentives will be weaker.

Overall, the "upstream" model, one that allows carbon trading between fossil fuel producers, has clear advantages over the others. It will be easier to implement, cause fewer economic distortions, be more enforceable, ensure greater coverage, and have

substantially lower transaction costs. This does not mean that an upstream permit system will be easy to develop or implement or that it will be inexpensive. As this paper explains, the challenges will be immense and will take years of work to overcome.

Though an upstream carbon trading program is feasible, successful implementation requires policy makers to be especially sensitive to five issues:

Balancing administrative hassle with coverage

1. Including all fossil fuel producers or all manufacturers will dramatically increase the program's administrative costs and make enforcement an overwhelming problem. However, if the program focuses on the few firms who either sell or emit a large percentage of the carbon and exempts smaller companies, larger firms will attempt to restructure to get below the threshold for program participation. As they game the system, production efficiency will decrease and Congress will be caught in a continual cycle of amending the program to deal with perverse incentives and loopholes while failing to achieve its environmental goals. One only need to look at the history of oil allocation controls in the 1970s to see how such a cycle can undermine even the most well-intentioned program.

   Furthermore, finding a balance between administration and coverage is critical for cost-effectiveness reasons. If 20% of the sources are not covered, then the remaining 80% assumes a greater reduction responsibility. If reducing carbon was cheap, this would not be a problem. But carbon reduction is not cheap and the residual economic

burden to the targeted industries would be significant.

Enforcement

2. Effective enforcement is essential to the credibility and effectiveness of any permit program. Achieving an acceptable level of compliance will require an unprecedented level of cooperation between the Treasury, the Department of Energy and the EPA, plus the support of the State, Justice, and Commerce departments. Only a widespread agency commitment to this program will ensure its effectiveness. Unfortunately, interagency cooperation of this magnitude is not commonplace.

Trade

3. Any domestic tradable permit regime must mesh with existing rules and regulations that govern international trade. Problems of competitive advantage and integrating domestic and imported fuel flows demand substantially more attention than they have received to date.

Politics

4. This broad, complex and expensive carbon trading program will stimulate hundreds of parties to lobby during the design and implementation stages. Policy makers will face a difficult trade-off between meeting important national and regional political concerns and limiting the incentives to block or game the program.

Timing

5. Designing and implementing a tradable permit regime will be a task of unprecedented dimensions. It cannot be done in one or two years. If the US would like to have a tradable permit regime in place by 2008, it needs to begin actively debating and discussing the provisions of such a plan in 1999, not 2006.

DESIGNING DOMESTIC CARBON TRADING SYSTEMS: KEY CONSIDERATIONS

In 1992, officials from around the world gathered in Rio de Janeiro to establish an international regime to control the rapid increase of greenhouse gas concentrations in the atmosphere. These concentrations are a result of carbon dioxide (CO_2), methane, and nitrous oxide emissions, and the declining availability of sinks, such as oceans and forests, to absorb them. Thus, an international regime must focus on both reducing emissions—the largest of which is CO_2—and increasing sinks.[1]

Since the Rio Summit, there has been an intense debate over whether countries should commit to tough reduction targets and a rigid timetable for those reductions. While this debate is likely to rage for many more years, there is general consensus that if the United States were to agree to a mandatory emission reduction regime, it would rely heavily on market incentives to reach its targets. The Clinton Administration has repeatedly stated its intentions to pursue market-based solutions.[2] Even US opponents of an international climate accord generally agree that if CO_2 reductions are required, market-based mechanisms, rather than traditional regulatory measures, are the preferred option.

Support for market incentives stems from the reality that greenhouse gases,

[1] This paper, focuses on program options to reduce energy related carbon emissions. The government could decide to expand such programs to include all greenhouse gases. The structure of the program would be similar, but the complexity of the program would be substantially increased. (Robert Hahn & Robert N. Stavins, 1995. "Trading in Greenhouse Permits: A Critical Examination of Design and Implementation Issues" in *Shaping National Responses to Climate Change*, ed. Henry Lee. Island Press, Washington DC. P. 199.)

[2] President Clinton's October 1997 proposals for meeting international agreements included a domestic tradable permit system that would begin in 2008. Warrick, Joby and Peter Baker (1997), "Clinton Details Global Warming Plan," *The Washington Post*, October 23, A1.

including CO_2, are uniformly mixed pollutants. Because, the location of emission reductions does not matter, sources can trade their reduction obligations without any negative environmental consequences as long as total global emissions remains below the official target. A ton of CO_2 eliminated in Mexico provides the same global benefits as a ton abated in China. There are no localized hot spots as found with pollutants such as air toxics, suspended particles, or tropospheric ozone.

The question for most policy makers is not whether to pursue market incentives but which to pursue and how to implement them. The two leading candidates are carbon (or energy) taxes and tradable permits. A tax-based system establishes a specific charge per unit of emissions to provide an incentive for a firm to invest in reductions. Under a permit system, policy makers determine the amount of pollution that can occur and allocate emission permits to sources up to this ceiling or cap.[3] Firms that find it cheap to reduce do so and sell their surplus permits to those who find it expensive.

While the Europeans have expressed a strong predilection for taxes, the United States is more inclined toward tradable permits for several reasons. First, the American public and their congressional leaders have repeatedly evidenced an aversion to energy taxes, making tradable permit schemes the default policy of choice.[4] Second, the costs of a tradable permit program are less explicit than those for a tax program. Given the public's uncertainty about the seriousness of the climate change problem and its reluctance to spend a lot of money on policy responses, the former is likely to be more politically feasible. Third, tradable permit schemes tend to be more appealing to special

[3] There is a variation of this model: offset trading in which no permits are allocated, but sources who reduce their emissions below a cap can earn credits and trade them. Most economists are skeptical about such a system because of the transaction costs inherent in certifying every credit created by the firm and the difficulties in setting each firm's cap or baseline.

[4] Muller, Frank. "Mitigating Climate Change: The Case for Energy Taxes," Environment, March, 1996, P 13-20 and P 36-43.

interests. Environmental interest groups are more comfortable with tradable permit systems because they know exactly how much pollution is being reduced. Business interests prefer permits because of the opportunity to make shrewd abatement decisions and be correspondingly rewarded in the marketplace. Finally, the US experience with sulfur dioxide (SO_2) permit trading is considered an environmental and economic success and advocates hope to replicate it with carbon dioxide.

Several design issues will affect the success of a tradable permit regime for carbon. One critical question is where in the economic system the government should assign the permits—upstream with fossil fuel producers, or downstream with fossil fuel consumers?[5] There is no inherent technical reason that one could not pursue either an upstream or downstream system. However, implementation differences can be significant.

The purpose of this paper is twofold. First, it compares and contrasts an upstream tradable permit regime for CO_2 with a downstream regime, focusing on their respective strengths and weaknesses. Secondly, using insights gained from similar historical efforts in the US, it assesses some of the problems that governments must solve to implement either type of program. For example, twenty-five years ago the United States imposed an oil allocation and price control program which had some of the same characteristics as an upstream tradable permit regime. That experience can inform the design and implementation of a carbon reduction program.

The two purposes of the paper are interwoven, because many of the largest

[5] The terms "upstream" and "downstream" are borrowed from the petroleum industry which considers primary fuel producers to be upstream and the processing, wholesale, and retail side of the business to be downstream. In the CO_2 tradable permit debate, the upstream locus includes producers while the downstream locus refers to users (remitters). Processors fall in between, but are usually put in the upstream category.

challenges—such as the appropriate size and scope of the program; enforcement and measuring; and integrating imports and exports of carbon-containing fuels and commodities—are common to both an upstream and a downstream program. This paper strives to highlight the tradeoffs among the design options and provide decision-makers with a better understanding of their choices and challenges.

The first section identifies major problems confronting the designers of an upstream or downstream system. The next assesses these two alternatives against the criteria of environmental effectiveness, economic effectiveness, administrative feasibility, and political feasibility. The paper concludes by presenting six key issues that Congress must address if it eventually decides to pursue a tradable permit program.

I. DESIGNING A TRADABLE CARBON PERMIT PROGRAM

The most fundamental decision in the design of a domestic tradable permit system is what specific activity to permit and where in the economy to locate the program. Should the government require all energy producers to have a permit in order to sell, buy, or extract carbon-containing fuel – an "upstream system" that focuses on primary energy producers? Or should the government require a permit to emit carbon dioxide – a "downstream system"?

Permits can relate to either the carbon content of fuels or to emissions produced when the fuel is combusted. An input permit is tied to the amount of carbon contained in the fossil fuel. The objective is to reduce emissions from fuel use. For example, with an upstream input system the government could reduce carbon emissions by restricting the amount of carbon in fuel that is sold. An energy producer would receive permits to sell a specified amount of carbon. If the fuels being sold contain carbon in excess of this amount, the fuel producers must purchase additional permits or forego the sale. A company might decide to sell less of a carbon intensive fuel, such as coal, and more of a low carbon fuel, such as natural gas. Since a tradable permit program will likely be accompanied by a cap on carbon that is gradually ratcheted down, the price of carbon will increase. Such increases will reduce the demand for fossil fuels. Thus, a company will sell less fuels, but at a higher price.

Upstream permits would be input permits while downstream permits could either be input or output emission permits. For example, the government can restrict the amount of carbon burned in manufacturing processes (an input restriction) to control the type and amount of fuel consumed. As long as the government could monitor the fossil

fuel flows, it can introduce a carbon input permit. Alternatively, it could restrict the volume of carbon dioxide emitted by the manufacturing company (an output restriction).

The US experience using input permits is based almost exclusively on its efforts to phase out lead in gasoline and ozone-depleting CFCs. In both cases, the number of emitters was a fraction of the number that would be involved in a CO_2 tradable permit scheme and the term of the program quite short. For example, 250 refineries were involved in the lead program, which lasted only five years. In the case of CFCs, the number of sources was even smaller, and the beneficial impact of the permit program was further blunted by the introduction and passage of an excess profits tax.

The U.S. has substantially more experience with emission limitations. Under such schemes, the government allocates a set number of permits, granting recipients the right to emit up to a certain capped volume. Such a system is presently used to reduce sulfur dioxide (SO_2) emissions from the nation's most polluting power plants. Users cannot emit more SO_2 than they have permits for. If they need more permits, they can buy them from other users who find it more economical to reduce SO_2 emissions below their permitted cap and sell their excess permits. As the market price of permits rises, companies have an incentive to invest in abating their emissions. When permit prices fall, they will be inclined to buy permits. The bottom line, however, is that total emissions cannot exceed the cap.

Emission permits are especially effective when the permittee has several pollution abatements options. In the case of SO_2, the permit recipient can install a scrubber or switch to a lower sulfur fuel. While end-of-pipe abatement is a viable option for pollutants such as SO_2, the technology to strip CO_2 from smoke stacks and sequester it is still in its infancy so fuel switching or reducing fuel use are the only economic options at

this time. However, the economics of CO_2 sequestration may yet prove to be much better than heretofore believed, especially for larger facilities, such as base load electric generating plants.[6]

The beauty of the SO_2 program is that the transaction costs are low, and there is an ever increasing number of trades, both within and between companies. It demonstrates that governments should strive for administrative simplicity when designing a permit program. The number of sources should be manageable, the bureaucratic requirements understandable, and the number of new agencies and institutions kept to a minimum. Even the SO_2 allowance system, a downstream program, initially involved only 110 generating plants (263 units).[7] Although the program will expand to include several thousand plants by the year 2000, EPA's implementation expenses during the first five years, including operating the banking system, were just $65 million.[8]

A CO_2 program – even an upstream program – will be many times more difficult to design and operate. It will be much larger, and require a substantially greater government commitment of staff and money. The complex interactive systems that characterize the US energy business will demand a sophistication of program design and a level of cooperation among federal agencies that is unprecedented.

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[6] Parson, Edward and David Keith. (1998) "Fossil Fuels Without CO_2 Emissions: Progress, Prospects, and Policy Implications." Draft Paper, April, 1998.
[7] Stavins, Robert. "What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading." Journal of Economic Perspectives (forthcoming).
[8] McLean, Brian. "The Sulfur Dioxide Allowance Trading Program: The First Five Years." US EPA Acid Rain Division, 1996.

A. An Upstream Carbon Tradable Permit Program

An upstream CO_2 tradable permit program is a vehicle for using market-based incentives to restrict the total amount of carbon in fuels sold in the marketplace. Participating companies must hold a certain number of permits and the total package of fuels they sell must not exceed a certain level of carbon. For example, if a coal company receives permits to sell fuel containing 100 tons of carbon and they want to sell coal containing 110 tons of carbon, they must either buy permits in the marketplace or forego the sale of the last 10 tons. Their decision to buy permits will depend on whether the profits from the sale of the 10 tons exceed the permit cost. Those selling permits will make the reverse calculations. Will the money they make from selling the permits exceed the money they will make from selling the carbon-containing fuel? Complicating factors such as transaction costs, information asymmetry, and irrational behavior will constrain the market.[9] Experience with other programs, such as the phase out of lead in gasoline, suggests that such a permit market can work.

Three Models for an Upstream System

There are three general upstream models that governments can pursue: 1) require permits for the larger fossil fuel producers who comprise a substantial portion of the market; 2) require permits for all fossil fuel producers; and 3) require permits for the operators of upstream processing facilities. Ideally, the government wants a program that is environmentally effective, efficient, and politically feasible. Maximizing all three criteria is difficult, since each model has its strengths and weaknesses.

[9] In a tradable permit system there are three potential sources of costs associated with facilitating a transaction of costs: (1) search and information, (2) bargaining and decision and (3) monitoring and enforcement. Stavins, Robert N. (1995) "Transaction Costs and Tradeable Permits." *Journal of Environmental Economics and Management*, vol. 29; p. 134.

Model 1: *Limit the Program to the Largest Producers*

The government could design a program encompassing the 200 companies that produce the majority of the nation's fossil fuel.[10] Twenty-four companies produce about 60% of the nation's oil[11] and about twenty companies mine about 55% of the coal.[12] This concentration is likely to grow as companies consolidate. For example, many electric utility companies that own their own oil, gas, and coal supplies are looking to shed these businesses. Further, many of the larger producers have significant holdings in all three major fuel areas. Exxon, for example, produces 6.7% of the nation's oil, 4.2% of its natural gas and 0.25% of its coal.[13]

Since most of these companies are accustomed to doing business with each other and the permits would be for a common item – the carbon embedded in the fuel – a market should quickly emerge in which trading flourishes. The problem is that the remaining would have a significant competitive advantage by being exempted from the permit requirements. It is inconceivable that the 200 largest producers, with all their political influence, will sit idly by and let such a system be implemented. They will either lobby vigorously to prevent its implementation or they will try to evade the program requirements by subdividing into smaller companies.

The federal program to control the allocation of crude oil in the 1970's encountered precisely such opposition from the major oil producers. This program created a "tiered" system of price controls with a below market price for crude oil already in production ("old" oil) and a higher price for "new" oil. The objective was to keep the

[10] Center for Clean Air Policy. (1998) "US Carbon Emissions Trading: Description of an Upstream Approach." Center for Clean Air Policy, Washington, DC.
[11] American Petroleum Institute (API) Basic Petroleum Data Book: Petroleum Industry statistics XVII. American Petroleum Institute, Washington DC
[12] U.S. Energy Information Agency. (1996) *Coal Industry Annual 1995*. DOE/EIA-0584(95), Washington, D.C.
[13] Exxon Corporation. (1997) *Exxon 1996 Annual Report*.

average price of crude oil down while simultaneously providing an incentive to expand domestic production. Since refined products could be sold at a single price regardless of what type of crude oil was used, this system made access to old oil very valuable to refiners. A gallon of gasoline produced with old oil could be significantly more profitable for a refiner than a gallon produced with the more expensive new oil. Small regional refineries, backed by their local politicians, argued that they lacked equal access to the cheap old oil, and therefore were unfairly disadvantaged. To avoid the perception of discrimination against small refiners, the government opted to reallocate supplies of cheap oil between refiners. An entitlements program was created in which refiners were allocated old oil in proportion to their past production. If the refiner used less old oil than it was allocated, it could sell the extra entitlements to other refiners.

Within this allocation scheme refiners with a capacity less than 175,000 barrels per day were granted extra entitlements on a sliding scale with the smallest receiving proportionally more.[14] As entitlements were based on past production, thus a refiner who produced less than 30,000 barrels per day could lower its marginal cost of crude oil significantly below the industry average.

In the first two years of the small refiner bias, eleven new refineries with sub-30,000 barrel capacity were opened; in the five years prior to the program, the number of refineries with this capacity had fallen by six.[15] These "teakettles" were inefficient and costly. As new, small refiners started up in lieu of larger, more efficient facilities, the cost to the U.S. to produce a barrel of any given petroleum product rose.

The small refinery bias was not the only example of the oil industry gaming an

[14] Kalt, Joseph P. (1981) *The Economics and Politics of Oil Price Regulation.* MIT Press, Cambridge, Massachusetts; p. 59.
[15] Ibid, p. 60.

arbitrarily imposed size threshold. Small oil producers, such as stripper well owners, managed to convince political officials to exclude them from the existing system of price controls, which effectively gave the least efficient segment of the industry a large subsidy.[16] As one might expect, producers tried to reconfigure themselves to qualify for this "stripper well" exemption.

If, in our carbon permit system, the government decides to require only fuel producers over a certain size to hold carbon permits for reasons of administrative efficiency, then producers will scramble to get below that threshold. For example, if the threshold is 100 barrels of oil per day, companies that are producing 291 barrels will be tempted to subdivide into three companies, each producing 97 barrels.

The bottom line is that if a segment of the industry is officially exempted from the program, that segment will grow as firms restructure to gain the exemption. Such a result would benefit the most inefficient segments of the energy producing industry. The government is confronted with a no-win trade-off. If it sets an arbitrary threshold, it risks triggering an onslaught of self-serving, cost ineffective, behavior. If it does not, it will trigger significant political opposition and greater administrative burdens.

Will the federal government be wiser this time around? Remember that in the 1970s, smart men and women with the best intentions found themselves caught in an endless cycle of rewriting regulations and designing exemptions to make the oil allocation program work in the face of continual gaming by private companies and demands of angry congressional committees. A new division was created in the Federal Energy Agency (later the Department of Energy) just to implement this program.[17] In the

[16] Ibid, p. 12.
[17] The Energy Regulatory Administration was established to implement and regulate the oil price and allocation program.

end, there were simply too many problems and the program collapsed.

An upstream carbon permit system may or may not be simpler to operate than a crude oil allocation program, but the problems encountered by the latter should provide useful lessons in how difficult it is to intervene in a market and how well-intentioned efforts to enhance the administrative capacity and improve the fairness of a program can result in unexpected and perverse responses.

Model 2: *Include All Producers*

Permits could be allocated to all the oil, gas and coal producers – big and small. This would entail working with a very large number of companies. There are approximately 600,000 oil wells and 300,000 gas wells in the United States (see Table 1).[18] The coal industry is more consolidated; there are less than 2100 major mines. However, there are numerous small independent operators in the eastern states that dig in one area for a few weeks and then move.

TABLE 1

Upstream Entities

	Petroleum	Natural Gas	Coal
Wells/Mines	594,189	298,000	2,100
Extraction Companies	8,000		3,402
Processors/Refiners	175	725	550
Distributors	14,127	150	
Local Distribution Companies		1,300	

Source: Center for Clean Air Policy. (1998) "US Carbon Emissions Trading: Description of an Upstream Approach." Center for Clean Air Policy, Washington, DC.

[18] American Petroleum Institute (API). (1997) *Basic Petroleum Data Book Petroleum Industry Statistics*, XVII. American Petroleum Institute, Washington, DC; p. 1.

The political and administrative challenge of constructing a program that encompasses the many small entities that produce 20% of the nation's fossil fuels is not trivial. The government might be able to win political support to auction carbon permits to the bigger producers, but it is hard to imagine that the Congress will make thousands of stripper well owners bid against Exxon for carbon permits.

Administratively, the job of monitoring and enforcement will dwarf that of any other tradable permit program. It would be necessary to track 15,000 companies or 900,000 oil and gas wells. The government would have to develop a self-auditing process—akin to a financial audit—under which each company or individual owner would report the total amount of carbon it produced.[19] The smaller producers will almost certainly protest the hardship of the additional paperwork, a protest that will reach a receptive audience in Congress. The EPA, or some other federal or state agency, would also have to develop and implement an enforcement program of spot-checks. When violations are uncovered, the agency would have to decide how many well-connected small producers to battle in time consuming court trials. Yet a credible enforcement process will be essential, and the agency will be forced to demonstrate an even-handed pursuit of violators.

While designing and implementing a program of this magnitude may seem an overwhelming challenge, it can be done. There are markets with many participants, such as the commodity and stock markets that work well. Further, the permits are homogeneous, making them easy to trade. The larger producers in each industry know each other, providing the same advantage that facilitated trading in both the lead and

[19] One option would be to delegate the reporting responsibility to an umbrella organization. For example, the Texas Independent Producers and Royalty Owners (TIPRO) could consolidate and file the required forms. While this is theoretically possible, it is politically unlikely that they will agree to help implement a program that they fundamentally oppose.

sulfur dioxide programs. This leaves the smaller producers; brokers and other entrepreneurial enterprises should emerge to bridge the information gaps and galvanize the market. In the same way that small farmers are familiar with the workings of the commodity markets, smaller oil and gas producers could develop a familiarity with a carbon permit market.

There will certainly be problems in the early phases of an "all producer" allocation program, but this model can work. Whether the government wants to spend the time and resources to design, implement and—most importantly—enforce such a program is another question.

Model 3: *A Midstream Option*

The third model, one that is receiving substantial attention in some circles, would identify the bottlenecks in the oil, gas, and coal sectors where the number of facilities to permit would be more manageable.[20] The candidates most often mentioned are refineries for oil, pipelines or processing plants for gas, and preparation plants for coal. The Center for Clean Air Policy estimates that there are approximately 175 refineries, 150 pipelines, 725 gas processing plants, and 550 coal preparation plants.[21] While the number of these facilities is still larger than that covered by any existing tradable permit program, this approach may be workable, despite some obstacles.

Owners of these intermediary facilities are often different than the owners of the production facilities. For example, some refineries never take ownership of the oil. Only a small percentage of gas pipelines are owned by major gas producers, and this number has been shrinking. The companies that own the coal preparation plants are not

[20] Center for Clean Air Policy. (1998) "US Carbon Emissions Trading: Description of an Upstream Approach." Center for Clean Air Policy, Washington, DC.
[21] Ibid, p. 7.

necessarily the companies that mine the coal. Already our "upstream" program has moved a step downstream.

Oil producers could acquire permits and then sell them to a refinery along with the crude oil. One can imagine an outcome in which most permits are bought not by the refineries or gas pipelines, but by the upstream producers, so that they can ensure that their products are processed. The end result might look very similar to our second "all producers" model.

If permits are allocated to oil refineries, the total amount of carbon in the crude oil that the facility could process over a year would be capped. Refinery X would receive permits to process 500,000 tons of carbon. If it wants to process crude containing more than this amount, it must purchase additional permits. If it decides to process less, it would have excess permits that it could bank or sell. Alternatively, policy makers could decide to require permits for products sold as opposed to product processed, but holding permits to sell products would miss the carbon emitted in the refining process, about 6% of the carbon in the crude oil.[22]

The permits for coal could be quite similar. Each preparation plant would need a permit to "prepare" a volume of coal containing one ton of carbon. Just as the oil refinery could not process any more carbon-containing crude oil than it had permits, the coal plant would be similarly constrained. However, approximately 10% of the nation's coal is not processed and would be missed by such a program.

In the case of natural gas, the situation is quite different. In our hypothetical case the government would require a pipeline to hold a permit for each ton of carbon in the gas

[22] Ibid, p. 13.

it transported. Alternatively, the entity seeking to transport the gas could be required to hold the permit. Either way there would be thousands of candidates. If the permits are grandfathered to historical users, large windfalls will accrue to entities who may no longer need to move gas at the expense of those who do. The potential for confusion and contention is large. Hence, designers may have no choice but to require the pipelines to hold permits as a condition of allowing gas into their lines. This would be akin to regulating the truckers instead of the food producers to reduce pesticide residues. This option is feasible, but given the number of transactions between producers, gathering systems, and different pipeline carriers, it will challenge both the operators of the system and their regulators.

Three additional political problems are likely to emerge. First the smaller independent producers will argue that processing plants will discriminate against their oil and gas and will opt instead to buy from the larger companies. The merits of this argument are dubious, as such a situation could exist with or without a permit program, but it will resonate with some members of Congress.

Secondly, producers or processors may gain the power to manipulate the market. On a national basis, market power probably will not be a problem, but federal regulators will have to monitor regional markets serviced by a small number of processing plants, such as refineries producing specialized products for smaller markets. The markets today are more integrated than they were in the 1970's and many of the specialty processors have been replaced by larger national entities. However, it is inevitable that certain interests will claim that the economic health of their region will be threatened.

Thirdly, a midstream model will still tempt certain parties to game the system. If one believes that the cost of the program will be passed forward to the customer, it is

irrelevant whether the producers or refiners buy the permits. But if one believes that some of the costs will have to be eaten rather than passed forward then one can expect the producing, processing, and transporting sectors to jockey to have the permit requirements put on the other. On the other hand, if the permits are grandfathered—allocated according to a format based on historical use—recipients could gain a large windfall. In this situation, jockeying among companies will be just as intense, but in the other direction as companies strive to maximize the number of permits they receive.

Requiring refineries to hold carbon permits in order to process crude oil is workable. There are only 175, and they are accustomed to interacting. Further, the lead-trading program demonstrated that a tradable permit program at the refinery level can work. It will be more difficult, however, to design and implement a gas pipeline or processing permit program, especially if a decision is made to allocate the permits administratively (as opposed to auctioning them). Placing the permit on coal processing plants is unlikely to work, since substantial amounts of coal presently bypasses such plants, and these amounts will increase as soon as a permit requirement is introduced.

Implementation Challenges in an Upstream System

Designers of an upstream tradable carbon program must resolve several key problems. Solutions will require significant cooperation within and between the governments and the development of new domestic and international programs. Three of the most pressing issues are addressed in this section: 1) estimating the carbon content of different fossil fuels; 2) determining how to treat the non-energy use of fossil fuels; and 3) managing the imports and exports of fuels.

Carbon Content

The carbon content of various fossil fuels differs greatly. For some resources such as crude oil, the differences are no more than two or three percent. But if you multiply this number by 18 million barrels per day or 6.57 billion barrels per year, a two or three percent difference represents a significant amount of carbon. More importantly, it could lead to a significant transfer of money between producers. These differences in carbon content are even larger for oil products, of which there are many. For example, gasoline has many octane levels. It can be reformulated or not. It can be oxygenated or not oxygenated. Each oil product can have a different carbon content. The same is true for natural gas streams and for coal from different mine seams.

There are two ways to handle this problem. The government can estimate carbon contents of various fuels or it can require that those contents be measured. In the latter scenario, the government places responsibility for calculating the carbon content of each shipment on the permit holder. Coal preparation plants and natural gas processing facilities already have the ability to measure and calculate the carbon content of the fuels they process. While it would require investment in equipment and resources, oil refineries, coal mines, oil and gas production facilities and pipelines could acquire this capability too. The government would need to build in-house capacity to audit and ensure the accuracy of these calculations.

Or, the government could estimate an average carbon content for each fuel type. For example, it could decide that subbituminous coal from the Powder River Basin of Montana has a carbon content of 1,700 pounds per ton. It would then be assumed that all subbituminous coal mined in Montana would have approximately the same carbon content. Procedures for estimating carbon content are presently used in the greenhouse gas inventory process that countries are required to conduct under the Rio Framework

Convention on Climate Change (FCCC). These could be modified and used to determine a carbon content for each fuel type.

If an "average" carbon content is selected, half the time the government would be over-regulating and half the time be under-regulating. If the range of error is narrow, society will pay prices that are close to the marginal price of carbon and will respond appropriately to those signals. If the differences are large, then the signals could be economically inefficient, resulting in either over-consumption or under-consumption of carbon. Society would not reap the benefits from intra-fuel substitution (substituting low carbon for high carbon coal). Individual firms could lose or gain depending on whether the carbon content of their fuel is below or above the "average." There could be significant inter-firm transfers, which in turn will be touted as a problem by firms who see themselves as "losers." Ultimately, the government will have to weigh the benefits of more precise measurements of carbon against the substantial costs of obtaining this information.

The government will probably decide to estimate the average carbon content, but determining the process by which these carbon estimates are made will be long and contentious. Impacted firms will lobby for a stakeholder process similar to that used to set the formula for reformulated gasoline. They are unlikely to embrace the same formula used in FCCC greenhouse gas inventory process as too much money will be at stake.[23] A stackholder regulatory process will be time-consuming and drain staff resources, since the government will also be developing formulas for dozens of energy products, not just gasoline.

[23] Since the US will ultimately be responsible for its emissions as verified according to the FCCC guidelines, some relationship between the domestic regime and the FCCC guidelines will be required, if and when an international trading regime is to be developed.

Non-Energy Use of Fossil Fuels

Approximately six percent of fossil fuels are not burned, but stored in products like plastics, steel, synthetic fibers, paints, lubricants and asphalt. In the petroleum sector, almost 11% of the carbon in crude oil is used for non-fuel purposes.[24] Since most of this carbon is not emitted, but rather stored, governments are unlikely to want to reduce its sale and use.

Furthermore, there are a number of products that come out of a refinery or are produced from natural gas liquids, such as ethane, propane, and naphtha, that can be burned as a fuel or used as a petrochemical feedstock. If governments require permits at either the point of production or the point of refining, they will not know whether these products will end up in a boiler or in a chemical manufacturing process.

Some petrochemically-based products such as packaging, diapers, or plastic plates are incinerated shortly after they are used. Others are disposed within ten years. While still others might last centuries. Some environmental groups have argued that a tradable permit program should cover petrochemicals that will be used and disposed within a short time frame such as 10 years or less.[25]

The Center for Clean Air Policy has produced a thoughtful paper that outlines several options for how the government could treat non-energy use: 1) Ignore the problem, since the amount of carbon sequestered in non-energy products is small and implementing a program to exempt this sector would be complicated and costly; 2) estimate the historical production of feedstocks that was sequestered in non-energy

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[24] U.S. Energy Information Agency. (1997) *Emissions of Greenhouse Gases in the United States 1996.* DOE/EIA-0573(96), Washington, DC.

[25] See Hargrave, Tim, David Festa, and Sam Keller. (1997) "Accounting for Non-fuel Uses of Fossil Fuels in an Upstream Carbon Trading System." Center for Clean Air Policy, Washington DC.

products and exempt that amount of carbon; 3) reward an allocation of permits to chemical companies and other producers of non-energy products and allow them to use the proceeds from their sale to offset the increase in feedstock prices.[26]

None of these options sound practical from a political or administrative perspective. Ignoring the problem of non-energy use of carbon is not feasible, because 11 percent of the carbon in oil is not a small amount and it is difficult to imagine the petrochemical industry remaining silent. Estimating the feedstock sequestered in non-energy products is an administrative nightmare that would be outdated as soon as it was finished--as products and processes are constantly changing. Finally, awarding an arbitrary number of permits to chemical companies—as compensation—will be a continuous process as the parties will argue about the "correct number." This problem will probably require the use of tax credits or deductions to offset the costs of the carbon permits borne by the producers of non-energy products. This will demand creative negotiations within the congressional Finance Committees, the Internal Revenue Service, the Department of Treasury and the Department of Energy.

Imports and Exports

The United States imports over 50% of its oil, mostly in the form of crude oil, and about 8% in product form.[27] The Energy Information Agency predicts that the latter figure could double by 2020.[28] Approximately 12.4% of the natural gas in the United States is imported, primarily from Canada.[29] Export numbers are lower, but not insignificant. Nine percent of coal production is exported, and oil exports are close to a

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[26] Ibid.
[27] U.S. Energy Information Agency. (1998) *Annual Energy Review1997.* DOE/EIA-0384(97) Washington, DC. Diagram 2, p. 115.
[28] U.S. Energy Information Agency. (1998) *Annual Energy Outlook 1998.* DOE/EIA-0383(98) Washington, DC. p. 67.
[29] Ibid, p. 61.

million barrels per day.

At first glance, solving the dilemma of how to implement an upstream system that includes imports and exports of fuels looks simple. The government could require importers to hold carbon permits, but exempt exporters. But if one looks closer, the task of designing a workable system is much more challenging.

Consider that custom officers, and perhaps an EPA or other enforcement official, would have to certify the carbon content of each shipment of crude oil or product. Repeating this ritual thousands of times per day at every entry point into the US will require a large trained workforce and substantial paperwork.

What if the shipment is residual oil that is to be refined into lighter products and then exported back to the country from whence it came? Perhaps the importer would still need a carbon permit, but qualify for some type of credit when the newly refined product was exported. Establishing such a system of credits or reimbursements will further increase the complexity of the program.

Hypothesize that this shipment of residual oil came from the Netherlands, which imposed a carbon tax on all crude oil sold to its refinery complex in Rotterdam. Since our hypothetical shipment of residual oil already includes the cost of the Netherlands carbon tax, should the US require the importer to hold a carbon permit? One can argue that the Netherlands is unlikely to impose a program that would put their refining industry in an uncompetitive position. It could exempt its exports from the carbon tax or arrange a protocol with the US to exempt the Netherlands' products from the US permit program. The US, though, would be concerned about meeting its emission target and therefore may be reluctant to grant any exemptions, regardless of the programs in the Netherlands.

To complicate this scenario further, suppose that instead of a shipment of residual oil, the cargo contained plastic goods that had a lifetime of less than two years. These goods were made from petrochemicals produced in Taiwan (not a signatory nation) that were produced from feedstocks bought from oil refineries in Japan which in turn bought their crude oil from Kuwait. To make our example even more interesting, the cargo from Taiwan was originally shipped to Vancouver, Canada and then delivered by truck to Seattle. Two of the countries, Japan and Canada, have carbon abatement programs. Canada has a permit program, but with a set of rules that are different than those in the US, and Japan has a carbon tax. Please solve.

This paper has discussed only problems arising from imports, but similar issues can be expected with exports. The Treasury Department will have to ensure that imports and exports of carbon-containing goods and products are integrated into a domestic permit regime without disrupting international trade patterns and triggering major disputes with the US's trading partners.

The US receives imports containing carbon from 20–25 countries, many of which will likely have adopted different programs and rules to meet their domestic carbon reduction requirements under an international climate change agreement. The same is true of many other countries with active trade in oil-based products. Without an international mediator, countries are likely to accuse each other of designing their treatment of the carbon content of imports to provide a trade advantage, triggering protests to the World Trade Organization (WTO).

Other Problems

There are many other problems with which designers will have to wrestle. How are wood producers to be treated? Ethanol producers? What about the holders of contracts that do not permit the pass through of higher energy prices resulting from government intervention? The challenge of solving these many design problems dwarfs any that has occurred for conventional pollutants. Environmentalists may protest that an upstream system will be too removed from the point of actual emissions and suffer from many of the same problems that plague environmental taxes. Will the price of energy products rise sufficiently to cause emitters of carbon to respond to these price signals and realize the desired emission reduction goals? If not, how can government guarantee that the targeted reduction levels will actually occur? These groups may also be concerned that wealthier downstream companies will buy their way out of compliance.

B. A Downstream Carbon Permit System

In a downstream system, all carbon emitters must possess permits equal to their volume of emissions. If they emit 100 tons of carbon but have permits for 90 tons, they must purchase permits to emit the additional 10 tons or reduce their emissions. As mentioned earlier, a downstream carbon permit system can be either an input system (controlling the carbon content of the fuel used) or an output system (controlling the amount of carbon emitted).

An output system can measure and control the amount of carbon emitted by time period or production level. For example, one could set a cap for electric generating plants equal to their 1990 levels of carbon emissions, and each plant would have to reduce its emissions to this level or purchase permits from the market. Alternatively, the government could set a carbon emission standard of so many pounds of carbon per some

measurement of production. For a power plant, this measurement could be megawatt hours; for a steel plant, it could be tons of steel. Proponents of this option argue that it will reward more efficient generators and provide a target to improve efficiency.[30] While this idea will resonate in those regions with newer, efficient plants, it will be less popular in regions with older facilities. There is also the danger that if the permits are allocated according to an output target, the resulting incentives could push industries in certain sectors to temporarily increase output in order to increase their initial allocation of permits.[31]

Support for a downstream system rests heavily on the premise that the US's success with its SO_2 allowance system can be replicated with CO_2. Looking only at the electric generating sector, this argument is persuasive. Certainly, one could design a tradable permit system for electric generating plants—not an insignificant emitter. But the premise that one could extend this system to other sectors, which emit the remaining 64% of the carbon, rests on a less stable foundation – especially when one tackles the transport sector which accounts for 28% of US carbon emissions.

Downstream programs will face many of the same challenges as an upstream system:

- Both will require the development of methodologies to estimate or measure carbon content—albeit the heterogeneity of products and their points of origin in a downstream system exceeds that of an upstream market. In principle, a downstream market can shift this responsibility upstream. That is, the

[30] Lashoff, Daniel, Tim Hargrave, and Sam Keller. (1997) "Output-Based Allocation of Emission Allowances." Draft paper.
[31] Fisher, Carolyn. (1997) "An Economic Analysis of Output-Based Allocation of Emission Allowances." Draft paper, Resources for the Future.

consumer of fossil fuels can require the seller to certify the carbon content of the fuel.

- Both systems will have to find ways to integrate exports and imports, though again the heterogeneity of the products and their points of origin in a downstream regime are greater. Further, under the General Agreement on Tariff and Trade (GATT), countries cannot discriminate based on the method used to produce a good. This rule makes it more difficult to overcome price disparities between domestic and imported goods arising from a downstream carbon reduction program.
- Both systems will need to integrate a US tradable permit system with the different systems adopted by its trading partners. How should US customs officials treat a car made in Italy, where the manufacturer paid a small carbon tax, as opposed to a car made in Detroit where the manufacturer had to buy carbon permits for a significant sum?

Four problems are more pronounced in a downstream system than in an upstream system: 1) the administrative difficulty of a system of this scope and size; 2) the transaction costs of cross-sector trading; 3) inadequate coverage; and 4) greater obstacles to effective enforcement.

Size and Scope of Program

The electric generating sector accounts for about 36% of the US's carbon emissions. The relatively small number of sources in this sector make it a realistic candidate for a tradable permit program, but what about the other 64% of carbon emissions? The transport sector with its 200 million motor vehicles emits 28% of the

carbon[32] and the industrial sector 25%. The remaining 11% is fairly evenly divided between the commercial and residential sectors. In the industrial sector alone, there are over 370,000 sources (see Table 2) and 1,004 separate industries in the Standard Industrial Classification System (SIC).[33] Even if the government concentrated on the twenty SIC codes which account for the greatest carbon emissions, it would still be managing over 100,000 sources.

TABLE 2

Downstream Entities

Sector	Units
Residential	102,264,000
Commercial	4,528,000
Industry	370,000
Transportation	Greater than 200,000,000
Electricity Generators	3,239

Source: Center for Clean Air Policy. (1998) "US Carbon Emissions Trading: Some Options that Include Downstream Sources." Center for Clean Air Policy, Washington, DC.

If the government decides to include only the largest emitting SIC codes in a permit system, economic distortions will result. Exempted sectors will have a competitive advantage. Companies will quickly repackage their product lines to fit all or part of their business within the uncovered sectors. As these sectors grow, their carbon emissions will increase. The covered sectors will protest what they perceive as a discriminatory system. In the end, the government will be pressured to include more sectors, thus increasing the administrative burden it had sought to minimize by limiting the coverage.

[32] US Department of Transportation. "National Transportation Statistics, 1997." Washington DC, 1996. (If all aviation and water-borne shipping is included, the number is 31A.)
[33] Center for Clean Air Policy. (1998) "US Carbon Emission Trading: Some Options that Include Downstream Sources." Center For Clean Air Policy, Washington, D.C.

Intersector Trading

Imagine that a downstream system includes twenty sectors. How should the government allocate the permits among them? What economic rule will be perceived by all the parties as fair? If an auction is held and several sectors secure a disproportionately large share of the permits, the losing bidders will be forced to buy permits or curtail production. From an economic standpoint this is an acceptable outcome because the market will reallocate the permits to the areas of greatest need, but from a political standpoint the perception of intersector inequality will elicit howls of protest.

If permits are allocated based on some type of index, should the basis be historical usage or projected future usage? If it is calculated according to historical use, it will benefit the biggest emitters. In fact, if a company believes there is a high probability of an administrative allocation process, it will have an incentive to resist any premature carbon reductions. Is this signal one that the government wants to send?

Both the initial allocation and any adjustments in later years will be tricky. For example, if five years into the program the government adjusts the allocation to reflect actual usage, the sectors that have reduced their carbon emissions the most will receive fewer permits than those sectors who have reduced less, since their carbon emissions as a percentage of total emissions have dropped.

Trading between companies in different sectors will be feasible but have high transaction costs. Brokers will emerge to manage the information asymmetries and transaction costs in a market, just as they have in the SO_2 allowance market. Even in the SO_2 programs, as of 1998, most of the SO_2 trades have been within a single company, i.e. "intracompany." Furthermore, the size and magnitude of trades in the SO_2 market pales in

terms of size and complexity with those that will emerge in a full-scale downstream CO_2 system. For example, there is little homogeneity between the industrial sectors responsible for CO_2 emissions, nor do they have much experience with intersector trading. These two factors alone will increase transaction costs, at least in the early years.[34] Stated simply, food producers are not accustomed to dealing with steel companies. Such a diffuse system will also increase the administrative and regulatory complexity for the government.

Inadequate Coverage

It will be difficult to cover all key sources of carbon in a downstream program. For example, full coverage of the transportation sector would require including over 200 million motor vehicles in a trading program—an infeasible proposition. Instead the permits would have to be allocated to the vehicle manufacturers and then new more stringent Corporate Average Fuel Efficiency (CAFE) standards developed to ensure that the fleets of cars, trucks, vans and buses burn less fuel per mile.[35]

Stricter CAFE standards have been proposed periodically during the past two decades, but Congress has repeatedly rejected them. Concerns about cost-effectiveness, competitive discrimination, and reduced consumer choice have resonated with political leaders, and are unlikely to fade. Further, it will be difficult to design a system in which CAFE permits can be traded for carbon permits.

While it would be feasible to build a carbon permit system similar to the SO_2

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[34] One of the reasons for the success of the lead trading program is the fact that most potential trading partners had substantial prior experience in dealing with one another. Hahn, Robert W. And Gordon L. Hester. (1989) "Marketable Permits: Lessons for Theory and Practice," *Ecological Law Quarterly*, 16(361):380-91.

[35] An alternative would be to impose a higher gasoline tax, but such taxes have traditionally run into significant political opposition.

program for the electricity sector, by doing so, the government would be raising the cost of one energy source—electricity—and not other competitive sources such as oil and natural gas. This will create a perverse incentive for companies and large users to switch from electricity to fossil fuels. For example, a number of federal and state programs promote electric vehicles as a substitute for gasoline-powered vehicles. A downstream electricity permit system, without some type of tax or fee on gasoline, will create incentives that work against these government programs.

Proponents of a downstream system might argue that an electric CO_2 cap and trade program could be accompanied by a carbon tax on fossil fuels to avoid distortions between the purchase of electric and non-electric energy. Putting aside the difficulties in designing and implementing a hybrid program, the political infeasibility of a carbon tax is one of the reasons that the US government would consider a tradable permit program. Under the proposal, the government would find itself in the ironic position of proposing a carbon tax in order to make a downstream electricity tradable permit program work.

Another coverage problem relates to cost-effectiveness. The downstream sectors targeted for a tradable permit program would likely be those that have demonstrated a willingness and capacity to reduce emissions and implement energy efficiency improvements. However, these may or may not be the sources where the most effective opportunities lie. Only trading across all sectors provides the incentive to identify the most cost-effective carbon reduction opportunities.

Enforcement and Monitoring

One of the major points of controversy in designing the SO_2 allowance system was how to ensure that electric generators emitted no more SO_2 than allowed by their *permits. The* solution was a very costly, but accurate, system of continuous monitoring

equipment which each electric generating plant had to install. A similar system might be feasible for a few hundred large CO_2 sources, but prohibitively expensive for several hundred thousand sources.

Alternatively, the government could require spot checks or simply rely on monitoring the carbon content of the fuel. In other words, fall back and rely on a downstream *input* standard. However, one of the major benefits of a downstream system is that by regulating *output*, government creates incentives to develop technologies for new sequestering options. By moving to an input standard, it becomes much harder to retain these incentives.

In summary, the argument that a downstream CO_2 trading system, involving at least 600,000 to one million sources, can build on the success of the SO_2 system, which as of 1998, involved only 110 sources, is a stretch. Especially when one considers that part of the success of the current trading regimes is due to the homogeneity of the companies involved. That is, they are familiar with each other and each other's business needs. Such would not be the case in a comprehensive downstream carbon trading regime. The enforcement and monitoring requirements would dwarf previous efforts, and without strong enforcement a trading regime would not be credible.

It is possible to design and implement a downstream CO_2 trading system. However, it will demand a commitment of resources and political patience on the same scale as gasoline rationing – something that the United States Congress has only been willing to do at a time of total public commitment, such as World War II.

II. COMPARING THE UPSTREAM AND DOWNSTREAM APPROACHES

Some members of Congress argue that the near term costs of any mandatory carbon reduction program are too high and that policy responses should be delayed until the country has more information. Putting aside the merits of this viewpoint, let us assume that the federal government eventually commits to implementing a greenhouse gas or carbon tradable permit program. How do decision-makers decide whether to locate such a regime at the upstream or downstream ends of the market? What are the tradeoffs?

Four criteria help us evaluate the choices:

- **Environmental Effectiveness:** Will the program cover most carbon emissions, not only in the first year of the program, but throughout its life? Will the program be enforceable?
- **Economic Effectiveness:** Will a program have lower costs per ton of carbon reduced than other programs? Will it provide incentives to develop and disseminate new technologies?
- **Administrative Feasibility:** Which program will entail the least complex and expensive administrative mechanisms? Which will minimize transaction costs?
- **Political Feasibility:** Will a downstream or upstream program be more effective in generating the political support needed for adoption and implementation?

A. Environmental Effectiveness

Coverage

Regardless of whether the recent Kyoto Protocol is rejected or ratified by the signatory nations, it does provide an idea of the size of the reductions that an international agreement may stipulate. The Kyoto target would require the US to reduce its carbon dioxide emissions by 600 to 800 million tons per year. To achieve such a significant reduction equitably, it will be important to include as large a percentage of the sources of carbon emissions as possible. If only 50% of the sources are included, then this segment of the economy must reduce emissions at least twice as much as if 100% are included.[36] Carbon reductions are generally perceived as expensive,[37] so a program that does not spread the burden equitably will meet with strong political resistance. Inadequate coverage also violates the cost-effectiveness criteria. Potentially inexpensive reductions among the 50 % of the sources not included in the program are lost, increasing the cost per ton reduced. With the growth in the demand for still further reductions in ensuing years, then the total cost of a program that asks 50% of the sources to make 100% of the reductions will be much higher than if the costs were borne by 100% of the emitters. Governments would have to rely on more expensive reduction options as the low cost investments will have already been made. On the other hand, any program that addresses only 50% of the emitters and asks them just for their fair share of the reductions will only meet 50% of the carbon reduction target.

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[36] Actually, they would probably have to make more than 100% in order to compensate for leakage as a result of increased emissions elsewhere.

[37] Recent estimates of complying with the Kyoto Protocol's target for the US of seven percent below 1990 levels range from $30 billion [Yellen, Janet. (1998) Testimony before the House Commerce Committee. March 4.] to $300 billion [Bernstein, Paul. (1998) "How Much Could Kyoto Really Cost?" Charles River Associates, Washington, D.C.

Reaching the majority of downstream emitters will be difficult, because program designers must include numerous sectors and numerous units within each sector. In 1996, the electricity industry emitted 36% of the US's manmade carbon, the transport sector 31%, industry 21% and the commercial and residential sectors 11.5%. If a permit program only includes 100% of the electricity generators, 80% of the transport sector (which includes cars, trucks, airplanes, trains, and ships), and 50% of the industrial emitters, then approximately 30% of the emitters escape the reduction requirements. Assuming a cost of $100 per ton of carbon and an average growth rate in emissions across the board, approximately $40 billion in carbon reductions will fall on the shoulders of the remaining 70% of the emitters. Fifty percent of this burden, or $20 billion, would fall on the electricity industry since they comprise half of the seventy percent who are participating in the program.

If the designers of the downstream system opt to capture as many sectors as possible by focusing only on the large units, companies will scramble to build units that are just under whatever threshold is selected. Six industry sectors— petroleum refining; paper and allied products; primary metals; stone, clay, and glass; chemicals; and food and kindred products—consume a disproportionate amount of the energy used in the industrial sector.[38] Therefore, if the government focuses the reduction program on these six sectors, it will capture a significant portion of industrial carbon emissions. If the designers follow this logic and only include the units within these six sectors, they will create the same economic advantages for the exempted *sectors* as they would have for exempted *firms*, while simultaneously stimulating gaming practices.

[38] EIA, (1997) *Manufacturing Consumption of Energy, (MECS) 1994.* DOE/EIA-0512(94) Washington, D.C.

The downstream problem of what to do with small manufacturing facilities, the apartment house boiler or the diesel powered river barge is, to a lesser extent, replicated at the upstream end. For example, there are 434,000 stripper wells in the United States, each of which produces no more than 10 barrels per day.[39] If they are exempted, more will appear as small independent producers seek the exemption. There are hundreds of small independent gas producers who usually sell or lease their production units to large integrated companies, but if the perceived financial cost of the permit system is high, they will try to avoid the carbon reduction system either by retaining ownership and signing service contracts with the larger companies or establishing hundreds of small partnerships, each with a different name, but with the same owners.

Although it will be difficult to encompass about 10-20% of emitters in either an upstream or downstream system, it appears that coverage will be easier at the upstream end. The problem of the small oil and gas producer might be resolved either by moving the locus of the permit to the processing plant or by addressing the concerns of the smaller producers through the design of the permit allocation procedures. There is no analogous solution downstream. A tax or fee on the residual sectors is unlikely to receive political support, since these sectors consist of many firms with strong local political support.

Enforcement

EPA has experience in enforcing both a downstream and an upstream system. The SO_2 allowance system is a downstream program and the lead trading program for refiners was more of an upstream program.

[39] Interstate Oil & Gas Compact Commission—http://www.iogcc.oklaosf.state.ok.us/.

To enforce the lead program the government used a system of self-auditing with spot checks. Each company had to file a form with the EPA that certified the amount of lead in the gasoline it sold and the number of permits it held. Since the EPA did not monitor the permit trades, this system relied on the honesty of the reporting refineries and the threat of EPA spot checks and enforcement action. The system seemed to work well. The estimates of non-compliance level are low—under 7%, and most in the first two years.[40] But keep in mind that the lead permit program only involved 250 references and a relatively small volume of fuel compared to a CO_2 program. When seeking to reduce 600-800 million tons of carbon emissions, 7% non-compliance would not be a trivial number. Further, Carolyn Fisher, an economist at Resources for the Future, notes that even in the lead program there were incentives for gaming as some producers took unleaded gasoline and added small amounts of lead to make the gasoline eligible for permits.[41]

An upstream carbon permit program would rely on a similar self-audit procedure, probably requiring an independent auditor to certify the information. This large enforcement initiative would also require the identification of sources through tax records or formal filings with the Federal Energy Regulatory Commission and the Energy Information Agency.

Identifying most of the sources is feasible. Approximately 300,000 companies currently hold air pollution permits and probably account for 80% of the nation's industrial carbon emissions. Furthermore, the Department of Energy's Manufacturing Energy consumption database has information on most companies. A computer-based self-auditing system can be set-up accompanied by spot checks and fines for non-

[40] Loeb, Alan P. (1990) "Three Misconceptions About Emission Trading." Presented at 83rd Annual Meeting and Exhibition, Air and Waste Management Association, Pittsburgh Pennsylvania, June 24-29.
[41] Newell, Richard G. (1996) "Trading System for the Phasedown of Lead in Gasoline." Manuscript, Kennedy School of Government, Harvard University.

compliance. Establishing the system will require an expansion of EPA's enforcement staff (or that of state government) and a significant up-front investment.

The enforcement of the SO_2 system relies on expensive continuous monitors that provide minute by minute data on how much SO_2 is being emitted. At the end of the year, the cumulative emissions of each company is compared to the volume of emissions for which it has permits, and if the former is greater than the latter, the company pays a large fine. This system is expensive, but buys a high level of compliance. Difficulty establishing a carbon monitoring system for the large number of sources that would be included in a downstream effort may lead regulators to embrace an input standard limiting the carbon content of the fuel burned, rather than the carbon emitted. Unfortunately, this would erode the incentive to develop cost-effective emission reduction technologies.

There are two remaining problems. Without installing an expensive monitoring system, how can the government be sure the system of self-reporting, supplemented by spot checks, will result in a high levels of compliance? Secondly, how should government manage the remaining twenty percent of the sources plus the 200 million motor vehicles?

The Treasury and Energy departments will have a much larger enforcement role with an upstream effort, especially if it encompasses imports and exports and a tax credit program to address non-energy use of carbon. A downstream system could be enforced through expanding mechanisms already in place at the EPA, but the necessary monitoring programs will be very costly.

In conclusion, the environmental effectiveness criteria favors an upstream system. The coverage will be greater, the economic burden more equitable, the impact more evenly spread across the economy, and the enforcement more manageable.

B. Economic Effectiveness

Three factors determine economic effectiveness: coverage; transaction cost; and incentives for technological innovation. The best tradable permit program would make trading easy, provide strong incentives for the development and innovation of new technologies, and minimize transaction costs.

Coverage

This issue was discussed in the previous section on environmental effectiveness, but coverage also has important implications for cost effectiveness. If the government seeks the lowest cost per ton of carbon reduced it must keep the menu of opportunities as broad as possible. When some sectors are omitted from the program, inexpensive reduction opportunities within those sectors are lost and the other sectors must reduce emissions further. Assuming that companies face an upward sloping supply curve—that is, the cost of each unit of carbon removed increases as the companies reduce more—the societal cost of the reduction target increases. Since emitters will want to get re-classified as exempted sources, some leakage is inevitable, and the volume of emissions not covered will grow as the program gets underway. Then the cost of requiring even greater reductions for those remaining in the program rises. The bottom line is that there is a higher probability that an upstream system can achieve greater coverage than a downstream program and thus have lower costs per unit of reduction.

Reducing Transaction Costs

When the government caps the supply of permits, it is capping the amount of carbon that can be burned. As the supply of permits decreases, the price of carbon rises, which raises the price of carbon-based fuels. In a perfect world, sources that can reduce their use of carbon cheaply sell their surplus permits to those that find reduction more expensive. Over time, these transactions equalize the marginal abatement cost for all firms. Pollution abatement shifts from a higher cost firm to a lower cost firm until all the opportunities to make cost-effective transactions have been pursued.

The greater the fluidity in the market, the greater will be the opportunities for identifying and consummating cost-effective trades, and the lower will be the total cost of abatement.

In a downstream CO_2 system, firms in one sector will have little experience doing business with firms in other sectors. Most of the trades will occur within sectors, at least at first, as most companies in the United States have little experience with intersectoral trading. This lack of fluidity will tend to raise the cost of abatement.

Upstream systems will involve firms who engage in similar activities – mining and producing energy resources. If the permit locus is moved to the processing plants, there may be less commonality among the plant operators than among energy producers, but the number of participating companies is smaller and within sub-sectors, such as coal processors or electricity generators, there is a high degree of familiarity. In either case, trading should be more fluid at the upstream end of the spectrum than at the downstream, and the transaction costs should be lower.

Incentives for New Technology

Increasing the price of fuels in proportion to their carbon content provides an incentive to burn less fuel or to switch from carbon-intensive fuels such as coal to low carbon fuels such as natural gas. Most consumers, facing higher fuel costs, will strive to use fuel more efficiently. And if the price of electricity rises because of higher fuel prices, consumers are motivated to buy machines, appliances, lighting and HVAC equipment that supply the same service with less energy. Producers of these goods will have an incentive to take advantage of this demand by investing in the development and marketing of energy efficient alternatives. By raising fuel prices, an upstream system will provide signals for the development of new, less-carbon intensive energy sources and more energy efficient equipment.

A downstream system has one clear and one possible advantage. First, it will provide strong incentives for the development of emission abatement technologies to reduce the cost of stripping carbon emissions at the stack. These technologies strip the carbon at the point of emissions and sequester it in the ocean or salt dunes. Analysis by Parson and Keefe suggests that CO_2 sequestration technologies may be more economically feasible than previously thought, especially for large electric generating plants.[42] Costs could fall further, as new research may lead to the development of new and more cost-effective CO_2 sequestration technologies. However, an upstream system may offer some of the same incentives since the costs to the coal and railroad industries in either system may be so high that they also will have an incentive to support the development of emission reduction technologies. If the industry stands to lose $50 billion, then spending $1 billion on R&D becomes attractive.

[42] Parson and Keefe. Ibid.

There is a second possible advantage to a downstream system that needs further analysis. In the Kyoto agreement, reduction targets are to take effect in 2008-2012. Some countries would like to stimulate emission reductions prior to those dates. Hence, there is active discussion on how to catalyze investments in "early reductions." At the moment, companies have no incentive to make such reductions, since they would incur costs without any benefits. In fact, if a company believes that carbon permits will be allocated according to historical use, it has a perverse incentive to *increase* emissions.

If a perfectly fluid trading program is created--one that allows for and facilitates an open market for carbon permits--one should be able to link early reductions to either an upstream or downstream program. But the probability of perfect fluidity in the early years is limited. Furthermore, the determinant of a successful early reduction program will be its credibility. Do participants believe its purported benefits are real? In a downstream system, this relationship between reductions and credits is likely to be clearer than in an upstream system.

C. Administrative Feasibility

Any type of permit program will demand a compliance system with sufficient resources to ensure that violators are caught and prosecuted. The program must be able to obtain compliance from both the primary energy related permitees and those impacted by the more complex provisions regarding non-energy fossil fuel, imports, and exports.

Because of its sheer size, a downstream system will require more administrative resources than an upstream system. All of the federal agencies now involved in interagency policy-making will have to add people and programs and cooperate at an extraordinarily high level. Into this mix, add the need to build enforcement capacity into

fifty state agencies, where the vast majority of the compliance responsibilities for air emissions lies.

An upstream system also will require an infusion of resources and significantly more integration between the Departments of Treasury and Energy and EPA, but not on the scale of a downstream system. A system that involves multiple SIC codes, several hundred thousand companies, and 200 million motor vehicles is clearly more difficult to manage and enforce than one that involves three to five industries, even though those industries are very large.

D. Political Feasibility

Environmentalists and the manufacturing communities, two key interest groups, are likely to disagree about the ideal system. The environmental interest groups will be biased in favor of downstream programs. They will prefer a downstream system's strong link between reduction targets and actual emissions and the fact that it will be regulated by EPA with the assistance of state environmental agencies--players with whom the environmental NGO community is comfortable.

The manufacturing community, if forced to accept a permit program, will prefer an upstream system because it causes fewer economic distortions. An upstream system raises fossil fuel prices but each emitter can choose how to respond to these price hikes. A paper mill in Oregon does not have to worry that it cannot get enough permits to operate. It will simply pay more for fuel. Gas companies will have an obvious preference for an upstream system because demand for their product will increase. If oil companies are forced to accept some reduction, they too will likely favor the upstream version, especially if the locus for permits is at the processing rather than the production level.

Ability to Obtain Congressional Passage Versus Ability to Implement

Disputes among interest groups as well as the cost to implement an upstream or downstream program will make it difficult to persuade Congress to approve specific carbon reduction programs. The greater the number and diversity of the interest groups, the more complicated the task to create legislation. The more complicated and complex the final result, the more difficult it is to implement. Heated conflicts among the interest groups increase the likelihood of time consuming and expensive court challenges. To make matters more complicated, the amount of money at stake is about $134 billion per year, as compared with less than $2 billion in the SO_2 case. In other words, a tradable permit regime for carbon could involve the allocation of rights that have a value equal to between 1–1.5% of GNP. Some of that value will return to the Treasury in the form of taxes, but the initial wealth transfer will be high. Once this is understood, parties will decide that spending several millions of dollars to lobby Congress to obtain an allocation scheme favorable to their interests is a good investment. Amidst the battle of dueling lobbyists, each with a hefty media budget, it will be very difficult to cobble together an agreement.

The political feasibility criterion favors the option that minimizes the magnitude and intensity of the blocking coalitions while simultaneously identifying benefits that might persuade certain interests to support the proposed legislation. Sometimes the strategies that favor the latter will violate the former. That is, dressing up the program with special provisions to please key interests will stimulate the other interests to demand equal consideration. In such situations, the proposal gets overloaded and runs the risk of sinking. Striking the right balance is important. Even more important will be engendering the discipline not to overreach or over-promise—a discipline that is not commonplace in our pluralistic government.

In a downstream system, the number of diverse interests will be even larger than in an upstream system. The intersectoral competition alone will give rise to many more coalitions. An upstream system will also stimulate blocking coalitions – but with fewer interests and fewer issues in need of resolution.

Stimulating Blocking Coalitions

What factors are likely to catalyze the formation of blocking coalitions? The predicted cost of the program and the uncertainty about that prediction are clearly important factors. Hence the interest in a permit system in which the government guarantees a maximum permit price.[43] In such a scheme, everyone is reassured that the price tag will be capped.

The perceived distribution of costs and benefits among geographical regions, industries, or firms is a second factor. The ability to make a strong case that a policy discriminates unfairly against certain regions, will resonate within Congress and the executive branch. An upstream system will be less susceptible to these inter-industry, inter-regional and intra-sectorial accusations of discrimination. Of course, there will still be substantial tension between gas, oil, and coal companies and even greater tension between large and small producers.

But a downstream system, because of its size, will stimulate greater political battles. The allocation system—which will be a daunting task in the upstream case—will

[43] See McKibbin, Warwick, and Peter Wilcoxin. (1997) "A Better Way to Slow Global Climate Change." *Brookings Policy Brief.*

be an overwhelming challenge in a downstream system. For example, each of the impacted industrial sectors will fight for a favorable allocation status. If some permits are grandfathered, then each sector will lobby Congress and the executive branch for the largest possible allocation. The political maneuvering would then be repeated within sectors as companies tried to maximize their individual allocation. Firms would find hundreds of compelling reasons that they should receive special help from Congress.

What System Will Engender the Least Public Outcry?

An upstream permit system will curtail the availability of carbon-containing fossil fuels and thus increase their price. Facing higher fuel prices, consumers will find ways to use less. From the perspective of a consumer, this is approximately the same scenario that would occur if the government implemented a carbon tax. If the permit system contains a low price threshold above which the government will intervene and sell permits, the system is akin to a carbon tax set at the threshold figure. On the other hand, if the threshold is high, then the system will operate more like the lead permit system. The price of a permit will be determined by the market and will be allowed to rise to the point where it mirrors the marginal cost of reduction.

On the other hand, the price increases that result from an upstream system are quite explicit. Where there is a clear relationship between the federal action and the subsequent price increase, the regressive character of the action is made more visible (although not necessarily more real). In a downstream permit system the causes of the price increases are hidden. An upstream system will be widely recognized as a government-induced increase in fuel costs, and thus it will stimulate some of the same negative reactions as a carbon tax. Americans have a strong aversion to energy taxes. Compare the political reaction to recent increases in gasoline taxes—increases that were modest at best—to the reaction to the price increases resulting from the 1990 Clean Air

Act Amendments required for reformulated gasoline. There was a public furor over the former, but very little response to the latter. Policy makers will have to consider whether the public will see an upstream system as simply a thinly disguised carbon tax. A downstream approach may have an equal impact on the economy, but the public will see the subsequent increases in product prices as similar in character to increases in conventional air pollution reduction programs.

The Urge to Build on the SO_2 Approach

After all these factors are weighed, some people may conclude that a pure downstream system is impossible, and argue for a hybrid approach: a downstream permit program for electricity generators and an upstream system for everyone else. This option is influenced by the early successes of the SO_2 tradable permit program where there is a workable market for emission allowances and the trading price has been much lower than anticipated. Intertemporal trading, allowed under the program, has provided participants with the capability to buy and sell permits over a seven year time period, thus providing the flexibility to pursue the most cost-effective compliance strategies. Perhaps most importantly, the SO_2 program is recognized as a success by almost all the parties—the business community, environmental groups, EPA, the states, and Congress.

A carbon reduction plan wrapped in the same cloth has much political appeal. Replicate the SO_2 permit success, the proponents argue, and the US can enjoy significant emission reductions at lower than anticipated costs. But as Robert Stavins points out, one cannot simply copy the SO_2 tradable permit regime and be assured of a successful carbon-reduction program.[44] While an electricity carbon tradable permit program might be politically attractive, an extension of the program to other downstream sectors is not. The

[44] Stavins, Robert N. (1998) "What Can We Learn from the Grand Policy Experiment? Lessons From SO_2 Allowance Trading" *Journal of Economic Perspectives*, Forthcoming.

US cannot meet a reduction target by burdening just the electricity sector. Further, this sector is in the midst of substantial change, as many utilities are selling their generating assets to other companies. The industry is becoming a contractually-linked set of unbundled market players, rather than a vertically integrated monopoly. In this new system, there will be strong political resistance to any plan that places a disproportionate burden on the electricity industry. As smaller distributive electric technologies enter the market, electricity will be competing with natural gas. If the government requires one energy source to meet greenhouse gas standards but not the other, it will provide the latter with an enormous competitive advantage.

Why not adopt a downstream system for electric generators and an upstream tradable permit system for all other users? This policy is attractive because we are fairly certain that a tradable carbon regime for electricity generation will work, but we do not have the same confidence in any other option. However, there are many inherent problems with this hybrid system, such as how to smoothly integrate the two different approaches. Would you exempt natural gas producers who sell to an electric generator? If so, would you require the generating company to obtain an upstream permit if it resold the gas? What if the resold gas was used to power a fuel cell that produced electricity for an apartment building? We can find answers to these questions, but designing a hybrid system is likely to be politically and administratively more complicated and costly than designing only an upstream system. The architects will have to manage all the problems of the upstream system plus the problems of a single sector downstream system.

In summary, the political feasibility criteria does not clearly favor either an upstream or a downstream system. Both have advantages and disadvantages.

Figure 1. Summary Comparison of Upstream and Downstream Tradable Permit Regimes

Criteria	Upstream	Downstream
Environmental Effectiveness	• Less Costly • Easier to enforce • Greater coverage ++	• Less coverage • Leakage could be a problem –
Cost Effectiveness	• Transaction costs will be lower • Market will be more fluid in early years +	• Since can't include all sources, will need more control from covered sources, increasing abatement costs • Greater incentives for technology innovation • Possibly easier to develop link to early reduction program o
Administrative Feasibility/Costs	• Will have to estimate carbon content of fuels, but less variability upstream than downstream. • Need to design system to deal with non-energy fossil fuel uses and carbon embedded in products. +	• More costly because of size of system • More costly to enforce • Managing imports and exports less of a problem o
Political Feasibility	• Number of affected blocking coalitions less • Fewer special provisions to compensate interests • Business support – Treasury and DOE play a larger role o	• Environmentalist support – EPA plays large role • Momentum to build on SO_2 program • Intersectoral disputes are greater, price increases less explicit o

III. CONCLUSIONS

If the US government decides to pursue tradable permits, there will be an intense political battle over the design of the program. The money at stake will be fifty times that of the SO_2 program and over three hundred times that of the CFC reduction ordered by the Montreal Protocol.[45] The size and complexity of the task exceeds any prior emission reduction program.

A tradable program is technically feasible but very challenging. The early support for such a program rests on replicating the success of the SO_2 allowance system and developing a downstream output-based program. However, most designers are focused on one industry: electricity. Few are confident that a downstream approach can be expanded to cover the remaining 65 % of the downstream sources. The transactions costs will be high and the potential for battles between and within industrial sectors will be great. If the decision is to replicate the SO_2 program and grandfather the permits, the task of designing an allocation formula that will satisfy twenty or more industrial sectors, the US automobile industry, and the electric utilities is daunting. Enforcement and monitoring will be a very large problem. A system of self-reporting and spot checks plus perhaps an expensive system of computer-based monitoring will be required.

Two criteria, environmental effectiveness and administrative feasibility, strongly favor the adoption of an upstream system. It will be easier to implement, cause less

[45] This assumes a mid-range estimate of the costs of reducing GHG emissions to seven percent below 1990 levels over the 2008-2012 period, about $100 billion per year. Annualized cost of complying with the SO2 program has been estimated at $2 billion (U.S. General Accounting Office. (1994) "Air Pollution: Trading Offers an Opportunity to Reduce Emissions at Less Cost" GAO/RCED-95-30. Washington, D.C.) Estimates of the cost of CFC and halon phaseout under the Montreal Protocol at $2.7 billion from 1990 to 2000 (Council of Economic Advisers. (1990) *Economic Report of the President*. US Government Printing Office, Washington, D.C.)

economic distortions, be more enforceable, ensure greater coverage, and will have substantially lower transaction costs. Admittedly, designing such a system is a daunting challenge—one that can only be met if the government commits substantial resources and political will to develop and implement such a program and manage the ensuing political maelstrom. Finally, no matter how brilliant the designers, there will be major loopholes and errors in any initial program that will need to be continually amended.

While the environmental effectiveness and administrative feasibility criteria favor adoption of an upstream system, there are also some advantages to a downstream system (See Figure 1). Economically, such a system will provide stronger economic incentives for the development and dissemination of emission reduction technologies such as CO_2 sequestration. It may facilitate the design and implementation of an early-reduction program and most of the relevant parties are more familiar with a downstream, than an upstream system. However, when the relative costs and benefits of each system are weighed, most analysts are likely to conclude that an upstream system, even with all its challenges, will be more effective and easier to implement.

If Congress decides to pursue such a system, many contentious issues must be addressed. Six of these are especially important.

1. Balance Adequate Coverage with Program Efficiency

Even though there will be fewer players in an upstream, as opposed to a downstream system, implementing a program for 15,000 fossil fuel producers will be a challenge. Many of them, such as stripper well owners, are small, and produce less than 15% of the nation's oil, gas, and coal. The strong temptation will be to focus the permit system only on the producers of the 85 %. Such a program will perversely reward the least efficient producers, and the percent of producers who fall outside the program will grow. Past air

pollution programs resolved this problem by wringing more reductions from the remaining sources, but in the case of a CO_2 tradable permit program just a three percent growth in the percentage of exempt emissions would equal an extra burden on the sources of approximately $4 billion per year. But the tradeoff is tough: if all sources are included in the program, the complexity and cost of designing enforcement and monitoring regimes becomes much greater.

An alternative is to have intermediate processors or transporters hold the permits, but such a system cannot circumvent all coverage issues. Small producers will complain of discrimination and it will be difficult for the federal government to craft an appropriate administrative and political response to those protests. The US's experience with the 1970s oil allocation programs offers little encouragement. Small producers, with strong local political backing, were able to obtain special dispensations or exemptions, which in turn created economic distortions. These distortions eventually created an endless process of amendments each of which shifted the problem to another part of the system.

In the case of carbon, so much money is at stake that coverage issues will dominate the debate. If policy makers can minimize the opportunities to game or manipulate the program they will maximize their chances of success.

2. Think through the permit allocation process

The conventional wisdom is to grandfather the CO_2 permits just as the SO_2 program did. But, as the dollar value of these permits will be very large, it will be politically difficult to grant such a huge windfall to the energy companies. Further, an auction approach would provide the government with some revenue that it could use to significantly reduce the

total cost of the program.[46] Consideration should be given to various "hybrid" possibilities in which at least a portion of the permits would be auctioned.

3. Treat non-energy fossil fuels and imports carefully

Approximately 11 % of the nation's oil and gas is processed into products that are not consumed for energy purposes. To complicate matters, it is not altogether clear whether the products leaving a refinery will end up in the engine of a jet plane or the rug in one's living room. This problem is solvable, but will demand additional administrative personnel, complex paper trails and probably amendments to the tax code.

Because oil and gas products are continually moving between countries, the best permit system will ensure that imports meet equivalent requirements to those imposed on domestic producers, while avoiding double-counting. The US treatment of imports must factor into its program the carbon reduction programs of other countries without violating the GATT or else significant trade disputes may arise. In the end, there will have to be an international mechanism—perhaps attached to an existing international body such as the World Trade Organization—empowered to work with countries to resolve import/export problems. It is likely that the Treasury Department will play a much greater role in the process than it has in past energy and environmental initiatives.

4. Establish effective enforcement and monitoring regimes

There is no existing enforcement and monitoring regime that can quickly be expanded to meet the needs of a carbon permit program. One will have to be established. A regime with a self-auditing component supported by a strong oversight and enforcement mechanism will be necessary. Perhaps a new office of compliance will also have to be

[46] Parry, Ian. (1997) "Revenue Recycling and the Cost of Reducing Carbon Emissions" *RFF Climate Issue Brief #2*. Resources for the Future, Washington, D.C.

established. This new office might be located in the Environmental Protection Agency or in the Department of Energy or the Treasury.

With huge amounts of money at stake, there will be a large incentive to cheat. Unless the enforcement threat is real, the program will lose its credibility with the public. Therefore, designing an effective compliance system will be the single most important factor in determining the success or failure of the carbon tradable permit program.

5. Allocate institutional responsibility carefully

While a downstream tradable permit system builds on existing capacity within the EPA, an upstream system will require an unprecedented level of cooperation between the Treasury, the Department of Energy, and EPA, plus the active support of the State Commerce and Justice departments. For example, a workable enforcement program at the upstream level will require a joint effort involving DOE, EPA, Justice, and Treasury. The program will not be effective unless all four of those agencies are equally committed. Unfortunately, there are very few examples where such a level of interagency cooperation—especially at both the design and implementation stage—has succeeded.

Also needed will be a mechanism to ensure and manage interagency cooperation and to work with the ten to twelve committees in Congress who will claim jurisdiction for parts of the program. Finally, it is not obvious which agency should lead the development and implementation of an upstream tradable permit program. The choice will have a major impact on the program's character. A tradable permit effort chaired by EPA will have a different flavor and bias than one chaired by DOE or Treasury.

6. Do not wait until the last minute to do something

If one believes that the US Congress will eventually decide to set mandatory reduction

targets, tradable permits will undoubtedly be one of the leading proposals on the table. As this paper has explained, designing and implementing such a program will present an unprecedented challenge. The design and implementation issues are so potentially controversial that they will not be resolvable in one to two years. This means that the government will not be able to wait until 2006 to engage debate about the design of a permit program and expect to have a program implemented in 2008. Pilot efforts, demonstrations, and much discussion with all of the participants should begin as soon as possible. It took ten years to obtain agreement on an acid rain bill, thus why should we think that a carbon permit program can be approved in one-quarter the time?

Much more analysis and planning is needed. The danger is that in the post-Kyoto "war of words" between members of Congress and the Administration, such analysis will be postponed.

Ignoring the topic would be a mistake and will result in the future implementation of an option not fully understood by any of the parties. Whether or not the government should decide to embrace a tradable carbon permit program is a different question than whether the government should assess and understand the challenges that it will face if it chooses to pursue such a program.

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