An Upstream/Downstream Hybrid Approach to Greenhouse Gas Emissions Trading

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Cover photo: The main house at the Airlie Center, the location of the Greenhouse Gas Emissions Trading Braintrust meetings. Photograph reproduced with the permission of the Airlie Foundation.

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The Airlie Carbon Trading Papers

The Airlie Carbon Trading Papers are intended to help lay the intellectual foundation for a US greenhouse gas emissions trading system, which is a leading policy option for realizing cost-effective reductions of greenhouse gas emissions. The papers are the product of a unique research, analysis and dialogue process directed by the Center for Clean Air Policy. Since November 1996, the Center has convened regular meetings of its "Greenhouse Gas Emissions Trading Braintrust", a group of high-level representatives of industry, environmental organizations, state and federal government agencies and academe. The opinions expressed in these papers are those of the Center, though our views are informed by the extensive dialogue with Braintrust participants.

Braintrust members and Center staff conduct research and analysis of key design and implementation questions, then bring their findings and proposals to the group for discussion. The purpose of this process is to investigate alternative design options in detail rather than to arrive at consensus on a preferred option.

At the outset, the Braintrust identified a number of priority issues, including: definition of the instrument that would be traded, determination of who would be required to hold allowances, methods for allocating allowances, and the elements of the trading system compliance infrastructure. Braintrust members agreed to start with a focus on energy-related carbon dioxide emissions. Secondary issues identified by the Braintrust include the integration of additional greenhouse gases into the system, the incorporation of emissions reductions from forestry and land use activities and foreign countries, and the mitigation of any adverse impacts of carbon regulation on US industry.

Why the "Airlie" Carbon Trading Papers? The Airlie Center serves as the backdrop for the Braintrust's meetings. Situated outside the Washington, DC beltway in Warrenton, Virginia, Airlie provides an informal, congenial atmosphere that allows participants to leave their affiliations "at the door" and to build strong working relationships. These factors have been critical to the success of the Braintrust process.

About the Center for Clean Air Policy

Since its inception in 1985, the Center for Clean Air Policy has developed a strong record of designing and promoting market-based solutions to environmental problems. The Center's dialogue on acid rain in the 1980s identified many of the elements of the SO_2 control program that were adopted by the Bush Administration and eventually codified in the Clean Air Act Amendments of 1990. Since 1990, the Center has been active on the issue of global climate change. Center staff have participated in the Framework Convention on Climate Change negotiations and in domestic efforts to address greenhouse gases, analyzing and advocating market-based climate policies such as emissions trading and joint implementation. The Center brokered the world's first energy sector joint implementation project. The Center is also active in the areas of air quality regulation, electricity industry restructuring, and transportation and land use.

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Executive Summary

A downstream GHG cap-and-trade system covering large point sources only may offer political and other advantages, but it would result in incomplete coverage of emissions sources -- which is a drawback both environmentally and economically. This lack of coverage could be addressed in one of two ways: by complementing trading with other policies and measures (PAMs) or by expanding the trading system beyond large point sources by covering smaller sources upstream. The latter is likely to be both more environmentally effective and economically efficient.

This paper examines alternative approaches to expanding the coverage of a downstream trading system by bringing in facilities from farther upstream. It calls attention to a number of issues that would need to be addressed in integrating upstream and downstream facilities into a single system, most notably the challenge of ensuring that all carbon is accounted for once and only once. The paper concludes that an upstream/downstream hybrid is feasible and should be implemented at the following points: large industrial point sources, electric power generators, oil refiners, natural gas processing plants and local distribution companies selling natural gas. Such a system would be preferred to a downstream system covering large point sources complemented by non-trading policies and measures.

It may be desirable to establish a downstream greenhouse gas trading system that covers only electricity generators downstream rather than all large point sources. In this case the main conclusion of this paper would still hold: that the best way to achieve full emissions coverage would be to combine the power sector trading system with upstream trading rather than with non-trading policies and measures. In fact, a hybrid trading system that covered only power generators downstream would be easier to administer than one covering all large point sources downstream, because there would be less potential for double-counting or the exclusion of emission sources from the trading system.

I. Introduction

One of the key issues in designing a domestic greenhouse gas (GHG) emissions trading system is identifying the appropriate incidence of regulation – that is, who will be required to surrender emissions allowances. The leading options include the *upstream* approach, which would require allowances of fuel producers,[1] and the *downstream* approach, which would require fossil fuel users to surrender allowances.[2]

An earlier paper in this series cited a number of potential advantages of a downstream approach.[3] One is the possibility of greater technical innovation: Corporate managers and/or engineers may respond more proactively to direct regulation (the downstream system) than to price changes (an upstream system.) Greater technical innovation would translate into a shift in the US GHG mitigation supply curve – in other words, lower program compliance costs. Another advantage cited by proponents of a downstream system is greater political feasibility, due to the fact that allowances probably would be grandfathered to major energy users; the fact that it may be easier to pass legislation covering large point sources or power plants only rather than an economy-wide bill; and greater familiarity, because almost all existing trading programs have followed a downstream model.

The major disadvantage associated with the downstream approach is the lack of coverage of total emissions in the economy. This problem arises because of the vast number of emissions sources in the US: There are about 380,000 establishments in the manufacturing sector alone, and literally millions of buildings and vehicles.[4] It would not be feasible to construct and implement a system that included all these sources; a system that was feasible to administer would have to be limited to covering large point sources alone, which in the US account for less than one-half of total energy-related carbon emissions.[5] This low coverage would mean first, that policies and measures that provide less environmental certainty than the cap-and-trade approach would have to be used to achieve full regulatory coverage of emissions sources, and second, that many cost-effective mitigation opportunities would fall outside the trading system and therefore be missed. An upstream system, in contrast, would provide nearly full coverage of energy-related carbon emissions.[6]

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[1] The term "fuel producers" is defined broadly here, as it has been in other papers in this series, to include the extraction, processing, transport and distribution stages of the fuel cycle.

[2] For more detailed discussion of upstream and downstream approaches, see *US Carbon Emissions Trading: Description of an Upstream Approach*, Tim Hargrave, Center for Clean Air Policy, 1998, and *US Carbon Emissions Trading: Some Options that Include Downstream Sources*, David Festa, Center for Clean Air Policy, 1998. Both available from the Center for Clean Air Policy at www.ccap.org.

[3] Again see Festa, 1998.

[4] Ibid. Based on the US Department of Energy's 1994 *Manufacturing Energy Consumption Survey* (MECS), EIA/DOE, December 1997. DOE/EIA-0512(94). The results of the MECS survey conducted in 1999 for 1998 energy use have not yet been released.

[5] Ibid.

[6] Again see Hargrave, 1998.

The purpose of this paper is to explore alternative approaches to extending the coverage of a downstream system. The goal is to preserve downstream trading among large point sources while at the same time achieving the broad coverage of an upstream system. The paper does not take a position on whether the reasons cited in favor of a downstream system – greater technical innovation and political feasibility – are valid. Our purpose is simply to try to identify ways that the major weakness of a downstream system –lack of coverage – may be remedied.

The paper proceeds as follows. Section II describes the components of a downstream system covering large point sources. This description comes from the earlier paper on downstream trading already mentioned. Section III then lays out a number of options for achieving a comprehensive trading system while maintaining the direct coverage of large point sources, and Sections IV through VI each explore the advantages and disadvantages of one of the proposed methods. Section VII discusses some issues that arise in hybrid system design regardless of which of the approaches is taken. Section VIII summarizes the discussion and offers conclusions.

II. Downstream Trading

The companion paper on downstream trading concludes that a downstream system that includes electricity generators and large industrial facilities could be successfully implemented. This program would exclude the commercial, residential and transportation sectors, as well as small industrial fuel users.

Such a downstream system would include the approximately 2,500 units now covered under the Title IV sulfur dioxide cap-and-trade program.[7] Beyond the power sector, it becomes more difficult to identify the facilities that should be included in the program due to the great number and diversity of emissions sources. As noted, just within the manufacturing sector, which accounts for over two-thirds of industrial emissions, there are 380,000 establishments,[8] and there are even more individual emission sources.

A relatively small number of facilities account for the majority of industrial emissions, however. Table 1 demonstrates this, showing that fewer than 3,000 facilities -- those in the seven major four-digit SIC codes that use more than 100 Tbtu of energy per year – account for 55 percent of industrial emissions and 70 percent of manufacturing emissions. A downstream program would require these facilities to turn in allowances for their direct combustion activities only, with their electricity use covered by the trading system at the power generator.

[7] This figure is expected to grow to 3,000 or even 3,500 in the near future as additional power generating units are built. However, the number of *plants* is significantly less, since large power plants include multiple units. Personal communication with Kennan Smith, USEPA Acid Rain Program division, April 6, 2000.
[8] *Manufacturing Consumption of Energy, (MECS) 1994*, page xx.

III. Alternative Approaches to Expanding Downstream System Coverage

Cap-and-trade systems offer a number of advantages over other greenhouse gas control instruments. Foremost among these is certainty of environmental outcome. By definition, a cap on total emissions ensures that the environmental goal of a cap-and-trade system is met; what is not known *a priori* is program cost. In contrast, the environmental benefits of other policies and measures (PAMs) cannot be known with certainty. If elasticities are less than expected (in the case of price instruments such as taxes) or economic activity is greater than expected (in the case of efficiency standards for vehicles, appliances, etc.), then PAMs will not deliver the desired environmental outcomes. Further, because standards are normally applied to new assets but not existing stock, initially they do not provide full coverage of the emissions sectors in which they are applied.

Table 1: Large Manufacturing Facilities That Could Be Included in a Downstream Trading Program[9]

Subsector	Tbtu	# of est.	% of sector btu
Petroleum			*99%*
Petroleum refining	6,263	247	
Chemicals			*74%*
Industrial organic	2,369	631	
Nitrogenous fert.	622	118	
Plastic & resins	642	456	
Alkalies & Chlorine	129	44	
Cyclic crudes & int.	155	187	
Paper and allied			*94%*
Paper mills	1,297	310	
Paperboard mills	954	219	
Pulp mills	251	55	
Primary metal			*77%*
Blast furnaces	1,649	284	
Primary aluminum	241	44	
Food and kindred			*23%*
Wet corn milling	173	58	
Cane sugar (not refining)	105	43	
Stone/glass			*35%*
Cement	327	190	
TOTAL	15,177	2886	
Percent of Industry	70%	1.2%	

Source: MECS 1994, Tables A1 parts 4 and 5

The second major advantage of a cap-and-trade approach is economic efficiency. Trading directs capital to the least-cost emissions control opportunities rather than mandating

[9] This table first appeared in Festa, 1998.

reductions in specific areas. In contrast, PAMs force emissions reductions in particular sectors. The reductions resulting from PAMs are unlikely to be efficient, because it may well be impossible to set the control costs of PAMs equal to the market price of carbon allowances. In other words, some of the reductions taken in response to PAMs would not be undertaken under a cap-and-trade approach because they would be too costly. It should be noted that in some instances standards will result in low-cost mitigation activities that will not be captured by trading (or other market mechanisms.) This will be the case when the standards force actions that are cost-effective but do not occur under trading because of market barriers such as lack of information.

The environmental and economic efficiency advantages provided by the cap-and-trade approach argue for improving downstream trading by *extending the coverage of the trading system rather than complementing the downstream system with other PAMs*. A limited downstream trading program coupled with PAMs provides neither the environmental certainty of the cap-and-trade approach nor the economic efficiency benefits.

The remainder of this paper examines three approaches to extending the coverage of a downstream trading system. These are:

- *An upstream/downstream hybrid approach*. Under this method, large point sources would be covered downstream while other emissions (those from small industrial sources, residential and commercial direct combustion, and the transportation sector) would be covered at the processing (refineries, coal prep plants) and bulk transport stages (major gas pipelines).
- *A distributor/downstream hybrid approach*. Under this approach, fuel distributors -- defined here to include wholesalers and others that take possession of the fuel between the point of processing or bulk transport and the end user -- would be required to surrender allowances for the carbon they sold that was eventually combusted by the small emissions sources not covered downstream.
- *Upstream coverage of emissions from small sources, with opt-in by distributors*. Under this system, fuel processors would be required to surrender allowances for carbon consumed by small sources, but wholesalers would also be allowed to opt in to regulation. The effect of this would be to shift the carbon allowance burden from the processor to the wholesaler, as the fuel processor would not have to surrender allowances for carbon embodied in fuels transferred to wholesalers included in the program. In essence, under this approach wholesalers could take some of the burden of direct program participation off of the fuel processor.

Another approach to expanding the coverage of a downstream system would be to include vehicle manufacturers in the trading system. The advantages and disadvantages of this approach are discussed in detail in another companion paper to this one.[10] We do not discuss the option here, because it is covered elsewhere and also because it is not a truly

[10] See *Transportation and Greenhouse Gas Emissions Trading*, Steve Winkelman, Tim Hargrave and Christine Vanderlan, Center for Clean Air Policy, April 2000.

comprehensive approach to carbon trading. This is because residential, commercial and small industrial emissions, which accounted for approximately 20 percent of 1998 fossil fuel-related carbon dioxide emissions, would not be covered.[11] Omitting any sector or portion thereof will increase the overall cost of compliance because reduction requirements will be borne by a smaller number of sources, forcing them to make more reductions than they otherwise would.

The three approaches that are discussed would be comparable in terms of environmental effectiveness and economic efficiency. However, they would differ in administrative feasibility and their impacts on competition. Accordingly, we give attention to the impacts of each system in these areas.

IV. Upstream/Downstream Hybrid Approach

A. Description of Upstream Trading

The earlier paper on upstream trading described the benefits of an upstream approach and identified the proper incidence of regulation in an upstream system. The paper used the following two criteria to make this assessment:

- *Coverage of total carbon dioxide emissions*. To ensure that it is cost-effective, equitable, and meets its goal of capping carbon emissions, the cap-and-trade system should cover as high a percentage of total emissions in the economy as possible. The choice of point of regulation in an upstream system will have implications for the level of coverage. For instance, if the oil industry were regulated at the point of distribution of refined products, then fuel used by the refinery would not be captured in the system. In general, the nearer that the incidence of regulation is to the point of extraction, the greater the coverage.

- *Administrative feasibility*, which is a function of:
  - ⇒ *the number of regulated sources*, which must be kept at a manageable level;
  - ⇒ *the level of reporting requirements* for the regulated industries and the level of government monitoring and verification of reported data that is needed;
  - ⇒ *the ability of regulated entities to plan compliance* and effectively participate in the allowance distribution process, whether distribution occurs through gratis allocation or via auctioning;
  - ⇒ *proper accounting*. A fundamental principle in designing a domestic cap-and-trade system should be that producers are required to hold allowances for carbon combusted in the US. It is therefore important that regulation take place at a point where imports, exports, non-energy uses of fossil fuels and transactions among fossil fuel producers may be properly taken into account; and

[11] This figure was derived from Table 2-3 of *Inventory of US Greenhouse Gas Emissions and Sinks, 1990-1998*, draft for public comment, US Environmental Protection Agency, 2000.

⇒ *the availability of needed data*. Allowance requirements must be imposed at a point in the fuel cycle at which future potential carbon dioxide emissions may be accurately assessed.

The earlier paper concluded that carbon regulation in an upstream system should take place at the following points:

- *Petroleum refineries*, because nearly all carbon in petroleum products combusted in the US flows through US refineries, and the number of regulated entities would be small (159).[12] In addition, the potential emissions associated with petroleum products can be reliably estimated at the refinery level.
- *Refined oil product importers*, because refined petroleum products that are imported from abroad would not be captured at the refinery. There are approximately 140 ports in the US used by about 160 different companies.[13]
- *Natural gas pipelines*, because of the high coverage of potential natural gas emissions at this point and because the number of interstate and intrastate pipelines is very small (approximately 150).[14]
- *Natural gas processing plants*, to capture the carbon embodied in natural gas liquids (NGLs). The number of gas processing plants operating in the US is about 700.[15]
- *Coal preparation plants*, because most coal consumed in the US passes through these plants, their small number (550), and the fact that the data needed to estimate potential carbon emissions are available.[16]
- *Coal mines*, because coal not passing though preparation plants would have to be captured at the mine. Mines would be required to hold allowances only for carbon contained in coal not going to prep plants.

B. Avoiding Double-counting and/or Exclusion of Fuel

The major technical challenge that would arise in trying to design and implement a hybrid system that included both large downstream point sources (those described in Section II) and upstream fuel producers would be ensuring that every ton of carbon was accounted for in the trading system once and only once. Most of the upstream points of regulation identified above are fuel processors. These points were chosen mainly because at the processing stage the number of facilities is small and the carbon content of fuel may be accurately estimated. In the context of a hybrid system, however, proper carbon accounting may be difficult at these points because to make a hybrid system work, it must

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[12] Number of refineries as of January 1, 1999. Per Mike Conner, Energy Information Administration. Personal communication, April 6, 2000.
[13] US Energy Information Administration: "US Petroleum Import Volumes by Product and Importer of Record, January-December 1999" and "US Petroleum Import Volumes by Product, Port and Importer of Record, January-December 1999." "Ports" include customs locations nearest to pipeline crossing points and places where tanker trucks and/or rail lines enter the U.S. with loads of crude oil and petroleum products. Mike Conner, Energy Information Administration. Personal communication, April 7, 2000.
[14] Per Joan Heinkel, US Energy Information Administration (EIA), the current number of pipelines is "140+." Personal communication, July 28, 1999.
[15] Ibid.
[16] Figure first quoted in Hargrave, 1998.

be possible to distinguish fuels eventually consumed by large downstream point sources included in the program ("exempt fuels") from those that are not ("non-exempt fuels"). Identification at the processing stage of eventual consumers is likely to be difficult because in many cases fuels change hands many times between the point of processing and the end user. For example, because oil refineries normally sell to wholesalers rather than end users, they are unlikely to know whether the fuel they sell will be combusted by large industrial customers regulated downstream or instead by smaller energy users. If fuel producers were not able to distinguish exempt from non-exempt fuels, then they would not know how many allowances to turn in. This problem will occur mainly in the oil and natural gas sectors but not coal, because over 97 percent of coal burned in the US is used by the power sector and large industrial facilities (those in the sectors included in Table 1.[17]) Coal mines and prep plants therefore should be able to segregate exempt and non-exempt fuels.

There are three possible approaches to handling this accounting problem. One would be to *exempt fuel producers from turning in allowances* for fuel transferred to wholesalers. Since wholesalers and other middlemen handle most fossil fuel used in the US, this approach would create a massive loophole and therefore is obviously unacceptable from an environmental standpoint. Allowances would not be surrendered for fuels sold to wholesalers and eventually consumed by energy users not regulated downstream, even though they should be. Even if most fuel did not now pass through wholesalers, the approach still would be unacceptable because it would create an incentive to avoid carbon obligations by selling fuel to wholesalers.

Another, opposite approach would be to *require upstream facilities to turn in allowances for all fuel sold to wholesalers*. Under this system some fuel – that consumed by establishments regulated downstream – would be double-counted: Since both the facility regulated upstream and that regulated downstream would turn in allowances, the fuel would be regulated twice. This would not be an environmental problem; in fact, it would be a *de facto* tightening of the cap-and-trade system's cap. Double-counting would, however, be an economic problem, in that the effective tightening of the cap would lead to higher total compliance costs. Further, potentially serious energy price distortions would result. Fuels that were double-counted would experience greater price rises than those that were not and therefore would suffer in the marketplace. In practice, oil and natural gas probably would be put at a disadvantage relative to coal, because it is the former two fuels that are more likely to be handled by middlemen and therefore double-counted.

A third method would have the government *require allowances for all fuel transferred by fuel producers to wholesalers, unless the producer could provide paperwork showing that the fuel ultimately was consumed by fuel users regulated downstream*. This "paper trail" approach would impose an additional accounting burden and transaction costs on fuel

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[17] Based on information for 1998 from the US Department of Energy's Energy Information Administration. Calculated using Table 37, *US Coal Consumption by End Use Sector, 1993-1999*, and Table 43, *US Coal Consumption at Manufacturing Plants by North American Industry Classification System (NAICS) Code*. Go to www.eia.doe.gov and then go to the home page for coal statistics.

producers. Government would also face a greater administrative burden because it would have to audit, at least on a sample basis, the documentation collected by the companies.

While this approach would be administratively unwieldy, it would not face some of the more fundamental problems that the other options suffer. Further, fuel producers likely would develop sophisticated accounting systems to track downstream activities. They would request monthly reports from their customers documenting end use splits between exempt and non-exempt fuels. Further, they would not have to collect background documentation for all transactions; instead they could just ask for numerical summaries and audit the monthly reports on a sample basis.

Over time, the data that fuel producers gathered could be used to manage program compliance. Given that allowance surrender under the program is likely to be fairly infrequent (once per year or even once every five years), unusually high splits between exempt and non-exempt fuels in a given month should not pose compliance problems. In other words, if in a given month the percentage of fuel sold that was consumed by small energy users was abnormally high, the fuel producer would have time to purchase additional allowances and would not be found out of compliance.

V. Distributor/Downstream Hybrid System

An alternative to the upstream/downstream hybrid would be to require distributors (again, defined here to mean wholesalers and others that take possession of the fuel between the point of processing and the end user) to turn in allowances for carbon emissions from small energy users. The reason for requiring allowances at this point rather than further upstream would be to avoid the just-described carbon accounting issues associated with the upstream/downstream hybrid (i.e., the need to distinguish exempt fuels from non-exempt fuels.) In the following sub-sections we seek to identify a point in each fuel cycle where administration of the trading system would be feasible.

A. Oil

Both large point sources and small energy users consume refined oil products. While by definition transportation fuel is not used by large point sources, oil is an industrial fuel as well as a transportation fuel. In 1998, approximately 20 percent of carbon emissions from the use of petroleum products came from the utility and industrial sectors.[18] For this reason, it is important to be able to identify a point of regulation at which refined oil products consumed by large point sources can be distinguished from those used by other sources.

The supply chain for refined fuel products is complex. Refined products are transferred from terminals in bulk to other terminals or more often are removed at the terminal "rack" to means of non-bulk transfer such as railroad cars, trucks and trailers. From these points, fuel may be delivered straight to facilities that deliver directly to the end user (e.g.,

[18] Based on Table 2-4, *Inventory of US Greenhouse Gas Emissions and Sinks, 1990-1998*, draft for public comment, US Environmental Protection Agency, February 2000.

gasoline service stations) or may change hands a number of times before reaching the end user, passing through a sometimes complicated maze of wholesalers, local delivery companies and others.

In seeking to identify an appropriate point of regulation downstream from the refinery for oil-related carbon emissions, it is tempting to look to the terminal because it is here that the excise tax on gasoline and other fuels is located (see Box 1.) It turns out that the excise tax model is not a useful one in this context, however, because the tax is paid by the fuel terminal "position holder" or operator.[19] These entities normally are not able to identify the ultimate consumer of the fuel. Essentially, the approach taken to implementing the excise tax argues for an upstream trading system.

Box 1: Federal Excise Taxes on Fuels

Generally, federal excise taxes on petroleum-based fuels (i.e. gasoline, gasohol, kerosene, and diesel) are imposed when the fuel leaves the "bulk transfer/terminal" system. This system includes refineries, pipelines, vessels, and storage terminals. Fuel leaves this system when it is loaded onto a truck, trailer, railroad car, or other means of non-bulk transfer at the part of the refinery or terminal facility that is called the "rack." The trucks, trailers and rail cars then take the fuel to distributors, retail centers, and industrial users for end use. Similarly, fuel imported into the US is not taxed if it is transported by pipeline or vessel, thus remaining in the bulk transfer/terminal system. Imported fuel is taxed if transported into the U.S. by non-bulk transfer (i.e. trucks, rail.)

Refunds are available when the taxes have been paid at more than one stage of this process. The entity paying the "second tax" claims the refund and is responsible for providing the paperwork that validates the first and second taxation events. Refunds are also available for certain uses exempt from federal excise taxes on fuel. For example, federal taxes are waived if the fuel is exported, sold to a state for its exclusive use, or sold to a nonprofit education organization for its exclusive use.

*Internal Revenue Service Publication 510, "Excise Taxes for 1999", December 1999.

This suggests moving the point of regulation farther downstream, to the level of distributors. To avoid double-counting the accounting system rules would have to stipulate that distributors not be required to surrender allowances for fuel transferred to other distributors. Also, the system would have to capture refiners selling directly to small end users.

[19] The position holder is the person that has a contractual arrangement with the terminal operator for the use of storage facilities and terminaling services. (Internal Revenue Service Publication 510, "Excise Taxes for 1999", December 1999.)

In implementing this approach it would not be necessary to include facilities that transfer fuel to small end users only (e.g., gasoline service stations.) Thus in the case of gasoline the event requiring the surrender of an allowance would be the transfer of gasoline from a distributor to a service station. A similar approach could be taken for other transportation fuels such as natural gas used in on-road vehicles and aviation fuel used by small aircraft. Removing this last step in the distribution chain would greatly simplify the administration of the trading system. There are currently about 181,000 gasoline stations in the US.[20]

Nevertheless, moving the incidence of regulation to the distributor level would increase the administrative cost of the program relative to that of a hybrid system including refiners, because there are many more distributors of fuel than there are refineries. Not only emissions monitoring, reporting and verification would be made more complicated by moving the point of regulation to the distributor level; the distribution of allowances would be as well. As noted earlier, it is essential to the smooth functioning of the cap-and-trade system that the regulated entities be able to plan their compliance and function competently in the allowance market. Whether allowances were grandfathered or auctioned, the distributors would have to manage their carbon positions and form relationships with brokers. They may have neither the time, inclination nor experience to do so. If allowances were auctioned, then these companies would have to participate in the auctions or hire someone to represent them; if allowances were grandfathered, then they would want to participate in the "formula fight" over the rules of allocation. (Trade associations might play a role here.) In any case, it is clear that the allocation process would be much more complicated if the trading system involved distributors rather than producers/processors.

B. Natural Gas

In the earlier paper on the design of an upstream system, we identified the gas pipeline as the correct point for requiring allowances for natural gas-related emissions. The paper noted that less than 150 interstate and major intra-state pipelines carry nearly all of the natural gas consumed in the country, and that due to quality specifications, the gas is homogeneous in content. The carbon content of the gas therefore may be easily estimated.

In a hybrid system, it may be more sensible to require allowances from local distribution companies (LDCs) and others selling to end users, such as pipelines that supply large customers directly. These establishments are quite small in number – approximately 1,400 – and they are able to easily segregate exempt fuels from non-exempt fuels, since they actually distribute the fuels to end users. Pipelines are unlikely to be able to distinguish exempt fuels from non-exempt fuels.

Another option would be to require allowances of gas processing plants, which strip gas of impurities so that it is of pipeline quality. The drawback to this approach is that processing plants, like pipelines, probably would be unable to identify eventual gas

[20] "1999 Industry Report", the Journal of Petroleum Marketing, volume 12, no. 7, mid-June 1999.

consumers; further, imported gas is not processed at these plants and therefore would be missed by the trading system.

Moving the allowance requirement downstream to gas distributors would mean that energy-related carbon emissions from gas processing plants and pipelines would not be captured in the trading system. Emissions from these two source categories are quite small, however, especially in the case of processing plant emissions. Further, it would be straightforward to add these facilities to the trading system. The burden placed on the government of bringing these sources into the system would be small, as the number of facilities is small (approximately 700 processing plants and 150 pipelines), and emissions could be easily estimated from fuel consumption records.[21]

A final consideration related to the natural gas fuel cycle is the treatment of natural gas liquids (NGLs). Gas processing plants separate natural gas liquids from the gas stream and then convert the liquid streams into marketable products such as ethane, propane and butane. These products are typically sold to distributors, which then sell them to end users, and refineries, which use them as inputs. Approximately 85 percent of NGL production is used either as a petrochemical feedstock, for the manufacture of motor gasoline or as a residential/commercial heating fuel. The remaining fifteen percent is used for a wide variety of industrial and transportation purposes.[22]

The cap-and-trade system could be designed to require allowances for carbon in NGLs either from the gas processors or the distributors.[23] Gas processors are much fewer in number than distributors, but they are unlikely to be able to distinguish exempt from non-exempt fuels. There are many more distributors, which as noted in the earlier discussion of the oil industry, would complicate both emissions monitoring, reporting and verification as well as the allowance distribution process. Distributors would have a clearer understanding of whom the end users were, however. The most sensible approach probably would be to take a "paper trail" approach here as well, requiring an allowance from processors for every ton of carbon produced and then giving them exemptions in cases where they could demonstrate that the fuel was ultimately consumed by a large point source already covered in the trading system.

C. Coal

Accounting for coal in a hybrid system would be straightforward because approximately 90 percent of coal consumed domestically is used by electric power generators and another nine percent is consumed for industrial purposes.[24] – most of that by large

[21] For a detailed discussion of the treatment of methane emissions from the natural gas fuel cycle see a forthcoming paper in the Airlie series, *Suitability of Methane Sources for GHG Emissions Trading*, prepared for the Center for Clean Air Policy by Dan Klein, Twenty-first Strategies.

[22] The Natural Gas Information and Educational Resources website (www.naturalgas.org), August 2, 1999. Last updated May 19, 1998.

[23] Carbon in NGLs transferred to refineries should be captured at the refinery as part of the regulation of refined products, rather than at the natural gas processing plant or NGL distributor.

[24] US Department of Energy Information Administration, Table 37, *US Coal Consumption by End Use Sector, 1993-1999*. Go to www.eia.doe.gov and the go to the home page for coal statistics.

facilities that would be included in a hybrid program. Less than one percent of coal combusted in the US is used for residential and commercial purposes. Therefore almost all coal use will be captured downstream.[25]

D. Preventing "Gaming"

A key issue in designing a distributor/downstream hybrid system is preventing strategic behavior, or "gaming", which could result from the fact that fuel producers, because they will need to hold allowances for fuel eventually consumed by small sources but not that used by large sources, will charge different prices for the two types of fuels. The prices charged by fuel producers for exempt fuels would reflect the value of carbon allowances but the prices of non-exempt fuels would not. This will create a temptation among distributors to purchase low-price exempt fuel and then sell it to small energy users that should be paying the higher non-exempt fuel price. Take for example an oil wholesaler that sells to both large and small industrial customers. Because it would be required to turn in allowances for products consumed by the small customer but not those by large customer, it would have an incentive to claim that all fuel sold was consumed by large customers. Similarly, it could try to avoid allowance requirements by actually selling to a large customer that had agreed to re-sell the fuel to a small customer (in effect becoming an agent of the wholesaler.) It is difficult to estimate the extent to which such gaming would take place; in large part this would depend on the level of carbon allowance prices.

Gaming could be eliminated through careful system design and implementation. The first type of behavior could be caught simply by auditing the records of the LDC and/or by contacting the large point source to verify that the sale took place. In the second case, where the large point source acted as an agent for the distributor, the problem could be solved by designing the system so that large point sources were required to surrender allowances for all fuel combusted or transferred, not just that combusted. Doing so would eliminate any incentive for the large point source to act on the wholesaler's behalf.

VI. Upstream/Downstream Hybrid, with Opt-in by Distributors

A third approach to expanding the coverage of a downstream system would be to regulate fuel producers for carbon emissions from fuel burned by small energy users, but with a provision allowing distributors to opt into the trading system. This approach is essentially a combination of the first two. The purpose of allowing distributors to opt in would be to simplify the paperwork required of fuel producers under the first approach. The reason that a distributor would want to do this is to improve its ability to compete by providing an additional service (reduction in paperwork on the part of the fuel producer.) Distributors of refined oil products would be most likely to opt in, because by doing so they would reduce the administrative burden borne by refineries. It is the refineries that are most likely to bear the greatest burden in identifying and documenting the ultimate consumers of their fuels.

[25] For a detailed discussion of how to capture methane emissions from coal mining in a trading system, again see *Suitability of Methane Sources for GHG Emissions Trading*.

Under this opt-in approach, when a fuel producer sold fuel to a distributor, it would not have to turn in allowances if the distributor had opted into the cap-and-trade program. The fuel producer therefore would be spared the expense of documenting that some of its fuel was consumed by already-covered large point sources. This responsibility would fall on the distributor, which in many cases would be better able to distinguish exempt from non-exempt fuels. A distributor that opted in to the trading system would turn in allowances for the carbon in all the fuel it transferred, except fuel transferred to other regulated distributors, fuel transferred to non-regulated distributors but consumed by large point sources, and fuel transferred directly to large point sources.

The obvious drawback of this approach is that it would result in a greater number of regulated entities in the trading program. While the reporting burden placed on refineries and other fuel producers would decrease, the verification burden placed on government would increase. For the distributors themselves, monitoring and reporting requirements would of course increase as a result of their joining the program; in addition, they would have to plan and manage their program compliance. It is difficult to assess the extent to which program administration would be complicated by allowing distributors to opt in; this would depend on how distributors weighed the competitive benefits gained by reducing refiners' administrative costs against the costs of joining the trading system. It is not obvious that the burden on refineries would be so great that it would provide a big incentive for distributors to opt in.

VII. Cross-Cutting Issues

Two issues that are relevant for all the hybrid options discussed here deserve further attention. These are:

- *The compatibility of upstream and downstream emissions measurement systems*. To calculate their emissions responsibility, upstream facilities (including both fuel processors and distributors) will use an equation to estimate emissions from the combustion of the fuels they sell. Downstream facilities may use this approach, though in some cases they may directly measure emissions. The implications of using different estimation/measurement techniques must be considered.

- *Gaining competitive advantage through the allocation process*. Upstream trading might well be associated with auctioning, mainly because it may not be politically feasible to allocate the potentially very large scarcity rents associated with carbon trading to the relatively small number of firms that would be included in an upstream system. Downstream trading, as noted earlier, is more likely to be paired with grandfathering.[26] Thus if an upstream/downstream hybrid system were implemented, there likely would be a political desire to simultaneously use both auctioning and

[26] These issues have been discussed at length in the meetings of the Center for Clean Air Policy's Greenhouse Gas Emissions Trading Braintrust.

grandfathering. It is worth exploring whether doing so would result in any pricing or competitive distortions.

A. Upstream and Downstream Emissions Estimation/Measurement Techniques

Fuel producers included in a hybrid system will be responsible for the emissions produced upon the combustion of the fuel they sell. Rather than measuring these directly (which they will not be in position to do), they will use the following equation:

Imputed Emissions	=	Fuel Sold to Small Sources	x	Carbon Content	x	Combustion Efficiency*

* In this equation combustion efficiency refers to the percentage of carbon released as CO_2.

Downstream facilities may use a similar equation to calculate their emissions responsibility, although in cases where emissions monitoring technology already is in place emissions may be measured directly. This raises the question of whether the use of different techniques to assess emissions responsibility will provide an advantage to facilities using one method over those using the other.

The trading system would best be served by relying on calculation of emissions rather than direct measurement, for both upstream and downstream sources. The main reason is that the two approaches can lead to different numbers. Thus downstream emissions sources, which would be able to use either method, would have the opportunity to game the system in search of the best result. Further, if upstream entities were calculating emissions and (some) downstream sources were measuring them directly, it is possible that some entities would be at an advantage or disadvantage relative to others, even if no gaming or systematic bias existed. Because upstream entities can only use calculation for emissions associated with the fuels they sell (since they themselves don't burn the fuel they sell), standardized accounting rules would have to require calculation rather than direct measurement. Other reasons for choosing calculation over direct measurement are that the cost of direct measurement will be prohibitive for smaller sources and that problems currently exist with the quality of direct measurements of CO_2.[27]

B. Gaining Competitive Advantage through the Allocation Process

As noted, if a hybrid approach to trading were taken then a desire may exist to distribute allowances both through auctioning (to upstream entities) and grandfathering (to downstream entities.) This raises the question of whether the two methods are compatible. The key issue here is whether energy users that were grandfathered allowances would gain a competitive advantage over those that purchased fuel from upstream entities that were required to buy allowances in the auction.

Under a competitive market, the grandfathering of allowances should not confer a competitive advantage, because it does not change the marginal cost of production, which

[27] Per Brian McLean, Acid Rain Division, US Environmental Protection Agency.

is the basis on which firms compete.[28] Firms receiving grandfathered allowances do receive additional wealth that will increase their profits or accrue to their shareholders, but they do not gain a competitive advantage. For a firm that buys fuel from upstream entities that have to buy allowances, the cost of activity will be the cost of an allowance that is passed on to it, while for a firm that is grandfathered allowances, the cost will be the opportunity cost of having to retire the allowance and not sell it. Thus no marginal cost advantage is given to the firm receiving allowances gratis. Similarly, with respect to the relative impacts on upstream entities, all things being equal a fuel producer that must buy allowances will be in the same competitive position as a firm whose customers are grandfathered allowances.

Allocation choices may have second order effects that do have a competitive impact, however. Grandfathered firms receive a capital injection because the market price of their products increases, reflecting increased marginal costs for all producers, and yielding increased revenues for them, while their financial costs have not changed. There is an opportunity cost to the use of this capital reflecting the expected rate of return in some other use; thus the grandfathered firm should employ this capital in the same way as if it had to borrow. This means the gift should result in no difference in the way that the capital is employed within the economy. However, this may not hold where there are constraints on access to capital and firms that are grandfathered have access to capital that others do not. Here there may be a real competitive advantage as access to capital allows firms to increase production or to subsidize current output. Such impacts have competitiveness effects if some firms in a particular industry are treated differently from others. If sectors are treated differently, more capital will flow to some sectors than would occur under a competitive and efficient market. Differential treatment might occur among fuel producers, because refineries would have to buy allowances while coal producers would not (since coal–related emissions will be captured downstream.) Differential treatment might also occur in the food and stone/glass industries, which are made up of a mix of small and large facilities (again see Table 1.) In an upstream/downstream hybrid system, large facilities would be grandfathered allowances while small firms would not.

These situations require further attention to determine whether or not secondary effects would be significant. In any case, it is clear that any competitive advantages that might be created by differential treatment of firms in the allocation process could be eliminated by harmonizing the allocation methods for the upstream and downstream components of the program.

VIII. Summary and Conclusions

This paper has examined three ways of expanding the coverage of a downstream system. They are:

[28] For an excellent treatment of this topic, see *Fair Competition and Annex I Trading*, Suzi Kerr, Center for Clean Air Policy, 1999. Available at www.ccap.org.

- *An upstream/downstream hybrid approach*. Under this method, large point sources would be covered downstream while emissions from smaller sources would be covered upstream (at the level of fuel processing or bulk transport);
- *A distributor/downstream hybrid approach*. Here distributors would be required to surrender allowances for the carbon they sold that was eventually combusted by the small emissions sources not covered downstream; and
- *Upstream coverage of small sources, with opt-in by wholesalers*. Under this approach, fuel producers would be required to surrender allowances for carbon consumed by small sources, and wholesalers would be allowed to opt in to regulation.

The main challenge in trying to implement a hybrid system would be one of accounting: It would be necessary to ensure that every ton of carbon consumed was counted once but that no carbon was counted more than once. In practice this would mean that for accounting purposes, the fuel producers and distributors regulated upstream of the large point sources would have to distinguish fuels consumed by large point sources from those consumed by smaller sources.

To accomplish this goal, it appears that a combination of the three approaches would be appropriate. For coal, downstream regulation alone will capture nearly all emissions and scarcely needs to be complemented. Mines and distributors selling directly to residential, commercial and small industrial energy users also would need to be captured in the system. For natural gas-related carbon emissions, it would make sense to require allowances from local distribution companies (LDCs) for fuel sold to small sources. LDCs should be able to distinguish fuel already captured downstream from that which is not, and they are small in number (about 1,400.) For oil, it appears that fuel not captured downstream should be captured at the refineries, although doing so will require the refineries to establish accounting systems to track fuel sold and identify the ultimate consumers of their products.

A hybrid system including the above elements and all large point sources would include about 8,400 facilities, as shown in Table 2 below. This is a greater number of facilities than in an upstream system, which would include less than 2,000 facilities. The greater number would increase the cost of administering the program; further, emissions accounting would be made even more complicated by the need to distinguish exempt from non-exempt fuels. The allowance distribution process, whether it is grandfathering or auctioning, also would be more complex. Nevertheless, the program appears to be quite manageable. It would appear to be easier to design and implement than a downstream system complemented by a suite of policies and measures, and is preferable from an environmental and economic viewpoint.

It also would be feasible to establish a hybrid system that covered just electricity generators downstream and all other energy-related carbon dioxide emissions upstream. Such a system would include all of the facilities listed in Table 2 except the large industrial facilities, so it would include approximately 5,500 facilities. Implementing a hybrid system of this sort would be easier than implementing one that included all large point sources not just because it would include fewer entities but also because fewer difficult accounting issues would arise. Specifically, there would be no danger of double-counting or excluding coal, oil and natural gas used by large industrial customers. An upstream/power plant hybrid system should be no more or less environmentally sound or economically efficient than a hybrid system covering all large point sources or than an upstream system.

Table 2: Facilities Included in a Hybrid Carbon Trading System

Industry	**Point of Regulation**	**Approximate Number of Entities**
Industry	Large facilities	2,900
Electricity	Electricity generators	3,000
Oil	Refinery	160
Oil	Refined product import ports	140
Natural Gas	Local distribution companies (A)	1,400
Natural Gas Liquids	Processing plants	700
Coal	Mines/prep plants	100 (B)
Total		**8,400**

(A) Includes pipelines that distribute fuel to large end users.
(B) Estimate of mines and prep plants selling coal consumed by small energy users.