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Tradable Permits for Greenhouse Gas Emissions:
A primer with particular reference to Europe

A. Denny Ellerman

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Tradable Permits for Greenhouse Gas Emissions: *A primer with particular reference to Europe*

A. Denny Ellerman[†]

Abstract

This paper is written as part of a two-year study of climate change policy choices facing Sweden, conducted under the auspices of the Center for Business and Policy Studies in Stockholm. As such, it aims to be a primer on emissions trading as an instrument for limiting greenhouse gas (GHG) emissions under the Kyoto Protocol to the Framework Convention on Climate Change. The first section notes general considerations concerning emissions trading, particularly in relation to climate policy. The second section explains the many forms of emissions trading included in the Kyoto Protocol. The third section provides a brief review of emissions trading proposals that have been advanced in Europe as of mid-2000. The fourth section addresses issues in the design and implementation of a national GHG emissions trading system. The brief conclusion is followed by an appendix, which draws applicable lessons concerning the choice and design of a cap and trade system from the U.S. SO_2 emissions trading program.

Contents

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1. GENERAL CONSIDERATIONS

1.1 The Basic Argument for Tradable Permits

Tradable permits have lately become fashionable as instruments for achieving environmental goals. This phenomenon may reflect the successful use of tradable permits for reducing sulfur dioxide (SO_2) emissions in the United States and their application in other contexts such as fisheries; but it more likely results from a more general disenchantment with conventional methods of achieving environmental goals, usually pejoratively termed "command-and-control," and a greater willingness to experiment with market-based approaches. Greater reliance on market solutions in other formerly heavily regulated sectors of the economy has been generally deemed a success, and environmental regulation presents an obvious new frontier for market-based reform. Whatever the reasons for the current popularity, the economic superiority of tradable permits rests on its ability to equalize marginal costs among all controlled sources and thereby to assure least-cost compliance with the particular environmental goal. Alternatively, for a given cost, more environmental benefit can be gained.

1.2 Applicability to Climate Policy

At least part of the increasing interest in tradable permits can be traced to the growing concern about climate change and the need to limit emissions of radiatively active greenhouse gases (GHGs), of which carbon dioxide (CO_2) is the most important. If ever there were an environmental problem in search of a policy instrument, it is climate change and tradable permits. GHG emissions quickly become uniformly mixed in the atmosphere so that, unlike most environmental problems, the location of the emission source does not matter.[1] A ton of CO_2 emitted or abated in Bombay will have the same effect on climate as a ton emitted or abated in Buenos Aires, Chicago, Kiev, or Stockholm. Moreover, the residence time in the atmosphere of CO_2 and of the other GHGs of policy concern is long, ranging from several decades to millennia. Whether a ton of GHG is abated this year, next year, or decades later is a matter of little environmental consequence, so long as the ton is abated. Consequently, trading permits and emissions through time, often called banking and borrowing, does not matter from an environmental standpoint.

Tradable permits, and more generally emissions trading, also commends itself as an instrument for climate policy because of "common but differentiated responsibilities," in the United Nations Framework Convention on Climate Change (FCCC), also known as the Rio Treaty. For reasons of both ability to pay and historical responsibility, industrialized nations are expected to commit themselves to reducing emissions sooner and in greater proportion relative

[1] As noted by Solomon and Lee (2000), when the emissions residual is uniformly mixed in the atmosphere, concerns raised by emissions trading about environmental justice are irrelevant. The effects of climate change may be quite unjust, but those effects are not influenced by the *location* of emissions or of emissions abatement.

to no-policy emissions than the developing economies. This criterion does not mean that developing countries will not be affected; in an interdependent world, the cost of the measures adopted in the industrialized world will have economic effects on developing countries through international goods trade (Babiker *et al.,*1999; Ellerman *et al*., 1998). To the extent that the industrialized countries adopt less costly measures to achieve their commitments, the effect on the developing world will be less. More importantly, the least costly measures for addressing this environmental problem, where location does not count, include very low cost emission reductions in the developing world. As has been shown by many studies, substituting these low cost abatement possibilities for otherwise more costly reductions at home through emissions trading will greatly reduce the costs of compliance in the industrialized world, and the adverse effects on the developing countries (Weyant, 1998; Ellerman and Decaux, 1998). Moreover, this option would open new export markets for the developing countries and provide compensating revenue flows and a means of technology transfer. For all these reasons, emissions trading is an attractive feature of climate policy for all parties encompassed by the common but differentiated responsibilities of the Rio Treaty.

1.3 Relation to Other Forms of Emissions Trading

Although tradable permits and emissions trading are often used as interchangeable terms, there is a difference, and that difference is important for the climate problem. Emissions trading can take two basic forms, generally known as allowance-based trading and credit-based trading. Allowance-based trading is also known as “cap-and-trade” because its essential features are a fixed cap on aggregate emissions and tradable emission rights, usually called allowances. Tradable permits usually imply a cap and, for this reason, the term is nearly synonymous to allowance-based emissions trading and will be so used in this paper.

Credit-based emissions trading refers to the trading of emission rights defined as differences from some pre-existing regulatory standard of performance, such as an emission rate limit. Over-complying sources can receive emission credits that are traded to sources for which the cost of meeting the standard is higher. As would be the case with allowance-based emissions trading, marginal costs will be equalized under a credit-based system in the absence of transaction costs and therefore lead to least-cost compliance. More generally, credit-based trading is a means to reduce the inefficiencies associated with prescribed standards, which arise both from the implicit assumption in uniform standards that cost functions are identical across sources and from the inability of the regulator to design non-uniform standards that would equalize marginal costs. The all-important difference in credit-based emissions trading is that there is no cap.

The nature of the climate change problem creates a decided bias for the allowance-based approach because of its ability to achieve a given quantitative limit. In theory, a price instrument, such as a tax, or a regulatory standard could be selected to achieve any given limit exactly, but the informational demands upon the climate policy-maker are great. In effect, the policy-maker

faces a classic "prices *vs.* quantities" dilemma. A price instrument will fix the marginal cost or price but not the quantity, while the quantity instrument will fix the quantity but not the price. A regulatory standard, of course, fixes neither. Fundamentally, the climate problem calls for anthropogenic emissions of greenhouse gases to be limited to some threshold amount; it does not call for these emissions to be reduced by some arbitrary amount corresponding to some level of taxation or a given regulatory standard. Whether quantitative thresholds exist and can be identified may be a matter of some scientific dispute, but the structure of GHG emission control adopted in the Kyoto Protocol fully embraces quantitative limits. The upshot is that any policy-maker interested in achieving the emission limits agreed to in the Kyoto and subsequent Protocols to the FCCC at least cost will be unavoidably drawn to tradable permits and allowance-based cap-and-trade systems.

Credit-based emissions trading suffers from one further liability, which is that it has not worked very well (Tietenberg *et al.*, 1999). Typically, credits for over-compliance are not automatically recognized, and the administrative process by which they are created is usually costly. In contrast, the one instance of pure allowance-based trading, the U.S. SO_2 emissions trading program, has worked decidedly well from both environmental and economic standpoints (Ellerman *et al.*, 2000).[2]

1.4 Controversial Features

While tradable permits have many advantages as an instrument for achieving climate policy goals, they also attract controversy. The most fundamental objection is that emissions trading is "immoral." The focal point of this objection is the "right to pollute" that is unavoidably and nakedly explicit in an allowance. This objection can arise from two related convictions: first, that all emissions, no matter how small in amount, are socially damaging, or pollution, so that the only morally acceptable level is zero, such as is the case for theft, or second, that private property is inappropriate for common resources.

Similar objections have been raised with respect to land, which is the nearest analogue in human history. Land is a God-given resource the use of which, like that of the environment, has been made scarce by the increase in human activity, both in numbers and in scope. In an earlier time, land was freely available for use, as the atmosphere is now. However, as land became scarce, humans devised means to allocate its use and these means have evolved in all industrialized systems into private property rights. Yet, until very recently, societies constituting a significant percentage of the global population have maintained the doctrine that private property in land is immoral. Thus, it should not be surprising that newly created property rights in the use of the atmosphere as a sink for emission residuals are controversial.

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[2] Shorter descriptions and evaluations of the program are provided by a paired set of articles in *Journal of Economic Perspectives:* Stavins (1998) and Schmalensee *et al*. (1998).

A related but decidedly secondary objection to tradable permit systems arises from the almost complete elimination of the discretion traditionally enjoyed by the environmental regulator. The regulator need no longer decide what is required of each and every source to meet the environmental goal, to entertain appeals for equitable exception, or to conduct inspections to verify that the prescribed standards are being observed. Once the cap has been set and the permits allocated, the regulator's task is limited to that of monitoring emissions and withdrawing permits. This remaining activity is aptly described as being like that of a bank clerk deducting money (allowances) from accounts as checks (emissions) are presented. Those who are more impressed with the potential for regulatory capture and the not necessarily environmentally friendly uses of administrative discretion view this feature of tradable permits favorably, but these persons may not constitute a majority. Those who object to emissions trading for this reason never couch their arguments in terms of capture; invariably, they stress the other worthy goals that can be achieved through the benevolent use of regulatory discretion.

1.5 Tradable Permits and Climate Policy

Tradable permits have emerged as the most appropriate instrument for achieving climate policy goals because of the remarkable correspondence between the attributes of the climate problem and tradable permits. The location and timing within economically relevant horizons of GHG emissions abatement does not matter; and by design, cheap sources of abatement lie outside of the industrialized nations accepting the earliest and most demanding limits on GHG emissions. Accessing these abatement possibilities through emissions trading will both reduce the cost to the industrialized nations of meeting those limits and provide developing nations with a new source of export revenue, which would compensate in part for the contractionary effects they may experience. The quantitative limits now seemingly enshrined in the process of international negotiations are easily transformed into tradable permits, and the underlying problem—limiting the use of the atmospheric sink—lends itself naturally to a quantitative limit, however hard that limit may be to define. Finally, as explained more fully in the appendix, tradable permits have been more effective in achieving environmental goals than the alternative and more conventional instruments of taxes and standards.

2. EMISSIONS TRADING IN THE KYOTO PROTOCOL

The Kyoto Protocol firmly embraces emissions trading as one of the key elements of global climate policy, although the controversy surrounding the concept led the drafters to engage in no small amount of semantic legerdemain. An economist would search the document in vain for any reference to markets, as in market-based instruments, much less to emission rights, or for any suggestion of buying and selling. Instead, the language speaks of "assigned annual amounts" (AAUs) that may be "acquired" or "transferred." The term, "emissions trading," is narrowly defined to refer only to some yet to be delineated activity under Article 17 of the Protocol; and

a more general term, "flexibility mechanisms" is used to refer to all the features an outside observer might consider emissions trading. Yet, once one gets beyond the semantics, the unmistakable reality is emissions trading. The annual assigned amounts are caps on national emissions, and the flexibility mechanisms are the means by which the emission rights implicit in the caps can be traded and by which additional rights can be created.

2.1 The Basic Commitment

The fundamental feature of the Kyoto Protocol is the legally binding commitment of certain signatory parties to limit greenhouse gas emissions to some percentage of 1990 emissions on an average annual basis over a five-year First Commitment Period, running from 2008 through 2012. Annex B of the Protocol lists the caps agreed to by these parties, who are all the traditional members of the OECD and the economies in transition of Eastern Europe and the former Soviet Union. This commitment becomes operational only if the Protocol enters into force, which will occur when fifty-five signatories constituting fifty-five percent of 1990 Annex B emissions have ratified the Protocol. The greenhouse gases included in the limit are listed in Annex A and they are CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The GHG limits are denominated in annual assigned amounts and the equivalence of the six included GHGs for the First Commitment Period is specified as the 100-year global warming potential (GWP) of each GHG as given in the Second Assessment Report of the International Panel on Climate Change (IPCC).

One need do no more than reflect upon the features of the basic commitment in the Kyoto Protocol to realize how thoroughly emissions trading has been embraced. First, the commitment is a cap, and caps imply emissions trading. Second, the multi-gas limit implicitly and unavoidably includes trading among the six included GHGs at the exchange ratios specified. With more abatement or less growth in methane emissions, less abatement of carbon emissions will be required. Third, the five-year commitment period implicitly and unavoidably sanctions banking and borrowing of emissions within the commitment period. In principle, a party could be x% above its limit in 2008 and still be in compliance if it is below its limit by a compensating amount in the later years of the commitment period.[3] Finally, the inclusion of "removals by sinks" in the commitment authorizes a means of creating additional AAUs to offset emissions above what the limit would otherwise be. Then, quite aside from these features embedded in the basic commitment, other articles of the Protocol provide several explicit forms of emissions trading.

2.2 Trading of Assigned Quotas at the State Level: The EU Reallocation

Article 4 of the Protocol allows two or more Annex B signatories to form a "bubble" whereby the AAUs allocated to those parties can be reassigned among themselves. This may be viewed as

[3] Article 3.13 allows parties to receive credit for unused AAUs in subsequent commitment periods, that is, to bank emissions between periods, although not to borrow them.

Table 1. *Burden-sharing Agreement among the European Union*

Country	*AAUs as % change from 1990 Emissions*	*% Share of 1990 EU Emissions*	*Country*	*AAUs as % change from 1990 Emissions*	*% Share of 1990 EU Emissions*
Luxembourg	– 28.0	0.3	Finland	0.0	1.7
Germany	– 21.0	27.7	France	0.0	14.7
Denmark	– 21.0	1.7	Sweden	+ 4.0	1.6
Austria	– 13.0	1.7	Ireland	+ 13.0	1.3
United Kingdom	– 12.5	17.9	Spain	+ 15.0	7.0
Belgium	– 7.5	3.2	Greece	+ 25.0	2.4
Italy	– 6.5	12.5	Portugal	+ 27.0	1.6
Netherlands	– 6.0	4.8	*European Union*	*– 8.0*	*100*

a re-negotiation of the binding limit within the overall Annex B cap without any obvious *quid pro quo*, but it is a form of emissions trading at the level of the signatories. The most salient example of the use of this provision is the burden-sharing agreement among the members of the European Union, more commonly known as the EU Bubble. This agreement re-allocated the uniform limit at 8% below 1990 emissions inscribed for all members of the European Union in Annex B as indicated in **Table 1**.

In general, five members comprising half of the EU emissions accepted lower ceilings so that the other ten members would have higher ceilings than the uniform 8% below 1990 emissions specified in Annex B of the Protocol. The two largest of these, Germany and the UK, were beneficiaries of other policy measures that had reduced CO_2 emissions relative to 1990 significantly: for Germany, the inclusion of the former East Germany and its subsequent economic collapse, and for the UK, the removal of coal subsidies and the consequent substitution of natural gas use. EU members having relatively lower levels of GDP per capita received higher limits, as did those most dependent on nuclear power. For the latter reason, Sweden has a limit under the EU bubble that is 4% above its 1990 emission level, twelve percentage points above the average for the European Union.

2.3 Emission Reduction Unit Credits through Joint Implementation

Article 6 of the Protocol allows Annex B countries to engage in Joint Implementation (JI) whereby one party, or more commonly a corporation or other legal entity belonging to that country, finances project-specific emission reduction activity in the territory of another Annex B party and thereby earns Emission Reduction Units (ERUs), which are transfers of AAUs from the host party. As such, JI activity can be seen as a partial or mini-bubble, carried out at the project level instead of at the state level, as is the case with Article 4. Although any Annex B party can be a host for a JI project, in practice these projects will occur almost entirely in those countries of Eastern Europe and the former Soviet Union that agreed to limits in the Kyoto Protocol which are higher than their expected emissions in the First Commitment Period.

In principle, the host country's emissions will be lower as a result of the JI activity than they would have been, so that the corresponding quantity of AAUs, which would otherwise be deducted from the host country's account, can be reassigned to the investing JI party. Since the likely host countries face no abatement requirement and they have inherited relatively inefficient energy practices from their communist past, JI activities will offer relatively cheap abatement opportunities for Annex B parties with binding Kyoto constraints.

A clear distinction should be drawn between the transfer of AAUs resulting from JI activities and the transfer of AAUs excess to the host countries needs without the JI activity, known generally as "hot air." If the JI project baseline is properly determined, the subsequent transfer of AAUs resulting from the JI activity would not be "hot air." In the jargon of the Protocol, the "additionality" criterion will have been met, and the JI activity will allow the AAUs thus freed up to be used to avoid an equivalent domestic emission reduction by the investing party.

From the standpoint of Sweden, JI activities are attractive not only for the obvious economic reasons but also because of the proximity and existing commercial activities with East European and Baltic countries that are expected to be JI hosts.

2.4 Certified Emission Reduction Vredits through the Clean Development Mechanism

Article 12 of the Protocol creates the Clean Development Mechanism (CDM) by which emissions trading can be conducted with non-Annex I parties.[4] In many ways, CDM activities are similar to JI activities. Abatement activity in the non-Annex I party's territory creates a Certified Emission Reduction (CER) that can be transferred to an Annex B party for use in meeting its emission limitation obligations under the Protocol. As is the case for JI, if the project baselines are properly determined, global emissions will be no greater because of CDM activities, and there will be some aggregate cost savings that can be split to the mutual benefit of the trading parties. There are, however, three salient differences from JI activities.

The first and perhaps most important difference is that the Clean Development Mechanism is a distinct legal entity, endowed with executive board and authorized to certify what constitutes a CER. Although the additionality criterion applies to CERs as well as to ERUs, Article 12 also states that the purpose of the CDM is to assist non-Annex I parties in "achieving sustainable development and in contributing to the ultimate objective of the Convention." How the CDM is to be constituted and what criteria it shall apply in certifying emission reductions are to be determined by subsequent Conferences of the Parties to the Framework Convention. Negotiations are proceeding to work out these details but they are highly contentious. A critical issue is whether "achieving sustainable development" is synonymous with reducing GHG

[4] Annex B parties and Annex I parties are largely overlapping. Technically, Annex I is the part of the Framework Convention on Climate Change (FCCC) that lists those countries "taking the lead in modifying longer-term trends in anthropogenic emissions" and aiming to return their emissions to their 1990 levels. Annex B is a part of the Kyoto Protocol to the FCCC and it lists those Annex I parties accepting emission limitations under the Kyoto Protocol. Belarus and Turkey are the only Annex I parties not included in Annex B.

emissions or whether this vague wording allows for other considerations to guide certification, such as addressing serious local environmental problems. Another theme in the ongoing negotiations about the CDM is the demand that projects should be allocated according to regional considerations instead of economic merit. Finally, one does not need to look hard to find advocates of using the CDM to provide a means for realizing the North-South redistribution of income that has so long eluded its proponents. Such objectives may all be worthy, but for a serious, responsible, environmentally conscientious nation concerned about climate change and limiting emissions of GHGs, the introduction of such considerations could diminish the value of CERs.

A second difference is that a share of the proceeds of CDM activities is required:

> to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

The size of this charge for administrative expense and adaptation assistance, and indeed what constitutes each of these activities, is yet to be worked out; however, any charge will lead to a lower return for abatement through the CDM since CERs are exactly equivalent for compliance purposes to AAUs acquired through JI activities under Article 6 or emissions trading under Article 17 and neither of the latter would carry this charge. Not surprisingly, proposals have been made to levy an equivalent charge on Article 6 and Article 17 trading activities.

A third difference is that CERs obtained during the period from the year 2000 until the start of the First Commitment Period in 2008 can be used to assist in achieving compliance during the First Commitment Period. In a word, CERs resulting from early emission reduction activities outside of Annex I can be banked. Early action has been proposed in a number of Annex B countries, but these equivalent reductions in Annex B countries would not be bankable for credit during the First Commitment Period under the terms of the Kyoto Protocol. It is possible, however, that individual countries would credit early action reductions and seek an interpretation of the Kyoto Protocol that would establish equivalence between CERs and other forms of early action.

This feature is potentially quite important with distinct advantages for both Annex B and non-Annex I parties, but it presumes that the various issues surrounding the CDM would be sufficiently settled by 2000 that CERs could be created. Such has not been the case, although it is hoped that the Sixth Conference of the Parties (COP-6), meeting in The Hague in November, 2000, will be able to resolve enough of the critical issues so that CDM activities can be undertaken and CERs earned early in the 2000-2007 period.

In summary, the CDM offers yet another form of emissions trading that could open up large amounts of cheap abatement both during the First Commitment Period and through early action in preceding years. The economic potential is large but the mediating institutional framework could become so bureaucratized and infused with other objectives as to frustrate the realization

of this potential. For a country like Sweden, the issue will be first whether the CDM ever becomes a viable entity, and assuming it does whether CERs will be both economically and environmentally attractive.

2.5 Article 17 Emissions Trading

Article 17 is at once the least well defined, most controversial, and potentially most important provision concerning emissions trading in the Kyoto Protocol. The language is short and general:

> The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitations and reduction commitments under that Article.

On the surface, this provision appears almost superfluous, simply restating the obvious concerning the various forms of emissions trading that have been discussed briefly above. But the circumstances of its inclusion and the meaning imparted to it by certain parties, chiefly the United States, implies much more. The article was a last-minute addition to the Protocol (initially Article 16b) inserted to gain the agreement of the United States. In practice and to use the jargon of the time, it includes cap-and-trade systems within the set of "policies and measures" that are deemed acceptable means of achieving an Annex B party's commitment. A party adopting such a system could then assign (or "download") its AAUs to domestic legal entities (corporations) that then might trade those AAUs across national borders. Emissions trading among Annex B parties would be thereby freed of the state-level exchange of quotas anticipated under Article 4 or the project-specific emissions trading sanctioned under Article 6. As monitoring, verification and enforcement procedures are developed to ensure the validity of traded AAUs, markets for the exchange of AAUs would develop—much as what has happened in currency, bond, and other paper markets.

The exchange of AAUs under Article 17 is usually seen as a distinct form of emissions trading, as evidenced by the use of the acronyms, JI, CDM, and ET, to designate trades under Articles 6, 12, and 17, respectively. Each is equivalent for compliance purposes; however, the first two forms would allow a party that did not adopt a cap-and-trade system to take advantage of cheaper abatement opportunities in other countries. Furthermore, the concept of allowance trading has become more acceptable during the past few years, and it is increasingly seen as something other than an accommodation to American idiosyncrasy. As will be discussed in greater detail below, cap-and-trade systems are now being proposed by individual European governments and by the European Commission for use by all members of the European Union.

Article 17 has also opened a highly controversial aspect of emissions trading: the selling of "hot air," or, AAUs excess to the needs of parties in the former Soviet Union and Eastern Europe

without any abatement being undertaken. Since these excess AAUs can be banked, or even reassigned in the First Commitment Period under Article 4, the trading of hot air does not make any difference from a climate standpoint, but some quarters view the concomitant lessening of aggregate abatement in the First Commitment Period as a loophole.

2.6 Supplementarity

No discussion of emissions trading under the Kyoto Protocol would be complete without mention of this yet to be defined provision. As quoted from Article 17 above, and similarly stated in Article 6, emissions trading is to be "supplemental" to domestic actions for the purposes of meeting the Kyoto limits. This provision responds to a concern voiced most frequently in Europe and among the G77 that emissions trading would allow constrained parties to escape their Kyoto commitments. The EU's Council of Environment Ministers has advanced a specific proposal for a "concrete ceiling" on the import of permits from abroad that would, if it were to operate as intended, limit parties to importing no more than 50% of the emission reduction implicit in the party's Kyoto emission limit.[5] In addition, the proposal would allow only a small amount of available hot air to be exported. The "Umbrella Group," generally the non-EU OECD parties plus Russia and the Ukraine, argue that such a limit is not needed since every party can be expected to undertake some cheap domestic abatement and that the limit would unnecessarily raise costs for any party so restricted.

Whether supplementarity would matter to an individual party, such as Sweden, would depend upon the comparison between marginal costs for domestic abatement and the cost of acquiring permits through any of the three Kyoto mechanisms. Parties facing relative high domestic marginal abatement costs can be expected to rely more heavily on acquiring permits from elsewhere, and such parties will be more interested in how this issue is resolved at COP-6. For instance, Norway, which is widely viewed as facing high marginal costs of abatement, has made its opposition to supplementarity well known both by being the only West European member of the Umbrella Group and by frequently voicing its dissent from the EU consensus on this issue. With respect to any member of the EU-15, the Council asserts that supplementarity applies only to the EU Bubble as a whole, not to trades among members of the European Union.

3. Post-Kyoto Proposals Relating to Emissions Trading in Europe

Over the past year, a number of proposals have surfaced in Europe for establishing emissions trading systems, generally of an allowance-based type. By far the most important of these proposals is the European Commission's Green Paper on Emissions Trading. In individual countries, emissions trading systems are in the process of being established in the United

[5] See FCCC Secretariat (1999) for the proposal. Ellerman and Sue Wing (2000) provide an evaluation of the principle of supplementarity and of the EU proposal.

Kingdom and Denmark. Norway has developed a comprehensive system to be implemented with the entry into force of the Kyoto Protocol. Still other countries, namely, Sweden, the Netherlands, France, and most recently Germany, have advanced proposals or announced intentions to include some form of emissions trading as part of their plans for implementation of the Kyoto Protocol.

There is a certain surprise and irony in this development. Any one familiar with the run-up to the Kyoto Protocol would not have predicted that the earliest and most concrete emissions trading proposals would have emerged in the EU and its member states that were at Kyoto generally opposed to emissions trading. Moreover, among the Umbrella Group of countries, heretofore, the strongest advocates of emissions trading, no comparable proposals have emerged, with the notable exception of Norway.[6] Of course, all Annex B parties are participating in international negotiations in developing the rules and institutions of a global GHG emissions trading system, but progress has been slow and, even with an ideally designed international system, trading will emerge only when at least some Annex B countries undertake the domestic action to implement a binding emission cap and to accept those rules.

Emissions trading in GHG credits among private parties has also emerged in embryonic form, but this market is driven entirely by the voluntary actions of corporations in order to learn about possibilities elsewhere for emission reduction and sink enhancement or to acquire credits for public relations purposes, or both. Such voluntary, credit markets could easily transition into markets for GHG emission allowances, but some type of cap will have to be created through government action first, and such action appears unlikely in the United States or in other large Umbrella Group countries. The ironic result is that, assuming the European proposals are realized, the rules and institutions of international GHG trading will develop from these practical experiments instead of from the hypothetical models put forward by the American and Umbrella Group advocates of emissions trading.

3.1 The European Commission *Green Paper* on Emissions Trading

In March 2000, the Commission for the European Union issued a remarkable *Green Paper on Greenhouse Gas Emissions Trading within the European Union*, (European Commission, 2000) the intent of which is:

> to launch a discussion on greenhouse gas emissions trading within the European Union, and on the relationship between emissions trading and other policies and measures to address climate change.

[6] Confederation of Norwegian Business and Industry (2000) provides a status report on emissions trading proposals in Europe and other Annex B countries. Although various domestic proposals have been advanced and are under consideration in non-European, Umbrella Group countries, all appear to be contingent on entry into force of the Kyoto Protocol and none have the official status of those in the UK, Denmark, and Norway.

This paper is remarkable not only for being issued by the Environmental Directorate-General, previously perceived to be largely hostile to the concept of emissions trading, but also for the completeness, competence, and impartiality with which the various issues involved in emissions trading are introduced. In doing so, the Green Paper states that emissions trading will be an "integral and major part of the Community's implementation strategy" and it proposes the broad outline of what could be a EU-wide emissions trading system. Moreover, it is proposed that this EU trading system begin in 2005 so that the Community and its Member States shall "gain experience … before the international emissions trading scheme starts in 2008."

In broad outline, the Green Paper proposes that emissions trading be the instrument for the limitation of emissions from large electric utility and industrial sources (approximately 43% of estimated CO_2 emissions) and that other policies and measures apply to the transportation, residential and commercial sectors and to small industrial sources. Emissions trading would be limited in the pre-2008 period to CO_2, although the system would be designed to expand to include non-CO_2 GHGs and sinks as measurement and verification problems for these options are resolved. An EU-wide cap over commonly included sectors is asserted as highly desirable for competitive reasons; although it is recognized that, at least initially, not all Member States may be able to join the system and that the sectors included may differ from one country to another. The expansion of the system to allow opt-ins from non-included sectors and closely allied non-EU members (Norway) is also anticipated. Since the end result of what is proposed would be a single emission permit market, the Green Paper identifies and invites comment on the division of responsibilities between Member States and the Community with respect to the essential functions of permit allocation, monitoring, verification, and enforcement. Comment on the Green Paper is solicited by September 15, 2000, "so that the Community's implementation strategy can be developed in the light of these opinions immediately after (COP-6)."

The Commission's goals may be ambitious, but the Green Paper has raised emissions trading to a status that it had not previously enjoyed in Europe and it seems certain to launch a vigorous debate about creating such a market. For any Member State anticipating the use of emissions trading as an instrument in meeting its Kyoto limits, the outcome of this debate will be important in determining the contours of any domestic emissions trading system that it might implement.

3.2 Norwegian Emissions Trading System

Among the various European nations, Norway has gone the farthest towards relying entirely on emissions trading as its instrument for meeting its Kyoto commitment. In October 1998, the Storting expressed a preference for developing a comprehensive cap-and-trade system as the means by which Norway would meet its obligation. Subsequently, a "Quota Commission" consisting of government, industry and academic participants was established to develop a concrete proposal, and that Commission delivered its report to the Ministry of the Environment in December 1999.

The proposed Norwegian system differs in important respects from the EU-wide system that is outlined in the EC Green Paper. Most importantly, the system would be far more comprehensive extending well beyond large industrial sources and including not only CO_2 but also other GHGs. In all, an estimated 88% of Norway's 1997 GHG emissions would be covered.[7] Early action is not anticipated and the proposed system is to begin with the First Commitment Period in 2008. The distribution of permits would occur three to five years before then and the permits would be valid for use in any year of the First Commitment Period (and bankable for later commitment periods). Assuming that an international market exists, the Norwegian system would be fully open to AAUs from other Annex B parties and CERs from the CDM. Since Norway is expected to face relatively high marginal cost of abatement due to the structure of its GHG emissions, it will likely import a significant portion of emission reduction required for it to meet its Kyoto limit (1% above 1990 levels).

The most interesting and significant aspect of the Quota Commission Report is the discussion concerning the allocation of permits. Whereas most of the technical aspects of the proposed Norwegian trading system were agreed to unanimously or by an overwhelming majority, agreement broke down completely on this point with opinion falling into three camps. A bare majority of six (out of eleven) recommends that the government auction the permits and that the proceeds accrue to the government to reduce other taxes and to earn a "double dividend." The sole industry representative and an environmental NGO recommended grandfathering of permits, and the other minority group consisting of civil servants from several ministries argued that allocation is a political issue and outside of the Commission's mandate. Fully one-third of the "Summary Report and Recommendations" is devoted to the arguments concerning the relative merits of auctioning and grandfathering. Given the fundamental issues of equity raised by the allocation of limited use and the associated rents, when heretofore freely exercised rights are restricted, the attention and disagreement concerning allocation is not surprising. In fact, it is a sign of the seriousness of the proposal under consideration.

3.3 United Kingdom Emissions Trading Scheme

The United Kingdom will soon implement an emissions trading system inspired by the Kyoto Protocol, but not nearly as closely tied to the UK's obligations as the Norwegian proposal. For one thing, the UK government claims to have measures already in place to ensure that it achieves its EU-bubble limit of 12.5% below 1990 levels, and most observers expect the UK to meet its limit (Gummer and Moreland, 2000). Among those measures is a Climate Change Levy (CCL), which is a tax on the energy (not carbon) content of natural gas, coal, and electricity used by business and public entities. The levy translates into a carbon tax ranging from about £16 to £30

[7] Sinks are to be included after further research has clarified the practicality of their inclusion and international agreement on the treatment of sinks has been reached.

per metric ton of carbon (US$24-45), depending on the fuel.[8] The CCL is included in the UK Government's 2000 Budget and it is to be imposed starting April 1, 2001.[9] The revenues from the CCL are to be wholly recycled through a reduction in employers' national insurance contributions and investment in alternative energy and energy saving technology.

The most interesting feature of the CCL is that large industrial users in energy-intensive industries are offered a 80% rebate of the tax if they negotiate a "voluntary" CCL agreement (CCLA) with the government for achieving an energy-efficiency standard or an absolute energy-use "cap" that would be translated and stated in CO_2 emissions. In parallel, large emitters, both CCL and non-CCL payers, have expressed a strong interest in negotiating absolute caps and the government is keenly interested in doing so to provide a "buffer" for assuring that the UK will meet its Kyoto commitment and to promote the City of London as a center for international emissions trading. This common interest has found expression in a UK Emissions Trading Group consisting of business and government representatives, which is to develop an Emission Trading Scheme (ETS). Reports from this group have been issued in October 1999 and March 2000 in which the key elements of the ETS have been laid out (UK ETG, 2000). Finally, in response to a recommendation from this group, the government agreed in July 2000 to provide £30 million in incentives for firms volunteering to accept a cap, whether those firms pay the CCL, have negotiated CCLAs, or are CCL-exempt, such as electricity generators and refineries.

The proposed Emissions Trading Scheme includes both allowance-based and credit-based emissions trading in what are called the "absolute" and "unit" sectors, respectively. The absolute sector would consist of all large business firms negotiating absolute targets under CCLAs and those that offer caps on emissions in return for the financial incentive. These firms would receive grandfathered, fully tradable permits and be required to surrender permits equal to the firm's CO_2 emissions. The unit sector would consist of firms negotiating energy efficiency standards, which could then receive carbon-equivalent credits for over-achievement of the negotiated energy efficiency standard. Alternatively, firms falling short of the standard would be able to acquire credits and to come into compliance by surrendering credits equal to the shortfall. Within certain limits, trade in permits would be allowed between the two sectors and firms could move from the unit sector to the absolute sector. Finally, firms not otherwise affected could join by engaging in CO_2 emission reduction projects to generate credits for later use or for sale to the unit or absolute

[8] Since the tax is levied on energy content and not carbon, the carbon-equivalent tax is lower for coal than for natural gas. The levy rate is 0.43 pence per kilowatt-hour for electricity and 0.15 pence per kwh for coal and natural gas use. These rates work out to a carbon tax at about £16 (US$24) per metric ton of carbon for coal and £30 (US$45) per metric ton of carbon for natural gas. In principle, electricity supplied to the business sector from renewable sources and "good quality" combined heat and power is exempt. Since the higher rate for electricity takes into account the energy losses from single cycle generation of electricity, the implied rates on coal and gas-fired electricity work out to be the same as those for the direct use of these fuels, although the levy itself would provide no incentive to the electric utility sector to switch to lower carbon content fossil fuels for generation.

[9] Refineries and petroleum products used by all business entities are exempt on the rationale that they are already sufficiently taxed in the UK. The electric utility, residential, and transport sectors are also not covered by this measure.

sectors. The absolute sector would be open to trade internationally and ETS permits would be fully exchangeable with AAUs and CERs. Permits would be bankable for use in future years, although with restrictions into the First Commitment Period. A portion of the UK AAU allocation for the First Commitment Period would be downloaded to firms in the absolute sector, since the permits received would cover the years 2001 through 2012.

Although the UK ETS will be put in place before other proposals, it is much more limited in scope than the Norwegian proposal. Perhaps, the most interesting feature of the UK system is the indirect but effective means of implementing a cap-and-trade system, namely, by offering it as a means to reduce the burden of the default tax and by offering an incentive to other emitters who voluntarily take a cap. In effect, the UK ETS offers a path for transitioning from the more conventional taxes and standards to a decentralized system of environmental regulation based on property rights.

In a related action, the International Petroleum Exchange (IPE) in London has advanced a proposal to establish a secondary market in CO_2 permits and to perform many of the accounting and reconciliation functions that are required for a viable cap-and-trade system and allowance market. The IPE proposal anticipates that it would initially function only in conjunction with the UK ETS but that over time it would perform the same functions for a EU-wide trading system. It is significant, and consistent with both the UK and EU proposals, that the proposed IPE market would be established for CO_2 only, in part because of the measurement problems associated with the non-CO_2 GHGs. This market would operate on a spot basis and on a forward monthly basis for contract deliveries up to thirty-six months ahead, in the same manner as other commodities traded on the IPE. The IPE proposal recognizes that certain functions, such as setting the caps, allocating permits, and enforcement actions, will rest with governments. Nevertheless, it makes recommendations for certain of these functions, for instance, grandfathering of permits on an historical basis, and stiff automatic penalties (two times the market price) for non-compliance. The IPE proposal shows the readiness of the financial community to facilitate the creation of markets for tradable permits and in this case to perform the bank-like accounting and reconciliation functions heretofore performed by the regulator in the few extant tradable permit systems. With the UK ETS becoming operational in April 2001, the role of the IPE and other financial institutions bears watching, for the UK experiment will likely influence the development of tradable permit systems both on an EU-wide basis and in individual member states.

3.4 Emissions Trading in the Danish Electricity Sector

The only other nearly operational tradable permit system in Europe is in Denmark's electric utility sector, which accounts for about one-third of Denmark's CO_2 emissions. In June 1999, the Danish Parliament adopted a measure to cap and to reduce CO_2 emissions from electricity generation as part of a more general reform of the Danish electricity system. The European Commission approved the Danish proposal in May 2000 and it is now expected to become

effective on January 1, 2001. The cap applies to CO_2 only and it is reduced from 22 million tons in 2001 to 20 million tons in 2003, after which the Danish Parliament will establish more stringent caps to achieve an announced target of reducing CO_2 emissions to 20 percent below 1988 levels by 2005. The 2001-03 levels are about 30% below average annual CO_2 emissions during 1994-98. Finally, the proposal anticipates that permits from outside Denmark would become acceptable as ERUs, CERs, and permits from other countries' emissions trading systems become available in the First Commitment Period.

Three aspects of the Danish emissions trading system are particularly important, the first of which concerns coverage. The cap is to apply to emissions used in the generation of electricity produced in Denmark, including that exported, which can vary considerably from year to year. Incentives for electricity producers to provide district heating and other industrial uses of by-product steam leads to a complicated set of rules governing that effectively excludes all but about 10-15 out of a total of close to 500 electricity producers from the cap. Nevertheless, about 90% of Danish electricity sector emissions appear to be included.

Secondly, permits are grandfathered to incumbents based on 1994-98 emissions and the government can set aside a part of the aggregate cap for distribution to new entrants. Permits would be distributed annually for the following year with at least a preliminary indication of the permits to be allocated to recipients for the following two years.

The third and perhaps most notable aspect of the Danish trading system is the penalty for non-compliance. Exceeding the permit limits will result in a charge of 40 Danish kroner (DKK) per ton of CO_2, which is equivalent to about US$22 per ton of carbon. The Danish penalty is so low because of the high volatility of demand for Danish electricity exports. The Danish electricity sector is both coal dependent and fully integrated with the hydro-dependent Norwegian and Swedish electricity systems. Thus, when rainfall is low, the demand for Danish electricity exports is high with a consequent surge in CO_2 emissions. In the absence of a thick international market, the low penalty structure puts a cap on what could be very high permit prices in periods of high export demand. As a result, the Danish system is more of a hybrid, "soft" cap in which the cap would be observed only if the market-clearing price is less than 40 DKK. Still, a soft cap can pose a problem for Denmark's compliance with its Kyoto limit, unless the Danish government is willing to purchase permits in the international market equal to the amount issued at 40 DKK.

3.5 Swedish Flex-Mechs Commission Proposal

In April 2000, a commission established by the Swedish Ministry of Industry, Employment and Communications issued a report with the revealing title (in Swedish) "Trade to reach climate goals!" This report urges the initiation of legislation to establish a Swedish emissions trading system for the First Commitment Period and before, perhaps as early as 2002, and it discusses the features of a proposed system in some detail. As such, the report, and the proposal contained therein, performs a function like the EC Green Paper; it opens a discussion instead of working

out the implementation of decisions that have already been made, as in Norway, the UK, or Denmark. Although similar in spirit to the frequently referenced Green Paper, the Swedish proposal contains some notable differences.

The most significant is the comprehensiveness of coverage. Although recognizing that it may be necessary to start with large sources and CO_2 only, the proposal clearly aims towards a cap in the First Commitment Period that would include most sectors, especially transportation, and most GHGs so that at least 75% of Swedish GHG emissions would be covered by 2008. Although not as comprehensive as what is proposed in Norway, the Swedish system would be decidedly more so than the EU-wide system proposed in the Green Paper or the decidedly partial caps being implemented in the UK and Denmark. Even more revealing of the spirit of this proposal are the provisions to replace the current Swedish CO_2 tax completely by the trading system and to substitute "least-cost" for the usual "best-available-control" technology criteria for GHGs in the Swedish Environmental Code. In contrast, the EC, UK, and Danish systems reserve a large role for taxes and standards in meeting the Kyoto Protocol emission limits. Even the Norwegian proposal is more equivocal on this point, allowing that the proposed hard cap could replace existing taxes and standards, but that it could as well function as a complement to ensure the further reductions that will be required.

Like the other proposals, the Swedish one anticipates that JI and CDM activities would be integrated into the system. Article 17 trading of AAUs is not mentioned, but such trading is implicit in the report's recognition that the Swedish system would be part of a wider EU system. Finally, the report expresses a preference for auctioning permits (effectively making the existing CO_2 tax redundant), although it is recognized that provisions of the Swedish Constitution may conflict with such a distribution of permits.

3.6 The French Proposal

No better evidence exists of the change in attitude towards emissions trading in Europe than recent announcement in France, as well as in Germany, concerning the use of emissions trading for implementing climate change programs. In January 2000, Prime Minister Jospin announced that an emissions trading market would be developed for large, energy-intensive firms entering into voluntary negotiated agreements with the government and that these firms would thereby be exempted from a proposed carbon tax on energy use by business enterprises. This announcement was met with considerable surprise in French environmental quarters and in the press where it was denounced both as a "hairpin turn" in climate policy, by which France was aligning itself with the United States, and for accepting the "cynical and brutal" reality of a market in "rights to pollute."[10]

[10] "Cela revient à parler d'achats de droits à polluer, c'est cela la réalité cynique et brutale." Mme. Voynet, Minister of the Environment, in an interview with *Le Monde*, January 21, 2000. The accompanying article about the Prime Minister's announcement, "Marché des 'permis de polluer': la France s'aligne sur les Etats-Unis," declared "Ce n'est pas une inflexion, c'est un virage en épingle à cheveux: la France se rallie massivement aux permis d'émission." Given the modest proportions of what was announced, this analysis seems exaggerated, but the hyperbole reveals the mental shock with which the proposal was received.

Soon thereafter, a joint ministerial-industry working group was created to examine how a nationwide emission trading system in France might be implemented. This group's report, submitted 31 March 2000, outlines a system in which voluntary negotiated agreements (VNAs) are the centerpiece and credit trading occurs in the differences between actual annual performance and the negotiated targets. The VNAs are to be negotiated between the government and about thirty fossil-fuel intensive sectors (excluding electricity) that would comprise about 80% of industrial CO_2 emissions and other GHGs when adequate measurement and monitoring procedures can be shown to exist. The targets may be expressed either as absolute quantities or as "specific" (per unit of value) emission rates; and the targets are to correspond to the quantitative targets established in the National Plan as the contributions of the individual industrial sectors to the national effort to control GHG emissions.[11] In principle, the French system would be designed to merge with the future European emissions trading system in 2005 and with an international system in 2008. Subject to supplementarity considerations, overseas abatement activities by French firms, including JI and CDM credits, would be recognized and fully exchangeable. Banking would be allowed but with an annual rate of deduction on banked credits to encourage their use in the current period and some potential restrictions on carrying credits from the pre-2008 years into the First Commitment Period.

The French government's announcement of the proposed carbon tax in October 2000 confirmed the broad outlines of this proposal. The tax, called a general tax on polluting activities (TGAP), will be levied on the use of energy by business enterprises starting January 1, 2001, at a rate of 260 French Francs (US$33) per ton of carbon. Energy-intensive enterprises can negotiate five-year VNAs, in which case the enterprises would be taxed only on the excess above the emissions that would result from the negotiated emission reductions. The possibility of emission trading in differences is also mentioned without further details.

The French proposal for emission trading bears some surface similarity to the UK ETS, with which it is often compared, but it is fundamentally different. Both proposals allow energy intensive firms to negotiate agreements with the government that effectively exempt a given level of emissions from a tax, but the similarity stops there. The UK system seeks to negotiate absolute caps and it goes so far as to allocate the corresponding quantity of permits to firms for the entire period, 2001-12. In contrast, the French proposal would allow at most credit-based emissions trading like that in the UK unit sector, whereby emissions are effectively grandfathered at the negotiated amounts but credits are available only when emissions are lower than the targets. In the French proposal, crediting would be automatic, thus avoiding the transaction costs that have plagued most credit-based emissions trading arrangements, but liquidity would still be low, especially in the beginning when few credits would exist.

[11] The difficulty of meeting a quantity limit with emission rate limits is recognized and the possibility of a second absolute quantity constraint is raised. For example, a firm would be in compliance so long as the observed rate is below the target rate and the quantity of emissions is below x% of predicted mass emissions.

3.7 German and Dutch Proposals

In July 2000, a spokesperson announced the German Green Party's willingness to consider limited emissions trading as a component of Germany's climate policy and a desired starting date of mid-2001. The announcement admits that the Greens had been "wary" of permit trading and states that the present attitude represents a "shift in thinking" on the issue, while noting that "emissions trading is something that cannot be stopped."[12] As in many of the European proposals, emissions trading would be limited to the large industrial companies that are typically exposed to international competition. As announced in October 2000, representatives of the Federal Environment Ministry and of interested companies and associations have formed a working party to discuss "the options, frameworks and consequences of a national emissions trading system." Little is known about what type of system might emerge; however, the large role given to regulatory measures, taxes and voluntary national agreements in the existing German climate policy suggests one like that proposed in France or in the UK. As is the case in France, the significance of the German proposal lies not in its details, which have yet to be developed; but in the public embrace of emissions trading by a government that had previously been on record as firmly opposed.

The Government of the Netherlands has been a long-standing advocate of Joint Implementation but not of domestic emissions trading. The government's approach to encouraging JI is direct and market-based: a government tender to purchase ERUs from companies conducting JI projects in Central and Eastern Europe. The first tender was announced in May 2000 with a budget of 22.7 million euros and recently closed with 23 firms offering. Aside from this use of international trading, the Dutch implementation strategy has contemplated mostly voluntary agreements and regulatory standards. Nevertheless, in what is perhaps another sign of the times, the Dutch government established a commission in August 2000 to study a domestic emissions trading program for the Netherlands and to report to the Minister of Environment in 2001.

4. ISSUES IN IMPLEMENTATION

As parties come to embrace emissions trading domestically and internationally, a number of difficult issues of implementation arise. Much could be written on these problems; here no more can be done than to identify the main issues and to discuss them briefly with appropriate note of how they are addressed in current proposals.

4.1 Allocating Permits and Monitoring of Emissions

Any allowance-based emissions trading system presumes an allocation of permits and some method of measuring emissions to determine compliance. At the international level, the Kyoto Protocol accomplished an initial allocation of permits for the years 2008-12 to all but a few

[12] *Environmental News Daily*, July 19, 2000.

Annex I signatories of the FCCC. If emissions trading is to occur below the state level, then AAUs will have to be "downloaded" to corporations and other legal entities and some method for measuring emissions and tracking allowance transfers will need to be devised at the national level.

Allocation of permits to firms is rightly seen as one of the most difficult issues to be dealt with in implementing a cap-and-trade system. Essentially, the decision involves an assignment of the newly limited use of the atmospheric sink and the associated scarcity rent. The two basic alternatives are either to auction the permits or to "grandfather" them, that is, to grant them without payment to incumbents based on some principle, usually historical use. The former is often advocated in conjunction with recycling the revenue to achieve some form of a "double dividend," as is to be done with the UK Climate Change Levy. Also, the double dividend argument was critical for the narrow majority of the Norwegian Quota Commission recommending auctioning permits. Nevertheless, grandfathering is the more common alternative, usually because of the practical necessity of gaining the consent of incumbents to the measures being proposed. Moreover, when the alternative to a tradable permit system is some regulatory standard, the latter endows incumbents with more or less the same rights, also without charge. In any case, allocation of permits is an explicit, transparent, and preeminently political decision, which can arouse fierce opposition to the explicit "right to pollute," as seen in the reaction to the French Prime Minister's announcement.

Monitoring may be a less contentious problem, but it presents its own difficulties, mostly of a more technical nature concerning whether monitoring would occur "upstream" or "downstream." Most trading proposals anticipate that monitoring would occur downstream at the polluter's facility, either by measuring stack exhaust, as in the U.S. SO_2 system, or by measuring the carbon content of the fuel used at the facility, as contained in several of the European proposals discussed earlier. This point of monitoring works for large industrial facilities, but it would prove prohibitively expensive, at least with current technology, for vehicles and homes, which typically constitute at least half of CO_2 emissions. This circumstance leads to proposals for upstream monitoring of carbon content at refineries, natural gas transport hubs, and points of sale for carbon-based fuels (Environmental Law Institute, 1997).

The decision on the point of monitoring is sometimes further complicated by two mistaken beliefs. The first is that permits would be allocated to the entities owning the facilities where monitoring is performed since those entities will be those required to surrender permits. Such was done in the U.S. SO_2 emissions trading program, but there is no necessary requirement to do so, as is the case when auctioning permits is proposed. In principle permits could be allocated to charities, which would of course sell the permits to those required to surrender permits for compliance, just as the government would do in an auction. The second mistaken belief is that if permits were allocated to an upstream point of monitoring, no incentive to reduce emissions would exist at the point of emissions. Again, as would be the case with auctioning, it can be expected that the cost of the permit, however obtained (including a grandfathered permit, which

has an opportunity cost), would be passed on to consumers, in the same manner as the cost for any other essential input into the production process.

4.2 Penalties and Liability for Non-compliance

A viable tradable permit system with a "hard" cap requires that the penalty for not surrendering a permit be relatively high and that its imposition be credible and non-discretionary. If penalties are low, then affected parties will pay the penalty rather than incur the higher marginal cost of meeting the intended cap. Usually, penalties are several times the expected market price. For instance, in the U.S. SO_2 allowance trading system, the penalty was set at $2000 in 1995 and escalated with inflation thereafter, well above even the highest estimates at that time of what clearing prices might be. In addition, any entity in non-compliance will have a like number of permits taken away from a succeeding allocation to maintain environmental integrity. With the exception of the Danish and French systems, all the European systems proposed anticipate high penalties and "hard" caps.

The credibility of the penalty structure is relatively easy to achieve for sovereign authorities implementing a tradable permit system within the nation; however, a credible penalty structure is hard to imagine on the international level. This circumstance creates another problem, usually described as "over-selling," which will have to be addressed by any domestic GHG trading scheme that anticipates integration with the prospective global system.

Over-selling is the sale of more permits than a party has excess to its own need to cover emissions in the relevant compliance period. To cite a commonly used example, suppose Russia is given 1000 permits and that as a result of either honest miscalculation or roguish behavior, it has sold permits so that at the end of the period it has only 600 permits to cover 700 tons of emissions. The over-all compliance problem is obvious, but the more practical problem is whether the 400 permits purchased in good faith and being used for compliance by buyers are valid, and if not, which ones are not valid. Where sanctioning is credible, the commercial norm of seller liability prevails. With such a rule in this example, Russia would be fined for being short 100 permits, have its quota for the next period reduced by like amount, and the 400 permits held by buyers would be deemed valid. In the absence of credible international sanctioning, "buyer liability" is proposed. In this example, a buyer liability rule might hold that one-quarter of each Russian permit held by others would be deemed invalid and the buyers of those permits subject to the penalty prescribed by the domestic authority. Such liability would lead buyers to discount permits of questionable validity in the same manner that lenders discount the debt of poor credit risks.

Although seller liability can be presumed to apply for any domestic system with a hard cap, the liability problem cannot be avoided if the domestic system is to be integrated with international trading. If Volvo submits a Russian permit (or an Italian one for that matter), and it is determined that the issuing country is out of compliance, is Volvo also out of compliance in the Swedish system, and if so, by how much? Resolution of the issues of buyer or seller liability at the

international level will simplify the problem for individual countries, but not remove it altogether since the individual country will still have to decide whether to accept the international rule and how it would be applied in the domestic system. The assignment of liability is one of the issues being negotiated at the international level and it will be among the issues addressed at COP-6.[13]

4.3 Comprehensiveness of the Emissions Cap

With the notable exception of Norway, most of the proposed European tradable permit systems are not comprehensive in the sense of covering all of the country's carbon or GHG emissions. Emissions trading is but one of several policies and measures undertaken to achieve climate policy goals, usually the one to be applied to large industrial sources. In principle, several instruments can achieve the target as surely, and perhaps as cheaply, as a single instrument, but distinct problems are created by the choice of partial caps when the Kyoto cap is comprehensive (Hahn and Stavins, 1999).

The most obvious one is assuring that the joint effect of the several instruments is adequate to achieve the Kyoto limit. The partial cap may impose an appropriate share of the national burden on the sectors to which it applies, but there is little reason to believe that the other instruments, taxes or regulatory standards, will be chosen to meet the target exactly. Almost surely, they will prove to be either too little, leading to non-compliance, or too much, leading to excessive cost. The former case invokes the liability issue just discussed. If Norwegian entities acquire UK AAUs through the UK Emissions Trading Scheme, would they be valid if the UK's other measures are not adequate and notwithstanding the fact that the capped UK sectors were in complete compliance? Governments could avoid invalidation of their exported permits by entering the domestic or international permit market to compensate for the deficit due to the inadequacy of the instruments used in the non-capped sectors, but such action assumes governments have the financial means and will to do so.

The use of multiple instruments also poses a problem of equity that is similar to that incurred in allocating permits in the capped sector. Even if the combination of instruments is adequate to ensure meeting the Kyoto targets, it is unlikely that the effect of each instrument on the respective sectors would be equal, however equal is to be defined. The chief difference from allocating permits is that if a permit market exists the competitive effects of permit allocation are limited to the lump-sum transfer, whereas differing instruments will almost surely create differing marginal costs. These competitive concerns are perceived as particularly important where an industry is engaged in international goods trade, and this reason is often given by European proposals for creating partial cap-and-trade systems for large, energy-intensive industries. Not only will the sector be able to achieve the particular emission goal at least cost; but, with international trading, the marginal costs of abatement would be equalized with competing firms in other countries that are similarly engaged in international permit trading.

[13] Nordhaus *et al.* (2000) provide an extensive evaluation of the options proposed prior to COP-6.

A closely related problem is the possibility of inefficient arbitrage between instruments of differing marginal effect. A less stringent tax or regulation may induce domestic leakage from the capped sector to the uncapped sector, which would make compliance that much more difficult. However, if the cap were to impose lower marginal costs than the other instruments, as seems likely, then leakage would flow the other way, raising permit prices but also making compliance more likely. In either case, the arbitrage will bring marginal costs closer together.

Finally, interacting instruments create another form of arbitrage that often raises objection. The common example is a capped sector that also pays an energy or carbon tax. For any given cap and level of activity, the domestic permit clearing price will be lower if the capped sector is taxed, or subject to other carbon-reducing regulation, than if it is not. With international permit trade, the country will either export more permits or import fewer with consequent effects on the international price of permits. Or, as is usually and accurately stated, by taxing the capped domestic sector, the government makes it cheaper for other nations to meet their obligations.

4.4 Integration of Emissions Trading with Related Systems: Renewable Energy Certificates

A similar interaction occurs when renewable energy certificate (REC) trading co-exists with carbon trading. In an REC trading system, owners of qualifying renewable energy generating units receive certificates that are required of all electricity distributors in some fixed percentage of electricity sales. Distributors of electricity purchase electricity and renewable energy certificates in separate markets, and generators are remunerated by their receipts from the sale of electricity and of certificates into these two separate markets. These systems are now being proposed as an alternative to the usual regulatory mechanisms for sustaining given levels of renewable energy generation, which are either not available or not as effective as a result of electricity sector restructuring.

A REC trading system is similar to emissions trading in that it creates a market for the renewable aspect of generation that is separate from the basic cost of electricity, in the same manner as allowance-based emissions trading creates a market for abatement that is separate from the market for the good being produced. However, when a carbon permit market and a REC market co-exist, there is an interaction and this interaction may pose a dilemma. A positive price for carbon will support some amount of renewable energy generation, but usually not as much as the ten to twenty percent share typically proposed for REC systems. When the REC requirement is greater than the amount of renewable energy that would be provided with the carbon cap alone, the price for carbon will be lower and less carbon abatement will occur in other sectors of the economy. Some observers may object to this interaction, but the objection is properly aimed at the quantitative target for carbon emissions, which logically implies less emission reduction in one place if there is more reduction in another place, even if there is no emissions trading. When trading exists for both requirements, the separate markets ensure that the two independent objectives are met at least cost, and the interaction means that the price in each market is conditioned on the other. If renewable energy is advocated only for its carbon-free attribute, implementation of a comprehensive, tight carbon cap removes the need for a separate renewable

mandate. Nevertheless, when a renewable mandate is already in place, owners of renewable energy assets, vendors of the same, and advocates of small scale, distributed generation systems are unlikely to accept a reduction in renewable energy generation and they can be expected to argue for some supplementary renewable requirement, such as a REC system, that would sustain the existing level of renewable generation and perhaps increase it.

Opening the domestic carbon market to international trade will have similar effects to what occurs when permits and taxes coexist. The lower domestic carbon price resulting from a REC requirement that leads to more renewable energy generation than would occur with the carbon cap alone will lead either to more export or less import of carbon permits with consequent effects on the world market price. For a small country in a large global carbon market, these effects on the global price and the abatement efforts of others would be minimal, but carbon markets are unlikely to be large initially.

4.5 Integration of Sinks and Other Gases into a Carbon Trading System

The Kyoto Protocol embraces possibilities other than CO_2 abatement for influencing the radiative forcing that causes climate change. The inclusion of non-CO_2 GHGs and carbon sinks among abatement options promises significant economic advantages (Reilly *et al.*, 1999), but serious questions can be raised concerning the practicality of doing so, at least in the First Commitment Period. The most serious questions concern data. Knowledge of the stocks and flows of these other gases and of sinks, and the ability to measure and monitor them, is much less than for carbon dioxide. These problems lead naturally to emissions trading proposals, such as those from the EU, UK, Sweden, and France, which start with CO_2 and then expand to include the other gases and sinks as appropriate measuring and monitoring procedures are developed.

The expectation that these problems will be solved is understandable since some agreement on procedures is implicit in the presumption that compliance with the Kyoto Protocol will be determined based on all the listed GHGs and at least some carbon sinks. Unfortunately, progress in addressing these issues is likely to be slow and controversial, in part because the combination of overly ambitious targets and data imprecision invite creative accounting, as exemplified by the recent U.S. submission to the FCCC on sinks. It proposes broad definitions of sinks that would provide the U.S. with 300 megatons of carbon sequestration in the First Commitment Period, which is about half of the estimated U.S. reduction requirement based on a more conventional and less inclusive accounting of sinks. Moreover, problems of measurement and monitoring are not limited to sinks. Monitoring the abatement of methane emissions from ruminant flatulence (through changes in diet) or from rice paddy cultivation (from changed agricultural practices) offer similar challenges and potential for creative accounting.

Whatever the degree of international agreement on these procedures, individual nations undertaking serious efforts to limit GHG emissions will still have to grapple with these problems. International agreement would greatly simplify the task, but agreement may not be reached or it

may not be acceptable. More generally, nations establishing an emissions trading system that is to be integrated with a global permit market will always have to consider whether to recognize permits from other countries that, in the absence of international agreement or in defiance thereof, adopt liberal definitions that create what may be seen as a new form of "hot air."

4.6 Cost Caps and Escape Valves

An occasional feature of the emissions trading systems being proposed in Europe is a relatively low penalty for exceeding the cap, at least when compared to most estimates of the likely cost of meeting the Kyoto targets. The Danish system provides a good example of the phenomenon and the reasoning behind it. The Danish penalty, 40 DKK per ton CO_2 (≈ US$22/ton C) is low compared not only to estimates of the marginal cost of meeting the Kyoto targets for Denmark, but also to penalties proposed elsewhere in Europe. The reason for the low penalty is that Denmark's most carbon intensive activity, coal-fired generation of electricity, is also its most variable because of the tight integration of the Nordic electricity grid and the high variability of the hydroelectric generation upon which Norway and Sweden are both heavily dependent. In the absence of a thick world permit market and banking, annual variations in rainfall could create very high prices in some years and very low ones in other years. The Danish penalty effectively truncates the high price variation by providing an escape valve that caps the price at 40 DKK per ton of CO_2, albeit at the potential expense of the quantity target. More generally, the argument is often made that a hard emission cap would limit economic growth or otherwise impose unacceptable costs. A more general proposal along these lines has been advanced for the U.S. by Resources for the Future, a think tank in Washington DC (Kopp, Morgenstern, and Pizer, 1997).

Countries adopting escape valve features will find that international trading will become problematic. No problem is posed so long as the global market-clearing price is lower than the capped price; permits would be imported, until the domestic and world prices were equal, and the price cap would not be invoked. A very different situation would prevail if the global market-clearing price were higher than the capped price. Permit export revenues would be little more than the payment of taxes to the Treasury of the country maintaining the low penalty. It is hard to imagine that other countries would allow the import of these permits, or if they did, that they too would not set up a similar facility. As noted by Pizer (1999), hybrid instruments such as this will necessitate either harmonized penalties across countries or the restriction of the permit exports by countries with low penalties.

Domestically, an emissions trading system with an escape valve closely resembles a carbon tax system with tradable, grandfathered exemptions. As described earlier, the grandfathering of some fraction of historic emissions is an essential feature of negotiated agreements in the UK and France and trading simply reallocates these exemptions, or rights to emit, at some price. The rationale for the escape valve is more obvious in Denmark, and no negotiated agreements are involved; but the effect of the cap and low penalty structure is the same. Prices are capped

but emissions are not, and the thing traded is an exemption, or more precisely the right to emit without paying the penalty/tax. In effect, the escape valve price is effectively the penalty for exceeding the allocation of grandfathered permits, and conversely, any penalty can be seen as an escape valve price. If the penalty is very high relative to the expected market-clearing price, as with hard caps, escape is not attractive; however, if it is low, payment of the penalty would be attractive unless other sanctions are invoked. Thus, if a EU trading system including electric utilities were set up to start in 2005, the Danish and French penalties would have to be raised to EU standards if these trading systems were to be part of EU-wide emissions trading.

5. CONCLUDING COMMENT

Emissions trading is not only theoretically appealing, but it is now increasingly seen as a practical and desirable component of climate change policy. There exists no better evidence of this evolution than the increasing number of proposals to implement emissions trading systems in Europe. Implementing a strictly domestic system poses problems enough; however, as repeatedly noted above, the most difficult problems are faced when the domestic system opens itself to international trading. These problems are but one aspect of the much greater problem of creating a global emissions trading system when there is no global sovereign. A few observations on how a global system would most likely develop may provide an appropriate concluding note.

The path on which the world is now launched is one in which the interested parties are presumed to agree upon the rules of trading in order to reduce costs to acceptable levels, whereupon the Annex B parties will impose upon themselves the legally binding limits that will cause the trading system to come into being. This is a nice vision of international harmony and efficacy, but it has little relation to reality. Quite aside from doubts about whether the Protocol will enter into force, serious question can be raised concerning the ability of the conferences of the parties ever (not to mention by 2008) to agree on such technical matters given the existing disagreements among parties to the FCCC about the provisions of the Kyoto Protocol and the near-unanimity rules governing the FCCC decisions. Under the most favorable circumstances, the development of a global emissions trading system involving all or most Annex I countries and non-CO_2 gases and sinks will take decades to evolve.

The far more likely development is that some parties to the Protocol will undertake domestic measures, including emissions trading, perhaps in keeping with their Kyoto commitments. Furthermore, such parties can be expected to adopt rules involving international exchange of GHG emission permits, which may or may not follow international norms, assuming there are such. For instance, the attractiveness of abatement from JI projects will provide strong impetus for developing procedures for generating JI credits as a means of compliance. Moreover, one can imagine that two countries, each with a domestic trading system, might judge the other's system to have sufficient integrity that permits would be deemed convertible at par, so that trade could occur to their mutual benefit. Such mutual recognition and bilateral trade could provide the seed

from which an international permit trading system might grow. The circle need not be limited to two, and as it expands, a standard, or set of rules and procedures, would be evolved to facilitate increasingly wider trade in permits.

The closest analogies are provided by the evolution of hard currency standards, such as the gold standard in an earlier day, or currently, the European currency unit. A single or small number of countries lead and a standard is evolved by example and negotiation as the core group becomes more inclusive. The key feature is that not all parties must be aboard for the benefits to be achieved by the core. Over time, followers join in response to self-interest, persuasion, or subtle coercion, but some party or small group must develop a standard and start the process. Serious, environmentally conscientious, and responsible leaders will not be deterred by the failure of others to join initially.

APPENDIX

6. THE U.S. SO_2 ALLOWANCE TRADING PROGRAM

Few discussions of emissions trading get very far without reference to the U.S. SO_2 allowance trading program, and this paper has been no exception. This program is the world's first large-scale application of a cap-and-trade system for addressing an environmental problem, and it has worked exceedingly well, surpassing even proponents' expectations. As such, it presents an attractive alternative to the usual command-and-control approach to environmental problems, and it has become a standard for such alternatives. More importantly, the U.S. experience has revealed other attributes, besides the conventional argument about cost savings, that make this instrument attractive.

Of course, the U.S. SO_2 program cannot be applied blindly to other environmental problems. Every problem is different and the institutional circumstances in which the program is implemented can differ significantly between countries and between the national and international level. A full discussion of the applicability of this program to international GHG emissions trading is beyond the scope of this paper, but some observations of broad applicability in the design of national GHG emissions trading systems can be made. The six observations offered below are directed both at common misunderstandings about emissions trading and aspects of the program that are particularly relevant for GHG emissions trading. Readers interested in more detail about U.S. SO_2 emissions trading are referred to the just published *Markets for Clean Air: The U.S. Acid Rain Program* (Ellerman *et al.*, 2000).

6.1 Emissions Trading Does Not Compromise Environmental Effectiveness

Perhaps the greatest misunderstanding about emissions trading, especially in the international arena, is the perception that it allows polluters to evade their emission reduction commitments. In part, this criticism rests on differing conceptions of the emission reduction requirement. If the goal is that each affected party reduce emissions in a specified manner, then the criticism is valid. Under a cap-and-trade system, complete flexibility is afforded affected firms and any single source may choose not to reduce at all. The catch is that for every source not reducing emissions other sources must reduce more. Alternatively, if a broader view of the emission reduction commitment is adopted—namely, that aggregate emissions matter, not emissions from individual sources—the criticism that polluters are able to evade the requirement is unfounded. The U.S. SO_2 emissions trading program has demonstrated decisively that a tight, binding cap will reduce the relevant emissions, even though who, where, and how are left completely open. In fact, SO_2 emissions have been reduced far more than required and more than expected in the first transitional phase of the program, as illustrated in **Figure 1**.

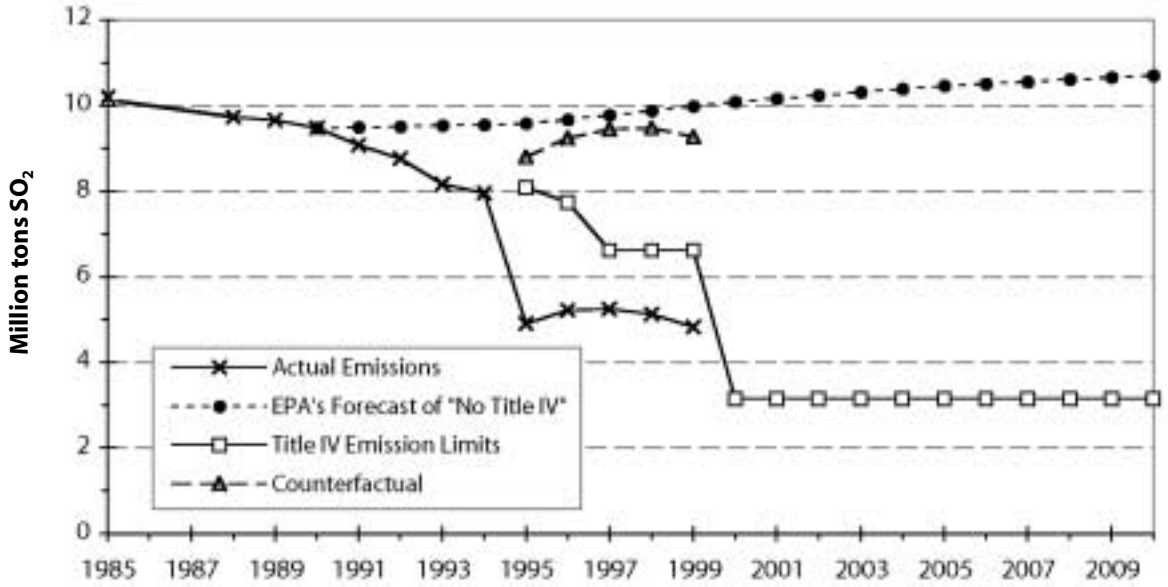

Figure 1. *U.S. SO_2 Emissions Trading: Emissions, Caps and Counterfactuals*

The solid line beginning in 1985 and continuing through 1999 indicates actual total SO_2 emissions from the 374 generating units that were subject to the cap during the first five years of the program. SO_2 emissions had been falling regularly before the acid rain program became effective in 1995, but the reduction of emissions in that first year was sharp and unprecedented. No one doubts that the cause was the SO_2 emissions trading program. The solid line beginning in 1995 and extending to 2010 indicates the cap, the number of allowances distributed to these units for the first fifteen years of the program.[14] Because of some special distributions of allowances, the cap was not particularly binding in the first two years of the program, yet emissions were reduced well beyond what was required in this and later years. The dotted line at the top indicates the baseline estimate of emissions from these units when the legislation was passed in 1990 and the dashed line provides a counterfactual estimate of what emissions would have been in the first five years given actual electricity demand in Phase I. The cumulative reduction of emissions in these first five years was approximately 20 million tons of which slightly more than half exceeded what would have been required to meet the cap in these years. This "excess" reduction has created "banked" allowances that will be used to smooth the transition to the lower Phase II cap by covering emissions greater than the annual allocations in the first years of Phase II. Thus, "over-compliance" in Phase I will be offset by "under-compliance" in Phase II; however, if earlier reductions are preferred to later reductions, the over-compliance in Phase I has brought an extra environmental benefit.

[14] The first five years, known as Phase I, form a transitional phase during which an intermediate cap, allowing 2.5 lbs SO_2 per million Btu of average 1985-87 heat input, was placed on the largest and most highly emitting generating units. A lower permanent cap begins in 2000. Known as Phase II, it covers all generating units and allows 1.2 lbs SO_2 per mmBtu of average 1985-87 heat input.

The more important aspect of environmental effectiveness is not the temporal acceleration of the required emission reductions, but the absence of exemptions and exceptions. Inevitably, the implementation of standards and regulations involve exemptions and exceptions that recognize unique circumstances at a unit that would result in undue hardship if the standard were to be applied uniformly. In many cases, such exception is equitable, but the special dispensations invariably detract from the environmental effectiveness of the prescribed standard. The problem is not so much the exceptions, but the lack of incentive to do more than is required where meeting the standard is relatively cheap. As a result, all the deviations from the standard are in the direction of loosening the requirement. In contrast, tight caps ensure that deviations in one direction are offset by deviations in the other direction. The flexibility afforded every source is one reason, but it is also true that no firm can claim undue hardship due to unique circumstance. With a market for allowances, the cost of an allowance represents the greatest hardship to be endured, and in a market with many buyers, none will be unique.

Figure 2 illustrates the extent to which the deviations in the SO_2 emissions trading program were offsetting. The columns represent observed emission rates and the bold line rising from the left to the right shows the emission rates that would have been observed at each affected unit in 1998 if every unit required to reduce emissions to meet its allowance allocation had done so without any trading.[15] Columns above the bold line indicate units that acquired permits from

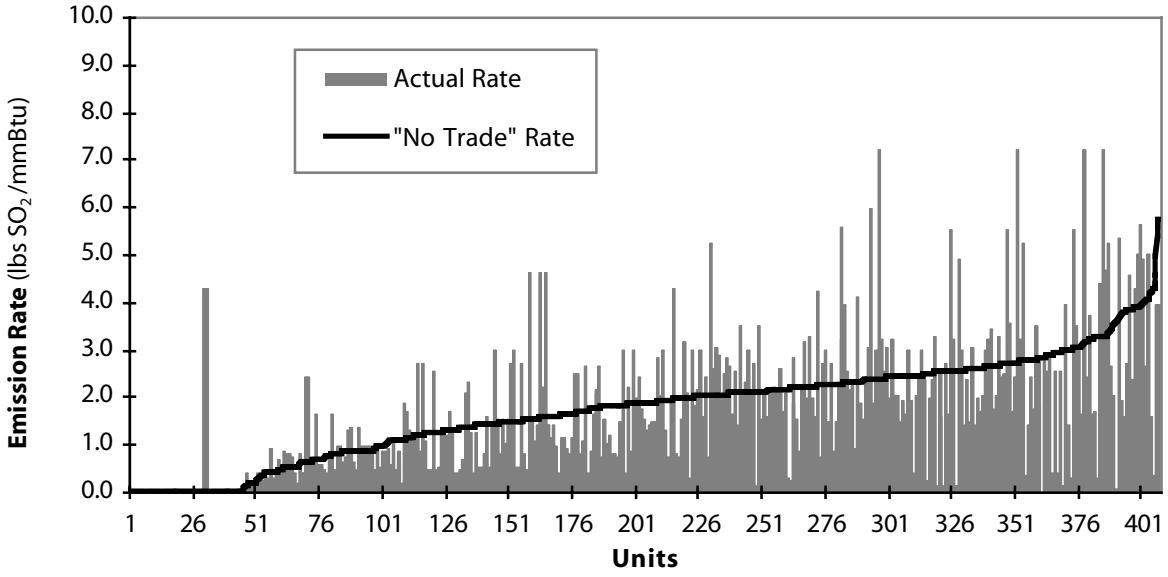

Figure 2. *SO_2 Emissions "Allowed" and Actual, 1998*

[15] The extent to which this line departs from the 2.5 lbs/mmBtu standard used to allocate allowances indicates the extent to which heat input at these units has changed since 1985-87. Heat input has been reduced for units on the right hand side that could have emitted at above 2.5 lbs/mmBtu, while many on the left hand side have increased heat input. Other units to the left of the graph had either switched to a low sulfur coal prior to 1995 or shut down (those on the extreme left) and were therefore not constrained by the allowance allocation.

other units to cover emissions greater than the quantity of allowances allocated to that unit. Without trading, these units would have been candidates for exception or exemption. Columns below the bold line indicate units that reduced more than necessary to be within the unit's allowance allocation. Without trading, some of these might have reduced emissions more than required, but certainly not in the large number or large amounts observed here.

The arguments for emissions trading are always based on cost-savings, and in an ideal, textbook world in which parties complied with environmental requirements however onerous they might be in individual cases, cost savings would be the only attraction of a cap-and-trade system. But, in an imperfect real world, in which equitable exception occurs, equal environmental effectiveness cannot be taken for granted. As noted in *Markets for Clean Air*, no other provision in three decades of experience regulating air emissions in the United States has been as effective as the SO_2 cap-and-trade program in reducing and limiting emissions. As a result, economists entranced with cost-saving possibilities are no longer the sole champions of emissions trading; an increasing number of environmentalists have come to advocate cap-and-trade systems as more environmentally effective than the traditional command-and-control alternatives.

6.2 Simplicity, Accountability, and Flexibility Go Together

The U.S. SO_2 emissions program is remarkable for the complete flexibility given affected sources. What is not so well appreciated is that this flexibility is made possible by a level of accountability that is far stricter than what is usually applied to environmental regulations. The requirement imposed upon emitters could not be simpler: to hold a valid permit to be surrendered for each ton of SO_2 emitted. Such singular simplicity both requires strict accountability and makes strict accountability possible. When nothing matters other than surrendering an allowance for each ton of emissions, there is no other basis for judging compliance than this simple one-to-one correspondence.[16] Not only does strict accountability result by default, but it also becomes eminently practicable when no complicating conditions introduce administrative discretion into the compliance decision. And, with such strict accountability in a well-designed program, the regulator can be very relaxed about whether and how individual emitters reduce emissions. Like the banker who cares not for what purpose a check is written but only that sufficient money is in the account, the environmental regulator need not ask how an emission reduction was accomplished, or even whether, but look only to see that there is an allowance to cover the debit.

This relationship between simplicity, accountability and flexibility also helps to explain the environmental effectiveness of the SO_2 emissions trading system. The simplicity removes wiggle-room, and the resulting strict accountability means that flexibility will have no effect on

[16] Emissions must be measured so that there are other requirements pertaining to the monitoring and reporting of emissions. In the U.S. SO_2 program, each stack was required to install a continuous emissions monitoring system and to report the results to EPA. It should be noted that the measurement of emissions as the basis of compliance is unusual in environmental regulation where more typically the requirement is to install a particular piece of equipment or to engage in certain practices.

the cap. More complicated, tailored rules diminish accountability and make flexibility less possible if loopholes are to be avoided. The lesson that emerges from this experiment—that simplicity encourages accountability, and strict accountability enables flexibility—should have wide applicability.

6.3 Allowance Markets Will Develop

One of the surprises about the SO_2 emissions trading program was the rapidity with which a market for allowances developed. Proponents of the program were not optimistic about the development of an allowance market mostly because the recipients of allowances, electric utilities, were viewed as unlikely traders. Since the cost-based regulation under which utility executives operated did not reward the risk-taking involved in trading allowances on an external market, the general expectation was that utility traders would avoid such risk and limit their trading to what could be conducted internally between units owned by the utility.

As shown in **Figure 3**, early allowance price indications showed a high degree of dispersion in keeping with this expectation; however, by mid-1994, about six months before the program went into effect, price indications from various sources converged. Thereafter, the law of one price, indicating a workable market, has existed. The price has displayed a fair degree of volatility over time, but there has always been one price at any one point in time.

Participants in this market were not limited to the electric utilities receiving allowances. The differences in marginal cost between utilities caused brokers to attempt to arbitrage these spreads, and the inevitable volatility created incentives for market makers and other speculators to provide hedging instruments to risk-averse utilities and to profit from the price differences through time. Other unexpected participants were upstream coal suppliers, who often bundled

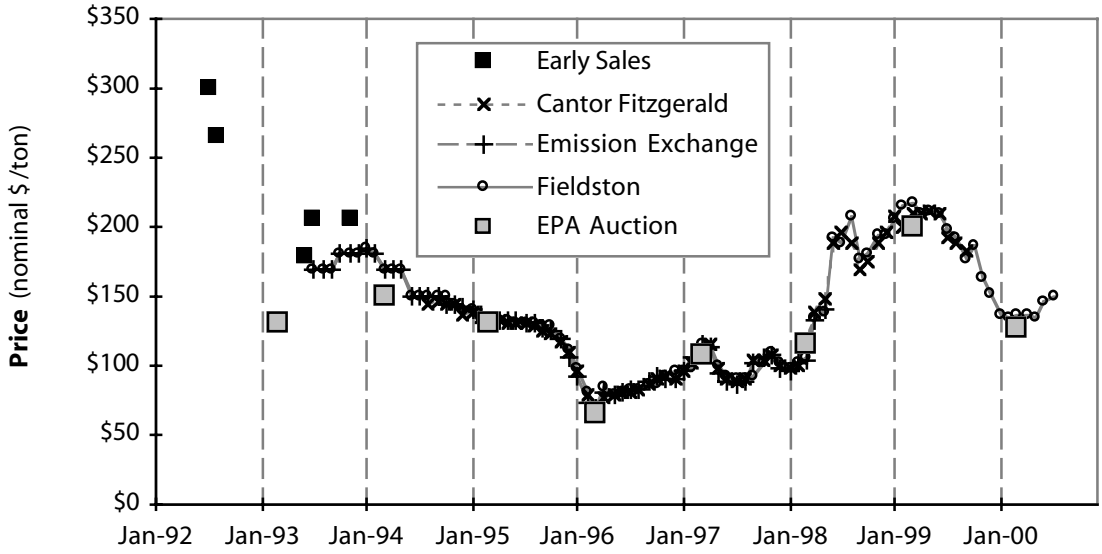

Figure 3. *SO_2 Allowance Prices, 1993-2000 (1995 or Current Vintage)*

allowances with coal supplies, and environmental organizations that retired a small number of allowances from circulation.

Experience with the U.S. SO_2 emissions trading program encourages the belief that markets will emerge when the need exists; however, the nature of the allowance and the rules of the system also make a difference. In the U.S. SO_2 program, the absence of any requirement that the regulator review individual trades greatly facilitated trading and the emergence of an external market. It is also important that the permits be viewed as reasonably secure and durable property rights, the value of which will not be altered arbitrarily by government fiat. In the U.S. SO_2 program, the allocation of allowances to firms up to thirty years in advance of when they could be used for compliance reinforced the sense that allowances were property rights and provided much more liquidity to the market than if the government had placed the allowances in accounts only a year or two ahead of time. This feature of the allocation also encouraged investment in capital-intensive, deep reduction technology (scrubbers) the cost of which would be recovered over a number of years. Investors knew up front how many allowances they would have available for use elsewhere or for sale to others over the life of the scrubber. When sold, the sale of such streams of allowances provided cash to reduce the financing needs for the initial capital investment while also fostering the development of the market. Finally, the ability and incentive to make such investments contributed to the over-compliance in Phase I that has made the program so attractive from an environmental point of view.

6.4 The Politics of Allowance Allocation Can Be Helpful

Quite aside from the environmental and economic merits of cap-and-trade emissions trading, the U.S. SO_2 experience suggests that the property rights created by these systems facilitate agreement on the enactment of the environmental programs. The proposal for allowance-based emissions trading broke what had been a decade-long stalemate on acid rain legislation during which environmental advocates of the conventional command-and-control measures had been defeated. The support of a new Republican administration was probably the decisive factor in breaking the stalemate, but the creation and grandfathering of the allowances to those on whom the new emission reduction requirement was to be imposed held an undeniable attraction. The granting of allowances was never called compensation and the incumbents would have received rights to emit under conventional regulation, but these new rights were more explicit, more secure, and perhaps most importantly tradable, which implied that the rights were no longer inseparable from and capitalized in the value of the emitting asset. A further advantage was that the allowances were easily divisible and allocable to address equitable concerns raised in the legislative debate and thereby to gain votes for enacting the legislation.

The legislative allocation of allowances was also important in achieving a degree of finality that would not have otherwise occurred. In earlier environmental legislation, Congress had indicated that certain goals were to be achieved and had instructed the executive, or appropriate

expert agency, to figure out how to implement the program to achieve those goals. The executive agency's rulings concerning the conditions for continuing to emit (the command-and-control equivalent of allowance allocation) were usually viewed by those on the receiving end as arbitrary and capricious with the result that, at least in the American system, implementation is tied up in litigation for years. The process by which allowances were allocated by the legislature was no more inspiring than is the case for tax or other legislation, but finality was achieved, if for no other reason that in the American system the grounds for suing Congress are many fewer than for a mere executive agency. Moreover, to the extent that legislatures are better at resolving genuine issues of equitable treatment than bureaucracies, the grounds for contesting implementation of the program were lessened.

Finally, despite all the bargaining with allowances in the legislature, there is no indication that the resulting allocations affected the efficiency of the market outcome. A nearly perfect Coasian separation of equity and efficiency appears to have been achieved. The process of allocation may not have been elegant, but it did deal with all the politics up front and thereby let implementation proceed more or less as a technical matter. And, having been endowed by valuable rights in the process, those most affected had a distinct interest in making sure that the system worked and that its integrity was maintained so that the value of the newly created rights could be realized.

6.5 Opt-in Provisions Are Tricky

The U.S. SO_2 emissions trading program has also revealed a troubling but not overwhelming problem with a frequent feature of cap-and-trade programs, opt-in provisions. An opt-in provision allows a source of emissions outside of the cap to volunteer to receive allowances and to become part of the cap. In theory, firms outside the cap with relatively low abatement costs would seek to join in order to exploit their cost advantage in abatement, thereby reducing costs and extending the cap. In practice, the U.S. experience has demonstrated that opt-in provisions contain an element of moral hazard.

The problem arises from the practical impossibility of setting a baseline for allowance allocation that will correspond exactly with what the volunteer's emissions would have been if it were not to opt-in. If the baseline is too stringent, low cost abaters will be discouraged from joining since doing so will impose some uncompensated costs upon them, and the purpose of the provision will be in part defeated. If the baseline is too lax, excess permits ("hot air" in Kyoto-speak) will be created, sources offering no low cost abatement will join to obtain the freebies, and the cap will be inflated to the detriment of the environmental objective.

Moral hazard enters as a result of the unavoidable lag between allocation and implementation and the effects of continuing change in the economy on the opt-in candidate. Allowances cannot be allocated simultaneously with implementation, when the regulator would know the demand placed on the unit and its immediately preceding emission rate. Instead, allowances must be issued several years ahead based either on some historical basis or a prediction of what is

expected. In the interval, the economy will change and affect opt-in candidates in ways that will cause the proposed allocation to any given unit to be either too stringent or too lax. Those for which intervening change has worked to create excess allowances will opt-in, even though they may offer little low cost abatement, while those for which intervening change has made the proposed allocation more stringent will be discouraged, even though they could offer relatively low cost abatement. The same factors work to tighten and loosen the effective requirement on mandated units, but with no opting out or in, the opposing effects offset each other.

In the case of the U.S. emissions trading program, the number of generating units that volunteered for the Phase I cap was unexpectedly large. Depending on the year, the number of voluntary units was half to three-quarters as many as those mandated to be subject to Phase I, and their entry expanded the scope of the cap by about 20% from what it would have been without the opt-in provision. More importantly, the allowances distributed to these units were about 23% *above* a reasonable *ex post* estimate of what aggregate emissions from the voluntary units would have been. In contrast, the number of allowances distributed to the units mandated to be in Phase I was about 24% *below ex post* estimates of their aggregate emissions. In all, about one million tons of excess allowances were distributed to opt-in units during Phase I or about 3% of the 37 million allowances issued to all units during the five years from 1995 through 1999. As a result, the aggregate, cumulative cap on SO_2 emissions has been inflated slightly. At the same time, these opt-in units reduced emissions by about 1.2 million tons in response to the incentives provided by participation in the cap-and-trade program so that there has been some savings in abatement costs.

The implications of this aspect of the experience with the U.S. SO_2 emissions trading program are mixed. Purists will likely argue that the moral hazard is unavoidable and the risks of cap inflation too great to allow inclusion of opt-in provisions. Pragmatists will argue that rules can be devised to minimize the selection bias and that the benefits of reducing costs and expanding the cap outweigh the small adverse effects of moral hazard in a well-designed opt-in provision.[17] In the U.S. program, it can be argued both that little was gained by the opt-in provisions since virtually all the participants would soon become subject to the law's provisions in Phase II and that the damage was slight when the million ton inflation of the cumulative ceiling is compared to the 90 million tons that will be allowed during the first ten years of Phase II, when these excess allowances will be used.

In the case of GHG emissions, where caps will be placed on CO_2 first because of measurement problems and on industrialized nations first because of their greater ability and willingness to pay, extending the cap to cover other gases and other countries is far more important in achieving the ultimate environmental goal than was extending the cap during Phase I of the U.S. SO_2 emissions trading program. In fact, the hot air embedded in the Kyoto Protocol can be seen as an inducement for the countries of Eastern Europe and the former Soviet Union to develop

[17] For instance, the U.S. program allowed substitution units to enter and exit from year to year. Requiring a unit to stay in once it opted in would have reduced the selection bias but not eliminated it.

acceptable inventories and measurement protocols that are the necessary precondition for voluntarily undertaking GHG emissions abatement and participating in global emissions trading.

Architects of GHG emissions trading systems, whether at the global or national level, will not have the luxury of deciding to forego opt-ins because of the moral hazard that will be encountered, as could be argued for the more limited environmental objectives of the U.S. SO_2 emissions trading program. Voluntary accession or opt-ins will be an essential part in achieving the environmental goal of GHG emissions cap-and-trade systems. The U.S. experience would suggest both that moral hazard cannot be ignored and that the damages in a well-designed system are not great. In the end, the damage will have to be weighed against the benefits of extending the cap to bring in other gases and other countries.

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