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International Tradable Carbon Dioxide Permits and Their Application Under the Kyoto Protocol

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The Kyoto Protocol has set binding targets for the reduction of greenhouse gas emissions by a large group of developed nations for the first time. This paper looks at the different policy instruments that may be used to help reach these goals, focusing on the tradable emissions permit scheme outlined by the Protocol. International trading of CO_2 credits is explicitly allowed under the Protocol, but the mechanisms for monitoring, certifying, and enforcing compliance has not yet been developed. In order to encourage countries to participate in such a scheme, a supranational organization—either an existing agency or a newly created one—must take on these responsibilities. While the first five-year budget period does not begin until 2008, countries must begin making transitions now. Procedures must be drawn up for the accounting of reductions, dispute resolution, and penalties for noncompliance. Options for individual countries to meet their reduction targets are also discussed.

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INTRODUCTION

Concern about the probability of global warming has led policy makers worldwide to search for ways of limiting the "greenhouse gases." The control of carbon dioxide emissions, released primarily from the generation of energy from fossil fuels, has been the focus of much debate. As the total accumulation of CO_2 and the other greenhouse gases may be responsible for changes in the climate, regardless of which country is responsible for their generation, climate change must be identified as a global problem.

A group of twenty countries, mostly developed, account for nearly 80 percent of CO_2 emissions. However, the developing countries' use of fossil fuels, and thus their emissions, is expanding rapidly as a percentage of world use. Thus the mechanisms chosen to reduce CO_2 emissions must do so as cheaply as possible, transfer resources to the developing countries to allow them to participate in implementation, and allow developing countries to continue their industrialization.

There are several policy instruments that have the potential to help reduce CO_2 emissions within individual countries, and on an international scale. This paper sets out to review the policy options available to reduce greenhouse gas emissions globally, the potential for their success, and their application under the Kyoto Protocol.

Policy Instruments

While the recent adoption of the Kyoto Protocol has set out specific emission reduction quantities for the Annex 1 countries, no requirements have been set out as to the means of meeting such goals. Policy instruments that may be of use in reducing greenhouse emissions have been described on two different scales that could be used separately or in combination: domestic policies and international policies. A government may institute domestic policies in order to reduce national emissions by the amount pledged to in the Protocol. International instruments are designed to reduce global emissions. In some cases international policies may give groups of countries the option to meet their combined goals jointly; one country may reduce emissions by a quantity less than required, if an agreement has been made for another country to reduce emissions more.

Over the past several years, there has been much concern over the probability of a large group of countries voluntarily agreeing to reduce greenhouse gas emissions. As climate change is a true "global commons" issue, individual nations have been reluctant to adopt policies unless they

expect to see a direct benefit from such changes. As the success of any action to slow global warming is correlated with the number of countries willing to take part, much stress has been put on the adoption of international treaties.

One criterion that is commonly employed to judge policy options is that of *cost-effectiveness;* the determination that a specific policy instrument can reach a given goal of emissions reduction at the least aggregate cost of abatement. Whether that target is an *efficient* cut back in pollution—one in which benefits are maximized—is a separate issue. In order to make a determination of cost-effectiveness, the uncertain task of measuring costs accurately must be undertaken. The major cost consideration, as assessed by most policy-makers and the general public, is that of administering environmental laws and regulations. The direct capital and operating expenditure incurred by compliance with regulations is an additional cost included by policy analysts. Other direct costs include legal and transaction costs, the cost of "refocused" management attention, and disrupted production. Indirect costs may include discouraged investment, transition costs of economies adjusting to new regulations over time, and effects on local employment levels. In some cases, "negative costs"—benefits unrelated to the immediate goal of the policy—may be associated with programs designed to reduce greenhouse gas emissions. In choosing domestic policies, each country will use its own set of criteria to calculate the cost-effectiveness of each option.

Regardless of scale, policy instruments fall into two major categories: direct regulation (often referred to as *command-and-control*), and market-based. Direct regulation of greenhouse gases on a domestic scale could take the form of quantity standards or control of materials, equipment, and fuel. Market-based policy instruments work by altering price signals, so that a cost is assessed on pollution, and that cost is internalized by individual firms. Examples of market based instruments are taxes and tradable permits.

There are certain criteria that must be met for any program to be accepted internationally and for it to successfully reduce worldwide CO_2 concentrations: it must allow for continued development in all countries, and especially for the continued industrialization in developing countries; it must be fair and equitable; it must minimize overall costs of implementation; and it must include means of transferring technical and financial resources to the developing countries, such that these countries are able to participate in the program (*Controlling Carbon Dioxide Emissions* 1995).

Domestic Policies

Standards

The majority of environmental policies in most countries apply uniform standards as their major policy instrument. Standards can take two forms: technology based or performance based. The former requires that specific equipment, processes, or procedures are used, regardless of differential costs across firms. The latter specifies an allowable level of pollution for each firm, but allows flexibility in choosing how those requirements will be met. Although both forms of standards could be effective on a domestic level in achieving a reduction of greenhouse gases, they can not be considered cost-effective methods. Even a performance-based standard that allows a firm to choose a cost-effective method of reducing emissions does not take into consideration that costs will vary among firms. A second disadvantage to a system of standards is the lack of incentives for the development or adoption of new technologies; once a regulation is met, a firm will not benefit from any further reduction that could be achieved through the adoption of superior technology, and may even fear that by doing so, performance standards will be tightened.

Market Based Policies: Taxes

In contrast to a program of standards, market-based policy instruments attempt to offer cost-effective solutions and also provide continuing incentives for the development of improved technology. These instruments achieve the same total level of pollution control as a standard, but with the burden shared differently among firms. Those that can reduce their pollution at a relatively lower cost will do so; those that have a higher cost of control will emit more pollution.

In an idealized, perfectly competitive market, either an emissions tax or a tradable permit system would allow polluters to reduce emissions exactly to the point where the marginal cost of an additional unit of abatement equals the per unit tax rate or the price of an emissions permit (Stavins 1997). Either system will lead to the chosen aggregate level of emissions reduction at the least cost. In addition, such programs will encourage the development of new technology, which will allow firms to abate more units of pollution at a cost that is lower than the tax or permit price.

A domestic tax can be levied on carbon at many different levels. The most common targets are the carbon content of fossil fuels or actual CO_2 emissions, which are both relatively easy to measure. Although the carbon content tax will provide an incentive to reduce the amounts of carbon-based fuels used, it does not encourage firms to use cleaner technology that

could reduce emissions further. However, the measurement of carbon content in primary fuels is significantly easier as there are far fewer monitoring points, thus such a tax will be less costly to implement than one on the direct measurement of CO_2 emissions. The net costs of a carbon tax can be lowered even further by instituting a system of "tax-recycling"—using revenues to lower other taxes.

Tradable Emissions Permits

The second market-based domestic policy instrument is a program of tradable emissions permits. Unlike a tax system, using tradable permits allows a government to specify in advance the total amount of pollution that is "desirable." A "permit" system can mean one of two things: trading "allowances" or trading "credits." An allowance is a right to pollute in a limited amount. It starts at zero and permits emissions up to some limit. Given a set amount of allowances, total emissions will be capped at a given level. A credit, however, is granted only for a reduction in pollution beyond what would otherwise be undertaken. A credit starts out at a limit, and provides a tradable good for doing better than the limit. Both can be used in a tradable system. In a world of perfect knowledge and no transaction costs, the two systems are equivalent. In the real world, they are not. Allowances are now considered to define a new form of property right—considered by some environmental groups and individuals as being reprehensible. Credits do not have such "property" aspects, but such a system runs into difficulties in determining what the baseline level of emissions is, and determining what the agent would have done in the absence of the credit (Ellerman 1998).

In an allowance trading system, regardless of the initial allocation of permits, the post-trading allocation will be the one in which total costs are minimized. Trades will take place until each firm's cost of an additional unit of abatement is exactly equal to the cost of a permit. At such a point, the cost of total reductions is minimized. Firms with total emissions being lower than their designated limits in any period can profit by selling their allowances, or can "bank" them for future use. Firms with emissions exceeding their caps will need to buy additional permits. If emissions exceed allowances at the end of a period, a firm would be subject to sanctions such as fines or a reduction of allowances for the next period.

As with a tax, permits or credits can be applied at many different levels. Allowances for carbon rights in fuel or for CO_2 emissions are feasible. Allowances for ambient pollution, measured as the effect that an individual source has on pollution concentrations at specified receptor points;

ecological or human exposure; or risk, referring to the consequences of such exposure have also been suggested. While each successive option may come closer to a theoretical ideal, each one is associated with greatly higher costs of monitoring and enforcement, and greater private transaction costs. Therefore all trading programs at this time focus on carbon content of fuels and products or on actual emissions.

The initial distribution of allowances can be accomplished in one of two ways. Firms can be given a share of the total permits based on historical record of emissions or fossil fuel sales. Alternatively, the government can auction permits. A third option would be a combination of these two.

The use of a marketable permit system for trade in greenhouse gas emissions has several potential advantages:

Flexibility: Individuals and businesses will have flexibility in choosing domestic strategies for reducing emissions of greenhouse gases. This flexibility will allow governments to focus on monitoring and enforcement rather than on developing more detailed regulations that prescribe specific technologies for energy efficiency or pollution reductions.

Direct control of aggregate emissions level: Marketable permits set an absolute limit on emission levels. Permits are issued only up to maximum allowable emission level. As long as such limits are enforced, the total amount of greenhouse gas emissions will be capped.

Cost-effective pollution control: Positive incentives for firms to seek out the lowest cost methods of controlling emissions are provided by the market.

Provision of mechanisms for trading among different greenhouse gases: A future advancement of the system could allow for trading among different gases, thus allowing for an even more efficient reduction to the threat of global warming.

Dynamic incentives for the development of low-polluting technologies and management strategies: As a market based approach, permit trading will provide incentive for the development of innovative approaches to emissions reductions that are rarely present in command-and-control programs (Hahn and Stavins 1995).

The primary role of the government in the permit system is to establish incentives such that costs incurred by firms who pollute are sufficient to achieve the desired level of aggregate pollution control and to monitor and enforce compliance. While market forces may ultimately dictate the course of the trading, the government is responsible for ensuring that environmental costs are factored into decision making. The government also retains the important roles of monitor and enforcer.

Programs on an International Scale

Internationally, there are three market-based instruments that have been considered, and in some cases have already been implemented to reduce worldwide greenhouse gas emissions: international carbon taxes, joint implementation, and international tradable permits. Studies of the effectiveness of policy instruments suggest that whatever form international agreements take, domestic solutions should not be imposed on sovereign nations. By proposing a target that each country can meet in its own way—as opposed to imposing a specific solution—there is a lower risk of countries coming to resent the process, and thus a greater likelihood of compliance.

International Taxes

A carbon tax could be used on an international scale with results similar to a domestic tax program. Either a uniform tax could be levied on all countries by an international agency, or an agreement could be made in which all participating countries individually assess domestic carbon taxes at the same level. A potential advantage of an international tax would be the ability to redistribute the revenue earned as a means of transferring resources from rich to poor countries. However, with the recent adoption of the Kyoto Protocol, international policies will most likely now focus on the methods outlined in that agreement: joint implementation and tradable permits.

Joint Implementation

Joint implementation (JI), as set out in both the Framework Convention on Climate Change and the Kyoto Protocol involves an arrangement between two countries in which one country provides the financial support—and often the technology—to reduce emissions in the other. The donor country receives the credit for the reduction, while the recipient receives the benefits of cleaner or more efficient production. Joint implementation has been looked at as serving three related purposes: a first step toward establishing a tradable permit system on an international scale; a cost-effective way for developed countries to finance emission reductions in developing countries; and an activity to identify when it may be cost effective to bring new emissions sources into an existing international emissions management program (Stavins 1997).

There are many concerns regarding the application of joint implementation programs. It will be difficult to estimate the actual amount of emissions reductions of specific JI projects, particularly when only the

funding country has committed to a binding emissions target. In some cases, low-cost abatement projects may be profitable, or nearly profitable, even in the absence of a JI agreement, such that it would likely have been carried out under any conditions. In such a case, there may be no objective way to measure and assess credits to the funding country. In the absence of an unbiased monitoring agency, there may be few disincentives against the exaggeration of reduction due to projects.

There is also a concern that when a wealthy country invests money directly in a poorer country, the donor country may acquire some degree of ownership of the assets involved. Such a transfer of ownership may make such investment undesirable to developing countries.

Tradable Permits

A tradable permit system on an international scale will be considerably more complex than comparable domestic programs. Important issues of measurement, monitoring, and enforcement—already difficult on a national scale—become even more complicated when applied to a group of sovereign nations. While individual countries already have governments in a position to regulate such programs, there is no equivalent supranational authority that has such powers.

The United Nations Conference on Trade and Development (UNCTAD) outlined two versions of an international marketable permit system (Stewart, Wiener, and Sands 1996). The first, an "allowance trading system" would establish an overall emissions limit for the group of participating countries, and an overseeing supranational agency would then distribute those permits to individual members. A "budgeted emissions system" would be one in which members committed themselves to specific limits or reductions to emissions. A reduction below the budgeted amount would generate credits that could be traded or reserved for future use.

The Kyoto Protocol, written in December 1997 outlines a system of international trading similar to this "budgeted emissions system." No distribution of allowances has been necessary; instead a credit system has been developed by the voluntary pledges made by Annex 1 countries for specific levels of emissions reductions. Credits will be assessed for any reduction beyond the pledged amount. With a system of tradable credits, each country can meet its standard either by reducing emissions or by purchasing credits from a nation that exceeds its reduction requirements. Such a system will ideally ensure that emissions reductions will be achieved

in a cost-effective manner. Each country will be free to choose any method—standards, taxes, tradable permits, or a combination of these—to reduce its domestic emissions.

An international trading system could be made more complex by allowing not only government-to-government trading, but also private firm-to-government or even firm-to-firm trading across national borders. While the flexibility of such a program makes it appealing, the process and costs of monitoring and enforcement make it unfeasible at this time.

In addition to the advantages already mentioned for a domestic marketable permit system, an international system also has the potential to address equity concerns of developed and developing countries. As developing countries (non-Annex 1) are brought into the Protocol beginning in the year 2000, a system of distributing permits to such countries could be developed such that they would not be penalized for having low historical levels of emissions.

The process of monitoring adherence to a tradable permit system may be somewhat simpler than in joint implementation. In JI projects, a value must be placed on emissions saved, which in turn requires some sort of accountancy for the amount of emissions that would have been produced had the offset not taken place and then a comparison made with actual emissions. In contrast, a system of tradable permits requires only actual emissions to be measured, to ensure that permit holders do not exceed their limits.

The cost-saving benefits of a tradable permit system will only be recognized if efficient markets develop. Several conditions must be met for this to occur: a high level of compliance by participating countries must be achieved; transaction costs must be low enough to allow for efficient trades to occur; the market for permits must be competitive; and the policy must be regarded as being long-term.

In an international trading system, the requirement of compliance refers to nations accurately reporting emissions and purchasing additional permits if net emissions exceed their allowance. The establishment of an unbiased international body to monitor emissions will be necessary—one area in which the international program may become considerably more complex than domestic programs.

If nations or firms do not have easy access to information on other nations and firms, the identification of prospective buyers and sellers may be prohibitively costly. However, such transaction costs would likely lead to the emergence of "brokers" to facilitate trading. Other potential

transaction costs could arise from regulatory constraints, if governments were required to obtain approval from an international body for each individual trade.

Potential cost savings are also likely to be linked to the level of competition in the market. Under idealized conditions, each nation or firm would compare its costs of reducing emissions to the market price of permits and make a decision whether or not to enter the permit market. However, if an individual trader buys or sells a significant fraction of the total number of permits traded, the market price might be influenced. If prices are manipulated in such a fashion, total emissions reductions will not be achieved in the most cost-efficient manner.

A final condition for the potential success of a tradable permit market is the stability of the system. If a policy is expected to change frequently or dramatically, nations will not be willing to invest in such a program.

For trading on an international scale, a supranational organization will need to monitor the compliance of nations to the reductions they have pledged to. Monitoring of such a large program will entail a trade-off between ease of monitoring and accuracy. The adoption of some simplifying assumptions regarding the impact of fuel use on emissions, along with other such issues, could lower the cost of an otherwise extremely expensive monitoring program.

Compliance, although often mentioned as an issue in instituting any international agreement, may not be a great problem. As a general rule, international treaties are obeyed once they are signed. Countries rarely have incentives to negotiate, sign, and ratify agreements if they do not have the intention of abiding by them. When compliance is less than complete, it is often a result of a country's lack of resources to meet the requirements. The difficulty most often lies in negotiating an agreement that requires countries to make sacrifices, getting them to sign it, and assuring that they have the means to abide by it.

The targets set by the Kyoto Protocol are to be reached over a five-year budget period of 2008–2012. Emissions will be averaged over this period to increase flexibility by helping to smooth out short-term fluctuations in each country's emissions. By allowing a full decade before the start of the binding period, countries and companies world wide have more time to make the transition to more energy efficient or lower carbon technologies.

Clean Development Mechanism

Within the Kyoto Protocol, a Clean Development Mechanism is outlined as a way to engage developing countries in the global effort to reduce

emissions of greenhouse gasses. The issue of developing country involvement was extremely contentious at the Kyoto conference, with developing countries insisting that they could take on no further obligations to reduce their emissions. The proposed mechanism is designed to allow developing countries, or individual companies, to propose private-sector projects for reducing their greenhouse gas emissions. With the success of these projects, the amount of the reductions can be sold as carbon credits to a special body established by the U.N. Framework Convention on Climate Change. Developed nations would then have the opportunity to buy these credits to use against their own reduction targets. Thus, developing nations will be able to benefit from the tradable emissions system without committing to binding reduction targets. The Clean Development Mechanism will certify and score projects based on actual reductions achieved.

Sink Enhancement

There is one additional abatement strategy that may have a place within a tradable emissions permit system: sink enhancement. This term refers to the process of increasing the uptake of CO_2 through natural sources. The most common examples of sink enhancement are reforestation projects. Although such efforts will reduce the amount of CO_2 released to the atmosphere and have other beneficial effects (such as on the water balance and soil erosion), the vast amount of forest needed makes the planting of trees reasonable only as a part of a greater abatement program.

Difficulties Associated with a Trading System

A tradable emissions permit scheme is considered by many authorities as the best way to limit CO_2 emissions. However, it is not without problems. One issue is that of trading "hot air." This term refers to cases such as the Russian Federation's commitment to "reduce" emissions levels to 100 percent of 1990 levels. However, due to the political and economic transitions occurring in Russia, industrial production has decreased significantly since the collapse of the Soviet Union, as have CO_2 emissions. Thus, "returning" to 1990 levels would in fact entail an increase in emissions. By keeping emissions at current levels, the Russian government will now be able to trade credits for emissions that would not be produced under any circumstances. While the United States or any other country would be free to buy such credits, it may be politically dangerous for them to do so, as the public may not support such action. In reality, by purchasing and using these "hot air" credits, the U.S. would be increasing worldwide emissions (Palmisano 1998).

Another important issue to be considered is that of property rights. Americans and Western Europeans have well-accepted notions of property rights, not only for real estate and material goods, but also for "intellectual property." Extending this definition to include the rights to emit greenhouse gases will not be problematic. However, many countries of the world do not have such well-defined concepts. There is a concern that a government that does not believe in property rights for physical property will not be committed to a system of property rights for air.

Although the general description of a permit trading program implies that the final allocation of credits or allowances will by definition be the most efficient, this is not a universally accepted opinion. It may be argued that of all possible ways of allocating a given total of emissions rights across countries, only a small number of allocations will lead to efficient patterns of resource allocation. The redistribution of permits allowing emissions is, in effect, a redistribution of wealth. As such, it may lead to changes in desired levels of consumption and abatement for each participating country (Chichilinsky 1996).

Two additional problems that are likely to arise in an international program are related to the actions of countries that are not part of the agreement: free riding and leakage. Both of these problems could lead to reduced benefits of the program, and thus to the cost-efficiency requirement not being upheld. These issues raise questions of how effective the abatement of emissions in one country or a group of countries will be in reducing global emissions.

Free riding is the phenomenon in which countries that benefit from a global reduction in greenhouse gas emissions do not make reductions domestically. While it is generally accepted that it is the global concentration of greenhouse gases that will affect climate change, countries differ widely in their willingness to adopt policies for abatement. As long as the participation in any international agreement to reduce emissions is voluntary, there will be incentive for some countries to share in the benefits without sharing the costs.

While it is realistic for a coalition of countries to participate in permit trading to reduce aggregate emissions while other countries do not participate, a coalition will be most successful if there are incentives for countries to remain in the group and for new countries to join. Such incentives could be in the form of a threat of a trade ban on carbon-based fuels and products between coalition members and non-members. Ideally, such a ban would not need to be enacted; as more countries join the coalition due to such a threat the benefits of being a part of the coalition

rise, thus encouraging even more joiners as long as the threat is credible. Although an actual trade ban would be less desirable, it may be ultimately beneficial if it significantly reduces the problem of free riders.

Leakage is the phenomenon in which a reduction of emissions by participating countries actually leads to an increase in emissions by non-participating countries. Emission leakage may occur by one of two methods. First, the implementation of a carbon abatement program by a group of cooperating countries would shift the comparative advantage in the production of carbon intensive goods to non-cooperating countries. The non-cooperating countries would thus be provided an incentive to increase the production of these goods, leading to increased emissions. Second, if such a coalition of abaters is large, the world demand for carbon-based fuels would decrease, leading to a drop in the world price. The result would be an increase in demand among non-coalition countries, leading to an increase in emissions. Estimates of potential leakage vary widely, from an 80 percent leakage rate (for every 10 tons of emissions abated, emissions in non-participating countries will rise by 8 tons) based on a 20 percent reduction in carbon emissions in the European Union, to an estimate of less than 4 percent associated with a 20 percent OECD reduction (Fisher, et al. 1996). These estimates are based on models and simulations with vastly different assumptions, and on different temporal scales.

History of Commodity Trading in Pollution

An international market for tradable permits in greenhouse gas emissions will break new ground. However, valuable information can be gained from reviewing the United States' markets for pollution that have been developed over the past twenty years. There are several examples of tradable permit schemes within the U.S., including the EPA's Emissions Trading Program, the phasedown of lead in gasoline, CFC reductions, point-nonpoint source trading for water quality control, the SO_2 emissions permit trading system authorized under the 1990 amendments to the Clean Air Act, and the RECLAIM program in California. Some of these programs are described below (Hockenstein, et al. 1997).

EPA Emissions Trading Program

The EPA began experimenting with emissions trading in 1974 as part of a program to improve local air quality under the clean air act. In the original emissions trading program, firms that reduced emissions at one location to an amount below a given level were given credits to be used

against excess emissions at another location. Thus firms could divide their pollution control efforts among different facilities in the most cost-effective manner. Beginning in 1976, an "offset" program was instituted that allowed firms to open facilities in areas not in compliance with ambient air quality standards if sufficient reductions were made at existing facilities to offset the new pollution. A "banking" program was also instituted to allow firms to save emissions credits for future use or sale. Although total participation in the emissions trading program has been limited, several large companies such as Amoco and DuPont have taken part in the emissions market. The program has been estimated to have saved between $5 billion and $12 billion (Hockenstein, et al. 1997).

EPA Lead Program

Between 1982 and 1987 the EPA also administered a trading program for lead, to allow gasoline refineries greater flexibility in meeting emissions standards while lead content of gasoline was being phased down below previous levels. To create lead credits, refiners were required to produce gasoline with a lower lead content than required by the standard. Beginning in 1982 lead credits were issued and could be traded. From 1985 a banking program was in place. By the time the program was terminated when the lead phasedown was complete in 1987, an estimated $250 million per year had been saved (Hockenstein, et al. 1997).

CFC Reductions

The United States has also developed a market system to help meet the CFC reductions called for by the Montreal Protocol. No studies have been conducted to determine cost savings for this program. During the course of the program the timetable for the CFC phaseout was accelerated and a tax on CFCs was introduced. It is thus difficult to determine to what extent the tradable permit scheme has been responsible for CFC reduction, and how much is attributable to the taxes. However, the low transaction costs of the permit system suggest that it has been fairly cost effective.

EPA Acid Rain Program

The most well known of EPA's trading schemes—and the most ambitious—has been the sulfur dioxide trading program created under Title IV of the 1990 amendments to the Clean Air Act. The act calls for SO_2 emissions in the U.S. to be reduced to 10 million tons below their 1980 levels, and for nitrogen oxides be reduced by 2 million tons. The first phase of this program began in 1995 (Hockenstein, et al. 1997).

In Phase I, the EPA allocated individual emissions limits to each of 111 electric utilities, most of them large coal-fired power plants east of the Mississippi River. Allowances were based on each plant's generating capacity and previous efforts to abate pollution. These utilities must purchase additional permits from each other if emissions exceed their limits. Due to provisions that allowed Phase II participants to voluntarily take part in Phase I, several additional utilities were affected in the early part of the program. In Phase II, to be initiated in 2000, nearly all electric utilities will be brought into the program.

The incentive to play by the rules is given in part by the ability to profit from the sale of permits. A steep penalty also exists to deter firms from exceeding their given limits: $2000 per ton of emissions exceeding the year's allowance, along with a requirement that the excess be offset the following year.

The EPA predicted in 1990 that permits would sell for approximately $750 per ton—equal to the estimated marginal abatement cost for an average utility. However, at the end of 1995, permits were trading privately for only $170, and at an EPA administered auction they went for only $122–140 per ton (Hockenstein, et al. 1997). There are several explanations for the lower than expected compliance costs. The allowance system facilitates competition across all emission reduction options. The incentives for innovation have led companies to experiment with different fuels and with blended fuels to minimize SO_2 emissions.

The low costs incurred over the first several years of the program have led to questions about the initial high estimates. There is a debate over how much weight the estimates by the regulated industry should carry in designing future programs.

While the program may not have met predictions for the number of trades, it is estimated that $2–3 billion has been saved each year over the cost of equivalent reductions under a command and control policy (McLean, 1997).

Lessons

Several lessons have been learned from the U.S. experience with tradable emissions programs. The EPA's SO_2 program has shown the importance of monitoring and enforcement provisions. Prior to the institution of the program, environmental advocates insisted on continuous emissions monitoring, a process that is expensive, but helps build market confidence. The Clean Air Act Amendment's stiff penalties for exceeding limits have provided sufficient incentive to achieve a high level of compliance.

In assessing the success of trading programs, it is essential to compare realistic versions of such systems and "likely alternatives," rather than looking at idealized versions of either. The SO_2 program has highlighted the fact that market based systems are likely to have greater gains relative to conventional command and control policies when the cost of abating pollution varies greatly among sources. SO_2 abatement costs varied due to differences in ages of plants and their proximity to sources of low-sulfur coal, thus the trading program realized substantial savings. If abatement costs are homogeneous, potential cost savings are less. As would be expected, tradable permit systems are likely to be most effective when transaction costs are low.

The government role in such programs generally involves the recording of yearly emissions, not a case-by-case review of trades. Thus the transactions costs can be kept relatively low. In the Acid Rain Program, the government is also involved in the annual no-fee auction of permits, which provides a small percentage of available permits for sale to new or existing utilities.

While the costs of continuous monitoring of SO_2 emissions has been estimated at $200–300 million per year, the savings assessed to the program have been ten times that (McLean 1997). It is important to remember in the planning of future programs that estimated costs may not be accurate, and that high costs alone do not have to make a program unfeasible.

IMPLEMENTATION

Market based programs can be used as tools to solve problems, but those problems must first be defined, goals set, and the need to take action accepted. The Kyoto Protocol has begun this process, and brought us to the point of implementation. The question now is how to allow implementation to take place with the most speed and ease.

The development of durable institutions and frameworks is desirable. Either an existing supranational organization (such as a United Nations agency) must be modified to establish measurement and certification protocols for a global market in emissions permits, or a new such institution must be created. Such an organization must be financed by the participating nations. The monitoring organization will have several responsibilities: to formulate monitoring procedures to be followed by all participating countries, including bookkeeping and annual reports on net emissions; to conduct monitoring to verify the accuracy of national monitoring reports; to review annual reports on net emissions and

determine their accuracy; and to certify each participating country's emissions total for each year. The role of such an organization could be primarily professional and technical. It should not be necessary for this organization to take on the role of providing additional incentives to make the markets work; an advantage to using a market based program will be that the entrepreneurial role can be taken on by the private sector.

The monitoring organization would be responsible for enforcing adherence to the agreed to emissions reductions. The primary response to a country exceeding its allowance (thus incurring a "deficit") would be for the administering agency to reduce that country's emission budget for the following year by an amount equal to the deficit. However, if a country runs a large deficit, or a deficit in several consecutive years, penalties must be imposed in the form of a fine and a greater reduction in future allowances. For continued large violations, further sanctions could include the suspension of voting rights, a freeze on permit-trades with the delinquent nation, or eventual expulsion from the program. Already stated by the Kyoto Protocol is the provision that a party not in compliance with its measurement and reporting requirements cannot receive credit for joint implementation projects. Additional procedures for addressing the issue of noncompliance are to be determined at a future meeting.

The monitoring organization would be responsible for recording trades and savings of allowances. If a futures market is to be created, they would need to establish the rules. This organization would also design and implement dispute resolution procedures in order to protect both buyers and sellers, and to increase confidence in the system.

Individual nations would also have responsibilities. The Annex 1 countries have already agreed to a cap on emissions. They must now determine how to allocate allowances or credits domestically, or determine another system to meet their reductions. Emissions must be monitored and reported annually to the international monitoring organization. Countries must allow this organization to conduct its own inspection and monitoring. Each country must agree to abide by the regulations determined by the international authority for accounting procedures. They must agree to respect free trade, to participate in and abide by the decisions of the dispute resolution system, and to submit to sanctions if emissions limitations are exceeded.

Conclusions

The Kyoto Protocol became open for signature in March 1998. To enter into force, it must be ratified by at least 55 countries, accounting for at least

55 percent of total 1990 carbon dioxide emissions by developed countries. United States ratification will require the support of congress. Because of the great percentage of world emissions released by the U.S., it will be difficult for the Protocol to come into effect without U.S. support.

Although the Kyoto Protocol explicitly allows for the international trade of CO_2 reduction credits, it is obvious that there is much to be accomplished before such a system becomes feasible. If the Protocol is ratified, much work will be needed to establish a widely accepted infrastructure for the trading program. As a first step, a general design for the overseeing organization should be drawn up, determining if an existing organization should be modified or a new such organization should be created. The sooner the procedures for monitoring, certification, and enforcement can be drawn up, the more confidence individual nations will have in the future of the program.

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