UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

GREENHOUSE GAS EMISSIONS TRADING

DEFINING THE PRINCIPLES, MODALITIES, RULES AND GUIDELINES FOR VERIFICATION, REPORTING & ACCOUNTABILITY*

August, 1998

*The views expressed in this report are those of the authors and do not necessarily reflect those of the UNCTAD secretariat.

List of Contributors

The following contributors collaboratively wrote this report:

Michael Grubb
Royal Institute of International Affairs
10 St. James' Square
London SW1Y 4LE, UK
Tel. 44 171-957 5700
Fax. 44 171-957 5710
email: mgrubb@riia.org

Axel Michaelowa
177 Bd. de la Republique
92210 St. Cloud
France
Tel/Fax. 33 1 4771 2680
email: michaelo@easynet.fr

Byron Swift
Environmental Law Institute
1616 P Street, # 200
Washington, DC. 20036, USA
Tel. 202-939 3808
Fax. 202-939 3868
email: swift@eli.org

Tom Tietenberg, Team Leader
Colby College
Waterville, Maine, USA
Tel. 207-872 3143
Fax. 207-872 3263
email: thtieten@colby.edu

ZhongXiang Zhang
Faculty of law and Faculty of Economics
University of Groningen
P.O.Box 716
9700 AS Groningen
The Netherlands
Tel. 31 50 363 6882
Fax. 31 50 363 7101
email: Z.X.Zhang@Rechten.RUG.NL

****

Frank T. Joshua, Project Officer
UNCTAD
Palais des Nations
CH-1211, Geneva 10
Switzerland
Tel. 41-22-917 5834
Fax 41 22-907 0274
email: Frank.Joshua@UNCTAD.ORG

EXECUTIVE SUMMARY

Introduction

The Kyoto Protocol authorizes four cooperative implementation mechanisms. These include bubbles, emission trades, joint implementation and the Clean Development Mechanism.

Emissions trading, the focus of this report, allows trading of "assigned amounts" among Annex B. nations. Authorized by Article 17 this provision leaves the crafting of implementation details to subsequent conferences. Three distinct trading possibilities emerge from this authorization: trading among countries with domestic emissions trading systems, trading among countries without domestic trading systems and trading among countries with and without domestic emission trading systems.

The case for a tradable entitlements system is based on the advantages that it would offer compared to other politically feasible alternatives. In the short run it offers the possibility of reaching the environmental goals at a lower cost than would be possible if each country were limited to reduction options within its own borders. Making it easier to reach the goals may allow more countries to join the Protocol and usually increases compliance with those goals.

Because it separates the issue of who pays for control from who implements control, it facilitates transboundary cost sharing (an item of particular importance to both the developing countries and the transition economies of Eastern Europe). Tradable permits also facilitate the mobilization of private capital for controlling global warming; private capital is likely to be a critically important component of any effective global warming strategy as long as public capital remains insufficient to do it alone.

Finally, and perhaps most importantly, tradable entitlements facilitate the development and implementation of novel approaches to climate change control. By offering greater flexibility in how the emission reductions are achieved (as well as by providing economic incentives for the adoption and use of unconventional approaches), tradable entitlements can significantly lower the long run cost. Lower long run cost may be an important element in gaining greater international acceptance of the idea of limits and reducing the difficulties associated with assuring compliance. Furthrmore if it becomes desirable to assure that participants cover the administrative costs of running the system, levying a low annual fee on each entitlement could raise revenue. This revenue could be used for financing technology transfers or for other worthy purposes without jeopardizing the cost-effectiveness of the system.

Historical Precedents: Other Emissions Trading Programs

Previous emission trading programs have taken one of two forms: credit trading or allowance trading. Credit trading allows emission reductions above and beyond prespecified legal requirements to be certified as tradable credits. Credit programs tend to focus on specific sources or projects. Allowance trading, on the other hand, starts by defining an aggregate emissions cap. The emissions authorized by this cap are then allocated to eligible parties.

In general, past programs that impose emission caps coupled with allowance trading have performed well, whereas credit-trading systems have generally not performed to expectations. Credit trading systems have proved to be less secure environmentally and to create higher transaction costs and greater uncertainty and risk compared to allowance trading, leading to reduced trading.

- The **Acid Rain Program** in the United States represents the largest and most successful emissions cap and allowance trading program in the world. The Program has achieved a strict environmental goal to reduce SO_2 emissions, and results from the first years of operation since 1995 show that compliance costs were less than half those predicted by EPA, and many times lower than those predicted by industry.

- The **Regional Clean Air Incentives Market (RECLAIM)** establishes an emissions cap covering most stationery sources of NO_x and SO_x in the Los Angeles area. RECLAIM has achieved significant success in reducing the price of compliance, with annual savings relative to command and control regulation projected at $58 million annually, or 42%.

- **New Zealand Fisheries License Trading** uses a cap and trade system for management of the majority of its commercial fisheries. Since 1986 the government has set Total Allowable Commercial Catch limits and Individual Transferable Quotas (ITQ) for each fish species in defined management areas, based on sustainable harvests. The ITQ system has led to heavy trading, and it is estimated that 77% of all ITQ initially allocated has changed ownership. The costs of monitoring, administration and enforcement are similar to those of other fisheries management programs. There are high penalties for non-compliance, including fines and forfeiture of vessels.

- **U.S. Emissions Credit Trading (1977)** programs in the United States have been established for major criteria pollutants since 1977. These programs allow firms to demonstrate emissions reductions that are below either the firm's permitted levels or actual emission history, whichever is lower. The U.S. credit trading systems have generally performed poorly due principally to their high transaction costs and the uncertainty and risk in obtaining the needed government approvals for credit trades. Although there have been thousands of trades over the decades, the extent of trading has been less than expected, and sometimes much less. More importantly, the programs have uncertain environmental impacts, nor have they achieved significant economic benefits or introduced flexibility into the fairly rigid regulatory system governing criteria pollutants. Finally, since credit trades are project-specific, continued oversight is needed to ensure the parties perform as promised. The history of U.S. credit trading demonstrates the tension between the need for high levels of government oversight to ensure credit trades are legitimate, and the high transaction costs this review entails.

- **US Lead Phasedown (1982)**. EPA established a lead credit market in 1982 and expanded it in 1985 to greatly reduce lead levels in gasoline. The lead phasedown program performed successfully as the first free and open trading market. Lead credits were briskly traded, and trading is believed to have so significantly reduced the cost to producers that it facilitated major additional lead reductions in 1985.

- A **Pilot Program for Activities Implemented Jointly** that reduce or sequester greenhouse gases was established under the FCCC (Article 4.2(a)) at the first Conference of the Parties in 1995. While not strictly comparable to other credit trading programs as investors gained no formal crediting for the tons purchased, experience under this program is useful to indicate procedures for determining "additionality" of emissions reductions, which is also required for trades under Articles 6 and 12. Results under this program indicate that a greenhouse gas credit trading program which requires a showing of additionality can involve even higher transaction costs and uncertainty than has been the case with other credit trading programs.

Lessons From Previous Trading Programs

Lessons drawn from emissions trading history are relevant both to the design of an international trading system and to countries that are structuring national compliance and trading systems. The design of trading programs is critically important to their success, as it will determine the transaction costs as well as the uncertainty and risk inherent in the trading system.

The United States history of emissions trading shows the **cap and trade** approach under the Acid Rain Program and RECLAIM has resulted in significant program-wide cost reductions, **while emissions credit trading** has not been as successful. Reasons for this have to do with the lack of commodity nature of credit trades, their higher transaction costs, and regulatory barriers to their creation.

Since only credible systems succeed, deviations from **simplicity** should be introduced when demonstrably necessary to promote the achievement of the climate change goals. Systems are not credible if they become a vehicle for evading, rather than complying with, international agreements. Hence, the administrative procedures must be adequate to assure compliance with the climate change goals.

All existing emissions trading programs involve trading between **private entities**. Allowing private entities to trade appears to be important if the efficiencies of trading are to be realized. The essential benefit of trading programs is that they allow private firms the flexibility to determine technology choices and options themselves, and compare these to emissions permit prices to determine an overall least cost path of compliance. Allowing private entities to trade amongst themselves creates maximum flexibility. Since emissions sources are the ones that would make decision to implement energy-saving technologies and processes, allowing them to trade allows them the greatest potential to achieve these efficiencies.

Banking of allowances allows Parties and sources significant additional flexibility in compliance investment and decision-making. There has been heavy use of banking in both the US Acid Rain Program and lead credit trading market, which has led to early reductions and substantially lower overall costs of compliance. Banking is especially significant for industries in which major capital expenditures must be made, as it allows individual sources flexibility in the timing of such major investments. The Protocol does allow banking in relation to expected future compliance periods, which may encourage further early reductions (Article 3(13)).

The **allocation** of allowances to sources is a contentious issue, since the allowances can be very valuable. The above programs have allocated allowances for free to existing sources. This may be the most politically practical method since it provides the greatest number of rights to existing sources. However, it makes it more difficult for new sources to enter the market, as these must buy allowances from existing sources. Alternative methods of allowance allocation would be to auction allowances or to allocate them based on a rolling average of past emissions. Both methods would reduce the barriers to new entrants, and better deal with shutdown sources.

A provision that allows otherwise uncovered sources to **voluntarily opt to be covered** under the regulatory system can increase the scope of a program. While it is desirable to include as many sources as possible under a regulatory system, it may not be practical to include all emitters of a pollutant in an emissions cap and allowance trading system due to uncertainties in measurement for some classes of sources. An opt-in process allows these sources to be included once the uncertainties are resolved to an acceptable degree.

Transaction costs play a key role in the success or failure of an emissions trading system. In the past, only emissions trading programs with low transaction costs have succeeded in substantially lowering the cost of compliance Credit trading programs create high transaction costs by requiring each credit generation or use to be separately approved by a regulatory authority. Cap-and-trade programs, on the other hand, have generally low transaction costs and low risk.

The experience of existing programs has been that the private market has supplied an adequate to high number of allowances or credits, so that **market power** issues have not been of concern. Several mechanisms can be and have been implemented in past programs to address concerns about market power and potential hoarding of allowances, such as regular auctions of allowances.

Providing price information is important to reduce the uncertainty of trading and create public confidence in the trading program. Disclosure of price information could be required by reporting requirements for emissions trades, or through alternative systems such as regular public auctions.

Some credit trading programs impose a 10% or greater **deduction** on trades for air quality enhancement, or for other purposes such as to grant to new entrants. This may help create public support for a trading program by creating public benefits if firms take advantage of trading to reduce their costs. On the other hand, imposing a percentage reduction on trades creates another barrier to the economic efficiency gained through trading. Arguably, the environmental benefits of clean air are better established by adjusting the overall cap, not by penalizing trades.

Past emissions trading programs show that high quality **monitoring** is essential to assure effectiveness of both compliance and trading systems. Several programs require continuous emissions monitoring by sources, but other verifiable methods are also possible. Some programs require ongoing testing of these monitoring systems on a frequent basis to assure reliability, and also require the results of monitoring to be publicly available.

Reporting is a key compliance mechanism and covers both emissions monitoring results and emissions trading activity. On a national level, many countries require monthly reporting of pollution emissions data, and continuous emissions monitoring technology allows reporting as often as every 15 minutes. US domestic trading programs require reporting of emissions trading activity to a government registry, which is open to the public, and may be available on the world wide web. This helps to assure openness of the system, and is also used by the government for compliance purposes. Additional procedures for compliance reporting can be extremely simple for allowance trading, and quite complex for credit trades which are individual and project based.

Allowance trading does not require **certification** of trades, as the structure of the program defines a limited cap and the authenticity of each allowance. However, almost all forms of credit trading require some kind of certification system. Under US credit trading programs, the principal certification criteria are that emission reductions be quantifiable, surplus, either permanent or discrete, and enforceable. The certification process is most complex and demanding for discrete project-based credit trading, especially if a showing of additionality is required.

The level of **penalties** in past trading programs appears to be positively correlated with compliance levels. The US Acid Rain Program has achieved 100% compliance in all years, due to reliable monitoring and reporting, high transparency, and high penalties. Penalties in

past programs typically include the restoration of tons of excess emissions, which are taken from the source's next budget period, and may include fines and other sanctions.

A relevant aspect of both the Acid Rain Program and RECLAIM is the provision of a **two-month reconciliation period** following the end of a year for sources to purchase any allowances needed to equal their emissions. This promotes compliance and reduces risk in the market.

Monitoring and Verification

The **national reporting system** of each Party would have the dual responsibility for tracking both emissions and allowances. Each Party would be responsible for tracking emissions of all greenhouse gases in the format proscribed by the oversight agency established by the COP. In the case of a Party that has delegated trading authority to private sources, emission levels for those sources or sectors must be included as separate entries in these inventories. Each Party would also be responsible for reporting all allowance transfers and would have the responsibility for verifying ownership of any traded allowances. Both reports would be submitted in a standardized format to facilitate comparison of "authorized" emissions with "actual" emissions and to facilitate comparisons with the reports of other Parties. Generally these reports would be submitted on an annual basis, although more frequent reporting is possible if the COP deems it necessary.

The **international authority** is expected to perform the following key monitoring and compliance functions: (1) Initial approval of a country's monitoring system that allows it to participate in emissions trading; (2) Receipt and review of the reports generated by countries that provide credible data on monitoring results and methods on an ongoing basis. Once a country is accepted into the international trading system, the international agency would need the capacity to receive and review the national reports, including those submitted under Article 3(13); and (3) periodic inspections to assure compliance and proper functioning.

The monitoring systems for both allowances and emissions must rest heavily on **self-reporting**. Polluters have the most information about their activities and thus can provide it as part of a monitoring system at a cost much lower than if independent monitoring systems were created. Virtually every domestic and international enforcement system is based on self-reporting, and other modes are not economically or politically viable.

The first level of reporting and coordinating allowance transfers with emissions will come at the Party level. **National monitoring** is not only a physical necessity; it is probably the most effective system.

All **reports must be harmonized** both in terms of reporting format and in terms of collection protocols to assure comparability and reliability. The ultimate authority for aggregating, standardizing, and interpreting reports from the Parties must remain with an authorized subsidiary of the Conference of Parties.

Creating **layers of veracity checks** should strengthen the integrity of the allowance and emissions monitoring systems. Systems of self-reporting do offer many risks of deception, although analysts may over-state the extent to which purposefully deceptive self-reporting occurs. Nonetheless, there are risks of deception, and assuring the integrity of the permit system will require assuring the integrity of self-reporting. National governments could provide many (or most) of the domestic checks, provided that those checks are themselves reviewed occasionally at the international level.

ENGOs (Environmental Nongovernmental Organizations) can exercise general oversight over the compliance process and may even play a role in the monitoring of individual sources. Issues of ENGO capacity and access to publicly available information are important determinants of how effective this component will prove to be.

Transparency of behavior should be promoted through wide public availability of collected data. The assurance function is better fulfilled if data are widely available; veracity-checking is easier if multiple sources of information are available; and, the involvement of private monitors is frequently heavily dependent upon the existence of rich database. A reluctance to reveal some information because of privacy and industrial secrets is to be expected, but free flow of information should be the norm.

One model for transparently reporting trading activity is provided by the US **Allowance Tracking System** used in the Acid Rain Program. This publicly open allowance registry system helps to create a transparent and self-enforcing compliance system, and has contributed to high compliance records in the programs.

Transparency could also be promoted by forcing some or all transferred allowances to be sold at **auction**. In addition to promoting good international information on allowance prices this technique would diminish opportunities for strategic manipulation of the market.

Certification and Verification

Since emission reductions used to generate Article 12 credits require considerably more scrutiny, a certification function is necessary to assure that only certified CERs would become part of the allowance system. Certified allowances would be treated as homogenous in quality to all other allowances. The **certification process** provides one concrete means of attempting to assure a smoothly running trading system, while simultaneously assuring that the trading system furthers the goals of the agreement.

While the ultimate authority for certification would be the Conference of the Parties (COP), the **operational authority for certification can, and should, be delegated** to subordinate organizations specifically designed to fulfill that function. While the Conference of the Parties would be well-suited for defining the parameters of the certification process and exercising general oversight over that process, it would be ill-suited for dealing with the day-to-day operations of certification.

Some certification authority could be delegated to specific governmental units within participating nations or communities of participating nations or even to private certification entities, providing certain **preconditions** had been met. These preconditions would include, *inter alia*: (1) an identified organizational unit willing and able to assume the responsibility for certification, (2) the existence of sufficient enabling legislation to assure adequate powers to carry out its mission, as well as adequate staff and resources, and (3) acceptance of, and willingness to apply, standard certification criteria.

Certification and monitoring processes should be **initiated promptly**. Although the commitment period lies a few years in the future, it will be important to test and refine the system before it bears the burden of ascertaining compliance. Furthermore non-Annex B nations that contemplate establishing private tradable entitlements systems will need guidelines for appropriate processes of certification and monitoring. If these are provided early, then the chances of harmonized procedures in the future will be higher. Viable and legitimate systems created today, even if they are small, will become the de facto standard. And, early creation of these institutions will highlight the needed changes in domestic institutions and procedures, allowing more time to make the necessary reforms.

Monitoring procedures and institutions should be designed with **future expansion** in mind. These systems will inevitably need to expand to accommodate different gases, different parties, and different commitment periods.

While certification is sufficient for transfer of a credit, use of a credit to fulfill part of an assigned amount obligation would also require **verification**. Whereas certification would provide assurance that a specific emission reduction or carbon absorption would be forthcoming from the project, verification would provide the assurance that these expectations had in fact materialized. (For example, verification of a forestry project would assure that the planned forest was in existence and was absorbing carbon at the expected rate, while an energy efficiency project would verify that actually emissions mirrored the emissions expected on the base of design criteria.)

Compliance and Enforcement

Multiple commitment periods offer significant opportunities to enforce compliance**.**. Principle tools include declaring noncompliant Parties ineligible for trading and reducing assigned amounts in subsequent commitment periods, which work best if subsequent commitment periods are in place and assigned amounts defined. Currently the Protocol establishes that there will be negotiations to set assigned amounts in subsequent commitment periods, but it is not clear that it has generally been recognized how important that task is in promoting compliance within the first commitment period. We believe that process should have a much higher priority than it has.

A wide range of enforcement and compliance instruments are available to **domestic** enforcers. The frequency and effectiveness of domestic environmental enforcement varies according to budgets, political will, and legal constraints on the types of penalties can be imposed. In some countries there may be an evolving norm in favor of stiffer penalties, including incarceration and personal liability for actions of organizations and firms, and administrators now possess a wider array of sanctions they can seek and apply.

The key issue in enforcement--whether at domestic or international level--is **deterrence**, not just reversal of noncompliance. There is empirical support for the proposition that frequency of monitoring and inspection as well as the level of penalty matters, but comparing across enforcement instruments is difficult.

Transparency is a compliance tool as much of internal law presumes that enforcement will be based upon public opinion and normative pressures to comply. Transparency is important complement to enforcment because it makes violations apparent, and the fear of detecting promotes compliance. Transparency systems require the disclosure of basic information regarding obligations, actual emissions, and trading activity, in order to allow judgements about compliance status. To date, transparency systems that exist are based heavily on self-reported data, and have worked best when data is made generally available to the public. Such data need to be collected and verified at the international level, and will require the use of international public databases of self-reported and verified information, an important function for the authorized body.

Transparency mechanisms also have been effective at the domestic level to promote compliance. In the US, a law requiring industries to report their pollution discharges to the public has resulted in dramatic voluntary decreases in discharges by these facilities. Due to their access to this information ENGOs have been able to act as agents for protecting the environment and to initiate suits on its behalf, augmenting the role of public agencies.

Designing **enforcement systems at the international level** is difficult because international institutions are typically weak and international treaties rest on the assent of their parties. These are tempered by strong norms in the international system in favor of complying with international law. Most environmental treaties have relatively weak enforcement mechanisms, and most episodes of noncompliance and potential enforcement actions take the form of disputes, which are addressed diplomatically through negotiation.

Although domestic agencies could provide most public enforcement functions, international institutions are needed at least to **supervise domestic enforcement** to provide assurance that the domestic system is operating properly. The international system need not force harmonization though a single international system, but rather assure that, despite national differences, internationally traded offsets and entitlement are secure. As with monitoring, this could be based primarily on self-reported assessments of effectiveness together with veracity checks through agreed procedures to assure the integrity of the system. Without this capacity operating on a regular basis with established guidelines for how parties must address failed checks, the market may destabilize on fears of incomplete domestic enforcement.

In addition to official international enforcement systems, some countries have been able to take **unilateral enforcement measures**, such as import bans or threats of retaliation, in areas where domestic interest is high. However, this is possible only for powerful states with large domestic markets and would be hard to apply in a fair and even-handed manner in a regime with large and small states alike.

Strict **eligibility requirements** for the right to engage in trading are an important element of a complete compliance system. Parties that do not comply with reporting or other requirements could be suspended from trading within the initial compliance period. Once subsequent commitment periods are established, it would also be possible to require that Parties be in compliance in the previous commitment period in order to be eligible to trade. Parties that are unlikely to have the infrastructure (or the will) to enforce the domestic polices and abatement measures would not able to participate in trading. Under this system, the more stringent the criteria, the greater the assurance that traded tons represent real reductions. From the environmental perspective, more stringent criteria are preferred. From an economic perspective excessively stringent requirements reduce the number of participants and, hence, the cost savings that otherwise could have been realized. Clearly a balance is needed.

An important element of an enforcement system is establishing a credible system for **restoring any ton of excess emission by a non- complying party**. This protects the environmental objectives of the Protocol by ensuring that the total cap on GHG is not exceeded. The most common way this has been done in past trading programs has been to require the non-complying party or source to purchase or restore the ton of excess emission in the next budget period, usually the next year. However, the nature and length of the current 5 year commitment period, and the lack of a defined commitment period subsequent to 2012, create uncertainty for such a methodology until future periods and targets are defined.

It is possible to consider ways of restoring tons during the commitment period. One method used in domestic programs would be to establish a **"true-up" period** of several months at the end of a commitment period to allow Parties finding themselves in non-compliance to obtain or purchase additional tons. This method could be enhanced if the Secretariat were authorized to reserve a percent of, or purchase, allowances for this purpose. Another way Parties could consider in future protocols is the desirability of dividing a commitment period into discrete budget periods, such as a one or two year periods, in order to facilitate transparency, trading, and particularly compliance mechanisms.

At the domestic level Parties could impose **financial penalties** for excess tons of emissions on sources or sectors. Most domestic trading programs impose fines per ton of excess emissions, typically at a level several times the expected economic value of the emissions. Imposing penalties on Parties has proven difficult under other international conventions.

Another enforcement tool, which is available to both domestic and international enforcers, is to require non-complying entities to **retire an added amount of tons** by a stated percent greater than their noncompliance overage. Assigned amounts covered by the penalty could be retired and therefore not used to legitimize excess emissions.

It is important to establish and ensure the proper operation of **dispute resolution procedures** for enforcement issues. Agreed procedures could help chart the way and keep disputes productively focused on the issues at hand. We recommend the early adoption of institutions and procedures.

Reporting

Art. 5 (1) states that each party to the Protocol shall install a **national system for estimating emissions and removals**. These systems shall use IPCC methodologies and Global Warming Potentials. Revisions of methodologies will only apply to future commitment periods. Inventories have to be submitted annually after 2008 via national communications and the MOP shall develop additional guidelines for reporting and accounting. Thus general reporting requirements have become stronger.

In designing the international trading system certain common methods and reporting formats should be considered as requirements for participants to be eligible to join the trading system, such as:

- comparable methods for setting emission baselines for individual emission sources that create CERs;
- common reporting formats for making information on emissions and greenhouse gas unit holdings accessible to other countries and the public.

Standard reporting formats would facilitate the review exercise. The frequency of reporting would need to be carefully considered, weighing the cost of information against market participants' need for certainty that emissions commitments are being met. Reporting requirements are not unique to trading, however. The frequency of reporting could increase, if necessary, as domestic reporting systems improve.

Countries who want to trade would need to take on the monitoring, reporting and compliance requirements of the trading system. The benefits from participating in an international emission trading system would be a strong incentive for prospective participants to comply with agreed trading 'rules' such as these.

The **national reporting system** of each Party would have the dual responsibility for tracking both emissions and allowances. Each Party would be responsible for tracking emissions of all greenhouse gases in the format proscribed by the oversight agency established by the COP. In the case of a Party that has delegated trading authority to private sources, emission levels for those sources or sectors must be included as separate entries in these inventories. Each Party would also be responsible for reporting all allowance transfers and would have the responsibility for verifying ownership of any traded allowances. Both reports would be submitted in standardized formats. Standardized formats would facilitate comparison of authorized emissions with actual emissions and would facilitate comparisons among

Parties. Generally these reports would be submitted on an annual basis, although more frequent reporting is possible if the COP deems it necessary.

All private traders, whether companies or individuals, should be required to **register** with a central governmental body responsible for recording all transactions, (such as the Environmental Protection Agency or Department of Environment), which will establish an account in the trader's name. In the case of a domestic trading system, companies would have to notify sales to foreign companies or governments to a domestic government agency, which records the transaction and adjusts the account of the seller. In the buying country the a government agency should also be notified of the transaction by the buyer. It will record the transaction, adjust the trader's account, send confirmation of the acquisition back to the buyer, and notify the UNFCCC secretariat. If trading is done between countries without domestic trading systems the governments should have to report the transaction in the official gazette.

All **international trades** would have to be reported by the Parties to the UNFCCC secretariat or designated subsidiary body. It would keep accounts of international permit trade and would calculate changes in allowances of participating countries by adding up all notified trades by the end of each year. Finally, it would inform the enforcement agency about each country's position at the end of the commitment period. It could use the experience of the U.S. EPA Allowance Tracking System that controls the trading through serial numbers attached to allowances.

All government agencies and the UNFCCC clearinghouse should have to **publish data** on transactions and permit accounts of countries on web sites as well as annual reports. This is crucial to enhance compliance because of the earlier exposure of fraudulent trades, such as through NGOs.

Non-compliance as to **reporting and monitoring requirements** is covered only under Article 6.4, which states that if an Annex I country is found in non-compliance with the reporting provisions of Article 8, any ERUs acquired by the buyer country can not be used to meet its commitments under Article 3 until the question of compliance by the seller country is resolved. Arguably the same rule should be made to govern non-compliance with all the essential monitoring and reporting requirements needed for a trading system to operate, and should apply to emissions trading under Article 17 as well as joint implementation under Article 6.

Accountability

An **accountability system** must be established between sellers and buyers of allowances. Seller liability systems are all that is needed if compliance mechanisms are strong and any tons of exceeded emissions are restored to the environment. In general the principle of strict seller liability is preferable in a strong enforcement environment. It provides incentives for those creating the credits to ensure their validity, and it reduces risk and uncertainty in trading, significantly enhancing the tradability of permits.

However, in this Protocol a **seller liability** policy may not always work because there is only one very long commitment period and, as of now, no additional commitment periods have been defined. Unless these and other elements of a strong compliance systems are defied, there may be a need for some form of a buyer liability program to assure that tainted acquired allowances could not be used to satisfy the buyer's "assigned amount" requirements. This may discourage purchasers from buying tons from countries that appear to be headed towards non-compliance.

Because **buyer liability** erodes the commodity nature of allowances by allowing them to be retroactively devalued, thereby creating uncertainty and discouraging trading, refinements of this approach may be desirable. One refinement would be to impose buyer liability only on Parties found to be in noncompliance in the previous commitment period. This approach could be extended to Parties whose annual emissions exceed by a certain margin its annualized assigned amounts during the commitment period.

If the Parties decide that buyer liability is needed to complement traditional compliance procedures, a "**vintage model**" probably is better than the "proportionate reduction" model. A vintage model imposes liability on the latest reductions sold by the noncompliant country (up to the level of noncompliance), whereas a proportionate reduction approach imposed proportional liability on all allowances from the seller.

Special considerations are needed for **Article 12 credits**. Both emissions trading under Article 17 and Joint Implementation under Article 6 involve the transfer of assigned amounts, creating an enforceable standard that ensures the environmental integrity of the trading systems and the overall cap on emissions. No similar system exists for ERUs created under the CDM, so an additional level of accountability, such as insurance or certification, is needed for such credits. Only verified actual reductions from CDM projects with developing countries could be incorporated into an international emissions trading scheme.

Under the Protocol, Parties may bank allowances by emitting fewer GHGs than their assigned amounts, thereby facilitating early emissions reductions. To assure the functioning of this **banking** mechanism, governments should never confiscate banked allowances even to reduce emissions levels, which should be accomplished through lowered emissions caps in subsequent periods. **Borrowing** is much more controversial, and if allowed, a number of safeguards (such as limiting borrowing to those periods with assigned amounts and restricting borrowed allowances to own use rather than sale) could be added to limit possible abuses of the system.

Article 17 specifies that emissions trading "shall be supplemental to domestic actions". The issue of **supplementarity** is influenced by perceptions of the likely cost of domestic emissions reductions, since with low cost domestic reductions this provision will have little affect on international trading. One advocated approach has been to implement a quota for the overall amount of assigned amounts fulfilled through any of the cooperative mechanisms or separate quotas for each cooperative mechanism.

If a **quota system** is adopted, one issue is how to ration available credits when their availability exceeds the demand as constrained by a quota. A first-come, first-served approach would encourage early reductions, and may advantage CDM projects. This approach could be implemented by setting a "soft" quota that slowly discounts the carbon credits achieved beyond the initial quota. Another possibility would be to allow banking of credits for the next commitment period after the quota is filled. These credits would get preference in filling the next quota, so projects with long duration would thus be penalized less.

Imposing quotas on trading is not necessary to respond to the concerns that motivated the placement of the supplemental norm in the Protocol in the first place. Rather the supplemental norm requirement in the protocol could be handled by **requiring Parties to demonstrate adequate domestic efforts** to control emissions. This approach would not jeopardize the benefits to be achieved from implementing a vigorous trading system.

The allocation of allowances has the potential to bring parties into conflict with the World Trade Organization (WTO) provisions, raising concerns about **international competitiveness**. Such concerns are not limited to trading, where allowance allocation can

make unequal treatment explicit, but can be even more easily hidden from the general public if conventional command-and-control regulations are used.

One way to deal with competitiveness issues, would be to ensure that the rules, modalities and guidelines for IET **ensure that domestic reallocation rules are compatible with basic WTO principles** and do not result in implicit subsidies and/or barriers to new entrants.

I. INTRODUCTION

A. EMISSIONS TRADING: THE CONCEPT

The case for a tradable entitlements system is based on the advantages that it would offer compared to other politically feasible alternatives.[1] In the short run it offers the possibility of reaching the environmental goals at a lower cost than would be possible if each country were limited to reduction options within its own borders. Making it easier to reach the goals may allow more countries to join the Protocol and usually increases compliance with those goals.

Because it separates the issue of who pays for control from who implements control, it facilitates transboundary cost sharing (an item of particular importance to both the developing countries and the transition economies of Eastern Europe) (Tietenberg 1990). Tradable permits also facilitate the mobilization of private capital for controlling global warming; private capital is likely to be a critically important component of any effective global warming strategy as long as public capital remains insufficient to do it alone.

Finally, and perhaps most importantly, tradable entitlements facilitate the development and implementation of innovative approaches to climate change control. By offering greater flexibility in how the emission reductions are achieved (as well as by providing economic incentives for the adoption and use of unconventional approaches), tradable entitlements can significantly lower the long run cost. Lower long run cost may be an important element in gaining greater international acceptance of the idea of limits and reducing the difficulties associated with assuring compliance. Furthermore if it becomes desirable to assure that participants cover the administrative costs of running the system, levying a low annual fee on each entitlement could raise revenue. This revenue could be used for financing technology transfers or for other worthy purposes without jeopardizing the cost-effectiveness of the system.

B. REVIEW OF RELEVANT KYOTO PROTOCOL PROVISIONS ON EMISSIONS TRADING

B. 1. General Rules on Emission Targets

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) recognizes the principle of global cost-effectiveness of emission reduction in Art. 3 (3) and thus opened the way for flexibility. As it did not fix a binding emission target for any country, the need to invest in emission reduction either at home or abroad was not pressing. In December 1997, though, industrial countries and countries with economies in transition agreed to legally binding emission targets at the Kyoto Conference and negotiated a legal framework as a protocol to the UNFCCC - the Kyoto Protocol (UNFCCC 1997). This Protocol will become

[1] We only summarize here a few major points. For a complete discussion of the advantages of this approach see United Nations Conference on Trade and Development.(1992).

effective once it is ratified by at least 55 parties representing at least 55% of the total carbon dioxide (CO_2) emissions of Annex I countries[2] in the year 1990.

Art. 3 of the Kyoto Protocol defines the five-year commitment period (2008-2012) in which the emission targets that are set out in Annex B for individual countries have to be reached. Together, Annex I countries must reduce their emissions of six greenhouse gases by at least 5% below 1990 levels over the commitment period 2008-2012. They cover a basket of six greenhouse gases listed in Annex A: carbon dioxide, methane, nitrous oxide, HFCs, PFCs and sulfur hexafluoride. 100-year Global Warming Potentials are used to convert gases in a common unit (Art. 5 (3)). Emission targets relate to the base year 1990 whereas countries in transition can use a different base year if established in their first national communication (Art. 3 (5)). This applies to Hungary (average of 1985-87), Poland and Slovakia (1988) and Romania (1989). Croatia, Lithuania, Slovenia and Ukraine can still choose their base year, as they have not yet issued their first national communication. The base year for HFCs, PFCs and sulfur hexafluoride can be shifted to 1995 (Art. 3 (8)).

Besides emissions reduction, "verifiable" sequestration through afforestation and reforestation taking into account deforestation shall be used to meet the targets (Art. 3 (3)). Art 3 (4) allows the Meeting of the Parties (MOP) to include further sequestration activities, e.g. soils, for the next target period after 2012. Countries are allowed to use such sequestration for the current targets if the decision of MOP is taken prior to 2008. Countries may include net emissions from land-use change and forestry in the 1990 inventory (Art. 3 (7)) – currently this only applies to Australia, the UK and Estonia.

Small countries for whom single projects have a significant impact on emissions in the target period shall benefit from special rules to be decided upon at COP 4 (Decision 1/CP.3, para 5 (d)).

If emissions during the commitment period are lower than the target, the difference may be banked for the next commitment period (Art. 3 (13)).

B. 2 Reporting and Accounting Rules

Art. 5 (1) states that each party to the Protocol shall install a national system for estimating emissions and removals. Inventories have to be submitted annually after 2008 via national communications (Art. 7 (1-3)). MOP shall develop additional guidelines for reporting and accounting (Art. 7 (4)).

B. 3 Monitoring and Verification

National communications are to be reviewed by expert teams (Art. 8 (1)). The members are to be appointed by parties and intergovernmental organizations (Art. 8 (2)). If the team identifies contentious issues, they are referred to the MOP (Art. 8 (3).

B. 4 Cooperative Implementation

Article 3.3 of the UNFCCC states "policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost". To implement this provision the Kyoto Protocol has incorporated a variety of provisions for cooperative implementation mechanisms (see Box).

---

[2] Annex I countries refer to the OECD countries and countries with economies in transition. These countries have committed themselves to legally binding greenhouse gas emissions targets.

Box: Mechanisms of Cooperative Implementation in the Kyoto Protocol

Article 4.1

"Any Parties included in Annex I that have reached an agreement to fulfil their commitments under Article 3 jointly, shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3. The respective emission level allocated to each of the Parties to the agreement shall be set out in that agreement."

Article 6.1

"For the purpose of meeting its commitments under Article 3, any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy..."

Article 12.2

"The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3."

Article 17

"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 purpose of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article."

Source: UNFCCC (1997).

- **Bubbles**

The Kyoto Protocol incorporates the "bubble" concept into the final text of Article 4. Although originally conceived as a way of allowing the European Community as a regional economic integration organization to accommodate its internal burden sharing of the Kyoto commitments among its member states, the final wording of the Article is framed in general terms. It allows a group of Annex I countries to jointly fulfil their commitments under Article 3, provided that their total combined aggregate GHG emissions do not exceed their assigned amounts. A bubble must be declared when the ratification is deposited. Once the terms of agreement has been registered with the UNFCCC Secretariat, the commitments agreed on cannot be revisited during the commitment period in question. The "bubble" approach is often termed as "trading without rules" because it sets few restrictions on trading between parties. If it turns out to be too difficult to agree on the common rules and guidelines "for verification, reporting and accountability for emissions trading" pursuant to the Kyoto

Protocol, the “bubble” approach at least opens the possibility of trading emissions permits within the voluntarily-formed group. In addition to the current EU bubble, the US has reached a conceptual agreement with Australia, Canada, Japan, New Zealand, Russia and Ukraine to pursue an umbrella group to trade emissions permits (USDOS, 1998). Whether this develops into a fully-fledged bubble under Art. 4 remains to be seen.

- **Emissions Trading**

The Kyoto Protocol also accepts the concept of emissions trading under Article 17, under which one Annex B country will be allowed to purchase the rights to emit greenhouse gases (GHG) from other Annex B countries that are able to cut GHG emissions below their “assigned amounts” (AAs). Although Annex B to the Kyoto Protocol and Annex I to the UNFCCC are now identical in nature, this change from Annex I into Annex B potentially allows a developing country to engage in emissions trading if it voluntarily adopts an emissions target and is inscribed in Annex B. Because the emissions trading proposal was adopted at the very end of the Kyoto negotiations, designing “the relevant principles, modalities, rules and guidelines” governing emissions trading has been deferred to a subsequent conference. Such design of a workable emissions trading scheme is essential to the success of emissions trading. The market-based emissions trading approach can only achieve significant cost reductions in cutting GHG emissions while also allowing flexibility for reaching compliance if it is structured effectively. The present study aims to facilitate the design of an international emissions trading scheme that is both workable for the parties eligible for emissions trading and acceptable to all the parties to the Protocol.

Emissions trading transfers "assigned amount units". Assuring that the post-transfer commitments are appropriately adjusted requires that the amount transferred should be added to the buyer’s assigned amounts and deducted from the seller’s assigned amounts (Art. 3 (10,11).

- **Joint Implementation**

The third option currently is most relevant concerning worldwide cost minimization — project-oriented emission reduction credited to the investing country. This possibility was named “Joint Implementation” (JI) in the negotiations leading to the Rio Conference. In 1995, the Berlin Conference of the Parties decided on a pilot phase for JI without crediting called “Activities Implemented Jointly” (AIJ). By 2000, it should be decided whether AIJ would be followed by JI with crediting. The Kyoto Protocol allows JI between Annex-I countries (Art. 6). It does not state, though, whether AIJ projects will automatically become JI after 2000.

JI projects shall be approved by all involved parties and be “supplemental” to domestic action (Art. 6 (1d)). MOP shall define guidelines, verification and reporting rules (Art. 6 (1c)). ERUs created through Art. 6 JI are treated in the same way as ERUs from emissions trading under Art. 17 (Art. 3 (10,11)). ERUs from JI do not accrue if inventories are not submitted annually or do not use the agreed guidelines (Art. 5, Art. 7). ERUs questioned through expert review teams may be transferred but are “frozen” until the question is resolved (Art. 6 (4)).

- **Clean Development Mechanism**

The Kyoto Protocol includes a new way of linking emission reduction with economic development. A "Clean Development Mechanism" shall be set up, which has been defined only rather vaguely (Art. 12). It leads to the creation of “certified emission reductions” (CERs) (Art. 3 (12)). Art. 12 (3) states that countries that fund projects through the CDM get credit for certified emission reductions from these projects provided “benefits” accrue to

the host country (Art. 12 (3a)). Crediting shall be only allowed until a certain percentage of the emission target is reached (Art. 12 (3b)) that remains to be defined. It is unclear whether crediting up to this quota is in full or only partial. Besides countries, companies are allowed to invest and execute projects (Art. 12 (9)). In contrast to the other flexibility mechanisms, CERs accrue for the whole period 2000-2012, not just for the commitment period (Art. 12 (10)). On the other hand it is unclear whether sequestration is covered.

The CDM shall cover its administrative budget through project revenues. Moreover, a "part" of these revenues shall be used "to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation" (Art. 12 (8)). It remains open who does certification of emission reduction but verification shall be done by independent bodies (Art. 12 (7)). The project criteria remain the same as for AIJ (Art. 12 (5)).

C. AN OVERVIEW OF THE REPORT

This report discusses the establishment of a trading system. We note that many of the issues discussed have great importance and relevance beyond any trading system. Monitoring and reporting requirements are fundamental not only to a trading system, but also to achieving the emissions-reduction obligations under Article 3 of the Protocol. So too the difficult issue of liability is a key issue not only in establishing an adequate compliance system for trading, but also for parties' basic obligations under Article 3. While we discuss these issues in the context of trading, we urge readers to keep in mind their importance and relevance to achieving the overall goals of the Convention.

Our purpose is not to sell a particular form of emissions trading, but rather to facilitate the process by examining two specific sources of evidence—the historical experience with existing trading programs and existing international agreements—in order to derive lessons that should prove useful in designing this particular system. Although we do not hesitate to point out where the evidence points in a particular direction, our main objective is to provide options and to trace out implications of various choices.

II. REVIEW OF LESSONS FROM OTHER EMISSIONS TRADING SYSTEMS

A. OVERVIEW

Lessons drawn from emissions trading history are relevant both to the design of an international trading system and to countries that are structuring national compliance and trading systems. The design of trading programs is critically important to their success, as it will determine the transaction costs as well as the uncertainty and risk inherent in the trading system.

In general, past programs that impose emission caps coupled with allowance trading have performed well, whereas credit-trading systems have generally not performed to expectations. Well designed allowance trading systems have led to both economic gains in reducing costs of compliance, and environmental gains because the reduced costs allow the acceptance of more stringent environmental standards. In comparison, virtually no system of credit trading has been associated with major economic or environmental gains. This has been due to the higher transaction costs and greater uncertainty and risk inherent in credit trading compared to allowance trading.

The lessons learned from past programs also indicate the importance of national compliance laws and trading systems if an international system is to work well. If a nation creates an allowance trading system, and especially if it allocates the allowances to private entities, transaction costs are expected to be low and trading to contribute to significant cost reductions. On the other hand, if a country relies exclusively on policies and measures to achieve its targets, only credit trading or joint implementation at the source level is feasible, and trading would be expected to be less effective.

A review of past trading systems also indicates the kinds of rules needed for monitoring, reporting, and verification of trades. While high quality monitoring is needed for all trading systems, the rules for reporting, verification and liability will depend on the kind of trading systems adopted under national laws. Allowance trading allows very simple rules to govern, which are coupled with very high credibility. The rules for credit trading systems are much more complex, and would depend in part on whether a nation implements a permitting system or other policies and measures for greenhouse gas abatement. All credit-trading systems however require extensive procedures for reporting, verification and liability enforcement, although the resulting quality assurance is not as high as with allowance trading.

B. EMISSIONS CAP AND ALLOWANCE TRADING SYSTEMS

B. 1. The Acid Rain Program (1990) [3]

The Acid Rain Program in the United States represents the largest and most successful emissions cap and allowance-trading program in the world. It was established in 1990 to reduce industrial emissions of SO_2 which cause acid rain and directly affect human health. The Program sets a national emissions cap equal to 50 percent of base year (1980) SO2 emissions, and allocates allowances in two phases to 2,200 utility units. It also allows operators of affected facilities — primarily electric utilities — to trade emissions allowances between their own facilities or with other utilities in order to save costs in achieving the emissions cap.

The Program creates a "gold standard" for compliance that assurance that can be adapted to Article 17 trading. It includes high quality continuous monitoring of all emissions, high penalties for non-compliance including fines and forfeiture of allowances, and self-reporting of both actual emissions and trading activities to a public database. The combination of these elements has led to 100 percent compliance without the need for further enforcement action.

Another notable feature of the program is an annual public auction ofapproximately 3% of the allowances, conducted by EPA. The auction does not raise revenue for the government, but serves a useful purpose in providing a highly visible price signal and addressing potential concerns about market power and hoarding of allowances.

The Program's emissions cap and allowance trading approach has achieved a strict environmental goal at dramatically lower costs than traditional forms of regulation. Results from the first few years of operations since 1995 show that plants over-achieved pollution reduction goals, at compliance costs less than half those predicted by EPA, and many times lower than those predicted by industry (Ellerman et al. 1997; USGAO 1994). Allowance prices have fallen from a predicted $400-1,000 per ton range to around $150. In addition, the program has fostered innovation, reduced litigation, and required only a very small regulatory staff to manage (McLean 1995; Burtraw and Swift 1996).

---

[3] The Acid Rain Program was promulgated in Title IV of the Clean Air Act as part of the 1990 Clean Air Act Amendments. Clean Air Act 401 et seq.; 42 USC 7651 et seq.

B. 2. RECLAIM (Los Angeles, California) (1993)

The Regional Clean Air Incentives Market (RECLAIM) was created in 1993 to cap the emission of NO_x and SO_x from most stationary sources in the Los Angeles area, which suffers from the worst air pollution in the United States. Under RECLAIM, all participating stationary sources with emissions over 4 tons/year receive an annual emission cap (Allocation) and an annual rate of reduction. Facilities are assigned starting (1994), mid-point (2000), and ending Allocations (2003), measured in annual tons of NO_x and SO_x. The allocation for any compliance year may be freely traded subject to reporting requirements and some spatial restrictions. (Schwarze and Zapfel 1998)

The District does not regulate the market or control prices, but does maintain an official registry and keeps a public bulletin board where facilities and interested parties can identify availability. About two thirds of all facilities must measure emissions with continuous emissions monitors that report actual emissions every 15 minutes to the District on a publicly available database.[4] Facilities are on a twelve month staggered compliance cycle. At the end of its compliance period each facility submits a final report and is given a two-month reconciliation period in which to sell or secure any emissions units necessary to balance its emissions for the final quarter. Facilities that fail to meet their reduction requirements are required to achieve the reduction by the following year and may be subject to monetary penalties.

RECLAIM has achieved significant success in reducing the price of compliance. Before RECLAIM, the marginal costs of NO_x control in the District had reached $25,000 per ton for some sources such as electric power plants, whereas the cost per ton under RECLAIM has been around $2000.[5] The District projects that annual savings in compliance costs relative to command and control regulation average $58 million annually, or 42% (Anderson 1997).

Although RECLAIM has worked successfully for NO_x and SO_x, the program failed to establish a VOC emission cap and trading element as initially contemplated. This was due to strongly held differences of opinion among differing stakeholder groups, notably environmental and industry groups, as to what the initial baseline allocations should be, and how quickly reductions were to be achieved. This demonstrates the political difficulties that may be experienced in setting and allocating initial allowances under a cap and trade system, as the value of the rights distributed is so great.

B. 3. New Zealand Fisheries License Trading (1986)

New Zealand has used Total Allowable Commercial Catch limits (TACCs) and Individual Transferable Quotas (ITQ) since 1986 for management of the majority of its commercial fisheries. Strictly enforced limits under this cap and trade system have enabled New Zealand to move commercial harvesting towards sustainable levels (OECD 1997).

The government sets total allowable annual catch limits for each fish species in defined management areas, based on sustainable harvest considerations. The TACC is the commercial share of that limit, and can be 100%.[6] The government initiated the program in 1986 by assigning ITQ, which are permanent rights to harvest fish from a particular area, to each of

[4] Cheaper and less exact monitoring methods are allowed for the remaining ssources.
[5] These results have to be taken with a grain of salt, however, since the initial permit allocations tended to be generous. The real test will come when the program requires substantial new reductions.
[6] The government relies on other polices and measures to manage the non-commercial catch of a fish stock.

approximately 2,500 commercial fishing permit holders based on their historic catch levels. If the sum of the individual quotas exceeded the TACC for a fish stock, the government made a one-time purchase of the difference in 1986, and retired that portion of the quota.

From 1986 to 1990, the ITQ were expressed as a fixed tonnage of fish per year, requiring the government to buy and sell quota to ensure the sum of ITQ equaled the TACCs. Due to the expense of this, since 1990 the ITQ have been expressed as a proportion of the annual TACC for each fish stock. At present, fishers may "borrow" up to 10 percent of the following year's ITQ but must then limit their catch in the next year. Similarly, 10% of unused ITQ can be "banked" or used in the following year. These provisions may be repealed, however, as borrowing has proven administratively complex and has caused enforcement problems.

ITQ are fully transferable subject to a minimum quota provision for administrative reasons and certain quota aggregation restrictions to restrict potential excess of market power. The program also has political elements, such as a requirement that holders must be New Zealand residents or be less than 25% foreign owned.

The ITQ system has led to heavy trading, and it is estimated that 77% of all ITQ initially allocated has changed ownership. The costs of monitoring and administering the ITQ systems are similar to those of other fisheries management programs, although costs were high during the initial establishment of the system. The main control point is the first receiver of fish, who must attest the fish products they receive are covered by ITQ. The government investigates the paper records to detect inconsistencies, and has successfully prosecuted violators. There are high penalties for non-compliance, including fines and forfeiture of vessels.

C. CREDIT TRADING PROGRAMS

C.1. U.S. Emissions Credit Trading (1977)

Emissions credit trading programs in the United States have been established for criteria pollutants (CO, lead, NO_x, SO_2, particulates and volatile organic compounds) since 1977, when emission offset rules were first developed for new sources entering degraded airsheds. These form part of a suite of EPA credit trading incentive policies, including bubbles, netting, offsets, and more recently discrete emission reduction credits.

Each of these programs allows firms to trade emissions reductions that are shown to be below the firm's permitted levels or actual emission history, whichever is lower. Each program contains rigid procedural requirements for reporting and approval by governmental authorities, in some programs multiple approvals, essentially making trades into rulemaking events. Consequently, these programs have suffered from high uncertainty, transaction costs and regulatory risk.

The U.S. credit trading systems have generally performed poorly. Although there have been thousands of trades over the decades, the extent of trading has been less than expected, and sometimes much less. More importantly, the programs have not achieved significant economic or environmental benefits, nor introduced flexibility into the fairly rigid regulatory system governing criteria pollutants. Disappointment in these programs has been generally attributed to their high transaction costs and the uncertainty and risk in obtaining the needed government approvals for credit trades (Dudek and Palmisano 1988: Hahn and Hester 1989)

In addition to the relatively weak economic impact of these programs, they have caused environmental concerns. Since each credit trade is unique they have uncertain environmental impacts, especially for shutdown credits which are allowed for offsets, as they may increase total net emissions. The uncertain environmental impact of these credit trading policies has led to criticism by the environmental community, and ultimately led to increasingly stringent rules for review and approval of credit trades, adding to transaction costs.

Finally, since credit trades are project-specific, continued oversight is needed to ensure the parties perform as promised. This has lead to complex liability rules to ensure that buyers or sellers are responsible for the potential failure of a trade. This reduces the tradable commodity nature of the credit trade.

The history of U.S. credit trading demonstrates the tension between the need for high levels of government oversight to ensure credit trades are legitimate, and the high to very high transaction costs this review entails. As a consequence, credit systems has been associated with far lower levels of trading and overall impact than allowance trading.

C.2 Lead Phasedown (1982)

As part of an effort to greatly reduce lead in gasoline, EPA established a lead credit market in 1982 and expanded it in 1985. The program, which ended in 1987, was designed to facitiate the transition to lead-free gasoline. The lead credit market paired efficiency gains for industry with lead reductions for the environment, the latter largely paid for by the cost savings of trading.

The program was a typical credit market: a refinery that used less lead in gasoline than the standard required earned credits; these credits could be traded to any other refinery, and unlike other credit trading programs, trading did not require prior approval by the government. Instead, trading activity was reported to EPA at the end of each quarter.

The trading market in lead credits was established primarily because imposing an equal lead reduction standard on all parties was inequitable because the marginal costs of control were vastly different among refiners, especially small producers. Trading allowed EPA to set a uniform standard while allowing small refiners the option of buying lead credits instead of making major capital investments in short time periods. Moreover, trading provided efficiency savings to refineries generally, such that total compliance costs declined nationally. Trading allowed those with excess capacity to sell to those who had not yet made the necessary capital investments.

Under initial rules in effect between 1982 and 1984, refiners could only trade and use credits within the same calendar quarter, but banking was introduced in 1985, and allowed credits to be sold or banked for later use or sale. The 1985 Amendments both significantly reduced overall lead levels and allowed the banking of credits for future compliance, which significantly reduced the total cost, even with the greater reductions.

The lead phasedown program performed successfully as the first free and open trading market. Lead credits were briskly traded, and trading is believed to have significantly reduced the cost to producers, as well as facilitating the additional lead reductions in 1985.

The enforcement history of the program is also instructive. Initially, EPA detected a significant number of violations under the program, especially after banking was introduced. Almost all violators were refiners who did not sell to consumers under their own brand name, indicating that concerns about public image complemented the regulatory incentives to

comply for the larger brand-name refiners. In response, EPA significantly increased oversight and enforcement efforts in 1986 in order to stop the cheating (Loeb 1996).

This history indicates the tension in credit trading programs between the need for low transaction costs and the need for high levels of oversight. One of the important reasons why lead credit trading worked more effectively than other pollutant credit trading programs is that it did not require government approval for credit trades. As a consequence, transaction costs were low and vigorous trading took place, associated with significant economic and environmental gains. However, cheating was a problem until EPA increased enforcement oversight.

Subsequent EPA credit trading programs have included much greater procedural requirements including advance governmental approvals, in order to assures that each credit trade is legitimate. However, these reduce the commodity nature of the credit, increase transaction cost and uncertainty, and inhibit trading.

C.3. Pilot Program for Activities Implemented Jointly

Under the FCCC (article 4.2(a)), a pilot program for activities implemented jointly was initiated at the first Conference of the Parties in 1995. This program was intended to explore the design of emission reduction and sequestration projects situated in developing countries and countries in transition and was financed through funds from Annex-I governments or private entities. It is not strictly comparable to other credit trading programs as investors gained no formal crediting for the tons purchased. The pilot phase explicitly excluded crediting and did not try to develop rules to implement crediting. However, experience under this program is useful to indicate procedures for determining "additionality" of emissions reductions, which also is required for trades under articles 6 and 12.

The AIJ pilot program focused on developing methodologies for showing how much of the reductions would be "additional" to what would otherwise have occurred. This showing has required a close scrutiny of the actual economic and contextual situation of each trade, and requires a forecast of what would have happened absent the project. This raises transaction costs and lengthening approval processes to one to two years. As a consequence of the lack of formal crediting, the lack of incentives for investing and high transactions costs, only a few projects have been approved (Michaelowa 1997)

Although the pilot nature of this program means the results may not be applicable to a full program, it does indicate that a greenhouse gas credit trading program which requires a showing of additionality can involve even higher transaction costs and uncertainty than has been the case with other credit trading programs. This indicates that it may prove difficult to foster significant trading under Articles 6 or 12, as both require a showing of additionality.

D. HISTORICAL PERSPECTIVES ON DESIGN FEATURES

D.1. Basic Structure of Program

- **Fixed Emissions Cap with Allowances.**

In order to implement an allowance trading system, a country must at a minimum establish a fixed emissions cap and create a specific number of allowances equal to that cap. It then decides whether to keep the allowances itself, or allocate all or part of them to private entities so they can trade with other entities (see Allowance Allocation below).

❑ Allowance Versus Credit Trading

A review of past history shows that allowance-trading programs have proven superior to credit trading systems in terms of both economic and environmental results. In particular, the United States history of emissions trading shows the cap and trade approach under the Acid Rain Program and RECLAIM has resulted in significant program-wide cost reductions, while emissions credit trading has not been as successful. Reasons for this are summarized below, but essentially have to do with the lack of commodity nature of credit trades, their higher transaction costs, and regulatory barriers to their creation (Dudek 1995; Naughton 1994; Hahn 1989).

A cap and trade program using allowances offers a systems-based solution in which issues such as baselines, allowable levels and allocation are dealt with in the initial phase of establishing the overall program. Allowance trading can then proceed without the need to revisit these issues for individual trades, greatly reducing the need for government oversight. However, if allowances are allocated to private entities, this initial phase can be contentious as valuable economic rights are being allocated.

Credit trading is project based, and requires all these issues to be analyzed and certified for each trade. Each source must establish its emissions baseline, permitted level, reduction plan and enforcement mechanisms. This system requires a process of verification and government approval, as well as continued monitoring. As a result, transaction costs and uncertainty are high. While an allowance might be comparable to a currency unit, a credit might be better compared to a specific good whose value must be determined each time though a regulatory process.

One of the most important differences in the two types of trading programs is the level of government involvement in trading. Although allowance trading has very high quality assurance, once the program has been designed it requires no government involvement in approval of trades and consequently has very low transaction costs.[7] Credit trading in contrast is project based, and requires one or more approvals for every trade, leading to higher transaction costs, uncertainty levels and risk, together with lower environmental quality assurance.

❑ Allowance Allocation to Private Entities

All existing emissions trading programs involve trading between private entities. Allowing private entities to trade appears to be important if the efficiencies of trading are to be realized. The essential benefit of trading programs is that they allow private firms the flexibility to determine technology choices and options themselves, and compare these to emissions permit prices to determine an overall least cost path of compliance. Allowing private entities to trade amongst themselves creates maximum flexibility. Since emissions sources are the ones that would make decision to implement energy-saving technologies and processes, allowing them to trade allows them the greatest potential to achieve these efficiencies.

❑ Banking/Savings

Banking/savings of allowances allows firms significant additional flexibility in compliance technology and investment decisions. There has been heavy use of banking in both the US Acid Rain Program and lead credit trading market, which has led to early reductions and

[7] Government involvement in the design phase of the program can be as high or higher than for credit programs.

substantially lower overall costs of compliance. Banking is especially significant for industries in which major capital expenditures must be made, as it allows individual sources flexibility in the timing of such major investments.

Banking/savings is expected to be important primarily as an element of national trading systems, since the Kyoto Protocol creates only one compliance period, from 2008-2012. However, the Protocol does allow banking in relation to expected future compliance periods, which may encourage further early reductions (Article 3(13)).

- **Method of Allowance Allocation**

The allocation of allowances to sources is a contentious issue, as economic rights of considerable value are allocated to sources based on their past emissions history or permit levels.[8] The above programs have allocated allowances for free to existing sources. This may be the most politically practical method since it provides the greatest number of rights to existing sources. However, it makes it more difficult for new sources to enter the market, as these must buy allowances form existing sources.

Alternative methods of allowance allocation would be to auction allowances or allocate them based on a rolling average of past emissions. Both methods would reduce the barriers to new entrants, and better deal with shutdown sources. An auction would also raise considerable revenue, which could become a revenue source for government, or else be recycled to sources or used to reduce other taxes on employment or investment. Due to the presence of distortionary taxes that raise the cost of pollution abatement relative to an efficient level, the regulator's decision whether to auction or grandfather allowances can have significant cost impacts (Goulder et. al. 1998).

- **Opt-in Provisions**

It is desirable to include as many sources as possible under a regulatory system. However, including all emitters of a pollutant may not be practical in an emissions cap and allowance trading system due to uncertainties in measurement for some classes of sources, political constraints, or because it is impractical to cover the smallest sources. In this case, a provision that allows otherwise uncovered sources to voluntarily opt to be covered under the regulatory system can increase the scope of a program.

The Acid Rain Program for example covers only emissions by utility boilers, but allows other industrial boilers with SO_2 emissions to voluntarily subject themselves to regulation under the program once they demonstrate their baseline emissions and accept an emissions cap calculated in the same manner as the utility sources. So far several industrial boilers have chosen to opt in.

Another way to broaden the scope of a program is to offer firms subject to the emissions cap a credit if they contract with uncapped sources to reduce their emissions. As long as the emissions can be verified and monitored, this approach also can expand the number of entities covered in a regulatory systems, although experience has shown its high administrative costs may reduce its usefulness.

[8] In the Acid Rain Program this issue led to numerous special rules for individual sources, and in the RECLAIM program contributed to the failure of the VOC trading element as agreement could not be reached on the allocation and scope of reductions.

❑ Inter-Gas Trading

None of the existing emissions trading systems allow inter-gas trading. For most, this is not possible, as the environmental effects of different gases are distinct. Inter-gas trading is feasible for greenhouse gases, however, based on their relative global warming potentials. Allowing inter-gas trading could expand the number of sources trading, and promote efficiency by including all GHG sources in a unified trading system.

❑ Phasing

The phased inclusion of gases or industries may be feasible if there is little interconnectivity between sources or industries in the different program phases. If there is economic interconnectivity, the program could experience leakage, as covered sources would shift activity to uncovered sources. The phased inclusion of sources within an industry sector has created significant administrative problems in the U.S. Acid Rain Program due to this problem of interconnectivity and leakage, and so should be avoided.

D. 2. Implementation

❑ Transaction Costs

Transaction costs play a key role in the success of an emissions trading system. In the past, only emissions trading programs with low transaction costs have succeeded in substantially lowering the cost of compliance. These include all the allowance programs such as the US Acid Rain Program, RECLAIM, New Zealand fisheries permit trading, together with US lead credit program, the only credit-trading program that did not require government approvals for trades. All other credit trading programs, have high transaction costs, and have failed to significantly reduce the costs of compliance.

Transaction costs have several components, including monetary costs borne by the generators and purchasers for documentation, verification and procedural requirements, the cost of delay, and costs created by the uncertainty of regulatory approval. Credit trading programs require each credit generation or use to be separately approved by a regulatory authority. They therefore create high transaction costs as well as risk and uncertainty to participating businesses, because transactions are typically only approved after reductions have been generated. Finally, they involve ongoing monitoring and liability concerns to assure continued compliance of the original credit generator.

Cap-and-trade programs, on the other hand, have generally low transaction costs and low risk. Instead of conducting a case-by-case review of credit transactions, firms can simply transfer issued allowances, without subjecting the transfers to regulatory intervention, and without having to bear any costs related to ensuring the environmental performance of the selling firm or for indemnification related to environmental non-performance. At the same time, credibility of the underlying emissions reduction is very high.

In addition to transaction costs borne by the sources involved in trading, transaction cost are also borne by the regulatory authority to validate and administer the trading system. Here again, allowance trading appears to have an order of magnitude lower costs than credit trading. EPA has estimated that total cost to the government for administering the Acid Rain Program is $1.50 per ton abated, compared to $25 or more for the case-by-case review process under a more typical permit process under Title V of the Clean Air Act (Kruger 1997; McLean 1995).

- **Auctions and Market Power Concerns**

Several mechanisms were implemented in past programs to address concerns about market power and potential hoarding of allowances, and are described below. However, the experience of existing programs has been that the private market has supplied an adequate to high number of allowances or credits, so that market power issues have not been of concern.

An auction of a certain portion of permits is one important tool to address potential market power concerns. An annual auction of approximately 3% of allowances under the US Acid Rain Program was created in part to address this concern, although a plentiful supply of allowances have become available under the program. The auction however has proved to be useful in signaling the low prices of allowances at the programs' outset. RECLAIM also included an auction at the beginning of the program's life in order to initiate the market, although it is quite different from the acid rain auction in nature and implementation. (Schwarze and Zapfel (1998)

Another provision in the Acid Rain Program to address market power concerns was a provision for the direct sale of a small percentage of allowances at a fixed price of $1,500. If these allowances are not bought, they are added to the auctioned amount.

- **Price Information**

Providing price information is important to reduce the uncertainty of trading and create public confidence in the trading program. However, existing emissions trading programs do not require that the price of privately conducted trades be revealed. Instead, they tend to leave the provision of price information to the private sector, although the Acid Rain Program supplements this with an annual auction.

It is possible to argue that price information should be included in emissions trades, and that the public benefits of revealing prices outweigh the interest of private entities in non-disclosure. Price information could be required to be revealed in reporting requirements for emissions trades, or through alternative systems such as regular public auctions.

- **Deduction or Depreciation**

Some credit trading programs impose a 10% or other deduction on trades for air quality enhancement, or for other purposes such as to grant to new entrants. This may help create public support for a trading program by creating public benefits if a firm takes advantage of trading to reduce their costs. On the other hand, imposing a percentage reduction on trades creates another barrier to the economic efficiency gained through trading. Arguably, the environmental benefits of clean air could be better established in setting the overall cap, not by penalizing trades.

D. 3. Compliance System

A final key feature of a successful emissions permit trading system is an effective compliance mechanism that ensures the integrity and fairness of the system and at the same time ensures that transaction costs are relatively low. The compliance system will normally include monitoring and reporting requirements and enforcement mechanisms.

- **Monitoring**

Past emissions trading program show that high quality monitoring is essential to assure effectiveness of both compliance systems and trading systems. Methods for monitoring emissions however have varied between past trading programs. The US Acid Rain Program requires continuous emissions monitoring by sources. This provides great certainty, but is expensive, as such monitors cost between $100,000 and $150,000 each. US emissions credit-trading programs rely on standard pollutant monitoring approved by EPA, whereas programs like the lead credit trading incorporate monitoring into regular paperwork reporting requirements.

Fortunately, carbon emissions from energy use can be accurately measured by predictive methods, which would significantly lower monitoring costs. Monitoring of a fuel-provider or emissions-source model could be done reactively simply through the filing of records about fuel transactions. Monitoring of methane emissions or biotic carbon sources is much more difficult however, and may limit the ability of certain of these sources to participate in a cap and trade model (ELI 1996).

Several element of the US Acid Rain Program are aimed at assuring the highest quality of monitoring data. First, monitoring devices and systems were required to be installed and verified in the year before actual trading started. Ongoing testing of these monitoring systems is required. Second, emissions data are sent hourly to EPA's Emissions Tracking System, and are summarized in a quarterly report to EPA together with the quality assurance data from the monitoring tests. These procedures could also be done in a greenhouse gas trading system to assure the quality of monitoring data.

- **Reporting**

Reporting requirements are of two kinds - the reporting of emissions monitoring results and reporting of emissions trading activity to the international authority for compliance purposes.

Emissions reporting is part of any nation's greenhouse gas compliance structure, regardless of trading, and is described in Article 3. On a national level, many countries require monthly reporting of pollution emissions data, and continuous emissions monitoring technology allows reporting as often as every 15 minutes. Emissions reporting to the international authority would be needed so that authority could assure the integrity of the basic monitoring system.

Trading programs, however, do require reporting systems for emissions trading activity for quality assurance and enforcement. One element of this is the reporting of trades. All recent US emissions trading programs require immediate reporting of trading activity to a government-controlled registry, which is open to the public. This helps to assure openness of the system, and is also used by the government for compliance purposes. Earlier US programs, such as the lead credit trading, as well as the New Zealand fisheries permit trading program, require reporting of trades less frequently.

The additional procedures needed for compliance reporting can be extremely simple for allowance trading, and quite complex for credit trades which are individual and project based. In allowance trading, reporting of emissions trading activity for compliance purposes is generally part of the reporting process at the end of each quarter and at year end. This is a paper or electronic report which states the source's total emissions limit, the units of pollution actually emitted during the compliance period, and any allowance trading activity such as sales or purchases. Units emitted during the year, plus or minus any allowance

transfers, must equal the source's total limit. Past reporting requirements for credit trading have varied depending on the kind of credit trading program. If sources are permitted, trading can be made enforceable under the permit system, and reporting requirements become integrated with regular permit reporting. Trading only changes the level of permitted emissions. This system is evident in the lead credit trading program and offset-type credit trading systems in the US.

The most complex reporting requirements are needed for project based credit-trading systems, such as joint implementation, CDM or trading of discrete emissions reductions (DERs). A precedent for such reporting is found in the US rules for DER trading, which require between three and five separate reports to ensure quality control (USEPA 1995). Late filing of reports can lead to penalties or deductions of credits.

EPA's model rule would include the following reports: (1) a notice of generation of DERs to be filed soon after generation of the credits; (2) a notice of intent to use DERs for compliance purposes must be filed at least 30 days prior to a source's first use of DERs and renewed at least annually in cases of continued use; and (3) a notice and certification of DER use by a purposes soon after the end of the use period. Some states require additional reports: (4) A notice of transfer whenever DERs are transferred; and (5) A notice of DER verification, which represents an independent third-party assessment of the validity of the DER.[9] Massachusetts is the only state that relies on its existing permit system, as opposed to a series of notices. [10]

- **Public Information**

US credit and allowance trading programs all provide for a state-maintained public registry containing documentation of all trades and trade notices. Possibly the most developed of these methods is the **Allowance Tracking System** used in the Acid Rain Program. These publicly open allowance registry systems help to create a transparent and self-enforcing compliance system, and has contributed to high compliance records in the programs.

Any additional relevant information submitted to the registry or to the department must be maintained as a public record open to inspection and duplication. In many cases, information contained in the registry is available on the world wide web. In addition, EPA's model rule and most state rules require a credit generator or user to make all documents and supporting information available to any person who requests it.

- **Certification**

The issue and methods for certification of trades is one of the key differences between allowance trading and credit trading systems. Allowance trading does not require certification of trades, as the authenticity of each allowance is built into the structure of the program. All the cap and trade programs discussed above allow free trading of allowances without verification or other forms of government approval.

---

[9] See, New Jersey Department of Environmental Protection, Emission Offset Trading Program: New Jersey Administrative Code (NJAC) 7:27-18 (effective June 30, 1979); New Jersey Department of Environmental Protection, Emission Reduction Credit Trading Program, 28 New Jersey Register (NJR) 3414(a)7 (effective date of July 1, 1996)(proposed rules at 28 NJ Register 1148, February 20, 1996); New York Code of Regulations Title 6 Part 231.

[10] Massachusetts Department of Environmental Quality, Emissions Offset and Discrete Emission Reduction programs, 310 Code of Massachusetts Regulations 7.00 Appendix B (1997).

However, all forms of credit trading require some kind of certification system. The history of certification under past programs is relevant to assuring the validity of trades under the CDM (Article 12) or if a country chooses to create a private entity system for international credit trading under Article 6 (JI).

In order to be acceptable, credit trades must be judged to be valid on a number of criteria. Under US credit trading programs, the principal criteria are: quantifiable, surplus, either permanent or discrete, and enforceable. Again, the form of certification depends on the kind of credit trading. If the credit trade is lasting and takes place in the context of an overall permitting system, certification can focus primarily on quantification; the surplus, permanent and enforceable nature of the trade is dealt with through the permitting system.

However, in discrete project-based credit trading, the certification process must address all of these issues. One of the most difficult showings is that of additionality, which in the absence of a permitting system requires a forecast of future economic events and probabilities. Under the pilot program for AIJ, this verification process has led to the rejection of many proposed trades, and can take one to two years, creating high transaction costs and uncertainty.

- **Penalties**

The level of penalties in past programs appears to be positively correlated with compliance levels. A remarkable achievement of the US Acid Rain Program has been its record of 100% compliance in all years. Highly reliable monitoring and reporting requirements, a public accountability system, and very high penalties, all help to create this record.

Under the Acid Rain Program a source that emits more than the number of allowances in its account must automatically pay a financial penalty of $2000 (1990 dollars, adjusted upwards for inflation) for every excess ton and offset the excess emission with equivalent allowances. This price is much higher than the current $100 price of an allowance, and is based on original perceptions of the likely cost of an allowance. These high penalties have helped to achieve a 100% compliance rate with low transaction costs.

Penalties are also high in the New Zealand fishing license trading program, and include fines and possible forfeiture of vessels. These have led to reported high rates of compliance. Fines are significant under RECLAIM and US emissions credit trading. Penalties under the lead trading program were initially low, principally involved the need to make up the lost credits, and enforcement was a problem for a time under this program.

A relevant aspect of both the Acid Rain Program and RECLAIM is the provision of a two-month reconciliation period following the end of a year for sources to purchase any allowances needed to equal their emissions. This promotes compliance and reduces risk in the market.

- **Liability and Enforcement**

Liability rules are fundamentally different for the different kinds of trading programs. Allowance trading requires few special liability requirements, reinforcing the low transaction cost of this system. Next most complex is credit trading based on a permit system, where liability can be integrated into existing permit rules. Most complex is a liability system which must be created for credit trades based on joint implementation or discrete reductions.

Liability is straightforward for allowance trading because all covered sources need simply show that they have sufficient allowances to cover their emissions at the end of each compliance period. Sources are liable if they do not have enough allowances. A GHG international trading

system could adopt this system if the integrity of the underlying monitoring and compliance systems of allowance trading countries are high, and a compliance system at least ensures that any country or source emitting an excess ton makes the environment whole by replacing that ton with emission reductions purchased or achieved elsewhere.

All credit trading involves greater transaction costs and effort to develop an adequate liability system. The most straightforward rules are when credit trades take place in a context where existing sources are already subject to a permit for their greenhouse gas emissions. Here the existing liability and enforcement mechanism of the permit system can be used to enforce credit trades, as the permit of the selling firm would reflect its new lower emissions limit after the trade, and that of the receiving firm its new higher amount. An international trading system would need to guarantee that the nations trading have adequate capabilities to enforce the permit levels.

In the absence of a permitting system, credit trading programs must create a separate liability system, as any discrete emission reduction is a one-time event and is not reflected in a permit. Developing an adequate liability system in this context is problematic, and involves a tradeoff between higher transaction costs on the one hand, and lowers credibility on the other. These problems are magnified in an inter-jurisdictional trading regime.

The two options are imposing liability on the buyers or users of traded credits, or on the sellers or generators of the credits. The relative advantages of the two systems have been addressed in US rules for discrete credit trades in its urban ozone abatement program. After considerable stakeholder discussion and review, EPA adopted the buyer-beware liability system in its model rule for this program (EPA 1995). EPA believed a seller or pre-certification system would significantly inhibit trading by requiring government pre-approval of all trades, and was concerned about how a regulatory authority could enforce against generators from other jurisdictions under that approach.

EPA developed four additional elements to reduce the uncertainties and transaction costs associated with a buyer-beware liability structure: (1) keeping certain liability with the generator through generator certification; (2) creating guidance through Emissions Quantification Protocols; (3) encouraging third-party relationships; and (4) enacting a separate policy for "good faith" purchasers. EPA believes these four features of the proposal would provide generators, users, and government authorities sufficient guidance and certainty to develop an active market in high quality trades.

However, both New York and New Jersey have adopted the seller certification system, and require credit generators to gain either government or third-party verification of the credits generated. These states stress the difficulty of requiring buyers to review all documentation relating to the generation of the credits, especially from different jurisdictions, and to the lack of government resources to inspect a reasonable number of credit trades under the buyer-beware approach. [11]

Independent authors have also criticized the "buyer beware" system, because it creates uncertainty and risk by failing to guarantee generators and users that they will benefit from reductions until they are approved. While this may be the case, the alternatives available under seller liability also constrain trading; for example, a pre-certification approach creates high transaction costs, and the alternative random audit approach has lower credibility.

---

[11] See, New Jersey Department of Environmental Protection, Emission Reduction Credit Trading Program, 28 New Jersey Register (NJR) 3414(a) 7 (effective date of July 1, 1996)(proposed rules at 28 NJ Register 1148, February 20, 1996); New York Code of Regulations, Title 6 Part 231.

These problems in creating a good liability appear inherent in a discrete credit trading system, which would include all joint implementation (Article 6) and CDM (Article 12) trades. For these, as well as discrete credit trades under other articles, some choice between higher transaction costs and uncertainty on the one hand, and greater credibility on the other, must be made.

III. RUDIMENTS OF AN ARTICLE 17 TRADING SYSTEM

A. EMISSIONS TRADING MODELS

In terms of whether there exist domestic emissions trading systems, three distinct international emissions trading models are likely to emerge (Joshua 1998):

1. Trading among countries with domestic emissions trading systems;
2. Trading among countries without domestic emissions trading systems; and
3. Trading among countries with and without domestic emissions trading systems.

In terms of whether sub-national entities are eligible for trading, two types of emissions trading models can be distinguished:

1. Inter-governmental emissions trading; and
2. Inter-source trading.

In the first model, governments elect not to allocate the assigned amounts to sub-national entities, and retain the sole right to trade.[12] As such, inter-governmental emissions trading takes place on a government-to-government basis. The legal basis for such trading has been provided by Article 17, which unambiguously states that Parties included in Annex B to the Kyoto Protocol are eligible for emissions trading. It should be pointed out that inter-governmental emissions trading differs from joint implementation (JI) as specified in Article 6, at least for two reasons. First, inter-governmental emissions trading separates the issue of the financing from the source of generating allowances, whereas JI creates ERUs which may be transferred and acquired, but are always tied with specific JI projects. Second, under normal conditions, no specific approval is needed to take the transactions in inter-governmental emissions trading, whereas any JI projects need the approval of both the host and investor Annex I countries. Moreover, inter-governmental emissions trading differs from the "bubble" approach as specified in Article 4 because the latter pre-determines the transfers and acquisitions of assigned amounts within the voluntarily-formed group prior to the beginning of the commitment period.

[12] Besides being based on domestic trading systems, inter-company international emissions trading could rely on other policy instruments such as emission taxes or regulation. If a domestic emission tax exists, companies could get a tax reduction proportional to the number of acquired international emission permits. In return for the tax break they would have to cede the permits to the state. The creation of permits for sale would be analogous to a credit program: if a company achieves certified emission reductions through a project which does not lead to a corresponding emission tax reduction it could sell them on the international market. Companies not subject to the tax for competition purposes could not create permits in this way.

In a system of regulation such as emission standards, permit purchases by a company might provide the basis for a temporary relaxation or waiver of the domestic standard. Here permits could be created if the standard is surpassed. Verification would need to be extensive in such a system.

In the second model, governments elect to allocate the assigned amounts to individual sub-national entities, and authorize them to trade on the international emissions allowances market. The great advantage over the first model is that it limits the governments to setting the rules rather than undertaking emissions trading themselves, and leaves individual companies the freedom to choose how to comply with their limits. By incorporating sub-national entities into an international emissions trading scheme, the companies that actually have control over emissions would be able to profit directly from emissions reduction activities, thus providing them with strong incentives to exploit cost-effective abatement opportunities. This would potentially increase the total amount of transactions in the international scheme, meaning greater capital flows to selling participants and greater cost reductions for buying participants. By increasing the number of trades, it would also improve market liquidity and reduce the potential for abuse of market power. The latter might occur in inter-governmental trading if one country or bloc holds a significant proportion of the total number of permits. Moreover, individual companies which have information on their technical options and costs can choose their efficient emissions level by comparing marginal costs and the international permit price, whereas, in the inter-governmental trading model, national governments can make errors in their decisions of how many permits to buy or sell because they possess only global and imprecise information about greenhouse gas emission reduction options and their marginal cost.

National trading systems could be modelled as either "*upstream*" or "*downstream*" or "*hybrid*" systems (Zhang 1998). An "*upstream*" trading system would target fossil fuel producers and importers as regulated entities, so would reduce number of allowance holders to oil refineries and importers, gas pipelines, LNG plants, coal mines and processing plants (Zhang and Nentjes 1998; Center for Clean Air Policy 1998a). Implemented effectively, an upstream system would capture virtually all fossil fuel use and carbon emissions in a national economy. Firms would raise fuel prices to offset the additional cost. In an upstream system the number of firms that has to be monitored for compliance is relatively small, thus it is easier to administer. Moreover, existing institutions for levying excises on fossil fuels, which exist in most industrialized countries, can be used to enforce the scheme (Zhang and Nentjes 1998). Even with such a relatively small number of regulated sources, market power would not be an issue. In the above upstream system for the US, the largest firm has only a 5.6 percent market allowance share and the lion's share of allowances would be held by smaller firms, with each having less than one percent share (Cramton and Kerr 1998).

In contrast, a "*downstream*" trading system would applied at the point of emissions. As such, a large number of diverse energy users are included. This would offer greater competition and stimulate more robust trading, thus leading to increased innovation. However, such a system would be more difficult to administer, especially concerning emissions from the transportation sector and other small sources.

To keep a downstream trading system at a manageable level, regulated sources could be limited to utilities and large industrial sources. Governments could then address uncapped sources through other regulatory means such as carbon taxes. In doing so, however, the governments need to establish additional programs. This would be administratively burdensome, let alone the political difficulties of introducing carbon taxes in some countries. Moreover, the actual achievements in reductions of CO_2 emissions by a proposed carbon tax remain uncertain because of imperfect knowledge of the price elasticities of demand and supply for fossil fuels, especially for the large price increases caused by carbon taxes for major emissions cutbacks (Cline 1992). This would put the governments at risk of non-compliance with the emissions commitments.

Alternatively, national trading systems could be modelled as "*hybrid*" systems (Zhang and Nentjes 1998). A hybrid system is similar to a downstream trading system in the sense that regulated sources at the levels of energy users are also limited to utilities and large industrial sources. On the other hand, like an upstream trading system, a hybrid system would require fuel distributors to hold allowances for small fuel users and to pass on their permit costs in a mark-up on the fuel price. As such, small fuel users are exempted from the necessity (and transaction costs) of holding allowances. Yet the rise in fuel price will motivate them to reduce fuel consumption or to switch from fuels with a high carbon content, such as coal, to fuels with a low carbon content such as natural gas.

No matter what national trading systems are adopted, importers and domestic producers of fossil fuels should be treated equally in obtaining emissions allowances under the "like product" provisions in the WTO (Zhang 1998). Moreover, regardless of whether individual countries choose to empower private trading, the ultimate responsibility for fulfilling the Kyoto Protocol commitments would, however, remain with the national government as a Party to the Protocol.

B. THE TRADING BASELINE

For the first commitment period the starting point for defining authorized emissions for Annex I nations is provided by Annex B, which defines the required reduction of anthropogenic carbon equivalent greenhouse gases (listed in Appendix A) from the base year or period. The base year is either 1990 or, for certain countries in Annex I which are undergoing a transition to market economies, an alternative year. The number of tons of anthropogenic carbon equivalent greenhouse gases produced by this multiplication is then multiplied by 5.0 to obtain "assigned amounts" (AAs) during the five year commitment period. For Annex I nations the assigned amounts are the basis both for determining compliance and for initiating a trading system.

Assigned amounts for subsequent commitment period will have to be announced by subsequent meetings. Changes in the baseline that are accepted during any commitment period should go into effect at the beginning of the next commitment period.

C. THE TRADABLE COMMODITY

Under Article 17 the tradable commodity would be a carbon dioxide equivalent allowances. Each allowance would authorize the emission of one metric ton of carbon dioxide equivalent gas. The total number of allowances a Party would hold at any time would consist of: (1) the assigned amounts (AAs) designated by Annex B (appropriately adjusted to reflect the "net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change an forestry activities, as authorized by Article 3.3), plus (2) allowances acquired from other Annex B parties, plus (3) certified emission reductions (CERs) acquired from non-Annex B countries under Article 12 minus (4) any allowances transferred to other Annex B parties.

The greatest cost advantages from Article 17 would accrue if all gases identified under Annex A would be eligible to be included in trades on a carbon equivalent basis. On the other hand if in the estimation of the COP monitoring and enforcement circumstances preclude including all gases in the initial trading system, trades could be limited to "eligible gases". Eligible gases in this case would be defined as the subset of gases listed in Annex A which have been approved for trading. Some have suggested, for example, that only energy-related CO_2 and CH_4 emissions would be eligible for trading (Lanchbery 1998).

Limiting trading to a subset of gases is not likely to be effective unless the Protocol is further amended to partition the assigned amounts into two categories—tradable and nontradable gases with separate goals assigned for each. In accordance with Article 5.3, Global Warming Potentials (GWPs) would be used to convert non-CO_2 gases into carbon equivalent terms both for verifying compliance and for defining the trading baseline and adjustments to it as a result of trades. [13] Without a separation of categories it would be easy for countries to use the flexibility inherent in the equivalence process to substitute freely among the gases.

D. DETERMINING COMPLIANCE

To comply with its obligations under the Kyoto Protocol, a Party's actual emissions of CO_2 equivalent tons during the commitment period must be no greater than the number of allowances it holds.

Unused allowances could be carried forward to be used in satisfying obligations in subsequent years. Overages (actual emissions higher than the assigned emissions) would incur a stipulated financial penalty and would result in at least a ton for ton reduction in the following commitment period.

Though not required by the Protocol, governments would be free to impose additional limits on emissions during the commitment period. For example, if a Party is allowed to emit 10,000 tons during the five-year commitment period that party might choose to add the restriction that no more than say 65 % of those allowances should be used by the end of the third year. This could either be a guideline or a standard applied domestically.

E. ELIGIBILITY FOR TRADING

Participation in Article 17 trading would be voluntary. Any Party that has an 'assigned amount', as set out in Annex B of the Kyoto Protocol, could elect to trade under Article 17. Countries that currently are not listed in Annex B can become eligible for Article 17 trading by negotiating an acceptable assigned amount.

Governments could either elect to allocate assigned amounts to sub-national entities (thereby facilitating private participation) or not. If they choose to allocate assigned amounts to private entities, a variety of possible allocation mechanisms could be used. The decision to allocate the assigned amounts to private parties would be the first step in allowing trades between private sources in addition to trades between Parties.

The freedom to allocate or not allocate assigned amounts to sub-national units would ensure that any individual government maintained its right to determine the domestic policies and measures that would be taken to meet its Kyoto obligations. For example, a government that wanted to use taxes or regulations for domestic emissions control could retain the sole right to trade. Alternatively, a government could allocate its assigned amounts to private entities to trade. In fact, any combination of domestic policies would be broadly consistent with Article 17 trading.

A final dimension that must be resolved involves whether the right to acquire allowances is reserved to eligible buyers. If so, the term "eligible buyers" must be defined. Possible choices include Annex B Parties and only Annex B Parties, all signatories, all Parties and private sources which have been allocated assigned amounts. An alternative, and we believe the

[13] Section 5.3 the Protocol requires that the GWP factors used in the conversion should be fixed for the first commitment period.

preferred alternative, is to allow anyone to purchase the allowances including private citizens and environmental groups, the approach taken in the US sulfur allowance program.

F. BANKING AND BORROWING

Banking allowances offers a greater degree of intertemporal flexibility, a flexibility that tends to reduce costs considerably (Kruse and Cronshaw, Forthcoming; Manne and Rutherford 1994; Rubin 1996). Banking of allowances involves allowing parties to carry allowances that are unused in one commitment period forward for use into the next commitment period. Borrowing involves using allowances assigned for one commitment period in an earlier commitment period.

Banking decisions arise in two different contexts: (1) "internal" banking within commitment periods and (2) "external" banking between commitment periods. The Protocol seems to place no restrictions on internal banking. In the absence of additional restrictions Parties seem free to allocate emissions within the commitment period any way they see fit.

The first type of external banking was built into Article 12.10 of the Kyoto Protocol. It specifies that certified emission reductions (CERs) obtained under the clean development mechanism (CDM) during the period 2000-2008 can be banked for later use in meeting Annex I country's commitments during the first commitment period 2008-2012. This banking clause provides the incentive for private firms in Annex I countries to invest in emissions reductions in developing countries prior to the beginning of the first commitment period.

The second type of external banking is similar to the banking element built in the US Acid Rain Program. Once an emissions trading scheme, either domestic or international, is established among Annex B countries, allowance holders are allowed to bank their unused allowances to offset future emissions or to sell them to others.

The third type of banking extends the second mechanism by including emissions reductions achieved within the jurisdiction of Annex I countries prior to the beginning of the first commitment period as well. In comparison with the first type of banking under the CDM, it also provides a similar incentive for private firms within Annex I countries to take early actions at home rather than shop around abroad. Currently, the type of banking has not been an option under the Kyoto provisions but warrants special attention.

Potential use of the option could be contingent on ratification of the Kyoto Protocol (Kopp et al. 1998). The banking option might only be authorized from the year in which the Protocol is ratified onwards. This would provide a strong incentive for Annex I countries to ratify the Protocol earlier than what otherwise would be the case.[14]

One option would be to allow the banking of Annex I country's own early reductions is that any credits one Annex I country awards its sub-national legal entities for pre-2008 reductions are drawn from the assigned amounts of the country in question. On the one hand, this option would give these "first-movers" a competitive advantage over those not undertaking early actions (Environmental Defense Fund 1998). On the other hand, since the credits awarded to early movers would be otherwise allocated to those entities not undertaking early

[14] If 'hot air' becomes a dominant issue, it would also be possible to deny the banking option to those countries that have accumulated excess emissions. This option would alleviate to some extent the concern about the "hot air" trading, because it would provide more incentive for legal entities in the advanced OECD countries to take abatement actions at home.

actions, with limited supply of early credits, the option amounts to government encourage of uneconomic rent-seeking (Fischer et al. 1998).

If an Annex I country starts with a very strict limit on GHG emissions, bottlenecks could be prevented by allowing the borrowing of a limited amount of future allowances provided that a premium is paid. By taking into account the turnover of capital stock, the prospect for low-carbon or carbon-free backstop technologies, and time discounting, borrowing would allow total abatement costs to be minimized while keeping to an overall emissions budget. Therefore, as with banking, borrowing is another way to increase flexibility and lower the cost of abating GHG emissions (Richels *et al*., 1996).

External borrowing is more controversial and is not addressed by the Protocol. In the accountability section we offer some possible options for integrating borrowing into an emission trading scheme while alleviating some of the concerns which have been expressed.

G. EXPANDING THE SET OF ANNEX B PARTIES AND ANNEX A GASES

Already under the Clean Development Mechanism a host country could finance projects on its own and sell credits earned. Art. 12 would not prevent this. Costa Rica has already pioneered this kind of trade by financing umbrella forestry and energy projects through a fuel tax and trying to sell certified tradeable offsets (CTOs).

As host countries have no targets they have an incentive to maximize credit sales. Here the baseline issue becomes crucial: it has to be avoided that there is a reward for developing countries if their policy promotes high emissions. This is due to a perverse effect of the additionality rule: Emission reduction measures are cheapest where there is a lack of a national sustainability policy (Michaelowa and Dutschke 1997). The CDM would have to be extremely cautious concerning baseline verification.

This problem could only be fully solved by setting an incentive for developing countries to adopt limitation targets voluntarily and participate in emissions trading and JI under Art. 17 and 6. In the medium and long term, emissions trading could be instrumental in establishing an international climate change policy that fully accommodates developing country economic growth, but requires that this growth be achieved in a carbon-efficient manner. Such an incentive could be to prohibit the trading of host country credits now but to allow them to bank credits against future targets. One could also envisage a quota for credit trades for each country and banking for additional credits created. Both approaches have drawbacks such as not considering different degrees of development or the differing likelihood of accepting a commitment.

Developing countries should be able to "opt in" in the allowance trading system by applying the concept of "growth baselines" (Center for Clean Air Policy 1998c). Countries opting in would have to make sure that their greenhouse gas emissions grew at a slower rate than their economic output in the near term and to accept the inevitability of an eventual cap on emissions. Developing country economic growth would thus not be constrained initially, but countries would commit to improving the "carbon efficiency" of this growth. The key benefit to developing countries of adopting growth baselines would be substantial capital inflows through emissions trading.

Other options could also serve to provide flexibility in the negotiations over including developing countries in the Annex B list of nations (Joshua 1998)

- Negotiations could also consider bubbles involving regional groupings such as ASEAN and MERCOSUR.

- Developing countries could be allowed to introduce "partial caps" which, for example, could be based on industrial sector limits, and coupled with joint implementation in the uncapped sectors, as a form of progressive restriction towards the imposition of a national cap involving all sectors. Countries operating industrial sector growth limits could continue to have access to the Clean Development Mechanism for investment and trading in CERs for uncovered sectors.

- Developing countries could be allowed to choose different base years for each greenhouse gas they propose to bring under a sectoral or national cap.

Allowance trading would result in greater total capital flows than the CDM, because transaction costs would be lower. To participate in trading, a country would simply need to develop an accurate emissions inventory and then compare actual emissions to the emissions budget. To the extent that actual emissions come in under the budget, the country could sell allowances. Issues such as additionality and the development of appropriate project emissions baselines, which may reduce the incentive to invest in CDM projects, would not be present in an allowance trading system.

Fears have been expressed that developing countries will seize the opportunity to negotiate unreasonably large assigned amounts, a phenomenon which has now been labelled the "tropical air" problem. Our review of the evidence suggests that this problem can be diminished by using uniformly applied specific criteria for defining assigned amounts for those seeking to join Annex B in the future rather than negotiating each situation from scratch on a case-by-case basis. This two-step procedure— negotiate fair and appropriate general criteria first then apply them to individual Parties— would seem to offer the opportunity to expand the set of Annex B nations without placing the goals of the convention in jeopardy.

The process for admitting new Annex B nations may also be quite important. Two avenues are available to establish such rules of procedure. One is based on voting to admit new entrants. So far any decisions made by the Conference of the Parties to the UNFCCC have been generally adopted by consensus. If admitting new entrants requires unanimous assent by all current Annex B countries eligible for emissions trading, this confers on any Party a *de facto* veto power that they could use to try to prevent the decline in allowance prices which might accompany any expansion of the sources of supply. A three-fourths majority vote of the current Annex B countries present and voting at the meeting could be adopted to prevent exploitation of market power.

The second avenue rests on automatic inclusion once a prospective country meets pre-determined criteria. In our view, the second avenue is superior to the first. Such criteria should include the conditions under which any new entrant could be incorporated into the emissions trading scheme. Once such criteria are set, they should remain stable in the short-run, although in the long run adjustments in the criteria might be the norm as greater information and experience is gained.

IV. DESIGNING THE ADMINISTRATIVE SYSTEM

A. GENERAL PRINCIPLES

The design and implementation of a trading system should be guided by the following general principles (OECD 1998a):

- environmental effectiveness. Satisfying this criterion requires successful evaluation, monitoring and verification.

- economic efficiency. This criterion demands minimization of transaction costs.

- equity. No interest groups should gain an unfair advantage.

- political acceptability. However desirable the rules may be in principle, if they can't be implemented by the COP process, they are of little practical use.

Table 1: Primary Responsibilities in an International Trading System

	Monitoring	Evaluation	Reporting	Verification
Companies creating ERUs	#	#	#	
CDM project developers	#	#	#	
Traders			#	
Consultants	#	#		
Private accreditors				#
Nongovernmental organizations	#	#	#	#
Governmental agencies	#		#	#
UNFCCC secretariat/clearinghouse	#	#	#	#

Guidelines should aim for consistency, technical soundness, verifiability, objectiveness, simplicity, relevance, transparency, and cost-effectiveness. They need to state qualification criteria for people to report, monitor, evaluate and verify GHG reductions.

It is important to provide as thorough an understanding as possible of the uncertainties involved when monitoring, evaluating, reporting and verifying. Inherent uncertainty in the scientific understanding of the basic processes leading to emissions and removals cannot be manipulated but will vary according to the different gases and types of emission and sequestration processes.

B. THE ROLE OF ADMINISTRATIVE STRUCTURES AND PROCEDURES

An effective tradable permit system presumes the existence of a supporting administrative structure. With such a supporting administrative structure in place a tradable permit program could facilitate the cost-effective achievement of global warming goals, could encourage the development of new greenhouse gas technologies, and could provide a basis for equitable sharing of the cost burden between the developed and less developed countries. Without the appropriate administrative structures and procedures a tradable allowances system could not only fail to achieve the objectives of the global warming convention, but it could make the problem worse. If entitlements were transferred without assuring that the appropriate compensating reductions were achieved, total emissions could rise, thereby violating one of the fundamental premises of the program.

Since the administrative procedures and structures to accomplish these functions did not exist before the protocol and were only partially addressed by the protocol itself, this task presents some considerable challenges. Put starkly, resolving global environmental problems will require some subordination of national power to the interests of the global community. For

nation states which have become comfortable with exercising their sovereignty relatively free of international restrictions, blending national interests with global interests is not going to be easy. The trick is to design a set of structures and procedures which can harmonize immediate and long term interests, but which also stand a reasonable chance of being accepted by the nations of the world.

C. THE NECESSARY COMPONENTS OF A FACILITATING INSTITUTIONAL STRUCTURE

An effective trading system relies upon two rather different sets of institutions and procedures: (1) a set of market institutions to promote cost-effectiveness and to provide incentives for the development of new ways of meeting climate change objectives and (2) a set of administrative institutions that assure that the pollution control objectives are met.

The market institutions would exist for the purpose of facilitating exchange and reducing the associated transactions costs. Trades could either be handled through a clearinghouse or an organized exchange. Contractual procedures would be used to apportion the risks (such as the risk of breach of contract). Furthermore it is not unreasonable to expect that private institutions could arise to fulfill many if not all of the market functions.

Since the market institutions are covered in a separate report, (Sandor et al. 1994), the administrative functions form the focus of this report. The functions of concern, as laid out in Article 17 of the Kyoto Protocol, include procedures for verification, reporting and accountability for emissions.

C.1. The Monitoring Function.

Monitoring serves two primary functions. First, it provides a basis for assessing compliance with the agreement. Assessing compliance is an important initial step in the process of assuring compliance. This monitoring function focuses on matching emissions with allowances. A second monitoring function focuses on the concentrations of greenhouse gases in the atmosphere and the consequences of those gases for climate change. Monitoring provides a basis for deciding whether stronger international actions would be necessary and adjusting the assigned amounts in future commitment periods accordingly.[15]

Since not all nations have Annex B commitments in the agreement, at least initially, even if the convention were completely successful in achieving the country-specific Annex B emission reduction, further increases are possible in the nations not covered by Annex B requirements. In order to track progress toward the global objectives specified by the Convention, it is important to keep track of emissions not only in the Annex B nations, but, to the extent possible, in the other nations as well. Establishing a monitoring process requires identifying a monitoring authority and specifying both its responsibilities and the responsibilities of those being monitored.

C.2. The Reporting Function

The ability to monitor the process presumes a flow of reliable, useful information to the monitoring authority. The information flows can be based on a self-reporting system, a system of direct or indirect inspections or some combination of these. Direct inspections, the approach taken in some of the disarmament agreements, would involve visits to the emission sources. Indirect inspections can involve the collection of related data (such as energy

[15] As the experience with the Montreal Protocol indicates initial international actions may not be strong enough.

consumption by fuel type) which can provide indirect evidence on emissions. Self-reporting involves the submission of reports which provide details on specific data requested by the monitoring authority.

C.3. The Verification Function

The reporting function generates a wealth of raw information. The verification function attempts to verify compliance with the agreement and to recognize uncertainties associated with measuring emission reductions as well as to design institutional ways of handling those uncertainties in such a way as to assure that the objectives of the agreement are fulfilled.

Verification is necessary to assure the global community at large that the entitlement transfers are facilitating, not impeding, the attainment of global warming goals. As described below verification procedures should differ considerably depending upon the type of allowance being transferred.

C.4. The Certification Function

When nations have assigned amount baselines (as all Annex B nations now do), sale of an allowance automatically reduces the number of allowances remaining to cover emissions during the commitment period. This would be true both for assigned allowances and for Article 6 created emissions reduction credits which are used to fulfill the Article 3 obligation. For this category of trade as long as every trade results in equal and offsetting changes in the two Parties' allowances, certification is not required because the need to balance emissions with allowances during the commitment period provides a check to assure that the trade will not increase emissions. No such assurance is automatically provided for nations that have no Annex B baseline, but that assurance can be obtained from the certification process. Specifically one of the purposes of certification is to assure that trading does not increase emissions and that purchasers of these credits have some assurance as to their validity.

V. MONITORING

It is widely acknowledged that emissions trading should only take place in an environment of highly credible monitoring of both emissions and trading activity. Annex B countries are required to have a reasonable estimate of aggregate national emissions of the six greenhouse gases mentioned in Annex B. However, the quality of monitoring needed may be greater for emissions trading than it is generally under the protocol, raising important questions regarding the countries and sources which are to be included in the trading system. In this way, the needs for accurate monitoring to underpin a trading system could improve the overall quality of monitoring and reporting requirements.

This section first reviews the basic issues involved in monitoring GHGs, as the accuracy of monitoring is an important consideration in determining whether and how each source should or could be included in an emission trading system. Fortunately, carbon and most sources of other GHGs may be effectively monitored, but there are exceptions such as N2O and agricultural and land-based sources of methane. Fundamental choices need to be made. One option could be to establish a trading system only for gases and sources that can be accurately monitored. Alternatively, rules are discussed below that could allow other sources to be included.

Secondly, we review the international system for monitoring both emissions and allowance trading that is required to give effect to Article 17 trading. The emissions monitoring system would be based upon the reports required by Article 3(4), and would attempt to cover insofar

as possible all signatories, not merely those with Annex B obligations. The allowance tracking system would be included the assigned amounts (AAs) designated by Annex B (appropriately adjusted to reflect the "net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change an forestry activities, as authorized by Article 3(3), and any transactions in ERUs and CERs.

A. EMISSIONS MONITORING.

This part will review the adequacy of emissions monitoring techniques for various gases and sources, and the implications of this in designing a trading system.

A.1. Accuracy of Monitoring

There is an extensive literature reviewing what is known about the different sources and sinks of greenhouse gases, and, studies have explored the extent to which monitorability of these is compatible with the administrative needs of a system of tradable entitlements (Sussman 1998; ELI 1997, Victor 1990).

Emissions can be monitored either directly using monitoring devices or indirectly using predictive methods. For **carbon** and possibly some other gases, we can expect that indirect emissions monitoring methods can be used. This involves monitoring related activities (such as the amount of fuel consumed) and using estimated relationships between the activity and emissions to estimate emissions. Sometimes this is as simple as an emission factor multiplied by the level of the activity while in other cases this may involve applying a function which depends on factors other than the level of the emission generating activity (the age of the plant for example).

If predictive methods are inaccurate, direct emission monitoring must be used which involves actual measurement of emissions as they are injected into the air. This can be done continuously, as it is in the U. S. sulfur allowance program, or by means of a periodic sampling technique. Continuous emissions monitoring is the most accurate, but it is also the most costly, and is not likely to become the core of any greenhouse gas monitoring program. Sampling approaches can be reasonably accurate in part because repeated samples can reveal patterns of emission over time as well as differences among source that may be due to the degree of maintenance, for example. The accuracy of the samples will depend on their frequency and on the "representativeness" of the samples. Infrequent samples drawn during announced visits are less likely to be representative than more frequent samples drawn during unannounced visits.

Finally, direct measurement of production may be an accurate monitoring method for manufactured gases such as HFCs, PFCs and SF6 if producers of these man-made gases are made responsible for future emissions.

In the case of **carbon dioxide emissions due to combustion of fossil fuels**, monitoring costs should be low because the proxy--quantities of fossil fuel disaggregated by type--is already monitored, and the emission factors are well understood. Because the vast majority of fossil fuels are traded commercially and energy is an issue of high political and economic salience, most countries have in place elaborate systems for monitoring flows of energy through the economy. Data systems are especially well developed--with detail to the level of individual refineries or even vendors to final consumers--in settings where sale of fuels is taxed, and thus existing institutions that administer fuel taxes could be used to administer an entitlements system. At the international level, the International Energy Agency (IEA, a quasi-independent arm of OECD) has a regularized system of assessing and harmonizing those

national data.[16] These data systems are disaggregated by fuel type, and the carbon emission factors for each of the fuels are well known.[17]

Including other GHGs is more difficult. Some analysts believe that sources and gases other than fossil fuel $_{CO2}$ are not sufficiently monitorable for inclusion in an entitlements system at present (Victor 1992). However, point sources of methane such as from coal mines and flared gas can be readily monitored, as can the actual production of gases such as HFCs, PFCs and SF6. Emissions from other sources of methane such as landfills can be monitored, but require estimations based on assumptions of overall humidity and temperature, which can vary throughout the landfill. Agricultural sources of methane, such as ruminant animals and animal wastes, sources of nitrous oxide and carbon sinks, are also difficult to monitor accurately.

Further, as recognized by Article 5.3 of the Kyoto Protocol determining compliance and allowing trading in a multi-gas system that allows trading between gases would require an index that converts different sources (and sinks) into common greenhouse units. Although such an index exists--the Global Warming Potential (GWP)--the key parameters are poorly understood (Swart 1992; Harvey 1993) And, any point index must integrate future effects into a single number, but a common index would require common assumptions about inter-temporal comparisons that would be misleading (Eckaus 1990).

A.2 Mechanisms for Coping with Imperfect Emissions Monitoring

One option would be to limit trading to GHG sources that may be readily and accurately monitored. This could include carbon emissions, certain methane sources, and all the manufactured gases if producers are made responsible for the gases' emissions. It could be argued that emission trading should be limited to these gases and sources under wither a private or government trading systems, as allowing trading of poorly monitorable sources or sinks creates too severe environmental risks.

For systems which private sources to trade, limiting international trading to certain gases and sources is both feasible and desirable. Only private sources with highly accurate monitoring systems should trade, which may exclude certain methane and nitrous oxide sources.

The situation is more complex for trading between Annex B countries, as their assigned amounts (AAs) include an undifferentiated set of sources and sinks of all six gases. However, under Article 17 more stringent rules could be developed for inter-country trading than for the country's emissions reduction obligation under Article 3. Inter-country trading might be allowed only for that amount of AAs which equal a country' emission of readily monitored gases, and compliance obligations for trading could also be based on the measured emissions of those gases. Doing so would greatly reduce the environmental risks in trading poorly monitorable gases.

Another possible strategy for coping with emissions uncertainty involve adjusting the emissions inventories or adjusting the trading ratios in the emissions trading program to

[16] This capacity can be used also to assess the national statistical systems for energy in non-OECD countries, and in some cases it has been.

[17] Those factors may be adjusted for local fuel types to provide more accurate estimates. We have not addressed whether those factors should be adjusted for other emissions, notably SO_2, which offsets some of the forcing due to CO_2. The exact amount of the offset is debated and depends on many factors, including issues of time horizons discussed later in this section.

reflect the uncertainty in monitoring.[18] The presence of uncertainty implies that a distribution of possible estimates exists. The range of that distribution will reflect the degree of uncertainty. This variation is an additional source of information that could be used in the monitoring process if the Conference of Parties deemed it necessary.

One approach to do so would be to impute presumptive values for emissions factors, which would considerably reduce the cost of developing more sophisticated (and more accurate) measures, or as a stop gap measure until more accurate data can be obtained. The values chosen for these imputed factors can be chosen to be conservative, thereby assuring environmental quality if the imputed values are chosen, and providing an incentive for development of more accurate monitoring techniques. [19]

B. ALLOWANCE MONITORING

Countries with Annex B obligations face two monitoring burdens: the need to keep track of actual emissions and the need to keep track of emission trading transactions to assure that the level of authorized emissions is accurate. Emissions must be monitored to ensure that total emissions do not exceed the sum of the assigned responsibility plus net acquired Article 17 or Article 12 allowances minus net Article 17 allowances transferred to other Annex I countries. Second, emissions of sources creating Article 12 credits (CERs) must be monitored to ensure that the reductions used to create the CERs are real. Taken together, these three monitoring tasks make it possible to balance the books.

For Annex B nations monitored emissions must be matched to allowances to verify compliance. The allowance monitoring system should be sufficiently harmonized with the emissions monitoring system that matches between the two are easily obtained. In practice this means a computerized data base with specialized software designed to perform such functions as aggregating the different gases using the Global Warming Potentials, aggregating across sectors and even aggregating across Parties. In addition to assure adequate transparency these data should be routinely be made available to the public, presumably on the internet on a "Read Only" basis.

C. THE INTERNATIONAL MONITORING AUTHORITY

Although much of the burden of monitoring will be born by the Parties using a self-reporting system, an international authority is necessary to assure the use of standardized monitoring procedures and to collect, aggregate, harmonize and interpret the reports from the parties. [20] The Protocol assigns a portion of this responsibility to the Subsidiary Body for Scientific and Technological Advice, but the responsibilities of a true monitoring authority would be larger than assigned by the current Protocol.

---

[18] Since the net change in uncertainty depends both on the uncertainty associated with the reductions achieved by the seller and the increases in emissions authorized for the buyer, both aspects should figure into the process for adjusting the trading ratio. Yet as a practical matter it may not be possible to identify the specific emissions associated with the trade for either the buyer or the seller. Therefore the adjustment would have to reflect "average" uncertainty for the two government Parties.

[19] Notice that conservatism means different things depending on whether these methods are used to define the emissions inventory or to define the reductions that qualify for CERs or ERCs. In the case of inventories a value in the higher range would be conservative while in quantifying emission reductions a value in the lower range would be conservative.

[20] For an elaboration of the possible models that could be used for organizing and governing this organization see Richard B. Stewart, et al. (1996).

In addition to providing a quality control check on the procedures this authority must oversee the development of both the allowance and emissions tracking systems. It must also supervise the monitoring effort and report to the Conference of Parties periodically. These reports will serve not only to inform the international community of progress on reaching the goals of the convention, but also in providing information which would be useful in guiding the evolution of the system over time.

Several options for funding this authority exist. One option, which is from both a fairness and efficiency point of view, would be to fund it from per ton fees on assigned amounts. Other possibilities include fees on international allowance trades or lump sum fees imposed on Annex B Parties or signatories.

The international authority is expected to perform the following key functions:

Initial approval of a country's monitoring system that allows it to participate in emissions trading. Arguably, only countries with an excellent system of monitoring domestic emissions should be allowed to participate in an international trading system. The international agency would need to initially determine whether a country has, at the domestic level, an adequate system of self-reporting from emissions sources, and the means and the program to adequately monitor or verify the self-reported data.

Receive and review the reports generated by countries that provide credible data on monitoring results and methods on an ongoing basis. Once a country is accepted into the international trading system, the international agency wold need the capacity to receive and review the national reports, including those submitted under Article 3(13).

*Inspections to assure compliance and proper functioning. E*xisting institutions, especially at the domestic level, along with familiar processes of extensive self-reporting, could form the basis for a viable monitoring system. But periodic veracity checks will be needed to assure the integrity of such a decentralized monitoring system. Such checks will both be needed within nations, to ensure that self-reports by individual sources are accurate, as well as at the international level to ensure the accuracy of national reports. In theory, multiple levels of self-reporting along with veracity checks should also allow cross-checking, but in practice this is frequently difficult unless all data are complete, accurate and collected in a harmonized format.

D. PRECEDENTS

Any monitoring system must necessarily fit within the context of existing international and domestic institutions. Thus, precedents are important because they form expectations on the types of systems that are economically and politically feasible.

D.1 International Precedents

Monitoring has not been a salient aspect of international environmental agreements and the extent to which previous international environmental agreements are sufficiently monitored varies widely.[21] Despite a long history of international monitoring systems based on self-reporting of data, secretariats typically do not do much with the data except make it available to the Parties and others. Secretariats are chronically overworked and typically do not have the political mandate to do anything too controversial, such as explicitly assess

[21]For a review of the functions, concepts and evidence related to each of these types of monitoring see Ausubel and Victor (1992).

levels of compliance on the basis of self-reported data or even assess the quality of reports. Although self-reporting systems are regularly established under international environmental agreements, the extent to which the parties take them seriously by providing timely and accurate reports is mixed and generally negative (General Accounting Office 1992). However, some evidence suggests that where the reporting systems are demonstrably useful, the parties are much more cooperative in providing the needed information. [22]

The arms control experience suggests a long-term trend towards increased acceptability of intrusive monitoring techniques that require physical presence in the territory or airspace of a country. Reduction of tension between the former superpowers has increased the sharing of data, and recent agreements such as those covering Intermediate-range Nuclear Forces (INF) and Conventional Forces in Europe (CFE) make much greater use of self-reporting along with periodic veracity checks, including intrusive inspections. However, most intrusive inspections have occurred at government facilities and thus issues of whether the international inspection schemes can examine private facilities have not been salient.

There is a long history of intrusive inspections under the Nuclear non-Proliferation Treaty (NPT) managed by the International Atomic Energy Agency (IAEA). This treaty is essentially based on self-reporting and trust, with periodic veracity checks by IAEA inspectors. The IAEA safeguards example reveals a tradeoff between the cost of and political opposition to fully intrusive inspections and their ability to completely check the veracity of self-reports. In theory, an optimal inspection strategy for IAEA would condition veracity checks on past behavior, with fewer checks on countries that consistently report accurate data.[23]

In the area of international economic agreements, self-reporting also is the norm. Governments maintain domestic systems of national accounts and other economic indicators in order to manage the economy, and self-reporting at the international level is based on data from these systems. Because it would be expensive and difficult to keep separate accounting systems, strategic mis-reporting of data by governments is probably rare, but the quality of data are dependent upon the quality of the underlying statistical systems. In the cases where good statistical data are needed, which will be true especially at the culmination stage of an entitlements system, inclusion of countries with poor statistical systems may require agreements on improving data and perhaps also financial assistance for that task. [24]

In sum, self-reporting is by far the most common mode of gathering information, and this experience is echoed in other areas. There is limited experience with intrusive inspections,

---

[22] Notably, see the study by Mitchell, (1992). Using the example of the self-reporting under MARPOL (the international oil pollution agreement), Mitchell shows that self-reporting was incomplete-- even parties (e.g. industrialized countries) that had the information simply did not bother to report it. But, when the European parties organized into a sub-group to track rogue tankers, they were able to set up a highly effective computerized data exchange system, at very low cost. The system worked because the parties each saw the benefit from their participation in terms of higher prosecution of illegal tankers, and failure to participate in the system resulted in exclusion from those benefits.

[23] This strategy of targeting a higher level of scrutiny on previous offenders can also produce significant deterrent effects even when the imposition of appropriate penalties is difficult. For an analysis of this approach to enforcement see Clifford S. Russell, et. al., (1986) and Harrington (1988) .

[24] An alternative to improving data (and enforcement) is to discount current data by an amount that reflects the uncertainty. If the errors are randomly distributed the discount rate might be zero. Some have argued that the discount rate should be set so that any errors do not harm the environment--that is, set the discount rate so that bias favors over-control of emissions. But, this would be economically inefficient and probably would inhibit trading, but it might provide an incentive to improve the statistical system (and enforcement).

and it is clear that regular systems of intrusive inspections, especially if they include private sites, will require prior and explicit international agreements.

D.2 Domestic Precedents

Much has been made of the differences between international and domestic settings, with the presumption that the international system is anarchic while the domestic is dominated by an all-powerful state. However, the authority under the Protocol to craft specific rules for countries if they wish to gain the benefits of trading allows considerably greater opportunity to impose adequate conditions. Also, the reality is that the extremes are not so pronounced. The international system is marked by substantial cooperation, sharing of information and some systems of inspection and enforcement--that is, nascent features of governance. At the domestic level, the state is not a Leviathan, and its ability to monitor, inspect and enforce is not unlimited. Limits on state action depend on what is politically acceptable, the state's ability to raise and leverage resources, and norms against intervention in private affairs.

Regarding inspection to check the veracity of self-reports, there is rich experience in many diverse areas from income taxation to labor standards. In the environment, experience in the United States suggests a wide range of effectiveness. At one extreme is inspection of compliance with workplace health and safety regulations, which is very infrequent, on average one inspection per century per firm; at the other extreme is inspection of behavior related to water pollution regulations, which is frequent, on average once per year per firm. Compliance with and effectiveness of these different laws varies with the frequency of inspection, suggesting support for the basic hypothesis that inspection frequency matters (Viscusi 1986: Magat and Viscusi 1990). The main conclusion from research on monitoring in the U.S. is that inspections of polluters are too infrequent and cursory (Russell, et al. 1986b, General Accounting Office 1990a; General Accounting Office 1989).

E. ROLES FOR DIFFERENT ACTORS

E.1. The Private Sector

The fundamental source of monitored information is private sources. They are the major economic actors responsible for most of the emissions, and they intrinsically have the most information about their behavior. Thus systems that rely on self-reporting will be much less costly--both in terms of social cost and in terms of on-budget governmental cost (for which tax revenue must be raised)--than those that establish independent full-blown monitoring systems. In the case of carbon emissions, carbon users such as utilities, refiners or airlines would self-report emissions. Even in the early stages of market development--when trading is limited--the system is likely to depend fundamentally on self-reporting by emitters because government self-reported data will be based on private self-reporting at the source level.

The potential exists for NGOs to play a monitoring role as well. Industry associations might facilitate exchange of data and help improve data quality, as is true in the international agreement to regulate whaling and in many fisheries agreements. New or existing associations may be willing to fulfill this function since establishing one harmonized reporting system is the duplication of effort involved when many firms develop independent reporting systems. It may prove helpful for governments to encourage the formation of such associations and to encourage the full utilization of existing associations.

ENGOs (Environmental Nongovernmental Organizations) can promote more effective agreements by monitoring the suitability of international agreements to address the problems

at hand and setting political agendas. They may also play a role in the monitoring of individual sources, but here issues of ENGO capacity and access to publicly available information are important. Perhaps those ENGOs that would gather information would do so as part of an enforcement action--a way to pressure emitters into compliance (or over-compliance) through public shame or legal action.

E.2 Scientific and Technology Research Organizations

Research on emission factors and inventories is already underway. This must continue, and with greater attention to the economic aspects, notably marginal economic costs of alternative monitoring instruments and systems. Scientific and technology research programs can discover accounting and surveillance methods that help check the integrity and effectiveness of international agreements and monitoring systems.[25] This can assist trading programs, especially for gases such as methane and nitrous oxide where more accurate emissions monitoring techniques are needed. Conversely, as shown in the US Acid Rain Program, the opportunity to trade can also create an incentive for more accurate emissions estimates within the private sector.

E.3. Public Agencies: International and Domestic

The conventional assumption is that monitoring is a public good and thus will be under-supplied, and the conventional prescription is that public agencies should perform this function. Indeed, while firms may have the basic information needed for a monitoring system, public law and administrative actions must ensure that information is reported. At a minimum, public agencies must provide the veracity checks needed to ensure that self-reported information is accurate. Furthermore national governments frequently have sufficient investigative power (such as conducting on-site audits) and sufficient sanctioning power (such as the use of criminal sanctions against those who falsify reports) to provide a degree of quality control. Therefore not all the monitoring capacity need be located at the international level--where effective institutions have proved difficult to create and fund.

Rather, international institutions need only approve and verify that domestic monitoring is functioning properly.[26] As with the self-reporting system itself, veracity checks will telescope from the local to the international. One element of this quality control involves the need to standardize, in so far as possible, the procedures for producing the emission inventories. Allowing complete discretion in how the estimates are generated provides an invitation for parties to interpret the data in the most favorable way possible. Not only can this produce estimates which may not in some larger sense accurate reflect the total picture, but it raises basic fairness issues which if not dealt with could undermine commitment to

---

[25] An example is the inverse method where regional emissions can be inferred from meteorological data, atmospheric concentrations and known emissions from other regions. This could be helpful for monitoring and verification, but it current rests on incomplete knowledge of the relevant parameters as well as incomplete models. For an initial demonstration case using CFC-11 see D. Hartley and R. Prinn, 1993. "Feasibility of Determining Surface Emissions of Trace Gases Using an Inverse Method in a Three-Dimension Chemical Transport Model," Journal of Geophysical Research **98**, 5183-5197. CFC's are the easiest case amongst the major greenhouse gases because the sources of CFC's are reasonably well known (i.e. the inverse method is relatively well constrained, at least in comparison with other greenhouse gases) and they are not chemically reactive in the lower atmosphere (i.e. their observed concentration depends primarily on air currents, not also chemistry, and thus the model used for comparing observed and calculated concentrations and emissions is much simpler than would be the case if both chemistry and air flow had to be simultaneously modeled.

[26] What is 'proper' is in part a political decision about the tolerance for noncompliance, uncertainty and other deviations from a perfect market. Presumably choices here will be based on experience as the market unfolds as well as analysis. Continued monitoring of such tolerances will be essential if the value of the entitlements--and thus the integrity of the market--is to be preserved.

fulfilling the imposed obligations. Standardization simultaneously produces more consistent data and it can produce a greater sense of fairness by assuring that every Party is treated the same.

F. MONITORING ARTICLE 12 EMISSIONS

Emission reductions used to generate Article 12 credits require considerably more scrutiny because they could be used to reduce emission obligations in Annex B nations. This monitoring is typically on a project or sector basis and should be specified and institutionalized as part of the process of certifying Article 12 reductions. Adequate monitoring of these emissions should be a condition for certification, For countries that have created CERs, it will be necessary to monitor emissions from the creating sources on an ongoing basis to assure that the reductions on which the credits are based represent real, not mere paper, reductions.

The task is not trivial because self-reported information under the Convention is likely to be at the level of the nation whereas certification takes place at the level of the individual source (or related class of sources, such as the electric grid). In recognition of the greater difficulties posed by this particular form of monitoring a certification function is proposed below. This function would assure that only certified CERs would become part of the allowance system, but once certified, these allowances would be treated as homogenous in quality to all other allowances. The certification process provides one concrete means of attempting to assure a smoothly running trading system, while simultaneously assuring that the trading system furthers the goals of the agreement.

VI. CERTIFICATION, VERIFICATION AND NOTIFICATION

A. THE ROLE OF CERTIFICATION AND VERIFICATION

Allowances to emit greenhouse gases in the systems being discussed in this report are of two different types: (1) assigned allowances (AAs) and (2) created emission reduction credits (ERUs and CERs). Created entitlements are more troublesome when they are not associated with a specific trading baseline. It is this difference that gives rise to the need for a certification process. Certification provide an *ex ante* judgment on the acceptability of the underlying emissions reduction.

When nations have baselines (as all Annex B nations now do), sale of an allowance automatically reduces the number of allowances remaining to cover emissions during the commitment period. This would be true both for assigned allowances and for created emissions reduction credits which are used to fulfill the Article 3 obligation. For this category of trade as long as every trade results in equal and offsetting changes in the two Parties' allowances, certification is not required because the need to balance emissions with allowances during the commitment period provides a check to assure that the trade will not increase emissions.

No such assurance is automatically provided for nations that have no Annex B baseline, but that assurance can be obtained from the certification and verification process. Specifically one of the purposes of this process is to assure that trading does not increase emissions.

Certification would be the first step in creating a tradable credit. The certification process would occur whenever a party not subject to an asigned amount wished to create a tradable credit. Its purpose would be to assure that a specific quantified reduction from a baseline could be expected

from the credit creating action. Verification, the second step, would provides assurance that the reductions actually occurred. This step would occur after the activity commenced operation to verify that the reduction expected from certification had, in fact, materialized. Trading would normally be allowed to occur following certification, but use would delayed until the reductions were verified.

Once they have been certified and verified, these credits could be used by Annex B nations for use in meeting their obligations under Article 3. Since non-Annex B nations have no internationally specified targets, trading among these nations would presumably be designed to satisfy only domestic goals and would therefore not be subject to the certification process.

Any nation that joins Annex B by negotiating an acceptable assigned amount eliminates the need for certification in that country.

B. THE CERTIFICATION/VERIFICATION AUTHORITY

The ultimate authority for certification/verification would be the Conference of the Parties (COP). While the Conference of the Parties would be well-suited for defining the parameters of the certification process and exercising general oversight over that process, it would be ill-suited for dealing with the day-to-day operations of certification. The operational authority for certification and verification can, and should, be delegated to subordinate organizations specifically designed to fulfill that function.

Although responsibility for the certification and verification of CERs would be vested in the subsidiary under stipulated circumstances the subsidiary body would have the power to further delegate some authority to specific governmental units or private organizations, providing certain preconditions had been met. These preconditions would include, *inter alia*: (1) an identified organization willing and able to assume the responsibility for certification and/or verification, (2) the existence of sufficient enabling legislation to assure adequate powers to carry out its mission, as well as adequate staff and resources, and (3) acceptance of, and willingness to apply, the standard certification and verification criteria.

Certification and/or verification workshops may be needed to ensure that the activities are being conducted in a responsible and credible manner. Training should be sector specific: e.g., a certified evaluator in forestry. The entities responsible for certification should be identified in the guidelines (Vine and Sathaye 1997).

C. CERTIFYING CREATED ENTITLEMENTS

Because they are not already part of national compliance plans, CERs must, at least initially, be certified on a case-by-case basis. The basic requirement is “additionality”. In other words the traded reductions must be surplus to what would have been done otherwise. Deciding whether created entitlements are "surplus" requires the existence of a baseline against which the reductions can be measured. When emissions are reduced below this baseline, the amount of the reduction that is “excess” can be certified as surplus. In this case the baseline has to be on the project level rather than at the national level as it is for the Annex B nations.

The threshold condition for certifying credits should be proof that the underlying “surplus” reductions are monitorable and enforceable. Reductions involving highly uncertain or unmonitorable emissions would not be candidates for certification.

One conscious aspect of the initial certification processes should be the development of general criteria, in so far as possible, that can be used to define additionality in place of a completely subjective case-by-case determination.

D. BURDEN OF PROOF

Two burden of proof issues arise during the certification process: (1) who bears the burden of proving that the certification criteria have been satisfied? and (2) how heavy a burden should they have to bear?

The most complete information on fulfillment of these criteria will naturally come from those creating the credits. However, should some nonfulfillment of these criteria become evident as the process continues, the Conference of the Parties would not have sufficient authority with nonsignatories to correct the situation. For this reason those CERs from nonsignatories would bear the responsibility for assuring the continued fulfillment of the certification criteria. Subsequent violations of the certification criteria would avoid the certification of affected CERs; they could no longer be used by the acquiring nation to justify carbon emissions during the commitment period. The risk of loosing that credit would underpin the certification responsibility of those acquiring CERs from nonparticipating nations.[27] Upon the loss of certification the recipient would have to make up for the lost entitlements by undertaking compensating reductions within its own borders or securing additional offsets from other nations.

E. ADDITIONALITY-THE BASELINE ISSUE

The different actors in a CDM project must have the incentive to publish credible estimations of emission reductions before a project starts and receive credits only to the extent the project really reduces emissions.

Investors and hosts of CDM projects - companies as well as countries - have the same interests. They want to get a maximum number of CERs through the project. The gain for the investor depends on the ratio of total project costs and CERs. The host will only find an investor if the project leads to a gain for the investor. Therefore he is likely to overstate the possible emission reduction. As the gain depends on the credited emission reduction, there also exists an incentive to overreport emission reduction during the project. This also enhances the possibility to get investors for a future project. It is obvious that cheating will be very widespread if there is no strong monitoring and verification of the projects.

Even if projects are very well monitored, it is still possible that the real emission reduction lies below the reduction credited. The amount of emission reduction depends on the emission that would have occurred without the project. The construction of such a hypothetical state is known as the “baseline” of the project.

Overstating of emission reduction would become rather difficult if an internationally agreed methodology existed to calculate where the emission levels of a country would be without a JI project. A single standardised methodology for designing forecasting models and amassing data would be required and it should be drawn up by the scientific and technological advisory subcommittee of the Framework Convention on Climate Change. The question is now how

[27] Private credit rating systems could also play a role here. When entitlements from a particular source become known as having a dubious underpinning of emission reductions or carbon absorptions, these entitlements would receive a lower rating, resulting in lower prices. This partly internalizes the costs of lax certification and reduced the incentives to engage in it.

this seemingly simple problem can be solved. The discussion below shows that there are no easy answers. A standard methodology is a long way away.

It seems very appealing to calculate a baseline for a whole country and then aggregate the effects of the different CDM projects. Reliable quantified measurements of actual emissions are an important prerequisite for establishing such a baseline. A number of very different approaches are currently used to this end, producing highly divergent results (Michaelowa 1995, pp 63f).

Several philosophical approaches for defining the created entitlements baseline are available based either on rules or discretion. Three possible rules include: (1) the "what would have happened otherwise" rule, (2) the marginal external cost rule and (3) the international benchmark rule. We shall consider each of these in turn.

The "what would have happened otherwise" rule allows deviations from expected outcomes to be counted as additional. For example, the carbon sequestering capability of a forest that is saved from being cut down or the reductions in carbon emissions from building a new energy efficient factory to replace a less energy efficient one might both qualify as credits under this rule.

The pitfall in using this rule is that potential credit creators for their own advantage can manipulate the resulting baseline. Since preventing forest destruction could create surplus credits, threatening the destruction of a forest becomes a means of creating an advantageous baseline. Under this rule actions which create more carbon dioxide could become individually rational in the short run as means of creating a favorable baseline. Naturally this type of strategic behavior undermines the achievement of the objectives of the climate convention .

Not all situations, of course, raise this concern. When what would have happened otherwise is clear from historical experience and no evidence of strategic manipulation is apparent, this particular rule could well be applicable. Even this circumstance is suspect, however, if for economic or other historical behavior is no longer rational. Suppose, for example, global energy prices increase. Historical energy-intensive production methods may no longer be economically rational. Investments in production changes, which are undertaken by investors undertaken for purely economic reasons, may have the side effect of diminishing greenhouse gases. It is not clear these gases reductions should be declared “surplus” even if they do represent a departure from historical patterns of use.

A major obstacle to defining a country-related baseline is that the emission levels have to be forecast for the entire lifetime of the project. In case of sequestration projects the lifetime can be up to a century. Forecasting emission levels for such a long period will amount to pure guesswork. The differences between the different ipcc scenarios, for example, reach an order of magnitude. But even for short-term projects that last for five to ten years, calculating an accurate baseline seems impossible. The difficulty of business cycle forecasting is well known. Take for example the development in Eastern Europe forecast in 1988.

E.1. Treatment of “No-Regrets” Projects

Many emission reduction opportunities are profitable either for a company or for a country as a whole. The latter includes externalities such as the reduction of other pollutants. Now the question arises whether these so called micro- or macroeconomic “no-regret”-projects are included in the baseline. So far, the question of “no-regret”-opportunities has led to heated debates in the economist community. While some say that there can be no “no-regret”-projects as such opportunities would have been grasped immediately, others estimate that 10-

30% of today´s emissions could be reduced via “no-regret” projects. For the former view see Sutherland (1996) and for the latter IPCC (1996).

These differences come from the fact that despite of the theoretical profitability of many options there are regulatory and juridical obstacles, lack of information and skilled personnel as well as organizational rigidities. This applies particularly to countries in transition and developing countries. Often an investor cannot appropriate a gain as it is an externality accruing to others. Therefore, it seems that pure microeconomic “no-regret”-opportunities are rather scarce whereas macroeconomic “no-regret” opportunities abound.

So far, emission reduction projects have not been funded by countries even if they are a clear macroeconomic “no-regret”. A good example is the ILUMEX project in Mexico that would lead to a macroeconomic gain of 0.05 US-$/t $_{CO2}$ by distributing subsidized compact fluorescent lamps;.the gains accrue to the participating households. Furthermore, the project accelerates the market development of the lamps. From a microeconomic perspective of the Mexican utility the project has net costs of 30 US-$/t $_{CO2}$ (Anderson 1995). Similar examples would also apply for the industrial countries. The abolition of coal subsidies in Germany would surely be a macroeconomic “no-regret” project of considerable size (Michaelowa 1995, p. 33). So far, the “no-regret”-issue has been markedly neglected in the debate on CDM and JI. It is mainly referred to in very general terms. While some authors say that all “no-regret”-projects have to be included in the baseline and therefore excluded as JI others would accept all of them. For the former view see van der Burg (1994) and for the latter Bedi (1994). A possible criterion could be whether a project is a microeconomic “no-regret”-project. If those projects would be excluded from JI an investor would have an incentive to artificially raise costs to demonstrate that his project has positive net costs. Therefore, even that distinction is fraught with peril..

E.2. Political Distortions of Baselines

The problems in establishing country-related baseline scenarios have also been felt in the business-as-usual projections in the national reports of the signatories of the framework convention on climate change. They are necessary for determining reduction targets within the framework of international negotiations. Substantial evidence can be found that countries tend to overstate business-as-usual emissions, which can be used to support a negotiating position that offers high reduction from the spurious baseline (Jochem et al. 1994). If realistic baseline scenarios cannot be established, then not only CDM crediting, but any form of controlled greenhouse gas reduction policy becomes impossible. The calculation of country-related baseline scenarios and aggregate reductions resulting from CDM projects is therefore very uncertain.

E.3. Project-Related Baselines

Taking into account the uncertainties of country-related baselines, project-specific baseline scenarios have been proposed as an alternative. In the case of a sequestration project, relevant sources and sinks of greenhouse gases must be identified prior to estimating their quantitative impact. Moreover, a quantification of past emissions is necessary. The calculation of the business-as-usual scenario has to take into account likely changes in relevant regulation and laws, the trend in autonomous efficiency improvements and changes of other basic variables such as development of markets for products of the project.

It is now either possible to define a “median” baseline or a set of baselines with different assumptions which are weighted according to their probability. If a power station project does not replace existing plant but creates additional capacity, the baseline scenario depends, for

example, on the fuel that might be used in an alternative solution. The alternative to a hydroelectric power station can be a coal-fired power station, for instance, burning either hard coal or lignite and producing very different emissions. For practical reasons, the host country's average fuel mix should be chosen when calculating the baseline scenario in such cases. This problem does not arise if the plant which is to be replaced already exists.

However, project-specific baseline scenarios do not take into account indirect effects which can arise, for example, when the project uses goods whose production causes greenhouse gas emissions. Emissions can also be influenced by price effects. For example, if carbon-rich fuels are largely substituted by low-carbon fuels, the price of the latter increases while the price of carbon-rich fuels falls. This price effect would provide an incentive for greater use of carbon-rich fuels and lead to an increase in emissions. Demand-side energy savings would also cause prices to fall.

Another negative indirect effect would arise from the alleviation of energy supply shortages. If one assumes rising incomes in these countries, these shortages would be alleviated in any case without any special incentives for emission reduction. It cannot be ruled out, though, that industrial countries could try to push strongly for extension of electricity supply in developing countries to enhance export markets for power supply technology. In this case, even the supply of state-of-the-art efficient technology would lead to additional emissions compared to a business-as-usual path. Nevertheless, the emissions from additional electricity use would certainly be at least partially offset by reduction of emissions from unsustainable biomass harvesting. Therefore, the indirect effect of CDM projects would be to raise emissions in the short term, but to lower them in the long term. It is likely that the latter effect would be greater. However, these indirect effects can only partially cancel out the emission reduction achieved by a CDM project.

The effects described arise in any sort of climate protection projects and not just in the case of CDM. Moreover, improved access to modern technologies via JI can contribute to emission reductions. The same applies if products of the project sequester greenhouse gases and substitute energy-intensive goods. It is impossible to specify whether indirect effects lead to more or less emission reduction than the project-specific baseline scenario suggests. Thus in the case of undistorted markets project-specific baselines show no systematic tendency toward excessive emission reductions.

Besides indirect effects, a problem with project-related baselines arises if the host country distorts fuel and electricity markets by granting production or consumption subsidies. A project-related baseline cannot take into account changes in these subsidies that would change a country-related baseline. As tight public budgets and liberalization of energy markets lead to subsidy cuts, project-related baselines could show an excessive emission reduction. Higher energy prices would produce an incentive to save energy.

A solution to this problem could be to prescribe a combination of a country-wide baseline with project-specific ones that allows for adjustment of the latter if the subsidies are phased out. This combination should only be used in cases of high subsidies or market distortion. It should be taken into account, however, that such a solution would provide a disincentive to phase out subsidies as the creditable emission reduction will be positively linked to the amount of subsidies.

The problems that are created by fixing baselines for projects with long lifetimes could be alleviated through “dynamic” baselines which use emissions and operating data of the project to adjust the baseline. “Dynamic” baselines would lead to uncertainty on the investor´s part as the credited emission reduction would depend on the adjustments of the baseline.

E4. Alternative Rules

Strategic manipulation of the certification process can also be countered by using other rules for baseline definition. Two other rules are not as susceptible to manipulation. The "marginal external cost rule" is a familiar one since it is the rule used by the Global Environment Facility to dispense funds for projects of global environmental significance. According to the "marginal external cost rule" emission reductions would be surplus if they exceeded levels that would be rational for individual nations to undertake purely in pursuit of their own self-interest. The test is based upon a benefit/cost analysis in which all benefits and costs of reducing emissions are defined purely in terms of the individual country's interests. No transboundary benefits or costs would be included in this particular calculation. The level of control up to and including a level of control which maximizes that nation's net benefits (total benefits minus total costs) from a purely self-interest point of view would be included in the baseline. Any control beyond that would be considered surplus.

While it does reduce the potential for strategic manipulation, the "marginal external cost" rule introduces a few problems of its own. First it takes no account of the ability of whether or not individual countries can afford the level of control which maximizes domestic net benefits. Second, relying on a benefit/cost test would not only make the certification process rather expensive and time-consuming, but it is not clear that current benefit estimation procedures can be relied upon to the extent necessary to satisfy the rather stringent requirements a certification procedure would impose. In many countries, for example, where this rule might be applied, the data necessary to implement these procedures are difficult, if not impossible, to come by at any reasonable cost. Finally, the marginal external cost rule prevents any rent from being transferred to developing countries. All funds they receive are designed to provide external benefits. Using the "what would have happened otherwise" baseline, by way of contrast, could provide developing countries with benefits for them as well as the global community.

A final approach to defining the baseline for created credits envisions the application of a predetermined threshold of control responsibility. Once this threshold was reached, additional reductions would be considered surplus. A source-specific threshold would stipulate how much control would be necessary from an individual source before additional reductions from that source could be certified as tradable entitlements.

Source-specific or sector-specific baselines could either result from the application of universal standards ("off the shelf") or from a case-by-case discretionary process. Whereas under a universal standards approach the bureaucracy would attempt to define baselines for likely projects in advance, applying those standards to all parties seeking certification as necessary, under a discretionary approach the baseline would be defined on a case-by-case basis as the need arises. Early case-by-case determinations could and should establish precedents for subsequent decisions. A case-by-case process would prioritize certification determinations by focusing on specific issues as they arise.

F. TRADES AMONG ANNEX B NATIONS: THE NOTIFICATION REQUIREMENT

Although no certification would be required for trades among Annex B Parties, all international trades would have to recorded in the dual tracking system and notification of all Parties of the intention to trade would be required. This would afford an opportunity to challenge the trade before large investments are made.

For international trades involving private sources an additional layer of notification would be required. Prior to trading private sources would be required to also notify all affected Parties

(normally meaning those who have either a buying or a selling source within their borders) of the intention to trade.

G. CERTIFICATION AND PROGRAM EVOLUTION

Would the certification process described above facilitate, or at least not impede, the evolution of the system? How smoothly the transition can be handled depends on the relationship between credits granted by the certification procedure and subsequent assigned obligations when Parties join Annex B.

The major possible impediment to a smooth transition could arise from the treatment of certified credits, which a non-Annex B nation has either sold or leased to others, once that nation decides to join Annex B. For example, if the rule for allocating allowances to new signatories were based on historical emissions (and all potential signatories were aware of that relationship), an incentive to increase emissions for the purpose of receiving a larger entitlement allocation, once the agreement was signed, would be created.

Basing future entitlement allocations on variables other than historical emissions is one practical solution to the problem, a solution that seems quite compatible with a basic sense of fairness. Most discussions of allowance allocation envision allocating more allowances to developing countries than would be justified by historical emission patterns as a means of accommodating future development.[28]

The remaining question is how certified credits should be incorporated into the definition of an assigned amount when a non-Annex B nation agrees to join Annex B. Once the assigned amount allocation for the new participant has been negotiated (presumably based on some criterion other than historical emissions), already transferred entitlements should be counted against the allocated entitlements. In other words suppose a country has leased or sold 30 tons of $_{CO2}$ offsets for five years to another country prior to signing the agreement and receives 1000 tons per year of allocated entitlements following acceptance of the agreement. How should the accounting of these two types of entitlements be handled?

Once the agreement is ratified and a specific entitlement allocation received, any outstanding offsets should be counted against that allocation for the years remaining. Consider the effect of adopting this rule in the context of our previous example. For the remainder of the sale or lease agreement the nation in question would have 970 unencumbered entitlements. Once the five years was completed it would have the full 1000.

VII. REPORTING

A. TRANSPARENCY: THE CORNERSTONE

As non-compliance can be much reduced through the deterrent of public loss of face, strong provisions for the disclosure of information are necessary. That means that strong reporting requirements help in achieving compliance.

Comprehensive reporting is a key feature of a successful trading system. For trading in stock exchanges, companies must agree to undergo financial audits, and disclose information. Reporting is even more important if formal enforcement is difficult as it enhances public pressure. Requirements differ according to the kind of participants.

[28] This can even be justified on efficiency grounds. See Chichilnisky,et. al. (1993).

B. REPORTING AND MONITORING COSTS

Concerning creation of ERUs in a domestic trading system effective monitoring and enforcement can be achieved at relatively low costs to government. In contrast, it will require high levels of private investment in monitoring systems and changes to legislative enforcement provisions as the following example shows: The monitoring requirements on emitters in the RECLAIM program cost an average of $30,000 more per emitter than earlier monitoring requirements. Increased monitoring costs can lead, however, to much more effective programs. The U.S. Clean Air Act Title IV Acid Rain program combines tamper-proof continuous emissions monitoring and reporting systems with automatic administrative penalties of $2,000 per ton. This program achieves 40% of emission reductions under the Clean Air Act while employing only 1% of EPA personnel. These sort of efficiencies are only achievable in a cap and trade program with automatic monitoring and penalties.

CER trading, on the other hand, may require devotion of significantly more resources for enforcement while reporting costs are similar. The validity of CERs will only be ascertainable through audits. The threat of audits will need to be sufficient enough to deter the creation of bogus CERs. Enforcement staff will have to analyze technologies and methodologies with which they are unfamiliar and to enforce projects at locations outside their normal purview (Rolfe 1997).

C. KYOTO PROTOCOL REQUIREMENTS

Art. 5 (1) states that each party to the Protocol shall install a national system for estimating emissions and removals. These systems shall use IPCC methodologies and GWPs (Art. 5 (2) and (3)). Revisions of methodologies will only apply to future commitment periods. Inventories have to be submitted annually after 2008 via national communications (Art. 7 (1-3)). MOP shall develop additional guidelines for reporting and accounting (Art. 7 (4)). Thus general reporting requirements have become stronger.

The Kyoto Protocol adopts a commitment period of five years. The multi-year compliance format is designed to avert the danger that a single-year target may pose due to fluctuations in economic performance or certain extreme weather conditions, and to provide countries with additional flexibility in meeting their targets. While enjoying such advantages over a single-year compliance, the establishment of multi-year commitment period might undermine the actual scope of a country's achievement in meeting its Kyoto obligations if monitoring, reporting and enforcement do not prove to be adequate. This underlines the importance of strong and frequent reporting obligations to help in achieving compliance. Such obligations will provide the basis for reviewing expected performance, facilitating early identification of plausible compliance problems, and then initiating early, corrective actions to encourage compliance with national commitments.

D. STRENGTHENING REQUIREMENTS

In designing the international trading system certain common methods and reporting formats should be considered as requirements for participants to be eligible to join the trading system. In particular:

- comparable methods for setting emission baselines for individual emission sources that create CERs;
- common reporting formats for making information on emissions and greenhouse gas unit holdings accessible to other countries and the public.

Standard forms or reporting formats would facilitate oversight. The frequency of reporting would need to be carefully considered, weighing the cost of information against market participants' need for certainty that emissions commitments were being met. Reporting requirements are not unique to trading, however. The frequency of reporting could increase, if necessary, as domestic reporting systems improve.

Countries who want to trade would need to fulfill the monitoring, reporting and compliance requirements of the trading system. The benefits from participating in an international emission trading system would be a strong incentive for prospective participants to comply with agreed trading 'rules' such as these (OECD 1997).

E. REPORTING ON A NATIONAL LEVEL

The national reporting system of each Party would have the dual responsibility for tracking both emissions and allowances. Each Party would be responsible for tracking emissions of all greenhouse gases in the format proscribed by the oversight agency established by the COP. In the case of a Party that has delegated trading authority to private sources, emission levels for those sources or sectors must be included as separate entries in these inventories. Each Party would also be responsible for reporting all allowance transfers and would have the responsibility for verifying ownership of any traded allowances. Both reports would be submitted in a standardized format to facilitate comparison of authorized emissions with actual emissions and to facilitate comparisons with the reports of other Parties. Generally these reports would be submitted on an annual basis, although more frequent reporting is possible if the COP deems it necessary.

All traders, whether companies or individuals, should be required to register with a central governmental body responsible for recording all transactions, (such as the Environmental Protection Agency or Department of Environment), which will establish an account in the trader's name (Joshua 1998). In the case of a domestic trading system, companies would have to notify sales to foreign companies or governments to a domestic government agency, which records the transaction and adjusts the account of the seller. In the buying country the transaction should also be reported to a government agency by the buyer. It will record the transaction, adjusts the trader's account, sends confirmation of the acquisition back to the buyer, and notify the UNFCCC secretariat. If trading is done between countries without domestic trading systems, the governments should have to report the transaction in the official gazette.

F. REPORTING ON THE INTERNATIONAL LEVEL

All international trades would have to be reported by the Parties to the UNFCCC secretariat or designated subsidiary body. It would keep accounts of international permit trade and would calculate changes in allowances of participating countries by adding up all notified trades by the end of each year. Finally, it would inform the enforcement agency about each country's position at the end of the commitment period. It could use the experience of the U.S. EPA Allowance Tracking System that controls the trading through serial numbers attached to allowances (Atkeson 1997).

G. ADEQUACY OF PUBLICLY AVAILABLE DATA

All government agencies and the UNFCCC clearinghouse should have to publish data on transactions and permit accounts of countries on web sites as well as annual reports. This is

crucial to enhance compliance because of the earlier exposure of fraudulent trades, especially through NGOs.

VIII. COMPLIANCE AND ENFORCEMENT

A. BACKGROUND AND RATIONALE FOR COMPLIANCE AND ENFORCEMENT

A1. Introduction

Effective procedures for promoting compliance and for dealing with non-compliance are an essential part of the process for achieving the goals of the climate change convention whether trading is involved or not. Trading, however, does put more pressure on the compliance system for it offers additional opportunities for non-compliance. In this chapter we review compliance objectives together with lessons from domestic and international law, and suggest options for promoting compliance, and if necessary applying enforcement actions under a trading system.

The compliance regime suggested in this report relies upon multiple commitment periods. Principal tools include declaring noncompliant Parties ineligible for trading and reducing assigned amounts in subsequent commitment periods. Currently the convention has a process for setting assigned amounts in subsequent commitment periods, but it is not clear that it has generally been recognized how important that task is in promoting compliance with the first commitment period. We believe that process should have more priority than it apparently currently has.

The essential foundation for effective compliance is creating a compliance system that Parties perceive as both fair and justified. Here, the Parties' power under Article 17 to "define the relevant principles, modalities, rules and guidelines" for emissions trading may allow the definition of clearer, more precise or stricter rules to govern compliance issues for trading than may be generally applicable under the Protocol. This may lead to better rules, for example, for the monitoring and reporting of emissions, or even to development of increased compliance mechanisms for countries that wish to trade. In addition, the withdrawal of the right to trade adds a possible sanction for noncompliance to other enforcement tools.

A certain amount of pressure for compliance is implicit even without investigation or formal penalties, and to date most international enforcement has relied heavily on this fact. However, it appears unlikely that moral suasion and informal pressures will be sufficient to induce specific individual emitters and nations to comply rigorously with the entitlement systems envisioned under the Protocol. The incentives could be strongly aligned against compliance, especially if the overall targets imposed by subsequent commitment periods are stringent and permit prices are high.

Despite these obstacles, enforcement is essential to assure the integrity of an emissions trading market. Any loss in market confidence will seriously erode the benefits of the emissions trading system. Trading systems work best in a strong enforcement and compliance context.

A2. Rationale For Compliance And Enforcement

The need for effective compliance and enforcement under the Protocol has two rationales. The first is the need to respect the fairness and economic allocation embodied in the obligations set by the Protocol. This may be met by imposing economic penalties on non-complying Parties, removal of benefits, or other sanctions including the restoration of

additional tons emitted. A second objective is environmental, and is met by ensuring that any additional tons of GHG emission are recaptured and restored under the compliance system, so that the total cap imposed by the Protocol is inviolate. Arguably the most important element of the compliance systems is to ensure that tons are recaptured, which can fulfill both objectives if recapture is the automatic consequence for non-compliance.

The goal of a robust enforcement system is to make ultimate sanctions credible so that threats--which are expensive to carry out-- rarely need to be imposed. It is difficult to design optimal enforcement systems within domestic political systems and even more difficult at the international level where history reveals relatively weak of enforcement mechanisms and where the difficulty of raising budgets or delegating political authority for enforcement institutions is exacerbated.

A3. Lessons From Domestic Law

The effectiveness of enforcement and compliance issues at the domestic level have received a great deal of attention (Russell, et al. 1986). Work by economists has focused on determinants of optimal enforcement system and over time has focused on a variety of enforcement instruments such as monetary fines, imprisonment, loss of reputation. Traditional approaches rely on investigation by public agencies, clarification and adjudication through the legal system, followed by penalties levied by public agencies and backed by the power of the state. Other complementary systems give greater role to private action through the legal system, such as liability for environmental harm or citizen suits. Those systems rest on private incentives: individuals and firms will monitor, investigate and initiate civil actions if they can gain by showing that they have been harmed.

In some countries, even those not directly harmed might initiate suits; notably, ENGOs seek to protect the environment and initiate suits on its behalf. ENGOs have received much attention as agents that can bring cases on behalf of the environment (the incentive being altruism or increased membership and dues when they are perceived to be working effectively). The details of the rules that allow such suits are important, for example the rules governing recovery of legal fees, existence and recycling of penalty revenue, standards of liability, and burdens of proof (Naysnerski and Tietenberg 1992; Babich 1995). Private actions will probably be relegated to an augmenting or complementary role when the number of stakeholders is very large, but even an augmenting role can free up resources of the public agencies that can be redirected toward more serious concerns.

As with monitoring, the frequency and effectiveness of domestic environmental enforcement varies considerably (Brickman, et al. 1985). Part of the variance is explained by budgets, but beyond financing, important political choices about the degree and type of penalties can be imposed. Studies in the U.S. in the 1970s and 1980s indicated that administrators and judges were unwilling to levy large penalties on violators because these lead to expensive legal challenges and delays. But, there may be an evolving norm in favor of stiffer penalties, including incarceration and personal liability for actions of organizations (e.g. firms)--administrators now possess a wider array of sanctions they can seek and apply.

In other settings, Ostrom's (1990) empirical study of management of local commons shows that graduated enforcement, supported by monitoring of behavior and compliance, contributes to effective management of natural resources. Where monetary penalties are involved, economic studies have shown that the social costs are low. While incarceration has not been favored by economists, in settings where it is rarely used it may be highly effective as a deterrent, especially if appropriately high penalties are unavailable such as when due to legal restriction or bankruptcy (Segerson and Tietenberg 1992).

The key issue in enforcement--whether at domestic or international level--is deterrence, not just reversal of noncompliance. Yet assessing the deterrent value of an enforcement instrument is an extremely difficult task. As suggested above, there is empirical support for the proposition that frequency of monitoring and inspection as well as the level of penalty matters, but comparing across enforcement instruments is difficult. And, crucially, demonstrating effectiveness is difficult because, by definition, the threat is visible to the analyst only when it fails. Thus it is empirically difficult to separate observed levels of compliance (where data exist) from what otherwise would have occurred under alternative enforcement systems.

Transparency mechanisms also have been effective at the domestic level in promoting compliance. In the US and in Indonesia, laws requiring industries to report their pollution discharges to the public have resulted in dramatic voluntary decreases in discharges by these facilities. Public disclosure of enforcement actions also seems to enhance the effectiveness of those actions (Tietenberg 1998)

When the difficulty of determining the optimal structure of penalties is coupled with the observation that different enforcement instruments are likely to work in different cultural settings, it is inevitable that a wide variety of enforcement systems will be involved.

A4. Compliance At The International Level

Designing enforcement systems at the international level is difficult because international institutions are typically weak and international treaties rest on the assent of their parties. These are tempered by strong norms in the international system in favor of complying with international law as well as strong pressures--in the form of reputation and reciprocity--in favor of joining legitimate international treaties. Thus states remain parties of treaties even when their narrow obligations under the treaty are inconvenient.[29] Fear of being exposed as a violator of one's agreements--and as a violator of international law in general--leads to strong predisposition towards compliance within government bureaucracies, through state leaders' reputations, and with the public. Some persuasive evidence suggests that despite this weak formal enforcement, compliance with international agreements is actually quite high in general.[30] The use of sanctions is rare in part because compliance is high and in part because nations are ultimately reluctant to use force.

Most environmental treaties have relatively weak enforcement mechanisms. By default, enforcement at the domestic level is left to the parties themselves, and enforcement at the international level tends to be done on an ad hoc basis. Most episodes of noncompliance and potential enforcement actions take the form of disputes, and in environmental treaties the parties can choose a variety of means to resolve disputes. Ultimate recourse is to the International Court of Justice, but this is cumbersome and rare. Consequently, disputes typically have no outlet and there is no regularized system of enforcement -- disputes are addressed diplomatically through negotiation or left as unresolved differences in interpretation.

Although international enforcement systems are poorly defined in the environmental area, much can be learned from other issue areas. The best developed system is dispute resolution under GATT, where disputants can initiate formation of a panel of experts to investigate the claims and make a judgment based on GATT principles.

---

[29] For example, Japan has remained within the Whaling Convention and portions of CITES even when the obligations of those wildlife agreements strongly clashed with Japanese practice.

[30] See, for example, the often quoted statement "Almost all nations observe almost all principles of international law and almost all of their obligations almost all of the time." (Henkin 1979)

In addition to official enforcement systems, some countries have been able to take unilateral enforcement measures, such as import bans or threats of retaliation, in areas where domestic interest is high. However, this is possible only for powerful states with large domestic markets. The quintessential cases are the Pelly and Packwood-Magnuson acts, under which the US threatens retaliation in access to fisheries and trade in wildlife products with countries whose policies "diminish the effectiveness" of wildlife treaties, notable CITES and the Convention on Whaling. In practice, sanctions are typically not imposed but the offending country is 'certified' and retaliation is readied--the threat is usually sufficient and leads to political compromise and change in behavior of the offending country.

A general review of unilateral actions shows their application has been spotty. Economic sanctions, especially restrictions on trade and conditional provision of foreign assistance, have been used in support of foreign policy goals is an enforcement option (Hudec 1993). Essentially all detailed studies of economic sanctions have focused on their uses where large matters of national interest are at stake, and their effectiveness is hotly disputed (Hufbauer, et al. 1990). It is difficult to mobilize the necessary domestic and international supporters when a state seeks to impose sanctions on another. Consequently, while some states may enforce international law under some conditions, it seems unlikely that through the unilateral use of sanctions any state will serve the detailed and regular enforcement that is needed to sustain trading system under the Protocol. Another tool is foreign assistance, but it is unlikely that foreign assistance can be used in a neutral manner to support international policy goals--rather than narrower national interests--on a sufficiently regular basis that it could form a significant legitimate international enforcement mechanism for a trading market. Also, as with any instrument of unilateral enforcement, relying on major powers for enforcement forecloses enforcement actions against those powers, resulting in effective coercion and enforcement only of weak states but not the strong. It is risky to draw lessons from instances of effective unilateral enforcement that would apply to even-handed maintenance of a regime for large and small states alike.

In sum, the international system is marked by reluctance to enforce treaties and by inflexibility within treaties and international institutions to take swift and regularized enforcement actions. Few examples of regular enforcement procedures have been built into international agreements, and international institutions that perform enforcement functions are limited in their power.

Since much of international law presumes that enforcement will be based upon public opinion and normative pressure to comply, transparency is important because it makes violations apparent, and the fear of detection promotes compliance. Transparency systems that do exist are based heavily on self-reporting, with some room for independent information. NGOs, where they are regularly and actively involved, have gained credibility and played some roles in identifying violations (e.g. IUCN under CITES and industry associations under the Whaling Convention), and Secretariats can help. But the ultimate authority lies with the Parties.

Enforcement actions are rare internationally because the imposition of sanctions usually requires consensus within the decisionmaking bodies of the treaty, and access to those bodies is open, leading to many potential vetoes; deviation from consensus is possible but difficult and may require actions outside the mandate of the treaty. Unilateral enforcement may be used, but the parties to any treaty would be reluctant to formally rely on enforcement that is subject to the interests of one of its members and not the collective.

B. COMPLIANCE MECHANISMS AND TOOLS

B1. The Role of Eligibility Thresholds in Compliance

Strict eligibility requirements are an important element of a compliance system. The approach assumes that trading is a privilege, not a right. Initially, trading would only be authorized for those "eligible" parties whose domestic monitoring and enforcement systems have met certain minimum quality criteria (Zhang and Nentjes 1998). In this way parties that are unlikely to have the infrastructure (or the will) to enforce the domestic polices and measures taken to live within the assigned amounts would not able to participate in trading until such time as they bring their domestic monitoring and enforcement systems up to the thresholds required for trading (CCAP 1998a).

Under this system, the more stringent are the criteria, the greater is the assurance that traded tons represent real reductions. From the environmental perspective, the more stringent criteria are preferred. On the other hand, this would lead to reduced participation in the trading market. As discussed further below, these measures should also be subject to continued refinement by the international authority on their effectiveness becomes clearer.

B2. Transparency as a Compliance Tool

Much of internal law presumes that enforcement will be based upon public opinion and normative pressures to comply. To make these effective, transparency is important because it makes violations apparent, and the fear of detection promotes compliance.

Transparency systems require the disclosure of basic information regarding obligations, actual emissions, and trading activity, in order to allow judgements about compliance status. To date, existing transparency systems are based heavily on self-reported data. Such data need to be collected and verified at the international level.

Access to this information could in principle be publicly provided or restricted for the use of Secretariat or the Parties. Experience in several countries with domestic enforcement shows that making such data generally available to the public is the best transparency mechanism, and creates the strongest force for compliance. Such public disclosure will require the use of international public databases of self-reported and verified information - an important function for the Secretariat.

B3. Supervision of Domestic Enforcement

Although domestic agencies could provide most public enforcement functions, international institutions are needed at least to provide assurance that the domestic system is operating properly. The primary public enforcement functions must be conducted by domestic agencies. They will have much more local information, and better access and budgets, than international agencies.

Domestic settings will vary enormously, as will cultures and characteristics of domestic enforcement. It would be politically and economically sensible not to force harmonized enforcement through a single international system, but rather to vest as much authority as possible in (especially existing) domestic institutions. All that is required at the international level is the assurance that, despite national differences, internationally traded offsets and entitlements are secure.

As with monitoring, this could be based primarily on self-reported assessments of effectiveness with veracity checks to assure the integrity of the system. Veracity checks and

international adjustments should be performed through agreed procedures. Without this capacity operating on a regular basis with established guidelines for how parties must address failed checks, fears of incomplete domestic enforcement may destabilize the market.

B4. Requiring Insurance as an Additional Compliance Tool

In addition to other compliance tools, the parties could require that insurance be obtained for traded tons of emissions reductions. In this context insurance could take the form of extra allowances held for the premium payer to be claimed in the event that traded tons fail to be verified as complying with the agreement. Insurance would use a private mechanism to provide assurances against possible excess emissions by the selling party.

On the other hand, it may be expected that buyers or sellers of allowances would obtain insurance anyway, especially private entities as a hedge against financial risk, obviating the need for any formal requirement. Overall, the best strategy to promote private compliance through insurance or other means may be to establish a credible international enforcement regime, thereby encouraging actions to ensure compliance.

C. INTERNATIONAL ENFORCEMENT AND SANCTIONS

This section discusses actions that may be initiated when a party is in non-compliance, specifically when it emits more tons of GHGs than its authorized amount. Enforcement is the most noticeable gulf between theorists and international lawyers. The theorists argue that tough collective action problems can be solved only if states submit to tough enforcement. Many international law scholars, on the other hand, argue that the need for such enforcement is overstated because compliance can be, and often is, high despite the absence of tough enforcement measures. Lawyers tend stress compliance motivations that occur informally, such as shame and loss of reputation from negative publicity.

While monitoring provides the base of information upon which suspicions of noncompliance can be lodged, enforcement is the process of moving from suspicions to penalties. The life cycle of an enforcement episode consists of several stages: 1) suspicion & flag raising, 2) investigation, 3) clarification and judgment, and 4) penalty. As the process progresses, ultimate sanctions become clearer and the parties frequently settle. In addition, transparency mechanisms involved in the previous stages of the process already lead to adverse publicity and consequences, which may lead to compliance without the need to use ultimate penalties.

C1. Restoring the Tons of Excess Emissions

To fulfill the environmental objectives of a compliance regime, a non-complying party must establish a credible system for replacing any ton of excess emission. This ensures that the total cap on GHG imposed by the Protocol is not exceeded.

The most common way this has been done in past trading programs has to require the non-complying party or source to purchase or restore the ton of excess emission in the next budget period, usually the next year. This creates an "air-tight" system in which any ton of excess emissions caused by failing to meet the standard or through trading is recaptured and the environmental made whole.

However, some problems arise in applying this system to GHG trading under the Kyoto Protocol. The first is the nature and length of the commitment period, a single, 5-year period. The long length means compliance is not determined until the end of the commitment period. Unlike existing trading programs the commitment period is not divided

into several (annual) budget periods, which could serve to facilitate compliance and enforcement within the overarching commitment period. In addition, the Protocol mandates no subsequent budget periods or assigned amounts after 2012. Both of these aspects of the Protocol create uncertainty for a methodology that would require excess tons of emissions to be taken from a subsequent commitment period.

It is possible to consider ways of restoring tons during the commitment period. One method used in domestic programs is to establish a "true-up" period at the end of a commitment period. This approach allows a Party some period of time, usually a matter of months, to come into compliance once it has tentatively been identified as being in noncompliance. Parties finding themselves in non-compliance could purchase available tons of allowances during the period. A Party that is able to come into compliance during the true up period is deemed to have complied with the agreement and therefore not subject to the eligibility threshold or other sanctions which follow from noncompliance.

The need to develop a method to restore tons exists regardless of whether liability is imposed on sellers or buyers in the trading system, as discussed below. Regardless of which system is used, excess tons of emissions generated must be restored, either by the buyer or seller.

The Parties should consider for future protocols the desirability of dividing a commitment period into discrete budget periods, such as a one or two year periods, in order to facilitate transparency, trading, and particularly compliance mechanisms.

C2. Withdrawing the Eligibility to Trade as a Sanction

Effective enforcement must balance the need to respect sovereignty with the need to promote compliance. This inevitably involves invoking a series of rewards for good behavior and sanctions for bad. One mechanism that appears to hold considerable promise in this regard involves using eligibility to trade as an enforcement mechanism.

The presumption that underlies this approach assumes that trading is a privilege, not a right, and should be reserved for those Parties that exhibit the requisite characteristics. Defining those characteristics then becomes the key to applying this approach.

Eligibility requirements can be useful in promoting both initial compliance and continuing compliance. Parties that do not comply with reporting or other requirements could be suspended from trading within the initial compliance period. Once subsequent commitment periods began to take effect it would also be possible to impose an additional requirement that only Parties that were in compliance in the previous commitment period could be eligible to trade. This particular approach, which could be used in addition to or instead of the approach described in the previous paragraph, would be particularly easy to implement because the determination of noncompliance would be relatively straightforward to apply.

C3. Additional Penalties

Financial penalties. Most domestic trading programs impose fines per ton of excess emissions. The fine is typically several times the expected economic value of the emissions, creating a strong compliance incentive. Although it has proved difficult to impose financial penalties on state parties under international conventions, the Parties could decide to impose fines on themselves.

Retirement of additional tons as a penalty. Another enforcement tool, implemented in US credit trading programs, is to subtract an amount from the subsequent commitment period that is some multiple of the noncompliance overage. If a Party misses compliance by 100

assigned amount units, its assigned amount for the next commitment period would then be lowered by more than 100 units as a penalty. The size of the penalty could be subject to negotiation at the initiation of the process, but would be uniformly applied to all noncompliers once it was decided.[31] Assigned amounts covered by the penalty could be retired and therefore not used to legitimize excess emissions; they represent initially authorized emissions that would be no longer authorized (EDF 1998).

C4. Facilitating Early Compliance

Easing the transition into full compliance can also facilitate compliance. Several schemes are now emerging for how this may be done without compromising the emission reduction targets. One scheme uses early compliance as one of the factors in determining how many allowances domestic sources would obtain in those countries that are likely to authorize private trading. Sources taking aggressive actions to reduce emissions early would, all other things being equal, end up with a larger share of the domestic allocation (Center for Clean Air Policy 1998e).

IX. ACCOUNTABILITY AND RISK IN INTERNATIONAL EMISSIONS TRADING

Emissions trading, as illustrated in this report, is neither new nor unproven as an instrument of national environmental and resource policy. Issues such as measurement, monitoring, verification, and the institutional requirements governing trading amongst different domestic companies have been addressed in the context of domestic systems such as those described above. Previous sections have considered how some of these lessons from previous domestic experience might be adapted to the issues raised by measuring, monitoring and verification of greenhouse gas emissions, whilst certification may also draw upon existing experience.

It is in the areas of accountability, risk, transparency, reporting and enforcement that international greenhouse gas emissions trading probably differs most fundamentally from any previous experience. Concerning these issues, to a large extent the Kyoto Protocol takes us into *terra incognito*. This is for two main reasons, both of which derive from the fact that the legal basis for international greenhouse gas emissions trading - the Kyoto Protocol - is an agreement between sovereign states. Ultimately, therefore, legal accountability derives from the legal authority of the governmental institutions that sign and subsequently ratify the Protocol.

The first line of accountability is, of course, provided by compliance and enforcement procedures. Compliance and enforcement procedures, when they work well, provide complete accountability. It follows that the first step in providing accountability in the case of inadequate compliance and enforcement procedures is to strengthen those procedures to the extent possible.

A. ACCOUNTABILITY: GENERAL ISSUES

What remains to be determined, after the issues in previous sections are resolved, is the question of liability, in the event that a Party sells tons of emission reductions and then fails to comply by emitting more than its (remaining) assigned amount? Should the seller or buyer of the traded ton be liable, or both? As we see below, strict seller liability is preferable if a

[31] To enhance this system Parties could authorize reserving a proportion of the allowances to fund a non-compliance bank. Parties in non-compliance could then secure allowances from this bank to cover overages. The prices for allowances from this bank would presumably reflect a considerable (50%?) mark-up.

strong compliance and enforcement context can be created. If that does not prove possible, consideration should be given to adding buyer liability.

In general the principle of strict seller liability makes sense in a strong enforcement environment for two reasons. In the first place it significantly enhances the tradability of permits, as it ensures all permits are a standard commodity, which reduces the risks and uncertainty in trading. Second, it provides incentives for those creating the credits or transferring the allowances to be sure that the supporting emission reductions are real. Internalizing this externality will reduce the incentive to cheat.

Seller liability systems are all that is needed if compliance mechanisms are strong and any tons of exceeded emissions are restored to the environment. In existing allowance programs, the normal compliance procedure is to subtract the deficiency from the assigned amount in the next commitment period and to add a penalty. This method could be used in GHG trading system as long as exceeded tons could be restored during or shortly after a compliance period.

However, in this Protocol a seller liability policy may not always work because there is only one very long commitment period and, as of now, no additional commitment periods have been defined.[32] In addition, it has been argued (Grubb,1998) that seller liability could lead to a regime of weak compliance because the lack of strong enforcement at the international level would provide few disincentives for buyers to acquire from sellers who take a lax attitude to compliance. This may create a need for some form of a buyer liability program to assure that tainted acquired allowances could not be used to satisfy the "assigned amount" requirements.

The rationale in adding buyer liability is that it may discourage purchasers from buying tons from countries that appear to be headed towards non-compliance. It may also prompt buyers to make additional emissions reductions toward the end of the commitment period if they perceived that tons they had obtained through trading may not be fully valid.

While adding buyer liability creates some added assurance of compliance, it creates its own set of problems. A major problem is that it erodes the commodity nature of allowances by allowing them to be retroactively devalued, thereby creating uncertainty as to their value until the end of the compliance period. Representatives of trading firms in UNCTAD trading meetings have emphasized that this may interfere with the development of financial markets for allowances, and discourage trading.

Buyer liability may act to throw well-intentioned buyers out of compliance. This is especially troubling since buyers may have difficulty ascertaining whether or not allowances are backed up by real reductions. The seller is in the best position to know.

While buyer liability adds a compliance incentive, it does not solve the compliance problem. Buyers who have relied on traded tons would find themselves out of compliance at the end of

[32] Article 4 bubbles also raise an accountability issue. In the case of a regional economic integration organization (REIO) bubble, such as the EU bubble, each REIO member and the regional organization itself are held accountable for the failure to achieve the required reductions for the REIO. Under the terms of the agreement notified to the UNFCCC Secretariat, the incentive for non-compliance is offset by the joint responsibility of both the individual members and the regional organization.

In contrast, in the case of a non-REIO bubble, the absence of a formal regional organization with enforcement powers means that the seller countries are solely responsible for their own non-compliance. As discussed in Article 17 trading, these countries may have an incentive to fall short of compliance. To ensure the environmental integrity of the Kyoto Protocol, it is thus desirable to assign some form of joint responsibility for non-REIO bubbles too. However, the countries concerned within a non-REIO bubble should be left free to work out an arrangement to bring the whole group into compliance.

the commitment period. The excess tons must still be restored to make the environment whole, either by the buyer or seller, though one of the above-mentioned methods, such as by deducting it from the next commitment period.[33]

Another way could be to use the process of evaluating Parties' efforts towards implementation during the commitment period. This includes annual reporting of the progress of each Party in meeting its assigned amounts. If in a given year a Party's actual emissions did not exceed by a certain margin its annualized assigned amounts, the seller's tons would be valid. After the year when the seller is found to go beyond that tolerance margin, however, buyers become liable for potential non-compliance by the seller. As such, the allowances acquired prior to that year would not be discounted, thus avoiding the imposition of retroactive liability for the buyer. Under both of these methods the instrument would be targeted on the source of the problem.

If the Parties decide that buyer liability is needed to complement traditional compliance procedures, a "vintage model" probably is better than the "proportionate reduction" model. Under the vintage model allowances are serialized from the time of **initial** transfer, with earlier transfers involving lower numbers. In the case of noncompliance of the seller, sufficient transferred allowances are voided to cover the overage, starting with the allowances transferred last. Because serialization provides the market with information that is helpful in assessing the magnitude of this risk, it minimizes disruption of the trading system if a seller is found to be out of compliance. It also provides a better means for the market to assess the degree of risk associated with acquired allowances and to discount prices accordingly. The vintage approach distinguishes buyers who acquire allowances from sellers when no implementation problems are on the horizon, from those buyers who do so when serious implementation problems have arisen in the seller country (Goldberg *et al*. 1998).

A final consideration is due to situations where Parties allow private entities to participate in trading activities. Since private entities are not accountable for the national targets under the Kyoto Protocol, another layer of accountability in necessary for them. Thus they are accountable to their governments which in turn assume the accountability of the aggregation of private entities' trades in the ways described above.

Governments can set rules that protect themselves against non-compliance by private entities. Parties may create a domestic enforcement system that imposes penalties for invalid trades and insures emitted tons are always restored. Another method would be to require obligatory insurance of private sellers/buyers of ERUs to minimize the risk that Parties do not comply because of invalid trades by private entities. Programs such as the US Acid Rain Program show how a domestic cap and trade system can be structured to be extremely effective while minimizing costs.

B. ACCOUNTABILITY FOR ARTICLE 12 ALLOWANCES

Both emissions trading under Article 17 and Joint Implementation under Article 6 involve the transfer of assigned amounts, creating an enforceable standard that ensures the

[33] A buyer beware system that applies to all transactions uses a fairly blunt instrument to solve a specific problem. In the long run a better solution would be to target the instrument only on those Parties that are causing the problem. One way to accomplish that would be to implement a "buyer beware" requirement only for any allowances purchased from any party found to be in noncompliance in the previous commitment period. Not only would this provide additional incentives to come into compliance, it would not saddle the trading system with this additional requirement except for those transactions where it was likely to be an issue. The disadvantage, of course, is the fact that it doesn't provide any help in facilitating compliance during the first commitment period.

environmental integrity of the trading systems and the overall cap on emissions. No similar system exists for ERUs created under the CDM, so an additional level of accountability, such as insurance or certification, is needed for such credits.

Article 12 provides that Annex I countries can acquire the certified credits obtained from GHG reduction projects with non-Annex I countries under the CDM. Under the system proposed here, only certified credits from CDM projects with developing countries can be incorporated into an international emissions trading scheme.

The certification function could be performed either by the CDM or a private certifier, making either the CDM or a private certifier responsible for CERs sold. The first option would be preferable, as there arises a default risk of the private certifier in the second. The CDM could demand insurance from project managers of projects that sell CERs or host country governments.

As discussed above, accountability of ERUs created through national trading systems would be made easier if the latter meet certain "minimum quality" criteria, in particular with respect to monitoring and enforcement.

As with trading under other Articles, an accountability issue arises. If the CDM credits are ultimately deemed not valid in whole or in part, should the seller, buyer or both be liable for restoring the tons of excess emission and any other penalties? Establishing an insurance or reserve allowance system operated by the CDM could allow liability to be imposed on the CDM or sellers. Alternatively, the buyer could also be made liable to provide greater motivation for compliance. However, as discussed above, adding buyer liability could be expected to raise the uncertainty of and discourage trading in CDM credits, reducing the value of CDM trading to developing countries as well.

C. SPECIAL ACCOUNTABILITY CONSIDERATIONS FOR BANKED /BORROWED ALLOWANCES

Under the Protocol, Parties may bank allowances by emitting fewer GHGs than their assigned amounts, thereby facilitating early emissions reductions (Article 3.13). No matter what degree of flexibility is allowed in banking or borrowing, governments should not confiscate banked allowances even if the latest scientific evidence suggests that further emission reductions are necessary. A more acceptable approach would be to reduce the issue of new allowances proportionally from the year for which the stricter emissions cap applies.

Although banking is relatively uncontroversial, borrowing is much more controversial (cf. Matsuo 1998; Mullins and Baron 1997; Zhang and Nentjes 1998). Opponents fear that borrowing makes it more difficult to check whether emission sources are in compliance with their emission limits. If borrowing is allowed, firms facing bankruptcy have an incentive to borrow without being able to meet their future commitments. Borrowing could conceivably even discourage trading among individual emission sources, thus reducing market liquidity or undermining the incentive to search for cleaner technologies.

In case the COP deems it desirable to allow some, but not complete external borrowing, some safeguards could be added to the system. Such safeguards could include:

* limiting the borrowing privilege to those countries with assigned responsibilities under Annex B and limiting borrowing to those periods with assigned amounts;

* restricting borrowed allowances to own use, rather than sale to others;

* restricting borrowing to special circumstances, such as insufficient availability of allowances on the international market;

* postponing its adoption of a borrowing provision until assigned amounts are defined for multiple commitment periods.

* limiting borrowing to those Parties with assigned amounts over multiple commitment periods.

* limiting borrowing to the one commitment period subsequent to the one in which the allowances would be used. Borrowing two or three commitment periods ahead would be disallowed.

D. THE PROVISION FOR EMISSIONS TRADING AS A SUPPLEMENTAL MEANS

Article 17 specifies that emissions trading "shall be supplemental to domestic actions". What is meant by this provision is an issue in the current international debate on emissions trading, and remains to be defined by the Conference of the Parties.

The issue of supplementarity is influenced by perceptions of the likely cost of domestic emissions reductions and the affect on international trading. If domestic costs are likely to be low in most countries, as some believe, compliance will take place largely domestically, and the supplementarity provision will never become a binding constraint. Only if domestic compliance costs are high would there be a need to consider mechanisms for promoting domestic compliance.

Following the decision of the EU Council of Environmental Ministers in March 1998, the UK circulated a "non paper" at the Subsidiary Body for Scientific and Technological Advice (SBSTA) meeting at Bonn on behalf of the EU plus the Czech Republic, Slovakia, Croatia, Latvia, Switzerland, Slovenia, Poland and Bulgaria. This states that:

> "We believe that domestic actions should provide the main means of meeting commitments under Article 3. This is consistent with the ultimate objective of the Convention. In this context, a 'concrete ceiling' on the use of all the flexibility mechanisms has to be defined ..... the rules governing the international emissions trading system should reflect this principle".

The form that such a “concrete ceiling” might take has yet to be elaborated. One interpretation of the "concrete ceiling” provision is that the amounts traded should be limited to a fixed percent of the assigned amount. Any quota could either apply to the overall amount of reduction reached through any of the cooperative mechanisms or specific quotas could also be set for each mechanism.

One issue for this interpretation of the “concrete ceiling” is how to ration available credits when their availability exceeded the demand as constrained by a quota.

A first-come, first-served approach would encourage early reductions. This may advantage CDM projects, as CDM credits can accrue from 2000. This approach could be implemented by setting a "soft" quota that slowly discounts the carbon credits achieved beyond the initial quota. For example, a quota for CDM credits could range between 20% and 30% of the national emission budget. The rule would be "first come first served", so that projects declared first would be fully credited, giving an incentive for early reductions. After reaching 20% of the total budget, the credits would be gradually discounted to a minimum of the initial value when the 30% mark of the national emission budget is reached. Any credit beyond this line

would still be accounted for at the minimum rate. Thus domestic reduction would be promoted while the global reduction would be enhanced.

Another possibility would be to allow banking of credits for the next commitment period after the quota is filled. These credits would get preference in filling the next quota. Projects with long duration would thus be penalized less.

However, defining "supplementarity" in terms of a constraint on emissions trading is not the only possible approach. It uses a blunt instrument to solve a problem that might be better handled with a more finely targeted instrument, and proposes a permanent solution for a transition problem. Moreover, setting a ceiling on trading might make it even more difficult to set stringent emissions targets for the subsequent commitment periods beyond 2012. As discussed earlier, it is the lack of the post-2012 targets that makes some of the compliance mechanisms and tools hard to implement (or restricts our choice of the compliance mechanisms and tools) and that creates some divergence of views in assigning liability.

Restricting trades interferes with the operation of a private sector trading market. If Annex B governments elect to allocate the assigned amounts to individual sub-national legal entities and authorize them to trade on the international emissions allowances market, no country would know up-front what a percentage of its obligations would have been fulfilled via emissions trading. No legal entity would be guaranteed up-front whether its transactions fall below the national threshold.

This rule would raise transaction costs and inhibit trades, which would limit the effectiveness of emissions trading. Moreover, because the fundamental integrity of the Kyoto Protocol relies on the accountability of a Party for ultimately matching its actual GHG emissions with its "assigned amounts", this approach to compliance explicitly suggests that no one means of meeting the emissions commitments is superior to, or more valid than, any others, provided that actual reductions in GHG emissions occur (Environmental Defense Fund 1998). In contrast a quota would infer that an investment in domestic energy efficiency would be inherently superior to an identical investment in a different country.

Fortunately imposing quotas on trading is not necessary to respond to the moral concerns that motivated the placement of the supplemental norm in the Protocol in the first place. Rather the supplemental norm requirement in the Protocol could be handled by requiring Parties to demonstrate adequate domestic efforts to control emissions. Indicators could be developed to demonstrate compliance. Such indicators might include: changes in the average 'price of carbon'; levels of subsidies for carbon intensive activities; road pricing; norms and standards for energy efficiency; and/or funding for R&D promoting GHG emissions abatement. Unlike quantitative limits on IET, these indicators would refer to process rather than to outcomes. This approach would not jeopardize the benefits to be achieved from implementing a vigorous trading system.

Yet another approach to implementing the "supplemental norm" requirement would be to discourage (but not prohibit) the use of externally generated allowances by placing a fee on allowance trades and using the revenue to promote the objectives of the climate change agreement. [34]

[34] The revenue from such a fee could be used in a variety of ways. It could be used to retire "hot air" allowances. It could also be nationally administrated and collected by buyer countries. Buyer countries could use the proceeds from such fees to strengthen their research, development and diffusion of low-cost climate friendly technologies, to subsidize transfer of such technologies to non-Annex I countries, or to buy and retire a portion of their allowed emissions allowances from the market.

Although imposing a transaction fee raises the cost of meeting their allowed emissions limits, it is much less trade-restrictive than imposing a percentage limitation on the use of emissions trading, because legal entities avoid the risk of being bumped over the national threshold. It alleviates to some extent the concern about the "hot air" trading, because legal entities in the advanced OECD countries face higher transaction fee rate when engaging in trading with their counterparts in other Annex I countries. It also provides the incentive to search for cleaner technologies, particularly when the proceeds from such fees are used as buyer countries' R&D investments in climate friendly technologies or to retire a portion of their allowed emissions allowances.

Finally, it should be pointed out that such a transaction fee differs from a carbon tax. A carbon tax is a mandatory tax for firms emitting carbon emissions. Therefore, it is expected that there are the great political difficulties of introducing such a tax in some countries. In contrast, a transaction fee leaves firms the freedom to determine how to meet their emissions limits. Firms that elect to meet their emissions limits only by taking domestic actions have no obligations to pay such a fee.

E. COMPETITIVENESS AND PRIVATE TRADING

The allocation of allowances has the potential to bring parties into conflict with the World Trade Organization (WTO) provisions, raising concerns about international competitiveness. Some fear, for example, that governments could allocate the allowances in such a manner to favor domestic firms against foreign rivals. This would violate the WTO principle of non-discrimination. The allocation of allowances could also be designed in such a manner to advantage certain sectors over others and further enhance their existing imperfect market competition. (Zhang 1998). All this clearly indicates that the manner in which countries allocate their assigned amounts should be compatible with these basic WTO principles and should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.[35]

IX. CONCLUSIONS AND RECOMMENDATIONS

The Protocol

The Kyoto Protocol authorizes four cooperative implementation mechanisms. These include bubbles, emission trades, joint implementation and the Clean Development Mechanism.

Emissions trading, the focus of this report, allows trading of “assigned amounts” among Annex B. nations. Authorized by Article 17 this provision leaves the crafting of implementation details to subsequent conferences. Three distinct trading possibilities emerge from this authorization: trading among countries with domestic emissions trading systems, trading among countries without domestic trading systems and trading among countries with and without domestic emission trading systems.

Some options could serve to provide flexibility in the negotiations over including developing countries in the Annex B list of nations. These include: allowing legally-binding limits (for countries that wish to join the emissions trading system) to be based for early commitment periods on a growing, rather than a stable, baseline; bubbles involving regional groupings such

[35] See Zhang (1998) for a detailed discussion on GHG emissions trading and the world trading system.

as ASEAN and MERCOSUR; developing countries could be allowed to introduce "partial caps" which, for example, could be based on industrial sector limits, and coupled with joint implementation in the uncapped sectors, as a form of progressive restriction towards the imposition of a national cap involving all sectors; and developing countries could be allowed to choose different base years for each greenhouse gas they propose to bring under a sectoral or national cap.

Design Principles

To comply with its obligations under the Kyoto Protocol, a Party's actual emissions of $_{CO2}$ equivalent tons during the commitment period must be no greater than the number of allowances it holds. The total number of allowances a Party would hold at any time would consist of: (1) the assigned amounts (AAs) designated by Annex B (appropriately adjusted to reflect the "net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change an forestry activities, as authorized by Article 3.3), plus (2) allowances acquired from other Annex B parties, plus (3) certified emission reductions (CERs) acquired from non-Annex B countries under Article 12 minus (4) any allowances transferred to other Annex B parties.

Participation in Article 17 trading would be voluntary. Any Party that has an 'assigned amount', as set out in Annex B of the Kyoto Protocol, could elect to trade under Article 17. Countries that currently are not listed in Annex B can become eligible for Article 17 trading by negotiating an acceptable assigned amount.

Governments could either elect to allocate assigned amounts to sub-national entities (thereby facilitating private participation) or not. If they chose to allocate assigned amounts to private entities, it could use a variety of possible allocation mechanisms. The decision to allocate the assigned amounts to private parties would be the first step in allowing trades between private sources as well as trades between Parties.

When designing the emissions trading system, simplicity should be the rebuttable presumption. The historic evidence is very clear that simple emissions trading systems work much better than severely constrained ones. The transactions costs associated with implementing and administering an emissions-trading system rise with the number of constraints imposed. And as transactions costs rise, the number of trades falls. As the number of trades falls, the cost savings achieved by the program also decline.

Article 17 specifies that emissions trading "shall be supplemental to domestic actions". What is meant by that is a very important issue in the current international debate on emissions trading, and remains to be defined by the Conference of the Parties.

Following the decision of the EU Council of Environmental Ministers in March 1998, the UK circulated a "non paper" at the SBSTA meeting at Bonn on behalf of the EU and some other countries and which called for, a 'concrete ceiling' on the use of all the flexibility mechanisms. The form that such a "concrete ceiling" might take has yet to be elaborated. One interpretation of the "concrete ceiling" provision is that the amounts traded should be limited to a fixed percent of the assigned amount. Any quota could either apply to the overall amount of reduction reached through any of the cooperative mechanisms or specific quotas could also be set for each mechanism.

Defining "supplementarity" in terms of a constraint on emissions uses a blunt instrument to solve a problem that might be better handled with a more finely targeted instrument, and

proposes a permanent solution for a transition problem. Restricting trades interferes with the operation of a private sector trading market.

Because the fundamental integrity of the Kyoto Protocol relies on the accountability of a Party for ultimately matching its actual GHG emissions with its "assigned amounts", this approach to compliance explicitly suggests that no one means of meeting the emissions commitments is superior to, or more valid than, any others, provided that actual reductions in GHG emissions occur. In contrast a quota would infer that an investment in domestic energy efficiency, for example, would be inherently superior to an identical investment in a different country.

The supplemental norm requirement in the Protocol could be handled by requiring Parties to demonstrate adequate domestic efforts to control emissions. Indicators could be developed to demonstrate compliance. Such indicators might include: changes in the average 'price of carbon'; levels of subsidies for carbon intensive activities; road pricing; norms and standards for energy efficiency; and/or funding for R&D promoting GHG emissions abatement. Unlike quantitative limits on IET, these indicators would refer to process rather than to outcomes. This approach would not jeopardize the benefits to be achieved from implementing a vigorous trading system.

Lessons from Previous Trading Programs

Allowance trading programs have proven superior to credit trading systems in terms of both economic and environmental results. In particular, the United States history of emissions trading shows the cap and trade approach under the Acid Rain Program and RECLAIM has resulted in significant program-wide cost reductions, while emissions credit trading has not been as successful. Reasons for this have to do with the lack of commodity nature of credit trades, their higher transaction costs, and regulatory barriers to their creation.

Since only credible systems succeed, deviations from simplicity should be introduced when demonstrably necessary to promote the achievement of the climate change goals. Systems are not credible if they become a vehicle for evading, rather than complying with, international agreements. Hence, the administrative procedures must be adequate to assure compliance with the climate change goals.

All existing emissions trading programs involve trading between private entities. Allowing private entities to trade appears to be important if the efficiencies of trading are to be realized. The essential benefit of trading programs is that they allow private firms the flexibility to determine technology choices and options themselves, and compare these to emissions permit prices to determine an overall least cost path of compliance. Allowing private entities to trade amongst themselves creates maximum flexibility. Since emissions sources are the ones that would make decision to implement energy-saving technologies and processes, allowing them to trade allows them the greatest potential to achieve these efficiencies.

Banking of allowances allows Parties and sources significant additional flexibility in compliance investment and decision-making. There has been heavy use of banking in both the US Acid Rain Program and lead credit trading market, which has led to early reductions and substantially lower overall costs of compliance. Banking is especially significant for industries in which major capital expenditures must be made, as it allows individual sources flexibility in the timing of such major investments. The Protocol does allow banking in

relation to expected future compliance periods, which may encourage further early reductions (Article 3(13)).

A provision that allows otherwise uncovered sources to voluntarily opt to be covered under the regulatory system can increase the scope of a program. While it is desirable to include as many sources as possible under a regulatory system, including all emitters of a pollutant may not be practical in an emissions cap and allowance trading system due to uncertainties in measurement for some classes of sources. An opt-in process allows these sources to be included once the uncertainties are resolved to an acceptable degree.

Transaction costs play a key role in the success or failure of an emissions trading system. In the past, only emissions trading programs with low transaction costs have succeeded in substantially lowering the cost of compliance. Credit trading programs create high transaction costs by requiring each credit generation or use to be separately approved by a regulatory authority. Cap-and-trade programs, on the other hand, have generally low transaction costs and low risk.

The experience of existing programs has been that the private market has supplied an adequate to high number of allowances or credits, so that market power issues have not been of concern. Several mechanisms can be and have been implemented in past programs to address concerns about market power and potential hoarding of allowances.

Providing price information is important to reduce the uncertainty of trading and create public confidence in the trading program. Price information could be required to be revealed in reporting requirements for emissions trades, or through alternative systems such as regular public auctions.

Some credit trading programs impose a 10% or other deduction on trades for air quality enhancement, or for other purposes such as to grant to new entrants. This may help create public support for a trading program by creating public benefits if a firm takes advantage of trading to reduce their costs. On the other hand, imposing a percentage reduction on trades creates another barrier to the economic efficiency gained through trading. Arguably, the environmental benefits of clean air could be better established in setting the overall cap, not by penalizing trades.

Monitoring and Verification

The national reporting system of each Party would have the dual responsibility for tracking both emissions and allowances. Each Party would be responsible for tracking emissions of all greenhouse gases in the format proscribed by the oversight agency established by the COP. In the case of a Party that has delegated trading authority to private sources, emission levels for those sources or sectors must be included as separate entries in these inventories. Each Party would also be responsible for reporting all allowance transfers and would have the responsibility for verifying ownership of any traded allowances. Both reports would be submitted in a standardized format to facilitate comparison of "authorized" emissions with "actual" emissions and to facilitate comparisons with the reports of other Parties. Generally these reports would be submitted on an annual basis, although more frequent reporting is possible if the COP deems it necessary.

The international authority is expected to perform the following key monitoring and compliance functions: (1) Initial approval of a country's monitoring system that allows it to participate in emissions trading; (2) Receive and review the reports generated by countries

that provide credible data on monitoring results and methods on an ongoing basis. Once a country is accepted into the international trading system, the international agency would need the capacity to receive and review the national reports, including those submitted under Article 3(13); and (3) periodic inspections to assure compliance and proper functioning.

Any discrepancies between authorized emissions and actual emissions can be corrected without penalty during a "true up" period. During this period, participants with too many emissions in their account could sell or bank their surplus greenhouse gas units and those with too few could buy. A verified emissions account would then be issued for the period. Based on the emission accounting and verification process, sanctions could be imposed for non-compliance.

The monitoring systems for both allowances and emissions must rest heavily on self-reporting. Polluters have the most information about their activities and thus can provide it as part of a monitoring system at a cost much lower than if independent monitoring systems were created. Virtually every domestic and international enforcement system is based on self-reporting, and other modes are not economically or politically viable.

The first line of monitoring authority will occur at the Party level. The first level of reporting and coordinating allowance transfers with emissions will come at the national level. National monitoring is not only a physical necessity; it is probably the most effective system.

The ultimate authority for aggregating, standardizing, and interpreting reports from the Parties must remain with an authorized subsidiary of the Conference of Parties. All reports must be harmonized both in terms of reporting format and in terms of collection protocols to assure comparability and reliability.

Creating layers of veracity checks should strengthen the integrity of the allowance and emissions monitoring systems. Systems of self-reporting do offer many risks of deception, although analysts may over-state the extent to which purposefully deceptive self-reporting occurs. Nonetheless, there are risks of deception, and assuring the integrity of the permit system will require assuring the integrity of self-reporting. At the initial stages of the permit system veracity checks of government self-reporting will be needed, but as the system matures more extensive checks at the domestic level will be needed. National governments could provide many (or most) of the domestic checks, provided that those checks are themselves reviewed occasionally at the international level. It remains to be seen how intrusive the international monitoring system for greenhouse gases will be.

ENGOs (Environmental Nongovernmental Organizations) can exercise general oversight over the compliance process and may even play a role in the monitoring of individual sources. Issues of ENGO capacity and access to publicly available information are important determinants of how effective this component will prove to be.

Transparency of behavior should be promoted through wide public availability of collected data. The assurance function is better fulfilled if data are widely available; veracity-checking is easier if multiple sources of information are available; and, the involvement of private monitors is frequently heavily dependent upon the existence of rich database. Further, a monitoring system will produce much data that could be useful in other settings, such as scientific research. There will be reluctance to reveal some information because of privacy and industrial secrets, but free flow of information should be a rule-of-thumb.

Transparency could also be promoted by forcing all transferred allowances to be sold at auction. In addition to promoting good international information on allowance prices this technique would diminish opportunities for strategic manipulation of the market.

When nations have baselines (as all Annex B nations now do), sale of an allowance automatically reduces the number of allowances remaining to cover emissions during the commitment period. This would be true both for assigned allowances and for created emissions reduction credits which are used to fulfill the Article 3 obligation. For this category of trade as long as every trade results in equal and offsetting changes in the two Parties' allowances, certification is not required because the need to balance emissions with allowances during the commitment period provides a check to assure that the trade will not increase emissions.

One model for tracking trading activity is provided by the US Allowance Tracking System used in the Acid Rain Program. This publicly open allowance registry system helps to create a transparent and self-enforcing compliance system, and has contributed to high compliance records in the programs.

One of the most difficult verification issues for credit trading is that of additionality. In the absence of a permitting system an additionality demonstration requires a forecast of future economic events and probabilities. Under the pilot program for AIJ, this verification process has led to the rejection of many proposed trades, and can take one to two years, creating high transaction costs and uncertainty. Another important issue in discrete credit trading systems has been enforceability, which requires the development of a detailed liability system, described below.

Certification

Since emission reductions used to generate Article 12 credits require considerably more scrutiny, certification function is necessary to assure that only certified CERs would become part of the allowance system. Certified allowances would be treated as homogenous in quality to all other allowances. The certification process provides one concrete means of attempting to assure a smoothly running trading system, while simultaneously assuring that the trading system furthers the goals of the agreement.

While the ultimate authority for certification would be the Conference of the Parties (COP, the operational authority for certification can, and should, be delegated to subordinate organizations specifically designed to fulfill that function. While the Conference of the Parties would be well suited for defining the parameters of the certification process and exercising general oversight over that process, it would be ill suited for dealing with the day-to-day operations of certification.

Some certification authority could be delegated to specific governmental units within participating nations or communities of participating nations or even to private certification entities, providing certain preconditions had been met. These preconditions would include, *inter alia*: (1) an identified organizational unit willing and able to assume the responsibility for certification, (2) the existence of sufficient enabling legislation to assure adequate powers to carry out its mission, as well as adequate staff and resources, and (3) acceptance of, and willingness to apply, the standard certification criteria.

Certification and monitoring processes should be initiated promptly. Although the commitment period lies a few years ahead in the future, it will be important to "work the

bugs out" of the system before it bears the burden of ascertaining compliance. Furthermore even non-Annex B nations that contemplate establishing private tradable entitlements systems will need guidelines for appropriate processes of certification and monitoring. If these are provided early then the chances of harmonized procedures in the future will be higher. Viable and legitimate systems created today, even if they are small, will become the de facto standard. And, early creation of these institutions will highlight the needed changes in domestic institutions and procedures, allowing more time to make the necessary reforms.

Design monitoring procedures and institutions with future expansion in mind. Although the trading system may "formally" be at an early stage, monitoring systems for later stages need not wait. These systems will inevitably need to expand to accommodate different gases, different parties, and different commitment periods.

While certification is sufficient for transfer of a credit, use of a credit to fulfill part of an assigned amount obligation would require verification. Whereas certification would provide assurance that a defined emission reduction or carbon absorption would be forthcoming from the project, verification would provide the assurance that these expectations had in fact materialized. (For example, verification of a forestry project would assure that the planned forest was in existence and was absorbing carbon at the expected rate, while an energy efficiency project would verify that actually emissions mirrored the emissions expected on the base of design criteria.)

Compliance and Enforcement

The challenge for emissions trading is that as allowance prices increase, incentives to defect will be strong, but the problem is not catastrophic. Based on extending current examples from international and domestic settings, the following design principles can frame an economically and politically viable enforcement system; many are in the same spirit as the design principles for monitoring systems:

Rely heavily on domestic enforcement, especially by existing institutions. A wide variety of domestic enforcement systems should be expected because there are many histories and cultures, and enforcement instruments will vary with these. The international system must accommodate this, and in practice that must be done by allowing the major enforcement activities to occur at the domestic level through familiar institutions.

Politically, it may also be important to keep institutional costs off budget, especially at the international level, because political systems appear overly sensitive to highly transparent budgeted costs. Economically, this is a dangerous strategy, and whatever choices are made about enforcement institutions should be supported by independent economic analysis that shows the costs are consistent with the benefits.

Set international standards for domestic enforcement. Although diversity must be expected, some international standards will be needed. At a minimum, agreed acceptable levels of noncompliance will be essential to assuring that property rights are more or less stable across different markets. Failure to do so would result in loss of confidence in the value of internationally traded permits and substantial thinning of the market. These standards will have significant political and economic implications, and the broad features of the standards must be negotiated rather than set by technical experts.

Perform veracity checks and international adjustments through agreed procedures. As with monitoring, compliance with international standards for domestic enforcement will fundamentally be assessed by self-reporting, but those reports must be subject to layers of

veracity checks. Without this capacity operating on a regular basis with established guidelines for how parties must address failed checks, the market may destabilize on fears of incomplete domestic enforcement.

Ensure proper operation of dispute resolution procedures. Disputes could be prone to escalation because enforcement may affect allowance prices, in turn affecting the costs of production (notably energy costs) and international competitiveness. Thus disputes, even over seemingly technical issues, could destabilize into divisive debates over economic competition and welfare. Agreed procedures could help chart the way and keep disputes productively focused on the issues at hand. We recommend the early adoption of dispute resolution institutions and procedures.

Push early adoption of institutions and procedures. The system will evolve if lead countries take the initiative and show the way. The international system of organizations and diplomacy is not well suited to forging the path, but it can help by working with leaders to establish institutions and procedures before they are needed. (OECD does this frequently, and as a result OECD helps to set the agenda and pace for collective action on issues such as harmonization of chemical standards and trade in hazardous waste.) An endless supply of important details must be addressed, and early experience can help ensure that bad choices do not undermine later, broader markets once they are underway.

However, leadership may require assumption of some (perhaps substantial) risk. This is not unprecedented in the international arena since countries decide to bear the risks of stable exchange rates by creating target systems supported by central banks, sometimes at enormous cost.

Transparency. The most important function of penalties is as a deterrent. Transparency is crucial to assure that noncompliance will be detected and that detection will lead to penalties. For reputable actors, a transparent system may be all that (or most of what) is needed because fear of losing reputation will be a strong deterrent. Especially for private enforcement, which is probably very sensitive to incentives, a dense and accessible base of information would be very helpful.

Assigned amount adjustments in subsequent commitment periods provide a reasonable means of protecting the goals of the climate change convention while encouraging compliance. Under this approach, an approach that has been applied in the US sulfur allowance program, noncompliance by a Party results in an amount being subtracted from that Party's previously determined assigned amount in the subsequent commitment period. The magnitude of the subtraction is greater than the amount of noncompliance. In other words suppose a party misses compliance by 100 assigned amount units. Its previously calculated assigned amount for the next commitment period would then be lowered by 100(1+x) assigned units, where x is the noncompliance penalty.

The value of x could be subject to negotiation at the initiation of the process, but would be uniformly applied to all noncompliers once it was decided. It represents not only a penalty to the noncomplying source, but also a source of an additional emission reduction. Assigned amounts covered by the penalty are retired and therefore not used to legitimize emissions; they represent previously authorized emissions that are no longer authorized.

Allowing trading only among eligible Parties and defining "eligibility" to include only those countries that have approved domestic enforcement systems and were in compliance in the previous commitment period can promote compliance. The approach recognizes that it is

easier to deal with circumstances that appear to promote noncompliance before they occur rather than after.

Currently the convention has a process for setting assigned amounts in subsequent commitment periods, but it is not clear that it has generally been recognized how important that task is in promoting compliance with the first commitment period. The compliance regime that has been suggested in this report assumes, and relies heavily upon, multiple commitment periods. Declaring noncompliant Parties ineligible for trading and reducing assigned amounts in subsequent commitment periods only works if subsequent commitment periods are in place. We believe the process of defining assigned amounts for subsequent commitment periods should have more priority than it apparently currently has.

Accountability

A regime that promotes universal compliance is the best means of promoting accountability. Therefore the first step in building accountability is to construct a widely accepted agreement with a reliable enforcement process.

Article 17 appears to impose a seller liability system because Article 3 refers to transfers of allowable emissions from one nation to another without anything suggesting that transfers would be invalidated if the seller is out of compliance. Therefore it seems clear that seller liability is already in place.

In general the principle of "seller beware" makes sense in a strong enforcement environment because it provides incentives for those creating the credits or transferring the allowances to be sure that the supporting emission reductions are real. Internalizing this externality will reduce the incentive to cheat. In existing allowance programs the normal compliance procedure is to subtract the deficiency from the assigned amount in the next commitment period and to add a penalty.

In this Protocol a "seller beware" policy may not always work for Annex B sellers because commitment periods are very long and, as of now, no additional commitment periods have been defined. This may create a need for some form of a "buyer beware" program where acquired allowances that are tainted could not be used to satisfy the "assigned amount" requirements.

If the decision is made that a "buyer beware" program is needed to complement traditional compliance procedures, a "vintage model" probably is better than the "proportionate reduction" model. Under the vintage model allowances are serialized from the time of transfer--earlier transfers involve lower numbers. In the case of noncompliance of the seller sufficient transferred allowances are voided to cover the overage, starting with the allowances transferred last. This provides a means for the market to assess the degree of risk associated with acquired allowances and to discount prices accordingly.

Another way could be to use the process of evaluating Parties' efforts towards implementation during the commitment period. This includes annual reporting of the progress of each Party in meeting its assigned amounts. If in a given year a Party's actual emissions did not exceed by a certain margin its annualized assigned amounts, the seller's tons would be valid. After the year when the seller is found to go beyond that tolerance margin, however, buyers become liable for potential non-compliance by the seller. As such, the allowances acquired prior to that year would not be discounted, thus avoiding the imposition of retroactive liability for the buyer. Under both of these methods the instrument would be targeted on the source of the problem.

REFERENCES

Anderson, R., (1997). The US Experience with Economic Incentives in Environmental Pollution Control Policy. Environmental Law Institute, Washington, D.C.

Atkeson, E. (1997). "Joint Implementation: Lessons from Title IV´s Voluntary Compliance Programs", MIT Center for Energy and Environmental Policy Research Discussion Paper No.3, Cambridge

Australia, Canada, et al. (1998) "Non-paper on Principles, Modalities, Rules and Guidelines for an International Emissions Trading Regime (in particular for verification, reporting and accountability)(Bonn).

Ausubel, J. H. and D.G. Victor (1992), "Verification of International Environmental Agreements," Annual Review of Energy and the Environment 17, 1-43.

Babich, Adam (1995). "Citizen Suits: The Teeth in Public Participation". 25 Environmental Law Reporter 10141-10151 (Washington, D.C.).

Bedi, C. (1994). No-regrets under Joint Implementation?, in: Prodipto Ghosh, Jyotsna Puri (eds.). Joint Implementation of Climate Change Commitments, New Delhi, 103- 107

Bill, S. (1997), European Commission's Experience in Designing Environmental Taxation for Energy Products, Presented at the European Union Advanced Study Course on Goals and Instruments for the Achievement of Global Warming Mitigation in Europe, 20-26 July, Berlin.

Bohi, D. R. (1994). "Utilities and State Regulators Are Failing to Take Advantage of Emission Allowance Trading." The Electricity Journal, 7(2), 20-27.

Brickman,R., S. Jasanoff, and T. Ilgen (1985). Controlling Chemicals: the Politics of Regulation in Europe and the United States, Ithaca: Cornell University Press.

Burtraw, Dallas & Byron Swift (1996), "A New Standard of Performance: An Analysis of the Clean Air Act's Acid Rain Program", 26 Environmental Law Reporter 10411-10423 (August).

Center for Clean Air Policy (1998a). "US Carbon Emissions Trading: Description Of An Upstream Approach", Washington

Center for Clean Air Policy (1998b). "Priorities for the Implementation of the Kyoto Agreement: Making Flexibility Mechanisms Work", Washington

Center for Clean Air Policy (1998c). " Growth Baselines: Reducing Emissions and Increasing investment in Developing Countries" Washington.

Center for Clean Air Policy (1998d). "Methods for Ensuring Compliance in an International Greenhouse Gas Trading System" Washington.

Center for Clean Air Policy (1998e). " An International Market in Credits for Early Greenhouse Gas Emissions Reductions" Washington.

Chayes, A. and A. H. Chayes (1995). The New Sovereignty: Compliance with International Regulatory Agreements, Cambridge, MA: Harvard University Press.

Chichilnisky,-Graciela; Geoffrey Heal, and David Starrett (1993). "International Emission Permits: Equity and Efficiency" Columbia University PaineWebber Working Paper Series in Money, Economics and Finance: PW-94-03.

Cline, W.R. (1992), The Economics of Global Warming, Institute of International Economics, Washington, DC.

Cramton, P. and S. Kerr (1998), Tradeable Carbon Allowance Auctions: How and Why to Auction, Center for Clear Air Policy, Washington, DC.

Dudek, Daniel and Palmisano, John. (1988). "Emissions Trading: Why is this Thoroughbred Hobbled?" 13 Columbia Journal of Environmental Law 217-56.

Dudek, Daniel, Wade, Sarah M. and Goffman, Joseph. 1995. Emissions Trading in Nonattainment Areas: Potential, Requirements, and Existing Programs, Environmental Defense Fund (June 1995).

Dudek, Daniel; Wiener, Jonathan (1996). Joint Implementation, Transaction Costs, and Climate Change, OECD (ed.), Paris

Eckaus, R. S. (1990), Comparing the Effects of Greenhouse Gas Emissions on Global Warming, Working Paper MIT-CEPR 90-022WP, Cambridge, MA: MIT Center for Energy Policy Research.

Ellerman, D. et al. (1997). Emissions Trading Under The U.S. Acid Rain Program, Massachusetts Institute of Technology.

Elman, B. (1992). Economic Incentives Under the Clean Air Act (USEPA 92-176.05, May 1992).

Environmental Defense Fund. (1998). Cooperative Mechanisms Under the Kyoto Protocol: The Path Forward (June).

Environmental Law Institute. (1996). Implementing an Emissions Cap and Allowance Trading System for Greenhouse Gases: Lessons from the Acid Rain Program (Washington, DC).

Fischer, C. et al. (1998), Using Emissions Trading to Regulate Greenhouse Gas Emissions: An Overview of Policy Design and Implementation Issues, Presented at the World Congress of Environmental and Resource Economists, 25-27 June, Venice.

Fischer, D. and P. Szasz, (1985), Safeguarding the Atom: A Critical Appraisal, Stockholm International Peace Research Institute, London: Taylor and Francis.

Fischer, W. et al. (1993) "International Greenhouse Gas Verification," March, Research Centre Jülich, Programme Group Technology Assessment (TFF).

Fisher, R. (1981). Improving Compliance with International Law, Charlottesville: University of Virginia Press.

General Accounting Office, U. S. Congress, 1992, "International Environment: International Agreements Are Not Well Monitored," GAO/RCED-92-43 (January).

General Accounting Office, U.S. Congress. 1989. Air Pollution: National Air Monitoring Network in Inadequate. GAO/RCED-90-15.

General Accounting Office, U.S. Congress. 1990a. Air Pollution: Improvements Needed in Detecting and Preventing Violations. GAO/RCED-90-155.

Goldberg, D. et al. (1998), Responsibility for Non-compliance under the Kyoto Protocol's Mechanisms for Cooperative Implementation, Center for International Environmental Law, Washington, DC.

Goulder, L. et al. (1998), The Cost-Effectiveness Of Alternative Instruments For Environmental Protection In A Second-Best Setting, Resources for the Future Discussion Paper 98-22, Washington

Grubb, M. J., D.G. Victor, and C.W. Hope (1991), "Pragmatics in the Greenhouse," Nature 354, 348-350.

Grubb, Ml. (1998). "Core Issues in Implementing the Trading Mechanisms of the Kyoto Protocol", Review of European Community and International Environmental Law, , 7 (July/Aug).

Hahn, R. and G. Hester. (1989a). "Marketable Permits: Lessons for Theory and Practice", Ecology Law Quarterly 16, 361-406.

Hahn, R. and G. Hester. (1989b). "Where Did all the Markets Go? An Analysis of EPA's Emissions Trading Program", Yale Journal of Regulation 6: 109-153

Hahn, R. (1989). "Economic Prescription for Environmental Problems: How the Patient Followed the Doctor's Orders". Journal of Economic Perspectives. 3: 95-104.

Harrington, W. (1988) "Enforcement Leverage When Penalties Are Restricted." Journal of Public Economics 37: 29-53.

Harrison, D. (1997). "Considerations In Designing And Implementing An Effective International Greenhouse Gas Trading Program", Cambridge, MA

Harvey, L. D. D., (1993), "A Guide to Global Warming Potentials (GWPs)," Energy Policy 11, 24-34.

Hausker, K. (1992). "The Politics and Economics of Auction Design in the Market for Sulfur Dioxide Pollution," Journal of Policy Analysis and Management, 11 (4), (Fall), 553-572.

Henkin, L. (1979). How Nations Behave, 2nd ed., New York: Columbia University Press.

Hudec, R. (1993). Enforcing International Trade Law: The Evolution of the Modern GATT Legal System (Salem, NH: Butterworth's).

Hufbauer,G. et al. (1990). Economic Sanctions Reconsidered: History and Current Policy, 2nd ed. Washington: Institute for International Economics.

IPCC (1996), Climate Change 1995: Economic and Social Dimensions of Climate Change, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge.

Jochem, E. et al. (1994). Analyse und Diskussion der jüngsten Energiebedarfsprognosen für die großen Industrienationen im Hinblick auf die Vermeidung von Treibhausgasen, Bonn

Joshua, F. (1998). "International Greenhouse Gas Emissions Trading - Structure & Organization Of The Emissions Market (Implications For Developing Countries)", Geneva

Kete, N. (1992). The Politics of Markets: The Acid Rain Control Policy in the 1990 Clean Air Act Amendments, Ph.D. Dissertation, Baltimore, MD: The Johns Hopkins University.

Kline, D., T. Hargrave and C. Vanderlan (1998), The Treatment of Biomass Fuels in Carbon Emissions Trading Systems, Center for Clean Air Policy, Washington, DC.

Kopp, R., et al. (1998), Cheap Emission Reductions: Use `em or Lose `em**,** Resources for the Future, Washington, DC**.**

Kruger, J. and M. Dean (1997). "Looking Back on SO_2 Trading", Public Utilities Fortnightly, August.

Kruse, J. and M. Cronshaw (Forthcoming). Temporal Properties of a Market for Emission Permits with Banking. Markets for Pollution Permits: Theory and Experiments. C. Holt and M. Isaac, JAI Press.

Lanchbery, J. (1998). "Input To The Forthcoming UNCTAD Study On Greenhouse Gas Emissions Trading: Defining The Principles, Modalities, Rules And Guidelines For Verification, Reporting And Accountability" by VERTIC, London

Lentz, J. and P. Leyden (1996). "RECLAIM: Los Angeles' New Market-Based Smog Cleanup Program," Journal of the Air & Waste Management Association, March 1996, 195-206.

Loeb, A. (1995). Surmountable Obstacles to the Adoption of Emissions Trading Program: The Historical Perspective. Argonne National Laboratory, No. 95-TP65.07 (Washington, D.C.).

Loeb, A. (1996). A Short History and Analysis of the Lead Phasedown Lead Credit Market. Paper presented to MIT Center for Energy and Environmental Policy Research (Cambridge, MA).

Magat, W. and Viscusi, W. (1990). "Effectiveness of the EPA's Regulatory Enforcement: The Case of Industrial Effluent Standards," Journal of Law and Economics 33, 331-360.

Manne, A. and T. Rutherford (1994). "International Trade in Oil, Gas and Carbon Emission Rights: An Intertemporal General Equilibrium Model." Energy Journal 15(1): 57-76.

Matsuo, N. (1998). "Key Elements Related to the Emissions Trading for the Kyoto Protocol." Energy Policy 26(3): 263-273.

McLean, B.. 1995. "Lesson Learned Implementing Title IV of the Clean Air Act". USEPA Report Number 95-RA 120.04.

Michaelowa, A. (1995). Joint Implementation Of Greenhouse Gas Reductions Under Consideration Of Fiscal And Regulatory Incentives, HWWA-Report No. 153, Hamburg

Michaelowa, A. (1997) Efficient Incentives For Private AIJ And Their Political Implications, in: Pelchen, Arthur (ed.): Proceedings International AIJ Workshop, Leipzig, 5-6 March 1997, 123-126

Mintzer, I. (1994). Institutional Options and Operational Challenges in the Management of a Joint Implementation Regime, in: Ramakrishna, Kilaparti (ed.): Criteria for Joint Implementation under the Framework Convention on Climate Change, Woods Hole Research Center, 41-50

Mitchell, R. (1992), "From Paper to Practice," Ph.D. Dissertation, J.F. Kennedy School of Government, Harvard University.

Mullins, F. and R. Baron (1997), International GHG Emission Trading, 'Policy and Measures for Common Action' Working Paper No. 9, Annex I Expert Group on the UNFCCC, OECD, Paris.

Naughton, M.. (1994). "Establishing Interstate Markets for Emission Trading of Ozone Precursor"s, New York University Environmental Law Journal 3:195-249.

Naysnerski, W. and T. Tietenberg (1992). "Private Enforcement of Federal Environmental Law," Land Economics 68, 28-48.

OECD (1997). "International Greenhouse Gas Emission Trading, Annex 1 Expert Group On The UNFCCC" Working Paper No. 5, OCDE/GD(97)76, Paris

OECD (1998b), Ensuring Compliance with a Global Climate Change Agreement, ENV/EPOC(98)5, Organization for Economic Co-operation and Development (OECD), Paris.

OECD (1997). Lessons From Existing Trading Systems For International Greenhouse Gas Emissions Trading. OECD (1998a). "Key Issues In The Design Of New Mechanisms Under The Kyoto Protocol: A Scoping Paper", COM/ENV/EPOC/DCD/DAC/IEA(98)1, Paris

Ostrom, E. (1990), Managing the Commons (Cambridge: Cambridge University Press).

Parry, I., Williams III, R. and L. Goulder (1996), When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets, Resources for the Future, Washington, DC.

Richels, R. et al. (1996), The Berlin Mandate: The Design of Cost-Effective Mitigation Strategies, in N. Nakicenovic, W.D. Nordhaus, R. Richels and F.L. Toth (eds.), Climate Change: Integrating Science, Economics and Policy, IIASA CP-96-1, International Institute for Applied Systems Analysis, Austria, pp. 229-248.

Rubin, J. (1996). "A Model of Intertemporal Emission Trading, Banking , and Borrowing." Journal of Environmental Economics and Management 31(3): 269-286.

Russell, Clifford S. et al. (1986a), "Lessons from Game Theory Approaches" Enforcing Pollution Control Laws ,Washington, DC: Resources for the Future, Inc, 184-217

Russell, C. et al. (1986b). Enforcing Pollution Control Laws, Washington: Resources for the Future.

Sandor, R., J. Cole, et al. (1994). Model Rules and Regulations for a Global CO_2 Emissions Credit Market. Combating Global Warming: Possible Rules Regulations and Administrative Arrangements for a Global Market In $_{CO2}$ Emission Entitlements. United Nations Conference on Trade and Development. New York, United Nations: 61-105.

Scheinman, L. (1987), The International Atomic Energy Agency and World Nuclear Order, Washington: Resources for the Future.

Schwarze, Reimund and Peter Zapfel . (1998), Sulfur Allowance Trading and the Regional Clean Air Incentives Market: How Similar are the Programs Really? Discussion Paper 98/06 Technical University Berlin, Presented at the First World Congress of Environmental and Resource Economists, Venice , Italy (June).

Segerson, K. and T. Tietenberg (1992). "The Structure of Penalties in Environmental Enforcement: An Economic Analysis." Journal of Environmental Economics and Management **23**, 179-200.

Selmi, D. (1994). "Transforming Economic Incentives From Theory to Reality: The Marketable Permit Program of the South Coast Air Quality Management District," Environmental Law Reporter, December. 10695-10711.

Stewart, R. J. Weiner, et al. (1996). Legal Issues Presented by a Pilot International Greenhouse Gas Trading Sytem. Geneva, United Nations Conference on Trade and Development.

Sussman, F. (1998). "Compliance and Uncertainty in Emissions Inventories" a presentation at the UNCTAD Meeting on Verification and Accountability, April 6.

Sutherland, R. (1996), The Economics Of Energy Conservation Policy, Energy Policy No.4, 1996, 361-370

Swart, R. (1992). Greenhouse Gas Emissions Trading: Defining the Commodity. Climate Change: Designing a Tradeable Permit System. T. Jones and J. Corfee-Morlot. Paris, Organization for Economic Co-operation and Development Publication: 137-166.

Tietenberg, T. (1985). Emissions Trading: An Exercise in Reforming Pollution Policy. Washington, DC, Resources for the Future.

Tietenberg, T. (1990). "Economic Instruments for Environmental Regulation." Oxford Review of Economic Policy 6, 17-33.

Tietenberg, T. (1992a). Implementation Issues: A General Survey. Combating Global Warming: Study on a Global System of Tradeable Carbon Emission Entitlements. United Nations Conference on Trade and Development. New York:, United Nations: 127-149.

Tietenberg, T. (1992b). Relevant Experience with Tradeable Permits. Combating Global Warming: Study on a Global System of Tradeable Carbon Emission Entitlements. United Nations Conference on Trade and Development. New York:, United Nations: 37-54.

Tietenberg, T. (1995). Design Lessons from Existing Air Pollution Control Systems: The United States. Property Rights in a Social and Ecological Context: Case Studies and Design Applications. S. Hanna and M. Munasinghe. Washington D.C., The World Bank: 15-32.

Tietenberg, T. (1998). "Disclosure Strategies for Pollution Control." Environmental & Resource Economics 11(3-4): 587-602.

Tietenberg, T. and D. Victor (1994). Possible Administrative Structures and Procedures. Combating Global Warming: Possible Rules Regulations and Administrative Arrangements for a Global Market In $_{CO2}$ Emission Entitlements. United Nations Conference on Trade and Development. New York, United Nations: 1-60.

Tripp, J. and D. Dudek (1989), "Institutional Guidelines for Designing Successful Transferable Rights Programs", 6 Yale Journal on Regulation. 6: 381.

United Kingdom, Northern Ireland, et al. (1998) Non-paper on Principles and Modalities; Rules and Guidelines for an International Trading Regime (Bonn:FCCC/SB/1998/Misc.1/ Add.3).

United Nations Conference on Trade and Development. (1992). Combating Global Warming: Study on a Global System of Tradeable Carbon Emission Entitlements (New York: United Nations).

United Nations Framework Convention on Climate Change (1997). "Kyoto Protocol to the United Nations Framework Convention on Climate Change", FCCC/CP/L.7/Add.1, Kyoto

United States Department of State (1998), The Kyoto Protocol on Climate Change, United States Department of State (USDOS), 15 January, Washington, DC.

United States Energy Information Administration. (1994). "Electric Utility Phase I Acid Rain Compliance Strategies for the Clean Air Act Amendments of 1990." DOE/EIA-0582, Washington, DC. p. 14-20.

United States Environmental Protection Agency. (1994). Final Economic Incentive Rules, 59 Fed.Reg. 16690 (April 7, 1994).

United States Environmental Protection Agency. (1997). 1996 Compliance Report: Acid Rain Program, EPA 430-R-97-025.

United States General Accounting Office. (1994). Air Pollution: Allowance Trading Offers An Opportunity To Reduce Emissions At Less Cost (GAO/RCED-95-30).

United States Office of the President (1998). Economic Report of the President, Washington

United States. Environmental Protection Agency, (1995). Proposed Open Market Trading Rule, 60 Fed.Reg. 39668 (Aug. 3).

United States. Environmental Protection Agency. Emissions Offset Credit Trading Rules: 40 CFR 51.165 (a)(3), 51.165 (b)(3), 51 Annex S.

van der Burg, T. (1994). Economic Aspects, in: Onno Kuik, Paul Peters, Nico Schrijver (eds.). Joint Implementation To Curb Climate Change, Kluwer, Dordrecht, 73-126

Vaughan, S. (1997), Tradeable Emissions Permits and the WTO, Presented at the European Union Advanced Study Course on Goals and Instruments for the Achievement of Global Warming Mitigation in Europe, 20-26 July, Berlin.

Victor, D, G. (1992), "Practical Aspects of Implementing Greenhouse Taxes: Issues for OECD Countries," in: OECD, Climate Change: Designing a Practical Tax System (Paris: OECD).

Victor, D. G., (1991), "Limits of Market-based Strategies for Slowing Global Warming: The Case of Tradeable Permits," Policy Sciences 24, 199-222.

Vine, E., Sathaye, J. (1997). "The Monitoring, Evaluation, Reporting And Verification Of Climate Change Mitigation Projects: Discussion Of Issues And Methodologies And Review Of Existing Protocols And Guidelines", Berkeley

Viscusi, W. K. (1986). "The Impact of Occupational Safety and Health Regulation, 1973-1983," Rand Journal of Economics. 17, 567-580.

Zhang, Z.X. (1997), The Economics of Energy Policy in China: Implications for Global Climate Change, New Horizons in Environmental Economics Series, Edward Elgar, Cheltenham, England.

Zhang, Z.X. (1998), Greenhouse Gas Emissions Trading and the World Trading System, Journal of World Trade, Vol. 32, No. 5, (October).

Zhang, Z.X. and A. Nentjes (1998), International Tradeable Carbon Permits as a Strong Form of Joint Implementation, in J. Skea and S. Sorrell (eds.), Pollution for Sale: Emissions Trading and Joint Implementation, Edward Elgar, Cheltenham, England.