Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

OLIS : 03-Aug-1998
Dist. : 06-Aug-1998

English text only

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

ENV/EPOC(98)13/REV1
Unclassified

LESSONS FROM EXISTING TRADING SYSTEMS FOR INTERNATIONAL GREENHOUSE GAS EMISSION TRADING

Annex I Expert Group on the United Nations Framework Convention on Climate Change
Information Paper

68010

English text only

ACKNOWLEDGEMENTS

This paper was prepared by Fiona Mullins (OECD). Review and comments were provided by Jan Corfee Morlot (OECD) and Richard Baron (IEA). For United States SO_2 allowance trading, expert review was provided by the US Environmental Protection Agency and the US Department of Energy. For New Zealand's Individual Transferable Quotas for fisheries management, expert review was provided by the New Zealand Ministry of Fisheries, and the New Zealand Department for the Environment. For "industrial rationalisation" under the Montreal Protocol, expert review was provided by Jim Curlin and Rajendra Shende (UNEP IE OzonAction Programme), Dr. Robert Van Slooten (Co-Chair of the Economic Options Committee of the UNEP Technology and Assessment Panel under the Montreal Protocol), Ger Klaassen (European Commission), the US Environmental Protection Agency, and the US Department of Energy. For joint implementation provisions under the UN ECE Convention on Long-Range Transboundary Air Pollution expert review was provided by Henning Wuester (UN ECE LRTAP secretariat) and Ger Klaassen (European Commission).

FOREWORD

This information paper forms part of the work programme of the Annex I Expert Group on the United Nations Framework Convention on Climate Change (UNFCCC) on emissions trading. The paper was distributed widely to provide analytical input to negotiations under the UNFCCC Ad hoc Group on the Berlin Mandate.

This document is published on the responsibility of the Secretary-General of the OECD.

TABLE OF CONTENTS

INTRODUCTION

This paper reviews four systems for trading pollution reductions or "rights" to natural resources. Other examples of tradable permit systems could also provide useful insights but have not been reviewed due to time constraints.[1] The design of each system reflects the nature of the commodity and the type of environmental impacts of concern. Because of this, some features of these systems are clearly not relevant to greenhouse gas and the climate change problem. However, many ideas emerge from this review that could be useful for an international greenhouse gas emission trading system. The four systems reviewed in the following sections of this paper are:

SO_2 Allowance Trading. In the United States, a domestic system of SO_2 allowance trading allows large sources to reduce SO_2 emissions at lower cost (both to industry and the government) than would have been possible without trading. The trading system gives electric utilities incentives to find the most cost-effective ways to reduce SO_2 emissions that contribute to acid deposition.

Transferable Fish Quotas. The New Zealand government created Individual Transferable Quotas (ITQ) to move the domestic commercial fishing industry towards sustainable fish harvesting. Fishers have rights to a proportion of limits set by the government for each fish species. The limits change as needed to ensure sustainable fish harvesting, but fishers' proportional rights remain the same. This system provides an example of how flexibility to change emission (or fish) limits can be achieved.

Montreal Protocol "industrial rationalisation". The "industrial rationalisation" provisions of the Montreal Protocol enable industry to transfer ODS production quota to companies in other countries as the ODS phase-out schedule progresses.

Oslo Protocol rules for "joint implementation". The Oslo Protocol of the Convention on Long-Range Transboundary Air Pollution (LRTAP) addresses acid deposition from SO_2 emissions for UNECE countries. Parties have not yet approved rules for trading, and the Protocol has not yet entered into force. Consequently, no trading has taken place under the Oslo Protocol to date. The possible acid deposition effect on third parties has greatly hampered agreement on the rules for trading (this difficulty is not relevant to greenhouse gases).

Some of the most useful experience of fully fledged trading systems comes from the two domestic systems reviewed in this paper. The two international systems reviewed are more limited in the type and amount of trading that is allowed. However, the Oslo Protocol and the Montreal Protocol provide examples of trading systems that have been, or are being, agreed at the international level. The international monitoring, reporting and enforcement functions that have been established for these systems could be very relevant to international greenhouse gas emission trading.

1. For example, trade in water rights, other tradable fish rights systems, and emission credit trading in the United States.

I. UNITED STATES SO_2 ALLOWANCE TRADING

Introduction

The United States 1990 Clean Air Act amendments include provisions for SO_2 allowance trading among electric utilities. The program is being implemented in two phases. The first phase of the SO_2 allowance compliance programme began in 1995.[2] In Phase I, the programme includes only large coal-fired electric utilities (almost all utilities will join in the year 2000 when Phase II begins).[3] However, it is already evident that many features of the Acid Rain program (for which allowance trading is the key implementation tool) are successful. These include legally binding emission limits, stringent monitoring, high penalties for non-compliance, relatively low transaction costs for participants, and low administration costs for government.

Compared to the cost of traditional regulations, SO_2 allowance trading has reduced the costs of lowering acidification.[4] The flexibility that trading provides enables electric utilities to comply with their commitments at lower cost. For example, under a performance standard with no trading, utilities need to ensure that emissions remain within the standard during maintenance of scrubbers or periods when electricity demand increases. In a trading system, utilities can purchase allowances to cover these circumstances. The United States SO_2 allowance trading system is under-pinned by legislation, effective regulatory institutions, and well-developed monitoring systems. The United States has a long history of requirements for industry to comply with environmental legislation. The United States also has 20 years of experience with emission trading systems of various types.

2. The Allowance Tracking System and the Emissions Tracking System began operating in late 1993. Consequently, both allowance trading and data reporting activities began before 1995, which was the first year compliance with emission limits was required.

3. From January 1995, 110 large coal-fired electric utilities located in the eastern and mid-western states were required to join Phase I of the Acid Rain Programme and their 263 boilers were given individual emission limits. Approximately 180 boilers that voluntarily joined the programme early in order to earn SO_2 allowances to bank for future use (the number of volunteers changes each year) were also given emission limits. There are about 2 050 electric utility boilers in the United States. In the year 2000, the remaining boilers (those with an output capacity of 25 megawatts or greater, and all new utility units that use fossil fuels with a sulphur content greater than 0.05 per cent) will be required to join Phase II of the Acid Rain Program and will be given emission limits.

4. It is estimated that the cost of compliance with SO_2 trading is $2.0 billion per year, compared to a cost of $4.9 billion for a traditional regulatory approach without trading (GAO, 1994).

Emission limit

National goal

The goal for national SO_2 emissions in the continental United States is to limit emissions to 16 million tons of sulphur dioxide (Mt SO_2) per year by the year 2010. If achieved, this would be a reduction of 10 Mt SO_2 from 1980 national emissions of 26 Mt SO_2 (a reduction of almost 40 per cent). Analysis established that this reduction would lower the adverse effects of acid deposition.

Sectoral emission limit

In order to achieve the national goal, the United States has established an emission limit (called a "cap") for its electricity production sector. The legislation for the emission limit was an amendment to existing legislation (Title IV of the 1990 amendments to the Clean Air Act). This "permanent" SO_2 emissions limit for the United States electricity production sector is 8.95 Mt SO_2 per year from the year 2010.[5] The 263 Phase I utility boilers listed in the Clean Air Act received an overall emission limit of 7.1 million tons in 1995. Their overall limit was 7 million tons in 1996, and will be lowered again to 6.0 million tons for each of the years 1997-1999. In the year 2000 when the Phase II utilities enter the system, the limit will no longer be applied to just the Phase I utility units. An overall limit of 9.48 million tons will apply to all Phase I and Phase II utilities together for the years 2000-2009.[6] From the year 2010, the "permanent" sectoral cap of 8.95 million tons will be fully implemented.

Emission limits for individual boilers

The 1990 Clean Air Act required monitoring of emissions from every United States electric utility boiler. The government allocates annual emission limits to each boiler of each electric utility participating in the program. The individual boiler emission limits are based on each boiler's average 1985-1987 energy production levels at standard SO_2 emission rates (SO_2/Btu). The Clean Air Act specifies the emission rates for different types of boiler. Emission limits based on these formulas do not exactly meet the sectoral emission limit. The limits are ratcheted down proportionally for each participant to ensure that the allowances issued equal the sectoral emission limit. Sources that were not yet producing in 1986 but that began operation by the end of 1995 receive allowances based on an agreed formula. New sources that began operation after 1995 do not receive an allocation of allowances, but must purchase them from existing utilities.

---

5. In 1980, the electricity sector emitted 17.5 Mt SO_2, so this emission limit represents a reduction of nearly 50 per cent from 1980 levels. By 1994, the sector was responsible for 14.8 Mt SO_2, so the emission limit represents a reduction of about 40 per cent from the year before the Acid Rain Program started.

6. The legislation allows 3.5 million extra "bonus" allowances to be allocated in Phase I as an incentive for utilities choosing to build Flue Gas Desulphurisation systems (scrubbers) which reduce SO_2 emissions by 90 per cent to 95 per cent. Thus, the basic allocation for Phase I boiler units is approximately 5.5 million allowances for each of the years 1995 to 1999, but the bonus allowances raise these limits to 7.1 million tons in 1995, 7.0 million in 1996, and 6.0 million for the years 1997-1999. Some (530 000) bonus allowances will continue to be allocated in each of the years 2000-2009, so that the cap in those years is actually 9.48 million tons. The bonus allowances will not exist after 2010, when the 8.95 Mt cap will come into effect.

Participants in Phase I of the programme have remained well below the overall limits set for them. Many Phase I participants have not had to purchase SO_2 allowances to meet their emission limits. Consequently, extensive trading has not yet been necessary, and the price of SO_2 allowances is much lower than expected. Some reasons for this are:

- The initial allocation was based on historical production levels ("grand-fathering") and the lower of the actual or allowable SO_2 emission rate (to reflect relative need). The emission limits in the initial phase of the programme reflect normal electricity production levels, although at reduced emission rates. The initial overall emission limit for Phase I utilities was consequently not too difficult to meet;[7]

- There was an unexpected supply of low-cost compliance options available to utilities, such as the increased availability of cheaper low sulphur coal due to de-regulation of railways; and

- Trading reduces the need for spare SO_2 scrubber capacity to cover periods of maintenance and unplanned outage. The Acid Rain programme also provided incentives for development of more efficient scrubbers and increased competition between suppliers, which has reduced the cost of scrubbers.

Many utilities have transferred emission reductions from one boiler to another within the same company. Fewer utilities are expected to rely heavily on inter-utility trading in Phase I. The majority of market activity involves the shifting or redistribution of allowances within one utility's (or group of utilities') holdings.[8] Approximately 20 per cent of private transfers to date have occurred between economically distinct entities. However, fewer than 25 per cent of all utility boiler units participate in Phase I of the program, so trading during Phase I cannot be taken as an indicator of long-term SO_2 allowance trading.

When Phase II boilers join the programme in 2000, the annual emission caps for both Phase I and II boilers will follow a common formula. From the year 2000, the sectoral emission limit is more likely to be one that requires emission reduction from the sector, and consequently greater demand for allowances is expected.

---

7. For example, a boiler unit burning high-sulphur coal in 1985 which emitted 6.0 lbSO_2 per million Btu, and which ran at 80 per cent capacity producing 10 269 000 million Btus would have emitted 30 807 tons of SO_2 in 1985. For the SO_2 allowance programme, that unit would have received an initial allocation based on its historical 10 269 000 million Btus, but would have been allocated allowances at 2.5 lb. SO_2 per million Btu (12 837 allowances) and in 2000, the allocation will be based on 1.2 lbSO_2 per million Btu (6 161 allowances).

8. The volume of allowance transfers reported to EPA's Allowance Tracking System (ATS) has doubled annually since the first transfers were recorded in 1994. As of December 31, 1996, ATS had recorded the transfer of more than 51 million allowances in over 3 100 transactions. Of these 51 million allowances, over 34 million were transferred by utilities from one account to another (the remainder were transfers from EPA to private parties under various provisions of the Clean Air Act). According to EPA's analysis, approximately 27 million allowances have been transferred within utility companies, and over 7 million allowances have been transferred from one utility company to some other entity, for example, either directly to another utility or through an allowance broker. (source: US EPA comment on early draft).

Banking

Banking has enhanced incentives to reduce emissions. If emissions from a boiler are lower than its emission limit, the unused SO_2 allowances (emission limit minus actual emissions) remain valid for use in future years. Participants can either sell unused SO_2 allowances to other participants or bank them for use or sale in future years. However, participants cannot use allowances before the year they are issued. To date, Phase I utilities that have been able to reduce their SO_2 emissions have tended to bank their allowances. They may use these allowances to offset future emissions when stricter emission limits come into force, or sell them when the allowance price is more favourable.

Participants are certain of their future emission limits

The Clean Air Act legislation specifies the permanent sectoral emission limit. Because it is set in legislation, this limit would be difficult to change. Each boiler receives individual annual emission limits for 30 years from the time they enter the programme. Each participant has an account that contains their allocation of allowances for each year from the time they enter the trading system until the year 2030. At the end of each year, the government allocates the 31st year of allowances. Participants may transfer allowances to others in perpetuity, i.e. extending beyond 30 years, if they wish. Phase I and II boilers will continue to receive their annual allocation of allowances each year, even if they close. There is consequently no incentive for utilities to keep old boilers operating just to continue to gain their allocation of allowances. Allocation to boilers that have shut down also ensures that there will be a supply of allowances for new entrants in the future without necessitating any increase in the sectoral emission limit.

Who trades

The main participants are large, easily monitored sources

Coal-fired electricity is the major source of SO_2 emissions and is easy to monitor. The electricity sector is the main target of the SO_2 allowances programme, and the main SO_2 traders are coal-fired electric utilities. The programme will eventually include around 2050 electric utility boilers. The programme excludes the smallest electric utilities (boiler units serving generators that are less than 25 megawatts) for reasons of practicality. It is more cost-effective (in terms of \$/t SO_2) and more feasible to control the 2000 or so "large" electric utilities only.[9]

Opt-in provisions allow sources that are not targeted by the SO_2 programme to participate on a voluntary basis. Under these provisions, some Phase II electric utilities and several industries (that are eligible, but not required, to join the programme) may choose to join Phase I of the programme. Opt-in volunteers must comply with the same or similar provisions as the targeted utility units. The opt-in participants only receive credit for actions taken to reduce their emissions rates, not for reducing production or for ceasing operation. If an opt-in facility reduces emissions below its emission allocation, it can sell its unused allowances in the SO_2 allowance market. Examples of eligible sources for opt-in include utility units serving generators less than 25 megawatts, industrial boilers, and municipal waste combustors. Many opt-

9. The 2000 boilers that are required to participate in the programme emitted over 99 per cent of the SO_2 emissions from the utility sector in 1995.

in participants joined the program in order to gain SO_2 allowances for future use or sale.[10] The opt-in provisions of the Acid Rain program offer financial incentives to facilities that volunteer to reduce their SO_2 emissions. Some Phase II units could also gain exemption from revised NO_x emission limits by joining Phase I.

Clear rules for introducing new sources

New sources that join the programme, other than the Phase I and II boilers with grand-fathered allocations, receive no allowances from the government. They will have to purchase SO_2 allowances from Phase I and II participants.

Anyone can trade

Any individual can buy and sell allowances. Electric utilities can sell allowances to anyone, and the buyers can, in turn, re-sell allowances to others. For example, some students and environmental non-governmental organisations have bought allowances (e.g. to retire SO_2 allowances from the market and reduce pollution).

What is traded

Clearly defined, homogenous unit of trade

The unit of trade is called an "SO_2 allowance". Each allowance is dated and entitles the holder to emit one ton SO_2 in the year of issue. If they are not used in the year of issue, the allowances remain valid for any future year. Although NO_x also contributes to acidification, participants cannot trade NO_x reductions (or increases) for SO_2 increases (or reductions). The SO_2 allowance is an "authorisation to emit", rather than a "property right". Under United States law, this subtle distinction in the definition of allowances means that the United States government could take away utilities' allowances if they needed to. However, the emission limit is firmly established in legislation and would be difficult to change, so it is unlikely that the government would take away utilities' allowances. There is no geographic differentiation of SO_2 allowances even though, unlike greenhouse gases, the location of SO_2 emissions affects their environmental impact.

No restrictions on trade

There is no restriction on the proportion of allowances that participants can sell. Participants could, in theory, sell their entire allowance allocation and buy back enough allowances to ensure they are in compliance at year end. Participants can emit above their emission limit during the year, as long as their emissions account (emissions plus allowances bought minus allowances sold) balances at year-end. In practice, participants only sell allowances they are sure they will not need. There are transaction costs to trading and the penalties for non-compliance are high.

10. 113 Phase II boilers had SO_2 emission rates lower than the allocation rate, and 82 Phase II boilers were either not being fully used or were being retired. 81 units faced a low marginal cost of SO_2 reduction by switching to lower sulphur coal or increasing the removal rate of their scrubbers (ref. Schmalensee and Montero, presentation to MIT conference Sept 13, 1996).

Initial system implementation

After ten years of research and analysis on the environmental effects of SO_2 and the cost of reducing SO_2 emissions, a market-based approach was proposed for addressing SO_2 emissions in 1989.[11] Legislation was passed in 1990. The sectoral emission limit had to be complied with regardless of whether allowance trading was implemented. Industry consequently had a strong incentive to co-operate with the regulators to ensure they produced the necessary trading rules quickly. Extensive experience in the United States with earlier forms of trading helped to reduce the time it took to develop the SO_2 allowance trading rules. By March 1993, the EPA had issued all of the initial rules necessary to make trading possible, and began to implement them. The rules required were:[12]

- permitting to allow eligible utility boilers to participate (all permits were issued by the end of 1994);
- allocations of SO_2 allowances to all eligible utility boilers;
- procedures governing transfers of allowances;
- monitoring requirements (both Phase I and Phase II utilities installed and tested continuous monitoring systems CEMS that were certified by the EPA by the end of 1996); and
- rules covering non-compliance penalties and administrative appeals.

Some allowance transfers (e.g. futures contracts) took place as early as 1992. The first annual allowance auction took place in 1993. In 1994, Phase I units began reporting their emissions of SO_2, NO_x and CO_2 to EPA (Phase II units began reporting in 1995). The EPA's tracking system for monitoring emissions and transfers began operating in March 1994, but continued to be modified. Phase I units had to comply with the Acid Rain program emission limits from 1995. In July 1996, the EPA completed the first annual reconciliation to determine compliance.

System administration, monitoring, and reporting

Low administration costs

Government administration of the SO_2 emission monitoring system has been much cheaper than for other forms of regulation. In the first five years of the program, government expenditures were less than $60 million. Approximately 150 full time equivalent staff operate the program.[13]

Accurate measurement of emissions

In the United States, electric utilities have been required to submit some emission data to State authorities for many years. The Acid Rain program requires direct reporting to the EPA (a federal government

11. McLean, US EPA, December 1996, p. 6

12. McLean, US EPA, December 1996, p. 10

13. McLean, US EPA, December 1996, p. 5

authority). The SO_2 monitoring systems imposed additional costs on industry as participants must install continuous emissions monitoring (CEM) equipment for each electric utility boiler. The current cost to install a full suite of CEMs monitoring equipment to measure SO_2, NO_x, and CO_2 at a stack is approximately $120 000.[14] The monitoring equipment provides data on hourly discharges of emissions. Utilities submit this data to the EPA four times a year.

Automated emissions monitoring

The EPA uses a computerised emissions tracking system to calculate each boiler's cumulative emissions from the data submitted by utilities. This computerised system is no more complex than those used by insurance companies, banks and department stores in the United States. The EPA measures each boiler's annual cumulative SO_2 emissions at the end of the year to check that they are complying with their annual emission limit. The allowance tracking system keeps account of:

- allowances that are issued;
- allowance holdings in each utility's allowance account;
- holdings of allowances in EPA reserves such as the CRER (discussed below);
- the deduction of allowances due to non-compliance; and
- allowance transfers.

Minimal government approval process lowers transaction costs

Participants do not have to notify the EPA when they have negotiated a trade. Individual trades are not approved by the government either before or after they take place. The EPA records trades at the end of each year when each utility must show that it holds enough allowances to cover its emissions. If transfers have occurred, the utility must present a simple form to EPA detailing the allowances that they have transferred. Transactions usually take less than 30 minutes to record and the EPA processes them within 24 hours of receipt.[15]

Enforcement

Strong penalties

There is a high degree of confidence in the allowance trading system because non-compliance is easily discovered and the penalty for non-compliance is expensive. If SO_2 emissions exceed the number of allowances held by a participant, the EPA imposes statutory penalties. Every excess ton of SO_2 emitted

14. Note, the Acid Rain Program regulations only require CEMs for coal-burning utilities where the pollutant concentration is inherently variable and must be monitored very frequently to obtain high accuracy. When utilities burn oil or gas, they may use less expensive monitoring equipment which they can also use to track the amount of fuel they burn.

15. McLean, US EPA, December 1996, p.11

automatically incurs a fee of $2,500.[16] This fee is much higher than the price of SO_2 allowances (analysts expected the marginal cost of reduction to be between $300 and $800 per ton, but allowance prices were around $100 per ton in 1996). In addition to this fee, the EPA deducts one allowance from the participant's entitlement for the following year for each ton over their emission limit. This deduction is automatic. The Clean Air Act defines the provisions for these penalties. It is a violation of federal law (and thus subject to criminal enforcement) to fail to comply with provisions of Title IV of the Act. The enforcement agency (the EPA) has both the mandate and capacity to carry out the required penalties. These strict enforcement provisions have facilitated political acceptance of trading.

Market mechanisms

Annual auction

The Chicago Board of Trade holds an annual auction on behalf of the US Environmental Protection Agency (EPA). At this auction, the EPA sells about 2.8 per cent of total allowances that it holds back from each utilities' annual allowance allocation as a special reserve. The auction delivers signals on allowance prices and ensures that allowances are available for new power producers or producers who want to increase production. The EPA distributes money from auctioning the special reserve to utilities based on the number of allowances that were with-held from them. Once the special reserve has been sold in the auction, privately held allowances are auctioned. The auction was considered very important initially to jump-start the market by enabling allowances to be traded easily. The design of the auction is not ideal, however; each bidder pays the price that s/he bids. This design created uncertainty over the clearing price in the early stages of trading, and provides incentives for participants to bid lower than they would otherwise. It may be preferable to have an auction where all successful bidders pay the market clearing price.[17]

Trading among utilities

Trading has increased steadily since 1994. The number of private allowance transactions has increased from 215 in 1994, to 613 in 1995, to 1074 in 1996. The cumulative total was 1 902 transactions, which represented 34.2 million allowances. Most of these transfers occurred between boiler units within companies. However, the number of allowances transferred between companies has increased from 0.9 million in 1994, to 1.9 million in 1995, to 4.4 million in 1996. In addition, there is likely to be a significant amount of trading activity taking place that the EPA has not yet officially recorded.

Information

Participants do not notify the EPA of the price at which they bought or sold the allowances. Private sector exchanges and trade information brokers collect and record information on the price of allowances. Trade

16. The fee was initially set at $2 000/ton. The fee is indexed to inflation so that it changes each year in line with the Consumer Price Index. The fee for exceeding the 1996 emission limits was approximately $2 500/ton. (EPA personal communication).

17. Under this design, the market price would be determined once all prices and quantities offered for sale/purchase were matched e.g. highest buyer matched with lowest price allowances offered for sale and so on until all possible sales/purchases had been matched.

association newsletters and electronic bulletin boards quoting prices and quantities of allowances sold have become features of the market.

Strategic reserve

The US government has created a Conservation and Renewable Energy Reserve (CRER) by holding back a small proportion of allowances from each participant. A pool of 300 000 allowances has been set aside. A utility can earn one bonus allowance from the CRER for every 500 MWh of demand-side management (DSM) energy saved or renewable energy generated. The number of bonus allowances per unit of energy is based on a calculation of emissions avoided according to a series of verification protocols that the EPA has developed.

Other policies and measures

The SO_2 allowance trading system is the main implementation tool of the Acid Rain Program, but utilities must also comply with other policies and measures. Utilities participating in the SO_2 allowances programme must comply with all other requirements of the Clean Air Act. Air pollution regulations limit SO_2 emissions at local and regional levels to ensure that health and environmental quality standards are maintained, for example:

- health protection under the "National Ambient Air Quality Standards" and "New Source Performance Standards" which limit SO_2 emissions per Btu;

- environmental protection under the "Prevention of Significant Deterioration" provisions to ensure that areas with relatively clean air do not become polluted.

State utility regulations

Utilities that participate in the SO_2 allowance trading programme are bound by state regulations. Some state regulations could inhibit allowance trading, but they are considered necessary to meet other policy goals such as employment, health and other environmental objectives. Some states with substantial Phase I compliance obligations have enacted rules or incentives that favour the use of local coal. These measures tend to increase the cost of compliance. For example, some state governments require users of high sulphur coal to install scrubbers that reduce SO_2 by 90 per cent to 95 per cent which stops them from switching to low sulphur coal.

II. TRANSFERABLE QUOTAS FOR COMMERCIAL FISHERIES IN NEW ZEALAND

Introduction

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 TACCs and ITQ for commercial fishers have enabled New Zealand to move commercial harvesting towards sustainable levels. Prior to the introduction of ITQ, the New Zealand fishing industry was over-capitalised and there was over-fishing in New Zealand in-shore fisheries. ITQ have provided incentives for fishers to manage their capital stock and fishing rights more effectively. Industry is now more interested in ensuring the future health and sustainability of the resource. The economic performance and competitiveness of many fishers have improved, or at least not declined. ITQ facilitated industry re-structuring as some fishers decided to sell out and seek other employment.[18] Alternative policies were estimated to cost the government more in the long-run.[19]

Catch Limits

Overall limit - Total Allowable Catch (TAC)

The Minister of Fisheries can review the TACs each year, if necessary. In 1986, the government set TACs for most of the commercially significant in-shore species. Separate TACs apply to 33 fish species, or species groups, in clearly defined quota management areas.[20,21] The main consideration for setting the

18. In June 1987, the three largest consortiums owned 43 per cent of the ITQ by tonnage, and by March 1992, they owned 50 per cent. Three large ITQ holders, who held 20 per cent of the ITQ by tonnage in 1987, have since left the industry and sold their quota to others. In some fisheries, the ownership of ITQ has become more widespread than it was before the ITQ system.

19. For example, an alternative policy to is to buy back excess boats and gear for sale or destruction to reduce over-capitalisation. It was estimated that this policy was estimated to cost NZ$20 million, and it was recognised that this would not secure a long-term solution.

20. Approximately 130 species are fished commercially in New Zealand's 200 mile limit, but only 40 are commercially significant. When the ITQ system was first established in 1986, 28 fish species were included. Five additional species have been added subsequently. The objective is to introduce all commercial species into the ITQ system as soon as is practicable.

21. There are 10 clearly defined fisheries management areas within New Zealand's EEZ. Species are managed as stocks, therefore the number of quota management areas depends on the number of stocks. For example, in the case of hoki, there are 2 quota management areas: the first Hoki quota management area is made up of fisheries management areas 1 to 9; and the second Hoki quota management area is fisheries management area 10.

TAC is to achieve sustainable harvest of fisheries resources. The Minister adjusts the TACs on the basis of the latest stock assessment information, advice from the Ministry of Fisheries, and following extensive consultation with stakeholders (including Maori, commercial fishers, recreational fishers and environmental groups). All stakeholder groups are involved in discussion of stock assessment information, and they often give conflicting advice to the Minister of Fisheries.[22] Criteria for setting TACs are set in legislation. The criteria specify that TACs must be set so as to move towards, or maintain, maximum sustainable yield (MSY) levels.[23] However, there is lack of clarity in the Fisheries Act 1983 about the use of MSY to set the TAC. The government has wide discretion in setting the MSY targets, and in deciding how quickly a fish stock should move toward these targets. There is still significant uncertainty for many fish species over maximum sustainable levels. Initially, TACs for most species were based on catch history data rather than research. For example, the first TACs for over-exploited in-shore species were set at between 24 per cent and 75 per cent of the pre-ITQ catch levels. TACs for newly exploited deep-water species that were unlikely to be close to unsustainable levels were at less stringent levels.

Limit for commercial fishers - Total Allowable Commercial Catch (TACC):

A TACC is the share of the TAC that commercial fishers can harvest. TACCs thus set an overall limit on the commercial fish harvest. The TACC cannot exceed the TAC for each species, but it can equal the TAC for some species where there is no interest in the resource by recreational or Maori customary fishers (e.g. deep-water species).

Limits for individual commercial fishers - grand-fathered allocations of ITQ

In 1986, the government assessed commercial fishing permit holders' best recorded catches in two of three historic fishing years (1981, 1982, 1983). This catch history information was the basis for individual allocations of ITQ.[24] The government also took into account the "commitment and dependence" of fishers on the fishery. The sum of the ITQ allocated on this basis exceeded the desired TACC for some fish stocks. To correct for this, the government purchased 15 800 tonnes of ITQ from existing fishers and

22. In addition to normal differences of perspective among different stakeholder groups, there are two problems with the current system which can provide incentives for conflict. Because of the poor specification of non-commercial fishing rights (non-commercial catch is not limited by the TACC, although individual limits and other measures apply to recreational fishers) and their inadequate integration with commercial fishing rights, commercial fishers consider that TACC cuts result in re-allocation of harvesting rights to the non-commercial sector. Another problem is a lack of certainty over the maximum sustainable yield (MSY) target. The qualifying factors in the use of MSY in the Fisheries Act and the lack of criteria on the rate at which the fish stock should move towards the size that will support MSY have resulted in differences of interpretation and conflict.

23. Maximum Sustainable Yield is defined in the Fisheries Act 1986 as the greatest yield that can be achieved over time while maintaining the fish stock's productive capacity, having regard to the population dynamics of the stock and any environmental factors that influence the stock.

24. The total catch thus calculated was approximately 560 000 tonnes of fish.

retired these ITQ from the market.[25] An appeal process resulted in allocation of further ITQ and increased the initial TACCs by around 10 per cent.[26]

Flexibility to change the limits

The Minister of Fisheries can review TACCs each year, if necessary. In preparing advice for the Minister on TACs and TACCs, the Ministry of Fisheries consults with commercial fishers, recreational fishers, customary Maori fishers, and environmental groups. The TACCs have changed (both up and down), when necessary. In some years significant changes have been required to ensure sustainable harvest of fish stocks. From 1986 to 1990, the ITQ were fixed tonnages of fish per year. The government had to buy and sell quota to ensure the sum of ITQ equalled the TACCs. This system placed a significant expense on the government whenever they tightened the TACCs. Since 1990, ITQ have been defined as proportions of the annual TACC for each fish stock. Under this system, ITQ proportions of the TACC remain the same, but the tonnage represented by the ITQ may vary each year according to changes in the TACC. TACC reductions are no longer compensated by the government, so industry bears the sustainability risks. However, industry also receives extra ITQ at no cost for any TACC increase.[27]

Borrowing

At present, fishers may "borrow" up to 10 percent of the following year's ITQ for each species. Borrowing allows them to exceed the current year's ITQ. However, if fishers borrow 10 per cent, they must limit their catch to 10 per cent below their ITQ holding in the following year. Borrowing is administratively complex and has caused enforcement problems. This provision will no longer be allowed when the system is simplified in 1998/99 under the Fisheries Act 1996.

Banking

TACCs have been substantially under-caught in some species. Under-catching represents a cost to the industry, but helps to conserve the stock. At present, 10 per cent of unused ITQ can be used in the following year. Under the Fisheries Act 1996, this provision will be removed when the system is changed in 1998/99. However, consideration is being given to retaining the banking provision in some form. Banking is considered to give fishers a useful forward trading mechanism and is not thought to add significant administrative or enforcement complexity.

---

25. The government spent NZ$45 million ($2 848 per ton on average) on this "restructuring assistance scheme". The level of compensation for the ITQ was based on the value of each species (from fishers' estimates and what the government estimated to be reasonable).

26. A Quota Appeal Authority was set up to give ITQ holders the opportunity to have their concerns regarding ITQ allocations reviewed and to change allocations if necessary. For most species, the appeal process took between three and four years to complete. Over 2 000 appeals were heard, of which about 1 000 resulted in additional quota being allocated and 100 resulted in reductions. Existing quota holders have realised that appeals dilute their rights and have called for a time limit to be placed on new appeals and for representation at appeals hearings. The Fisheries Act 1996 provides for a new process for allocation of ITQ with significantly stricter criteria for review of ITQ allocations.

27. Fishers were provided compensation by the government for fishing harvest rights they lost through the move to a proportional ITQ system. Between 1990 and 1995, fishers were compensated for ITQ reductions which resulted from TACC reductions. After 1995, no further compensation was offered.

Flexibility for "by-catch"

At present, there is a range of flexibility provisions to take into account "by-catch" (i.e. a species caught unintentionally along with the species that is being harvested). The majority of these provisions will remain when the Fisheries Act 1996 is implemented. The section on enforcement, below, discusses these provisions.

Who trades

The participants in the ITQ trading system are commercial fishers. Initial allocations of ITQ were granted to approximately 2 500 commercial fishing permit holders, not to crew or to down-stream processors. All commercial fishers receive ITQ, subject to minimum quota holding provisions. TACCs do not apply to recreational fishers or Maori customary fishers. Ventures with more than 25 per cent foreign ownership cannot own ITQ. However, a significant portion of deep-water TACCs is harvested by foreign vessels under commercial charter arrangements with the New Zealand ITQ owners. New entrants to the industry have to purchase ITQ from existing ITQ owners, or enter a contractual arrangement to lease or "fish against" the ITQ of an existing owner.

What is traded

Individual transferable Quotas (ITQ) are the unit of trade. ITQ are a "harvesting right" to the fishery and are secure property rights in perpetuity for a species of fish from a particular area. Initially, ITQ were expressed as a harvest right to a fixed tonnage of fish. From 1990, ITQ have given the holder access to a proportion of the TACC from a fishery. Each year, the proportional ITQ are converted to tonnes of fish that can be harvested in that year. For example, if a fisher's ITQ is 2 per cent of the TACC for a certain fish species, and the TACC in a particular year is 1 000 tons, the fisher's ITQ for that species in that year is 20 tons.

ITQ are fully transferable, with some exceptions:

- quota aggregation restrictions prevent very large ITQ holdings that could lead to abuse of market power and protect small fishers;
- minimum quota holding provisions require participants in the ITQ system to be of a certain size to make it feasible to allocate ITQ and to monitor their catch;
- holders must be New Zealand residents or companies less than 25 per cent foreign owned or controlled;
- Fishers cannot use ITQ for one species to harvest any another species, except for a few special cases such as species that may be caught as "by-catch" during harvest of another species.

Future simplification of ITQ system

Under the Fisheries Act 1996, future changes will make it easier to monitor compliance. From 1998/99, the tradable units will be both Annual Catch Entitlements (ACE) and ITQ. ACE will be a tonnage of fish harvesting rights that equal the share of the TACC that is represented by each commercial fisher's ITQ holding. The ACE's will represent a fisher's tonnage of harvesting rights for the year. The ITQ will represent the fisher's perpetual right to a fixed proportion of the TACC.

Initial system implementation

The legislative context for ITQ in New Zealand is relatively simple. Central government is responsible for fisheries management. The fishing industry is governed by the Ministry of Fisheries. There are currently two pieces of legislation governing fisheries: the Fisheries Act 1983; and the Fisheries Act 1996.

The New Zealand ITQ system was resource intensive for the government in 1986 when ITQ were first allocated. In the initial stages, the government had to carry out the following tasks:

- establish the catch history of commercial fishers;
- decide initial allocations based on catch history and "commitment and dependence";
- settle appeals to initial allocations; and
- set up monitoring and surveillance systems.

The ongoing cost of administration and monitoring are similar to those of other fisheries management controls.[28] Processes for introducing additional fish species have been streamlined under the Fisheries Act 1996.

The government introduced a prototype quota trading system in 1983 to manage deep-water resources. This system gave New Zealand experience on which to for developing the ITQ system.[29] The initial allocation for deep water species in the prototype system was relatively uncontroversial, compared to allocations for in-shore fisheries. There was less competition for deep water resources, and companies did not have security of access to the resources under an open-access, competitive system. In addition, all companies had an interest in a system that protected the new investments required to exploit the deep-water resource.

System administration, monitoring and reporting

Administrative process

The Ministry of Fisheries is responsible for monitoring the ITQ system. Each year, the government checks the catch records of commercial fishers against their ITQ holdings. The number of staff needed for monitoring ITQ paper flows increased by 10 per cent compared to the previous management system.

Monitoring paper records

Because there are many landing points around the country, dockside monitoring of fish catches would be very expensive. Consequently, the main control point is the first receiver of fish. The first receiver of fish must attest that all of the fish product they receive can be matched with ITQ. They must also keep a

28. The cost of fisheries management did rise slightly after introduction of ITQ because more highly qualified staff were needed and staff numbers increased (OECD, 1993, p. 60)

29. With the expansion of New Zealand's Exclusive Economic Zone in 1978 to 200 miles, New Zealand was able to exercise sovereign rights over deep-water fish resources.

record of the fish products they sell. The system relies heavily, though not exclusively, on paper records. These records include catch and landing reports by fishers, and records of product flows to and from fish receivers. The government investigates the paper records to detect inconsistencies that could indicate mis-reporting of catch. Paper trail monitoring enables the government to detect mis-reporting even long after the offence occurs.

Satellite surveillance and observers

Satellite surveillance is used to check which management area vessels are fishing in. Since January 1994, certain classes of vessel (e.g. deep-water, foreign licensed, and for some species) have been required have an approved transponder for satellite monitoring. Satellite surveillance can identify individual vessels and the area they are in when they are at "fishing speed. Fishers must carry an observer if they intend to fish in two different management areas or outside New Zealand's Exclusive Economic Zone (i.e. beyond the limits of the ITQ management areas).

Enforcement

Administration

The Ministry of Fisheries is responsible for enforcement. The government initially concentrated its resources on getting the system administration in place. Consequently, enforcement efforts did not begin until several years after the introduction of the system.[30] The ITQ system has not required an increase in the number of fisheries' enforcement staff. Approximately 100 fisheries officers hold extensive legal powers enforce the ITQ system.

Surveillance, inspections

Fisheries officers investigate suspicious operations if the paper trail monitoring detects inconsistencies. Specialised teams gather intelligence and carry out physical surveillance, under-cover checks on physical flows, and random inspections of vessels, fish receivers, and fish dealers.

Prosecutions and penalties

The government has brought several successful prosecutions against long-standing illegal operations. The government can initiate legal action for the harvest of any fish managed under the quota management system that are not covered by ITQ. Fisheries cases are tried before a judge (not a jury) in the general criminal courts. Large economic benefits are available to anyone who catches fish without having to acquire ITQ, so the incentives to cheat are high. High penalties for non-compliance reflect the large present and expected rents that ITQ represent. Quota, vessels, and equipment can be forfeit, and monetary penalties up to NZ$250 000 can be imposed. Forfeiture of vessels and quota regularly occurs, but heavy

30. Resources were initially concentrated on getting the administrative systems right. This delay in setting enforcement mechanisms probably allowed bad habits to develop that were much more difficult to address later on. (OECD "The Use of Individual Quotas in Fisheries Management" Paris, 1993, p. 49)

fines are seldom imposed. The threat of forfeiture has allowed the system to maintain a high level of integrity even when, in the early years of the system, the probability of detection was low.

Over-fishing provisions

Fishers who do not comply with their ITQ limits are subject to prosecution. However, there are two types of action that fishers can take if they have exceeded their ITQ holdings. The first type of action gives the fisher absolute defence against prosecution, and consists of four different options:

- Fishers may purchase additional ITQ to cover their overfishing within a "reasonable period" (the period considered "reasonable" varies for different species, and is shorter for fishers that have been non-compliers in the past).
- "By-catch" provisions allow fishers to cover accidental catch of one species with ITQ for another species. For example, fishers are allowed to exchange ITQ for one by-catch species for another at specified ratios based on the value of the fish.
- 10 per cent borrowing from the following year is allowed (this provision will not apply after 1998/99, due to administrative problems and resultant compliance difficulties).
- Fishers can "fish against" unused ITQ held by another fisher (this provision will not apply after 1998/99).

The second type of action gives fishers only a qualified defence from prosecution - the government may still decide to prosecute. Options include:

- Surrendering the extra fish to the government.
- Paying a "deemed value" fee for the extra fish. This fee discourages over-fishing, but is not so high that fishers have an incentive to dump any extra fish at sea.

These multiple compliance provisions have increased the complexity of the ITQ system. However, the number of ITQ and TACC overruns has decreased as industry has gained more experience with ITQ.

Future simplification of the system

From 1988/89, under the Fisheries Act 1996, the actions fishers can take if they are fishing without ACE will change. The options available will depend on whether the fisher is in an "annual balancing" regime or a "monthly balancing" regime. As these titles suggest, the regimes relate to the amount of time fishers will have to cover their catch by obtaining ACE. The annual regime will apply to most ITQ species and fishers. Fishers under the annual regime will have the following options for covering overfishing:

- purchase additional ACE within 15 days after the end of the fishing year;
- pay a deemed value (described above) 60 days after the end of the fishing year; or
- enter into a by-catch trade-off (described above).

The monthly regime will apply to rock lobster and shellfish, any fish stock where the TACC was exceeded in the previous year, and for any fisher who exceeded their ACE in the previous year. Fishers under the monthly regime will have to cover any overfishing by purchasing additional ACE within 15 days following the end of the month. If fishers cannot cover their catch by ACE, then they will be required to

pay a deemed value. Fishers may have a defence from prosecution if they can prove that the taking of the fish was accidental and that reasonable precautions were taken to avoid it.

Industry involvement

The ITQ system has resulted in increased industry involvement in fisheries management decisions, research, and compliance (e.g. through voluntary compliance and tip-offs of illegal catches). Fishers soon realised that mis-reporting of catch was a crime against fellow ITQ holders. Because of this, commercial fishers have an incentive to co-operate in reporting their catches accurately and to help the authorities to discover cheating.

Market Mechanisms

Types of trade

Fishers can purchase, lease or "fish against" the of another fisher, providing they have an appropriate contractual arrangement with the holder of the ITQ. The majority of trading in ITQ is through leasing, rather than actual sale. Of the ITQ initially allocated, 77 per cent has changed ownership. There are no specific mechanisms for ITQ trading. Frequently, fishers sell ITQ as part of a package together with the sale of their vessel.

Under the new system from 1998/99, ITQ and ACEs will be fully tradable, but other types of contractual arrangements, such as “fishing against”, leasing, or assigning, will not be possible. An ACE sale under the new system will be equivalent to an ITQ lease under the current system. ACE will also be divisible during the year (e.g. a fisher may fish a portion of the ACE and sell the remaining portion to another fisher).

In the early years of the system, ITQ were a new type of commodity and participants were not yet familiar with the system. Initial uncertainties over the nature of ITQ may have depressed demand (and therefore prices). Prices for ITQ have tended to increase over time, reflecting growing confidence in the nature of ITQ as a harvest right.[31]

Other policies and measures

All fish species in the ITQ system are subject to other management controls, such as minimum level sizes, closed seasons and areas, gear and method restrictions. All existing measures remained when ITQ were introduced. The government relies on other policies and measures to manage the non-commercial catch of a fish stock. In New Zealand, the national catch limit (TAC) for each fish stock has both commercial and non-commercial portions. The Minister of Fisheries takes into account the non-commercial portion when setting the commercial fish harvest limit. The government uses other policies and measures to manage customary Maori and recreational interests that are not included in the trading system. The lack of integration between the non-commercial fishing measures and the commercial ITQ system has posed

31. Prices for abalone, for example, were trading for NZ$49 500 per tonne in 88/89 and for NZ$210 000 per tonne in 94/95 (nominal prices). Hoki ITQ traded for NZ$2 000 per tonne in 88/89 and for NZ$4 500 per tonne in 94/95.

problems in setting fish harvest limits for commercial fishers. Commercial fishers perceive any reduction in their limits as giving extra rights to the unconstrained recreational and customary fishers.

III. "INDUSTRIAL RATIONALISATION" UNDER THE MONTREAL PROTOCOL

Introduction

The Montreal Protocol sets a time-table for the gradual elimination of production and consumption of certain Ozone Depleting Substances (ODS).[32] The Protocol contains provisions that allow "industrial rationalisation" of ODS production and consumption rights in the period before complete phase-out.[33] The "industrial rationalisation" provisions of the Montreal Protocol allow the production quota from a country where production becomes uneconomic earlier to be used by a company in another country where it is cost-effective to increase production. Trade in ODS rights is limited to transfer of rights from one large ODS producer to another. The Montreal Protocol defines "industrial rationalisation" as:

> "the transfer of all or a portion of the calculated level of production of one party to another, for the purpose of achieving economic efficiencies or responding to anticipated shortfalls in supply as a result of plant closures." (Montreal Protocol Article 1.8)

The rules for transfer of production quotas between Parties are:[34]

- the total combined levels of production of the Parties concerned are not allowed to exceed the production limits agreed to;
- the UNEP Ozone secretariat (Nairobi) must be notified of transfers no later than the time of the transfer (Article 2.5, and 2.7).

---

32. Ozone Depleting Substances controlled by the Montreal Protocol are: the most widespread chlorofluorocarbons (CFC-11, 12, 113, 114, 115) used for e.g. refrigerants, solvents, and aerosols; halons (1211, 1301, 2402) used for fire extinguishants; other fully halogenated CFCs not in widespread use at time of phase-out; carbon tertrachloride, used as a feedstock, process agent and in solvents; methyl chloroform, a solvent used by metals industry; hydrochlorofluorocarbons (HCFCs), a transitional substance with lower ODS than CFCs; hydrobromofluorocarbons (HBFCs), not in widespread use at time of phase-out; and methyl bromide, used as a fumigant and pesticide.

33. Production is defined as total production minus the amount destroyed by approved technologies minus the amounts used as chemical feedstock and process agents. Feedstock is defined as "a controlled substance that undergoes transformation in a process where it is entirely converted from its original composition", and a process agent is "a controlled substance that because of its unique chemical and/or physical properties, is used in a chemical process without being entirely chemically transformed" Supplement to the 1994 Assessments (Nairobi: UNEP March 1995). Consumption is defined as production plus imports minus exports (Brack 1996, p. 16.)

34. Klaassen, 1996, pp. 166 - 167.

Initially the transfers were not allowed to increase the individual production levels by more than 10 per cent to 15 per cent of the base-year (1986) level, except for Parties with very small levels of production. However, the London amendments of 1990 removed this restriction.

ODS limit

Overall limit

The Montreal Protocol established a schedule to gradually phase-out certain ozone depleting substances (ODS). The objective for most ODS is to reach a "zero" limit.

Individual limits for each Party

Limits on production and consumption (i.e. production plus imports minus exports) of each group of ODS were agreed for each Party.[35] ODS limits are an agreed proportion of the Party's ODS levels in an historic base-year. Parties must comply with their limits by an agreed year in the future. Each Party's total production and consumption of ODS is calculated by weighting each ODS by ozone-depleting potentials (ODP). Annexes to the Montreal Protocol specify the ODP for each ODS. The allowable levels of ODS production and consumption decrease over time. Developing countries have a longer period (called the "grace period") in which to phase-out ODS. The limits for developing countries are for later and longer reference periods (average production over a period spanning several years), or a per capita limit, whichever is lower.

For CFCs (Annex A, Group I) the limits are:

Table 1. CFC Limits

CFC limits for developed countries:	CFC limits for developing countries:
100% of 1986 level by 1989	100% of average 1995-97 levels by 2002
25% of 1986 level by 1994	50% of average 1995-97 levels by 2005
0% of 1986 level by 1996*	15% of average 1995-97 levels by 2007
	0% of average 1995-97 levels by 2010*

* Parties can apply for exemptions from these control schedules, if they would otherwise incur unacceptably high economic costs. The exemptions are highly specific and are limited by use, quantity, and time.

ODS limits for industry

Both the European Union and the United States have translated national limits into individual limits for industrial ODS producers and consumers under their jurisdiction. In the United States, since 1989, the government has given ODS limits to US ODS producers based on their 1986 ODS levels.[36] These limits

35. There are separate limits for: the most widely used CFCs, halons, other fully halogenated CFCs, carbon tetrachloride, methyl chloroform, HCFCs, HBFCs, and methyl bromide. Because there are ODS with different Ozone Depleting Potential (ODP) in many groups, the production and consumption limits are calculated using agreed ODP values specific in Annexes to the Montreal Protocol.

36. ODS Allowances were assigned to five CFC producers, 3 halon producers, 14 CFC importers, and 6 halon importers, based on their 1986 market share (Cook, 1996 p.32).

decline over time, in accordance with the Montreal Protocol phase-out schedule. Because the allowances allocated to industry have significant economic value, the United States government implemented an ODS tax to redistribute the income from ODS allowances.[37] The European Commission has also established production and consumption quota for individual producers on the basis of past production levels (1986 or 1989, depending on the substance controlled).[38] The Montreal Protocol allows countries to impose more stringent limits than those required by the Protocol.[39] The United States and the European Union have set faster domestic phase-out schedules than those agreed internationally for certain ODS.

Banking

Surplus ODS that are produced within the production limits can be stock-piled for future consumption, but unused ODS production quota cannot be accumulated for future use. Under the Montreal Protocol the term "banking" refers to schemes for pooling information on available supplies of ODS and on mechanisms for exchange between buyers and sellers.

Changes to overall limit

The Montreal Protocol contains provisions for further adjustments to be made in light of evolving scientific knowledge and technological developments. A number of adjustments to the phase-out schedule have brought forward the dates by which Parties must achieve the reductions. Parties have also added ODS to the list of controlled substances. These adjustments were made in response to reports by the United Nations Environment Programme (UNEP) Panel for Scientific Assessment on scientific evidence of the seriousness of the ozone depletion problem.[40] These adjustments also take into account an assessment of technical and economic feasibility by the UNEP Technology and Economic Assessment Panel, and an assessment of environmental effects by the UNEP Panel for Environmental Assessment.

Who trades

Large ODS producers

The main current traders carrying out "industrial rationalisation" of ODS production quotas are companies in industrialised countries that produce ODS. When the Montreal Protocol came into force, there were

37. Vos *et al*, 1992, p. 52 cited in Klaassen, 1996, p. 144

38. The European Community Council regulation is EEC No 594/91 of 4 March 1991. This was adapted in 1992 (EC Regulation No 3952/92) and again in 1994 (EC Council Regulation No 3093/94) ref. G. Klaassen (1997).

39. The United States set faster domestic phase-out schedules than those agreed internationally for certain ODS. In accordance with the protocol, United States ODS producers are allowed to produce 10 per cent over their ODS "zero-limit" after the phase-out date to export to developing countries if sufficient documentation is produced to prove that the chemicals are shipped overseas.

40. Adjustments to the control schedule and amendments to add new chemicals for control have been agreed at regular meetings of the Parties: London (1990), Copenhagen (1992), and Vienna (1995).

only 17 ODS producers in the world. There are now 79 producers, 57 of which are located in non-OECD countries, primarily in India and China.[41]

United States companies

The United States government allocates ODS production and consumption allowances to ODS producers. ODS importers receive consumption allowances. United States producers and importers can trade allowances either with other domestic ODS allowance holders, or with ODS producers in other countries.

European Union companies

European Union rules allow producers in European Union member states to trade their allocated production quotas. They can trade either within the European Union or with any other Party to the Montreal Protocol, as long as their combined levels of production quotas do not exceed their combined quota limits. Consumption quotas are also transferable within the European Union under the Protocol's joint implementation provisions for regional economic organisations.[42]

No trade with non participating countries

For most ODS, the Montreal Protocol prohibits imports from and exports to non-Parties. The objective of this prohibition is to prevent "leakage" of ODS from Parties to non-Parties.[43] National legislation and monitoring systems are relied on to prevent domestic importers and exporters of ODS from trading with countries that do not comply with the Montreal Protocol ODS limits.[44] These trade restrictions are very important for the success of the Montreal Protocol, although some analysts consider that they potentially violate the non-discrimination principles of the General Agreement on Tariffs and Trade (GATT). No trade disputes regarding ODS have been take to the GATT to date.[45]

---

41. UNEP IE OzonAction Programme: "CFC Production and Related Issues" UNEP, 1996

42. "Parties which are members of a regional economic integration organisation such as the EC may jointly fulfil their consumption limits, provided that their combined consumption is kept below the ceiling imposed by the Protocol." (Montreal Protocol, Article 2.8a)

43. As of 31 December 1996, 161 countries were Parties to the Montreal Protocol (UNEP personal communication). The only significant consumers of ODS not within the Protocol are Iraq and Mongolia. (Brack, 1996 p.54)

44. For more information on the role of regulations, financial incentives/disincentives, and customs monitoring schemes in various OECD and non-OECD countries, see two documents produced by UNEP IE's OzonAction Programme - "Regulations to Control ODS" (1996) and "Monitoring Imports of ODS" (1996).

45. The reasons disputes have not arisen could be the very wide membership of the Montreal Protocol, since the main potential for conflict is with non-members (although the initial membership was much smaller). Another reason could be the broad international support for both the Montreal Protocol and the GATT, and a desire by the international community not to create unnecessary conflict between the two agreements. (Brack, 1996, p. 72)

Amount of trading

It is difficult to know how much international trade in production quotas has occurred because until the date for phase-out is reached, this information is commercially sensitive. As of January 1994, the UNEP Ozone Secretariat had not received any notification of transfers of production quotas, but international transfers had taken place. European Union companies traded between 20 and 40 thousand tonnes of ODS in 1992 and 1993, much of which was among European Union member states.[46] United States companies traded 36 million kilograms of ODS internationally between 1992 and 1995. They traded 238 million kilograms domestically in the same period. The table below contains data on annual trades of some ODS by United States companies.

Table 2. United States: Pre phase-out trades of allowances for Class 1 controlled ODS:

Year	Number of international trades	kilograms traded	Number of inter-company trades	kilograms traded
1989			4	1 151 555
1990			15	1 016 740
1991			48	80 707 158
1992	1	541 000	171	73 355 338
1993	4	11 694 608	123	67 264 045
1994	9	13 452 247	138	56 656 718
1995	6	10 328 610	62	40 932 991
Total	**20**	**36 016 465**	**561**	**321 084 545**

Source: US EPA

What is traded

Unit of trade

The production and consumption quotas are defined in kilograms of ODS produced and consumed per year. The unit of trade for "industrial rationalisation" deals is typically a million kilograms of production or consumption of the ODS concerned for the calendar year.[47]

Limited exchange of different ODS

Production and consumption of each group of ODS have separate control schedules. ODS quota for different ODS within the same group can be used inter-changeably, based on agreed ODP values that are set in the Montreal Protocol. For example, any unused quota for CFC-11 (which is in Annex A, Group I: CFC-11, 12, 113, 114, and 115), can be used for production or consumption of another ODS in that group, such as CFC-12. Parties can thus choose which ODS within a group to concentrate their controls on, and have been able to phase-out fastest the ODS that are easiest to replace. However, no trading is allowed

46. Klaassen, 1997

47. Dow Chemicals transferred 4.5 million kg of methyl chloroform to another of its plants in the United States. (Cook, 1996, p. 34.)

between ODS from different groups. For example, CFCs that are in Annex A Group I cannot be exchanged for halons that are in Annex A Group II.

System administration, monitoring and reporting

National Monitoring

National government institutions monitor ODS. Different countries use different methods to monitor legal production and consumption and industrial rationalisation of ODS. Monitoring is typically based on records of ODS production, imports, and exports. Companies must notify the relevant national authority of any industrial rationalisation transaction. The administration costs and the cost to industry of meeting monitoring requirements are quite low. The system requires little additional information beyond the data on production and imports that industry already had to provide.[48] Developing countries often lack sufficient resources for this monitoring. However, they are eligible to receive assistance under the Multilateral Fund to establish National Ozone Units. The role of these units includes monitoring and reporting ODS production and consumption.

For trades within the United States, ODS allowance holders must notify the US EPA before a trade occurs. The notification has to include information on:

- the participating companies;
- the type of allowance being traded (e.g. production or consumption);
- the type of ODS;
- the control period; and
- the remaining allowances that will be held after the transfer.

The EPA checks whether the seller has enough allowances to justify the transfer and responds within three working days.

International monitoring

Companies must notify the relevant authority of any transfers between producers in different countries. European Union companies must notify the European Commission. United States firms must notify the US EPA. The EPA runs a computerised ODS allowance tracking system. If United States companies buy production allowances from other countries, the EPA only grants these additional allowances to them once the embassy of the selling firm's country has declared that the country has reduced its production rights by the amount transferred.[49]

In the case of international transfers involving European Union companies, both the European Commission and the European Union member states involved have to agree beforehand. Pre-approval of

48. Klaassen, 1996, p. 168-170.

49. Peeters, 1992 cited in Klaassen, 1996. p. 142 and 143

transfers requires little administration. Transfers are usually approved although delays may occur.[50] The European Commission has refused transfers in one or two cases where transfers were for production rights for future years which had not been yet clearly defined.

For transfers between non-European Union countries, the UNEP Ozone secretariat must be notified of transfers, their terms, and the period for which they apply, no later than the time of the transfer. International transfers involving article 5 parties (mainly developing countries) that have no agreed production and consumption levels tend be rejected.[51] Governments report annually to the UNEP Ozone Secretariat on their progress in reducing ODS.[52] Because countries have complied with their national ODS limits, the UNEP Ozone secretariat does not consider it very important that industries did not report their trades (a fact noted earlier in this paper).[53]

Enforcement

National enforcement

The success of the Montreal Protocol depends largely on national enforcement institutions. Recycled and used ODS are not included in the calculations of ODS consumption (although they must be reported). UNEP has received anecdotal information that illegal exports and imports of ODS have been carried out by falsely labelling them as "recycled".[54] The objective of the Montreal Protocol (phase-out of ODS) is being undermined to some extent by illegal trade. Domestic legal action is the main mechanism for penalising illegal trades. International information exchange, improved detection equipment, improved monitoring systems, and actions to eliminate the sources of illegal ODS supplies also discourage illegal ODS transfers. In the United States, there are high financial penalties for non-compliance (US25,000/kg).[55]

International non-compliance procedures

A Party can be called before the Implementation Committee, which is the main compliance body of the Montreal, if Parties request. The Implementation Committee was established in 1990 and has ten members selected from the Parties. The committee meets once or twice per year to review ODS data submissions from Parties. The committee also considers questions of implementation and non-compliance, and discusses ways to assist non-complying countries to overcome whatever obstacles they face. In 1992 Parties agreed a non-compliance procedure that gives maximum opportunities for compliance, as opposed to punishment. The specific list of measures to encourage compliance includes:

- technical and financial assistance;

50. Klaassen, 1997.

51. Klaassen (1996), page 170.

52. The European Union is a Party to the Montreal Protocol, and separate European Union member states are also Parties. Each European Union member state must each report its ODS production and consumption.

53. UNEP IE OzonAction Programme, personal communication.

54. UNEP IE OzonAction Programme, personal communication.

55. Peeters, 1992, cited in Klaassen, 1996, p. 145

- the issuing of cautions; or
- suspension.

In the case of suspension, the country would no longer be a Party to the Montreal Protocol. A suspended Party would lose access to the ODS market of other Parties, and (for developing countries) lose any rights to financial support.

Market Mechanisms

Bilateral contracts between large companies are the mechanism for industrial rationalisation trades. Governments must formally sanction the international trades of companies within their jurisdiction. Unfortunately, little information is available about trading activity under the industrial rationalisation provisions because of commercial confidentiality concerns. Transaction costs for industrial rationalisation are low because a small number of firms produce ODS, trading takes place between large firms, and pre-approval of trades requires little administration.[56]

Other policies and measures

Some countries have used additional national policies to control the production and consumption of ODS. The objective of these policies is typically to achieve national objectives that are consistent with, but not required by, the Montreal Protocol. The United States, Canada, Sweden and Norway have imposed regulations prohibiting the use of CFCs as an aerosol propellant in non-essential applications. The United States, Czech Republic, and Denmark have imposed excise taxes on ODS. Sweden and the United States have imposed total or partial bans on imports of ODS. The Netherlands and Norway have negotiated voluntary industry agreements with industry to restrict ODS imports.[57]

Links with domestic trading systems

Some countries have used tradable ODS permits as a way of allowing domestic industry to meet their commitments more flexibly. Examples of domestic systems that are in place in the United States, Singapore, and New Zealand are outlined below.

56. Klaassen, 1997

57. This list is not exhaustive. The examples are taken from Brack, 1996, p.40. For a much wider international survey of such regulations (including legislation, economic incentives/disincentives, and voluntary agreements) see UNEP "Regulations to Control ODS" (1996)."

United States: domestic and international trade

In the United States, producers and importers are assigned production and consumption allowances that permit them to produce or import a certain quantity of CFCs or halons. United States companies can trade allowances with other companies in the United States or with companies in other countries. In 1990, separate allowances were assigned for each type of CFC and halon. Companies could transfer unused ODS quota for one ODS to authorise production of another ODS in the same Group. For every ODS allowance traded, the EPA retired 1 per cent of the amount of ODS represented by the allowance from use.[58] The objective of this 1 per cent offset was to ensure that trading would result in greater total ODS reductions than would occur without trading, as required by the 1990 Clean Air Act amendments.[59]

United States companies carried out about 40 trades with companies in other countries between 1989-1995 about 40 trades (approximately 45 million kilograms of ODS). The trading system helped to lower the administrative costs of implementing the Montreal Protocol in the United States and gave companies flexibility in timing their phase-out of ODS. For example, Dow Chemical ended methyl chloroform production in Canada when the market declined and shifted 4.5 million kilograms of production to the United States. It cost Dow less to boost United States production and ship the chemical to Canada than to run two under-capacity plants. Dow stopped production in the United States at the end of 1993.

Singapore: domestic tradable permit system

In Singapore, a domestic tradable permit system has been operating since 1991. In order to trade, a company must register and pay a fee of $240 a year. The government sends out application forms to registered end-users or distributors of ODS to establish their ODS requirements and bid prices. The government then distributes the total national allowance of ODS consumption allowances (based on the Montreal Protocol phase-out plan) to registered companies. Half of the allowances are distributed by auction and half by allocation. Each company's ODS allocation cannot exceed its ODS consumption of the preceding year. Permit holders can trade with other Singaporean permit holders.

New Zealand: domestic import permit system

In New Zealand, a tradable import permit system has been in place since 1986 (there is no ODS production in New Zealand). The Minister of Commerce issues ODS import permits to importers based on each applicant's ODS consumption in the base year. Trading is allowed among, but not restricted to, New Zealand ODS import permit holders. However, anecdotal evidence suggests that trades are rare.

58. Cook, 1996

59. Klaassen, 1996, p. 143

IV. UN ECE 1994 OSLO PROTOCOL

Introduction

The 1994 Oslo Protocol[60] is one of a number of protocols on sulphur, nitrogen, and volatile organic compounds that have developed from the 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP). The LRTAP Convention is under the auspices of the United Nations Economic Commission for Europe (UNECE). A 1985 Protocol set a uniform percentage target for all Parties to reduce SO_2 emissions by 30 per cent from the 1980 base year level by 1993.[61] Parties negotiated the 1994 Oslo Protocol because they considered that further reductions were necessary. The European Commission and 27 UNECE countries have signed the Oslo Protocol, but only five countries have ratified it, which is not enough for it to enter into force.

The Oslo Protocol contains enabling language that allows two or more Parties to jointly implement their obligations, if other Parties agree:

> "The Parties to this Protocol may, at a session of the Executive Body, in accordance with rules and conditions which the Executive Body shall elaborate and adopt, decide whether two or more Parties may jointly implement the obligations set out in Annex II" (Article 2, paragraph 8).[62]

The language in the protocol enables international transfer of emission allocations to take place. However, there has been no transfer of emissions allocations among different countries to date as it has not yet entered into force. The proposed rules and conditions for trading can only take effect once the protocol has entered into force (i.e. once it has been signed by at least 16 Parties). In addition, the trading rules have not yet been approved. Parties have spent some years considering rules to ensure the attainment of environmental objectives and to guard against adverse effects on third parties from SO_2 emissions trading.

---

60. "The Protocol on Further Reduction of Sulphur Emissions" or "Second Sulphur Protocol", opened for signature in 1994, has been ratified by five countries (Luxembourg, Netherlands, Norway, Sweden, and the United Kingdom of Great Britain). Sixteen ratifications are needed for the protocol to come into force.

61. Helsinki Protocol: "The Protocol on Reduction of Sulphur Emissions or their Transboundary Fluxes by at least Thirty Per Cent" came into force in 1987.

62. The "obligations" of Annex II Parties consist of national emission ceilings for the years 2000, 2005, and 2010. Proposed rules and conditions for joint implementation recommended by the LRTAPs main negotiating body, the Working Group on Strategies define a "joint implementation agreement" as "an agreement between two or more Parties to co-operate to implement their emission reduction obligations". UNECE document EB.AIR/WG.5/R.57, 23 November, 1995. The Working Group on strategies recently decided to recommend the adoption of the rules stated in this document to the Executive Body for the Convention (Henning Wuester, UNECE, personal communication).

The proposed rules for "joint implementation" agreements state that joint implementation proposals should specify:

- the part of its emission reduction obligation (expressed as kilotons of SO_2) which one Party will implement through reductions carried out by another Party;
- the emission reduction (expressed as kilotons of SO_2) which the other Party will undertake in addition to its emission reduction obligation, in accordance with the Protocol;
- the duration of the agreement;
- an assessment of the acid deposition impact of the agreement; and
- the level of the expected cost savings resulting from the agreement and the means of compensation chosen.

The proposed rules also state that joint implementation agreements must:

- lead to a decrease in deposition compared to the agreed national ceilings;
- not lead to an increase in national deposition in third parties by more than x per cent; and
- not lead to an increase in deposition at grid cell level of third parties by more than y per cent.

The Oslo Protocol trading provisions are rather vague and there is as yet no experience of trading under the proposed rules for "joint implementation agreements". The main difficulty that has hampered agreement on SO_2 trading rules is the differing spatial impacts of SO_2 emissions on acid depositions. This difficulty is not relevant to international greenhouse gas emission trading because the location of greenhouse gas emissions does not affect their impact on the climate.

SO_2 Limits

European Union ceiling

The European Union has an emission ceiling of 30 063 kilotons of SO_2 in the year 2000. [63]

National limits

All Parties have emission limits. National limits are phrased as emission reductions from 1980 levels in the year 2000. Many Parties also have limits for the years 2005 and 2010. Different SO_2 emission limits have been agreed for each Party based on "critical loads"[64] and model estimates of the relationship between SO_2 emissions and critical loads. The objective is to achieve a 60 per cent reduction in the gap between 1990 emissions and the agreed "critical loads" for each country. However, the actual emission

63. SO_2 emission limits have been set for all EC member states individually and for the EC collectively.

64. "Critical Loads" are defined as the maximum level of deposition below which, according to current scientific knowledge, no damage to sensitive ecosystems occurs.

limits that were agreed deviate from this level. SO_2 from fuel oil used by ships in international waters (the Baltic Sea, North Sea, and the Atlantic Ocean) is excluded from the emission limits.

Sub-national limits

A Party may differentiate its obligations to reduce sulphur emissions between the various parts of its territory. Canada is the only country that has used this differentiation of sub-national emission limits. To use this option, the country's total land area must be greater than two million square kilometres, and its total national emissions must not exceed 1990 levels, or the 30 per cent reduction required by the First Sulphur Protocol (whichever is lower).[65]

Some countries have established emission limits for electric utilities under domestic programs to control SO_2 (electric utilities are responsible for 65 per cent of SO_2 emissions in Europe). These sectoral limits are not part of any international agreement. Examples include:

- In Denmark, the government has set an annual sectoral SO_2 emission limit for electricity sector plants that are 25MW or larger in capacity. The two power company consortiums decide how to allocate the SO_2 emission limit among their individual power plants. The sectoral limit is binding for four years in the future, with provisional emission limits for an additional four years. There is flexibility for utilities to exceed the limit by 10 per cent in any one year, as long as the cumulative emission limit over four years is reached.

- A Dutch Covenant with the association of electric utilities established sectoral emission limits for SO_2 and NO_x together. The sector is able to trade reductions in one plant for increased emissions in another as long as emission standards are met.

Flexibility to change the emission limits

The preamble of the Oslo Protocol recognises that "scientific and technical knowledge is developing and it will be necessary to take such development into account when reviewing the adequacy" of the Protocol's obligations. The first review of adequacy is scheduled for 1997.

Who trades

The proposed rules for joint implementation agreements state that only Parties to the Protocol could engage in joint implementation, and only if their proposals for joint implementation agreements are adopted by consensus of the Parties at sessions of the Executive Body. Many UNECE countries (41 out of 55) and the European Commission are Parties to the LRTAP Convention, and so could become Parties to the Oslo Protocol.[66]

---

65. There is one other requirement: that any of its SO_2 emission that affect other countries' must be from "SO_2 management areas".

66. The 42 Parties to the LRTAP Convention are: Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Czech Republic, Cyprus, Denmark, EC, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechenstein, Lithuania, Luxembourg, Malta,

Sub-national territories or industries with emission limits could presumably be authorised to trade SO_2 rights internationally if their governments gained approval from the Executive Body for the transactions.

What is traded

There is no unit of trade defined in the Oslo Protocol. However, emission limits, monitoring provisions, and the proposed rules for joint implementation proposals are defined in kilotons of SO_2 per year. This would be an obvious unit to use for joint implementation transactions. One of the major difficulties in setting up an SO_2 trading system in Europe is that a ton of SO_2 emitted at one location can have very different acidification impacts than a ton of SO_2 emitted at another. Trade between two parties might have negative impacts for the environment in a third party. Because of this, it appears that it will not be possible to trade SO_2 emissions on a one-to-one basis in Europe.[67] It has been proposed that it would be possible (although complicated) to convert SO_2 emissions from different areas to a standard unit using "exchange rates" that reflect the environmental effects of SO_2 deposition from different locations.

System administration, monitoring and reporting

Under the LRTAP Convention, good quality emission data is considered essential both for assessing the state of air pollution in Europe and for establishing Parties' compliance with their Protocol commitments.[68] Most sulphur emissions are from point sources such as power stations, and so are relatively easy to monitor. At present, the Oslo Protocol does not require monitoring for each point source. However, many Parties already have this data because of monitoring requirements for European Union regulations on sulphur emissions. The UNECE established the European Monitoring Programme (EMEP) in 1976. EMEP is used for calculating national sulphur emissions, transboundary fluxes, and deposition of sulphur compounds. The Oslo Protocol requires each Party to report annually an inventory of actual levels of sulphur emissions for the previous year.

The only additional requirement for joint implementation agreements is that proposals for joint implementation must be submitted in writing to the UNECE secretariat. The secretariat will keep a record of joint implementation agreements.

Enforcement

Under the Oslo Protocol, an "Implementation Committee" will review the implementation of the Protocol and compliance by Parties with their obligations once the Protocol has entered into force. This Committee will consist of representatives from eight Parties, who will periodically review and evaluate Parties' compliance with the Oslo Protocol, and report to the Executive Body. The Committee may recommend solutions in cases of non-compliance, such as assistance for the non-complying Party or other measures agreed by the Parties. Parties may call for action to bring about full compliance with the Protocol. Under the proposed rules for "joint implementation", if a Party is in non-compliance with the emission reduction obligation arising from a joint implementation agreement, the agreement will be terminated.

Netherlands, Norway, Poland, Portugal, Republic of Moldova, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK, Ukraine, US, and Yugoslavia.

67. Jackson, Tim and Peter Baily (1996)

68. UNECE document EB.AIR/GE.1/R.111, 28 June 1996

Market Mechanisms

There are no specific market mechanisms in the Oslo Protocol for trading SO_2 internationally.

Other policies and measures

Several countries have begun to experiment with market instruments domestically, and some have instituted "bubble" concepts for domestic SO_2 emissions, allowing firms to offset increased emissions from one source with decreased emissions from another. Joint implementation agreements under the Oslo Protocol will not replace existing European Union Directives and national legislation on SO_2 emissions standards and fuel standards. The Oslo Protocol sets SO_2 emission standards for large combustion plants. The Oslo Protocol also contains guidance and specific obligations on actions Parties should take to achieve the agreed emission reductions. The Protocol states that Parties should make use of the most effective measures "appropriate in their particular circumstances", including measures to increase energy efficiency and renewable energy. Another requirement of the Protocol is to "apply best available control technologies not entailing excessive cost". Analysts have observed that the number and diversity of policies and measures imposed on electric utilities and other sources of SO_2 will prevent the full potential cost savings from trading from being realised.[69]

69. Burtraw, 1993, p.23., Klaassen, 1993 p.16., Klaassen, 1996 p. 239-272

V. POSSIBLE LESSONS FOR INTERNATIONAL GREENHOUSE GAS EMISSION TRADING

This review has looked at four existing systems out of the many that could provide insights for international greenhouse gas emission trading. Some of the most useful experience of fully fledged trading systems comes from the two domestic systems reviewed in this paper: the United States SO_2 allowance trading and the New Zealand ITQ system. The two international systems reviewed were more limited in the type and amount of trading that occurred (in fact, there has been no trading under the Oslo Protocol). However, the Oslo Protocol and the Montreal Protocol provide useful experience of agreeing trading systems at international level and of international monitoring, reporting and enforcement functions. Some possible lessons from this review that could be useful in developing a framework, or options, for international greenhouse gas emission trading, are described below.

Initial set up and gradual evolution

Support from participants enhances the initial political feasibility of the trading system

In New Zealand, support for the ITQ system by participants greatly enhanced the feasibility and success of the system. Industry support was gained as a result of:

- initial allocation of ITQ based on incumbent fishers' catch histories;
- widespread recognition that the problem of over-fishing was serious and agreement on the need for improved fisheries management;
- support from key industry players who promoted the ITQ idea among industry; and
- initial compensation to industry participants for any loss of fish harvesting rights.

In the United States, it was clear that industry would have to comply with the sectoral SO_2 emission limit once it was set in the Clean Air Act legislation. Because of this, industry supported trading to ensure the lowest possible compliance cost.

Ideal systems are rarely constructed from the beginning, and have to be modified

In New Zealand, the initial process for participants to appeal their allocations of ITQ complicated the system, increased the allowable catch beyond the desired level initially, and diluted the value of other fishers' quotas. Recent legislation provides for a new process for allocation of ITQ which will have significantly stricter criteria for review of ITQ allocations. In the United States, bonus SO_2 allowances issued for reasons of political feasibility have extended the emission cap and made the system more complex to administer. From the year 2010 these bonus allowances will no longer exist. The United States system has required relatively few amendments, perhaps because the United States had two decades

of experience with trading systems of various types on which to draw. However, their computerised reporting, monitoring and tracking systems began two years before compliance with the SO_2 emission limits was required. This early start enabled administrators to solve problems and improve the system before it was used to assess compliance.

Clearly defined rules for compliance and trading provide certainty for participants

The types of rules that were required for the trading systems reviewed were:

- language in legislation or international agreement enabling trade;
- permitting of eligible participants (in the United States, permits had to be issued to allow utilities to emit SO_2 and join the trading system; in New Zealand, only existing commercial permit holders were eligible to participate in the ITQ system);
- initial allocation of tradable rights to all eligible participants (this was part of the initial set-up of both the New Zealand ITQ system and the United States SO_2 allowance trading system, but is not necessarily linked to the trading mechanism. For example, national ceilings were established in the Oslo Protocol long before joint implementation rules were considered);
- procedures governing transfers of emission rights;
- monitoring requirements (for both emissions and trades);
- rules covering non-compliance penalties and administrative appeals (in some systems, such as New Zealand's ITQ system, non-compliance rules were seen as an integral part of the trading system, but in others, such as the Montreal Protocol and Oslo Protocol, non-compliance procedures were tied to the initial agreement on ODS or SO_2 limits and were not linked to the trading provisions);
- rules governing entry of new participants (in the United States system, the "permanent" emission limit is enshrined in legislation and any new participants must purchase allowances from existing participants; in New Zealand also, new entrants must purchase fish harvest rights from existing participants); and
- participants or Parties may need to decide whether other suitable entities can "opt-in" voluntarily by accepting emission limits and undertaking verifiable emission reductions (in the United States, individual industry boiler units were able to opt-in. These opt-in participants remain outside the electric utility sectoral cap, so there is no change to the overall emission limit established in the Clean Air Act legislation for Phase I and II utilities.)

Simplicity and workability may require limits on flexibility

In New Zealand, some provisions that give participants flexibility will soon be removed. The objective is to simplify the system both for government monitoring purposes and to facilitate participation and compliance requirements for industry, such as some trading options and borrowing provisions. In the United States experience, the provision that allows Phase II utility boilers to volunteer or not volunteer for

each of the five years during Phase I has complicated the monitoring of compliance. The annual sectoral limits during Phase I vary depending on how many "opt-in" utility units volunteer to participate each year.

Emission limits

Binding limits on individual participants. Emission limits on participants who can be held legally accountable are a feature of all the trading systems reviewed in this paper. The United States SO_2 allowance trading system places emission limits on each utility boiler unit. The New Zealand fish ITQ system places limits on each commercial fisher. Both the Montreal Protocol and the LRTAP Oslo Protocol define limits for each Party.

Translating national emissions limits into ceilings or baselines for individual companies can help get trade started and increase the number of trades that take place (enhancing market liquidity). Under the Montreal Protocol, some Parties (the United States and the European Union) have translated national ODS quota into individual quota for sub-national entities such as ODS producers and importers. Under the Montreal Protocol, the question of whether to assign individual limits to companies and the methods for translating national ODS limits into quota for individual companies were left to the discretion of each Party.

Emission trading should make a clear contribution to the environmental objective and constitute a win-win solution for all/most Parties involved. The system-wide emission limit that is set (i.e. the sum of all individual emission limits) largely dictates the environmental credibility of the system. Ideally, it should be widely perceived that the system-wide limit meets environmental objectives. Under the Oslo Protocol, the lack of confidence by many Parties in the contribution that joint implementation can make to the environmental objectives of the Protocol has led to disagreement. The proposed rules for joint implementation are consequently restrictive and partially unclear and are likely to limit incentives to trade. In New Zealand, the lack of clearly defined maximum yields and of clear guidance on timing of achieving maximum sustainable yields has led to conflict between stakeholders and decision makers. In the United States, the government retired 1 per cent of the amount of ODS represented for every ODS allowance traded. The objective of this 1 per cent offset was to ensure that trading would result in greater total ODS reductions than would occur without trading, as required by the 1990 Clean Air Act amendments.

Emission trading can contribute to environmental objectives by making emission limits more politically feasible. Trading could lead to agreement on more stringent emission limits than would be possible without trading. In the United States, the decision to control SO_2 emissions and on how stringent to make the sectoral SO_2 emission limit was linked to the decision to use emission trading as the primary implementation tool.

Stringent limits (i.e. limits that are difficult to meet) provide greater credibility regarding the environmental benefits and greater incentives for trading, but it may be necessary to phase in more stringent limits. The system-wide emission limit should be set below the current (or projected) emissions level and so require at least some participants to make greenhouse gas reductions at some point. However, it may be necessary to phase in more stringent limits, with a clear time-table to strengthen them in the future. Phased-in limits give participants an incentive to participate and time to plan to meet more stringent emission limits. In the United States SO_2 allowance trading system, the initial emission limits reflected normal electricity production levels at reduced emission rates, and there is a clear time-table to strengthen the limits in the future. In the New Zealand ITQ system, the initial grand-fathered rights

reflected historical catch levels. However, the catch limits for each fish species have been, and will continue to be, changed as necessary to ensure sustainable fish harvesting.

Flexibility to change the limit to reflect changing information on environmental impacts, and changes in the control costs. This is an important feature of most of the trading systems reviewed. The New Zealand ITQ system enables the government to review total commercial catch limits each year to ensure sustainable fish harvest. Frequent amendment of TACCs is possible because each fisher receives rights to a proportion of the limit, not to an absolute tonnage of fish. When the TACC changes, the fishers rights to a certain proportion of the total remains the same, but the tonnage of fish they can catch in that year changes. Under the Montreal Protocol there is a clear schedule of ODS limits for each Party. However, flexibility to change the limits in response to changes in scientific knowledge, new response options, and changes in the economic feasibility of the response options is explicitly stated in the Protocol. The LRTAP Oslo Protocol itself was an international agreement to increase the stringency of national SO_2 ceilings that Parties had agreed previously. Under the United States SO_2 allowance trading system, an allowance is defined as an "authorisation to emit", rather than a "property right". This definition enables the government to take away utilities' allowances without having to compensate them, if necessary. This seems unlikely to occur, however, as the "permanent" cap is enshrined in the Clean Air Act legislation.

Banking provides added incentives to reduce emissions. If banking is allowed, any over-compliance in early years can be used in future years when compliance may become more difficult, or sold to other participants. In the United States, banking has provided incentives to reduce SO_2 emissions early. In New Zealand, the government is considering reinstating banking provisions when the system is simplified in 1998/99. In the New Zealand fisheries management system, banking is viewed as an important mechanism that allows fishers additional flexibility to trade and does not compromise sustainable fish harvest.

Who trades

The participants who are required to have emission limits and are authorised to trade in order to ensure they are in compliance with these limits should ideally be legal entities that can be monitored. Participants' emissions need to be measurable and independently verifiable. Participants should ideally be entities that have the capacity to trade efficiently. The United States SO_2 allowance trading system covers most of the SO_2 emissions by targeting large electric utilities, which are the most easily monitored entities. In New Zealand, the government only allocates ITQ to commercial fishers. Under the Montreal Protocol, industry participants authorised by their governments to trade have been the main traders. Governments are bound by the international agreement and are responsible for reporting national compliance with ODS control schedules.

If the main participants are entities accustomed to trading with each other, transaction costs are likely to be lower. Contractual relationships already exist between United States utilities, for example, to ensure security of electricity supply in emergencies. In New Zealand, ITQ often change hands when a vessel is sold, as part of a package deal. Under the Montreal Protocol, transaction costs are low because the main traders are a small number of large industries, and pre-approval of transfers is not administratively complex. Only Parties are authorised to trade under the Oslo Protocol. This restricted participation might limit the amount of trading that takes place. For industry to trade, they may have to submit their proposal to their government, who would submit it to a meeting of the Executive Body for approval.

Trading systems require both buyers and sellers with sufficiently diverse marginal costs of reduction to sustain active trading. In the United States, excess supply of allowances from Phase I utilities is not yet

demanded by likely buyers that will join the programme in Phase II. Introducing participants in two phases has meant that cost-effective opportunities to reduce emissions may have been lost. Phase I participants have banked a large number of allowances for sale when Phase II participants join the scheme. Phasing in participation can increase complexity, particularly where emissions sources in the first phase can create credits (or excess allowances) by reducing activity levels and shifting production to facilities not affected until later phases.

Allowing anyone to trade enhances liquidity (e.g. individuals, and environmental non-government organisations in addition to the main participants). In both the United States SO_2 allowance trading system and the New Zealand ITQ system, anyone can buy and sell rights. The rights are fully tradable with no restrictions.

It may be possible, although more complicated, to allow unconstrained entities to participate. In the United States, the ability of non-covered industry SO_2 emitters to "opt-in" voluntarily by accepting lower emission limits and undertaking verifiable emissions reductions at a designated facility has contributed to the efficiency of the program. Opt-in sources only receive credit for actions taken to reduce their emission rates, not for reducing production or for ceasing operation. Under the Montreal Protocol, international ODS transfers involving developing countries that have no agreed production and consumption levels tend to be refused. Within the European Union, in cases where there were no ODS allocations for individual companies, or no clear baselines for future production levels, applications to trade ODS were not approved. Under the LRTAP Oslo Protocol, Parties that have not signed the Protocol (and that therefore do not have agreed baselines for their future emissions) will not be able to engage in joint implementation projects.

What is traded

In all of the systems reviewed in this paper, the tradable unit is a measurable commodity that can be clearly defined. When different commodities (e.g. different ODS or fish species) are included in the same trading system, the ability to exchange the rights for one substance or species for another hinges on the ability to monitor them, and concern over environmental impacts. In New Zealand, fishers cannot use ITQ for one fish stock for harvest of another fish stock. The government issues separate catch limits and ITQ for each fish stock. The one exception to this is in the case of “by-catch”, where one species is caught accidentally when another is being harvested. In this circumstance, fishers can use the quota from the legally harvested species to cover the by-catch, at an “exchange rate” based on the market value of the species concerned. Under the Montreal Protocol, there are separate ODS limits for each Group of ODS. Parties can choose which ODS within a Group to concentrate their controls on, which means the easiest ODS to replace have been phased-out fastest. However, no trading can take place between ODS in different Groups, which limits the flexibility to exchange different ODS.

Emissions that are included in the trading system should be able to be estimated with sufficient certainty to ensure integrity of the system. In each of the systems reviewed, the commodity being traded is independently verifiable. For greenhouse gases, some categories of greenhouse gas emissions and some sinks and sources may need to rely on estimation techniques instead of direct emissions monitoring. In the New Zealand ITQ system, the populations of some fish species are not known with certainty. The government issues ITQ allocations for commercial fishers based on catch history records. The government amends TACC limits as the information on the maximum sustainable yield of the fish stocks improves. There may be a parallel for some greenhouse gases that are not known with certainty at present.

Conditions that restrict the percentage of emission limits that participants can trade could be useful in the beginning to gain confidence. However, it is possible that such restrictions could be lifted when Parties are able to monitor and enforce emission limits effectively and as trading becomes more important. Under the Montreal Protocol, trading was restricted initially to 10 per cent to 15 per cent of the ODS limits, but this restriction was removed after several years. Applications to trade future allocations that have not yet been defined have been rejected. There are almost no restrictions on trades under both the United States SO_2 allowance trading system and in the New Zealand ITQ system. This is possible because both systems have strong monitoring and enforcement provisions.

System administration, monitoring and reporting

Emission trading does not necessarily require modified rules for monitoring and enforcement of compliance beyond those required for ensuring compliance with emission limits, other than reporting and monitoring of the trades themselves. Monitoring requirements (and the authorisation to trade emissions to meet their commitments) tend to be placed on the entities can be monitored most easily. In the United States, the EPA monitors each utility boiler that has an SO_2 allowance allocation. In New Zealand, the government has placed monitoring requirements on the first receivers of fish as well as the commercial fishers. The first person who buys the fish from the commercial fishers has to report the catch they have purchased, show that it is matched by ITQ, and report the product they sell. Retrospective monitoring has proved a good deterrent in New Zealand. The government has been able to check compliance through monitoring of paper records even long after the non-compliance occurred. Under the Oslo Protocol, the only additional requirement for joint implementation agreements is for joint implementation proposals to be submitted in writing to the UNECE secretariat.

The need for prior approval of trades may lead to delays and higher costs but may not be an unworkable barrier for trades as long as the rules for approval are clear. Under the Oslo Protocol, all Parties must give prior approval by consensus for all joint implementation agreements. This requirement is likely to limit the amount of trading that will occur and may lead to only very large agreements being put forward. The burden that approval of joint implementation agreements could place on the Executive Body may limit the number of such agreements. Under the Montreal Protocol, international transfers do not require prior approval by the international secretariat or Parties (the UNEP Ozone secretariat must simply be notified no later than when the transfer takes place). Transfers are taken into account when a Party's compliance is reviewed. However, governments of the European Union and the United States require their companies to receive government approval before they trade. This may lead to delays but may not be a complete stumbling block for trades as long as the rules for approval are clear beforehand.

Trading can enhance industry incentives to comply and to help to ensure that other participants also comply, which could reduce monitoring costs. In the New Zealand ITQ system, fishers soon realised that mis-reporting of catch was a crime against fellow ITQ holders. This has made the industry more inclined to report their catches accurately and to help the authorities to uncover cheating.

Tracking embodied emissions complicates monitoring The difficulty of tracking embodied ODS has lead to illegal trade. This has undermined confidence in the Montreal Protocol ODS control system. Greenhouse gases are also embodied in products and processes, but embodied emissions are not reported in national greenhouse gas inventories.

Enforcement

High, automatic, and well enforced penalties for non-compliance in the United States SO_2 allowances system and the New Zealand ITQ system make non-compliance extremely unattractive. Non compliance can be prosecuted as a criminal offence. This level of punishment and enforcement may be difficult to achieve under an international agreement.

Domestic legal action. The Montreal Protocol relies on domestic legal action to punish illegal trades and enforce compliance by domestic companies. At the international level, emphasis is placed on giving maximum opportunities for compliance, rather than on punishment. Once all other options have been exhausted, an offending Party can be suspended from the Protocol. Suspension removes a countries' protection from trade provisions, and makes it ineligible for technology transfer and financial assistance. Under the Oslo Protocol, if a Party involved in a joint implementation agreement does not comply with its commitments, the agreement will be terminated.

Market mechanisms

Use of existing market mechanisms. Most of the trading mechanisms in the trading systems reviewed were already common practice among private sector entities. The only mechanisms specifically designed to facilitate a trading system is the annual SO_2 auction that the Chicago Board of Trade operates on behalf of the United States EPA. Under the Montreal Protocol, bilateral contracts between large companies are the mechanism for trading. No exchanges or other market mechanisms emerged for trading ODS because of the small number of trades occurring between a few large participants who could easily identify potential trade partners. In the New Zealand ITQ system, fishers often trade fish harvest rights as part of a package when they sell a vessel.

Ideally, there would be no restrictions on the type of trades. However, some restrictions may be necessary to ensure the credibility of the system e.g. to make monitoring easier. In the United States SO_2 allowance trading system, while there are no restrictions on the types of trade, there are no provisions for borrowing from future periods. For both the United States SO_2 allowances and the New Zealand ITQ system, any proportion of the tradable rights can be traded with anyone. In addition, in both of these systems, trades can be conducted for years far in the future. In New Zealand, the fish harvest rights are "perpetual". In the United States, authorisations to emit SO_2 can be transferred even for years beyond the 30 year rolling allocation. The New Zealand's fisheries ITQ system includes provisions for banking and borrowing up to 10 per cent of a fishers' ITQ allocation. Fishers can also lease, sublease and "fish against" harvesting rights, rather than buying and selling them. However, New Zealand has found it necessary to modify the system to make monitoring simpler. From 1998/99, trading options will be limited to outright sale and purchase of the fish harvest rights. Fishers will no longer be able to lease, fish against, sub-lease, or assign rights to other fishers. The 10 per cent borrowing provisions will be removed, so that fishers will have to buy and sell ACEs to ensure they are in compliance with their annual limits. However, in the New Zealand fisheries management system, banking provisions are considered to provide a useful option for forward trading. The New Zealand government is re-assessing options for banking and may decide to re-introduce this provision.

An auction (if well designed) can be a useful mechanism for encouraging trades. The United States SO_2 allowance trading system is the only one of the four systems reviewed here that uses an auction for emission trading. Benefits of auctions are that they:

- reduce transaction costs by providing a market place;

- provide a price signal, and provide information on prices and quantities to all participants;
- reduce the possibility of hoarding by large holders; and provide a way for new sources to obtain allowances;
- encourage active trading by demonstrating that there is a market where anyone can buy greenhouse gas units.

Other policies and measures

In some cases in the systems reviewed, other policies and measures have been imposed in addition to the trading system. These policies and measures can prevent the most cost-effective solutions from being achieved, but may be considered necessary to ensure that environmental and other domestic objectives are met. Some countries have implemented additional policies and measures for ODS that, in some cases, are more restrictive than is required by the Montreal Protocol. Analysis of the Oslo Protocol trading potential indicates that large efficiency gains may be lost through the existence or imposition of other policies and measures. Measures such as emission standards for large combustion plants will prevent the most cost-effective emission reductions from being made. In the United States, too, some state regulators impose additional measures. Some states require flue gas de-sulphurisation, which reduces SO_2 emissions from high sulphur coal by over 90 per cent, rather than allowing utilities to choose the most cost-effective solution, such as switching to low sulphur coal. In New Zealand, commercial fishing is managed using ITQ only. Few other policies and measures are imposed on commercial fishers.

Governments can use other policies and measures to target emitters (or fishers) that are not included in the trading system. In New Zealand, the national catch limit (TAC) for each fish stock has both commercial and non-commercial portions. The Minister of Fisheries takes into account the non-commercial portion when setting the commercial fish harvest limit. The government uses other policies and measures to manage customary Maori and recreational interests that are not included in the trading system. The lack of integration between the non-commercial fishing measures and the commercial ITQ system has posed problems in setting fish harvest limits for commercial fishers. Commercial fishers perceive any reduction in their limits as giving extra rights to the unconstrained recreational and customary fishers.

National monitoring and international reporting of international trades by domestic entities can provide links between domestic trading systems and international monitoring systems. For example, in the United States, the EPA only grants allowances to a United States firm once the embassy of the selling firm's country has declared that the country has reduced its production rights by the amount transferred.

REFERENCES

United States SO_2 allowance trading

GAO (1994), *Air Pollution: Allowance Trading Offers an Opportunity to Reduce Emissions at Less Cost* GAO/RCED-95-30, US General Accounting Office, Washington, D.C. December 1994).

McLean Brian J. (1996), *Evolution of Marketable Permits: The U.S. Experience with Sulfur Dioxide Allowance Trading* (US Environmental Protection Agency, Washington D.C. December 6, 1996)

New Zealand ITQ

OECD (1993); "The Use of Individual Quotas in Fisheries Management", Paris.

Several unpublished papers by the New Zealand Ministry of Fisheries

Montreal Protocol

Brack, D.(1996), *International Trade and the Montreal Protocol*, Royal Institute of International Affairs, London.

Cook, E., ed. (1996), *Ozone Protection in the United States* World Resources Institute, Washington D.C., USA, November.

Klaassen, G. (1996), *Acid Rain and Environmental Degradation: The Economics of Emission Trading*, Edward Elgar, Cheltenham, United Kingdom.

Klaassen, G. (1997), "Emission Trading in the European Union: Practice and Prospects" (in Sorrel and Skea eds: *Tradeable Permits, Tradeable Quotas and Joint Implementation*, Edward Elgar, Cheltenham, UK, forthcoming)

Kuik, O., Peters, P., and Schrijver, N. (1994) *Joint Implementation to Curb Climate Change: Legal and Economic Aspects*, Kluwer Academic Publishers, Dordecht.

UNEP IE OzonAction Programme: "CFC Production and Related Issues" (UNEP 1996)

UNEP IE OzonAction Programme: "Regulations to Control ODS" (UNEP 1996)

UNEP IE OzonAction Programme: "Monitoring Imports of ODS" (UNEP 1996)

UNECE LRTAP Oslo Protocol:

Burtraw, D. (1993), The Promise and Prospect for SO_2 Emission Trading in Europe" Resources for the Future, Washington, D.C., September .

Churchill R.R., Kutting G., and Warren L.M. (1995) "The 1994 UN ECE Sulphur Protocol" *Journal of Environmental Law* Volume 7 No 2 (Oxford University Press).

Klaassen, G. (1993), *Sulfur Emission Trading and Regulation in Europe* WP-93-69, IIASA, November 1993.

Klaassen, G., "Emission Trading in Europe with an Exchange Rate" *Environmental and Resource Economics* Kluwer Academic Publishers, Netherlands Vol. 4, pp. 305-330, 1994

Klaassen, G. (1994) "Joint Implementation in the Second Sulphur Protocol: A Tempest in a Teapot?" Report to the UN/ECE Task Force on Economic Aspects of Abatement Strategies, May 5 1994 (IIASA, Austria)

Klaassen, G. 1995: "Trade-Offs in Sulfur Emission Trading in Europe" *Environmental and Resource Economic,s* Kluwer Academic Publishers, Netherlands, Vol. 5, pp. 191-219.

Klaassen, G. (1996) *Acid Rain and Environmental Degradation: The Economics of Emission* Trading"Edward Elgar, Cheltenham, UK,

Jackson, Tim and Peter Baily, (draft, 1996) "Transboundary Initiatives for Controlling Sulphur and Possible Lessons for CO_2" .