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## An emerging market for the environment:

# A Guide to Emissions Trading

United Nations Environment Programme
Division of Technology, Industry and Economics

UNEP Collaborating Centre on Energy and Environment

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# Foreword

Since its inclusion in the Kyoto Protocol—as one of the three market-based mechanisms to reduce greenhouse gas emissions—international emissions trading has attracted widespread interest among policy makers, industrialists and others.

An international emissions trading system would undoubtedly break much new ground in terms of environmental protection and indeed in terms of international trade, there has therefore been much specialist discussion of the subject. However, to date, little clear basic information has been made available on the subject of emissions trading in general, making it difficult for non-specialists to see how a future system might work and even leading to misunderstandings in some quarters. The purpose of this *Guide* is to paint a clear picture of emissions trading and to help dispel such misunderstandings.

# Acknowledgements

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The principal author of the *Guide* was Erik Haites of Margaree Consultants. The text was edited by Geoffrey Bird.

The *Guide* is based on work by UNEP, UCCEE and UNCTAD and will provide the basis for a more detailed on-line e-learning course by the UNCTAD Carbon Market E-Learning Centre, hosted by www.LearnSD.org.

The report benefited from comments and suggestions from a panel of external reviewers, including:

| | |
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The project was coordinated by Martina Otto. UNEP staff involved included Anja von Moltke and Mark Radka, UCCEE staff involved were John Christensen and Stine Skipper, UNCTAD staff were Lucas Assuncao, Lalen Lleander and Gao Pronove.

# Contents

# Introduction

There are a number of options open to regulators or sources of air pollution that wish to reduce their emissions. A first option is, of course, a traditional command and control approach. However—in an international context in which emissions of greenhouse gases from human activities need to be curbed considerably if we are to avoid damaging climate change—such an approach may prove too difficult and too costly to be the sole solution. Market-based instruments, including emissions trading, offer a way in which some emissions can be regulated by those best placed to control them, that is to say by the sources themselves, and at minimal cost.

The term emissions trading in fact refers to a fairly broad spectrum of possible instruments that are of different design and cover different emissions, making the subject a potentially complex one. This *Guide* adopts a step by step approach to emissions trading, in three Parts, to allow readers to build up their understanding:

- Part I provides a simple theoretical model of an emissions trading system, used as a basis for understanding the real-world designs explained in the following parts;
- Part II covers the various types of system design and presents and examines the ways in which they achieve their environmental aims;
- Part III presents examples of existing systems, gives some comment on their performance to date, and considers what future systems may be like.

# Part I: Emissions trading—basics

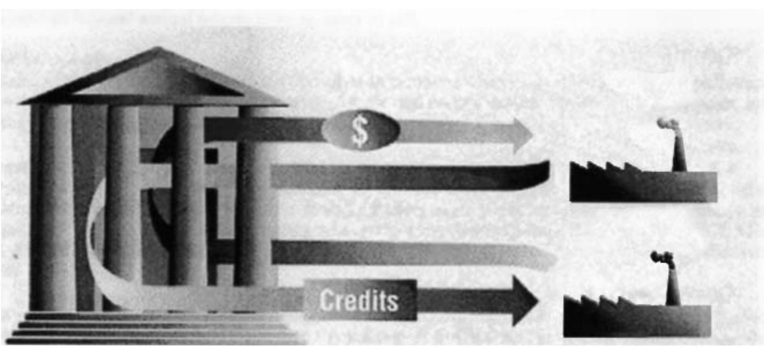
*Using tradable rights as a means of pollution control was first suggested in 1968 by the Canadian economist John Dales, and the first emissions trading programmes were implemented in the United States following the Clean Air Act amendments of 1977. In the ensuing years of the last century, several other emissions trading programmes were implemented in the United States. Provisions for international emissions trading for greenhouse gases were then included in the Kyoto Protocol of 1997. Since then interest in emissions trading has spread, leading to implementation of several programmes for greenhouse gases and conventional pollutants outside the United States.However, before delving into the complexities of the different existing emissions trading systems, there is one basic question that needs to be answered.*

## What is emissions trading?

Consider two companies, A and B, both of which emit significant quantities of a given pollutant. Their emissions may be damaging to air quality, and the relevant authorities may decide that there is a need to reduce emissions by a given amount, say by 10 per cent of current emission levels. At first glance, the solution seems simple: both A and B cut down emissions by 10 per cent. But in the real world, this may impose very different burdens on the two companies. For example, company A may, by the nature of its activities, be able to reduce by 10 per cent or even more at relatively low cost. Company B, on the other hand, may find this a difficult and costly process. It is this potential difference in reduction cost between A and B that creates a market opportunity. It works as follows.

Once the authority has decided how much of the pollutant is allowed to be emitted in a given area or region in a given time, it divides this quantity into a number of equal entitlements to emit and distributes these among the various sources of the pollutant. It is here that the market kicks in, as illustrated by Figure 1.

*Figure 1*
*An emissions market)*



Company A can reduce its emissions by the required amount at a relatively low cost and can then make further affordable reductions. For company B, the cost of reductions is far greater, and it would welcome a way of avoiding some of the outlay. Now, what if company A agrees to make those additional reductions instead of company B, provided company B is prepared to pay for them at a price that is above the cost to A but below what it would cost company B? In this situation, A's additional reduction capacity becomes a valuable tradable item. And of course emissions are cut, overall, by the required amount. In this simplified model of a trading system, it makes no difference whether the cuts are made at company A or company B, it is the overall amount that counts. The numerical example in Box 1, based on this simple model, will help to clarify the process.

In later sections it will become clear that there are many variants on this basic model, but it will nevertheless serve to establish a formal definition of emissions trading: essentially, a properly designed emissions trading programme is a cost-effective, market-based form of environmental regulation that allows a group of sources of emissions to reach a specified emissions target at lower cost.
With this formal definition, it is now possible to state some elements that are necessary for a successful emissions trading programme; these are given below. The first two emerge from or are implicit in the theoretical example and formal definition above. The others are discussed in Part II.

> *… essentially, a properly designed emissions trading programme is a cost-effective, market-based form of environmental regulation that allows a group of sources of emissions to reach a specified emissions target at lower cost.*

- A limit must be set on emissions and this must be lower than the 'business-as-usual' emissions of those participating in the programme.
- The participants must face divergent clean-up costs, so that there will be something real to trade and must be sufficiently numerous to constitute a veritable market.
- Accurate monitoring of actual emissions by each participant is essential.
- There must be effective enforcement to ensure that participants' emission entitlements and actual emissions tally with targets.
- When emissions have local impacts, provision must be made to protect local air quality by preventing shifts in the location of emission sources from having adverse environmental consequences.

The simple model and the example in Box 1 show that emissions trading allows specified emission limits to be met at lower cost than conventional regulations which impose the same percentage emission reduction or the same control technology on each source. This is achieved in two ways. First, because sources have the flexibility to determine the least cost emission reduction strategies for their specific facility. Second, because sources able to reduce their emissions at relatively low cost implement larger reductions. Furthermore, as explained below, flexibility in choosing strategies creates an incentive to develop lower cost technologies or practices for emissions reductions.

## Box 1: How does emissions trading reduce costs?

To flesh out the simple model of emissions trading, the tables below present a numerical example which demonstrates how emissions trading can provide cost savings when a source with relatively low emission reduction costs reduces its emissions beyond a required amount and sells its reduction surplus.

For the purposes of the example, we assume that the regulator requires a 10 per cent reduction in a total of 150 000 tonnes of a pollutant emitted by two sources: Source A and Source B. This is illustrated below:

| | Source A | Source B | Total |
|---|---|---|---|
| Current emissions | 50 000 t | 100 000 t | 150 000 t |
| Required reduction (10%) | 5 000 t | 10 000 t | 15 000 t |
| Emissions after reduction | 45 000 t | 90 000 t | 135 000 t |

A conventional regulatory approach could, for example, require each source to reduce emissions by the required amount or could impose the use of a specific technology to achieve and maintain reductions. In this situation, let's assume that Source A could achieve the required 10 per cent reduction for a cost of $10 000, while Source B would bear a cost of $50 000 for the same percentage reduction. That means a total cost of $60 000, as summarized below.

**Emission reduction cost breakdown with conventional regulation**

| | Source A | Source B | Total |
|---|---|---|---|
| Emission reduction | 5 000 t | 10 000 t | 15 000 t |
| Cost per ton reduced | $2.00/t | $5.00/t | |
| **Compliance cost with conventional regulation** | $10 000 | $50 000 | $60 000 |

Now let's see what happens if emissions trading is introduced. Source A—which has low-cost emission reduction options—implements reductions over and above the required amount, and sells the surplus to Source B, the facility with higher reduction costs.

The example assumes that Source A can reduce its emissions by up to 10 000 tonnes at a cost of $2.00 per tonne and that additional reductions cost in excess of $5.00 per tonne. Source A implements the 10 000 tonne reduction, but needs only 5 000 tonnes of reductions for its own compliance. This means it has 5 000 tonnes of allowances it can sell to Source B. The price would be between $2.00 per tonne (the cost of the reductions to Source A) and $5.00 (the cost at which source B can make its own reductions). This example assumes a price of $3.50 per tonne. Source B still needs to reduce its own emissions by 5 000 tonnes to meet its reduction requirement.

**Emission reduction cost breakdown with emissions trading**

| | Source A | Source B | Total |
|---|---|---|---|
| Allowance allocation | 45 000 t | 90 000 t | 135 000 t |
| Reductions implemented | 10 000 t | 5 000 t | 15 000 t |
| Cost of reductions implemented | $20 000 | $25 000 | $45 000 |
| Allowances sold | 5 000 t | None | |
| Allowances purchased | None | 5 000 t | |
| Assumed price per allowance | $3.50/t | $3.50/t | |
| Revenue from sale of allowances | $17 500 | No sales | |
| Cost of purchasing allowances | No purchases | $17 500 | |
| **Compliance cost with emissions trading** | $20 000<br>–$17 500<br>$2 500 | $25 000<br>+$17 500<br>$42 500 | $45 000 |

The total compliance cost for Source A, after deduction of the revenue from the sale of allowances, is $2 500, a saving of $7 500 or 75 per cent. The total compliance cost for Source B, including the cost of purchasing allowances, is $42 500, a saving of $7 500 or 15 per cent. The total cost of achieving the emissions limit is reduced by $15 000 or 25 per cent. In short, the emissions target is achieved, the total cost is lower and each source has shared in the cost savings.

**Comparison of reduction costs with and without emissions trading**

| | Source A | Source B | Total |
|---|---|---|---|
| Savings relative to no trading | $10 000<br>–$2 500<br>$7 500 | $50 000<br>–$42 500<br>$7 500 | $15 000 |
| Savings relative to no trading (%) | 75% | 15% | 25% |

**Final comment**

The magnitude of the savings and how they are shared between participants will depend on the specifics of the example. However, the fact that emissions trading reduces costs relative to conventional regulations does not. The available evidence suggests that trading programmes have achieved substantial cost savings relative to conventional regulations designed to achieve the same environmental goal. A more detailed discussion of this can be found in Annex 1.

*The experience from several emissions trading programmes is that they have successfully stimulated the search for lower cost emission reduction measures and that this has reduced compliance costs substantially.*

### Incentive to develop lower cost emission reduction technologies and practices

By giving an economic value to each unit of emissions reduced, emissions trading creates an incentive to find ways to lower the cost of emission control technologies and to implement any measure that reduces emissions. For example, initial estimates of the cost of compliance with the $SO_2$ cap for electric utilities imposed in the US (see Part III) were based on installation of 'scrubbers' (i.e. devices that clean flue gases) as the lowest cost control option. However, as explained in Box 2, in practice most of the reduction has been achieved by switching to low sulphur coal. The cost of scrubbers has also fallen dramatically and their efficiency has improved.

The experience from several emissions trading programmes indicates that they have successfully stimulated the search for lower cost emission reduction measures and that this has reduced compliance costs substantially.

**Box 2: How emissions trading creates incentive to develop lower cost emission-reduction strategies**

The objective of the US Electric Utility $SO_2$ Allowance Trading Programme is to cap utility $SO_2$ emissions at 8.95 million tonnes/year after 2010. Much of the compliance under the programme has been achieved by switching to low sulphur coal rather than installing end-of-pipe devices such as scrubbers. However, the scale of the possible fuel switch was not known until emissions trading provided an incentive to experiment with such shifts.

Plants in the eastern states were designed to burn eastern bituminous coals. Low sulphur coal from the western US has higher ash and moisture content and so has different combustion characteristics. Modifications are required to the boiler, coal handling equipment and particulate controls to burn the western coal. The cost of those modifications ranges from $50 to $75 per kW. When deregulation of rail transportation lowered freight rates, making the cost of western coal competitive in more of the eastern states, the combination of low cost modifications and lower freight rates made the use of low sulphur coal the least costly compliance option for many participants.

Emissions trading also reduced the cost of scrubbers dramatically, with the capital cost of a scrubber dropping from $249 per kW in 1995 to about $100 per kW in 2000. In 1995 (the first year of the programme), scrubber designs included substantial redundancy to ensure that the scrubbers could achieve the minimum 90 per cent removal efficiency specified by regulations Trading programme participants, however, do not need to achieve a minimum removal efficiency with their scrubbers; whatever the efficiency they need allowances for the remaining emissions. Emissions trading therefore made it possible to eliminate the redundancy in the design and thus reduce the capital cost of scrubbers.

Trading has had two other beneficial effects: scrubber efficiency has improved, because they have to compete with low sulphur coal and other emission controls options; and emissions trading encourages use of scrubbers when they are installed. This is because, under regulatory programmes scrubber operation is a cost, and costs are therefore reduced if the machine is not operating. Conversely, for a source participating in a trading scheme, operating the scrubber reduces emissions and thus frees up allowances for sale. When the allowance price is above the scrubber operating cost, the source has an incentive to keep scrubber utilization as high as possible.

# Part II: System design

*The design of an emissions trading programme requires decisions on many issues including the form of programme to be implemented, the sources of emissions to be covered and at which point in the production chain the emissions are to be controlled. Once these decisions have been made, further consideration must be given to how allowances or credits are distributed and to aspects such as monitoring, enforcement and penalties for non-compliance. These and other issues are addressed below.*

## Forms of emissions trading

There are three basic types of emissions trading programmes: 'cap and trade', 'baseline and credit', and 'offset'.

### Cap and trade

In a cap and trade programme, the participants agree on an overall limit on emissions—the 'emissions cap'—at the outset. In most programmes, this the total amount of a pollutant that the participants in the programme are allowed to emit in a given period (e.g. emission of a number of tonnes of the pollutant per year). Allowances equal to all of the emissions permitted under the cap are then distributed.

The way in which allowances are distributed is a key issue for emissions trading system design and this is discussed further below. For the moment, however, it is enough to know that there are two types of distribution: free or by auction. Once the allowances are distributed, they may be traded freely.

During the compliance period, each participant must monitor or calculate its actual emissions using specified procedures. Then, at the end of the period, it must hand over to the regulatory authority allowances that are equal to its actual emissions during the period. Examples of cap and trade programmes include the American programmes for ozone-depleting substances, sulphur dioxide ($SO_2$) emissions by electric utilities and nitrogen oxide ($NO_x$) emissions in the north-eastern states as well as the Danish carbon dioxide ($CO_2$) programme. These are described in Part III.

### Baseline and credit

The participants in a baseline and credit (or 'averaging') programme have to 'earn' credits before they can begin trading. First, an emission baseline is defined for each participant—in other words the participant is told at the start of the compliance period how much of a pollutant it is allowed to emit. Each participant then makes reductions and monitors or calculates its actual emissions using specified procedures. At the end of the compliance period, the regulatory authority compares the baseline calculation with the actual emissions from the source during the period. Participants whose actual emissions are lower than their baseline allocation receive 'credits' equal to the difference. Credits can then be traded freely. A participant whose actual emissions exceed its baseline must purchase credits equal to its excess emissions to achieve compliance. The American lead in gasoline and heavy duty engine emission standards programmes are baseline and credit programmes (see Part III).

### Offset

Offset programmes are used to compensate for (i.e. offset) the additional emissions that would result from creation of a new source of pollution or expansion of an existing one. Under such schemes those responsible for the new or expanding source purchase credits equal to emission reductions achieved by existing sources. The requirement to offset is mandatory for the new or expanding source but the decision by existing sources to reduce is voluntary. The existing sources are given a free allocation which is equivalent to a baseline against which their emissions reductions will be calculated. For the new and expanding sources, the baseline is equivalent to the emissions they are not required to offset. The US Clean Air Act makes provision for large new and expanding sources to offset their emissions in areas with poor air quality (see Part III).

### Absolute level or emissions rate?

It should be clear from the above that the sum of the baselines of the participants in a baseline and credit or an offset programme is equivalent to the emissions cap under a cap and trade programme. However, there is often an important difference. In contrast to cap and trade programmes, which tend to establish an absolute level (e.g. tonnes of emissions per year) of total allowable emissions by all participants, baselines are frequently defined in terms of emission rates (e.g. kg of emissions per unit of output). Total allowable emissions will then vary with output. The numerical example in Box 3 shows how this works in practice.

A cap and trade programme typically establishes an absolute limit on total emissions in a given period and distributes allowances equal to that limit to participants prior to the start of the period. Baseline and credit or offset programmes typically define a baseline that varies with output and issue credits at the end of the period if a participant's actual emissions are below its baseline.

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### Upstream, downstream and hybrid programmes

The point at which emissions are regulated also affects system design, and three types of design are distinguished: 'downstream', 'upstream' and 'hybrid'.

In a downstream programme, emissions are regulated at the point of release to the atmosphere. For example, emissions of oxides of sulphur and nitrogen result

**Box 3: Example of a baseline defined using an emission rate**

Take the case of a coal-fired power plant which emits 700 grams of $CO_2$ for every 1 kilowatt-hour (kWh) of electricity generated.

If, in a given year, the plant produces 2 000 000 kWh of electricity, its baseline would be 700 x 2 000 000 grams of $CO_2$—equal to 1 400 tonnes of $CO_2$. If during that year the plant's actual emissions were 1 350 tonnes of $CO_2$, it would receive 50 credits (each credit being equal to 1 tonne of $CO_2$).

In the following year, the electricity generated might be 1 900 000 kWh. The baseline then would be 700 x 1 900 000 grams—equal to 1 330 tonnes of $CO_2$. If the plant actually managed to emit only 1 325 tonnes of $CO_2$, it would receive 5 credits.

The point here is that the emission rate is fixed (i.e. it is always 700 grams of $CO_2$ for each kWh generated) but the output (i.e. number of kWh generated) varies. The value of each credit is also fixed (1 credit = 1 tonne of $CO_2$), but changes in the baseline lead to changes in the number of credits earned each year.

from the combustion of fossil fuels and can, therefore, only be regulated at the point of combustion. The existing programmes to control acid rain caused by sulphur dioxide and the RECLAIM programme, described in Part III, are downstream programmes.

When emissions are related to the characteristics of a product, they can be regulated prior to their release to the atmosphere. Programmes involving this type of control are upstream programmes. For example, emissions of lead from leaded fuels are directly related to the lead content of the fuels, just as $CO_2$ emissions from burning fossil fuels relate to the carbon content of the fuels. By reducing lead content or choosing low carbon content fuels, it is possible to regulate emissions prior to the point of release.

A hybrid programme is one which combines elements of both downstream and upstream ones.

Where a choice concerning the point of regulation is available, the preferred point of regulation is a compromise among the following considerations:

- Focusing the regulation on the entities best able to reduce the emissions.
- Ensuring that all potential emission reduction actions can be used.
- Keeping the number of participants manageable, while ensuring there are enough participants to create a competitive market.

*In some cases, emissions of substances can be controlled by regulation at different steps along the origin-to-emission chain. In such cases, the design of an emissions trading programme will, typically, reflect a compromise among several considerations that affect the coverage, effectiveness and cost of the programme.*

- Imposing the compliance obligation on the entities able to monitor the emissions accurately and at low cost.
- Covering as large a share of the total emissions as possible.

In some cases, emissions of substances can be controlled by regulation at different steps along the origin-to-emission chain. In such cases, the design of an emissions trading programme will, typically, reflect a compromise among several considerations that affect the coverage, effectiveness and cost of the programme.

## Open and closed systems

Implementing an emissions trading programme implies placing an administrative or financial burden on the sources participating in the scheme and on the regulating authority. As a result, emissions trading programmes often do not cover all sources of the regulated emissions because the potential financial or administrative burden of participation may outweigh the advantages of the potential emissions reductions. This is true particularly for smaller sources. In fact, participants in emissions trading schemes typically represent a relatively large share of total emissions but a much smaller fraction of the total number of sources. When a trading programme is restricted to specified participants it is referred to as a 'closed' system.

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However, allowing other, sometimes smaller, sources to participate voluntarily can provide access to a wider range of emission reduction options and can therefore reduce compliance costs. A trading programme that allows participants to 'opt-in 'in order to make use of emission reductions from sources other than the original participants is known as an 'open' system.

Emission reductions by non-participants can be included in the trading programme in two ways:

- There may be provision for non-participants to 'opt-in' to the programme. In this case they will be assigned a specified baseline or allowance allocation and will have the same compliance obligations as participants. Sources are only likely to 'opt-in' if they expect to be able to reduce their emissions cheaply and have surplus allowances or credits to sell.
- Alternatively, non-participants may be allowed to earn credits for emission reductions achieved by emission reduction projects they implement.

Awarding credits for emission reductions achieved by emission reduction projects usually involves establishing a baseline for the emissions covered by the project and then monitoring or calculating actual emissions. At the end of each compliance period, the baseline calculation and the actual emissions are reviewed and credits are issued for the difference. The sources generating the credits have no compliance obligations, so the credits earned represent an asset that they can sell to participants with compliance obligations.

An open system can reduce compliance costs for participants. In practice, however, uptake of this option has been limited by the relatively high costs associated with development, monitoring, reporting, and verification of emission reduction projects.

### Establishing baselines and distributing allowances

When designing an emissions trading system, establishing baselines in a baseline and credit or offset programme or deciding just how to distribute allowances in a cap and trade programme is usually the most difficult issue to resolve, because it involves the distribution of valuable assets—the emission rights. Baselines represent a free allocation of emission rights to participants. In cap and trade programmes, the emission rights are in the form of allowances. There is a wider range of available options for their distribution and this forms the focus of the discussion below.

Allowances can either be sold at auction and/or be distributed free, with any combination of the two being possible. Free distribution, at first sight, seems like handing out a valuable asset at no cost. However, participants in emissions trading programmes generally argue for free distribution on the grounds that they will incur costs in reducing emissions (see below). Virtually every emissions trading programme to-date has distributed all of the allowances free to participants but several proposed programmes for greenhouse gases plan to auction some of the allowances.

### Passing on the costs and potential effects on taxes and prices

While it is true that participants incur costs to comply with emissions limits, some of the costs are, in fact, shifted to others. They can, for example, be passed on to customers through higher prices, to governments through lower tax payments by firms and individuals, to employees through lower wages and benefits, or to suppliers through lower prices for inputs. It is the remaining portion of the costs, the part that cannot be passed on, that reduces the value of the source's assets and so is borne by its shareholders.

Studies of greenhouse gas trading programmes in the United States suggest that a free allocation of 10–25 per cent of the allowances is sufficient to offset the loss of shareholder value due to a programme. However, this percentage varies widely depending on the sector of industry, the portion of cost that can be shifted being determined by elasticities (i.e. sensitivity to price change) of supply and demand for products and inputs. Estimating an appropriate allocation for individual firms would be very difficult.

The costs of reducing emissions borne by participants, suppliers, employees and shareholders lead to lower tax payments to governments. To compensate for this loss of revenue, and to sustain the level of government services, some portion of the allowances could be auctioned with the revenue going to the government.

Auction revenue could also be used by governments to reduce existing taxes. If the taxes in question are ones that discourage economic growth, their reduction can stimulate the economy and so partially offset the economic cost of the emission reductions.

And finally, since all of the costs are ultimately borne by individuals in their capacities as consumers, workers, shareholders or users of government services, auction revenue could also be used to adjust taxes paid by individuals so that the cost is distributed equitably.

The way in which allocation is organized can also sometimes be passed on in terms of price increases. This is the case when, for example, an upstream design for energy-related $CO_2$ emissions leads to higher prices for fossil fuels because customers pay higher fuel prices and incur costs in switching fuels and conserving energy. This results in price increases for products with virtually no costs to participants in the programme. In such cases, auctioning the allowances would capture a substantial part, perhaps all, of the extra revenue.

### Importance of distribution rules

Establishing rules for distribution of allowances that are considered fair by everyone is one of the most difficult aspects of emissions trading system design. The rule for free allocation of allowances can be based on historic data or can change over time.

A rule based on historic data allocates the same percentage of the available allowances to each recipient over the life of the programme. One that changes the allocation over time bases the allocation on output, input or emissions—e.g. **x** g/kWh generated, **y** g/kJ of energy input, or **z** % of emissions during the previous year. These types of rules are commonly used to establish baselines.

Potential recipients of allowances have a strong incentive to lobby for an allocation rule that will treat them favourably, especially if the allocation is to remain fixed over time. Allocation rules can have a significant impact on the way in which the economic benefits of emissions trading are shared, so it is very difficult to find a rule that is considered fair by all recipients. Box 4 demonstrates the impact of a new allocation rule on the example given in Box 1. The effect is clear: the total allowable emissions and the total compliance cost remain the same as in Box 1, but one of the sources now earns a profit while the other finds itself bearing a cost that is higher than it would face under conventional regulation.

### Banking and borrowing

Banking allows those participants in an emissions trading programme which have emissions below their allocated limits to save surplus allowances/credits for use during a later compliance period. Borrowing is the opposite of this, permitting use of allowances or credits from a future period for compliance

## Box 4: Impact of allocation on how savings are shared

The example here shows how changing allocation of allowances affects the savings made by Sources A and B already described in Box 1. The original situation is recapitulated below:

| | Source A | Source B | Total |
|---|---|---|---|
| Allowance allocation (Box 1) | 45 000 t | 90 000 t | 135 000 t |
| Compliance cost savings (Box 1) | $7 500 | $7 500 | $15 000 |

Now, let's see what happens if the allocation is changed so that Source A's allocation is increased to 50 000 tonnes and Source B's reduced to 85 000 tonnes.

| | Source A | Source B | Total |
|---|---|---|---|
| Revised allowance allocation | 50 000 t | 85 000 t | 135 000 t |
| Reductions implemented | 10 000 t | 5 000 t | 15 000 t |
| Cost of reductions implemented | $20 000 | $25 000 | $45 000 |
| Allowances sold | 10 000 t | | |
| Allowances purchased | | 10 000 t | |
| Assumed price per allowance | $3.50/t | $3.50/t | |
| Revenue from sale of allowances | $35 000 | | |
| Cost of purchasing allowances | | $35 000 | |
| **Compliance cost with revised allocation** | $20 000<br>–$35 000<br>–$15 000 | $25 000<br>+$35 000<br>$60 000 | $45 000 |

The total allowable emissions and the total compliance cost remain the same. Source A receives a higher allocation and earns a net profit of $15 000 from its emission reduction actions, while Source B receives a lower allocation and faces a cost of $60 000—higher than the total compliance cost and higher than it would face under conventional regulation.

during the current period, with the implicit commitment that repayment will be made in the form of equivalent reductions in a future period. Both banking and borrowing have environmental and economic implications. Banking is quite common while, for reasons explained below, borrowing is rare.

The main environmental concern regarding banking is the possibility of short-term increases in emissions beyond the aggregate cap as participants 'cash-in' their banked allowances and increase their actual emissions accordingly.

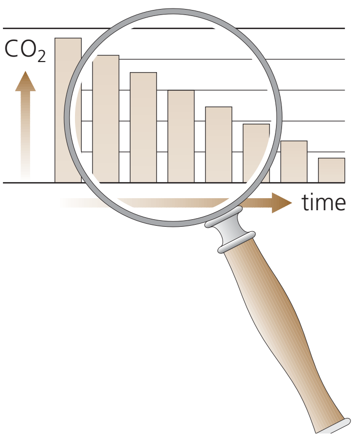
However, banking can also yield environmental benefits, by helping to reduce damage from emissions to human health and to the environment. In order to obtain surplus allowances/credits to bank, participants have to make real emission reductions bringing them below their allocated limit. In a situation where total emissions are declining (to be expected during a period of environmental regulation), these reductions will be made at a time when total emissions are still relatively high. The same allowances/credits will be used at a later time when total emissions are relatively lower, and lower emissions mean less environmental damage.

From the point of view of economics, an inventory ('stock') of banked allowances/credits provides some compliance flexibility, and hence more price stability in the event of unanticipated developments. For instance, it is thought that a more generous banking provision under the US RECLAIM programme (see Part III) would probably have mitigated price increases and non-compliance experienced during the electricity crisis in 2000. In that period, an increased demand for RECLAIM Trading Credits (RTC) for nitrogen oxides caused a dramatic rise in the price of credits: from less than $5 000 per tonne in 1999 to a peak of $124 000 per tonne in February 2001. This was accompanied by about 5 per cent non-compliance.

Borrowing creates a fairly evident risk for the environment: a source that uses borrowed allowances/credits to comply in a given period may cease operation before the borrowed allowances/credits are repaid through lower emissions. The participants may then save themselves the costs of compliance while the consequences of this failure are borne by the environment in the form of higher emissions. Although deals can sometimes be brokered to lower this risk, borrowing is rarely allowed

### Accurate monitoring

It is a fundamental principle of emissions trading programmes that each tonne (or similar unit) of emissions reduced has a value that is equal to the price of an allowance or credit. In other words, allowances/credits are valuable assets and, in an imperfect world, this can create an incentive to retain them by under-reporting actual emissions.




In order to avoid such under-reporting, emissions trading programmes often require participants to ensure accurate monitoring of emissions. For example, the US $SO_2$ programme for electric utilities, the Ozone Transport Commission $NO_x$ Budget programme and RECLAIM all require the use of continuous emissions monitors (CEMs) by large participants. These monitoring requirements are more rigorous and more costly than those required by conventional regulations, but the extra monitoring cost is justified by the savings in compliance cost made possible by emissions trading.

Emissions trading programmes usually mandate the use of the most accurate monitoring systems available for large sources and audit a high percentage of participants for compliance.

### Effective enforcement

Effective enforcement of compliance is critical for the environmental integrity of emissions trading programmes. Emissions trading increases the scale of potential non-compliance by a given participant and, as demonstrated by the example below, may even reward non-compliance.

*Effective enforcement of compliance, and penalties that deter non-compliance are critical to the environmental integrity of an emissions trading programme.*

Consider a regulatory authority that, in 2003, wants to reduce emissions by given sources by 10 per cent in relation to their emission levels for 2000. A regulation could be introduced requiring the sources to implement the required reductions. Alternatively, a cap and trade programme could set the cap at 10 per cent below total emissions for 2000 and allocate allowances equal to 90 per cent of 2000 emissions to participants.

With the regulatory approach, non-compliance by a source is limited to the difference between its business-as-usual emissions for 2003 and its 2003 target, and the financial benefit of non-compliance is equal to the emissions reduction costs avoided.

Under the cap and trade programme, maximum non-compliance for a source—which implies a source making no reductions and selling all its allowance—would be equal to the source's 2003 business-as-usual emissions plus the emissions made by other sources under the allowances purchased from the non-complying source. The financial benefit in this case would be equal to the emissions reduction costs avoided plus the revenue from the sale of allowances.

In a real trading scheme, it is unlikely that non-compliance on this scale would be available to all participants as some participants buy allowances, meaning that they are making some efforts to achieve compliance. The example, nonetheless, reinforces the importance of effective enforcement. Effective enforcement involves audits of a high percentage of participants and penalties that deter non-compliance

Effective enforcement of compliance, and penalties that deter non-compliance are critical to the environmental integrity of an emissions trading programme.

### Penalties


Like effective monitoring, effective penalties that deter non-compliance are critical to an emissions trading programme's environmental integrity. Penalties that involve loss of allowances/credits equivalent to the excess emissions plus automatic fines appear to be effective. The loss of allowances/credits restores the environmental damage due to non-compliance. It also ensures that the non-compliance penalty will exceed the cost of compliance, regardless of the price of allowances/credits.

### Safety valve

As seen when discussing banking, external events can sometimes lead to volatility in the price of allowances, and therefore in the cost of compliance. If the price of allowances/credits were to rise too steeply, participants could find themselves facing much heavier than expected costs to achieve compliance. One way of controlling this is to introduce a mechanism to limit that cost, known as a 'safety valve'. The central idea behind the safety valve is that, if circumstances require it, the regulatory authority will sell to participants all of the allowances they need in order to achieve compliance, at a pre-set price. In economic terms, with the safety valve in place, the marginal cost of achieving emission reductions is limited to the safety valve price.

### Direct and indirect emissions

The emissions that occur at a participant's site are 'direct' emissions. Emissions due to a participant's activities, but which occur at another location are 'indirect' emissions. Indirect emissions include those from the production of purchased electricity, contracted manufacturing, employee travel on scheduled flights, and emissions due to the use of products.

An emissions trading programme must specify which emissions are covered. Programmes often exclude emissions that are small or difficult to monitor. For example, programmes covering emissions of nitrogen oxides ($NO_x$) for electricity generators do not cover the nitrogen oxide emissions from vehicles owned by the company. Fugitive emissions are also often excluded because they are difficult to measure.

From the design point of view, the participants in an emissions trading programme should be the entities best able to control the target emissions. For example, emissions of pollutants such as oxides of nitrogen ($NO_x$) and sulphur ($SO_x$) can be limited by the use of control technologies. This means that entities are able to control their direct emissions. The participants in $NO_x$ and $SO_x$ trading programmes are, therefore, electricity generators and large industries.

Energy-related $CO_2$ emissions, on the other hand, are determined by the type and quantity of fossil fuel burned. Electricity generators and large industries often have limited scope for fuel switching in existing facilities and so have few options for reducing their energy-related $CO_2$ emissions. Such emissions can therefore be better regulated directly or indirectly by focusing on the amount of electricity used by customers.

## Protecting the local environment

Many pollutants have adverse impacts on human health or the environment near the source. Emissions trading shifts the location of emission reductions and so may increase the adverse impacts. The concern is that a large source or a concentration of sources will use purchased or banked allowances/credits to increase emissions, thus creating an emissions 'hot spot'. However, where evidence is available it suggests that emissions trading has reduced, rather than increased, concentration of emissions.

Two factors tend to counteract a substantial increase in emissions by a single source or a concentration of sources. First, emissions trading programmes reduce overall emissions by participants below their business-as-usual level. Second, most sources operate close to capacity (85–100 per cent) leaving little scope for massive increase.

Several emissions trading programmes, nevertheless, include provisions to protect local air quality. For example, the US $SO_2$ trading programme requires that participants meet all restrictions designed to protect local ambient air quality. Emissions cannot exceed those restrictions regardless of the quantity of allowances held.

For some emissions such as lead from gasoline or greenhouse gases, location of the emissions is not a concern. After all, driving patterns are unlikely to change because of a lead emissions trading programme, so lead emission reductions at any place are likely to be roughly proportional to overall reductions in the lead content of gasoline. Similarly, the climate change impacts of greenhouse gas emissions do not depend upon the location of the emissions. Furthermore, actions to reduce greenhouse gas emissions often lower emissions of other pollutants associated with the combustion of fossil fuels. It may therefore be desirable to reduce greenhouse gas emissions in some locations for the ancillary emission reductions they yield.

The timing of emissions is important for some pollutants. $NO_x$ emissions, for example, contribute to formation of ground-level ozone during the summer months. The Ozone Transport Commission $NO_x$ Budget programme therefore regulates $NO_x$ emissions during the months of May through September. While total $NO_x$ emissions during the balance of the year are not covered by the emissions trading programme, they are limited by regulations that specify maximum emission rates.

Trading programmes for pollutants that have adverse impacts on human health or the environment near the source often include restrictions on emissions or on trading to protect local air quality, even though experience suggests they may not be needed.

*Trading programmes for pollutants that have adverse impacts on human health or the environment near the source often include restrictions on emissions or on trading to protect local air quality, even though experience suggests they may not be needed.*

## Key points

- Emissions trading is a form of environmental regulation that allows a group of sources to achieve a specified emissions target at lower cost. Emissions trading is becoming more common and is likely to be widely used to regulate greenhouse gas emissions. Emissions trading programmes must be adapted to the environmental problem, the emissions sources, and the institutional setting.

- Cost savings stem from differences in participants' marginal costs in reducing emissions.

- An emissions trading programme also needs enough participants to create a competitive market for allowances/credits. The number of participants must be small enough to allow each participant to be audited for compliance annually. Participants should be the entities best able to control the emissions. Where control technologies are cost-effective, this is the emissions source. But where the emissions occur at numerous small sources, it may be the product manufacturer.

- Since emissions trading is a form of environmental regulation, it is important to ensure that the design will achieve the environmental goal. In the case of air pollutants that have local health or environmental impacts, this may require restrictions on total emissions by sources, on the direction of trades, or on the geographic area from which allowances/credits can be purchased to ensure that trading delivers local environmental benefits. In all cases emissions trading requires accurate monitoring of emissions and effective enforcement of compliance to ensure that the environmental target is achieved. Non-compliance is very low in most programmes.

- Emissions trading focuses on achievement of the environmental goal. The costs that will be incurred to achieve the goal are uncertain. A safety valve can be used to ensure that the costs do not become excessive.

- Banking is desirable because it encourages early reductions and provides flexibility to respond to unforeseen developments. If banking is not allowed unforeseen developments may lead to price volatility and/or non-compliance. The environmental concerns raised by banking are that it allows an increase in emissions beyond the aggregate cap and that accumulation of a large bank can delay achievement of an emissions target.

- Emissions trading creates a valuable asset—allowances/credits. How this asset is distributed is often one of the most difficult issues in the design of an emissions trading programme. They can be distributed free or auctioned in any combination. Distributing all of the allowances/credits free to participants may give them assets that exceed the costs they incur to reduce their emissions, especially under an upstream design. If that is the case, it can be argued that at least some of the allowances should be auctioned to maintain government revenues; fund transitional assistance for adversely affected workers, communities and entities; and to ease the impact on individuals. The allowances/credits distributed free should be allocated in a manner that provides a net benefit to all participants.

- Studies of potential savings due to a proposed emissions trading programme are more numerous than studies of cost savings actually achieved by trading programmes. The available evidence suggests that trading programmes have achieved substantial cost savings relative to conventional regulations designed to achieve the same environmental goal, although the potential cost savings are usually not fully realized.

# Part III: Experience with emissions trading

*The earliest emissions trading programmes were introduced in the US in the 1970s. The US has been the leader in using this form of environmental regulation and most of the examples of experience summarized below are from that country. National examples from Denmark and the UK and an example from the European Union are also presented, followed by discussion of the mechanisms proposed under the Kyoto Protocol.*

*Control of air quality in the US is regulated by one major law, the Clean Air Act. As the examples below make reference to the Act, and use some of the specialist vocabulary it introduced, the Act is summarized in Box 5.*

### Emission reduction credit offset trading

Under the CAA , major new and expanding sources in non-attainment areas must adopt LAER (lowest achievable emissions rate) technology and offset any remaining emissions with emissions reduction credits (ERC) 'earned' through reductions at an existing source.

To create an ERC, an existing source must implement measures to shut down or achieve other permanent emission reductions. The reductions must be real, surplus to permit requirements, quantifiable; permanent and enforceable. The emission reduction action must reduce emissions below actual or permitted emission levels, whichever is lowest. About 80 per cent of ERCs are generated by shutdowns, often an older facility owned by the firm building the new source.

Although many ERCs are generated by older sources that are shutdown for economic reasons, such offset trades typically create significant environmental benefits because:

- The 'potential to emit'—the difference between the allowable and actual emissions of the existing source—is eliminated.
- The new source has to acquire ERCs up to its potential to emit or its permit limit, although its actual emissions will be lower.
- The quantity of ERCs purchased must be 10 per cent to 50 per cent higher than the potential new emissions, depending on the level of degradation of the airshed.
- Some states withhold 5 per cent of the ERCs created until attainment is achieved.

The result is estimated to be a 30–40 per cent reduction in emissions from older sources.

## Box 5: the US Clean Air Act

### Background

The Clean Air Act (CAA) was passed in 1963 but has undergone important revisions since then. The present air pollution control programme in the US is based on the 1970 version of the law and on the far-reaching revisions introduced under the 1990 Clean Air Act Amendments.

The CAA is a federal law covering the whole of the US and the US Environment Protection Agency (EPA) sets limits on how much of a pollutant is permissible in the air anywhere in the country. However, individual states do much of the work required to implement it. States are therefore required to develop State Implementation Plans (SIP) which have to be approved by the EPA.

### Criteria pollutants

The EPA is mainly concerned about emissions that could be harmful to human health and has therefore defined a set of principal air pollutants, known as criteria pollutants. These are: carbon monoxide (CO); lead (Pb); nitrogen dioxide ($NO_2$); ozone (O3); particulate matter (PM); and sulphur dioxide ($SO_2$).

### Market-based approaches

The 1990 CAA includes features designed to clean up air pollution as efficiently and inexpensively as possible, allowing businesses to make choices as to how they meet clean-up goals. Such instruments, which include emissions trading, are referred to as market-based approaches.

### Key terms for understanding the CAA

The following are some key terms that will help in understanding the examples of emissions trading given below or which are widely used elsewhere in the literature on emissions trading and related issues.

*Air quality control region (AQCR):* a geographical area within which concentration of criteria pollutants are regulated and monitored.

*Attainment area:* a geographical area in which levels of a criteria air pollutant meet the meet the primary (i.e. health based) standard for a pollutant. An area may have acceptable levels for one criteria pollutant but not for others.

*National Ambient Air Quality Standard (NAAQS):* a national standard for each of the criteria pollutants.

*Non-attainment area:* a geographical area in which the level of a criteria air pollutant is higher than allowed by federal standards.

*Lowest Achievable Emissions Rate (LAER):* the most stringent emission limitation in a state's implementation plan or achieved in practice.

Principal source: http://www.epa.gov

Two features distinguish the ERC offset programme from typical emissions trading programmes:

1) ERCs are required by new and expanding sources, so the volume of ERC offset trading is driven solely by economic growth in the non-attainment area, not by firms seeking to reduce their compliance cost.
2) The LAER technology requirement is very stringent so it eliminates virtually all flexibility to use different combinations of technology and ERCs to reduce compliance costs.

Analyses of the ERC programme indicate that only a fraction of the potential benefits of ERC trading have been realized. The disappointing level of trading activity is blamed on high transaction costs, the uncertainty and risk in obtaining the needed government approvals, and lack of clear legal authority and clearly specified objectives.

### Lead in gasoline

In November 1982, the US EPA introduced a maximum lead content for gasoline of 1.1 grams per gallon (around 3.8 litres). A baseline and credit trading programme was introduced to ease the burden of the standards on small refiners. Each refiner and importer was required to keep its actual lead use during each quarter below the regulatory limit, plus net purchases of lead use rights.

No overall cap was placed on the lead used in gasoline. Total lead use was limited by the quantity of leaded gasoline produced and imported multiplied by the maximum permissible lead content. Lead use rights were allocated free, based on each participant's production or imports of leaded gasoline during the quarter. Banking of lead use rights was not allowed, but leaded gasoline could be stored for sale in future periods.

Subsequently, when faced with new evidence of health damage from lead, the EPA reduced the maximum lead content for leaded gasoline to 0.5 grams per gallon as of 1 July 1985, and to a minimum of 0.1 grams per gallon after 1 January 1986. This minimum level was determine by the EPA as being necessary to avoid wear to valve seats in the engines of vehicles using leaded fuel.

To facilitate this sharp reduction in the lead content, the EPA introduced banking into the trading system. Participants were allowed to bank lead use rights during calendar 1985 and to withdraw them until the end of 1987, when the trading programme concluded.

One of the reasons EPA set up the allocation rule this way was to encourage new entrants and so transfer some of the value of the lead use rights from producers to consumers. The number of participants grew from 265 in 1983 to 849 in 1985, and then fell to 547 in 1987.

Only about 200 of these participants were refineries that produced leaded gasoline from crude oil. The balance were firms that added ethanol to leaded gasoline thus 'manufacturing' leaded gasoline equal to the amount of ethanol added. Entry of such firms on this scale was possible only because every firm that manufactured gasoline during a given quarter received lead use rights equal to its leaded gasoline production.

At least one expert has concluded that that competition from these new manufacturers led to lower gasoline prices for consumers and lower profits for gasoline refiners.

### Electric utility $SO_2$ allowance trading

The 1990 Clean Air Act Amendments created a cap and trade programme for sulphur dioxide ($SO_2$) emissions from electric utilities. The objective of the programme is to cap utility $SO_2$ emissions at 8.95 million tonnes per year after 2010, a 10 million tonne reduction from the 1980 level.

The programme began in 1995. It was implemented in two phases, with each phase designed to achieve a roughly 5 million tonne reduction. Phase II, from 2000 on, applies to all electric utility generating units with an output capacity of 25 MW or greater and that use fossil fuels with a sulphur content greater than 0.05 per cent. There are over 2 250 participants.

Allowances are distributed free to participants. In Phase II the allowance allocation is of 1.2 pounds per million BTU multiplied by the average energy input (million BTU) for the years 1985 through 1987 or, if lower, the actual emissions rate multiplied by the average energy input for the same period. The basic allocation rules are supplemented by a number of special provisions.

Sources built after 1995 receive no allowances and must purchase allowances to cover their total emissions from existing sources. Sources operating in 1990 continue to receive allowances even if they cease to operate.

The vast majority of units are required to install continuous emissions monitors and to report their hourly emissions data to the EPA each quarter. The penalty for non-compliance is $2 000 (1990 dollars) plus a loss of one allowance from the next year's allocation per excess tonne. Allowances can be banked for future use. Federal, state and regional regulations limiting $SO_2$ emissions by participants to protect human health and the local environment take precedence. In other words, if federal or state regulations limit actual emissions the unit cannot use allowances to exceed that limit.

Data on the operation of the programme are presented in Table 3.1. Actual emissions were well below the allowance allocation during each year of Phase I, leading to the accumulation of a large bank that is being drawn down during

Phase II. Full compliance was achieved from 1995 through 1999, but in 2000 a few sources failed to comply, with total excess emissions of 54 tonnes.

Sources are individual generating units and a single company may own many generating units. The trading volume reported in the table is for transactions between unrelated participants. Since 1997 the volume of such trades has generally exceeded the annual allocation, because trades may involve allowances for future years and an allowance may be sold several times during a year. The prices of allowances have been lower than projected when the legislation was being debated due to the adoption of low cost compliance options made possible by emissions trading. As explained in Part II, a switch to low-sulphur coal has been the most common compliance option and scrubber costs have fallen while their performance has improved.

## RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) was established in California by the South Coast Air Quality Management District (SCAQMD) for $NO_x$ and $SO_x$ emissions by large point sources (i.e. emitting more than 4 tonnes per year). The programme began on 1 January 1994.

The $NO_x$ programme has roughly 340 participants which account for approximately 65 per cent of the $NO_x$ emissions from permitted stationary sources in the SCAQMD; the $SO_x$ programme has approximately 40 participants

**Table 3.1: $SO_2$ allowance trading programme**

| Year | Number of participants | Allowances allocated (million) | Actual emissions by participants (million tonnes) | Actual emissions by all sources[a] (million tonnes) | Allowances banked[b] (million) | Allowances traded[c] (million) | Price range (dollars per tonne)[d] |
|---|---|---|---|---|---|---|---|
| 1995 | 431 | 8.74 | 5.30 | 11.87 | 3.44 | 1.92 | $108–$138 |
| 1996 | 445 | 8.30 | 5.44 | 12.51 | 6.30 | 4.41 | $68–$95 |
| 1997 | 423 | 7.15 | 5.48 | 12.98 | 7.96 | 7.9 | $87–$114 |
| 1998 | 408 | 6.95 | 5.29 | 13.13 | 9.63 | 9.5 | $98–$198 |
| 1999 | 398 | 6.99 | 4.95 | 12.45 | 11.62 | 6.2 | $153–$214 |
| 2000 | 2,262 | 9.97 | 11.20 | 11.20 | 10.38 | 12.7 | $126–$155 |
| 2001 | | | | | | | $150–$214 |

Notes: a Emissions by sources participating in the programme in 2000.
b Allowances banked at the end of the year
c Allowances traded between unrelated parties. The allowances traded may be for the current or any future year. Allowances may be traded several times during a year.
d Price range is determined from monthly prices quoted by *Utility Environment Report* and the clearing price for the annual auction.

Sources: Annual compliance reports for 1995 through 2001.

accounting for roughly 85 per cent of $SO_x$ emissions from permitted stationary sources. However, the RECLAIM programme covers only 17 per cent of total $NO_x$ emissions and 31 per cent of total $SO_x$ emissions in the SCAQMD.

Each facility receives a free allocation of RECLAIM Trading Credits (RTCs) annually. The allocation is calculated from a starting allocation for 1994, a mid-point allocation for 2000, and an ending allocation for 2003. Each allocation is calculated by multiplying the *historic use* or throughput of each item of $NO_x$ and $SO_x$ equipment at the facility by appropriate emission factors based on the adopted and proposed rules. The *historic use* is based on the peak year for each facility between 1989 and 1992. Allocations for intermediate years are straight line interpolations between the 1994, 2000 and 2003 allocations. New sources must purchase sufficient RTCs from existing sources to cover their emissions. Existing participants continue to receive allowances if they cease to operate.

All participants are randomly assigned to one of two compliance cycles: 1 January–31 December, or 1 July–30 June. Trading can involve facilities in either compliance cycle, but the RTCs are only valid for the compliance year for which they are issued and cannot be banked. The staggered compliance cycle eliminates the price uncertainty that could occur if all participants had the same compliance deadline with no banking.

Each participant must hold sufficient RTCs at the end of the year to cover its actual emissions. Facilities that do not hold sufficient RTCs are subject to enforcement actions—the excess emissions are deducted from the next year's allocation, monetary penalties of up to $500 per violation per day may be imposed, and other penalties may be applied. Several participants have been found to be out of compliance each year the programme has been in operation, although the excess emissions have been small.

Estimated actual and allowable emissions for RECLAIM facilities are shown in Table 3.2. Actual emissions were well below allowed levels from 1994 through 1998 suggesting that the allocations during the first few years may have been above the 'business-as-usual' emissions. During 2000, electricity generators operated at significantly higher than their historical levels due to California's energy crisis. Although they purchased all available RTCs, driving up prices significantly, their emissions exceeded their allowance holdings (see note ** to Table 3.2). The price increases caused by the electricity crisis triggered a review that led to temporary isolation of power producing facilities from the programme, a requirement that power producers install emission controls, and a number of other changes in May 2001.

Table 3.2 shows the quantity of RTCs traded with price. RTCs used for compliance or remaining unsold in the facility's account are subject to an emission allocation fee of roughly $374 per tonne. Surplus RTCs can be

**Table 3.2: Actual and allowable emissions of $NO_x$ and $SO_x$ by RECLAIM participants**

| Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| *$NO_x$ (thousands of tonnes/year)* | | | | | | | | | |
| Allowable[a] | | 40.1 | 36.0 | 32.0 | 27.9 | 24.7 | 21.0 | 17.2 | |
| Actual[a] | 25.0 | 25.3 | 25.7 | 24.8 | 21.8 | 21.0 | 20.8 | 20.5 | |
| Traded[b] | | 2.21 | 11.68 | 5.60 | 9.18 | 26.00 | 8.92 | 8.32 | 7.14 |
| Average price (dollars/tonne)[b] | | $679 | $710 | $786 | $1 024 | $1 373 | $2 557 | $21 308 | $41 151 |
| *$SO_x$ (thousands of tonnes/year)* | | | | | | | | | |
| Allowable[a] | | 10.4 | 9.6 | 8.9 | 8.2 | 7.6 | 6.9 | 6.2 | |
| Actual[a] | 7.2 | 7.2 | 8.1 | 6.5 | 6.5 | 6.8 | 6.4 | 6.0 | |
| Traded[b] | | – | 3.05 | 5.17 | 5.08 | 1.78 | 1.55 | 2.09 | 3.87 |
| Average price (dollars/tonne)[b] | | | $524 | $1 063 | $2 305 | $618 | $840 | $2 108 | $5 756 |

Notes: a Figures relate to the compliance year — the 18 months beginning on 1 January of the year shown.
b Data relate to the calendar year. RTCs traded may be for the current year or any future year. The quantities are for trades with a price; excluding transfers to brokers, etc.

** The table shows the overall programme exceedance by comparing Compliance Year 2000 emissions to the allocations for the same compliance year. The staggered compliance years allow RTCs from 1999 and 2000 to be used during Compliance Year 2000. Since some 1999 RTCs were used for emissions during 2000, the total amount of emissions in excess of allocations held by individual facilities is 1 089 tonnes rather than 3 294 tonnes as suggested by the table.

SCAQMD, 2002.

transferred without price to brokers to avoid the fee. The volume of $NO_x$ trades with price has been rising relative to the annual allocation and is now approaching 50 per cent. The quantity of $NO_x$ RTCs traded in 1996 was inflated by changes in ownership of electricity generators. The volume of $SO_x$ traded with price relative to the allocation, has been lower than for $NO_x$ in most years.

## Ozone Transport Commission $NO_x$ budget programme

$NO_x$ emissions are known to contribute to the formation of tropospheric ozone (i.e. formation in the lower atmosphere). To help reduce this phenomenon, the US Ozone Transport Commission (OTC), composed of 12 north-eastern states and the District of Columbia, has implemented a regional $NO_x$ Budget Programme to reduce summertime $NO_x$ emissions. Under this cap and trade programme, reductions are to take place in two phases, the first of which began on 1 May 1999. The second phase will begin on 1 May 2003.

The emissions caps for $NO_x$ the May–September ozone season are: 219 000 tonnes in Phase I and 143 000 tonnes in Phase II. $NO_x$ emissions during the balance of the year are not capped, but many sources are subject to emission rate limits under other regulations.

The cap was divided among the states under a negotiated agreement and each state then allocates allowance to the participants. Each allowance permits a source to emit one tonne of $NO_x$ during the control period (May through September of a given year) for which it is allocated, or any later control period. Allowances may be bought, sold, or banked. Participants remain subject to other federal, state and local regulations governing $NO_x$ emissions.

In general, the programme applies to large industrial boilers with a maximum rated heat input capacity of 250 mmBTU/hour or more, and to all electricity generating facilities with a rated output of 15 MW or more. States have the option of subjecting additional source categories to the programme.

Data on the performance of the programme are summarized in Table 3.3. Only nine of the twelve states in the OTC participate in the trading programme. The number of sources in the programme has risen each year. Emissions have been less than the allowances allocated each year, so the size of the bank has increased annually. The cost of compliance has been significantly lower than anticipated, leading to a sharp decline in allowance prices during the early part of the programme. The quantity of allowances traded between economically unrelated participants rose from 9 375 tonnes in 1998, to 42 603 in 1999, to 101 303 in 2000.

A unique feature of this programme is a limitation on banking called 'progressive flow control'. This allows unlimited banking of allowances, but discourages the 'excessive' use of banked allowances. A two-for-one discount rate is applied to the use of some banked allowances when the total number of banked allowances exceeds 10 per cent of the allowable $NO_x$ emissions. Current year (i.e. 2002 allowances for 2002 reconciliation) are used first for compliance purposes. Then, and only when needed, banked allowances can be used. For each source, the first X per cent of the banked allowances cover emissions at face value (1 tonne per allowance),

**Table 3.3: Ozone Transport Commission $NO_x$ budget programme**

| Year | Number of states participating | Number of participants | Allowances allocated (thousand) | Emissions by participants (thousand tonnes) | Allowances banked[a] (thousand) | Flow control ratio[b] | Price range (dollars per tonne)[c] |
|---|---|---|---|---|---|---|---|
| 1999 | 8 | 912 | 218.7 | 174.8 | 48.6 | 0.50 | $717–$6 375 |
| 2000 | 9 | 937 | 195.4 | 174.5 | 60.6 | 0.36 | $371–$912 |
| 2001 | 9 | 970 | 207.8 | 183.3 | 78.7 | 0.36 | $540–$1 712 |

Notes: a Allowances banked at the end of the year
b See text for discussion of flow control.
c Price range is determined from monthly prices quoted by Utility Environment Report.

Sources: Annual compliance reports for 1999 through 2001.

where X depends upon the size of the bank Any additional banked allowances used are discounted by 50 per cent (two allowances per tonne of emissions).

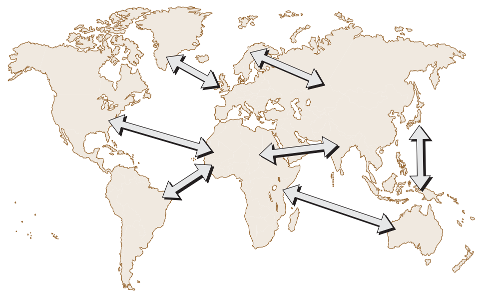
Participants must install continuous emissions monitors, and face a penalty of three allowances for each tonne of excess emissions. There has been a minor amount of non-compliance each year, ranging between one and five participants with total excess emissions of less than 60 tonnes per year.

## Emissions trading for greenhouse gases

Emissions of greenhouse gases—carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) —contribute to climate change. The Kyoto Protocol, if it comes into force, will limit emissions of greenhouse gases in the industrialized countries that ratify the Protocol (Annex B Parties). The Protocol establishes three forms of international emissions trading for greenhouse gases involving all Parties to the Protocol to help the industrialized countries meet their commitments at lower cost.

From an environmental perspective, greenhouse gases are ideal candidates for emissions trading. Emissions of greenhouse gases have no direct health or environmental impacts. The effect on climate depends on their concentration in the atmosphere. Since they have relatively long atmospheric lives (decades to millennia), a release anywhere in the world has the same impact on climate.

From an economic perspective, greenhouse gases are also excellent candidates for emissions trading. There are millions of sources of greenhouse gas emissions globally, and abatement costs differ widely. Thus the potential cost savings for a given reduction target are significant. The main challenge is to design emissions trading programmes that cover a substantial share of the total emissions with an administratively manageable number of participants.



*Thus emissions trading for greenhouse gases can occur on a global scale.*

Countries will design and implement domestic policies, including emissions trading programmes, to meet their commitments under the Kyoto Protocol. They may use the Kyoto mechanisms to trade allowances/credits internationally if they wish, although the way the mechanisms can be used by individual sources will depend upon the domestic policies adopted. Since measures to reduce greenhouse gas emissions often lower emissions of other pollutants that have local health and/or environmental impacts a country may favour domestic emission reductions over the use of allowances/credits as a means of meeting its commitment.

## Kyoto mechanisms

The Kyoto Protocol establishes three mechanisms that allow Parties to use international trading of greenhouse gas emissions to meet their commitments. These are: International Emissions Trading (IET); the Clean Development Mechanism (CDM); and Joint Implementation (JI).

International emissions trading is a 'cap and trade ' system for Annex B Parties. The allocation to each Party is its initial assigned amount—its national emissions limitation commitment for 2008–2012—plus adjustments for net removals by sinks due to eligible human-induced activities. The allowances traded are assigned amount units (AAUs) and removal units (RMUs).

The Clean Development Mechanism allows Parties without emissions limitation commitments to earn credits for implementing emission reduction and specified types of sink enhancement projects. Sink enhancement measures, e.g. planting trees and no-till agriculture, are actions that can remove carbon from the atmosphere for relatively long periods (decades). The rules establish an international process for reviewing the baseline and the emission reduction or sink enhancement achieved by each CDM project. Implementation of CDM projects can begin immediately. Credits awarded for CDM projects—known as certified emission reductions (CERs)—can be used by Annex B Parties toward compliance with their national commitments.

Joint Implementation allows Annex B Parties to award credits for emission reduction and sink enhancement projects. Since these actions help the Party meet its national commitment, any JI credits—known as emission reduction units (ERUs)—awarded are subtracted from its available AAUs or RMUs to avoid double counting. The rules allow countries not eligible to participate in IET to host JI projects. Parties eligible for IET may host JI projects as well and may prefer this mechanism under some circumstances even though the transaction costs are likely to be higher.

The main environmental risk associated with international emissions trading is enforcement of compliance. There is no international regulatory authority with the power to impose penalties on Parties that fail to meet their emissions limitation commitments. And the track record for voluntary compliance by sovereign nations with their commitments under international environmental agreements is poor. To compensate for the lack of a regulatory authority, excess emissions will be subject to loss of AAUs for the next commitment period. However a Party that believes the sanctions to be excessive can threaten to withdraw from the Protocol, so these penalties cannot guarantee full compliance.

The ways the mechanisms can be used by an individual source will depend upon the domestic policies adopted. This is discussed below, after presentation of two national programmes.

### Danish $CO_2$ programme

Denmark established an emissions trading programme for $CO_2$ emissions by electricity generators for the years 2001–2003. The emissions cap is 22 million tonnes of carbon dioxide ($mtCO_2$) for 2001 declining by 1 $mtCO_2$ each year to

20 $mtCO_2$ for 2003. Denmark's total emissions are around 60 $mtCO_2$ per year, so the system covers about 33 per cent of national emissions.

The cap covers emissions by about 500 electricity producers, most of which are very small combined heat and power plants, but emissions trading is limited to eight firms. A 'small' plant is one with emissions of less than 100,000 tonnes of $CO_2$ per year. Small plants do not receive allowances and are not subject to penalty in case of non-compliance. Allowances are allocated free to the eight participants based on their 1994–98 emissions. Two firms, Elsam and Energi E2, received 93 per cent of the allowances allocated.

To work well, an emissions trading programme should establish a competitive market for the allowances. A programme with only eight participants, two of which account for 93 per cent of the allowances, will not be a competitive market. Since the firms are all in the same industry, selling allowances could be interpreted as providing market share to a competitor. Trading activity, therefore, is likely to be minimal. Some allowances that could not be banked were sold to foreign buyers at the end of 2001

### UK GHG Emissions Trading Scheme

The UK Emissions Trading Scheme is a voluntary programme with strong incentives to participate. Sources can enter the programme in one of three ways:

- Through Climate Change Levy Agreements (CCLA)—energy intensive sectors accept energy efficiency or emissions targets in return for an 80 per cent discount of the Climate Change Levy (an energy tax). Participants can earn tradeable allowances for $CO_2$ reductions computed in relation to the targets.
- Companies that met specified eligibility conditions were allowed to 'bid' absolute emission reductions measured relative to average annual emissions for 1998–2000 in return for incentive payments from the government. Successful bidders (Direct Participants) can engage in emissions trading to help meet their commitments.
- Any UK company may carry out a project that results in verified emissions reductions credits, which are also tradeable. The rules for project participation have not yet been devised.

Targets for Climate Change Levy Agreement (CCLA) participants were negotiated with the government. Over 40 industrial sectors have such agreements, covering some 8 000 individual entities. A sector's target may be an absolute or rate-based target for energy savings or greenhouse gas emission reductions. Most of the agreements have rate-based energy targets (lower energy use per unit of production). Regardless of how the target is defined, it is converted to $CO_2$ reductions. The estimated reduction in the annual emissions of the participants is 9.30 $MtCO_2e$ by 2010.

An auction, on 11 March 2002, resulted in 34 Direct Participants joining the programme. These participants bid reductions of about 4 $MtCO_2e$ for 2006 from their base year (1998 to 2000) emissions. A linearly declining cap applies during the intervening years. The penalties for non-compliance with the absolute cap are non-payment of the incentive, possible clawing back of previous years' payments with interest, and docking of allowances for subsequent years at a rate between 1.1 and 2 times the shortfall.

A 'gateway' has been established between the absolute and the rate-based sectors to avoid inflation of the emissions of the absolute sector by the rate-based sector. The gateway prevents any net sales from the rate-based sector to the absolute sector. The gateway is expected to close permanently at the end of 2007. Effectively, trading between the two sectors will only take place when the marginal cost of abatement is lower in the absolute sector.

The first compliance period started on 1 January 2002 for the calendar year. There will be a three month grace period before compliance is assessed at the end of March 2003.

Unlimited banking is allowed by all participants through 2007. Banking of pre-2008 allowances for use during 2008–2012 is available to participants with absolute caps to the extent that they have over-complied with their targets (i.e., they cannot buy to bank). The Government reserves the right to impose restrictions on banking of all other allowances and credits beyond 2007. Restrictions will be in the form of percentage-based cancellations applied to applicable holdings at the end of 2007.

Each Direct Participant will be required to measure and report its emissions annually using the specified measurement and reporting guidelines. Measurement and reporting requirements for CCLA participants are specified by the respective agreements. Direct Participants and CCLA participants that wish to sell allowances must have their annual emissions reports verified by an accredited independent verifier.

Allowances will be treated as revenue items for tax purposes. The cost of purchased allowances is a business expense and revenue from the sale of allowances is taxable income. Allowances are not subject to stamp duty. The price for 2002 vintage allowances rose from £5.00/$tCO_2e$ in April 2002 to over £7.25/$tCO_2e$ in July 2002.

### European Commission Directive

The European Commission has drafted a Directive that would require each Member State to implement a domestic emissions trading programme for specified sources of $CO_2$ emissions. The Directive, which would come into force in 2005, would also apply to accession countries when they join the European Union. Countries in the European economic area, such as Norway and

Switzerland, could also choose to adhere to the Directive, so it could apply to as many as 30 domestic emissions trading programmes by 2008.

The proposed Directive would require each Member State to implement a domestic greenhouse gas emissions trading programme. Some elements of the design would be common to all of the domestic programmes, while other elements could vary across Member States, at the discretion of the national government. Participation is intended to be mandatory for 4 000 to 5 000 installations in specified sectors which are responsible for about 46 per cent of the European Union's projected $CO_2$ emissions for 2010. Coverage could be extended to additional gases and sectors at the request of a Member State or at the initiative of the Commission.

The total quantity of allowances issued and their distribution to participants is largely left to the Member States, with each State having to submit a national allocation plan in advance to the Commission. The proposed Directive specifies that allowances be distributed free during the 2005–2007 period, but allows some or all of the allowances to be auctioned during subsequent periods. If allowances are to be distributed free, the national allocation plan must include objective and transparent criteria for the distribution of allowances. In addition, the distribution of allowances to participants must be consistent with the EU requirements regarding state aid to industry and must treat new entrants fairly.

The life of allowances would be limited to the period for which they are issued: 2005–2007 or 2008–2012. Unrestricted banking is allowed within each period. Member States will have the option to allow banking from 2005–2007 into the 2008–2012 period. The proposed Directive requires Member States to allow banking between subsequent periods, e.g. from 2008–2012 into 2013–2017, even if the Member State does not meet its national emissions limitation commitment. This would be accomplished by exchanging banked allowances for an equal number of allowances for the new period.

By 31 March of each year, participants would be required to surrender allowances equal to their actual emissions during the previous calendar year. The penalty for non-compliance would be loss of allowances equal to the excess emissions plus a financial penalty, for each metric tonne of excess emissions, of €100 (€50 during 2005–2007) or twice the average market price during a predetermined period per, which is ever is higher.

The proposed Directive is currently being discussed in the European Parliament and Council and may be modified before it becomes law.

## Other proposed trading programmes

In addition to the examples given so far, emissions trading for greenhouse gases has been studied in Australia, Canada, France, Germany, Japan, Netherlands, New Zealand, Norway, Slovakia, Sweden and Switzerland. In the United States, Massachusetts and New Hampshire have passed legislation that will limit $CO_2$ emissions by electricity generators in those states and allow emissions trading as a means of compliance. The State of Oregon also requires new energy facilities to offset part of their $CO_2$ emissions.

It therefore appears that many countries that will have emissions limitation commitments under the Kyoto Protocol will implement an emissions trading programme to help meet their commitment. The share of national emissions covered could range from about 25 per cent to 85 per cent, with different categories of sources covered in different countries. If the European Commission adopts a Directive that makes an emissions trading programme mandatory for Member States, almost all countries with emissions limitation commitments under the Kyoto Protocol are likely to have domestic emissions trading programmes.

## Links between the Kyoto mechanisms and domestic policies and measures

Governments and legal entities (firms) can participate in all three Kyoto mechanisms. However, the governments of Annex B Parties remain responsible for compliance with their national commitments. A government of an Annex B Party can use the Kyoto mechanisms regardless of the domestic policies and measures adopted. The government of the Netherlands is already contracting for the purchase of ERUs and CERs to help meet its national commitment.

The ability of legal entities to use the Kyoto mechanisms to meet domestic policy obligations is essential for full realization of the potential cost savings due to emissions trading. The ability of a legal entity to use the Kyoto mechanisms depends upon the nature of the domestic policies to which it is subject, and national policies on the use of those mechanisms for compliance.

Legal entities are best able to use the Kyoto mechanisms if they are participants in a domestic emissions trading programme. Potential cost savings are fully realized when the marginal cost is the same for all sources. An emissions tax or an emissions trading programme are the only policies that can achieve this result. A domestic emissions tax will not reflect the international market price for $CO_2$ at all times, so a domestic emissions trading programme linked to the international market is the only policy able to achieve the potential cost savings made possible by international emissions trading.

As noted above, many and perhaps almost all Annex B Parties are likely to implement a domestic emissions trading programme. However, the designs of those programmes are likely to differ in many respects. It is appropriate that emissions trading programmes be adapted to the emissions inventory and institutional structure of the country. Design differences should not preclude links between domestic emissions trading programmes.

The Kyoto mechanisms could be used for compliance by the participants in any domestic emissions trading programme regardless of the design. In simple terms a participant in a domestic programme could exchange a surplus domestic allowance for an AAU, which it can sell to a firm in any other country. The buyer can exchange the AAU for a domestic allowance in its country. Governments may impose some restrictions on imports and exports of AAUs, CERs, ERUs and RMUs by legal entities:

- government may restrict use of imported allowances/credits to ensure that domestic action constitutes a significant element of the effort made to meet its emission limitation commitment or to reap the ancillary benefits of domestic emission reductions.
- A government that wishes to allow legal entities to export allowances/credits will need to implement procedures to ensure continued compliance with the commitment period reserve. The commitment period reserve is designed to prevent countries overselling their emissions permits by requiring them to keep a certain amount of permits in their account. If no procedure is established many legal entities will wish to move AAUs to another country immediately because of the extra flexibility this provides. Once out of the country, the AAUs can be sold to a buyer in any other country or be repatriated to comply with domestic policy obligations. If enough AAUs have been moved out of the country to make the commitment period reserve binding, further exports are not allowed. Thus entities that wait to move AAUs out of the country may find their options restricted to domestic sales or use for compliance purposes. A limit on exports of AAUs can be implemented in various ways. For example:
    - participants in the domestic emissions trading programme could be required to demonstrate compliance with their domestic obligations and then be allowed to exchange surplus allowances for exportable AAUs;
    - AAUs could be used as the allowances in the domestic emissions trading programme with a fraction of the AAUs distributed being designated as exportable; or
    - participants, export permits could be issued and firms wishing to export AAUs would need to exchange a domestic allowance and an export permit for an AAU (export permits could also be issued to firms that import AAUs, ERUs, or CERs).

Domestic emissions trading programmes can also be linked prior to the availability of international emissions trading in 2008. Governments can agree to mutual recognition of allowances/credits. Alternatively, a programme could accept allowances/credits from another programme after a review to ensure that they met specified conditions to ensure environmental integrity.

# Annex 1: How big are the cost savings?

The table below summarizes estimates of potential or actual cost savings for various emissions trading programmes in the United States. Most studies provide estimates of potential savings for a proposed emissions trading programme. Estimates of savings for programmes actually implemented are:

- 20 per cent ($250 million) for the lead in gasoline trading programme;
- $5–12 billion cumulative savings for the netting[1], offsets, bubbles[2] and banking for criteria air pollutants in non-attainment areas over approximately ten years; and

[1] Netting refers to trade within a firm when new emissions from an existing source are compensated for by an equal decrease in emissions from another source in the same plant (unlike offsetting which applies to new sources only)..

[2] Plants with multiple emission sources can be enclosed in an imaginary 'bubble' encompassing all of the sources. It is then left to the plant management to regulate the total emissions from the bubble, rather than regulating each source individually.

**Estimates of cost savings for emissions trading programmes**

| Pollutants Covered | Geographic Area | Regulatory Benchmark | Type[a] | Cost Saving |
|---|---|---|---|---|
| Particulates | St. Louis | SIP regulations | P | 83% |
| Sulphur dioxide | Four corners, Utah | SIP regulations | P | 76% |
| Sulphates | Los Angeles | California emission standards | P | 7% |
| Nitrogen dioxide | Baltimore | Proposed RACT regulations | P | 83% |
| Nitrogen dioxide | Chicago | Proposed RACT regulations | P | 93% |
| Particulates | Baltimore | SIP regulations | P | 76% |
| Sulphur dioxide | Lower Delaware Valley | Uniform percentage reduction | P | 44% |
| Particulates | Lower Delaware Valley | Uniform percentage reduction | P | 95% |
| Airport noise | United States | Mandatory retrofit | P | 42% |
| Hydrocarbons | All DuPont plants in the US | Uniform percentage reduction | P | 76% |
| CFCs from non-aerosol applications | United States | Proposed emission standards | P | 49% |
| Lead in gasoline | United States | Uniform standard | A | $250 million 20% |
| Criteria air pollutants | Non-attainment areas in the US | No netting, offsets bubbles or banking | A | $5–$12 billion |
| $NO_x$ and $SO_2$ | Greater Los Angeles area | Regs replaced by RECLAIM | P | 42% |
| Criteria air pollutants | Non-attainment areas in the US | No bubbles | A | $430 million |
| $NO_x$ | North-eastern US | Regulations | P | 40–47% |
| $SO_2$ | United States | Efficient regulations | P | $1 bn/year 45% |

Notes: a 'A' denotes an estimate of actual savings, 'P' denotes an estimate of prospective savings

Sources: Annual compliance reports for 1995 through 2001.

- an estimated cumulative saving of $430 million for bubbles for criteria air pollutants.

There have been many studies of the potential cost savings due to international emissions trading for greenhouse gases under the Kyoto Protocol. The studies differ in terms of the emissions covered (from energy related $CO_2$ only to all greenhouse gases), the coverage of sinks (no sinks to maximum allowable sinks), the projected emissions in the absence of emissions limitation policies, the scale of CDM activity (none to all reductions from business-as-usual emissions in developing countries), transaction costs for project-based mechanisms (none to 30 per cent), and the structure of the model used.

Most studies have assumed that the United States would ratify the Kyoto Protocol. The savings estimated by such studies differ widely for given regions, depending on the model used. When emissions trading is limited to countries with emissions limitation commitments (Annex B trading), the US realizes the smallest savings (average 46 per cent, range 30 per cent to 76 per cent) and Japan realizes the largest savings (average 64 per cent, range 21 per cent to 93 per cent). The estimated savings for Europe and Canada, Australia and New Zealand regions are approximately the same (average of 54 per cent and 55 per cent respectively). Global trading always yields larger savings than Annex B trading because it provides access to more low cost emission reduction opportunities.

There have been fewer estimates of the potential cost savings if the United States does not ratify the Kyoto Protocol. In percentage terms the cost savings are higher for each of the remaining regions. Since the demand falls (due to the absence of the United States) but the supply remains the same the international price for Kyoto mechanism allowances/credits falls significantly. This means that the absolute cost savings are much smaller without American participation despite the higher percentage savings.

The estimates of potential cost savings assume that the emissions trading programmes are perfectly efficient. in reality, that will not be the case. Emissions trading experiments, and simulations where individuals represent participants, show that they do not always achieve the least cost result. Findings by some experts indicate 97 per cent potential cost savings realized, others 82.5 per cent and still others as low as 45 per cent for some experiments

In summary, numerous estimates of the potential savings due to proposed emissions trading programmes are available. In most cases the potential savings are large—50 per cent to 90 per cent. Although the potential cost savings are unlikely to be fully realized in practice estimates of the cost savings actually achieved are still over 20 per cent.

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# About the UNEP Division of Technology, Industry and Economics

The mission of the UNEP Division of Technology, Industry and Economics is to help decision-makers in government, local authorities, and industry develop and adopt policies and practices that:

- are cleaner and safer;
- make efficient use of natural resources;
- ensure adequate management of chemicals;
- incorporate environmental costs; and
- reduce pollution and risks for humans and the environment.

The UNEP Division of Technology, Industry and Economics (UNEP DTIE), with the Division Office in Paris, is composed of one centre and five branches:

- **The International Environmental Technology Centre (Osaka)**, which promotes the adoption and use of environmentally sound technologies with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.
- **Production and Consumption (Paris)**, which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.
- **Chemicals (Geneva)**, which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety worldwide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).
- **Energy and OzonAction (Paris)**, which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of the Unit.
- **Economics and Trade (Geneva)**, which promotes the use and application of assessment and incentive tools for environmental policy and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.
- **Coordination of Regional Activities Branch**, which coordinates regional delivery of UNEP DTIE's activities and ensures coordination of DTIE's activities funded by the Global Environment Facility (GEF).

UNEP DTIE activities focus on raising awareness, improving the transfer of information, building capacity, fostering technology cooperation, partnerships and transfer, improving understanding of environmental impacts of trade issues, promoting integration of environmental considerations into economic policies, and catalysing global chemical safety.

For more information contact:
*UNEP, Division of Technology, Industry and Economics*
39–43, Quai André Citroën
75739 Paris Cedex 15, France
Tel: 33 1 44 37 14 50;
Fax: 33 1 44 37 14 74
E-mail: unep.tie@unep.fr;
Website: www.uneptie.org

# About the UNCTAD-Earth Council Carbon Market Programme

The Kyoto Protocol and other measures to address climate change through the reduction of greenhouse gas emissions have spurred the emergence of a market for carbon emissions. Domestic climate policies and the application of the Kyoto mechanisms will have trade, investment and economic impacts on both developed and developing economies. The Carbon Market Programme explores these impacts, and works to promote a fair and effective global carbon market.

### Current activities

Engaging the Private Sector in CDM—UNFIP-funded inter-agency project. The UNCTAD component is focused on supporting the development of a CDM Investor's Guide under the auspices of the Brazilian National Development Bank, Inter-Ministerial Commission on Climate Change and the Brazilian Climate Change Forum.

Getting started with CDM in Least Developed Countries—a capacity-building project aimed at prompt starting CDM from the ground-up in LDCs. Currently involves Tanzania and Malawi in partnership with Environmental Protection and Management Services (EPMS) in Tanzania and Sustainable Development Promotion Centre (SDPC) in Uganda.

Supporting GHG markets in countries with economies in transition – a plan of action project to develop the capacity of economies in transition (starting with the Central Group 11 – Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia) to participate in the Kyoto Protocol mechanisms, including the proposed EU emissions trading scheme.

Carbon Market E-Learning Center (www.LearnSD.org) – prototype funded by UNFIP. The E-Learning Center provides complementary learning opportunities to a global audience on the use of emissions trading (including trading in CDM and JI credits) as an economic instrument to implement the UNFCCC and Kyoto Protocol. The Center offers its own on-line courses but more importantly offers its "virtual workshop" facility to other institutions so that they can effectively and conveniently implement their own courses through the e-learning facilities of the CMEC.

### About the Carbon Market Programme

In 1991, the United Nations Foundation for International Partnerships (UNFIP) funded the UNCTAD Emissions Trading Programme. At that time, UNCTAD's mission was to promote and develop a plurilateral greenhouse gas (GHG) emissions trading programme. In 1993 the Kyoto Protocol placed caps on emissions from developed countries and allowed the trading of emission allowances amongst them, and the introduction of project-based emission credits from developing and transitional countries.

Since then the programme at the request of client countries now focuses on exploring the economic, trade and investment impacts of climate change in developing and transitional countries, and works to promote their effective participation in the emerging carbon market. The programme's web site keeps the following:

- Publications: latest include Greenhouse Gas Market Perspectives: Trade and Investment Implications of the Climate Change Regime; The Clean Development Mechanism - Building International Public-Private Partnerships under the Kyoto Protocol; and International Emissions Trading Manual
- Newsletter: Published quarterly since 1997
- Projects
- Policy/Market Forum Reports: from the first Policy Forum in 1997 through the 5th Policy Forum, including links to the IISD coverage of the Rio Policy Forum
- Information on the carbon market

For more information visit www.unctad.org/ghg or contact Mr. Lucas Assuncao, Programme Coordinator, UNCTAD, Email lucas.assuncao@unctad.org, Tel: +41 22 917 2116, Fax +41 22 917 0432.

www.unep.org
United Nations Environment Programme
P.O. Box 30552, Nairobi, Kenya
Tel: (254 2) 621234
Fax: (254 2) 623927
E-mail: cpiinfo@unep.org
web: www unep.org

UNEP

UNCTAD

UNEP

Division of Technology, Industry and Economics
Tour Mirabeau
39–43 quai André Citroën
75739 Paris Cedex 15
France
Tel: +33 1 44 37 14 50
Fax: +33 1 44 37 14 74
E-mail: unep.tie@unep.fr
Website: www.uneptie.org