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

United Nations Conference on Trade and Development
Earth Council Carbon Market Programme

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Foreword

Emissions Trading, a market-based instrument used for environmental protection, has been adopted as one of the primary tools for international cooperation to reduce greenhouse gas emissions under the Kyoto Protocol. As a result, many countries will implement emissions trading programmes for the first time. However, Emissions Trading is not new—tradable rights for pollution control were first proposed in 1968—and trading programmes have been implemented to reduce emissions of SO_x, NO_x, CO_2 and other pollutants.

Emissions Trading allows sources flexibility to determine how and where to meet an overall limit on the amount of emissions. This compliance flexibility reduces the cost of meeting the overall emissions limit. To ensure that the environmental goal is achieved, an emissions trading programme requires accurate monitoring, effective enforcement and, in the case of conventional pollutants, provisions to protect local air quality.

This publication draws on recent work of the United Nations Conference on Trade and Development and the United Nations Environment Programme and its Collaborating Center on Energy and the Environment. It summarizes in non-technical language the central issues related to emissions trading:

- How can it reduce the cost of environmental protection?
- What are the challenges in designing emissions trading programmes?
- What has worked or not worked in practice?

By raising awareness of these issues among a wider audience, we hope to contribute to a better understanding of the public policy challenges that lie ahead.

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Introduction

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

An international system would undoubtedly break new ground in terms of international trade, and there has therefore been much specialist discussion of the subject. However, to date, little 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. In particular, misgivings have been voiced about how achieving environmental targets can be guaranteed. In order to dispel some of these misgivings and misunderstandings, this *Guide* paints a clear picture of emissions trading, including consideration of the aspects of system design that ensure that environmental targets are met.

In principle, emissions trading is simple. However, in practice, applying the concept effectively to different pollutants can become quite complex and the term emissions trading applies to a fairly broad spectrum of systems of different design. This *Guide* adopts a step-by-step approach to emissions trading, in three parts, to allow readers to build up their understanding of both the environmental and economic aspects of the subject:

- 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. The emphasis here is on the economic advantages of emissions trading in relation to more conventional forms of regulation.
- Part II covers the various types of emissions trading system designs, with an emphasis on 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 might be like.

Part I:
Emissions trading—basics

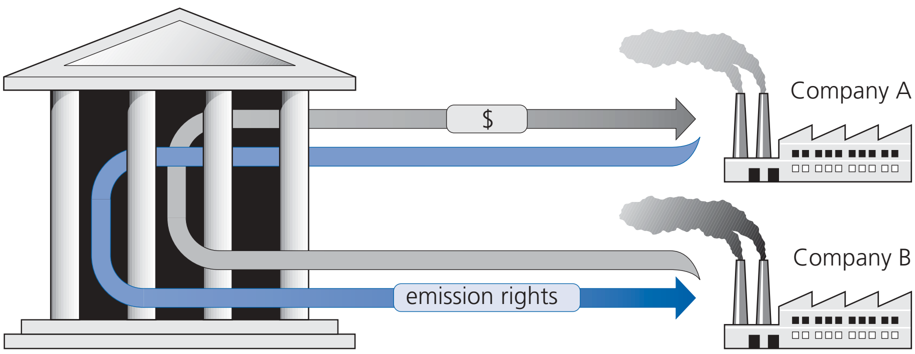
Using tradable rights as a means of pollution control was first suggested in 1968 by the Canadian economist John Dales, and the first emissions trading programmes were implemented in the United States following the Clean Air Act amendments of 1977. In the ensuing years, several other emissions trading programmes were implemented in the United States. Provisions for international emissions trading for greenhouse gases were then included in the 1997 Kyoto Protocol. Since then, interest in emissions trading has spread, leading to implementation of several programmes for greenhouse gases and conventional pollutants. 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 damage air quality, and the relevant authorities may decide that emissions should be reduced by a given amount, say by 10 per cent. At first glance, the solution seems simple: both A and B cut their 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 its emissions 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 emission rights that are distributed equally among the various sources of the pollutant. It is here that the market comes into play, 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, emissions are cut, overall, by the required amount, company B saves money, company A earns a profit for its additional reductions and the total cost is reduced. 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 model, helps 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 form of environmental regulation that allows a group of sources to reach a specified emissions target at lower cost.

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With this 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 are economic in nature; the others, essential for environmental regulation, are discussed in Part II.

- A limit must be set on emissions and this must be lower than the 'business-as-usual' emissions of the sources participating in the programme.
- The participants must face divergent clean-up costs so that there will be cost savings from trading. The number of participating sources must be sufficiently large to constitute a competitive market.
- Accurate monitoring of actual emissions and reductions by each participant is essential.
- There must be effective enforcement to ensure that each participant holds enough emission entitlements to cover its actual emissions.
- 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, with emissions trading, specified emission limits can be met as effectively as with conventional regulations but at lower cost to the participating sources. 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 that are 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 illustrate the simple model of emissions trading, the tables below present a numerical example that 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:

Emissions reductions required by the regulator

	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 tonne 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 –$17 500 $2 500	$25 000 +$17 500 $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 –$2 500 $7 500	$50 000 –$42 500 $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, but 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 the Annex.

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 measures that reduce emissions. For example, initial estimates of the cost of compliance with the SO_2 (sulphur dioxide) cap for electric utilities imposed in the USA (see Part III) were based on the 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.

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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 USA 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 regulation. 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

Emissions trading is first and foremost an environmental policy instrument. It is therefore essential to ensure that the design of a trading system will achieve the environmental goals. Designing an emissions trading programme implies making decisions on many issues ranging from the sources of emissions to be controlled to questions such as monitoring, enforcement and penalties for non-compliance which are of particular importance for attainment of environmental objectives. These 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 regulator establishes an overall limit on emissions—the 'emissions cap'—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 by the regulator. The baseline often varies with the level of output (see below and Box 3). 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 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 from a new source 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. In effect, the existing sources are given a free allocation equivalent to the baseline from which their emissions reductions are calculated. For the new and expanding sources, the baseline is any emissions they are not required to offset; if they are required to offset all of the increase in their emissions the baseline is zero. 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 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

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.

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.
- 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.

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Open and closed systems

Implementing an emissions trading programme places a financial burden on the participating sources and an administrative burden 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 cost benefits 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.

However, allowing other, usually 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 use emission reductions from sources other than the original participants is known as an 'open' system.

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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.

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 some 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 employees through lower wages and benefits, or to suppliers through lower prices for inputs. The portion of the costs that cannot be passed on reduces the source's profits and hence the value of its assets and so is borne by its shareholders.

Studies of greenhouse gas trading programmes in the USA 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, 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.

An upstream design usually leads to higher prices for the regulated product, resulting in costs for the consumers and higher profits for the participants. For example, an upstream design for energy-related CO_2 emissions leads to higher prices for fossil fuels because their supply is limited by the cap on the carbon content of these fuels. Customers pay higher fuel prices and incur costs in switching fuels and conserving energy. The higher prices lead to higher profits for the participants since they incur virtually no costs. In such cases, auctioning the allowances would capture a substantial part, perhaps all, of the extra profits.

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 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 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.

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 –$35 000 –$15 000	$25 000 +$35 000 $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 ($45 000) and higher than the $50 000 cost it would face under conventional regulation (see Box 1).

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.

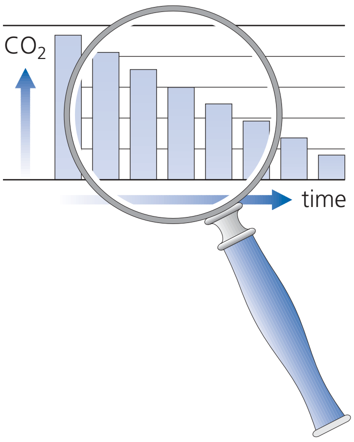
However, banking can also yield environmental benefits by helping to reduce damage from emissions to human health and to the environment. In order to obtain surplus allowances/credits to bank, participants have to make real emission reductions bringing them below their allocated limit. Greater reductions are therefore made early in the life of a trading programme, precisely at the time when total emissions are highest. The same allowances/credits will be used at a later time when total emissions are relatively lower.

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. During the electricity crisis, higher output by generating units participating in RECLAIM increased demand for nitrogen oxides RECLAIM Trading Credits (RTC), causing 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 will have saved themselves the costs of compliance while the consequences of this failure are borne by the environment in the form of higher emissions. Borrowing is therefore 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.



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 and, as demonstrated by the general 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 from 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 allowances—would be equal to the source's 2003 business-as-usual emissions. 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 in the discussion on 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 costs than expected 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 the extra allowances they need 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, business-related air travel 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.

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 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. The greenhouse gas trading programme in the United Kingdom is the only one that regulates CO_2 emissions due to electricity generation indirectly.

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 greenhouse gases, location of the emissions is not a concern. The climate change impacts of greenhouse gas emissions do not depend upon the location of the emissions. However, 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 restrict trading in a greenhouse gas trading programme to achieve emissions reductions in locations where the benefits of the ancillary emission reductions are greatest.

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

Economic

- Emissions trading is a form of environmental regulation that allows sources of emissions to achieve a specified emissions target at lower cost.
- Cost savings stem from differences in participants' marginal costs in reducing emissions. These are made possible by flexibility in determining the least cost emission reduction strategies for each facility, and by incentives to develop lower cost emissions reduction technologies and practices.
- An emissions trading programme needs enough participants to create a competitive market for allowances/credits. Participants should be the entities best able to control the emissions. Where control technologies are cost-effective, these are the emissions sources (e.g. SO_2 from power plants). However, where there are numerous small sources of emissions, it may be a product manufacturer (e.g. leaded fuels).
- Emissions trading focuses on achieving an environmental goal. The costs that are incurred in achieving that goal are uncertain. A safety valve can be used, to ensure that costs do not become excessive.
- Emissions trading creates valuable assets—the allowances/credits. How these are 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. Free distribution may amount to giving participants assets that exceed the costs they incur in reducing emissions. It can therefore be argued that at least some of the allowances should be auctioned. The revenue could be used, for example, to: fund transitional assistance for adversely affected workers, communities or other entities; ease the impact on individuals; or maintain government revenues.
- Banking is desirable because it encourages early reductions and provides flexibility to respond to unforeseen developments that could lead to price volatility and/or non-compliance in the absence of banking.

Environmental

- Emissions trading is becoming more common and is likely to be widely used to regulate greenhouse gas emissions. Emissions trading programmes must be carefully designed to suit the environmental problem, the emissions sources and the institutional setting.
- The number of participants must be small enough to allow each participant to be audited for compliance.
- Banking, although economically desirable, raises environmental concerns because it allows an increase in emissions beyond the cap, and the accumulation of a large bank can delay achievement of an emissions target. However, banking can also bring environmental benefits as it encourages sources to reduce emissions below their allocated limits (to build up 'bankable' credits). This increases the rate of reduction earlier in the life of an emissions trading programme.
- The available evidence suggests that, to date, trading programmes have achieved substantial cost savings relative to conventional regulations designed to achieve the same environmental, and that non-compliance is very low in most programmes.

In summary

The main purpose of emissions trading is to achieve effective environmental control. It is therefore important to ensure that implementation of the system does not entail too high an administrative or financial burden for regulating authorities or participating sources, and that it is designed in such a way as to ensure that specified environmental targets are achieved. In the case of 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 geographical area from which allowances/credits can be purchased, to ensure that trading ensures 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.

Part III: Experience with emissions trading

The earliest emissions trading programmes were introduced in the USA in the 1970s. The USA has gained most experience 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 a proposal from the European Union are also presented, followed by discussion of the mechanisms proposed under the Kyoto Protocol.

Control of air quality in the USA 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.

Box 5: the US Clean Air Act

Background

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

The CAA is a federal law, covering the whole of the USA, implemented by the US Environment Protection Agency (EPA). The EPA sets a limit on the maximum allowable concentration of a pollutant in the air anywhere in the country. If a region exceeds one or more of the limits, the state must develop a State Implementation Plan (SIP), which must be approved by the EPA, to reduce emissions of the pollutant(s) so that the concentrations will be reduced to acceptable levels. Thus, individual states do much of the work required to implement the CAA.

Criteria pollutants

The EPA is mainly concerned about emissions that could be harmful to human health and has therefore set maximum allowable concentrations for several air pollutants, known as criteria pollutants, that adversely affect human health. These are: carbon monoxide (CO); lead (Pb); nitrogen dioxide (NO_2); ozone (O_3); particulate matter (PM); and sulphur dioxide (SO_2).

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 is regulated and monitored.

Attainment area: an ACQR in which the monitored levels of a criteria air pollutant are lower than the NAAQS (see below) for that pollutant.

National Ambient Air Quality Standards (NAAQS): the national standard for the maximum allowable concentration of each of the criteria pollutants.

Non-attainment area: an ACQR in which the monitored levels of a criteria air pollutant are higher than the NAAQS for that pollutant. Since there are six criteria air pollutants an ACQR can be an attainment area for some pollutants and a non-attainment area for others.

Lowest Achievable Emissions Rate (LAER): the most stringent emission limitation achieved in practice. A large new source or expansion of an existing source in a non-attainment area must implement control measures to achieve LAER for the relevant pollutant(s) and offset any remaining emissions through the purchase of emissions reduction credits (ERCs—see main text) created by existing sources in the same ACQR.

Principal source: www.epa.gov

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 (ERCs) 'earned' through reductions at an existing source.

To create an ERC, an existing source must shut down, or implement measures to 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 lower. About 80 per cent of ERCs are generated by shutdowns, often of an older facility owned by the firm building the new source.

Although many ERCs are generated by older sources that are shut down 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.

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 low level of trading activity is blamed on high transaction costs, the uncertainty and risk in obtaining the needed government approvals for ERCs, 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 determined by the EPA, at that time, 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 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.

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 new firms received free lead-use rights equal to the leaded gasoline production.

At least one expert has concluded that competition from these new manufacturers not only prevented existing refineries from raising the price of the low lead (unleaded) gasoline, but led to lower gasoline prices for consumers.

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 tons per year after 2010, a 10 million ton 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 ton 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 more than 2 500 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 ton. 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.

Table 3.1: SO_2 allowance trading programme

Year	Number of participants	Allowances allocated (million)	Actual emissions by participants (million tons)	Actual emissions by all sources[a] (million tons)	Allowances banked[b] (million)	Allowances traded[c] (million)	Price range (dollars per ton)[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	2 792	9.55	10.63	10.63	9.30	12.6	$150–$214

[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

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 and 2001 a few sources failed to comply, with total excess emissions of 54 tons and 11 tons respectively.

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 tons 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 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 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

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 tons/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/ton)[b]		$679	$710	$786	$1 024	$1 373	$2 557	$21 308	$41 151
SO_x (thousands of tons/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/ton)[b]			$524	$1 063	$2 305	$618	$840	$2 108	$5 756

[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.

Note:
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 tons rather than 3 294 tons as suggested by the table.

Source: SCAQMD, 2002

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 its compliance period 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 and their price. RTCs used for compliance or remaining unsold in the facility's account are subject to an emission allocation fee of roughly $374 per ton. Surplus RTCs can be 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

Ground-level ozone is formed in the atmosphere by complex chemical reactions involving nitrogen oxides (NO_x), volatile organic compounds (VOCs) and sunlight. To help limit ozone formation, 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 during the May–September ozone season are: 219 000 tons in Phase I and 143 000 tons 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 allowances to the participants in its jurisdiction. Each allowance permits a source to emit one ton 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,

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 tons)	Allowances banked[a] (thousand)	Flow control ratio[b]	Price range (dollars per ton)[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

[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

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.

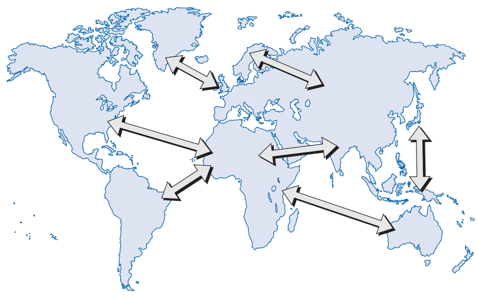
A unique feature of this programme is a limitation on banking called 'progressive flow control'. This allows unlimited banking of allowances, but discourages the 'excessive' use of banked allowances. A two-for-one discount rate is applied to the use of some banked allowances when the total number of 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 ton per allowance), where X depends upon the size of the bank. Any additional banked allowances used are discounted by 50 per cent (two allowances per ton of emissions).

Participants must install continuous emissions monitors, and face a penalty of three allowances for each ton 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 tons 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 enters into force, will limit emissions of greenhouse gases in the industrialized countries that ratify the Protocol (Annex B Parties). The Protocol establishes three mechanisms to curb 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 total 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 and, equally, their reduction anywhere in the world will have the same effect in reducing climate change.



Emissions trading for greenhouse gases can occur on a global scale.

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.

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 give Parties greater flexibility in reducing 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 sink enhancement activities. Sink enhancement activities, e.g. planting trees and no-till agriculture, are actions that can remove carbon from the atmosphere for relatively long periods. 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. 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 relatively poor. Each ton of excess emissions by an Annex B Party will result in the loss of 1.3 AAUs for the next commitment period. To help compensate for this relatively weak enforcement regime, each Annex B Party is required to hold a specified quantity of AAUs and other units — the commitment period reserve — at all times. This limits the extent to which trading can contribute to non-compliance.

The ways the mechanisms can be used by an individual source will depend upon the domestic policies adopted. These are 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 2001–03. 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 CO_2 emissions are around 60 Mt 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, does not constitute 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. More than 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 2008–12 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 more than £10/tCO_2e in September 2002.

European Commission Directive

The European Commission has drafted a Directive that would require each EU 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 adopt 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 2005–07 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: 2005–07 or 2008–12. Unrestricted banking is allowed within each period. Member States will have the option to allow banking from 2005–07 into the 2008–12 period. The proposed Directive requires Member States to allow banking between subsequent periods, e.g. from 2008–12 into 2013–17, even if the Member State does not meet its national emissions limitation commitment.

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 of €100 (€50 during 2005–07) for each tonne of excess emissions, or twice the average market price during a predetermined period.

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 USA, 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 from 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 do 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:

- An Annex B 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.

- An Annex B government that wishes to allow legal entities to export allowances/credits or discount the value of AAUs will need to implement procedures to ensure continued compliance with the commitment period reserve. A limit on exports of AAUs to ensure compliance with the reserve requirement 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
  - a limited number of 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, RMUs, 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: How big are the cost savings?

The table below summarizes estimates of potential or actual cost savings for various proposed and implemented emissions trading programmes in the USA. 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	USA	Mandatory retrofit	P	42%
Hydrocarbons	All DuPont plants in the USA	Uniform percentage reduction	P	76%
CFCs from non-aerosol applications	USA	Proposed emission standards	P	49%
Lead in gasoline	USA	Uniform standard	A	$250 million 20%
Criteria air pollutants	Non-attainment areas in the USA	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 USA	No bubbles	A	$430 million
NO_x	North-eastern USA	Regulations	P	40–47%
SO_2	USA	Efficient regulations	P	$1 bn/year 45%

[a] 'A' denotes an estimate of actual savings; 'P' denotes an estimate of prospective savings

Sources: Stavins 2000 and Tietenberg 1990

- 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 USA 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 USA 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 the Europe and Canada region and the Australia and New Zealand region 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 USA 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 USA) 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.

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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 (CMEC)—prototype funded by UNFIP. The E-Learning Center (www.LearnSD.org) 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 website contains 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, E-mail: lucas.assuncao@unctad.org, Tel: +41 22 917 2116, Fax: +41 22 917 0432

About the UNEP Collaborating Centre on Energy and Environment

The UNEP Collaborating Centre on Energy and Environment (UCCEE) focuses on energy, environment, and development planning at the national, regional and international levels. Furthermore UCCEE supports multi-lateral activities related to the implementation of international environmental agreements, such as the UN Framework Convention on Climate Change (UNFCCC).

UCCEE was conceived by the United Nations Environment Programme (UNEP) in 1989 as a research and technical support unit, based at a well established scientific research centre in Denmark, RISØ National Laboratory. Funding for UCCEE has been supplied by the Danish government, by RISØ National Laboratory and a number of international research funds.

UCCEE supports UNEP in pursuing its aim of incorporating environmental aspects into energy planning and policy worldwide, with special emphasis on developing countries. UCCEE works catalytically, supporting research by local institutions, coordinating projects, disseminating information, and carrying out a full in-house research programme in close collaboration with other institutions in Denmark and internationally.

Major UCCEE activities include:

- Active participation in planning and implementing UNEP's energy programme.
- Partnership with regional and national institutions in developing countries.
- Research on selected Energy, Environment, and Sustainable Development issues.
- Developing and applying analytical methodologies and tools.
- Targeted technical and advisory support to developing countries.
- Building and enhancing institutional capacity in developing countries.
- Supporting implementation of sustainable energy projects.

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