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Review of Alternative Emissions Trading Options

Prepared for:

Pilot Emissions Reduction Trading (PERT) Project

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Appendix A: A Numerical Example of Emissions Trading

1. Introduction

1.1 Purpose

The purpose of report is to review alternative emissions trading options for SO_2, NOx and CO_2.

1.2 Structure of the Report

The next chapter provides an introduction to emissions trading, and classifies different types of trading systems.

Chapter 3 discusses American trading programs for SO_2 and NOx emissions, emissions trading pilot projects in Canada and the status of efforts to develop trading programs for greenhouse gas emissions.

Chapter 4 discusses possible performance indicators for emissions trading programs. A preliminary assessment of the performance of selected American trading programs for sulphur dioxide (SO_2) and nitrogen oxides (NOx) is also presented.

Potential applications for emissions trading in Ontario for SO_2, NOx and CO_2 are discussed in Chapter 5. The applications are implementation of the Smog Plan, managing emissions from the electricity sector after restructuring, and limiting greenhouse gas emissions to help meet Canada's commitment under the Kyoto Protocol.

2. Introduction to Emissions Trading

2.1 Emissions Trading[1]

Emissions trading lowers the cost of achieving a specified environmental objective, such as reducing emissions of a specified pollutant, relative to traditional forms of environmental regulation.[2] Different types of emissions trading have been developed for different circumstances. This section provides an introduction to emissions trading and classifies different types of trading systems.

In its simplest form, a limit on total emissions of a pollutant by a specified set of sources is established. Allowable emissions within this total are then defined for each source. Each source must limit its actual emissions to its allowable emissions. A source whose actual emissions are below its allowable emissions can sell credits or allowances equal to the difference.[3] A source whose actual emissions are higher than its allowable emissions must buy credits or allowances from other sources to cover its excess emissions.

Participants are not obligated to trade; but they have a financial incentive to trade if it reduces compliance costs. Sources able to control their emissions at low cost can sell surplus credits or allowances at a profit. Sources facing high cost control options can save money by purchasing credits or allowances from other sources. Trades continue until the set of emission reduction actions that meets the overall limit on emissions at the lowest total cost is implemented.

Emissions trading, then, enables a given environmental objective to be achieved at lower cost than with conventional regulations.[4] In practice the environmental objective and the type of environmental regulation are determined simultaneously.[5] Thus, the objective of

[1] This section is based on Erik F. Haites, *Briefing Document on Emissions Trading for Greenhouse Gases*, National Round Table on the Environment and the Economy, Ottawa, December 1997.

[2] Other possible objectives of emissions trading programs are: to enable a more stringent objective to be achieved because the cost is lower; to enable an environmental objective to be achieved more quickly; or to enable economic growth to occur without adversely affecting the environment.

[3] The differences between credits and allowances are discussed later in this chapter.

[4] Conventional regulations require each source to reduce its own emissions to comply with its allowable emissions. This option is also available under a trading program. But with a trading program sources also have the option to buy or sell credits or allowances if that is financially advantageous. Thus, emissions trading reduces compliance costs relative to conventional regulations. A numerical example illustrating how cost savings are achieved through emissions trading is provided in Appendix A.

[5] The cap on total emissions is set by the regulatory authority to protect human health or the environment; the cap is **not** determined by the emissions trading market.

an emissions trading program may be faster reduction of emissions rather than cost reduction. But the faster reduction of emissions would not be acceptable without the cost savings afforded by the emissions trading program. Thus, the key benefit of a successful emissions trading program is the cost saving relative to other regulatory approaches for achieving the same environmental objective.[6]

The cost savings stem from differences in the cost of emissions control among participants. The larger the differences, the greater are the potential savings. If there is only one way to reduce emissions and it has almost the same cost for every source, emissions trading will not yield any cost savings. To get the benefit of all of the potential cost savings, the trading program should be designed to allow sources to choose from among all available control options.

To work well, emissions trading requires a competitive market. This implies a large number of participants, none of which is large enough to influence the market. Economic theory indicates that in a perfectly competitive market, the price of a credit or allowance will equal the cost of the last measure implemented to meet the overall cap (the marginal cost). In practice the price will reflect expected changes to emissions limits, anticipated growth in emissions by regulated sources, changes in the costs or effectiveness of emissions control technologies, and similar factors.

Emissions trading shifts the location and timing of the emissions allowed within the overall limit. A trading program must be designed to ensure that the shifts in the timing and location of emissions are environmentally beneficial or neutral. Trading programs that involve ground-level ozone precursors, for example, allow emission reductions achieved during the ozone season to be used at any time of the year but do not allow reductions achieved outside the ozone season to be used during the ozone season. Similarly, sources are generally limited to buying credits from local or upwind sources within the same airshed.

Since allowances are valuable, sources have an incentive to under report their actual emissions. Most trading programs, therefore, have strict requirements to ensure accurate monitoring and reporting of actual emissions. An effective trading program requires penalties for non-compliance that exceed the market price of a credit or allowance. To ensure this is the case, the penalty usually consists of loss of credits or allowances (to protect the environment) plus fines.

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[6] The only emissions trading program whose objective is not cost reduction is the offset requirement for major new and expanding sources in areas that have not attained the national ambient air quality standards. The offset requirements in these non-attainment areas are designed to accommodate economic growth without hampering progress toward achievement of the air quality standards.

The term emissions trading is applied to a variety of generic designs, including "credit trading" of documented emissions reductions and "allowance trading" of emissions rights issued by the regulatory authority. Either of these designs can be applied to the actual emissions stream or to a substance that is ultimately emitted as a pollutant.[7] These designs are discussed briefly in the following sections.

2.2 Credit Trading

In a credit trading system a baseline of allowable emissions is established for each source.[8] The baseline is typically the lesser of historic or allowable emissions. The allowable emissions are determined by the regulations governing emissions of the pollutant by the given source. The regulations may define an allowable emissions rate (e.g., X kg. of emissions per unit of output) or an absolute limit on emissions for a given period (e.g., Y tonnes per year).

A source can create "credits" by documenting that its actual emissions are below its baseline. Credit creation is voluntary. Credits can be used to meet voluntary commitments or regulatory obligations. Credit use for regulatory compliance requires that the regulations specify the conditions under which this option can be used. A source whose projected emissions are higher than its baseline may choose to buy credits if they are less costly than alternative compliance options and are allowed by the regulations.

Credits should represent real reductions from the emission levels that would otherwise prevail. Such trading programs generally specify criteria that credits must meet; typically that the emission reductions be real, measurable, surplus to regulatory requirements, and additional. To be additional, credits should represent real reductions from the emission levels that would otherwise prevail under the applicable voluntary and regulatory policies and measures.[9] Operational interpretation of the criteria ultimately resides with the regulatory authority when it decides which credits to accept or reject for compliance purposes.

Acceptance of credits for compliance with a regulatory obligation may be subject to various conditions designed to ensure that trading is neutral or beneficial for the environment. Thus, sources may be required to buy credits from upwind sources to ensure that the trade yields local benefits. And seasonal restrictions are common for ozone precursors to ensure that the trade contributes to smog reduction.

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[7] Allowance trading systems are also called "cap and trade" programs.

[8] The limit on total emissions is simply the sum of the baselines of all sources.

[9] Credit trading programs for greenhouse gases may also require that actions which store (sequester) carbon that would otherwise be released to the atmosphere store the carbon for a long time (decades).

Credits are measured in two different ways; as Discrete Emission Reductions or as Emission Reduction Credits:

- Discrete Emission Reductions (DERs) define the emissions reduced as a quantity measured in tonnes or pounds. If the emission reduction action has a relatively short life (less than two years), DERs equal to the emissions reduced would be created after the project was completed. If the emission reduction action has a longer life, DERs are created each year for the emissions reductions achieved during the year. Changes in production levels or other factors could cause the number of DERs created by a given action to vary from year to year.

- Emission Reduction Credits (ERCs) define the emissions reduced as a stream of pollutant emissions reduced measured in tonnes (or pounds) per year. The reduction is assumed to be the same each year over the life of the emission reduction action. ERCs are usually created only by actions with a relatively long life. The reduction must be permanent and enforceable so that the reduction will be achieved every year in the future.[10]

The main difference between ERCs and DERs is that the latter represents a specific quantity of emissions reduced while the former represents a stream of reduced emissions.[11]

ERCs are used to offset emissions by a major new or expanding source located in an area that has not attained the national ambient air quality standard. The new or expanding source increases emissions by a permitted amount every year for the foreseeable future. To ensure that this new or expanding source does not aggravate the already unacceptable air quality, its increased emissions must be offset by reductions from existing sources in the same area. The ERCs represent a stream of emissions reductions from an existing source, which can be used to offset a stream of increased emissions by a new or expanding source.

[10] The need to demonstrate permanence has meant that most ERCs have been created through shutdowns, installation of pollution control equipment, or process changes, including fuel switches. The difficulty of scheduling permanent emission reduction actions to match emission increases by new or expanding sources has led many non-attainment areas to allow banking of credits.

[11] To illustrate the difference between ERCs and DERs, consider a manufacturing plant that implements control technology to reduce its NOx emissions below the level required by the applicable regulations. Assume that the reduction in emissions is 100 tonnes per year if the plant is operating at maximum capacity and 85 tonnes per year if the plant is operating at normal capacity. If the credit trading program uses ERCs, the regulator would review the documentation and approve the creation of ERCs. The approved quantity of ERCs might be more or less than 85 tonnes per year depending on past production levels, anticipated changes to the applicable NOx regulations, and other considerations. Assume, however, that the regulator approves ERCs of 85 tonnes per year. If the credit trading program uses DERs, the source is required to document the emissions reductions achieved each year. Based on actual operations during the year the number of DERs created might be 87 tonnes for year 1, 92 tonnes for year 2, 53 tonnes for year 3, 96 tonnes for year 4, 84 tonnes for year 5, etc. for the life of the control equipment.

2.3 Allowance Trading

In an allowance trading system an overall cap on total emissions by a defined set of participants is established. Participation is mandatory for existing and new sources that meet the specified criteria (e.g., electricity generating units with a boiler rated at 25 MW or higher). The regulatory authority creates allowances equal to the overall cap. The allowances are distributed to the participants (or others). Each participant must monitor its actual emissions in the prescribed manner and report them to the regulatory authority. At the end of the year each participant must provide the regulatory authority allowances equal to its actual emissions to achieve compliance.

The method of distributing allowances to participants is one of the most difficult issues to resolve in the design of an allowance trading system. The simplest approach is to sell the allowances at auction. But every existing trading program distributes the allowances free of charge to participants according to a specified allocation rule.[12] Since the allowances are valuable, devising an allocation rule that is considered fair by all participants is very difficult. Hence, some rules have numerous provisions to cover sources that have successfully argued that they warrant special treatment.

Trading is not mandatory. A participant can reduce its actual emissions below the quantity of allowances it receives or buys at auction. But sources have an economic incentive to trade as long as the marginal cost of control differs. In all existing programs the allowances have been defined as quantities, like DERs.

2.4 Substance and Emissions Rights Trading

When a credit or allowance trading system is implemented at the point where emissions are released to the atmosphere it is an emissions rights trading system. In other words the credit or allowance represents a right to release a given quantity of a pollutant to the atmosphere. Emissions rights trading programs have been implemented in the United States for SO_2, NOx, VOCs and CO, and on a pilot basis in Ontario for these gases and CO_2. These programs include both credit and allowance trading programs.

In some cases it is administratively simpler to control substances that will ultimately be emitted as pollutants rather than to regulate the actual emissions at the point of discharge. Controlling the quantity of the substance in specific uses effectively controls emissions of the pollutant.

[12] It is not necessary to distribute the allowances to the participants, but virtually all programs do so. The Canadian trading program for methyl bromide import allowances allocates the allowances to users rather than importers. Users are then free to choose the importer they wish to purchase their supplies from. The allowances are then transferred to the importer so that the methyl bromide can be imported. This arrangement was adopted to address concern over possible market power by the five methyl bromide importers some of whom are also users competing with users who are not importers.

Substance trading systems for substances that are ultimately discharged to the atmosphere are generally also considered to be emissions trading systems. Then the credit or allowance represents the right to produce, import, or sell a given quantity of the substance rather than the related pollutant. Substance trading programs have been implemented in the U.S. for lead in leaded gasoline and for ozone-depleting substances and in Canada for ozone-depleting substances. These programs also include both credit and allowance trading programs.

2.5 Open and Closed Trading Systems

An emissions trading program often excludes smaller sources because the administrative burden imposed on the sources and/or the regulatory authority is judged to be too costly relative to the emissions controlled. Thus the participants in an emissions trading system are often a subset of the sources of the pollutant. Typically, the participants represent a relatively large share of the total emissions, although they may be much smaller fraction of the total number of sources.

This raises the question whether the trading program allows participants to use emissions reductions from sources that are not part of the program. A trading program is said to be ***closed*** if trading is restricted to the specified participants and to be ***open*** if emissions reductions from other sources can be used by participants for compliance. Existing regulatory and pilot emissions trading programs are classified in Table 1. A separate category is included for programs that have an open design, but that are closed in practice.

2.5.1 Open Trading Programs

Three of the open trading programs listed in Table 1 are pilot programs; the Pilot Emission Reduction Trading (PERT) in southern Ontario, the Greenhouse Gas Emission Reduction Trading (GERT) pilot program in five other provinces, and the "project-based" stream of the NESCAUM demonstration program for greenhouse gas emissions trading in the United States. Any source of the pollutants covered by these programs can create credits by reducing its emissions below a self-defined baseline. Sources that buy credits through these pilot programs typically do so to meet voluntary commitments.

The only regulatory program in the group applies to offsets for criteria air pollutants -- particulate matter, sulfur oxides, carbon monoxide, lead, nitrogen oxides and ozone -- in areas that exceed the National Ambient Air Quality Standards (NAAQS) for these pollutants. All areas of the country are designated as either attainment (where the

NAAQS are met) or non-attainment (where NAAQS are exceeded) areas for each of the six pollutants.[13]

Table 1

Classification of Regulatory and Pilot Emissions Trading Programs

	Credit Trading	Allowance Trading
Open System	• Offsets for criteria air pollutants in non-attainment areas • PERT • GERT • NESCAUM	
Open Design, but Closed in Practice		• Electric utility SO_2 allowance trading • RECLAIM
Closed System	• Lead in leaded gasoline • ABT provisions for heavy-duty vehicle engine emissions standards	• Ozone-depleting substances - U.S. • Ozone depleting substances - Canada

Each state is required to develop and implement a State Implementation Plan (SIP) to achieve attainment in non-attainment areas and prevent deterioration in attainment areas. Plans must include some programs specified by the EPA, such as vehicle inspection and maintenance, and other programs, such as creation and use of mobile source credits, that are optional. State implementation plans, including the mandatory and optional programs, must be approved by the EPA.

Different regulations apply to major new (and expanding) sources whose emissions will exceed minimum threshold levels and to existing sources in attainment and non-attainment areas. These requirements and the emissions trading options available (in bold) are summarized in Table 2. Most states that have non-attainment areas, including California, Colorado, Connecticut, Delaware, Louisiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Oklahoma and Texas, have credit trading programs. Some states, notably California, delegate air quality management to local districts, which may implement their own credit trading programs. The South Coast

[13] Ozone is the pollutant with the largest number of non-attainment areas. Since ozone is formed by chemical reactions in the atmosphere, regulatory efforts focus on reducing emissions of the precursors -- NOx and VOCs. Ozone non-attainment areas are classified as marginal, moderate, serious, severe, or extreme.

Air Quality Management District (SCAQMD) is one of 35 regional air quality management and air pollution control districts in california.

Table 2

Goals and Requirements of New and Existing Source Regulatory Programs in Attainment and Non-Attainment Areas

	Attainment Area	Non-Attainment Area
Major new sources	Goal: *Prevent significant deterioration (PSD)* Best available control technology (BACT) Air quality analysis Can not exceed PSD increments **Netting** allowed	Goal: *Can not interfere with attainment efforts* Lowest achieveable emissions rate (LAER) **Offsets** mandatory State-wide compliance **Netting** allowed in some areas
Existing sources	Goal: *Maintain air quality standards* Maintain level of pollution control	Goal: *Attain air quality standards* Reasonably available control technology (RACT) for large sources **Offsets** allowed in some areas Reductions from existing sources

Offsets are required in non-attainment areas for major new sources as part of the New Source Review (NSR) process. These sources must implement lowest achievable emissions rate (LAER) technology. Any remaining emission increases must be offset by purchasing from existing sources emission reduction credits (ERCs) at least equal to the expected increase.[14]

Large existing sources in non-attainment areas are often required to install reasonably available control technology (RACT) to help reduce overall emissions. In some areas sources are allowed to meet RACT requirements by purchasing ERCs or through other forms of trading.

Netting allows an expanding firm to balance expected emission increases with emission decreases at the same facility to keep the net increase below the minimum threshold level at which the New Source Review requirements are triggered. Netting enables the expansion to qualify for a quicker and simpler review process than the NSR and to avoid

[14] Offset rules require a major new source to purchase more ERCs than their planned increase in emissions (i.e., the "offset ratio" of ERCs to planned emissions is greater than 1:1). The EPA specifies minimum offset ratios depending on the degree of non-attainment.

the offset requirement associated with the NSR. A state may choose not to allow netting in non-attainment areas.

Economic growth is constrained in non-attainment areas unless a sufficient supply of ERCs is available. Offsets are mandatory in a non-attainment area for new (and expanding) sources with planned emissions beyond the minimum threshold. [15] These sources can not locate (expand) in the area unless they are able to purchase sufficient ERCs from existing sources.

2.5.2 Open Designs that are Effectively Closed

Two allowance trading programs have an open design, but are effectively closed systems. The American SO_2 trading program for electric utilities allows industrial sources to "opt-in" to the program and hence is in principle an open program. Electric utilities account for about 70% of total SO_2 emissions with most of the rest being due to industrial sources. Over 400 utility units are currently required to participate in the program. To date only two industrial sources with a total of seven boilers and one small utility source have chosen to opt-in, making it effectively a closed program.[16]

The RECLAIM program in the South Coast Air Quality Management District (SCAQMD) is mandatory for approximately 330 stationary sources of NOx or SOx. These sources account for only 17% of total NOx and 31% of total SOx emissions in the district. Other sources can choose to opt-in to the program and emissions reductions achieved by other sources can be converted to RECLAIM Trading Credits (RTCs).

- Only four facilities have chosen to join the program during the first three years.[17] Over 50 facilities originally identified as participants succeeded in having themselves excluded from the program.[18]

[15] A major new or expanding source is one whose planned emissions exceed a minimum threshold. The threshold for a given pollutant varies across regions depending on the severity of the non-attainment and can be as low as zero.

[16] The program is described in more detail in the next section. It is being implemented in two phases. When the second phase begins in 2000 approximately 2,000 electricity generating units will be required to participate.

[17] SCAQMD, *RECLAIM Program Three-Year Audit and Progress Report*, May 8, 1998, Table 1-3, page 1-7.

[18] SCAQMD, *RECLAIM Program Three-Year Audit and Progress Report*, May 8, 1998, Table 1-2, page 1-5.

- Emissions reductions at other sources increased the supply of NOx RTCs by 4.5% and of SOx RTCs by 9.7% in 1994.[19] Since actual emissions have been 16% to 37% below the allocated RTCs over the first three years, the reductions from other sources are not a significant part of the program.[20]

Access to emissions reductions from other sources may become more important in the future as the cap becomes more stringent.[21]

2.5.3 Closed Trading Programs

The American programs for lead in leaded gasoline and for heavy-duty vehicle engine emissions standards are closed credit trading programs. All producers and importers of leaded gasoline were subject to standards on the lead content of the leaded gasoline they sold.[22] A participant could create credits by reducing the lead content below the standard and sell the credits to a participant with lead content above the standard.[23] .

Standards for emissions by heavy-duty engines apply to eleven manufacturers of spark ignition (Otto cycle) and compression ignition (diesel) engines for heavy-duty trucks and urban buses. A manufacturer can create credits by selling engines whose emissions are lower than the standard. The averaging, banking and trading (ABT) provisions introduced in 1990 allow credits to be used for current compliance by engines whose emissions exceed the standard, banked for future use, or sold to another manufacturer.[24] The ABT

[19] SCAQMD, *RECLAIM Program Three-Year Audit and Progress Report*, May 8, 1998, Tables 2-5 and 2-6, page 2-5.

[20] SCAQMD, *RECLAIM Program Three-Year Audit and Progress Report*, May 8, 1998, Table 3-1, page 3-3.

[21] Banking is not allowed in RECLAIM, so credits from other sources can not be converted to RTCs now and be banked for later use.

[22] Some might argue that the lead in gasoline trading program was open because hundreds of new producers and importers of leaded gasoline entered the business over the life of the program. All of these new producers and refiners were required to participate in the program. An open program, as defined here, allows emissions reductions from sources not required to participate in the program to be used by participants for compliance. Only reductions achieved by other participants could be used for compliance in the lead in gasoline program, so it does not meet our definition of an open program.

[23] From the start of the program in November 1982 until the end of 1984, banking was not allowed so the only use for credits was for sale to another participant. Banking was allowed from the beginning of 1985 until the end of 1987 when the program was terminated. Participants had to report every quarter, so credits had only a three month life during the first phase of the program.

[24] Reports on ABT activity have been submitted on paper and are confidential. Data on use of the ABT provisions is expected to be made public late in 1998, but is currently not available. Program staff indicate that manufacturers have used averaging a little more than banking. Banking tends to be used just before

provisions are limited to NOx and PM because the emissions standards for these pollutants have been tightened to the point where they are driving engine technology.

The United States implemented trading programs for production and consumption of ozone-depleting substances in July 1989 as a means of meeting its commitments under the Montreal Protocol. The trading programs cover five separate groups of ozone-depleting substances listed. All producers and importers of ozone-depleting substances were required to participate in the program.

Canada has used a system of "consumption allowances" to meet its Montreal Protocol commitments. Transfer of consumption allowances between companies has been permitted since 1993. CFCs and methyl chloroform were the first substances covered by the transferable consumption allowance system. Only a few transfers of CFC and methyl chloroform allowances took place between 1993 and 1996 when production and imports of these substances ceased. The system is currently used for methyl bromide and HCFCs. All importers of these substances are required to hold allowances for the quantities imported.[25]

Methyl bromide allowances were introduced in 1995.[26] In contrast to the other ODS allowances, methyl bromide allowances were distributed to *users* rather than importers. This was done to address the concern that, given the small number of importers (5), they could control the market. Some importers apply the substance themselves and sell it to other applicators, so a distribution to importers might place firms that are only applicators at a disadvantage relative to firms that are both applicators and importers.[27] From a logistical point of view, distribution to users was a viable alternative as the total number of users was relatively small (133).

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standard changes. The first inter-company trade occurred in 1997 and involved a small quantity of PM credits.

[25] There is no Canadian production of methyl bromide or HCFCs, so restrictions on imports limit consumption.

[26] Although the base year for methyl bromide consumption under the Protocol is 1991, the allowances were distributed on the basis of average use over 1991-1993 period because use fluctuates a lot from year to year.

[27] Users could become importers, but becoming a licensed importer of a toxic gas like methyl bromide may involve considerable effort.

3. SO_2, NOx and CO_2 Emissions Trading Programs

This chapter discusses American trading programs for SO_2 and NOx emissions, emissions trading pilot projects in Canada, and the status of efforts to develop trading programs for greenhouse gas emissions.

3.1 American Trading Programs for SO_2 and NOx Emissions

Three trading programs are summarized, the Connecticut NOx emission reduction credit trading program, the electric utility SO_2 allowance trading program and the RECLAIM program for SOx and NOx emissions. The Connecticut NOx emission reduction credit trading program is representative of state (and district) credit trading programs for criteria air pollutants in non-attainment areas. It is one of the older programs of this type and has experienced more trading activity most of the others.

3.1.1 Connecticut NOx Emission Reduction Credit Trading Program

Connecticut has had a NOx Emission Reduction Credit Trading Program since mid-1995. The program involves voluntary trading and banking of NOx ERCs. Two types of ERCs are defined: mass-based, reflecting discrete emission reductions (DERs); and rate-based, reflecting continuous emission reductions (ERCs). The DERs are measured in tons and the continuous ERCs in tons per year. Credit generators have shown a preference for DERs because they offer more flexibility than the permanent commitment associated with continuous ERCs. All credit generation and use requires the Commissioner's approval.

Both stationary and mobile sources may participate in the program, either as credit generators or users. Participation is primarily by stationary sources, however. So far, credits amounting to almost 8,000 tons have been approved from five stationary sources. Approximately 15 credit generation requests are currently being reviewed, two of which are from mobile sources (for reformulated gasoline). Approximately 2,000 tons of NOx credits have been traded. These credits are being used by about 35 stationary sources as well as one mobile source.[28]

The program is primarily intended for cost-effective and flexible RACT compliance but credits are also being used as offsets in new source review (NSR) and for penalty

[28] The mobile source is a casino that opened in October 1996. The casino is required to compensate - analogous to the concept of an offset - for its customers' automobile emissions. This includes VOC as well as NOx emissions. Currently no VOC credits are available in Connecticut. As a result, the Department is temporarily allowing the casino to offset VOC emission increases with NOx ERCs on a 1.1 to 1.0 (in tons) basis.

purposes. An environmental benefit is ensured by a ten percent discount on credits created. The Department may also apply a further five percent discount for measurement (emissions quantification) uncertainty on a case-by-case basis, such as credits generated by mobile sources and used by stationary sources.

The program is scheduled to run until 1999 (the attainment target), at which time a review by the Commissioner will determine whether or not it will be continued.

3.1.2 Electric Utility SO_2 Allowance Trading

Title IV of 1990 Clean Air Act Amendments created an allowance trading system for SO_2 emissions by electric utilities. The objectives are to reduce SO_2 emissions by 10 million tons from 1980 levels and to cap utility emissions at 8.95 million tons per year after 2010.[29] The system is introduced in two phases, each designed to achieve a 5 million ton reduction, beginning in 1995.

Phase I, from 1995 through 1999, is mandatory for 263 units listed in Table A of the Act. These units include, with few exceptions, all units of 100 MW capacity or greater with average emission rates above 2.5 pounds of SO_2 per million BTU of energy input. Phase I is optional for *compensating* and *substitution* units and other sources that choose to *opt-in*.[30] The total number of units participating during 1995 and 1996 was 445 and 431 respectively.[31]

Phase II, from 2000 on, applies to all electric utility generating units with an output capacity of 25 MW or greater that use fossil fuels with a sulfur content greater than 0.05%. There are now approximately 2,050 units that will be regulated under Phase II. These units accounted for over 99% of electric utility SO_2 emissions in 1995.

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[29] Approximately 1.5 million tons of the reduction is expected to come from industrial sources through existing programs and 8.5 million tons is expected to come from electric utility sources, which account for about 70% of total SO_2 emissions.

[30] If there is reduced utilization, in aggregate, of Table A units in the same dispatch system, the operator of the unit may designate Phase II units -- *compensating units* -- to which generation was shifted. The reduction obligation is then shared between the Table A unit and the compensating unit. To provide more flexibility, the owner or operator of a Table A unit may reassign a unit's emission reduction obligations to a designated non-Table A unit under the owner's or operator's control -- the *substitution unit*. Non-electric utility sources of SO_2 emissions may choose to *opt-in* to the trading program. The emission reduction is accomplished by giving allowances to the new units and increasing the emissions cap by an amount equal to the allowances issued to the new units. The compensating, substitution and opt-in units receive allowances approximately equal to their historic emissions.

[31] U.S. EPA, 1997, Exhibit 1, p. 4.

In Phase I the Table A units are allocated SO_2 allowances on the basis of a standard emission rate (2.5 lbs of SO_2 per million BTU) multiplied by the average energy input for the years 1985 through 1987.[32] The allowance allocation for compensating, substitution and opt-in units is generally the lower of the actual or allowable emission rate multiplied by the baseline energy input.[33]

In Phase II the emission rate drops to 1.2 pounds per million BTU but it is still multiplied by the average energy input for the years 1985 through 1987.[34] The basic allocation rules are supplemented by a number of provisions for special cases.[35] Efforts by many utilities, states and Congressional delegations to obtain a "fair share" of allowances led to a system with six special allowance reserves in Phase I and Phase II and 29 different methods to allocate allowances in Phase II, some of which are designed primarily to achieve environmental objectives while others provide differential treatment for various categories of units.[36]

Sources built after 1995 receive no allowances and must purchase allowances to cover their total emissions from existing sources.[37] Existing sources continue to receive allowances even if they cease to operate. All units are required to install continuous emissions monitors and to report their actual emissions quarterly to the EPA. 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.[38] Allowances can be banked for future use.[39] State and

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[32] The rate of 2.5 lbs per million BTU was determined as the rate needed to achieve a 3.5 million ton reduction from electric utility sources during phase I. (Brian McLean, EPA, personal communication, November 1997).

[33] For example the emission rate for a substitution unit is the lowest of the following three rates: (1) 1985 actual (or allowable, if it is lower) SO_2 emission rate, (2) the greater of 1989 or 1990 actual emission rate, and (3) the most stringent federal or state allowable SO_2 emission rate applicable in 1995-1999 as of November 15, 1990.

[34] The rate of 1.2 lbs per million BTU is the 1971 NSPS for coal-fired boilers.

[35] If the allocations based on the formulae do not exactly meet the overall emission limit, the allocations are scaled down proportionally to ensure that the allowances issued equal the emissions cap.

[36] Solomon, 1994, p.9.

[37] Sources that began to operate after October 1990 and before December 1995 receive allowances at a rate of 0.3 lbs per million BTU.

[38] The penalty of $2,000 is adjusted annually by the change in the consumer price index.

[39] Banking encourages early reduction of emissions. Assuming that a ton of SO_2 does less damage when total emissions are lower, early reductions benefit the environment.

regional regulations limiting SO_2 emissions by electric utilities to protect human health and the environment take precedence.[40]

The allowance allocations, actual emissions and allowances traded during the first two years are shown in Table 3. All participants were in compliance for both years. In aggregate actual emissions were well (35% to 40%) below allowable levels and a substantial quantity of allowances (6.38 million) have been banked for future use. Since Phase I focuses on large, high-emitting units and includes incentives for early action, over compliance and banking during the initial years of the program is not surprising although the extent of the over compliance was not anticipated.[41]

Table 3

SO_2 Allowance Allocations, Actual Emissions and Allowances Traded, 1995 and 1996

Year	Allowances Allocated (million)	Actual Emissions (million tons)	Allowances Traded (million)
1995	8.74	5.30	1.92
1996	8.30	5.44	4.41
1997	7.15	5.47	7.9

Source: U.S. EPA, 1997 and U.S. EPA, 1998, Exhibits 3 and 6, pages 7 and 11 in the 1997 report and 8 and 12 in the 1998 report. The allowances traded may be for the current or any future year.

The prices of allowances have been lower than projected when the legislation was being debated.[42] The lower prices are due to lower compliance costs. The most common compliance option has been the use of low sulphur coal. An increased supply of low sulfur coal has been available at competitive prices in the midwest due to lower costs of

[40] In another words, if state regulations limit actual emissions (annually or for particular periods) the unit can **not** use allowances to exceed that limit.

[41] In effect many of the expected sellers are regulated in Phase I but most of the likely buyers are not regulated until Phase II, so sellers are building up their inventories for their own future use or for future sales.

[42] See Bohi and Burtraw, 1996.

rail transport. Utilities found that boiler performance did not deteriorate when the fuel mix was changed to include low sulfur coal. In addition, scrubber costs have fallen and performance has improved, in part, due to competition from low sulfur coal and other compliance options.

3.1.3 RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) was established by the South Coast Air Quality Management District (SCAQMD) for NOx and SOx emissions by point sources beginning January 1, 1994. All stationary sources that held permits for equipment or processes that generally emit more than 4 tons per year of NOx or SOx or which emit more than 4 tons of NOx or SOx per year during any year after 1990 must participate.[43] Other point sources may choose to participate, but once in the program can not leave.[44]

The NOx program has roughly 340 participants which account for approximately 65% of the NOx emissions from permitted stationary sources in the SCAQMD and the SOx program has approximately 40 participants which account for roughly 85% of the SOx emissions from permitted stationary sources.[45] But the RECLAIM program covers only 17% of total NOx and 31% of total SOx emissions in the SCAQMD.

RECLAIM allows the air quality goals of the 1991 Air Quality Management Plan to be met in a more cost-effective manner with equal or lower impacts on jobs, costs and public health. The trading program replaced more than 30 adopted rules and 12 potential future rules that required implementation of various emission control measures.

Each facility receives an 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.[46] Each allocation was calculated by multiplying

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[43] Sources such as equipment rental facilities, essential public services (police, fire, landfills, wastewater treatment, hospitals, prisons and schools), restaurants, and dry cleaners are exempted.

[44] The reasons given for opting-in include: administrative efficiency due to consolidating local operations under RECLAIM, and the opportunity to acquire RTCs based on past emissions.

[45] Some 392 NOx sources were identified initially, by the end of 1995 there were 343 participants in the NOx program and at the end of 1996 there were 330. For the SOx program the corresponding numbers are 41, 38 and 37.

[46] The starting allocation was based on rules adopted as of December 31, 1993. The 2000 allocation reflects 100% implementation of 1991 Air Quality Management Plan proposed Tier I control measures. And the 2003 allocation reflects 100% implementation of proposed Tier I and Tier II control measures.

the *historic use* or throughput of each piece of NOx and SOx equipment at the facility by appropriate emission factors based on the adopted and proposed rules. The *historic use* was based on the peak year for each facility between 1989 and 1992. Allocations are in annual tons of NOx or SOx. Allocations for intermediate years are straight line interpolations between the 1994, 2000 and 2003 allocations.[47]

In addition, existing Emission Reduction Credits were converted to RECLAIM Trading Credits (RTCs) and added to the starting allocation. The external offsets provided by facilities subject to New Source Review during 1993 were added to their starting allocation.[48] A facility may also have non-tradable credits (NTCs) for the first three years (1994,1995 and 1996) if its reported 1987, 1988 or 1993 emissions are greater than its starting allocation.[49]

All new or relocated sources are subject to BACT as well as to air quality modelling. In addition, they are required to provide RTCs equal to their emissions for the first year of operation and every year thereafter at the beginning of the compliance period. In other words, new sources must purchase sufficient RTCs from existing sources to cover their emissions.[50] Existing participants continue to receive allowances if they cease to operate.[51]

Anyone can participate in the RECLAIM market provided they follow the protocols and reporting requirements. Sources wishing to sell RTCs may do so without pre-approval.[52] Purchasers can hold the RTCs in the form of a certificate, apply them to emission

[47] Each facility has its own emission reduction rate determined by its allocations for 1994, 2000 and 2003 with linear interpolation for the intervening years. The weighted average emission reduction rates are 8.3% per year for NOx and 6.8% per year for SOx from 1994 through 2003.

[48] The ERCs and external reductions are not reduced during the 1994-2000 period, but are reduced at the same rate as the RECLAIM inventory from 2000 to 2003.

[49] The NTCs are available for 1994 and reduced by 1/3 for 1995 and a further 1/3 for 1996 and are eliminated for 1997 and later years.

[50] This is similar to the requirement that existed prior to RECLAIM; new sources were required to purchase emission reduction credits (ERCs) representing emission reductions from allowable levels from existing sources. The ERCs have been converted to RTCs to improve liquidity in the market.

[51] Under the previous rules a source that ceased operating could create Emission Reduction Credits which could be sold to a new or expanding source, so continued allocation of allowances is similar to the provisions of the previous rules.

[52] If the seller is a RECLAIM facility, registration of the sale will result in an automatic decrease in the RTCs contained in its Facility Permit. The facility is responsible for ensuring that its actual emissions do not exceed the new allocation.

reduction requirements, or apply for an increase in their annual allocation.[53] RTCs have a term of one year and may only be used for emissions that occur during that year -- RTCs can not be banked.

All participants are randomly assigned to one of two compliance cycles: January 1-December 31 or July 1 - June 30.[54] Trading can involve facilities in either compliance cycle, but the RTCs are only valid for the year for which they are issued. Trades that involve a new or relocated facility, or a facility exceeding its starting allocation are subject to a geographic restriction.[55]

Each participant must hold sufficient RTCs at the end of the year to cover its actual emissions.[56] Facilities that exceed their annual emission allocation (after adjustment for trades) will be 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, Facility Permits may be revised to include conditions to ensure future compliance, or, if the violation is egregious, the Facility Permit could be revoked.[57]

Participants are also required to install specified monitoring equipment -- continuous emissions monitoring, fuel meters, timers, etc. -- and to report electronically.[58] As of November 1996, 86 facilities were required to install a total of 431 continuous emissions monitoring devices.[59] In addition, RECLAIM facilities were required to install approximately 4,400 fuel meters, timers or equivalent devices, although many were already required and in place before the program began.

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[53] When the buyer uses the RTCs for a new source at the facility or for an increase above its annual allocation, an amendment to the Facility Permit must be obtained.

[54] SCAQMD, 1993, p. EX-15 states that "[s]taggered compliance schedules will help ensure that RTCs will be available, thereby providing a more liquid market with better price stability." Cycle 1 facilities began compliance on January 1, 1994 and Cycle 2 facilities began compliance on July 1, 1994.

[55] A facility in the Coastal zone may only obtain and use RTCs that originated in the Coastal zone. A facility in the Inland zone may obtain and use RTCs from either zone.

[56] During the first three years NTCs may also be used to achieve compliance.

[57] Polesetsky, 1995, pp. 397-401.

[58] Electronic reporting was required beginning in the second compliance year. Electronic reporting is new for most facilities and delays were encountered.

[59] At the end of the first year approximately 30% of the continuous emissions monitoring devices had not been approved. By the end of the second year this had been reduced to about 10% and most of these installations were confronted with technical problems.

Estimated actual and allowable emissions for RECLAIM facilities are shown in Table 4. Actual emissions during the first two years were substantially (20% to 40%) below allowable levels for both NOx and SOx. However, actual NOx emissions for 1994 and 1995 are higher than in 1993 and SOx emissions in 1995 may also be higher than in 1993 although this value is believed to be inflated due to heavy use of the "missing data" procedures.[60]

Table 4

Actual and Allowable Emissions of NOx and SOx by RECLAIM Participants, 1989 through 1995

Year	1989	1990	1991	1992	1993	1994	1995
NOx (thousands of tons/year)							
Allowable						39.6	35.9
Actual	41.0	33.1	29.4	27.5	25.0	25.6	26.0
SOx (thousands of tons/year)							
Allowable						10.4	9.6
Actual	7.7	8.3	8.0	7.0	7.2	7.0	7.8

Source: SCAQMD, 1997, Figures 3-1 and 3-2, p. 3-4.

Note: Emissions for the years 1989 through 1993 were estimated using different quantification procedures and so may not be exactly comparable with the figures for 1994 and 1995 which are derived from data reported under RECLAIM.

Trading activity was limited during 1994 but was valued at $10 million during each of 1995 and 1996.[61]

[60] SCAQMD, 1997, pp. 3-2 and 3-3. Many of the SOx facilities did not have their CEMs fully operational for the year, as a result approximately 40% of all data were estimates calculated using missing data procedures which impart an upward bias to the figures.

[61] The quantities traded -- 95,000 tons in 1995 and 70,000 tons in 1996 -- are equivalent to 1.5 to 2 times the annual allocation. The quantities include trades of RTCs for future years and are dominated by transfers at zero price -- transfers due to change of ownership, transfers between facilities within the same company, transfers to and from brokers associated with auctions, and "dumping" --transfers to avoid payment of fees associated with holding RTCs.

At the end of the first year, 46 facilities exceeded their allocations and 20 facilities had not submitted complete compliance reports.[62] During the second year, 28 facilities (8%) exceeded their allocations. The total amount of exceedances was about 400 tons of NOx and about 7 tons for SOx.[63]

RTCs used for compliance or remaining unsold in the facility's account are subject to an emission allocation fee of roughly $374 per ton.[64] The fee is intended to stimulate transactions. An exemption for RTC holders that are not "permitted facilities" allows unused RTCs to be "dumped" to brokers or others to avoid the fee.

3.2 Emissions Trading Pilot Projects in Canada

Two pilot projects are summarized, the Pilot Emission Reduction Trading (PERT) project and the Greenhouse Gas Emission Reduction Trading (GERT)

3.2.1 Pilot Emission Reduction Trading (PERT)

The Pilot Emission Reduction Trading (PERT) project is a demonstration project established in 1996 to:

- evaluate the environmental and economic benefits of using emission reduction credit trading as a tool to improve air quality in the Windsor-Quebec Corridor;
- examine the compatibility of credit with the regulatory framework in Ontario;
- identify and resolve stakeholder concerns with trading program design elements; and
- design a trading system for Ontario and bordering airsheds that is acceptable, easy to use, and can be integrated with other trading systems.

PERT is a self-funded and non-profit organization. It is managed by a multi-stakeholder Working Group and supervised by an Executive Committee. Large industrial organizations, governments, consultants and smaller organizations contribute financially to the operations of the Working Group. Health and environmental organizations

[62] SCAQMD, 1996, Chapter 5, pp. 34-39.

[63] SCAQMD, 1997, Chapter 5, pp. 5-2 to 5-4.

[64] Dudek and Wiener, 1996, pp. 33-34.

participate voluntarily and are provided limited reimbursement for travel and other expenses.

The initial focus of the PERT project was NOx and VOC emissions in southern Ontario. It was expanded in 1997 to include SO_2 and CO_2. Participants are, in any case, requested to track changes in emissions of all pollutants as a result of actions under PERT.

Credit creation actions are documented in the form of a "protocol" that describes the actions implemented and the reductions achieved. The protocols are reviewed by the PERT registration team and the PERT Working Group to ensure that the reductions are real, measurable, verifiable and surplus. The role of PERT in the review of the protocols is to gain information that would assist in the development of a successful emission trading program. Review does not imply approval of the protocol, this authority remains with the provincial Ministry of the Environment. Working Group reviews are attached to the file provided to the registry and are available to anyone purchasing the credits.

A summary of the credit creations, trades, uses and retirements posted to the registry through 1997 is presented in Table 4.[65] The data reflect approximately 10 credit creation actions, most of which last several years. A few participants have implemented more than one credit creation action, so the data reflect the actions of 5 to 10 companies. Many of the credit creation actions by PERT participants had not yet been listed with the registry and so are not reflected in the data in Table 5.[66]

All of the trades and uses registered represent purchases by one participant to help meet a voluntary commitment. Most of the credits created were banked (held as balances) in anticipation of agreement on a letter of understanding with the provincial Ministry of the Environment. The letter of understanding, signed in July 1998, enables actions under the pilot project to be used to meet potential future regulatory obligations. Specifically,

> "[i]n the event the project does not lead to a trading program, all emission reductions created or transacted in the project will be recognized as early progress towards future requirements or regulations or towards all self-imposed commitments. If the project leads to a trading program, all emission reductions created or transacted by corporate participants in the project will be subject to the rules of that program."

[65] One of the PERT participants has retired 10% of the credits created to benefit the environment, but this is not a PERT requirement. Companies that create credits under PERT have been permitted to claim emissions reductions back to 1994.

[66] During 1997, 15 credit creation protocols were reviewed by PERT. Only five had been listed on the registry as of June 1998. Reasons for not listing credits on the registry include plans to hold the credits for internal use, delays in securing senior management approval to proceed with registration, and waiting for the PERT letter of understanding to be officially signed by the Ontario Minister of the Environment. Only emissions reduction credits listed on the Clean Air Action Corporation registry are recognized by PERT.

Table 5

PERT Creation, Trading and Retirement Summary Report
(tonnes)

Pollutant/year	1994	1995	1996	1997	Totals
CO Created			38	38	76
CO Traded			38	38	76
CO Retired			4	4	8
CO Used					
CO Balance			34	34	68
# CO Creations			1	1	2
NOx Created	397	2,651	4,660	6,252	13,960
NOx Traded*		334	1,007*	2	1,343*
NOx Retired	40	321	573	540	1,474
NOx Used		111	214		325
NOx Balance	357	2,219	4,236	5,712	12,524
# NOx Creations	1	6	7	4	18
CO_2 Created	128,167	284,936	363,757	326,044	1,102,904
CO_2 Traded					
CO_2 Retired	12,817	28,494	36,376	32,604	110,291
CO_2 Used					
CO_2 Balance	115,350	256,442	327,381	293,440	992,613
#CO_2 Creations	3	4	4	1	12
SO_2 Created	867	1,363	1,708	1,829	5,767
SO_2 Traded					
SO_2 Retired	87	136	171	183	577
SO_2 Used					
SO_2 Balance	780	1,227	1,537	1,646	5,190
#SO_2 Creations	3	4	4	1	12
VOC Created			6	6	12
VOC Traded			6	6	12
VOC Retired			1	1	2
VOC Balance			5	5	10
# VOC Creations			1	1	2

* Trading in 1996 included 363 tonnes NOx added to PERT inventory from Detroit Edison
Source: Adapted from Clean Air Action Corporation Emissions Registry

Although not shown in the summary data in Table 5, NOx and VOC emission reductions achieved during the ozone season and non-ozone season are tracked separately.

One of the major activities of the PERT Working Group is to develop a draft trading rule that could serve as a template for the Ministry of the Environment should it consider emissions reduction credit trading in Ontario. The development of this rule started with a review of relevant trading rules, guidances, policies and regulations developed in the United States. Participants are currently formulating a proposal for the draft rule, which is expected to include the following components:

- Emission Reduction Credits - including identification of eligible substance, sources of emissions, units of measurement, credit eligibility criteria, computation of the emissions reduction credit, baseline determination issues, credit life, eligibility of credits for shutdown, and critical dates for generating credits;

- Credit Use and Transfer - including participant eligibility, user liability, eligible credit uses, trading zone and inter-jurisdictional trading, trading ratios, ozone season, environmental donation, credit transfer and credit banking;

- Registry, Reporting and Monitoring - including requirements for subscription to a registry, notices, protocols for creation and use, monitoring, documentation requirements, reporting requirements of activity, prices and confidentiality of proprietary information;

- Audit and Verification - including authority of the Ministry to require information, defer uses pending and audit, order a third party audit, determine credit eligibility, require annual reports, perform a program audit and administer prohibitions, restrictions and penalties.

The rule is intended to be simple enough to encourage trade while maintaining environmental integrity. It is expected that the draft rule will be available for submission to the Ontario Ministry of the Environment when the PERT project terminates in March 1999.

3.2.2 Greenhouse Gas Emission Reduction Trading (GERT)

In 1996 British Columbia, along with Environment Canada and the Greater Vancouver Regional District, funded a design study for an offsets pilot. The study "Requirements for a Pilot Greenhouse Gas Offsets Program in British Columbia: A Discussion Paper" was released in March 1997.[67]

[67] Alchemy Consulting Inc., Constable Associates Consulting Inc. and Margaree Consultants Inc. in association with BOVAR Environmental, *Requirements for a Pilot Greenhouse Gas Offsets Program in British Columbia: A Discussion* Paper, prepared for Environment Canada, BC Ministry of Employment and Investment, BC Ministry of Environment, Lands and Parks, Greater Vancouver Regional District, and Fraser Valley Regional District, March 1997.

The Greenhouse Gas Emission Reduction Trading Pilot (GERT) was launched by a multi-stakeholder partnership in June 1998. The partners in the pilot include representatives of provincial, federal and local government agencies, the private sector, labour and environmental groups. Participating governments include: Alberta Departments of Energy and Environmental Protection, BC Ministries of Energy and Mines, and Environment, Lands and Parks, Environment Canada and Natural Resources Canada, Greater Vancouver Regional District, Nova Scotia Natural Resources, Quebec Ministry of Natural Resources, and Saskatchewan Energy & Mines.

The GERT Pilot is designed to:

- Provide all participants with practical experience in emission reduction trading;
- Assess environmental and economic benefits of emission reduction trading;
- Test and evaluate the technical, administrative and legal elements of an emission reduction trading system;
- Maximize involvement of the private sector by emphasizing the use of business principles to achieve environmental and economic objectives;
- Encourage identification and joint investment in GHG emission reduction, avoidance and/or sequestration activities; and
- Help build the foundation for a possible future emission reduction trading system.

The GERT pilot is administered by a Pilot Manager who reports to a Steering Committee of senior representatives from participating stakeholder groups. A Technical Committee, with parallel stakeholder representation, will prepare the administrative elements (eligibility rules, measurement protocols, etc.), review projects, record and track trades, and develop an evaluation framework for the pilot as a whole.

Industry participants agree to bring forward, for review by the pilot Technical Committee, emission reduction projects and trades, which result in emissions reduction, avoidance or sequestration and to share detailed information on these projects and trades. The Technical Committee reviews projects and trades to assess whether they meet the criteria and rules established by GERT.

To be eligible for review by GERT, an emission reduction project must have started generating emission reductions no earlier than January 1, 1997. Projects can reduce or sequester any greenhouse gas. Projects can be located anywhere, but either the buyer or the seller must be Canadian. If the project is located outside of Canada, the buyer must report the reduction only in Canada. As well, if either the buyer or seller is outside the

country, use of the emission reduction for compliance purposes will depend on future international trading agreements signed by Canada. Canadian participants must be registered in Canada's Climate Change Voluntary Challenge and Registry (VCR) Program.

The pilot will only consider projects where a trade occurs. To be eligible for registration, projects must result in emission reductions that are real, measurable, verifiable and surplus, which have been defined by GERT as follows:

- ***Real***. An emission reduction is real if it is a reduction in actual emissions, resulting from a specific and identifiable action or undertaking, net of any leakage of emissions to a third party or jurisdiction.

- ***Measurable***. An emission reduction is measurable if the actual level of greenhouse gas emissions with the project, and the level of greenhouse gas emissions in the reference case, can be quantified.

- ***Verifiable***. An emission reduction is verifiable if the calculation methodology is acceptable, transparent and replicable and the raw data required to verify/audit the calculations are available.

- ***Surplus***. An emission reduction is surplus if it represents a reduction that is not otherwise required by law. If legal requirements affecting greenhouse gas emissions by source come into effect during the life of the project, then the reference case(s) must be adjusted to reflect the new requirements.

The Technical Committee has not yet achieved consensus on a definition of "project additionality", but is interested in exploring, on a project-by-project basis, the merits and methods for applying this criterion. Therefore, while the demonstration of "project additionality" is not mandatory for the registration of an emission reduction, participants may be requested to submit information relevant to its assessment as part of the review process[68].

Emission reductions that satisfy GERT conditions and reporting requirements will be designated as Registered Emission Reductions and will be recognized by government partners in GERT. Reporting must be done by participants to the trade on an annual basis and filed with GERT during the first quarter following the end of the calendar year. After this information has been reviewed and accepted by the Technical Committee as having met the conditions of the registered trade, the emission reductions will be registered. The Technical Committee may require a third party review/audit at the participant's expense.

[68] See C. Rolfe, "Additionality: What is it? Does it Matter?", Report prepared for the Technical Committee of the Greenhouse Gas Emission Reduction Trading Pilot, available from the Pilot website at <*http://www.gert.org*>.

For the immediate future, buyers can use emission reductions to meet their own voluntary greenhouse gas emissions reduction targets at lower cost. For example, companies and municipalities can include GERT trades as part of their action plans registered with the Voluntary Challenge and Registry Program (VCR Program).

In the longer term, "Government partners will recognize emission reductions from trades registered under the Pilot as progress toward possible compliance obligations in the context of any future greenhouse gas trading regime. The form this recognition takes shall be consistent with any future international and domestic greenhouse gas trading rules." In addition, "Government partners will work to ensure that participants are not penalised, with respect to the setting of potential future emission limits, for having undertaken the emission reductions from trades registered under the Pilot…"

Government partners may restrict the amount of emission reductions considered under the pilot. GERT will operate until December 31, 1999, unless extended by the partners.

3.3 Status of Efforts to Develop Trading Programs for Greenhouse Gas Emissions

The Kyoto Protocol provides for the creation of three mechanisms for international trading of greenhouse gas emissions: international emissions trading (Article 17), joint implementation (Article 6) and the clean development mechanism (Article 12). Rules for all of those mechanisms are still being negotiated.

Several efforts to design an emissions trading program for greenhouse gases are underway, internationally, in the United States and in Canada. These are discussed below.

3.3.1 The UNCTAD/Earth Council Initiative

The United Nations Conference on Trade and Development (UNCTAD) has sponsored several studies on emissions trading for greenhouse gases beginning in 1992. As an outgrowth of this work UNCTAD and the Earth Council established a Greenhouse Gas Emissions Trading Policy Forum.

The aim of the Policy Forum is to provide timely support to interested governments, corporations, and non-governmental organizations in their efforts to design and implement an initial-phase international pilot greenhouse gas emissions trading system in accordance with the Kyoto Protocol.

The goal is to launch a pilot market for trading greenhouse gas emission allowances and reduction credits by 2000 thus contributing to early and effective implementation of the Kyoto Protocol. The Policy Forum met in Chicago in June and in Toronto in November. The latter session was devoted to discussing a draft work program aimed at establishing the pilot trading program. The work program is divided into issues related to the:

- Institutional structure -- the regulatory framework for defining the tradable commodity, accounting, monitoring, certification, reporting, non-compliance and enforcement; and

- Market operations -- trading rules, trading instruments, and supporting institutions.

In September 1998, UNCTAD and the Earth Council announced the formation of the International Emissions Trading Association (IETA). The aim of the IETA is to become an independent international organisation dedicated to advancing and disseminating technical, economic and professional knowledge related to emissions trading, and to promoting best practices and know-how among its members. More importantly, the Association aims to become one of the first truly independent international verifiers of company emissions reports and carbon credits, and issue certificates that can facilitate trading.

3.3.2 The World Bank's Carbon Investment Fund

The World Bank proposes to establish a Carbon Investment Fund (CIF) to supply high quality offsets at a competitive price and to ensure that suppliers and buyers receive a fair share of the value added. The CIF will invest in carbon emission reduction actions in developing countries and countries with economies in transition. It is expected that many of the actions financed by the CIF would be enhancements to regular World Bank or International Finance Corporation (IFC) projects to reduce the greenhouse gas emissions.

The fund will be similar to a closed-end mutual fund. Private sector and government investors in the CIF would receive greenhouse gas emission reduction credits created through the actions financed by the fund. An independent body would verify the emission reductions achieved and certify that they met the internationally agreed criteria for credits from joint implementation projects. These credits could be used to meet national emission limitation commitments. Risks are reduced by pooling funds to finance a portfolio of projects.

The World Bank's target capitalization for the CIF is $100 million by 2000. The Bank estimates that the market for joint implementation credits could be $1 billion by 2000 and $10 to $60 billion by 2020 depending on the strength and scope of future greenhouse gas emission limitation commitments.

The activities of the CIF in developing countries could complement, or be subsumed by, the clean development mechanism established by the Kyoto Protocol. The CIF could function as planned in Annex I Parties with economies in transition.

3.3.3 Center for Clean Air Policy[69]

The Center for Clean Air Policy has a project underway to analyse alternative designs for a domestic greenhouse gas emissions trading system in the United States. Representatives of industry, environmental groups, and the federal government participate in the project. However, the report will be the responsibility of the Center, not a collaborative report. The project has produced reports on a series of issues that need to be addressed in the design of a greenhouse gas trading program, such as the treatment of feedstocks and approaches to the distribution of allowances.

3.3.4 NESCAUM GHG Emissions Trading Demonstration Project

The North East States for Coordinated Air Use Management (NESCAUM), a body for coordinating state regulatory activity related to air quality among eight states in the U.S. northeast, launched a greenhouse gas trading demonstration project in February1998.

The project has two major components:

- Enlist companies to voluntarily undertake a strategic planning process demonstrating how it would comply with a carbon budget while pursuing traditional business objectives (allowance trading).

- Develop case studies of innovative measures to reduce greenhouse gas emissions (credit trading).

The former component is the first attempt at a pilot voluntary allowance trading program. The credit trading component will be modelled on the NESCAUM demonstration project for NOx and VOC trading, which ran from 1993 through 1996 and developed the discrete emission reduction form of credit trading. This demonstration project might provide insight into issues surrounding the coexistence of allowance and credit trading.

The demonstration project includes participants from state and federal agencies, the private sector and environmental advocacy organizations. It uses a consensus-based process to clarify key issues involved in the design of a greenhouse gas emissions trading program. The demonstration project is expected to last two years.

3.3.5 National Round Table on the Environment and the Economy

The National Round Table on the Environment and the Economy (NRTEE) has launched a project to analyse alternative designs for a domestic greenhouse gas emissions trading

[69] Another project to design a domestic emissions trading program by the H.John Heinz III Center for Science, Economics and the Environment produced a report on *Designs for Domestic Carbon Emissions Trading* in July 1998 but was not able to attract sufficient funding to complete the analysis.

program. The project was launched in the spring of 1998. The first phase involved the compilation of a list of possible designs, selection of a short list of designs for further analysis, and identification of issues common to multiple designs for further research.

The fourteen designs identified and the six selected for further analysis are described in Table 6.

Table 6

Summary of Possible Designs and Recommended Short List

Design	Short List	Description
Prospect of future commitment to limit GHG emissions		
1	✓	Voluntary credit trading
2		Voluntary cap and trade system
No specific prospect of a commitment to limit GHG emissions		
3		Voluntary credit trading
Commitment to limit GHG emissions exists		
4	✓	Cap on carbon content of fossil fuels produced and imported with trading by producers, importers and exporters
5		Cap on carbon content of fossil fuels crossing provincial and international borders, with trading by owners of the fuels
6		Cap on the carbon content of fossil fuels implemented at the narrowest point in the distribution chain, with trading by owners of the fuels
7		Voluntary credit trading
8	✓	Voluntary credit trading with mandatory performance standards
9		Mandatory credit trading
10		Voluntary cap and trade system
11	✓	Cap on emissions by fossil fuel users, trading by large fuel users and oil companies for transportation fuels
12		Same as previous option, but excluding transportation sector
13	✓	Same as option 11 but with no opportunity to purchase credits or allowances from sequestration or sources outside the program
14	✓	Cap on emissions by fossil fuel users, trading by large fuel users and municipalities for transportation and commercial/residential buildings

The sixteen issues common to multiple designs that require further research are listed in Table 7.

Table 7

Issues Common to Multiple Designs and Recommendations for Further Study

Issue	Further Study	Deferred	Description
1	✓		Determination of the type(s) of emissions trading system suitable for each greenhouse gas source or sink
2	✓		Analysis of legislative authority to implement different forms of emissions trading for various sources and sinks
3			Methods to link the domestic emissions trading system to the provisions of the Kyoto Protocol
4	✓		Implications of international trade agreements for design of a domestic emissions trading program
5	✓		Options for treatment of fossil fuels used as feedstocks
6	✓		Analysis of options for *gratis* allocation of allowances to participants in a domestic emissions trading program
7	✓		Analysis of options for distributing allowances by auction
8	✓		Analysis of emissions trading program design features
9	✓		Specification of criteria for credit creation where credit trading is accepted
10	✓		Analysis of implications of using life-cycle emissions in trading system designs
11	✓		Evaluation of possible complementary policies
12		✓	Assessment of the administrative resources needed to implement emissions trading for greenhouse gases
13		✓	Evaluation of the need to regulate the allowance/credit market
14		✓	Analysis of the economic effects of different emissions trading systems compared with a regulatory regime
15		✓	Analysis of the ancillary environmental benefits of the anticipated greenhouse gas emissions reductions
16		✓	Analysis of potential market power

Papers describing the six designs and the ten issues are currently in preparation. They will be distributed to the Mulitstakeholder Expert Group for discussion at a meeting in mid-September. At that meeting detailed designs for a domestic emissions trading program will be developed by fleshing out the framework designs with detailed assumptions relating to common issues. The detailed designs will be used to analyse issues such as the administrative requirements and economic effects of different designs. The analysis of the detailed designs is expected to be completed in the spring of 1999.

4. Performance Indicators for Emissions Trading Programs

This chapter discusses possible indicators of the effectiveness and operational efficiency of emissions trading programs. It also compares American emissions trading programs for NOx and SO_2 emissions using these indicators.

4.1 Objectives of Emissions Trading Programs

Emissions trading programs always have an environmental objective. But environmental objectives can be achieved using other forms of regulation as well, so the interesting question is: why has emissions trading been chosen in preference to other forms of environmental regulation? There appear to be three main reasons:

- Emissions trading enables the environmental objective to be achieved at lower cost or enables a more stringent objective to be achieved because the cost is lower;

- Emissions trading enables the environmental objective to be achieved more quickly; or

- Emissions trading can be designed to enable economic growth to occur without adversely affecting the environment.

The first objective applies to the electric utility SO_2 allowance trading program, the RECLAIM program, and the ozone-depleting substances programs in Canada and the United States. The second objective applies to the lead in leaded gasoline program and the ABT provisions for heavy-duty vehicle engine emissions standards.

The third objective applies to offsets for criteria air pollutants in non-attainment areas, such as the Connecticut emissions reduction credit trading program. Offsets are mandatory in a non-attainment area for new (and expanding) sources with planned emissions beyond the minimum threshold. These sources can not locate (expand) in the area unless they are able to purchase sufficient ERCs from existing sources. Thus, economic growth in non-attainment areas is constrained unless a sufficient supply of ERCs is available.

4.2 Indicators of Emissions Trading Program Performance

An emissions trading program, like any program, can be evaluated on the basis of how well it meets its explicit and implicit objectives -- an ***impact evaluation*** -- or on the basis of how well it functions -- a ***process evaluation***.

4.2.1 Impact Evaluation

Possible indicators of the performance of an emissions trading program for an impact evaluation include:

- Achievement of the environmental objective
- Achievement of the economic objective

These indicators are discussed below. An emissions trading program may also be intended to promote technology innovation or to increase the number of sources contributing to meeting the environmental goal. If an emissions trading program had such an objective, or any other implicit or explicit objective, its achievement should also be addressed as part of an impact evaluation.

Achievement of the environmental objective: An emissions trading program is designed to contribute to an environmental objective, so the extent to which the objective is achieved is an important indicator of its success. An emissions trading program may be adopted to enable an environmental objective to be achieved more quickly or to enable a more stringent environmental objective to be reached. Regardless of the objective, the trading program will have explicit or implicit emissions reduction targets.

Meeting the emissions reduction targets of the trading program is then a key indicator of the program's contribution to the environmental objective. Focusing on the trading program's emission reduction target, rather than a broader environmental objective, is important if the trading program covers only a fraction of the sources and emissions contributing to the problem. The extent of non-compliance in terms of the number of participants and excess emissions are useful supplementary indicators of the achievement of the program's emissions targets.

Indicators of the success of the program in achieving the environmental objective more quickly or achieving a more stringent environmental objective are more complex. They require a comparison of the actual performance of the trading program to be compared with the projected performance of the program that would otherwise have been adopted. A trading program that meets its emissions reduction targets is probably successful since the targets can be presumed to reflect the (earlier or more stringent) environmental objective. But a trading program with some level of non-compliance may still be more successful than the program that would otherwise have been adopted.

Achievement of the economic objective: An emissions trading program also has economic objectives, so achievement of the economic objective is an important indicator of its success. An emissions trading program may be adopted to enable an environmental objective to be achieved at lower cost or to enable economic growth to occur without adversely affecting the environment.

If the objective is to reduce the cost of meeting the environmental objective, the total cost of the reductions achieved under the emissions trading program must be compared with the projected cost of achieving the same reductions with the program that would otherwise have been adopted.[70] The correct measure of the performance of the trading program is the reduction in the total cost of meeting the environmental objective.

The total cost of the emissions trading program and the alternative program should include the costs of the emissions reduction measures implemented; monitoring costs; administrative costs for participants, regulators and others; transactions costs and any other relevant costs. The costs must also include capital costs and program development costs as well as operating costs.[71] Focusing on any one of the cost components could be misleading.

If the economic objective is to enable economic growth to occur without adversely affecting the environment, actual economic growth must be compared with the economic growth in the absence of the trading program. Assuming that new or expanding sources would not be allowed locate in an area in the absence of trading, trading activity is an indicator that economic expansion has occurred.

4.2.2 Process Evaluation[72]

A process evaluation of an emissions trading program focuses on how well the program is being administered. Possible measures of the effectiveness of the administration of an emissions trading program include:

- Volume of trading activity
- Time lags for executing trades
- Percent of proposed trades approved
- Costs of trading
- Costs of enforcement

[70] Such studies have been performed -- prospectively, retrospectively or both -- for most of the American emissions trading programs. Staff of the Massachusetts Institute of Technology, for example, have published numerous studies evaluating the SO_2 trading program. R. Schmalensee, P.L. Joskow, A.D. Ellerman, J.P. Montero and E.M. Bailey, "An Interim Evaluation of Sulfur Dioxide Emissions Trading," *Journal of Economic* Perspectives, v. 12, n. 3, summer 1998, pp. 53-68 provides a recent overview of their work with references to many other studies. The South Coast Air Quality Management District, *RECLAIM Program Three-Year Audit and Progress Report*, May 1998 evaluates the performance of that program over its first three years of operation. The report includes dissenting comments by members of the Advisory Committee.

[71] Each program should be assumed to be implemented with a comparable level of efficiency.

[72] This section is taken from Barakat & Chamberlin, *Study of Atmospheric Emission Trading Programs in the United States*, Canadian Council of Ministers of the Environment, September 1991, Chapter VII, pp. 71-80.

- Market behaviour
- Frequency of revision of the rules

Trading activity: Perhaps the most basic indicator of process efficiency is trading activity. If there are no trades, the theoretical advantages of emissions trading are not being realized. Trading activity can be measured by the number of sources that participate and the volume of emissions allowances traded. However, in the case of an emissions reduction credit trading program, a lack of trading activity is not necessarily an indicator of program failure.

A lack of trades suggests a need for further analysis. In an allowance trading program a lack of trades may indicate that other regulations leave little flexibility for compliance and hence little scope for trading. Sparse trading activity in an allowance trading system may also indicate that a few large sources are able to dominate the market. In an emissions reduction credit trading program, a lack of offset trades may be due to high threshold levels. Alternatively, a lack of offset trades may simply reflect a lack of economic growth in the region. A low level of netting trades in an emissions reduction credit trading program may indicate that the approvals process is too cumbersome or that the savings relative to the command-and-control regulations are small. In any case, trading activity serves more as an indicator of the need for further investigation than as a measure of the success of the program.

The trading process: The relevance of the other measures of process effectiveness is self-evident. Long time lags for executing trades suggest that the approvals process is cumbersome or that insufficient staff and resources are available to process proposed trades. The percent of proposed trades approved is a crude indicator of whether the rules are explicit. Clear rules for the most common types of trades will lead to a high percentage of approvals. A low approval percentage suggests either that the rules are not as clear as they should be or the capricious use of discretionary authority.

Trading and enforcement costs: An applicant's cost to transact a trade will influence the volume of trading. Processing fees are usually only a small part of this cost. Consulting fees, legal costs and the other costs of preparing documents needed to support a transaction can be high. Simplifying the trading process will tend to reduce the transaction costs and promote trading. The total cost of trading - all the costs associated with preparing the necessary documents, processing and other fees, as well as costs due to delays - is a good indicator of the effectiveness of the administration of the trading program.

The enforcement costs to the regulator and the regulated are another good measure of the effectiveness of the administration of the trading program. Are the monitoring and reporting costs imposed on emissions sources unnecessarily high? Are inspection and enforcement expenditures by the regulatory agency too high? The total cost of ensuring that the program is reasonably enforced is an appropriate issue for the process evaluation.

Market behaviour: The behaviour of the market for tradable allowances or emissions reduction credits can also provide an indication of how well the program is administered. Wide fluctuations in prices over time or space suggest that the market may not be functioning smoothly. Some of the fluctuations may be due to regulatory or administrative decisions that limit the ability to trade or otherwise affect the market.

The market may also be affected by hoarding or noncompetitive behaviour by larger firms. Hoarding, that is, a reluctance to sell, may indicate high transaction costs or a high degree of uncertainty concerning future requirements. Noncompetitive behaviour by larger firms may involve hoarding or attempts to distort prices by other means. Evidence of hoarding or noncompetitive behaviour is an indicator that there may be problems with the administration of the trading program.

The regulatory authority can also affect market behaviour. In the case of emission reduction credits the regulatory authority can affect the liquidity of the market. If a credit owner's rights are not secure, fewer credits will be created. The offset ratio is another regulatory distortion of the market. The provisions by which regulators withhold and sell SO_2 allowances are an attempt to ensure that the market will have an opportunity to function smoothly. Thus, a market that is not functioning well may also be evidence of deficiencies in the administration of the trading program.

Frequency of rule changes: A history of frequent rule changes makes a trading program less attractive to potential participants. It becomes more difficult and costly to keep abreast of the trading rules and this lowers trading activity. Of course, the air quality administrators may not be fully in control of the frequency of rule changes. Provincial or federal government actions may force rule changes on the local air quality administrators. A new trading program will also encounter some teething problems, and it is usually better to correct these problems than to let them persist out of a reluctance to change the rules.

4.3 Indicators of Effectiveness Suggested in the Request for Proposal

The Request for Proposal suggested the following possible indicators of the effectiveness of emissions trading programs. The order in which they are listed has been changed to facilitate the discussion.

- Fair playing field
- Achievement of environmental goals
- Economic performance/cost effectiveness
- Volume of trades
- Economic value of trading
- Administrative burden to government and industry
- What other jurisdictions are doing

Fair playing field: A fair playing field requires that participants in the trading program be treated equitably relative to each other and relative to sources not required to participate in the trading program. Equity is a matter of judgement, so it is generally not part of an evaluation of an emissions trading program.

The manner in which different sources are treated is reflected in the rules of the trading program. All sources of a pollutant are required to participate in a closed trading program, so concerns about the treatment of participants and sources not required to participate in the program do not arise. Equitable treatment of sources with emission reduction obligations and those without such obligations is an issue for an open trading program.

In trading programs with *gratis* distribution of allowances, the relative burdens on participants are determined by the allocation rule. The basic allocation rule often includes a number of adjustments for sources that would otherwise be unfairly treated. Both the SO_2 allowance trading program and RECLAIM have such provisions, some of which are temporary. In a closed credit trading program all of the participants are typically required to achieve the same standard. This was the case for the lead program and is also the case for the ABT program for heavy-duty engine emissions. A universal standard may still impose different compliance burdens on different sources.[73] In an open credit trading program the relative burdens on sources with emission reduction obligations are determined by the baselines.

Treatment of new sources relative to existing sources, especially those that cease to operate, also needs to be considered. Many trading programs - including the open credit trading programs, the SO_2 allowance program and RECLAIM - require new sources to obtain allowances or credits to offset their emissions. In those cases the new sources probably bear a heavier compliance burden than existing sources. These same programs typically continue to allocate allowances of credits to sources that cease to operate.

Achievement of environmental goals: As discussed earlier in this chapter achievement of the environmental goal is a key indicator of the effectiveness of the emissions trading program. However, the appropriate measure of the effectiveness of the trading program is achievement of the emissions cap or emissions reduction target for the participants. If the trading program covers only a fraction of the sources and emissions contributing to the problem, failure to achieve the broader environmental objective may be due to sources outside the trading program. The extent of non-compliance in terms of the number of participants and excess emissions are useful supplementary indicators of the achievement of the program's environmental goals.

[73] The CAFE standards for automobiles illustrate the point. Every manufacturer had to meet the same fleet average fuel efficiency. Due to the product mix of different manufacturers, japanese importers found it easier to meet the standard than American manufacturers. And General Motors found it more difficult to meet the standard than other American manufacturers.

Economic performance/cost effectiveness: This indicator is interpreted as achievement of the economic objective of the trading program. The economic objective usually involves achieving an environmental goal at lower cost; then the cost effectiveness of the program is a measure of its performance against this economic objective. But an emissions trading program can have other economic objectives, such as accommodating economic growth in non-attainment areas without causing a deterioration in air quality. Where the economic objective is not achievement of an environmental goal at least cost, a suitable indicator of economic performance should be used to measure the effectiveness of the program.

Volume of trades: The number of transactions, quantity of allowances or credits traded, or value of trades is not a reliable indicator of the magnitude of the cost savings. volume of trades is not a good indicator of the effectiveness of an emissions trading program. The way in which the trading program is designed has a major impact on the volume of trades. For example, the participants in the SO_2 trading program are individual generating units. Approximately two-thirds of all trades are transfers between generating units owned by the same electric utility. If the program had been designed with electric utilities rather than the individual generating units as the participants, all of the trading among units owned by the same utility would disappear.

RECLAIM does not allow banking and charges participants a fee for holding RTC credits. Trades with no price dominate in both number and tonnage. Trades without prices include transfers due to change of ownership, transfers between facilities within the same company, transfers to and from brokers associated with auctions, and "dumping" - transfers to avoid payment of fees associated with holding RTCs. Eliminating the fee for holding RTC credits would eliminate a substantial volume of trades.[74] The Canadian program for methyl bromide allocates the allowances to users rather than importers. This guarantees a higher level of trading activity than if the same number of allowances were allocated to importers.

Program features, such as costly and time consuming approval requirements or discounts for banking or trading can discourage trading activity. In short, every trading program has some features that could be changed without affecting the environmental or economic goals but which affect the volume of trading activity.

The volume of trades is therefore not a reliable indicator of the effectiveness of a trading program. However, trading activity can serve as an indicator of the need for further investigation of the operational effectiveness of a trading program.

[74] The cap during the early years of the program was substantially above the actual emissions. The surplus credits could not be banked and were subject to the holding fee if owned by a participant. They were sold to brokers who are not required to pay the holding fee at zero price. As the cap declines the number of surplus credits will decline and the volume of such trades will fall.

Economic value of trading: The economic value of trades is not a reliable indicator of the effectiveness of, or the cost savings due to, a trading program for the same reasons that the volume of trades is not a reliable indicator of program effectiveness.

Administrative burden to government and industry: as discussed earlier in this chapter, the costs to the regulator and the regulated are another good measure of the effectiveness of the administration of the trading program. They are a measure of how well the program functions rather than a measure of the effectiveness of the program.

What other jurisdictions are doing: What other jurisdictions are doing may provide useful benchmarks for assessing the effectiveness or operational performance of an emissions trading program. Programs in other jurisdictions may provide data on the cost per tonne of emissions reduced, administrative costs, processing times, compliance levels, etc. that can be used to help evaluate the effectiveness and operational efficiency of an emissions trading program.

However, an emissions trading program should be designed to address the specific environmental problem effectively and efficiently. Replicating the design implemented in another jurisdiction to address a similar problem may not yield the best result. First, the trading program in the other jurisdiction may not be as effective or as efficient as it could be. Second, the nature of the environmental problem may differ between jurisdictions in important respects, such as the number or mix of sources.

4.4 Evaluation of American Trading Programs for NOx and SO_2 Emissions

This section compares three trading programs that deal with NOx and SO_2 emissions: the Connecticut NOx emission reduction trading program, the electric utility SO_2 allowance program and the RECLAIM program for NOx and SOx. The Connecticut program is representative of several state and district programs for non-attainment areas. The Connecticut program is an open program while the SO_2 allowance and RECLAIM programs have an open design, but are effectively closed programs.

The programs are compared using the impact evaluation and process evaluation indicators discussed earlier. The comparison is summarized in Table 8.

4.4.1 Environmental Effectiveness

All three programs appear to meet their environmental objective, although there is room for some debate about the achievements of the RECLAIM program. The objective of the Connecticut program is to lower the cost of RACT compliance and accommodate new and expanding sources while preventing deterioration of the air quality. The control technology requirements (LAER) for new and expanding sources combined with the requirement to offset any remaining emissions with reductions from existing sources and

an offset ratio greater than 1 all serve to ensure that the environmental objective is achieved.

Actual emissions by sources participating in the SO_2 allowance program have been well (25-40%) below allowable levels for each of the first three years. In addition every source participating in the program during the first three years has achieved compliance with its emissions limits.

Table 8

Qualitative Evaluation of American Trading Programs for NOx and SO_2 Emissions

	Open	Open, but Closed in Practice	
	Connecticut	SO_2	RECLAIM
Impact Evaluation			
Environmental effectiveness	✓?	✓	✓
Economic effectiveness	✓	✓	✓
Process Evaluation			
Volume of trading	see text		
Time lags for trading	?	days	days
Percent of trades approved	100%?	100%	100%
Costs of trading	?	1-2%	≅7%
Enforcement costs	see text		
Market behaviour	?	competitive	competitive?
Frequency of rule changes	?	?	?

Total emissions of NOx and SOx by facilities participating in the RECLAIM program were substantially (20-40%) below allowable levels during the first two years. However, the allowable emissions were well above actual emissions for earlier years. Actual NOx emissions during the first two years of the program were slightly higher than during the last year prior to the program. The pattern of actual SOx emissions is more difficult to determine due to heavy use of the "missing data" procedures during the second year of the program. At the end of the first year, 46 facilities (13%) exceeded their allocations and 20 facilities had not submitted complete compliance reports. During the second year, 28 facilities (8%) exceeded their allocations. The total amount of exceedances was about 400 tons of NOx and about 7 tons for SOx.

4.4.2 Economic Effectiveness

All of the programs appear to meet their economic objective. The Connecticut program has enabled new and expanding sources to locate in the region. Information on the cost savings for RACT compliance is not available. Various studies of the SO_2 allowance trading program suggest that the costs of reducing emissions have been substantially lower than they would be under alternative regulatory regimes. The three-year audit of the RECLAIM program also finds that the program has reduced costs relative to compliance with the regulations it replaced.

4.4.3 Volume of Trading

The volume of trading in the Connecticut is determined by requirements for RACT compliance, the emissions of new and expanding sources, and penalties for excess emissions. The number of trades and quantity of credits traded is small relative to the other programs. The volume of trades under the SO_2 allowance program has grown rapidly. The quantity of allowances traded in arms length deals currently exceeds the quantity allocated. And the quantity transferred between units under the same ownership is about twice as large as the quantity traded in arms length deals.

The quantity of NOx traded under the RECLAIM program currently exceeds the annual allocation by 20 to 40% and the quantity of SOx traded annually is almost three times the annual allocation. Only 10-25% of the RECLAIM trades are made at a positive price. The total value of such trades has been about $10 million per year. Most of the trades are made at zero price as transfers to and from brokers and to avoid payment of the fee for holding RTCs.

4.4.4 Time Lags for Trading

Trades under the SO_2 allowance and RECLAIM programs can be processed in a matter of days. Although data on the time required to get approval for the creation or use of credits under the Connecticut NOx emission reduction credit trading program are not available it certainly is longer than a few days.

4.4.5 Percent of Trades Approved

All trades are approved under all three programs, but for different reasons. Each credit creation and use under the Connecticut NOx emission reduction credit trading program must be approved by the Commissioner. By definition, then, all trades are approved. The

SO_2 allowance and RECLAIM programs do not approve trades. Instead the seller is responsible for holding enough allowances or RTCs to cover actual emissions regardless of the quantities sold. Failure to do so triggers penalties for non-compliance.

4.4.6 Costs of Trading

The costs of trading under the SO2 allowance and RECLAIM programs are relatively low. Brokers handle most of the trades under the SO_2 allowance program. They charge both the buyer and the seller a commission of $0.50 per allowance, for a total cost of $1.00 per allowance. The price of an allowance has fluctuated between $100 and $200, so the transaction cost is less than 1%.

Many of the RECALIM RTCs are sold through periodic auctions. Auction managers charge a fixed fee to both the buyer and the seller of either 3.5% or $35 per ton transacted plus a flat $150 per order placed. The total fee includes a $50 fee charged by SCAQMD to register each trade. The SCAQMD collects the registration fee each time, so it receives at least $100 for each trade through a broker. Thus, the total cost to complete a trade is $300 plus $70 per ton. An average trade consists of a little over 1,000 tons and the weighted average price has been just over $1,000 per ton. Thus the transaction cost averages about 7% of the price.

Information on the costs of getting approval to create or use credits under the Connecticut NOx emissions reduction credit trading program is not readily available. The costs are likely to vary with the size and type of credit creation or use action. They are almost certainly higher than the costs under the SO_2 program and probably higher than the costs under the RECLAIM program.

4.4.7 Enforcement Costs

Enforcement costs are probably higher for the SO_2 allowance and RECLAIM programs than for the Connecticut program. All sources participating in the SO_2 program are required to install and maintain continuous emissions monitoring systems. Such systems typically cost over $100,000 per year to install and maintain. Participants in the RECLAIM program are also required to install continuous emissions monitoring systems or other monitoring systems depending on their annual emissions.

A source creating credits under the Connecticut program may not need any additional monitoring systems. A source that buys credits probably will not need to install any additional monitoring systems. A user will already be required to have appropriate monitoring systems. The quantity of credits needed to comply with the RACT requirements, to offset the emissions by a new or expanding source, or as a penalty for

non-compliance is calculated. Thus actual emissions do not need to be monitored for the credit trading program.

In addition to the compliance costs, program development costs may differ significantly. Regulations for both the SO_2 allowance and the RECLAIM program took several years to develop. The Connecticut NOx emission reduction credit trading program was developed more quickly. Estimates of the costs involved in developing the three programs are not readily available. Interpreting the costs, even if they were available, would be tricky. The phased structure of the SO_2 program apparently complicated the process of developing the regulations significantly and led to a disproportionate amount of litigation. The development of state credit trading programs, on the other hand, is facilitated by drawing upon rules and guidance developed by the Environmental Protection Agency.

4.4.8 Market Behaviour

The number of participants and the volume of trading activity suggests that the markets for the SO_2 allowance and RECLAIM programs are competitive. The number of participants and trades under the Connecticut emissions reduction credit trading program are relatively small. Research on activity under that program would be needed to assess whether buyers or sellers have been able to exercise market power.

4.4.9 Frequency of Rule Changes

It is too early to comment on the frequency of rule changes for any of the programs. All of the programs came into effect in 1994 or 1995 and so have been operating for less than five years.

4.4.10 Conclusion

All three programs appear to be reasonably effective at meeting their environmental and economic objectives. However, the objective of the Connecticut NOx emission reduction credit trading program is quite different from the objectives of the SO_2 allowance and RECLAIM programs. As a result, the program designs differ significantly in important respects.

Direct comparisons of the programs may not be meaningful, given the differences in objectives and design. A valid comparison of a credit and an allowance system, or an open and a closed system, should probably be based on programs with the same economic objective. But it is difficult to imagine a closed system whose economic objective is to accommodate economic growth in a non-attainment area. An open system

whose objective is to reduce the cost to specified sources of reducing their emissions is easier to imagine. Indeed, both the SO_2 allowance and RECLAIM programs have an open design. But the extent of participation by sources other than those required to reduce their emissions is very limited, as documented in chapter 3.

4.5 Considerations in Emissions Trading Program Design

The design of an emissions trading system should reflect the nature of the environmental problem, the characteristics of the contributing sources, the trading program objective, the need to create a competitive market, and jurisdictional considerations.

The environmental problem addressed by trading program has a geographic scope and temporal characteristics. The region affected by an environmental problem can range from a radius of a few kilometres to the entire world. Candidate sources for the trading program are those that contribute to the problem. A local environmental problem may not have enough sources to create the competitive market needed for a trading program. The temporal scale of the environmental impacts can range from a few hours to a century or more. Since trading shifts emissions in time, the trading program should be designed so that these temporal shifts reduce, or at least do not aggravate, the environmental problem.

Emissions trading requires the ability to monitor or calculate the actual emissions of every participant. This is usually easier if there are a manageable number (10 to a few thousand) of relatively large stationary sources than if there are a large number (many thousands) of small, mobile sources.[75] Emissions trading requires that emissions control costs differ across sources. If all sources have the same least cost control option and the marginal cost is the same for all sources a trading program probably is not appropriate.[76] If emissions by small sources do not make a significant contribution to the problem, they may be excluded from the trading program to limit the administrative burden.

As noted in the previous section, emissions trading programs can have different objectives. The objective can affect the design.

To function well, an emissions trading market needs enough participants to create a competitive market. This requires, both a reasonable number of participants and that no single source, or small number of sources, be large enough to influence the market.

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[75] Ten may be too few sources for an effective trading program, although this is the number of participants in the ABT and Canadian ozone-depleting substances programs. Virtually no inter-firm trading has occurred under those programs.

[76] Even if the control option is the same for all sources, the costs could vary due to differences in capital costs due to economies of scale or differences in expected life of the facility.

Market power can be exercised not only in the allowance or credit market, but also in the market for the products sold by trading program participants. Some market power concerns can be addressed through the design of the trading program.

Environmental problems do not respect administrative boundaries. But regulatory authority does depend on administrative boundaries. If an emissions trading program needs to involve multiple administrative jurisdictions to effectively address the environmental problem, it may affect the design.

5. Potential Applications for Emissions Trading in Ontario

This chapter discusses potential applications for emissions trading in Ontario for SO_2, NOx and CO_2. The applications are implementation of the Smog Plan, managing emissions from the electricity sector after restructuring, and limiting greenhouse gas emissions to help meet Canada's commitment under the Kyoto Protocol.

5.1 Implementation of the Smog Plan

Smog can damage human health, property and the environment.[77] The components responsible for most of the damage caused by smog are ozone and inhalable and respirable particulates. Ozone is formed in the atmosphere through chemical reactions involving nitrogen oxides (NOx) and volatile organic compounds (VOCs). Sunlight and warmer temperatures stimulate the reactions, so ozone levels tend to be highest during the summer months.

The smog problem is most serious in southern Ontario. Ozone concentrations exceed the provincial guideline of 80 ppb as a one hour average a number of times each year throughout most of the region.[78] When ozone concentrations are highest, approximately half of the ozone and its precursors (NOx and VOCs) that affect southern Ontario originate in the United States.

The Ontario Ministry of the Environment has set an Air Quality Target for Smog. The target is to reduce the number of times the one hour ozone concentration guideline is exceeded by 75% from the 1990-94 average by 2015. To achieve this target, the Ministry estimates that 1990 NOx and VOC emissions will need to be reduced by 45%. Total NOx emissions in 1990 were 659 kilotonnes and of VOCs were 868 kilotonnes. Both NOx and VOCs are emitted by a variety of sources, including motor vehicles, industry, heating and combustion, consumer products, and power generation.

To date the Smog Plan has identified NOx reductions of 190 to 216 kilotonnes and VOC reductions of 1990 to 216 kilotonnes from 1990 levels. Details of these reductions are shown in Table 9. These reductions represent about two-thirds of the target for NOx and about half of the target for VOCs. Given the diversity of emissions sources, it is not surprising that the identified reductions originate in a variety of sectors.

Given the diversity of emission sources, it is very likely that the marginal cost of reducing NOx or VOC emissions varies widely. With differences in the marginal cost of reducing emissions, emissions trading can lower the cost of achieving a given target.

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[77] See MOEE, 1996 for information on smog in Ontario.

[78] The number of exceedances varies from year to year depending upon weather conditions, emissions and other factors. The number of exceedances also varies by location in southern Ontario.

Table 9

Proposed Reductions for NOx and VOCs

Sector	Subsector	Measure	NOx Reductions		VOCs Reductions	
			kt	year	kt	year
Transportation	Cleaner fuels	Vehicle technology and fuel improvements	65.0-80.0	2000	80.0-97.0	2000
		Increased propane usage in cars, buses and heavy-duty trucks	5.1	2015	2.4	2015
		Increased natural gas usage in light- and heavy-duty vehicles	0.9	2015	0.8	2015
Transportation	Cleaner vehicles	Vehicle inspection and maintenance programs	15.0	2005	47.0	2005
Transportation	Demand management	Range of land use, transit and user-pay pricing actions[3]	0.3-10.0[3]	2015	0.3-10.0[3]	2015
Industry and manufacturing	NOx emissions (stationary combustion sources)	Copper and nickel production	43.0	1995		
		Ontario Hydro	19.0	2000		
		Combustion turbine guideline	29.0	2015		
		Combustion system performance standard	4.0	2015		
		Voluntary boiler system review, inspection and maintenance	2.0	2000		
Industry and manufacturing	NOx and VOCs: Iron and steel	Combustion control improvements	2.0	1996		
		Combustion control improvements	1.5	2001		
		ARET[2] program			0.3	1996
		ARET[2] program			0.6	2001
Industry and manufacturing	NOx and VOCs: Chemicals	Rage of process changes, leak detection and repair, tank controls, boiler and energy measures	3.7	2000	11.8	2000
Industry and manufacturing	NOx and VOCs: Petroleum	Stage 1 vapor recovery			19.0	1998
Industry and manufacturing	VOCs: Coatings automotive refinishing	Greater Toronto body shop accreditation program			0.5	1999
		Use of high-efficiency spray guns and low-solvent coatings			2.6	NS[1]
Industry and manufacturing	VOCs: Consumer coatings	Product reformulation			3.8	1995
Industry and manufacturing	VOCs: Solvent use adhesives and sealants	Reductions in solvent use: switch to water-based product			1.6	1995
Industry and manufacturing	VOCs: Solvent use, wood treatment	Declinming use of oil-borne preservatives			0.6	2015

Sector	Subsector	Measure	NOx Reductions		VOCs Reductions	
			kt	year	kt	year
Industry and manufacturing	VOCs: Solvent use, rubber products	Various efficiency measures, changes in solvent use, etc.			1.2	1995
Industry and manufacturing	VOCs: Consumer products	Adoption of U.S. rules for solvent content			5.0	NS[1]
Total reductions identified to date			**190.5 to 215.2**		**189.6 to 216.3**	
1990 baseline emissions			**659**		**868**	

1. NS - not specified
2. ARET - Accelerated Reduction and Elimination of Toxics
3. The range of potential reductions from the 11 transportation demand management initiatives is shown. Each initiative has the potential to reduce emissions by 0.3 to 10 kilotonnes.

Source: Ontario Ministry of the Environment, *Ontario's Smog Plan*, Steering Committee Report, Toronto, January 1998, Appendix 1, pp. 17-18.

Sources than can reduce emissions at relatively low cost can implement larger reductions and sell credits to sources facing relatively high control costs.

The possibility of emissions trading is mentioned in the smog plan implementation tools.[79] In principle, then some form of emissions trading could be implemented among sources in a given sector or among all smog plan participants to reduce the cost of achieving the Smog Plan targets. The trading system would need to be appropriate for the environmental problem and the mix of participating sources. Thus, it would probably distinguish ozone season and non-ozone season emissions, the direction of trades might be restricted, and provisions would probably be included to ensure that VOC trades did not lead to increased emissions of toxics.

5.2 Emissions Trading for the Electricity Sector in Ontario

At present virtually all of the electricity consumed in Ontario is generated by Ontario Hydro. Ontario Hydro is subject to regulations that limit its total annual emissions of acid gases (SO_2 and NOx). In addition, Ontario Hydro has adopted voluntary commitments to limit its annual emissions of NOx and CO_2 beginning in 2000.

[79] MOE, 1998, p.13 mentions "categories of incentives and rewards that could be used to address the level playing field issue. These include: …process incentives such as the use of a performance-based approach that would allow use of tools such as emissions reduction trading; …"

The provincial government has announced its intention to restructure the electricity sector in the province to allow competitive supply of electricity beginning in 2000. This means that the regulatory limits and voluntary commitments that apply to Ontario Hydro have to be translated into limits for the electricity generation sector if the level of environmental protection is to be maintained. The government has stated its commitment to maintaining or enhancing the environmental protection as part of the electricity restructuring plan. Emissions trading has been recommended as a means of meeting this commitment in an efficient manner.

5.2.1 Emissions Trading Recommended for SO_2, NOx and CO_2

The Advisory Committee on Competition in Ontario's Electricity Sector (the Macdonald Committee) reported that:

> The process of restructuring Ontario's electricity system must be accompanied by consideration of the most appropriate regulations or other instruments to secure the protection of the environment and specifically, to support energy efficiency and the introduction of renewable energy technologies.[80]

The White Paper states that in implementing an electricity market, the Government will ensure that the province's environmental protection record is maintained and improved.

> In particular, the existing limits on emissions of sulphur dioxide, nitrogen oxides, and carbon dioxide will remain in place. Further environmental protection measures that are flexible and cost-effective will be considered in the design of the electricity market. Options to be considered include a nitrogen oxides emissions cap and trading program for all Ontario-based generation, and an emission performance standard for all generators selling power into the Ontario market.[81]

In addition, both the proposed *Electricity Act, 1998* and the proposed *Ontario Energy Board Act, 1998* state their intent "to facilitate energy efficiency and the use of cleaner, more environmentally benign energy sources in a manner consistent with the policies of the Government of Ontario."[82]

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[80] Advisory Committee on Competition in Ontario's Electricity System, 1996, p. 91.

[81] MEST, 1997, p. 20.

[82] Electricity Act, 1998, Section 1(g); Ontario Energy Board Act, 1998, Section 1(6).

The Market Design Committee advising the Minister of Energy, Science and Technology on issues related to restructuring of the electricity industry in Ontario recommended adoption of allowance trading for SO_2, NOx and CO_2 emissions from the electricity sector serving Ontario beginning in 2000.[83]

5.2.2 Existing Emissions Limits are Inadequate for a Restructured Electricity Sector[84]

Existing environmental regulations were written on the assumption that the fossil fuel generation of electricity in Ontario would be produced predominately by Ontario Hydro. Regulation 355 under the *Environmental Protection Act* (Ontario) states that beginning in 1994, Ontario Hydro will not emit more than 175 kilotonnes of sulphur dioxide per year. The same regulation limits the sum of sulphur dioxide and nitrogen oxides emissions to 215 kilotonnes per year.[85] This regulation applies only to the existing Crown Corporation and not to any other electricity generator in the province.

Ontario Hydro has made a voluntary commitment to stabilize its emissions of carbon dioxide at 1990 levels by the year 2000, and to reduce them by 10 per cent by 2005.[86] Ontario Hydro has also made a voluntary commitment to limit net emissions of nitrogen oxides to 38 kilotonnes per year by the year 2000. These commitments apply only to Ontario Hydro and do not include emissions from any other electricity generators in the province.

Existing regulations that pertain only to Ontario Hydro no longer will be adequate in the newly competitive electricity market. The White Paper states that existing limits on emissions of sulphur dioxide, nitrogen oxides, and carbon dioxide from electricity generation will remain in place. The Market Design Committee believes that a market-based instrument, such as an emissions cap and trade system, would achieve this goal at the least cost.

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[83] Market Design Committee**,** 1998, Chapter 5, Environmental Protection, Recommendation 5.1.

[84] This section is drawn from the Market Design Committee**,** 1998, Chapter 5, Environmental Protection.

[85] Ontario Hydro, R.R.O 1990, Reg. 355.

[86] "Management Strategy for Greenhouse Gas Emissions," 16 January, 1995, recommendation by J.R. Burpee, General Manager, Fossil, submitted to the Board of Directors by the President and the Chairman, approved by the Board of Directors of Ontario Hydro in January 1995.

The Market Design Committee identifies a number of issues that need to be addressed if an emissions trading system is to be implemented in the competitive electricity market These are:

- Emissions monitoring and verification. It notes that almost all major fossil fuel generation facilities in Ontario have implemented either continuous emission monitoring systems (CEMs) or flue-gas monitoring systems and that the Independent Electricity Market Operator (IMO) will record how much each generating unit operates in the course of dispatching electricity generation. [87] Thus monitoring and verification processes already will be in place in the competitive market.
- Implementation date. Emissions trading system should be implemented when the competitive electricity market opens in the year 2000. This will create a level playing field from the beginning, and send appropriate investment signals to new entrants, even if emissions limits and regulated pollutants are modified over time.

- Pollutants other than SO_2, NOx and CO_2. If the White Paper's commitment to maintaining the province's environmental record is to be fulfilled, other pollutants, including air toxics and particulate matter, also must be included in the design of the emissions trading system.

- Potential adverse effects on local air quality. Although local and regional regulations provide some protection against local impingement problems, an emissions trading program could lead to higher emissions in some areas because existing sources comply by purchasing credits or allowances and/or new sources locate in the area. In addition, the seasonal impacts of nitrogen oxides and VOCs have to be addressed.

- Market power. Ontario Hydro's successor generating company, Genco, may possess and could exercise market power in the market for emissions allowances as well as the market for electricity. One way to mitigate market power in the market for emissions trading is to include pollutant emitters other than electricity generators in the emissions cap and trade program.

- Emissions due to imported power. A competitive electricity market in Ontario may lead to electricity imports from other provinces and the United States, and

[87] "United States – Canada Air Quality Agreement," Progress Report 1996, pp. 2, 12-13; conversation with Ontario Hydro.

these imports could be generated by units that produce more pollution than those in Ontario and so lead to environmental damage in the Ontario.[88]

5.2.3 Emissions Trading Program Design Issues

It is tempting to try to design an emissions trading system for SO_2, NOx and CO_2 emissions by the electricity sector in Ontario by simply transferring Ontario Hydro's regulated and voluntary commitments relating to these pollutants to the generators operating in the province. As the Market Design Committee recognizes, that does not ensure that the current level of environmental protection will be maintained.

Electricity can be traded over a large area and purchases from sources outside the province can aggravate environmental and health problems in Ontario. Industries, distribution utilities, and electricity retailers will be buying electricity from a variety of suppliers in and outside Ontario. Purchases from outside the province will help local generators meet the caps imposed on their emissions. But supplies from sources in Ohio and Indiana could lead to higher deposition of emissions in Ontario while purchases from sources in Quebec and Manitoba could reduce deposition of emissions in Ontario.

Thus environmental conditions in Ontario will be affected by electricity purchases from outside the province. It is very difficult to regulate electricity purchases based on the environmental performance of the source. Even if such restrictions are imposed, it may simply shift the pattern of sales rather than the sources used to generate the electricity. In any event, imposing emissions caps on electricity generators in Ontario will not be sufficient to protect the environment in the province.

Electricity generators are only one source category for NOx, SO_2 and CO_2 emissions. They are a relatively large contributor to total SO_2 emissions in the province, but account for only a relatively small share of total NOx and CO_2 emissions. Efficiency argues for including as many of

[88] The Market Design Committee notes the difficulty of determining which power plant is actually responsible for producing imported electricity given the complex transmission network and the portfolio of generation stations that may be owned by or available to an exporter. A company with both clean and dirty units could report that the electricity being sent to Ontario was generated by the clean unit while at the same time increasing its generation from the dirty unit to provide the excess power. This difficulty must be resolved before attempting to control the emissions associated with imported power. The same issue occurs with respect to consumers looking to purchase green power from imported power.

the sources of each pollutant in the trading program. Efficiency also argues for including as large a geographic area as possible, consistent with the scale of the environmental impacts, in the trading program.

Those considerations suggest a separate trading program for each of the major pollutants. In the case of NOx the trading program should attempt to include a wide range of sources within the province and to link to the trading programs currently being implemented in adjacent regions of the United States. A cap and trade program may not be well suited to all NOx sources. Motor vehicles, lawnmowers, and outboard motors could be included by allowing credits created from such sources to be used for compliance by the electricity generators.

The SO_2 trading program should include major industrial sources in the province as well as the electricity generators. It could also be linked to the American program for SO_2 emissions by electric utilities. The only existing trading programs for CO_2 emissions are pilot programs that involve credit trading. Ontario's PERT program was the pioneer among these pilot programs. Trading for greenhouse gases is likely to develop on a global scale. The trading program developed for CO_2 emissions by electricity generators in Ontario should allow easy integration into future national and global trading programs.

Assuming one or more trading programs are developed for NOx, SO_2 and CO_2 emissions by electricity generators and other sources of these pollutants in Ontario, many design issued remain to be resolved. These include: the sources required to participate in the cap and trade program(s), method for allocating allowances to participants, allocations to new sources and those that cease to operate, establishment and operation of a registry, determining monitoring and reporting requirements, decisions on liability, banking, allowance life, compliance period, penalties for non-compliance, price disclosure, etc.

If the design of one or more of the programs involves credit trading, either as the basic design or as a compliance option for participants in the cap and trade program, the design issues that need to be addressed include: eligible sources of emissions reductions, units of measurement, credit eligibility criteria, computation of the emissions reduction credit, baseline determination, credit life, eligibility of credits for shutdown, critical dates for generating credits, user liability, eligible credit uses, trading zone and inter-jurisdictional trading, trading ratios, ozone season, credit banking, notices, protocols for creation and use, monitoring, documentation requirements, reporting requirements of activity, prices and confidentiality of proprietary information.

In summary, designing emissions trading program(s) for NOx, SO_2 and CO_2 emissions by electricity generators in Ontario,

or for all sources that contribute to the environmental problems caused by these pollutants in Ontario, will be challenging because:

- The geographic scope of the environmental problem is different for each pollutant; local for particulate matter, regional for NOx and SO_2, and global for CO_2.
- The range of sources and the contribution of the electricity sector differs for each pollutant; the electricity sector is a relatively small contributor to total emissions of all of the pollutants except SO_2.
- Incorporating a wider range of sources into each trading program increases efficiency by expanding the range of emissions control options and the range of control costs.
- Regulatory jurisdiction over emissions that affect Ontario is divided among numerous states, provinces and the federal governments in Canada and the United States so coordinated regulation may be very difficult.
- Emissions of NOx, SO_2, particulate, and air toxics by many sources are already regulated in some of the jurisdictions that affect Ontario; some existing and prospective regulations allow emissions trading.
- Market power in the market for electricity or the market for allowances or credits may be a problem for emissions trading programs focused on the electricity sector.
- The relationships to Green Power and to tradable renewables standards need to be addressed.[89]

These considerations suggest that a closed allowance trading system for NOx, SO_2 and CO_2 emitted by electricity generators in Ontario may not be the most appropriate design. Including more sources, in either an open or closed system, helps address the market power concern, incorporates more of the contributors to the respective environmental problems, and improves efficiency by increasing the range of emissions control options.

5.3 Limiting Greenhouse Gas Emissions

[89] Technologies that generate green power or meet a renewables standard also help meet emissions caps for NOx, SO_2, CO_2, particulate, and air toxics. Procedures must then be implemented to ensure that the same power is not sold at a premium as Green Power, counted toward a renewables standard and contributes to meeting emissions limits.

The Kyoto Protocol establishes emissions limitation or reduction commitments for 38 wealthier countries, including Canada.[90] The emissions limitation or reduction commitments apply to each Party's aggregate emissions of six greenhouse gases during the period 2008-2012, calculated as an average over these five years.

The six greenhouse gases covered by the commitments are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). will be measured from their 1990 levels.[91] The commitments cover emissions of those six gases due to energy production and transportation, fuel combustion, industrial processes, solvent and other product use, agriculture, and waste disposal.

Commitments are established relative to baseline emissions. A Party's baseline emissions for are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_20) are its 1990 emissions of those gases.[92] In the case of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) a Party may choose either its 1990 or its 1995 emissions as the baseline.

A Party's commitment is expressed as a fraction of its baseline emissions. Canada's commitment is to limit its average annual emissions during the period 2008 through 2012 to 94% of its baseline emissions.

A Party's aggregate emissions allowed for the 2008-2012 commitment period are its initial "assigned amount". The Kyoto Protocol includes three mechanisms that enable a Party to increase its initial assigned amount. These mechanisms are:

- Emissions trading between Annex I Parties (Article 17). One Annex I Party may transfer part of its assigned amount to another Annex I Party in return for financial or other considerations.

- Joint implementation between Annex I Parties (Article 6). The government of, or an entity from, one Annex I Party may provide financial, technical or other assistance to projects to reduce greenhouse gas emissions or enhance sinks in another Annex I

[90] Annex B to the Protocol lists the commitments of 39 Parties consisting of 38 countries plus the European Community (each of its member countries is also included separately) so they are often called Annex B Parties. But the text of the Protocol refers to Annex I Parties, referring to the Parties listed in Annex I of the Framework Convention on Climate Change. Annex I has been amended to be identical to Annex B except that Annex I includes Turkey, which has asked to be removed from Annex I and has not ratified the Convention pending a decision on this issue. This report will use the term Annex I Parties (or countries) to be consistent with the text of the Protocol.

[91] The gases differ significantly in terms of their impacts on the climate system. Emissions of the different gases are converted to CO_2 equivalent tonnes using internationally agreed global warming potential (GWP) values. These values range from 1 for CO_2 to 23,900 for SF_6 over a 100 year time horizon.

[92] The former centrally-planned economies may, with the approval of the Conference of the Parties, choose a base year earlier than 1990.

Party. The emission reductions achieved by such projects may be shared by the Parties involved.

- The clean development mechanism (Article 12). Projects to reduce greenhouse gas emissions (and possibly, to enhance sinks) can be implemented in developing countries. The emission reductions from such projects can be used by Annex I Parties to meet their commitments.

The rules for these mechanisms remain to be finalized. Assuming that the rules allow the mechanisms to function reasonably efficiently, the mechanisms will allow emissions trading for greenhouse gases on a global scale.

Canada will need to implement policies domestically to meet its commitment. In April 1998, federal, provincial and territorial Energy and Environment Ministers approved a process to engage governments and stakeholders to examine the impact, the cost and the benefits of implementation, and management of the Protocol. Ministers approved the creation of a national climate change secretariat to support the development of a national implementation strategy.

The necessary analysis will be undertaken by Issue Tables, which include representatives of the federal, provincial and territorial governments and stakeholders. Ministers agreed to the creation of the following eight Issue Tables initially:

- analysis and modelling
- transportation
- electricity
- kyoto mechanisms
- technology
- sinks
- credit for early action
- public education and outreach.

Subsequently, another seven Issue Tables have been established, including:

- agriculture and agri-food
- forest sector
- buildings
- industry
- enhanced voluntary action
- municipalities
- science and adaptation

Various forms of emissions trading are being evaluated as potential elements of the domestic implementation strategy. The National Round Table on the Environment and the Economy is also evaluating alternative designs for domestic emissions trading for greenhouse gases.[93]

[93] See section 3.3.5 for a description of this work.

If national policies are adopted for different categories of sources, Ontario could support emissions trading as a preferred option, where feasible, to meet Canada's emissions limitation commitment at the lowest cost. If Ontario is responsible for regulating emissions from some or all of the sources in the province, it could consider emissions trading where feasible.[94]

Regardless of whether emissions trading for greenhouse gases is implemented on a national or provincial scale, it is desirable to include as wide a range of sources and gases as possible to maximize the economic benefits. A national or provincial trading program should also provide easy links to the international mechanisms established by the Kyoto Protocol to minimize the costs of meeting the target.

[94] It is possible that the national commitment could be translated into a series of provincial and territorial commitments. Then Ontario could consider emissions trading for sources in the province. A more likely possibility is that the province is responsible for regulating emissions from some categories of industrial sources located only in Ontario.

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Appendix A

A Numerical Example of Emissions Trading

A Numerical Example of Emissions Trading

The potential for cost saving is illustrated by the example in Table A-1 involving two companies with different costs of emissions control. The regulator imposes a 10% emissions reduction obligation on each firm. If trading is not allowed, each company must implement the reduction internally and the total cost is $60,000. If trading is allowed, the company with low cost emissions control options (Company 1) implements a larger reduction and the company with high cost control options (Company 2) implements a smaller reduction.

Since Company 1 implements a larger emission reduction than necessary for its own compliance, it has surplus allowances or credits. To achieve compliance Company 2 implements some emission reduction measures internally and purchases surplus allowances from Company 1. The total cost of compliance is reduced to $45,000 from $60,000 and each firm shares in the financial benefits of trading.

Table A-1

Numerical Example of Emissions Trading

	Company 1	Company 2	Total
Current emissions	50,000 t	100,000 t	150,000 t
Emission limits	45,000 t	90,000 t	135,000 t
Emission reduction	5,000 t	10,000 t	15,000 t
Cost per ton reduced	$2,000/t	$5,000/t	
Compliance cost without trading	$10,000	$50,000	$60,000
With Emissions Trading			
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
Surplus allowances	5,000 t	-5,000 t	
Allowances purchased (sold)	(5,000 t)	5,000 t	
Assumed price per allowance	$3,500/t	$3,500/t	
Revenue from sale of allowances	$17,500		
Cost of purchasing allowances		$17,500	
Compliance cost with trading	$20,000 -$17,500 $2,500	$25,000 +$17,500 $42,500	$45,000
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%