CANADA'S GREEN PLAN

ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION

Discussion paper

Government of Canada
Gouvernement du Canada

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Foreword

The Government of Canada believes that good environmental policy is good economic policy, that a healthy environment and a prosperous economy are compatible and reinforcing goals. Indeed, this is the essence of sustainable development.

We are pleased to release this discussion paper on *Economic Instruments for Environmental Protection* as part of the Government's strategy and action plan for achieving sustainable development set out in *Canada's Green Plan for a Healthy Environment.*

A fundamental principle of the *Green Plan* is that the environment must become integral to the decisions we all make – governments, businesses, and individual Canadians. The *Green Plan* commits Canada to strong and effective environmental regulations to ensure environmentally sound decisions. It also recognizes that market incentives can be an effective alternative or complement to our traditional approach to regulation. As with traditional regulations, governments, in consultation with Canadians, would establish environmental targets and ensure that they are attained. With market incentives, however, decision-makers would be allowed more flexibility in the measures they take to meet our environmental goals. This would be an incentive to creativity in finding innovative and cost-effective means of meeting our targets, with continual economic incentive to develop and implement "cleaner" technology and processes.

The Government's goal is the balanced use of regulations and market-based approaches for environmental protection. Canada has had little experience in the use of market instruments to achieve our environmental objectives. Different market instruments are best suited to different environmental problems. In addition, these instruments differ in their complexity to design and implement, and in their potential economic and regional impacts. Some instruments must be evaluated in an international context. The Government will address these practical considerations in consultation with stakeholders.

This discussion paper is our first step. It seeks to inform stakeholders of practical design and implementation considerations surrounding the use of economic instruments, and possible options for addressing them. It also provides a starting point for our second step – consultations with Canadians on these issues.

Our next steps will be guided by the outcome of the consultations. The consultations will identify the most promising applications and pilot projects. Some instruments will need to be examined in more depth. For example, those which are complex to design and implement, and those which have significant economic and regional implications.

Every day, the world is becoming more economically interdependent. At the same time, governments and citizens worldwide are attaching a great deal of importance to a healthy environment. Harnessing the power of the market can help us achieve high levels of environmental quality, and also create business opportunities, and help build a sound and prosperous Canadian economy. With the release of this discussion paper we begin a process of examining how market incentives can work for environmental purposes in Canada.

Jean Charest
Minister of the Environment

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Executive Summary

1. Introduction

A key message in the federal government's *Green Plan* is that economic growth and preservation of a healthy environment are fully compatible and reinforcing goals. In the preface to the *Green Plan*, the Prime Minister stated, "The challenge we now face is to build upon our economic strengths in harmony with our environment, the basis of our health and prosperity. . . . The *Green Plan* will help Canada be a country which is both economically prosperous and environmentally healthy."

The *Green Plan* diagnoses the root cause of today's environmental problems as a general failure of all sectors of society – individuals, organizations, businesses and governments – to take into consideration, as a matter of course, the impact of their decisions on the environment. Thus in order to achieve sustainable development, the first step must be for Canadians, individually and collectively, to build the environment into their choices and their decision-making.

An essential base for environmentally sensitive decision-making is a population well-informed about environmental realities in general, and about the environmental impacts of their actions in particular. This requires, in turn, a sound and constantly updated base of scientific knowledge and the educational and information systems needed to disseminate its findings. The *Green Plan* introduces a number of initiatives to support scientific research and promote environmental education and information.

The *Green Plan* also addresses means for translating environmental awareness into environmental action. It recognizes that, while better environmental science, education and information are necessary for enhancing environmentally responsible decisions, they are not sufficient. More direct measures are also required, specifically regulations and economic instruments.

There has been a strong tradition in Canada of using regulations to achieve our environmental goals, and the *Green Plan* recognizes that they continue to have an important role to play. But the *Green Plan* also recognizes that there can be significant advantages to harnessing market forces to attain our environmental objectives. The *Green Plan* therefore established as Canada's goal the balanced use of strong and effective environmental laws with market-based approaches to address environmental problems.

The basic difference between regulations and economic instruments is that the former directly prescribe behaviour; they "command" polluters to "control" specific activities. Economic instruments, by contrast, use market signals to influence behaviour in a manner which is consistent with environmental goals; they focus on environmental results rather than methods. In both cases, governments intervene to integrate environmental considerations into the decision-making process. However, economic instruments leave specific, detailed decisions about how to achieve an environmental objective to the decision-maker.

The flexibility allowed to decision-makers on how to achieve an environmental objective is an important advantage of market-based economic instruments over the traditional regulatory approach. For example, because firms can decide on the methods they use, provided they meet the goals and targets established by governments, the market-based approach is favourable to the development of innovative and cost-effective solutions. The U.S. experience with market-based economic instruments, in particular with tradeable permits, indicates that potential cost savings can be considerable, in the order of hundreds of millions of dollars. Another key advantage of economic instruments is that they provide a continuing rather than a temporary incentive for firms to cut back pollution and to develop and use new technology and processes to control pollution. By virtue of these advantages, economic instruments can help achieve high levels of environmental quality while at the same time creating domestic and international business opportunities.

Canada's international competitors also recognize the advantages of economic instruments. Some are in the process of examining or implementing them. Canada faces large and complex environmental challenges, and we may face difficult choices in resolving them. We also need to remain competitive in global markets. It is crucial to success on both fronts that Canada explore every avenue for new, cost-effective and innovative solutions.

In doing so, it must be realized that Canada has had little direct experience with economic instruments and the complexities of their design and use. There are a host of practical considerations to be weighed in assessing the merits of putting these instruments to use in Canada. To begin with, there is a wide range of tools to choose from, and some are better suited to one environmental goal than another. Moreover, each type of instrument and each application raises practical design and implementation issues, some more complex than others, and some that involve significant economic and distributional impacts.

In short, before we launch into the use of economic instruments in Canada, we need to carefully examine the design and implementation issues associated with their use.

This discussion paper is a first step in that process. It explores ways in which economic instruments might be used to attain the goals set out in the *Green Plan*. It links this part of the discussion to certain specific and topical issues: global warming, acid rain, ground-level ozone, water quality and use, waste management, and stratospheric ozone depletion. The purpose of the discussion paper is to stimulate further debate and research into practical issues of design and implementation, and to identify points of focus for further work. Its purpose is also to serve as a basis for consultations with Canadians on the practical application of economic instruments to environmental problems in Canada.

This paper covers three main areas: the rationale for economic instruments; the criteria for assessing and designing economic instruments; and examples of the potential application of specific economic instruments to address specific environmental issues.

The types of economic instruments explored in this paper include environmental charges, tradeable emission rights, user charges, and deposit-refund schemes. In order for these economic instruments to use markets effectively as the basis for sending "green" signals, the markets themselves should be working as efficiently as possible. Certain measures can be taken to improve the efficiency of markets and the clarity of market signals, including education and information for the general public, regulatory and institutional changes, and the removal of subsidies. While measures of this kind are not addressed in depth in this paper, their importance is recognized in the *Green Plan*, which introduces a number of initiatives to promote environmental education and information, and there may be potential for additional measures. Removal of subsidies is being examined in the context of the *Green Plan* initiative to review the environmental implications of existing statutes, programs, regulations and policies.

Certain areas are outside the scope of the discussion in this paper. The paper focuses on pollution and other unintended effects of economic activity. It therefore does not address the issue of appropriate pricing of natural resources, or the related issue of appropriate pricing of electricity. These are issues of great importance and relevance, however, and important areas for further research. The direct use, commercial or otherwise, of our natural resource base is an environmental concern, and it can be influenced by economic instruments. Improvement of markets and establishment of more clearly defined property rights may be good for the environment, where common access leads to overuse of natural resources. Resource prices are themselves economic instruments that can play a critical part in encouraging efficient and environmentally responsible management of natural resources. Possible adjustments to resource prices have to be examined under the wider heading of public policies which may inadvertently discourage users from acting in ways consistent with sound economic and environmental values.

This discussion paper also does not address the question of which order of government has jurisdiction to implement specific instruments in specific applications. Nor does it focus solely on those instruments over which the Government of Canada has jurisdiction, but instead examines a "tool kit" of economic instruments that are available to the different orders of government to achieve environmental objectives. In practice, some of the applications examined in the paper would most appropriately be implemented at the local level by municipal governments or First Nations. Others would more appropriately be introduced by the federal or provincial governments. Still others may require interjurisdictional cooperation and be implemented jointly by the federal and provincial governments.

2. *Rationale for Economic Instruments*

Economic instruments use market forces to integrate economic and environmental decision-making. These instruments can provide the price and other market signals that help decision-makers to recognize the environmental implications of their choices. For example, some economic instruments directly affect the prices facing producers or consumers. Other economic instruments create a market and a price for access to environmental resources.

Economic theory suggests that if it were possible to place a monetary value on environmental damage caused by pollution, then it would be possible to establish an environmental charge equal to the cost of damage, to serve as a disincentive to harmful behaviour. The resulting level of pollution would be the theoretical "optimal" level.

Attractive in theory as it may appear, there are so many obstacles to the implementation of such an approach as to make it virtually unfeasible. A simpler and more manageable approach is to make the compass point the cost of achieving a predetermined and tangible environmental goal. This is the approach taken in this paper – it examines the potential for economic instruments to achieve environmental targets set by society. In examining that potential, the costs and benefits of using an economic instrument are assessed relative to alternative regulatory approaches that would achieve the same level of environmental protection.

Principal Types of Economic Instruments

The paper distinguishes between two broad categories of economic instruments that may be used for environmental goals – non-tax instruments and tax instruments.

Non-Tax Instruments

This paper examines three principal types of non-tax instruments: tradeable permits, user charges and deposit-refund systems.

Tradeable permits

In this approach the responsible regulatory authority sets a ceiling on total allowable emissions of a pollutant. It then allocates the allowable emissions total among the sources of the pollutant. It does this by issuing permits which authorize plants or other sources to emit a specified amount of the pollutant over a specified period of time. Permits are allowed to be bought and sold.

User charges

These are charges which can be imposed on users of services that have an impact on the environment, and which are structured to reflect the full cost of supplying the service. Examples of such services include water supply and wastewater treatment, and solid waste collection and disposal.

Deposit-refund schemes
These economic instruments can be used for products which can be reused or recycled and/or which create environmental problems if not disposed of in an acceptable manner. Under a deposit-refund scheme, a charge is imposed on the sale of such products. The charge, in full, or in part, is refunded when the product is returned to a collection system.

Tax instruments
This paper also examines three principal tax instruments: environmental charges, tax incentives, and a combination of environmental charges and tax incentives.

Environmental charges
Environmental charges are designed to modify behaviour by imposing a charge on particular activities or sources of an environmental problem. They can be applied to pollution emissions, inputs to a production process, or final products.

Tax incentives
Tax incentives are designed to modify behaviour by encouraging particular types of activities.

Combined environmental charges and tax incentives
This instrument combines elements of a carrot-and-stick approach. The intent is to encourage environmentally benign behaviour by offsetting charges with incentives, thus giving policy-makers more flexibility.

Advantages of Economic Instruments
While not necessarily the best solution for every environmental problem, economic instruments have a number of potential advantages over traditional regulations.

The first and most important is cost-effectiveness. Compared with regulations, economic instruments allow a given degree of environmental protection to be achieved at lower cost. This advantage stems from their greater flexibility and particularly from their ability to take account of differences in the costs of pollution clean-up and control faced by different sources of pollution. It is more cost-effective to have the source with the lowest abatement costs go further in cutting back its discharges than other sources, instead of requiring all sources to meet the same pollution standard.

A second advantage is that economic instruments provide a continuing economic incentive for firms to cut back pollution, and therefore to develop and implement new pollution control technologies and processes. This is good not only for the environment, but for Canada's competitiveness and prosperity.

A third advantage is that economic instruments can, in some cases, allow the setting of more ambitious environmental goals, or encourage faster achievement of goals, than is possible through regulation.

A fourth advantage is that economic instruments (tradeable permits in particular) can be used to achieve multiple environmental objectives more easily than would be possible with regulations. This is because the approach is based on a recognition that the company involved, not the regulator, is in the best position to make a judgment as to the least-cost combination of emission reduction options.

A fifth advantage is that economic instruments can, in some cases, be less cumbersome for government and business to administer.

A sixth advantage is that, compared with regulations, certain economic instruments can more easily accommodate entry into and growth within an industry without generating an increase in emissions.

3. Criteria for Assessing/ Designing Economic Instruments

Different economic instruments are appropriate for dealing with different environmental problems. Moreover, while in theory a given economic instrument may be suitable for addressing a particular problem, in practice its success will depend on its being properly designed. Several key criteria need to be applied in determining whether a given economic instrument is suitable for a particular environmental problem, and in deciding on an appropriate design.

The first consideration is effectiveness in achieving its environmental objective. Certain instruments may be unsuitable for certain situations.

The second is the ability of a specific economic instrument, in a given situation, to realize its potential cost advantages.

Other important considerations are the impact on international competitiveness; distributional impacts; transition and adjustment costs; administrative, monitoring and compliance costs; jurisdictional issues; consistency with other government policies; and industry and public acceptability.

4. Non-Tax Instruments

4.1 Tradeable Permits

Tradeable permits are potentially more cost-effective than regulations. They can also better accommodate growth in an industry without a lowering of environmental quality. They can also be used to achieve several environmental objectives simultaneously.

If *all* the potential cost savings of a permits system are to be realized, the permits must trade freely. Experience in the United States has shown that in those trading programs where there have been tight restrictions on trades and procedural requirements, trading has been inhibited, and the realized cost savings have not been as large as they could have been. Moreover, for trading to occur, firms must not seek to gain a competitive advantage by, for example, withholding permits from the market. Generally, the greater the number of sources targeted by a permit system, the greater the likelihood the permits will be actively traded among firms. Even where permits do not trade perfectly freely, however, a tradeable permits system can still result in significant cost savings provided some trading takes place.

It is critical to the success of a trading program – both in meeting its environmental objective and in realizing potential economic benefits – that it be appropriately designed. This section first discusses the key design issues generic to or common in the application of tradeable permits to different environmental problems. Using case studies, it then explores the potential application of tradeable permits systems to specific environmental problems. The case studies focus on those generic design issues which present considerations unique to the environmental problem.

Key Design Issues

A *trading zone* is the geographical area within which sources of a given pollutant would be allowed to buy and sell permits. Ideally, a trading zone would encompass an area throughout which emissions could be traded without exacerbating the environmental problem in any one part of the area. The appropriate trading zones therefore vary by environmental problem. An important objective in defining trading zones is to ensure that each zone contains a sufficient number of emission sources to create an active permit market.

Ideally, from an environmental and economic standpoint, all *sources of pollution* would be included in a given trading program. Frequently, however, it would be administratively costly and impractical to include directly many small sources. It would be more cost-effective to include the large, easily identifiable sources in the trading program, while applying other measures, such as regulatory standards or other economic instruments, to the smaller sources. Alternatively, it may be possible to include small sources indirectly through a "choke point" in a distribution system, where the fewer number of sources could make trading more practical.

There are two main options for the *initial distribution of permits* among the sources of pollution included in the program. One is to allocate the permits to existing emission sources based on emissions in some historical period. The other option is to hold an auction, in effect leaving the distribution of permits to the market. From the standpoint of realizing the potential economic benefits of a trading program, there is little to choose between the two options. The main difference is in their distributional impact. Essentially, under an auction scheme, the government would capture the economic gains that would otherwise be captured by firms. As a result, firms would bear more of a financial burden. Allocation by auction would also involve more uncertainty for the emission sources. There are several possible ways to address these issues in the design and implementation of a permit system.

As in the case of regulation, a trading program would require that emissions be *monitored.* It would also require that firms report any trades. Appropriate penalties would need to be established ansd enforced for sources that emit more emissions than allowed by the permits they hold.

As noted above, for the potential cost savings of an emissions trading program to be fully realized, it is important that a *well-functioning market* for permits develop. Appropriate design of a trading program would help to overcome any barriers to trading. For example, trading could be facilitated while ensuring the integrity of the system by requiring companies to report trades (with appropriate monitoring) after the fact, rather than to require prior approval for trades. Measures could also be introduced to help potential buyers and sellers of permits find each other, and to discourage firms from hoarding permits.

Other questions of design include whether to allow firms to carry over unused permits from one period and apply them to emissions in a later period (banking); whether to allow trading between emissions of different pollutants in cases where more than one pollutant is responsible for an environmental problem; and how to take account of seasonal and periodic variations in pollution.

Potential Applications

Application to acid rain

Under Canada's Acid Rain Control Program, the federal government and the seven provinces east of Saskatchewan agreed to reduce total eastern Canadian emissions of sulphur dioxide (SO_2) to 2.3 million tonnes per year by 1994. They also agreed to a series of limits to provincial emissions to achieve this objective. Canada has pledged to extend the cap on SO_2 emissions by the seven easternmost provinces from 1994 to the year 2000, and to establish a permanent national emissions cap of 3.2 million tonnes of SO_2 by the year 2000.

Tradeable permits appear well-suited to the problem of controlling SO_2 emissions, since an overall emissions cap has already been established. The existing control program has some of the characteristics of a tradeable permits system in that it gives firms some flexibility on how to meet emissions limits. Ontario Hydro, for example, is free to "trade" emissions between its various electricity generating stations, so long as its total emissions do not exceed the authorized level. A formal permit trading program would allow emissions "trading" within companies as is currently permitted Ontario Hydro, and it would also allow trading between companies, thereby increasing the potential cost savings.

A single trading zone would not be desirable from an environmental point of view. Three zones might be appropriate, comprising respectively the Atlantic provinces, Ontario and Quebec, and the Western provinces (including Manitoba). Zones defined in this way would probably not unduly distort the environmental effectiveness of the system, and would be convenient for administrative purposes.

A potential difficulty associated with the trading program approach is that a large part of Canada's total SO_2 emissions comes from a small number of companies: six corporations included in the Acid Rain Control Program for eastern Canada account for approximately half of all Canadian emissions of SO_2. While a national program would also include major Western sources, and although some smaller sources might be included, there could still be a problem of a relatively small number of sources in each trading zone. The problem could be at least partially offset by allowing some trading between zones. Allowing interpollutant trading between SO_2 and nitrogen oxides (NO_x) – which also contribute to acid rain – could potentially expand the market for permits. The appropriateness of allowing trading between SO_2 and NO_x from an environmental perspective would need to be examined carefully. Similarly, given the transboundary nature of acid rain, trading between Canadian and American sources could potentially be allowed. Allowing trading among Canadian and U.S. sources could not only expand the market for permits and thereby increase potential cost savings, but could make for a more effective response to the acid rain problem.

Application to ground-level ozone (smog)

Ground-level ozone, a major component of smog, is caused by the reaction between emissions of NO_x and volatile organic compounds (VOCs). Canada's target concentration level for ground-level ozone is no more than 82 parts per billion (per hour).

The Canadian Council of Ministers of the Environment (CCME) in November 1990 released a management plan to contain ground-level ozone in areas where the target has already been met, and to reduce it in three major problem areas (the Lower Fraser Valley of British Columbia, the Windsor-Quebec City corridor, and the Southern Atlantic region). The Plan includes possible initiatives to control NO_x and VOC emissions. While these consist mostly of regulatory measures, the Plan provides for the substitution of "environmentally equivalent" measures (for example emissions trading) which could offer advantages in terms of cost-effectiveness.

Regional NO_x and VOC trading programs could be considered for each of the three problem areas. In order to achieve the 82 parts per billion target throughout each area, it may be necessary to have two or more trading zones within each area. Preliminary analysis indicates that, in the case of NO_x emissions in the Lower Fraser Valley and the Southern Atlantic areas, this could lead to an insufficient number of sources in each trading zone to promote trading. In the case of VOCs, there may be similarly limited scope for more than one trading zone within each problem area. It might be possible, however, to include large stationary solvent sources of VOC emissions; this could add enough sources to allow for more than one trading zone.

Ground-level ozone is a problem which occurs almost entirely in the summer months. Moreover, during these months weather conditions can create episodes of high ozone build-up. There are a number of options for designing trading programs to prevent increased summer-month emissions from occurring as a result of the program. Restrictions on carry-overs of permits into summer months might be necessary. Supplementary controls could also be introduced to address episodic problems.

Allowing interpollutant trading between NO_x and VOC sources would be desirable both economically and environmentally. However, we would need a better understanding of NO_x and VOC emissions and their relation to ozone formation before interpollutant trading could be considered. Consideration could also be given to allowing trading between Canadian and U.S. sources.

Some sources of VOC and NO_x emissions do not lend themselves to inclusion in regional trading programs, but could fit well into a national program. It might be possible, for example, to implement a national trading program for emissions from transportation sources. This program would apply to car manufacturers and would entail first setting emissions standards on a fleet average basis. Trading would then be allowed between manufacturers according to their fleet average performance compared to the standard. The program could also be integrated with a complementary system targeted at fuel suppliers.

A national trading program, for example, may be an efficient way to control VOC emissions from small users of solvents. Such a program would set a limit on the total amount of solvent available for use throughout Canada. The program would apply to producers and importers of solvents, as well as to importers of products that contain solvents. Exports would be exempted. A number of administrative issues would need to be examined in determining the feasibility of this program. They include the question of what to do about solvent uses which do not contribute to VOC emissions, and about emissions already controlled through other means. Despite these complications, a trading program might be administratively less cumbersome than controlling VOC emissions from small sources of solvents through regulations.

Application to global warming

Tradeable permits could help Canada reach its goal of stabilizing CO_2 and other greenhouse gas emissions at 1990 levels by the year 2000. Ideally, from both the environmental and the economic perspective, all greenhouse gases should be included in a trading program. However, the lack of reliable data on emissions of gases other than CO_2 suggests that the only feasible tradeable permit program at this time would be one covering CO_2.

Environmental and economic considerations alike suggest that a greenhouse gas-trading system in Canada should be national rather than regional or provincial in scope. Administrative considerations may require that a trading program based on CO_2 emissions be limited to large energy users in the industrial and power generation sectors. A separate program, based on fuel efficiency, could be introduced for the transportation sector.

A more practical alternative to this direct targeting of emissions might be to allocate permits for carbon in fuels. Such a system could capture virtually all CO_2 emissions from fuel combustion. In this approach, firms would be required to obtain permits, denominated in tonnes of carbon or CO_2, in order to sell fossil fuels into the domestic market. The number of permits required to sell a unit of a given fuel would depend on the carbon content of the fuel.

While a trading system for greenhouse gases other than CO_2 may not be feasible at this stage, it might be possible to allow a firm to receive a credit in terms of CO_2 emissions for a reduction in emissions of another greenhouse gas, such as methane. Another design consideration is whether to allow credits for carbon-sink enhancement, for example through tree-planting.

If a tradeable permit system for CO_2 emissions were introduced in Canada, one issue would be whether to allow inter-country trading. To do so would be consistent with the principle of dealing with a global problem at a global level. A possible first step would be to enter into a permit trading system with the U.S., and perhaps Mexico. More generally, tradeable permits could play a role internationally in helping to address the problem of global warming cost-effectively. Should the international community agree to a framework convention on climate change, the agreement would have to make explicit accommodation for a trading system in order for trading to be feasible. If it did not, trading could lead to an individual country not strictly meeting its emission target. Trading could be incorporated formally or informally in the convention. International permit trading could also be possible without a convention. And technology transfer could be the basis for a less formal type of trading arrangement between developed and developing countries.

Application to water quality

Regulations are the most appropriate instrument for controlling discharges of persistent toxic substances into water. However, trading of effluents (discharges into water) could be used to phase out the discharge of these substances in moving towards their virtual elimination.

Effluent trading could be an efficient way to bring the level of non-persistent substances which can be assimilated by a water body into line with target ambient water quality standards. Effluent trading schemes could be used to prevent water quality problems from arising in water bodies. They could also be used to clean up "hot spots" – areas which do not meet ambient water quality standards – and prevent problems from recurring in those areas.

Non-persistent pollutants discharged into water can be combined into three basic categories: toxic substances, nutrients and sediments. All three categories should be subject to separate trading programs because their environmental impacts are different. An effluent trading program could focus on one critical pollutant in each category, or, where appropriate, several pollutants could be grouped together and treated as a composite.

Some discharge sources, such as municipal sewage treatment plants and industrial plants built at the edge of the water, are easily identifiable and could relatively easily be included in an effluent trading program. Plants in the area that emit toxic air pollutants entering the watershed in the form of precipitation ideally should also be included. Pollutants and sediments from diverse sources entering water bodies through run-off would be very difficult to include directly in a trading program. They might be included indirectly by allowing sources included in the program to earn credits for reducing discharges through run-off.

Other questions include how to take account of seasonal variations in pollution, and how to structure trading between riverside sources whose discharges have different environmental impacts.

Application to stratospheric ozone

Tradeable permits could play a role in helping to meet Canada's commitment to phase out chlorofluorocarbons (CFCs – the most common ozone-depleting chemical) by the end of 1995.

The existing legislation goes a long way toward establishing the parameters for a trading program. It sets out a schedule of the maximum allowable quantity of total CFCs that each producer and importer can produce or import in each year. (The five most damaging CFCs are subject to the schedule.) In addition, each producer is allowed to substitute production at any of its facilities, effectively allowing trading within firms. In effect, trading between firms is also possible, as the Minister of the Environment may allocate any unused allocations from one firm to another. The legislation in effect also allows, within firms, trading between the five types of CFCs subject to the legislation.

A tradeable permits system would require that each producer and importer be issued permits according to their allocations. The permit holders would be free to trade unused portions of their permits without ministerial approval. Monitoring and enforcement requirements would essentially be the same as in the current system, except that permit holders would also be required to report any trades.

Since the existing program already incorporates many of the features of a trading system, there is probably little difference in terms of cost-effectiveness between it and one that would incorporate tradeable permits.

4.2 User Charges

User charges are payments for the use of collective goods and services and should reflect the full cost of the resources used in providing the service. The charge should be directly related to the amount of the service consumed, thereby giving consumers an incentive not to "overuse" a service.

Potential Applications

Application to municipal water services

Municipal water rates generally cover the operating costs of providing water services but not the infrastructure costs and not the cost of system upgrading and expansion. Moreover, a significant majority of municipal rate schedules either provide no incentive or a declining incentive for conservation of water. This has led to higher levels of water consumption than would otherwise be the case. As a result, Canadian municipalities have incurred larger expenditures on distribution as well as water and wastewater treatment facilities than is economically efficient. Moreover, the revenue shortfall resulting from consumers paying less than the full cost of water services can discourage municipalities from undertaking investments in facilities to treat wastewater.

Under a user-pay system, the price per unit of water would be based on the full incremental cost of providing water services. This would include the capital cost of expanding or replacing the existing system, operating costs, and, perhaps, a component reflecting the scarcity value of the water itself. Different classes of users could pay different user charges. The charge for industrial users, for example, could reflect the fact that the unit costs of delivering water to these users may be lower than they are for households. On the other hand, industrial users could pay a higher charge than households if their wastes are more expensive to treat than household wastes.

The most significant difficulty is that as much as 50 per cent of the water use in many of the larger cities in Canada is not individually metered. For unmetered users, an increase in the unit price of water would not affect consumption as they could only marginally reduce their own water bill by individually cutting back on use. Overcoming this problem would require the installation of individual metering systems, in some cases at a substantial cost.

Application to municipal solid waste

In an economic sense the disposal of solid waste is generally not efficiently managed in Canada. Many municipalities do not recover the full cost of collecting and disposing of household waste through waste charges, but subsidize the cost of waste management from general tax revenues. Even where the full cost of garbage collection and disposal is recovered through an explicit waste charge, there is no direct relation between the volume of waste generated by an individual consumer and the cost of waste disposal to that consumer. There is therefore little financial incentive for each consumer to reduce the amount of waste he or she generates. Moreover, some municipal landfill sites in Canada allow private haulers to dispose of trucked-in wastes for free, or at fees so low that they fall far short of reflecting the full costs of landfilling solid waste. This practice provides little incentive for reduction, reuse or recycling.

This has led to more solid waste being generated and landfilled than is economically efficient. Moreover, the revenue shortfall resulting from consumers paying less than the full cost of waste management services can limit the ability of municipalities to undertake the investments necessary to dispose of waste in an environmentally sound manner.

Under a user-pay system, consumers would bear the full cost of collecting and disposing of the solid waste they generate. Private sector haulers would pay landfill "tipping" (unloading) fees that reflect the full costs of landfilling. And, as far as possible, the charges would reflect additional costs for the disposal of wastes that are relatively more difficult to manage. This approach would provide an economic incentive to households and commercial/industrial generators to reduce the amount of solid waste that is disposed of in municipal landfill sites. It would also make recycling or reuse more economically attractive, thereby further reducing waste.

A full-cost tipping fee for private haulers would be relatively easy to implement. It could, for example, be based on the weight or volume of the load. A user charge for households could be structured in several ways. It could, for example, be based on weight, or alternatively volume of waste generated. Consumers could be required to purchase a special bag, or stickers for a specified size of container.

A potential problem associated with the application of user charges is the possibility of illegal dumping, increased littering and backyard burning. Experience in the U.S., however, suggests that these problems are generally manageable.

4.3 Deposit-Refund Systems

Deposit-refund systems can be appropriate for products that can be reused or recycled and/or which create environmental problems if not disposed of in an acceptable manner. Under deposit-refund schemes, the authority imposes a charge on the products at the point of sale. The charge is refunded, or partly refunded, if the product is returned to a collection depot.

Deposit-refund schemes have been used in Canada for beverage containers, and could be considered for other products such as tires, batteries and used lubricating oils.

Potential application to used oils

Used lubricating oils can be reused directly as fuel, or reprocessed or re-refined for reuse as fuel or lubricants. Used oils are potentially hazardous if not disposed of properly, and therefore pose a serious environmental threat. A deposit-refund scheme could assist in the better management of used oils by encouraging proper disposal. At the same time, it would reduce waste by promoting recycling.

A deposit-refund scheme could focus on do-it-yourself oil changers and small commercial users who do not have access to existing collection services. Special collection depots for used oils could be established in local communities. Alternatively, existing service stations and other commercial businesses could be used as collection points.

The charge and the refund would need to be high enough to encourage users to return the used oil to the collection depots. In cases where the return rate is low, the authority could offer a refund greater than the deposit as a temporary measure to encourage return of the product. On the other hand, where necessary, the refund could be set at less than the deposit to finance the management of the system. There could also be proceeds from the sale of used oils, depending on the price of oil. External funding may still, however, be required to cover initial capital costs.

5. *Tax Instruments*

Among the assessment criteria identified in the paper, some are of particular importance in determining whether tax instruments might be more effective than other means in achieving environmental objectives. One essential consideration is international competitiveness. Any evaluation of a technically feasible tax option would require careful assessment of the implications for the competitive position of Canadian business. Ideally, this assessment would distinguish between imposing a tax unilaterally within Canada, and doing so as part of coordinated international action.

Two other essential considerations are the distributional impacts and adjustment costs. Different economic instruments can result in different cost and distributional impacts for various firms, sectors, regions and income groups. In situations where a tax instrument would raise concerns about the level or distribution of costs – either in the short term or over time – it may be possible to deal with these problems by modifying the design of the tax structure or by developing some offsetting measures. Alternatively, a non-tax instrument may offer a more acceptable way to achieve the same environmental objective.

5.1 *Environmental Charges*

Environmental charges alter the relative prices that influence producers and consumers. This encourages these groups to pay closer attention to environmental costs and benefits when making their choices. A well-designed environmental charge also offers producers and consumers the flexibility to minimize the costs of achieving a given environmental goal. The range of possibilities might include changes in product mix, modification of production technologies, or the use of "end-of-pipe" equipment to filter or clean harmful pollutants. Environmental charges also encourage the development and use of "cleaner" processes and products over time. Compared with a tradeable permits system, they provide polluters with more certainty about the full cost of pollution abatement, but less certainty about the resulting level of pollution.

Whether or not the full potential benefits of environmental charges are realized will depend on a number of practical considerations. For example, charges would probably work best in situations where there is a reasonably simple and well-understood cause-and-effect relationship between a polluting action and the impact on the environment. It is also important to be able to achieve a close connection between the charge and the making of decisions that bear significantly on a given environmental objective. In addition, the environmental effectiveness of a charge will depend on whether it is possible to distinguish clearly, and in an environmentally sound way, between what should be subject to the charge and what should be excluded. Finally, an appropriate rate for the charge needs to be established.

Charges on Emissions, Effluents or Solid Waste
The most direct way to tax harmful pollutants or waste materials is to tax emissions, effluents or waste. This approach gives producers complete flexibility in selecting the most cost-effective method of reducing discharges in the short term and over time. Any change in equipment or patterns of production that brings down their pollutant-discharges can reduce their payments of the charge.

In general, administration, compliance and enforcement costs are key factors in determining whether environmental charges will achieve a given environmental objective effectively. It is important, for instance, to be able to obtain fair and reliable measurements of emissions at reasonable costs.

Another vital consideration is international competitiveness. In markets where Canadian producers are competing with foreign suppliers, charges that are imposed on emissions in Canada but not in other countries can give a competitive advantage to foreign firms. It may be possible to avoid this problem by building various safeguards into the design of the charge – although these can be expected to increase the costs of compliance and administration.

Charges on Inputs or Materials
In some situations, it may be more practical to impose a charge on the use of certain inputs or materials rather than on effluents or emissions. An important feature of input charges is that they can be levied without having to monitor the levels of the emissions, effluents or waste leaving each source of pollution. In addition, there are likely to be fewer taxpayers subject to an input charge, because the charge could be collected upstream rather than downstream – from the producers of the input on the basis of their sales. Both of these factors tend to reduce administration costs.

One limitation of input charges is that, unlike emission charges, they provide no incentive for polluters to develop or invest in "end-of-pipe" emission reduction technologies. In addition, the potential impact of an input charge depends on the availability of substitutes and the extent to which demand for the input is responsive to price. It may also be more complicated to apply an input charge when some uses of an input are much less damaging than others.

Charges on Final Products
A charge on final products could be useful in cases where input or emission charges cannot be used effectively, or to address environmental problems that are closely linked to consumer demand. A final-product charge

makes it possible to modify price signals close to the point at which consumers make their choices. It also gives consumers the latitude to cut down on consumption of these products or to switch to alternatives, and it can stimulate development and marketing of more environmentally friendly substitutes. A final-product charge can also address international competitiveness concerns more easily than other types of charges – it could probably be added to imports and removed from exports without having to devise a complex tax structure.

Product charges, like other instruments, have their limitations. They are unlikely to change patterns of production and consumption when the demand for a product is not very responsive to changes in price. The impact of a product charge will also depend on whether there is a close connection between the purchase of the product and an environmental problem. Another important consideration is whether it would be possible to establish and maintain a clear distinction between products that should bear the tax and those that should not. For example, it may be desirable but difficult to exempt products made from recycled materials. At the same time it should be recognized that imposing a large number of charges on a diverse range of products would make the system more difficult to administer.

Specific Examples of Environmental Charges

Two of the most widely discussed examples of an environmental charge are a carbon tax to address the issue of global warming, and a tax on ozone-depleting chemicals to address the issue of stratospheric ozone.

A carbon tax – a tax on the carbon content of fossil fuels – is an input charge. Since there is a close connection between the carbon content of a fuel and the amount of CO_2 that is generated when it is burned, a carbon tax can achieve a close link between the amount of the charge and the amount of CO_2 emissions. Moreover, a carbon tax would be easier to administer than a charge applied directly to carbon dioxide emissions. International considerations and distributional impacts – including industrial and regional impacts – are important considerations in the design and implementation of such a tax.

Another example of an input charge is a tax on CFCs and other ozone-depleting chemicals. A tax of this kind now exists in the U.S. It would be a relatively straightforward matter to establish one in Canada as there are only two domestic producers of CFCs. However, questions about the treatment of recycled chemicals and imported products raise complex design issues.

5.2 Tax Incentives

Tax incentives subsidize particular groups of taxpayers or particular types of activities. They can be provided for particular types of investment, or to investors who provide funding for eligible projects or activities.

Investment Incentives

Environmental investments could be encouraged through the tax system by the provision of deductions, exemptions or credits. One type of incentive that has been used to encourage desired forms of activity in the past is the accelerated depreciation deduction. An accelerated deduction allows capital expenditures to be fully deducted for tax purposes long before the end of their economic life. Another way of providing investment incentives is through Investment Tax Credits (ITCs). An ITC reduces corporate taxes payable and results in a direct reduction in the cost of a firm's investment.

Investment incentives in the income tax system could help to reduce any adverse impact on international competitiveness by minimizing the costs to industry of stricter environmental regulations. Also, incentives could be targeted to particular sectors and/or regions which are adversely affected by environmental regulations. Incentives have been useful in the past in providing transitional relief when new regulations were imposed which had an adverse effect on particular sectors of the economy.

Canada's experience with tax incentives suggests that incentives are not always effective in achieving their goals. In addition, the added complexity of the tax system – a result of the introduction of incentives – has led to questions of fairness and instability of government corporate tax revenues. This experience suggests that the broad-based use of accelerated write-offs and/or investment tax credits for pollution control or other environmental purposes may not be the most effective or desirable way to proceed. From the environmental point of view, another drawback is that these measures may actually encourage more firms to enter an industry, thereby actually increasing pollution levels. It has also been argued that investment incentives are contrary to the Polluter-Pays Principle.

Financing Incentives

A financing incentive lowers the cost to the investor of raising funds for a particular activity or provides for a tax sheltering of the income from such funds. One example of a financing incentive is "flow-through" shares for oil and gas and mining companies, which allow the tax deductions for activities such as exploration to "flow through" to investors from the corporation. Another approach is the provision of after-tax financing instruments such as a "green bond" which would provide preferential tax treatment for returns from investments in "environmentally friendly" activities.

Most experience with financing incentives indicates that the benefits tend to accrue to profitable corporations and high-income individuals. In addition, U.S. experience with tax-free bonds suggests that they were not an effective means of lowering the cost of financing. In general, tax-assisted financing instruments have many of the same problems as investment incentives. Other considerations include fairness, leakage of benefits away from the environmental objective, and the difficulty of linking this type of incentive to a specific environmental activity.

Specific Examples of Tax Incentives
The existing accelerated depreciation allowances for water and air pollution abatement equipment were originally introduced to soften the impact of new environmental regulations. Another incentive that has been suggested is to allow contributions to provincially mandated mine reclamation funds to be deductible from income.

5.3 Combining Environmental Charges and Tax Incentives

Some environmental charges may lead to unacceptable consequences in terms of international competitiveness, distributional impacts or adjustment costs. A system that combines charges with tax incentives may ameliorate some of these problems. This approach would also alleviate many of the problems associated with tax incentives such as high revenue costs and inconsistencies with the Polluter-Pays Principle. It would also allow for the matching of polluting activities with clean-up activities. Charges could be offset directly through reductions, exemptions or rebates in respect of the charge, or indirectly through investment incentives or tax credits.

Some of the practical problems associated with tax incentives would still exist under a charge/incentive scheme, particularly in terms of effectiveness. Additionally, the scope for combining charges with accelerated depreciation deductions may be limited. However, some form of investment tax credit coupled with an environmental charge may raise less concern than the separate use of either instrument.

Specific Examples of Combining Charges with Incentives
A possible application of this approach would be to acid rain. A charge could be applied to emissions of SO_2 and NO_x. Firms liable for the charge could be eligible for a tax credit if they initiated remedial measures. Such measures could range from production process modifications to end-of-pipe clean-up activities. Another possible application is in the area of waste management, where the approach could be used to promote recycling. For example, a charge could be applied on products made from virgin materials, with credits earned on the use of recycled inputs.

1. Introduction

A key message of *Canada's Green Plan* is that economic growth and care for the environment are fully compatible and reinforcing goals. The Prime Minister pointed out in the preface to the *Green Plan*, "The challenge we now face is to build upon our economic strengths in harmony with our environment, the basis of our health and prosperity. . . . The *Green Plan* will help Canada be a country which is both economically prosperous and environmentally healthy."

The *Green Plan* diagnoses the root cause of today's environmental problems as a general failure of all sectors of society – individuals as well as organizations, businesses as well as governments – to take into consideration, as a matter of course, the impact of their decisions on the environment. The corollary of that diagnosis is that to achieve the goal of sustainable development in this country, the first step must be for Canadians, individually and collectively, to build the environment into their choices and their decision-making.

There are two main reasons why the environment has not been fully built into decision-making. One is a lack of information on the part of decision-makers about the environmental consequences of their choices and their actions. The second is a lack of economic feedback; the prices we pay for goods and services generally do not include the environmental damage or costs associated with their use, including their production, their consumption or both.

When motorists drive their cars, for instance, they are often not aware of the environmental consequences of the pollutants emitted from their automobiles, nor does the cost of operating their vehicles fully reflect the environmental impact. Similarly, our understanding of the environmental impact of industrial emissions is not complete, and production costs often do not reflect the effect of pollutants emitted into the atmosphere by production processes.

Even if decision-makers were aware of the environmental consequences of their actions, each feels powerless to make an impact on environmental problems by changing his or her own individual behaviour. One commuter's decision to take public transport would not have an impact on air quality. Similarly, one manufacturer's decision to replace existing equipment with less-polluting equipment might not have a significant impact on air quality in an industrialized area. For this reason, decision-makers do not have the incentive to make lifestyle changes or incur costs to lessen the negative environmental impact of their individual actions.

There are a number of ways to integrate environmental costs and benefits into decisions. An important basis for environmentally sensitive decision-making is a population well-informed about environmental realities in general, and about the environmental impacts of their actions in particular. This requires, in turn, a sound and constantly updated base of scientific knowledge and the educational and information systems needed to disseminate its findings.

While better environmental science, education and information are necessary for enhancing environmentally responsible decisions, they are not sufficient. More direct measures are also required, specifically regulations and economic instruments.

There has been a strong tradition in Canada of using regulations to achieve our environmental goals. We have, however, had little direct experience with the use of economic instruments to attain environmental objectives.

The basic difference between regulations and economic instruments is that the former directly prescribe behaviour; they "command" polluters to "control" specific activities. Economic instruments, by contrast, use market signals to influence behaviour in a manner which is consistent with environmental goals; they focus on environmental results rather than methods. In both cases, governments intervene to integrate environmental considerations into the decision-making process. However, economic instruments leave specific, detailed decisions about how to achieve an environmental objective to the decision-maker.

The flexibility allowed to decision-makers on how to achieve an environmental objective is an important advantage of market-based economic instruments over the traditional regulatory approach. For example, because firms can decide on the methods they use provided they meet the goals and targets established by governments, the market-based approach is favourable to the development of innovative and cost-effective solutions. The U.S. experience with the market-based approach, in particular with tradeable permits, indicates that potential cost savings can be considerable, in the order of hundreds of millions of dollars. Another key advantage of economic instruments over regulations is that they provide a continuing economic incentive for firms to cut back pollution and to develop and use new technology and processes to control pollution. By virtue of these advantages, economic instruments can help achieve high levels of environmental quality while at the same time creating domestic and international business opportunities.

Canada's international competitors also recognize the advantages of economic instruments. Some are in the process of examining or implementing them. This country faces large and complex environmental challenges, and Canadians may face difficult choices in resolving them. We also need to remain competitive in global markets. It is crucial to success on both fronts that Canada explore every avenue for new, cost-effective and innovative solutions. By finding such "smarter" ways of achieving our environmental goals, we can both achieve those goals and build our economic prosperity.

While economic instruments offer a number of potential advantages, it must be realized that Canada has had little direct experience with these instruments and the complexities of their design and use. Other countries have had more experience both in terms of types of instruments used, and of the environmental problems to which they have been applied. However, this experience has been limited in the sense that, in most cases, many of the instruments used were designed primarily to raise revenues for environmental protection.

There are a host of practical considerations to be weighed in assessing whether and how to put economic instruments to use to address environmental problems in Canada. To begin with, there is a wide range of tools to choose from, and some are better suited to one environmental goal than another. Moreover, each type of instrument and each application raises practical design and implementation issues, some more complex than others, and some that involve significant economic and distributional impacts.

In short, before we launch into the use of economic instruments in Canada we need to carefully examine the design and implementation issues associated with their use.

The *Green Plan* introduces a program to support practical research into the use of economic instruments. The program will consist of independent academic research on how economic instruments could be applied in Canada; an academic research network to exchange ideas and information and to encourage the widespread review of practical research results; and contributions to the study programs of independent research and policy institutes.

This discussion paper is also a *Green Plan* initiative. The *Green Plan* set out goals and action plans for addressing specific environmental problems facing this country. This paper explores the potential use of economic instruments to achieve the *Green Plan* goals in several of these problem areas: global warming, acid rain, ground-level ozone, water quality and use, waste management, and stratospheric ozone depletion. Its aim is to stimulate further debate and research into practical issues of design and implementation, and to identify points of focus for further work. This paper is also intended to serve as a basis for consultations with Canadians on the practical application of economic instruments to environmental problems in Canada.

The types of economic instruments explored in this paper include environmental charges, tradeable emission rights, user charges, and deposit-refund schemes. In order for these economic instruments to use markets effectively as the basis for sending "green" signals, the markets themselves should be working as efficiently as possible. Certain measures can be taken to improve the efficiency of markets and the clarity of market signals, including education and information for the general public, regulatory and institutional changes, and the removal of subsidies. Measures of this kind are not addressed in depth in this paper. However, it should be noted that the *Green Plan* introduces a number of initiatives to promote environmental education and information, and there may be potential for additional measures. Removal of subsidies is being examined in the context of the *Green Plan* initiative to review the environmental implications of existing statutes, programs, regulations, and policies.

This paper also does not deal with the issue of appropriate pricing of natural resources, or with the related issue of appropriate pricing of electricity. The direct use, commercial or otherwise, of our natural resource base is an environmental concern and it can be influenced by economic instruments. Improvement of markets and establishment of more clearly defined property rights may be good for the environment, where common access leads to overuse of natural resources. Resource prices are themselves economic instruments that can play a critical part in encouraging efficient and environmentally responsible management of natural resources. Possible adjustments to resource prices have to be examined under the wider heading of public policies which may inadvertently discourage users from acting in ways consistent with sound economic and environmental values. The appropriate pricing of natural resources and electricity are important areas for further research.

Finally, this paper does not address the question of which order of government has the authority to use specific instruments in specific applications. Nor does it focus solely on those instruments over which the Government of Canada has jurisdiction, but instead examines a "tool kit" of economic instruments that are available to the different orders of government to achieve our environmental objectives. In practice, some of the applications examined in the paper would most appropriately be implemented at the local level by municipal governments or by First Nations. Others would more appropriately be introduced at the federal or provincial levels. Still others may require interjurisdictional cooperation and be implemented jointly by the federal and provincial governments.

2. The Rationale For Economic Instruments

2.1 Overview

Governments in Canada and in most other countries have traditionally used the regulatory or "command and control" approach to achieving environmental goals. The federal government, for example, sets emission standards for automobiles; regulations set maximum automotive emission levels, on a gram-per-mile basis, for nitrogen oxides, hydrocarbons and carbon monoxide. Other sources of pollution are addressed by various provincial regulations. Quebec, for example, regulates SO_2 emissions from metal smelters – in some cases by placing a ceiling on emissions, and in others by placing a ceiling on the percentage of the sulphur introduced in the concentrate (feedstock) that can be emitted as SO_2. In the case of water pollution, both federal and provincial governments limit the discharge of harmful substances.

Economic instruments, on the other hand, work through the forces of the market to integrate economic and environmental decision-making and thereby make environmentally benign behaviour economically attractive. Some economic instruments – for example, environmental charges, tax incentives – directly affect the prices facing producers or consumers. A charge on consumer products, for example, increases the price of the products to consumers. A charge on inputs to the production process, or a charge on industrial emissions, increases prices to industry and indirectly to consumers. A tax incentive, on the other hand, reduces the cost of pollution abatement to producers.

Other economic instruments – for example, tradeable permits – create a market and a price for access to environmental resources. These instruments can affect consumer and producer prices directly or indirectly.

2.2 Approach

Economic instruments can be used in different ways to achieve different policy goals, and this section defines the objectives that are visualized in this paper.

Economic theory suggests that if it were possible to place a monetary value on environmental damage caused by pollution, then it would be possible to establish an environmental charge equal to the cost of damage, to serve as a disincentive to harmful behaviour. The resulting level of pollution would be the theoretical "optimal" level.

Attractive in theory as it may appear, there are so many obstacles to the implementation of such an approach as to make it virtually unfeasible. One is the immense difficulty of arriving at a general agreement about what monetary value to attach to a given degree of environmental damage. Even with this hurdle cleared, the determination of a theoretically "correct" level for a charge would be complicated by a number of factors that affect the functioning of markets and market prices.

There is a simpler and more manageable approach; it is to make the compass-point not a debatable or hypothetical environmental value, but instead the cost of achieving a predetermined and tangible environmental goal. And this is the point of departure for our discussion of economic instruments. It is assumed, in every case, that society has set or will set particular environmental targets, for example for preventing acid damage to lakes and forests caused by sulphur dioxide emissions, or for preventing negative health impacts caused by emissions of NO_x and VOC emissions, or, by way of international consensus, for the reduction of greenhouse gas emissions. The paper examines the potential for economic instruments to achieve those predetermined environmental targets. In examining that potential, the costs and benefits of using an economic instrument are assessed relative to alternative regulatory approaches that would achieve the same level of environmental protection.

2.3 Principal Types of Economic Instruments

The market-based approaches we are concerned with in this paper fall into two main categories: non-tax instruments and tax instruments.

2.3.1 Non-Tax Instruments

Three principal types of non-tax instruments qualify as potential candidates for environmental purposes: tradeable permits, user charges and deposit-refund systems.

Tradeable permits

Under a tradeable permits program, the government would establish a ceiling or limit on total allowable emissions of a given pollutant. It would then assign shares of the total allowable emissions among the sources of the pollutant, doing so through permits which would authorize each source to emit a specified amount of the pollutant, up to a limit stated in the permit, for a specified period of time.

An essential feature of this approach is that the permits would be tradeable; holders would be allowed to buy or sell them among themselves, or to sell them to others. Firms which found ways to get their emissions down below the limits authorized by their permits, and who could do so more cost-effectively than others, would have the incentive to do so and sell the unused portion of their allocation. And firms which were not able to reduce their emissions as cost-effectively would have an incentive to buy these permits, provided, of course, that the purchase price was less than their abatement costs.

On examination, it can be seen that tradeable permits are a hybrid approach, combining as they do regulation with market incentives, and drawing on the most effective features of each.

Tradeable permits can be applied directly to limit the actual discharge of pollutants into air and water. They can also be used, indirectly, to influence activities giving rise to pollution: fuel consumption, for instance.

User charges
User charges, in this context, are charges which can be imposed on users of services that affect the environment (e.g., water supply and wastewater treatment) and which are structured to reflect the full cost of these services. Again, their basic purpose is to bridge the information and price-signal gap mentioned earlier by presenting users with an indication that there are costs associated with their actions, and by providing an economic incentive for environmentally responsible behaviour.

Deposit-refund systems
Some products can be reused or recycled. They include many which can cause environmental difficulties if not disposed of in an acceptable manner. Deposit-refund schemes are appropriate instruments to deal with this particular problem. Under these schemes, a surcharge is added to the price of such products and is refunded in full or in part when the product is returned to a collection system. The effect is to encourage the reuse, recycling, and recovery of products thus helping to reduce waste, conserve natural resources, and encourage the proper disposal of potentially polluting products.

2.3.2 Tax Instruments

There are three principal types of tax instruments: environmental charges, tax incentives, and a combination of environmental charges and tax incentives.

Environmental charges
Environmental charges are designed to modify behaviour by imposing a charge on particular activities or sources of an environmental problem. The most direct approach would be to impose the charge on the actual amounts of emissions, effluents (discharges into water bodies) or other types of waste being discharged into the environment. However, a variety of tax designs are possible and warrant consideration. The charge could be applied to the total amount of certain emissions, or – by combining the charge with regulation – to emissions above a specific level. In some instances, a tax on inputs or products that are closely linked to an environmental problem may be a feasible and effective alternative to an emissions charge, or may be better suited to an environmental problem.

Tax incentives
Tax incentives are designed to modify behaviour by encouraging particular groups or activities. Incentives could take the form of preferential tax treatment to certain producers through tax credits, exemptions or deductions, or through tax benefits provided to investors who provide funding for eligible projects or activities.

Combination of charges and incentives
In this case, environmental charges and tax incentives are designed to work together. The aim would be to modify behaviour while providing policy-makers with more flexibility to develop ways to offset some of the economic costs and any inequities associated with charges. For example, an environmental charge on emissions could be coupled with a rebate for new pollution abatement equipment.

2.4 Advantages of Economic Instruments

As a means of achieving a specified degree of environmental protection, economic instruments have a number of potential advantages over traditional regulations. These advantages are set out below. Economic instruments are not necessarily the instruments of choice for every environmental problem. In the case of persistent toxic chemicals, for example, where virtual elimination of discharges is the environmental objective, regulation may be the preferable approach. But even in this case, one can visualize a role for an economic instrument used in conjunction with regulation; for example, a tradeable permit system could help in the phase-out of a given pollutant.

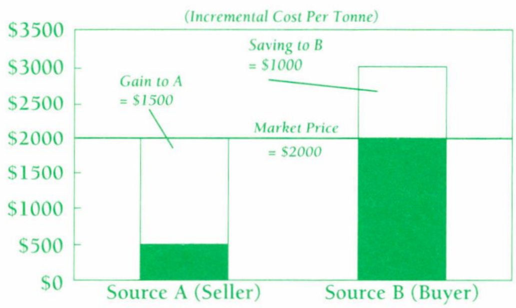
Given the advantages set out below and Canada's need to keep our production costs competitive with those of global competitors, this country cannot afford not to examine the potential use of economic instruments. If we were to restrict ourselves to the regulatory option in addressing a particular problem, while a trading partner opted for the economic instrument approach, we would be putting ourselves at a potential competitive disadvantage.

Cost-effectiveness
The most important advantage of economic instruments is their ability to achieve a specified level of environmental protection at lower cost. This is a function of the flexibility of these market-based approaches. Economic instruments are able to take into account the reality that the cost of controlling pollution may not be the same for all sources. And it is possible to make good use of these differences in designing a program to protect the environment. For example, it is more cost-effective to have sources with the lowest abatement costs cut back their emissions by more than other sources, than to require all sources to meet the same emissions standard.

This advantage is illustrated in Figure 1. In this case it is assumed that it costs source A \$500 per tonne to reduce emissions, and source B \$3000 per tonne. Requiring each source to cut back emissions by one tonne results in a total cost of \$3500. If, on the other hand, the sources were allowed to trade emission reductions, source B could pay source A a negotiated amount – say \$2000 – to reduce emissions by one tonne on its behalf. As a result the total cost of reducing emissions would be \$1000, and there would be a cost saving of \$2500. An environmental charge set at an appropriate level would have a similar result. For some firms – those with lower abatement costs –

the best way to reduce the financial burden imposed by the tax would be to undertake a certain amount of abatement. For other firms – those with higher abatement costs – it would be cheaper to pay the charge than to undertake abatement. In short, an effective charge would reduce the overall level of emissions by encouraging firms with lower abatement costs to reduce their emissions by more than the firms facing higher costs.

Figure 1
Possible cost reduction from using Economic Instruments



Total Gain: $2500 ($3000-$500)

Incentive to go further
A second advantage is that economic instruments provide a continuing economic incentive for firms to cut back pollution, and therefore a continuing incentive for firms to develop and implement new technology and processes to control pollution. This is not only good for the environment but for Canada's competitiveness and prosperity. Under regulation, on the other hand, there is generally little or no incentive for a firm to go beyond required performance standards. There are two principal reasons for this: first, because research and development into improved pollution control is costly, and its adoption may not lead to direct cost savings; second, because firms may believe that, if better technology is discovered, the government will require that it be adopted to achieve stricter emissions limits.

Faster results
A third advantage is that, in some cases, economic instruments can allow for faster achievement of environmental goals, or for more ambitious goals to be set, than regulation. This is partly because they are potentially more cost-effective than regulation – for a given cost, it may be possible to go further in terms of environmental protection using economic instruments. In addition, there may be greater support for adopting more stringent environmental targets if economic instruments are available, in view of the flexibility they allow firms in adapting their operations to meet the target.

Multiple objectives
Economic instruments in general, and tradeable permits in particular, can also have the important advantage of more easily addressing multiple environmental objectives than would be possible with regulations. This advantage could be particularly useful in the case of atmospheric emissions, where a single activity can give rise to a number of different types of emissions. The burning of coal by an electric utility, for example, can produce SO_2 emissions which lead to acid rain, NO_x emissions which lead to acid rain and smog, and CO_2 emissions which contribute to global warming. A regulatory approach to limiting these emissions would require the regulator to make complex and often difficult choices between different types of equipment producing different combinations of emissions. An economic instruments approach focuses on the result rather than the method. It recognizes the fact that the company, rather than the regulator, is in the best position to make a judgment as to the least-cost combination of methods for reducing emissions. And a variety of options could very well exist, including demand-side management initiatives to reduce electricity demand, investments to improve combustion efficiency, investments in pollution abatement equipment, and the purchase of emission reductions from a source outside the company, such as an industrial boiler. A tradeable permits approach would set overall ceilings for emissions of each of the pollutants, and allocate permits for each pollutant to the targeted sources. The targeted companies would then employ their own expertise to find the least-cost way of staying within the various limits.

Less administrative burden
A fifth advantage is that economic instruments can, in some cases, involve lower administration costs for both governments and industry than would be incurred under a regulatory approach. One significant factor in this equation is the reduced need on the part of the regulator for information about abatement technology options for achieving the targets in question. An economic instruments approach draws on the fact that much of this information already resides with the pollution sources. Economic instruments can also lead to lower administration costs for the targeted industries. For example, use of economic instruments can avoid the need for government certification of production processes and technologies – which, in some cases, can be a costly item for a regulated company.

Accommodates growth and entry
Finally, economic instruments can more easily allow for the entry of new companies into an industry, and the expansion of existing ones, than would be possible with a regulatory approach. Tradeable permits, in particular, have the advantage of being able to facilitate entry into an industry without a resulting increase in emissions. Under a permit system, a new firm can be allowed to enter an industry provided it acquires the necessary emission permits. Under a regulatory system, on the other hand, there is more likely to be a trade-off between targeted emissions and growth; and, in the process, the cost of maintaining environmental quality may have to be prevention of new entries or expansion. Indeed, it was to allow growth and entry that certain trading components were added to the air pollution control program in the United States. Of course, this advantage of a permits system over regulation presupposes an active trading

market, so that a new firm will in fact be able to acquire permits from existing firms.

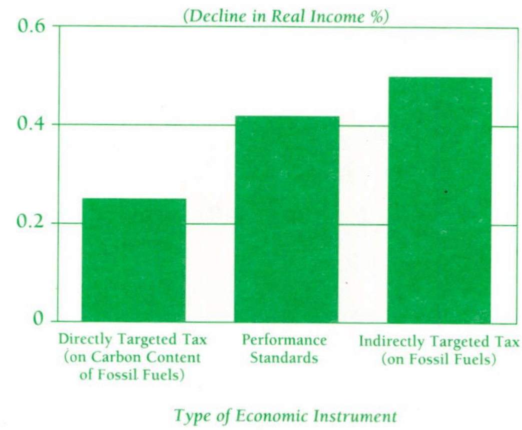
2.5 An Empirical Analysis of the Advantages of Economic Instruments

The theoretical advantages of the economic instrument approach over traditional command-and-control regulation have received some empirical confirmation in recent analytical work by the Department of Finance.[1] In a computerized simulation utilizing a general equilibrium (GE) environment-economy model (the methodology is described in the box below), the relative cost advantages of economic and regulatory instruments to achieve environmental goals were compared.

On the cost-effectiveness of economic instruments

Stabilization by the year 2000 of CO_2 emissions at the levels of 1990 was a goal addressed with the model. The economic instruments featured in the model were two kinds of environmental taxes. One was a tax on the carbon content of fuels – in other words, a tax levied directly on the pollutant in question. The other was a tax on fossil fuels in general. These instruments were compared with regulatory performance standards in the form of quantitative restrictions on pollutant emissions, arbitrarily imposed on a subset of high carbon-polluting industries which are responsible for about three quarters of CO_2 emissions from industrial sources.

Figure 2
Cost-Effectiveness of Economic Instruments to stabilize CO_2 emissions by 2000



Using the environment-economy model to simulate the effect of these approaches on Canadian real income, it was found that an economic instrument – the tax targeted directly on the carbon content of fossil fuels – was the most cost-effective instrument for the achievement of the stabilization goal. This result, depicted in Figure 2,

A General-Equilibrium, Environment-Economy Model of Canada

Determining the impacts of a major structural initiative such as environmental protection on a modern economy requires the use of a comprehensive analytical framework, one capable of capturing the wide range of interactions of a multitude of economic and environmental variables. A general-equilibrium (GE) environment model provides such a framework.

This type of economic model consists of a set of mathematical equations which attempt to summarize the functioning of the economy and the environment. They do so by taking into account the complexities of a large number of commodities and commodity prices, a multitude of economic agents and their interactions, and the influence of a variety of pollutants. To assess the effects of policy changes on economic behaviour and performance, GE models are simulated both with and without the policy change. The economic and environmental impacts of the policy change are then measured by the differences in the simulation results for key economic variables such as real income, real output, and sectoral resource reallocation and the quality of the environment.

The GE methodology used to analyze environment-economy linkages in this section is similar to that utilized by other organizations such as the Organization for Economic Cooperation and Development, the Congressional Budget Office of the United States, and a growing number of academics. Like the majority of GE environment models, the GE environment-economy model used in the analysis reported here does not capture the benefits of environmental protection – it is limited to an analysis of the economic costs of environmental protection. It examines the longer-term impact of relative price changes, caused by economic instruments and regulations on resource allocation (factors of production, industry outputs, consumer demands and trade) and overall real income. The model's sectoral detail allows the identification of the major industrial and residential sources of pollution. In the air pollution examples used in this section to illustrate the properties of economic instruments, five common air pollutants of current concern are included. These are nitrogen oxides, methane, volatile organic compounds, sulphur oxides and carbon dioxide. Further detail on the structure of the GE model is provided in Annex 1.

1 *"An Environmental CGE Model of Canada and the United States", forthcoming working paper of the Department of Finance Canada.*

supports the traditional theoretical proposition that the market approach is more cost-effective than the regulatory approach. The other instruments – the tax focused on fossil fuels generally, and the performance standards – were not as cost-effective. On the other hand, it should be noted that the simulation results indicate that the use of performance standards can produce a smaller real income loss than the tax on fossil fuels.

These results convey an important message about the ranking of economic and regulatory instruments. They indicate that two main considerations determine which instrument is most effective in minimizing the cost of achieving an environmental objective. The first is the extent to which the policy instrument makes use of market forces to change behaviour – the stronger the links to the market, the more cost-effective the instrument. The second factor relates to the directness of the approach. An instrument that uses the market directly, rather than circuitously, to achieve an environmental objective is the most cost-effective.

Economic instruments used in a roundabout manner (e.g., a tax on the use of fossil fuels rather than on their carbon content) are less cost-effective. So too are policy instruments that address objectives directly but without the help of the market (e.g., performance standards).

In other words, this is an area in which it is prudent to avoid generalizations about cost-effectiveness rankings of various approaches. Not all economic instruments are necessarily more cost-effective than regulatory ones.

It should be kept in mind that the simulation deals with the relative loss of income associated with the use of the alternative instruments analyzed. It does not include informational, administrative, compliance and monitoring costs that can be significant in certain cases, in particular for performance standards. These costs are discussed in more detail in Chapter 3.

There are also other considerations that would need to be addressed in assessing alternative approaches. For example, the very targeting which makes an instrument, such as a carbon tax, highly effective and hence less costly overall, can result in a concentration of the initial adjustment costs in certain regions and sectors rather than spreading such adjustments more widely across the economy. These issues are discussed in more detail in Chapter 5 (Section 5.1).

On providing continuous economic incentives

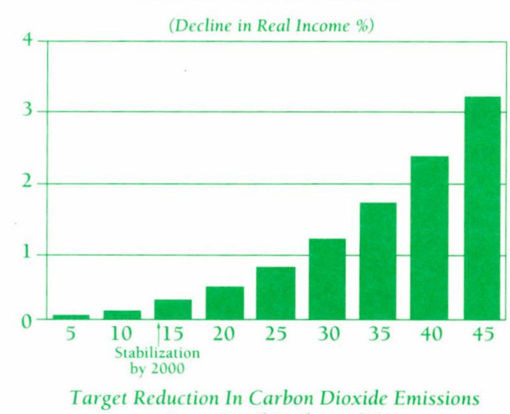
Regulation provides little or no incentive for firms to reduce pollution by more than the required performance standard – nothing in the system tempts them to go the extra mile. Economic instruments, on the other hand, provide a continuous and dynamic incentive for firms to implement new technologies and processes to control pollution if the cost of doing so is lower than that imposed by the economic instruments. This point is confirmed by the environment-economy model. The results from a simulation for controlling sulphur oxides emissions show that industries subject to quantitative emission standards do not purchase the full amount of abatement capital equipment (e.g., scrubbers and filters) available to them. Under an emission charge set to achieve an identical target, previously regulated industries confronted with abatement costs that are lower than the emission charge do, in fact, purchase all available abatement capital equipment.

On setting targets for pollution control

The results of the environment-economy model imply that, for a given economic cost, appropriate economic instruments make it possible to achieve more stringent targets than is possible with the use of performance standards.

The results also show, however, that pollution control is subject to rising incremental costs. As shown in Figure 3, for example, the results of a simulation in which a carbon tax was used to achieve increasingly demanding CO_2 objectives reveal that as environmental protection increases, real income deteriorates by an increasing proportion. This finding, which applies to other economic instruments as well, argues for caution in setting targets for pollution control.

Figure 3
Costs of Pollution Control

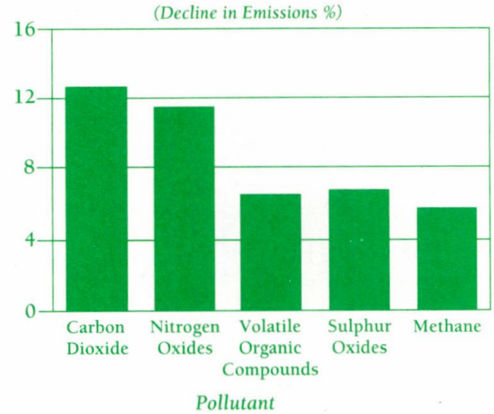


On multiple environmental objectives

In designing an efficient package of economic instruments to achieve a number of environmental objectives, the interdependence existing among a range of pollutants needs to be taken into account. For example, the burning of fossil fuels causes emissions not only of CO_2 but of sulphur oxides and other pollutants. The properties of economic instruments discussed earlier lend themselves to the exploitation of this interdependence. As mentioned in Section 2.4, use of an appropriate economic instrument to control a single pollutant, such as a carbon tax for reducing emissions of CO_2, can also reduce flows of other pollutants (see Figure 4). Since the instrument would be more cost-effective than regulation, it could also free up resources for pursuit of other environmental goals.

Furthermore, the achievement of more ambitious environmental targets using economic instruments can be expected to lead to larger reductions in the release of the whole range of pollutants into the environment. However, because of differences in uses, prices and the substance content of individual sources of pollution, the additional reduction in pollutants may not necessarily be equi-proportional.

Figure 4
Complementary environmental effects of reducing carbon dioxide emissions: Stabilization target



3. Criteria For Assessing/Designing Economic Instruments

In general, more than one economic instrument could potentially be used to address a given environmental problem. However, certain instruments are better suited to certain types of problems. Therefore, in order to deal effectively with a given environmental problem, one must select the appropriate economic instrument. Moreover, while in theory a given economic instrument may be suitable for addressing a particular problem, in practice its success will depend on its being properly designed. Taking these factors into consideration, this chapter discusses the principal factors that need to be taken into account in determining whether a given economic instrument is suitable for addressing a particular environmental problem, and in determining the appropriate design for that instrument.

Environmental effectiveness

The first consideration in assessing an economic instrument must be its effectiveness in achieving its environmental objective. In this regard, certain instruments may be fundamentally unsuited to certain situations. For example, if the objective is to virtually eliminate the discharge of a particular pollutant, neither an environmental charge nor a tradeable permits system may be effective. Regulation is likely to be preferable in this situation, although its use in combination with a tradeable permits system could be helpful in a phase-out period.

In some situations, an emissions or effluent charge might not be a suitable instrument since there are practical difficulties in attempting to "fine-tune" the design of these charges to certain types of environmental problems. One such case is environmental damage related specifically to the location of emissions – an example of this would be water pollution on a particular stretch of a water body. Another would be environmental damage related specifically to the time at which emissions occur (for example, smog on a hot summer day). In these situations, a tradeable permits system may be a feasible option, although it would have to be designed appropriately.

Realization of economic benefits

As noted previously, the prime advantage of economic instruments is that, compared with regulation, they can achieve a given environmental goal at lower cost. Therefore, in assessing the feasibility of using a given economic instrument in a particular situation, and in considering the design of that instrument, a key consideration must be the ability to realize these potential cost advantages.

This implies, for example, that administrative and monitoring costs must not be excessive. In the case of the design of a tradeable permits system, it requires a realistic presupposition that some trading will actually take place. This may require that specific design elements be incorporated into the system to promote trading.

Related considerations in designing and assessing an economic instrument are the extent to which it can be expected to encourage the development of innovative technologies to protect the environment, and to accommodate the entry of new firms and the growth of existing ones within the industry in question.

International competitiveness

Because of the crucial importance of world trade to Canada, it is important to understand the impacts on international competitiveness of introducing a given economic instrument. Economic instruments can, in theory, have less of a negative impact on international competitiveness than regulations. This advantage derives from the potential for economic instruments to meet environmental targets at a lower cost to the economy as a whole than would be possible through the use of regulations. However, economic instruments can have other implications for international competitiveness, and these need to be recognized.

Some applications of economic instruments could, depending on the design of the instrument, impose a greater financial burden on a targeted industry than would regulation, and could cause greater harm to the international competitiveness of that industry. A charge on emissions, for example, could be more costly to the targeted industry in the short term than regulation, since the industry would have to pay both the emission charge and the cost of its pollution abatement equipment. There are ways, however, in which potential impacts on international competitiveness could be addressed. In some cases, it may be possible to design the charge so that it is applied only to emissions above a certain level. Another approach may be to refund the revenue raised by the charge in a manner that (a) did not provide an incentive to increase emissions, and (b) was revenue-neutral for the industry. In other cases, issues of competitiveness could be addressed by taxing competing imports to level the playing field.

A factor which would determine whether or not a tradeable permits system would be more costly to a targeted industry than regulations would be whether the industry would be required to pay for the permits at the outset. If the permits had to be purchased, either through auction or some other means, the financial burden on the industry would be greater than with regulations, since the industry would have to pay the cost of abatement plus the cost of permits. As in the case of an emissions charge, the additional financial burden on the industry could be addressed by redistributing the proceeds from the sale of the permits.

The impact on international competitiveness of measures to improve environmental protection is one that can best be addressed through international coordination of environmental policies. Governments around the world are, in fact, enhancing their environmental policies to provide for increased environmental protection, and are increasingly looking to economic instruments as a cost-effective means of changing behaviour.

Distributional impacts

Any environmental initiative will have distributional implications (i.e., impacts on certain groups, sectors, regions, industries, etc.). This is true for both regulatory measures and economic instruments.

Economic instruments can be designed so as to ensure that the distributional impacts resulting from their use are no less desirable than in the case of regulation. This is possible because an economic instrument has the ability to achieve an environmental objective at lower overall abatement costs than is possible through regulation. Different economic instruments, however, can have different distributional impacts. The cost of taking action, for example, can be shared quite differently depending on which instrument is chosen, and how it is designed. For reasons of equity, therefore, and to ensure acceptability, it is important that the distributional impacts of an economic instrument be carefully assessed. Several such impacts would have to be taken into account.

One important consideration is the impact on a targeted sector or industry relative to other sectors. This issue can arise when it is not desirable or feasible to apply an economic instrument to all sources of emissions of a particular pollutant. In certain situations, an economic instrument may be right for limiting emissions from relatively large sources, but not from smaller sources. In these cases, equity would require that another program be introduced to target the smaller sources, so that the burden of reducing emissions would be equitably shared.

A second issue is the relative impact of an economic instrument on individual firms within a targeted industry. The method by which permits are first allocated at the start of a tradeable permits system, for example, is an important part of this issue, since it involves the allocation of access rights to a common property resource.

A third issue is the impact of an economic instrument on firms already in an industry, as compared to its impact on potential entrants to that industry. Resolution of this issue hinges on the choice and design of the economic instrument. An environmental charge, for example, would treat established and new firms equally – since the same unit charge would be imposed on all firms. In some cases, however, it may be more difficult for existing firms to change their processes or equipment to reduce the financial burden imposed on them by the charge. A tradeable permits system, by contrast, would generally favour existing firms, unless the permits are distributed by periodic auction.

The possibility of other distributional implications also needs to be examined. As with any environmental protection measure, an economic instrument could affect different regions of the country in varying degrees. Regional equity must be a key consideration in assessing and designing an economic instrument. Similarly, the impact of any environmental protection measure is likely to be at least partly felt by consumers, and possibly with different impacts for different income groups. This issue should also be taken account of in designing an economic instrument.

Finally, it would be important to consider the relative impact of an economic instrument on the targeted sector and on government. The use of an environmental charge, or a permit system in which the permits were distributed by auction, could impose significant financial costs above and beyond the costs of pollution abatement, while generating significant revenues for the government.

Transition and adjustment costs

Any significant environmental initiative will involve some change in production patterns and/or levels and will, therefore, entail some adjustment costs. These costs may be felt in the short term, while the environmental benefits may only be realized in the longer term. Over time, in addition to the environmental benefits that will result from taking action, there will be economic benefits such as increased investment in research and development, the emergence of new technologies, and a general improvement in operating efficiency (companies that take the environment seriously find themselves changing not only their technology but also the way they run themselves). In the short term, however, adjustment costs could include reduced profits for some firms, higher prices for consumers and, perhaps, some loss of jobs.

It is unlikely that the transition and adjustment costs incurred by industry in adapting to an economic instrument would be greater than for a regulatory regime. In some cases these costs may very well be less, because of the added flexibility conferred on industry by economic instruments. Moreover, there are measures that can be taken to minimize the adjustment costs arising from any environmental initiative, such as seeking coordination of environmental policies at the international level. It may also be possible to plan the introduction of an economic instrument in such a manner as to minimize any initial negative effects. For example, by giving advance notice of the introduction of an economic instrument, government can provide lead time for firms to modify production processes and products. In the case of some instruments, such as an environmental charge, it may be feasible and appropriate to schedule a phase-in period.

It can also be important – for example, in the case of a tradeable permits system – to make it clear in advance that a firm will not be penalized for pollution abatement actions taken between the date of announcement and date of implementation of the initiative. Otherwise firms might delay action to reduce pollution until after an economic instrument is actually introduced.

In general, the transition and adjustment costs for industry in meeting environmental targets – whether by economic instruments or regulations – can be eased by ensuring that industry is well-informed of longer-term as well as short-term targets. This would provide some certainty to firms, and enable them to make provisions for these targets in any equipment and process changes.

Administrative and compliance costs
It will be important to assess carefully the administrative, monitoring and compliance costs involved in implementing an economic instrument. While in many cases there would also be significant administrative costs associated with a regulatory approach, it is possible that in the case of some environmental issues the costs associated with applying a particular economic instrument would be so great as to make regulation a preferable instrument. A case in point could be emissions of nitrogen oxides from automobiles, where the large number of relatively small sources of emissions limits the feasibility of applying an emissions charge to measured levels of emissions. (In such a case, however, other examples of economic instruments – such as an input charge on fossil fuels or a product charge on vehicles to promote the use of catalytic converters – could be considered as alternatives to regulation.)

In other cases, administrative costs may make one type of economic instrument preferable to another. This would be true, for instance, when a large number of pollution sources would make a permit system unwieldy, while the application of an environmental charge could be accommodated within existing federal or provincial tax systems. In general, the administrative costs associated with an economic instrument will tend to be reduced to the extent that there is an existing administrative structure on which it is possible to "piggyback". The administrative costs of introducing a charge on automobile emissions, for example, would be reduced to the extent that it would be possible to make use of existing provincial licensing systems. In still other cases, the administrative costs associated with applying a particular economic instrument may depend on the design of that instrument. A particularly complex environmental charge, for example, could impose significant administrative costs on taxpayers.

Jurisdiction
In a federal state such as Canada, the division of legislative jurisdiction between Parliament and the provincial legislatures can be an important factor in the implementation of economic instruments. Several aspects of this issue need to be considered. One is the authority of different orders of government to take action to address a given environmental problem. A second is the legal authority of different orders of government to introduce a particular economic instrument. A third is the question of which order of government would, from an environmental point of view, most appropriately take action to address a particular environmental problem.

Recent judicial pronouncements have confirmed that environmental issues cannot readily be assigned wholly to either the federal or the provincial governments. Both orders of government could have an interest in the development of a solution to a given environmental problem. A province may, in a given situation, have a predominant role in combating local pollution which does not affect areas of federal interest. Conversely, the federal government may play a prominent role in resolving environmental problems which have an impact on (for example) fisheries, or which involve transboundary pollution. And there are other cases in which both orders of government can play a role.

In considering the use of economic instruments to address environmental problems, another issue that arises is the legal authority of different orders of government to introduce a specific instrument. For example, there is the matter of tax instruments. Parliament has unlimited authority with respect to taxation, but its power to tax is considered to be restricted to matters over which it has jurisdiction. The authority of the federal government to impose a charge on emissions or effluents, for example, can vary by environmental problem. It may be argued in some cases that a charge of this kind does not have the structure of a genuine tax, that essentially it is a regulatory measure aimed at environmental control; thus, depending on the circumstances, this might be regarded as an area that does not involve a federal interest. Also, there is the issue of whether applying an environmental tax to an agent of a provincial government, such as a provincial Crown corporation, would violate the constitutional restriction against taxing the Crown.

Another complication is related to provincial taxing powers. The provinces have primary authority for regulating the use of the air, water and land within their boundaries. However, their use of environmental taxes is limited to areas in which a direct tax can be applied – they do not have authority to impose indirect taxes. The taxing powers of the federal government, however, include both direct and indirect taxes. Therefore, if there are good reasons to apply an environmental charge at the manufacturer's trade level, a federal levy may be the only tax option that can be considered.

Emissions trading, which has not yet been tried in Canada, raises other constitutional questions. The most basic is whether a government which has authority to prohibit or regulate a particular form of pollution can achieve those ends through the use of emissions trading. For the provinces, the addressing of this issue may require examination of the property and civil rights power. For Parliament, it may be necessary to look at the criminal law authority, or the peace, order and good government authority. The appropriate jurisdictional basis for an emissions trading scheme would depend on the nature of the environmental problem being addressed, and therefore could only be properly assessed in the context of a specific scheme.

These legal aspects of the jurisdictional issue are important. But equally important are the questions of which order of government could best take action on a particular environmental problem, and of how to meet the need for coordinated action on the part of different jurisdictions where that kind of response is needed. History shows that cooperative development of joint schemes has been encouraged within Canada's constitutional framework. The courts have very rarely invalidated administrative schemes aimed at cooperative resolution of a problem, provided one order of government did not purport to delegate legislative authority to the other. In short, although jurisdictional constraints should be carefully considered when assessing the feasibility of using economic instruments, the possibilities within our constitutional framework for using joint mechanisms to achieve shared goals should not be discounted. The environment, perhaps more than any other area, is appropriately the subject of cooperation.

There are several examples of interjurisdictional cooperation in dealing with environmental problems in Canada. The Canadian Council of Ministers of the Environment (CCME), which represents the federal government, the provinces and the territories, has taken effective action to address the transboundary issue of acid rain, and is taking similar action to combat smog. CCME is also working effectively to deal with issues such as waste management and packaging; while not strictly transboundary issues, these issues have a cross-jurisdictional dimension.

CCME has already expressed its interest in examining the role economic instruments can play in resolving environmental problems. It is currently examining the possible application of emissions trading to two specific problems: the control of SO_2 emissions in Canada, and the reduction of emissions of nitrogen oxides and volatile organic compounds in the Lower Fraser Valley. The federal government is committed to continuing to work with CCME to explore further the potential for using economic instruments to address environmental problems.

Consistency with other government policies
In considering the use of economic instruments, it is important to take account of other, potentially relevant government policies.

One is deficit control. Using tax initiatives to provide financial incentives would reduce government revenues and therefore increase the deficit. Environmental charges, on the other hand, would generate revenues which could be used to reduce the deficit, reduce taxes or help fund federal programs. Alternatively, as noted above, the revenue raised could be redistributed to the targeted industry. A tradeable permits system would be largely revenue-neutral unless the permits were distributed by auction, in which case it would raise revenue.

Certain economic instruments could also raise issues related to trade policy. In some cases, tax incentives may not be consistent with international trade rules. Moreover, a financial incentive could be incompatible with the Polluter-Pays Principle which has been endorsed by the OECD. In this connection, it should be noted however that the OECD has made room for possible exceptions to the Polluter-Pays Principle. Notable among these are exceptions allowed in transitional periods while new environmental policies are being implemented. Other exceptions are allowed for in cases of conflict with other social or economic policy objectives such as regional policy, and in relation to aid to environmental research and development.

In assessing the feasibility of regulatory and economic instruments, a factor to be considered is the extent to which existing government programs, designed to achieve non-environmental objectives, may work against a particular environmental initiative. In the *Green Plan*, the federal government announced that, in 1991, it would begin a comprehensive review of the environmental implications of existing statutes, policies, programs and regulations, and that it will propose modifications as necessary.

Industry and public acceptability
Since the use of economic instruments to achieve environmental objectives would be a new departure for Canada, any instrument introduced would have to be broadly acceptable, not only to the targeted sector or industry but to the public at large.

Public opinion polls carried out to date provide limited insight into the way Canadians feel about the use of economic instruments for environmental protection. Polls that have sought the views of Canadians on so-called "green" taxes indicate that Canadians see them primarily as means to raise money to fund environmental protection, or as instruments to change behaviour.

Other clues to Canadian popular thinking about economic instruments emerged in the comprehensive consultations which accompanied the drawing up of the *Green Plan*. Participants in that process agreed on the goal of striking an appropriate balance of economic and regulatory mechanisms to promote sustainable development, both at home and abroad. They agreed that the selection and application of instruments must be undertaken in accordance with certain principles (simplicity, visibility, achievability and acceptability) that would ensure consistency, minimize duplication, and also guarantee periodic evaluation. It was also generally agreed that while different problems required distinct solutions, overall environmental goals must be consistent with responsible fiscal policy. Partnerships within and between the private and public sectors were considered essential to the effective use of economic instruments. Participants agreed that study and assessment of economic instruments (through, among other means, pilot projects) would be essential, if the full benefits of these instruments were to be realized.

Industry has also shown considerable interest in economic instruments, particularly in tradeable permits systems. Industry groups potentially affected by proposed regulations to control NO_x and VOC emissions have cooperated in a study funded by Environment Canada of the possible use of tradeable permits systems to reduce these emissions. Industry groups have also funded studies of the possible use of tradeable permits to reduce other atmospheric emissions such as sulphur dioxide and carbon dioxide.

4. Non-Tax Instruments

As noted earlier, this paper focuses on three main types of non-tax instruments: tradeable permits, user charges and deposit/refund systems. This chapter discusses these instruments in more detail and examines some of the key issues that arise in their application.

4.1 Tradeable Permits

Main Features

Tradeable permits offer a number of advantages. One is a high degree of confidence that they can achieve pollution control targets. Another is their ability to accommodate growth in an industry without compromising environmental quality. They are particularly useful when it is necessary to pursue several related environmental objectives simultaneously. And, because they deal with quantities (i.e., pollution loadings) rather than prices, they are insensitive to inflation.

At the same time, tradeable permit systems do have some limitations. Perhaps the most important is that, in order for them to realize their full potential, the permits must be actually, rather than theoretically, tradeable – and not only within individual firms but between firms. One prerequisite for achievement of this goal would be that firms not behave "strategically" in the permit market – that is, that they not seek to gain a competitive advantage by, for example, withholding permits from the market. Two points need to be considered in this connection. First, the greater the number of sources targeted by a permit program, the more likely it will be that there will be free, competitive trading. Second, even where permits do not trade perfectly freely, they can still produce economic benefits, provided some trading takes place.

Another potential difficulty with a permit system is that the resulting cost of pollution to the firms involved – that is, the permit price – cannot be predicted in advance. This means that until the program gets under way, it will be difficult for firms to estimate the financial cost of the overall emission ceiling that is being introduced.

The Experience in Other Countries

Up to now, practical experience with trading has been limited almost exclusively to the U.S. Trading has been applied there primarily to control air pollution and, in one case, to control discharges into a river. More recently, trading has been introduced as a part of the U.S. program to control acid rain.

Emissions trading was first introduced in the U.S. in the 1970s to add flexibility to an existing regulatory program for the control of a number of pollutants. In the American application of the system, sources of air pollutants are allowed to trade emission reduction credits. These credits are generated when sources control emissions by more than the amount required under the regulatory program. The rules for trading have evolved over time. Generally speaking these have imposed tight restrictions on allowable trades and have involved procedural requirements that raise the costs of trades and that create uncertainty and delay. This has inhibited trading and, as a result, the cost savings realized by introduction of the system have not been as large as they could otherwise have been. Nevertheless, many trades were in fact transacted, particularly within firms. The estimated cost savings from emissions trading range quite widely, from $1 billion to in the order of $10 to $12 billion.

Trading of effluents is allowed on the Fox River in Wisconsin. The number of trades under this program has been small, primarily because of cumbersome trading rules.

A much more successful application of tradeable permits in the U.S. was their use to accelerate the phase-out of lead in gasoline in the mid-1980s. The program allowed this goal to be achieved more rapidly than would otherwise have been possible, and at the same time resulted in cost savings estimated to be in the hundreds of millions of dollars. The success of the program is attributed to several factors, including the fact that refiners were allowed to trade lead rights relatively freely, administrative costs were minimal, and the initial allocation of lead rights was clear and easy.

In 1988, a system of fully tradeable CFC production permits was introduced by the U.S. as part of its program to phase out CFCs. Permits were issued to producers and importers in proportion to their 1986 production/import levels. In this system, the number of permits declines over time in step with the phase-out schedule. There are no restrictions on the use of CFCs produced within the permit limits. As yet there is little evidence as to the success of this program.

In the most ambitious trading program undertaken so far, the 1990 amendments to the U.S. Clean Air Act establish a comprehensive tradeable permits system for SO_2 emissions from electric utilities. The first phase of the program, which begins in 1995, targets the power plants with the highest rates of SO_2 emissions. In 2000, the number of permits or allowances will be reduced, and the program will be extended to all power plants. Few restrictions are imposed on trading. Taking account of concerns about whether the market for permits would work, the designers of this program built features into it specifically intended to promote competitive trading. It is estimated that the trading program will result in cost savings of about $1 billion annually, a sum that represents about 25 per cent of estimated compliance costs.

Key Design Issues

Experience in the U.S. supports the conclusion that it is critical to the success of a trading program – both in meeting its environmental objective and in realizing the potential economic benefits, which can be substantial – that it be appropriately designed.

This section discusses the key design issues, common in the application of tradeable permits to different environmental problems. Using case studies, we then explore the potential application of these permits to specific environmental problems, namely: acid rain, ground-level ozone, global warming, water quality, and stratospheric ozone depletion. The case studies focus on those generic design issues which present considerations unique to the environmental problem.

Key design issues for tradeable permits systems include:

- the areas in which trading would be allowed (trading zones);
- seasonal and episodic controls;
- the sources of pollution that would be included in the trading program;
- the total emissions/effluents limit for the sources included in the trading program;
- the initial allocation of permits among the included sources;
- monitoring and enforcement;
- potential barriers to trading;
- "banking" permits for future use; and
- cross-pollutant trading.

Certain issues are critical to the success of a trading program in achieving its environmental goals. They include: the definition of the trading zone(s), the sources to be included in the program, the emissions/effluents limit set for those sources, the decision whether to permit "banking" of permits, and the need for effective monitoring/enforcement. Other key issues relate to the writing of "rules of the game" for trading permits. If all the potential cost savings are to be realized, the rules must not make the trading process so cumbersome that it inhibits trading. At the same time, to ensure the integrity of the system, the rules must allow for effective monitoring and enforcement.

Trading zones

A trading zone is the geographical area within which sources of a given pollutant would be allowed to buy and sell permits.

Looked at from the viewpoint of environmental protection, the ideal trading zone is one that encompasses an area throughout which emissions can be traded without exacerbating the environmental problem in any one part of the area. The contours of an appropriate trading zone would vary according to the environmental problem. In the case of global warming, for example, increased emissions of the so-called greenhouse gases have a worldwide impact. The appropriate zone in this case would be at least all of Canada and preferably all of the world. In other cases, such as acid rain, the impact of the emissions that cause acid rain is more localized – increasing emissions in some areas could exacerbate the acid rain problem in those limited areas. So the appropriate trading zones for emissions that cause acid rain would be more narrowly defined. Ideally, each would encompass areas in which the problem of acid rain is of similar severity.

Another critical factor in the definition of trading zones is the number of emission sources per zone. In order to realize all the potential cost savings from emissions trading, there must be a sufficient number of sources in each trading zone to create an active market in the buying and selling of permits. It should be noted that this is not an all-or-nothing situation. Even if there were not enough sources to ensure that permits were traded perfectly freely, some of the potential economic benefits would be realized if at least some trading took place.

Trading between zones could be considered, under some circumstances. For example, it may be desirable if the number of sources in the trading zones is limited. In such a situation, permitting trading between zones might increase the number of sources that could trade permits. Holders of permits in a trading zone in which the environmental problem is relatively more serious than in others could be allowed to sell their permits in those zones in which the problem is less severe. They would not, however, be permitted to buy permits from holders in other trading zones. Alternatively, permits could be bought and sold in any trading area, but the exchange would not be one-for-one. For example, a source of pollution may want to increase emissions by one unit in a trading zone in which the environmental problem is relatively more serious. It could do so by buying one permit within the same trading area or, for example, two permits from another trading zone in which the problem is less serious.

Seasonal and episodic controls

Some environmental problems vary greatly by season. For example, ground-level ozone is mainly a summer problem and, environmentally speaking, it would be undesirable to allow trading which would increase emissions in the summer months.

One way in which seasonal environmental problems could be addressed within a trading program would be to issue permits only in the season in which the problem arises – summer in the case of ground-level ozone. Alternatively, separate permits could be issued for the summer and for the other times of the year in which the problem is less severe. Trading would not be allowed across seasons. A third option would be to issue separate permits, but to allow trading between seasons if summer emissions would be reduced – for example, a "summer permit" could be used in winter, but a "winter permit" could not be used in summer. Allowing trading between seasons in this way would only be considered if it could be determined that this did not increase the severity of the environmental problem in the other seasons. In general, it is not probable that this would occur; it is unlikely that a large number of summer permits would be traded in the other months, given that their market value would likely be significantly higher than the non-summer permits.

In addition to seasonal variations in emissions, there can be, in the case of certain environmental problems, episodes in which the concentration of a pollutant is particularly high. Weather conditions, for example, can lead to episodes of particularly high concentrations of ozone at times during the summer. It may be desirable to include in a trading system the possibility of implementing supplementary controls to deal with episodic problems.

Sources of pollutants
Pollutants often have a multitude of sources. In some cases, large sources such as industrial plants generate most of the emissions of a given pollutant. In others, many small sources together are responsible for most of the emissions.

Ideally, from an environmental and economic standpoint, all the sources should be included in the trading program. From an environmental perspective, this would give greater assurance that target reductions would be achieved. From an economic perspective, the cost of achieving that objective would be lower if all the sources were included, particularly if the cost of reducing emissions varies significantly among the sources.

In most cases, it would be administratively costly and impractical to include numerous small sources in a trading program. It would be more cost-effective to include the large, easily identifiable sources in the trading program, while applying other measures, such as regulatory standards, to the sources that cannot practically be included. However, to the extent that there are differences in the cost of reducing emissions between sources included in the trading program and sources that are not, some economic benefits would not be realized. Moreover, applying different measures to different categories of sources could raise questions of equity that would need to be addressed, particularly if the distributional impacts vary significantly. In some cases, it may be possible to include small sources indirectly through a "choke point" in a distribution system, where the fewer number of sources could make trading more practical. For example, VOC emissions from solvents used by small sources could possibly be dealt with through a tradeable permit program at the producer/importer level.

Emissions/effluents limit for included sources
In those cases where all sources cannot practically be included in the trading program, an emissions limit needs to be established for those sources that can be included. The limit must be consistent with the environmental objective, taking into account the expected emissions from the sources not included in the trading program.

Initial allocation of permits
When a trading program is first launched, the total number of permits must initially be allocated among the sources of pollution included in the program. Two options for the initial distribution could be considered. One is to allocate the permits to existing emission sources based on historical emissions – the ultimate distribution of the permits would be determined by the market as the permit holders buy and sell their permits. The other option is to hold an auction, in effect leaving the distribution to the market from the start of the program.

Distribution on a historical basis requires choosing a period that would serve as the basis for the initial allocations. The period should be recent enough that the allocations are consistent with current output levels, thereby enabling firms to carry on their business. It should not, however, be so recent that firms could have knowingly increased their emissions in order to increase their initial allocation. The period could be an average over several years. This would compensate for temporary fluctuations in emissions caused by, for example, business cycles and shut-downs. In finalizing initial allocations based on the historical period, adjustments should be made to take into account any prior emission reduction actions taken by firms, in order not to penalize those that have already restricted emissions.

Under an auction, the sources of pollution would be required to pay for permits. The market would, in effect, determine the initial distribution among the firms. This would relieve the regulatory authority of the necessity of determining the number of permits to issue to each source through the type of procedure discussed above.

From the standpoint of realizing the potential economic benefits of a trading program, there is little difference between the two options. Auctioning, however, may encourage the potential economic benefits to be realized sooner. For example, auctioning, if announced well in advance, can encourage corporations to compare the expected costs of purchasing permits with the cost of investments in pollution abatement. It is true that these cost comparisons and the appropriate investments would eventually be undertaken under a functioning trading market regardless of the initial means of distribution. But under an auctioning system these things would likely happen sooner.

The main difference between the two options is their distributional impact. Given the supply of permits is fixed, they become valuable. If the permits are initially allocated on a historical basis, firms which receive the allocations may profit substantially from the sale of permits. Moreover, those firms that both were the biggest sources of emissions in the past and have relatively low abatement costs (and therefore would be sellers of permits) would stand to be the biggest winners. Under an auction scheme, on the other hand, the government would essentially capture the economic gains that would otherwise be captured by the firms. Moreover, firms would bear more of a financial burden under an auction scheme; this could have an impact on their international competitiveness.

Several options could be considered to address the distributional and competitiveness issues. One option is for the government to charge firms a fee per permit for their allocation based on historical emissions. In this way, the government would capture some of the gains to be made from the sale of permits. Another possibility is to distribute the permits through an auction, but redistribute some of the proceeds. Redistribution could be carried out on the basis, for example, of each firm's share of industry output.

An auction scheme could raise an additional distributional issue in a case where the permit market was dominated by a small number of large firms which competed with smaller firms in the product market. The large firms could seek to bid up the price of permits as a means of driving their weaker competitors out of business. Distribution on the basis of historical emissions might be preferable to an auction in such a case of market power.

Another difference between the two options for allocating the permits among the sources of pollution is that allocation by auctioning creates more uncertainty for the sources of pollution than allocation based on historical emissions. Auctioning would likely, therefore, be less acceptable to industry.

It is important to note that the method of initial allocation of permits does not affect the consistency of a tradeable permits system with the Polluter-Pays Principle. This is because, however permits are distributed, the polluter bears the cost of cutting back emissions.

Monitoring/enforcement
Once established, a trading program would require two types of monitoring: the monitoring of emissions, as required under any regulatory program, and the monitoring of trades.

Under current provincial regulations, large-scale sources of pollution – which are the kind most likely to be included in a tradeable permits program – are often responsible for monitoring and reporting emissions on a regular basis. This would continue under an emissions trading program. In addition, they would be required to report any trades.

The integrity of the system would require the establishment and enforcement of penalties for exceeding the emission levels allowed by permits. The penalties should be high enough to be an effective deterrent to willful violations over an extended period, but not so high as to impose an unfair burden on companies that produce excess emissions in a given period for reasons beyond their control. Moreover, the system must not only penalize but effectively discourage excess emissions which would jeopardize the attainment of the environmental goal. For this reason the penalties should be in proportion to the amount of excess emissions.

Strict penalties on excess emissions could be balanced by measures to ensure that permits will be available for purchase in case of emergency. Such measures are discussed in the next section in the context of removing potential barriers to trading.

Potential barriers to trading
For the potential economic benefits of an emissions trading program to be fully realized, it is important that a well-functioning permits market develop. In designing such a system it should be kept in mind that there are three types of barriers to trading that could inhibit the development of an active market in permits:

i) high transaction costs created by, for example, cumbersome and/or unclear trading rules established by the regulatory authority;
ii) the inability of willing buyers and sellers to identify one another; and,
iii) the hoarding of permits.

Concerning the first possibility, it would be necessary to strike an effective balance. To ensure the integrity of the system, the trading rules would have to allow for effective monitoring of emissions and trades. However, they should not create transaction costs so high as to discourage willing buyers and sellers from trading. Decisions about other aspects of the process would have to be made with the same objective of balance in mind. Requiring prior approval of trades, for instance, would make trading cumbersome and inhibit trading; it would, in any case, not be necessary to ensure the integrity of the program. The program could effectively be monitored through a process for reporting both trades and emissions, supplemented with random spot checks of emissions. A significant fine could be imposed on polluters whose emissions exceeded the levels allowed by their permits.

On the second point, there are two possible ways to ensure that potential buyers and sellers of permits would be able to find each other. The regulatory authority could publish a regular list of permit holders, identifying those that have permits to sell and those interested in buying permits. Alternatively, this function could be undertaken by private-sector firms which could, in addition, act as brokers.

On the third potential pitfall, if a firm is not sure that it will be able to acquire permits on the market at a later date, it may be inclined to hoard surplus permits to meet future possible needs. Firms may also be inclined to hoard permits as a means of gaining an advantage over a competitor. To some extent, permit markets are self-regulating against this tendency: the more permits are withheld from the market, the greater their price will be and the greater the implicit cost of withholding. Firms would also be less inclined to hoard permits if the permits were frequently reissued. The possibility of hoarding would be avoided if permits could not be carried over from one period to the next (although for reasons discussed below, in some cases it may be desirable to allow permits to be carried over into subsequent periods). In addition, the regulatory authority could promote active trading, and thus reduce the incentive to hoard, by holding back a certain number of permits and auctioning them off at intervals.

Measures of the kind discussed above can help to ensure that active trading takes place, thereby allowing the full potential economic benefits of a tradeable permits system to be realized. And, to repeat an observation made earlier, even if trading is limited, a tradeable permits system can be more cost-effective than traditional command-and-control regulation.

Banking
Banking of permits would allow a company to save unused permits from one period, carry them over and apply them to emissions in a later period. This could inhibit permit trading, as firms might be inclined to accumulate excess permits for future use. However, banking does offer certain advantages. It prevents instability in the price of permits, which might occur near the end of a trading period as permit holders attempt to unload excess permits before they expire. More important, banking can accommodate businesses that experience pronounced business cycles, and can give firms more flexibility in meeting emission reduction targets or in phasing out polluting substances. Banking can provide another advantage where the program calls for a progressive reduction, over time, in the number of permits allocated. In such cases it can provide an incentive to a firm to invest in pollution control earlier rather than later, and thus accumulate surplus permits to sell at what is likely to be a higher price later.

An important consideration in determining whether to allow banking, or to restrict it, is the nature of the environmental problem being addressed by the tradeable permit program. For example, banking may not be appropriate in a situation where additional emissions later in the program schedule would jeopardize the environmental goal. A possible compromise in such situations would be to impose restrictions on when "banked emissions" could be used.

Interpollutant trading
In some cases, more than one pollutant may be responsible for an environmental problem. Ground-level ozone, for example, is caused by volatile organic compounds (VOCs) and nitrogen oxide (NO_x) emissions. One issue, in this case, would be whether to include sources of emissions for both of the pollutants in the trading program. Another would be whether to allow trading between the emissions of the two pollutants.

From an environmental perspective, the ideal arrangement would be an inclusion in the trading program of all the pollutants involved in the environmental problem. Theoretically, at least, trading could be permitted across pollutants without jeopardizing attainment of the environmental goal. This would require that the relationships between the pollutants in creating the environmental problem were reasonably understood, thus allowing the appropriate trading ratios to be established. In practice, determination of these relationships could be a complex challenge.

From an economic perspective, cross-pollutant trading is desirable because it could increase the number of sources in the trading scheme, thereby allowing for greater flexibility and cost savings.

4.1.1 Acid Rain

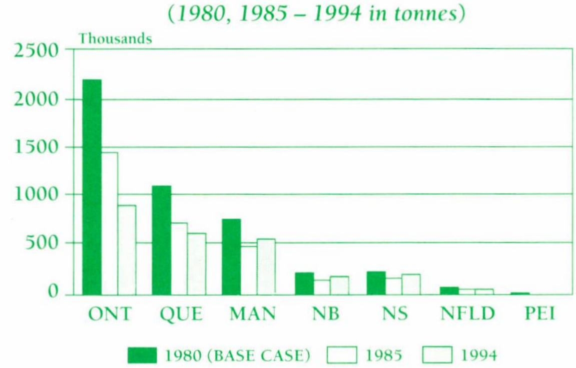
Background

Acid rain is caused in Canada principally by emissions of sulphur dioxide (SO_2), although nitrogen oxide (NO_x) emissions are also precursor pollutants. Once released into the atmosphere, the emissions are carried long distances by prevailing winds and return to earth as acid rain, snow, fog or dust. When the environment cannot neutralize the acid being deposited, damage occurs to forests, lakes and fish populations.

Canada's existing program
Launched in 1985, Canada's Acid Rain Control Program targets Eastern Canada. Under the program, the federal government and the seven provinces east of Saskatchewan agreed to reduce total eastern Canadian emissions of sulphur dioxide (SO_2) to 2.3 million tonnes per year – about 50 per cent of 1980 base case levels – and to achieve this goal no later than 1994. To achieve this objective, they also agreed to a series of limits to provincial emissions.

By 1985, as shown in Figure 5, five provinces – Manitoba, New Brunswick, Nova Scotia, Newfoundland and Prince Edward Island – had already reduced emissions below their 1994 caps (although in some cases emissions rose again by 1987 to exceed the cap). All provinces had reduced emissions significantly relative to 1980.

Figure 5
Eastern Canadian SO_2 emissions
(1980, 1985 – 1994 in tonnes)



Source: Environment Canada

Ontario, Quebec and Manitoba have issued regulations to ensure that they meet their 1994 emission ceilings. The Ontario and Manitoba regulations each set annual emission ceilings for individual companies (four companies in the case of Ontario, two in the case of Manitoba). Quebec's regulations, by contrast, apply to specific sectors, such as copper or zinc smelting, rather than to companies. Also, Quebec's limits are generally specified in terms of emission rates (per tonne of output, or as a percentage of sulphur contained in the raw materials), rather than overall quantities. In addition, all three provinces set air quality standards for SO_2 (as well as other emissions), and installations generating these gases are not allowed to cause emissions that would exceed these air quality standards.

SO_2 emissions in Eastern Canada have already been reduced to about 2.8 million tonnes (almost 40 per cent below the 1980 base case level). Regulatory and program measures that will reduce emissions to 2.5 million tonnes are already in place. The remaining reduction in emissions will be allocated to meet the goal of 2.3 million tonnes by 1994.

U.S. program

The United States has also introduced a comprehensive acid rain control program, and has signed a bilateral agreement with Canada. In 1990, Congress legislated a 10-million-ton reduction in U.S. SO_2 emissions, and has permanently capped these emissions at the reduced level. As a result of these actions, it is expected that by the year 2000, the transboundary flow of acid rain into Eastern Canada will be reduced by more than 50 per cent. The March 1991 Canada-U.S. agreement covering acid rain and other transboundary air pollutants incorporates the emissions caps set forth in the amended U.S. Clean Air Act.

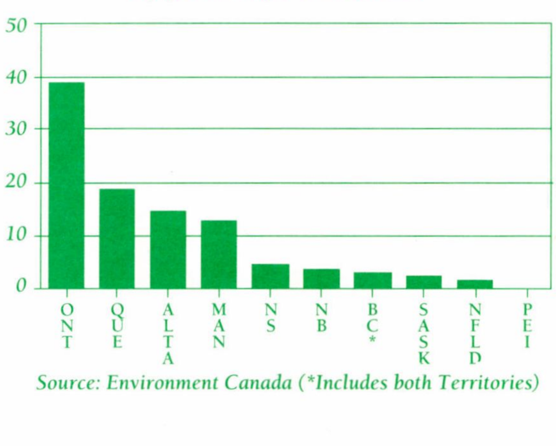
Next steps

In the Canada-U.S. agreement, Canada made a commitment to extend the cap on SO_2 emissions by the seven most easterly provinces from 1994 to the year 2000. Canada also pledged to establish a permanent national emissions cap of 3.2 million tonnes of SO_2 by the year 2000. The *Green Plan* commits the federal government to determine with the provinces the feasibility of using emissions trading as a means of controlling emissions in both Eastern and Western Canada in a more cost-effective manner.

Sources of SO_2 emissions in Canada

The 1985 distribution of Canada's SO_2 emissions by province is shown in Figure 6. Emissions from the seven provinces included in the Acid Rain Control Program account for about 80 per cent of total national emissions. Ontario accounts for the single largest share of total emissions (39 per cent), slightly more than twice as much as the next largest contributor, Quebec (19 per cent).

Figure 6
National SO_2 emissions - 1985
(by province, per cent of total)



*Source: Environment Canada (*Includes both Territories)*

Table 1 outlines national SO_2 emissions in 1985 by sector. Metal smelting, power plant fuel combustion and petroleum processes account for approximately 86 per cent of total national SO_2 emissions, with the single largest source being non-ferrous metal smelting (48 per cent of the total). Utility power plants account for 20 per cent of the total. This breakdown is substantially different from that in the United States where utilities account for the majority of SO_2 emissions (roughly 70 per cent).

Table 1
National SO_2 emissions
(by category, 1985)

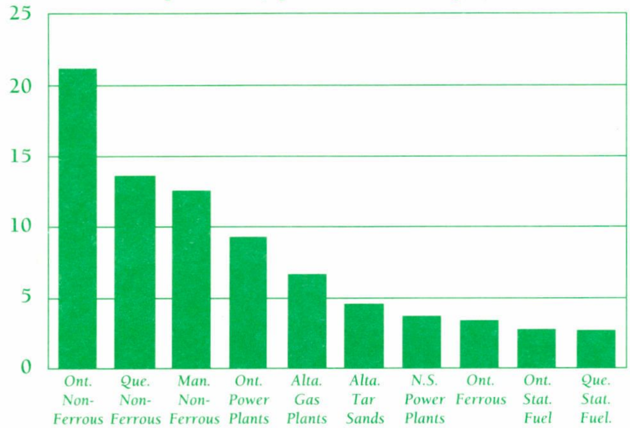
Category	Tonnes/Year	Percentage
Metal Smelting	1,898,126	51.5%
Non-Ferrous	1,781,469	48.3%
Ferrous	116,657	3.2%
Power Plant Fuel Combustion	737,731	20.0%
Petroleum Processes	531,960	14.4%
Crude Oil	30,003	0.8%
Refineries	73,959	2.0%
Gas Plants	265,573	7.2%
Tar Sands	162,425	4.4%
Stationary Fuel Combustion	279,361	7.6%
Other Industrial	142,826	3.9%
Transportation	94,857	2.5%
Incineration	1,748	0.1%
TOTAL	3,686,609	100.0%

The ten largest source categories of SO_2 broken down by province and sector are shown in Figure 7. These ten sources account for 79 per cent of total national emissions. It is noteworthy that the four largest sources, and eight of the top ten sources, are located east of Saskatchewan. Also of interest is the fact that the Saskatchewan and Alberta electric utility sectors, despite their reliance on coal, do not figure among the top ten emitters – the two Western Canadian sources in the top ten are Alberta gas plants and Alberta tar sands plants.

Figure 7

Ten largest SO_2 emitters - 1985

(per cent by province and category)



Source: Environment Canada

Design Considerations

Overview

Tradeable permits appear particularly well suited to the problem of controlling SO_2 emissions, since an overall emissions cap has already been established.

Indeed, Canada's existing acid rain control program has some of the characteristics of a tradeable permits system in that it gives firms some flexibility in how to meet emission limits. Ontario Hydro, for example, is free to shift or "trade" emissions between its various electricity generating stations, provided its total emissions do not exceed the authorized level.

Under a formal program of tradeable permits, emissions "trading" would be allowed within a given company, either within a plant or between plants, as is currently permitted Ontario Hydro. But the program would also allow emissions trading between companies – in the same province, if the program were applied on a provincial basis, and in various provinces, if the program were applied on a regional or national basis.

Certain issues specific to acid rain would need to be addressed in designing any trading program to control SO_2 emissions.

Trading zones

Simply put, the trading zone is the area within which emissions could be traded on a one-for-one basis. Ideally, from the point of view of environmental protection, trading zones would encompass areas in which the acid rain problem is of similar severity. Otherwise, trading could lead to a decrease in environmental quality.

In the case of acid rain in Canada, the creation of a single trading zone would not be desirable from an environmental point of view, since there is considerable variance, from region to region, in the gravity of the problem. The problem is most serious in Southern Ontario and Western Quebec, considerably less serious in the Atlantic provinces and Northern Quebec, and less serious again in Western Canada. This suggests that three zones might be appropriate: the Atlantic provinces, Ontario and Quebec, and the Western provinces (including Manitoba). Zones defined in this way might not distort the environmental effectiveness of the system unduly, and would be convenient for administrative purposes.

However, only a relatively small number of firms in each zone would qualify as major sources of emissions. This could impede the development of a functioning trading market and the realization of the economic benefits of trading, since it could induce "strategic" (non-competitive) behaviour. Given the small size of the Canadian market, this would be a potential problem no matter how trading zones were defined. The point is that it could be exacerbated by a configuration that decreases the zone size and the number of sources in each zone.

This particular pitfall could be at least partially addressed by allowing limited trading between zones. One option would be to allow sources in Ontario and Quebec to sell permits to sources in other zones, but not to buy from sources in those zones. Another option would be to allow permits to be bought and sold in any trading area, but not on a one-for-one basis. A source in Ontario or Quebec which wished to increase emissions by one unit could buy one permit from another source in its own zone, or, say, two permits from a source in another trading zone.

Sources to include

A large proportion of Canada's SO_2 emissions comes from a small number of companies. In Manitoba, according to 1985 data, Inco and Hudson Bay Mining and Smelting are responsible for roughly 95 per cent of provincial SO_2 emissions. In Ontario, four corporations – Inco, Algoma, Falconbridge and Ontario Hydro – contribute 80 per cent of the province's emissions. In Quebec, Noranda accounts for over half of provincial SO_2 emissions. Together, these six corporations, all of which are included in the Acid Rain Control Program, account for approximately half of all Canadian emissions of SO_2. In addition, the largest SO_2 emitters in New Brunswick and Nova Scotia are provincially owned electric utilities. At the very least, therefore, any tradeable permit system would have to include these sources. In addition, a national program would have to include major Western sources such as tar sands plants and utilities. Gas plants should also be included provided the number of these sources would not lead to excessive administration and monitoring costs.

Consideration could be given to also including other "minor" sources such as pulp and paper mills, refineries and other relatively large industrial sources. (It would be cumbersome to include transportation sources in the system because of their large number, but in any event their relative contribution to the overall acid rain problem is small). Broadening the system beyond the large sources could significantly increase the number of firms subject to the tradeable permits system. This could be seen as making the system more equitable. What it would probably not do is add significantly to the competitiveness of trading, since the market for permits would continue to be dominated by the major sources. It is also questionable whether the environmental benefits would warrant the increased administration costs.

Inter-pollutant trading
Another design consideration is whether or not to allow inter-pollutant trading between NO_x – which also contributes to acid rain – and SO_2, and if so whether such trading should be on a one-to-one basis. Allowing inter-pollutant trades could potentially expand the market for permits and improve the effectiveness of the trading system. This could be particularly advantageous in the case of SO_2 emissions in Canada, in view of the small number of major sources. Allowing inter-pollutant trading could also increase the diversity of sources covered by the program, and therefore increase the potential benefits from trading. Ontario, through its regulation dealing with Ontario Hydro, already implicitly allows trading between SO_2 and NO_x emissions on a one-for-one basis. The issue of whether or not to allow more general trading between SO_2 and NO_x must be examined carefully from an environmental perspective, for example, in some sites nitrogen is taken up by the ecosystem as a nutrient and therefore does not contribute to the acidity of freshwater ecosystems. It must also be examined in the context of measures being taken to control ground-level ozone, a problem in which NO_x is also implicated.

Trading with U.S.
Another issue is whether to allow trading between Canadian and American sources. Allowing such trading could make sense on environmental grounds, since each country contributes to the other's acid rain problem. Inter-country trading would likely increase the scope for cost reductions through trading by greatly expanding the permit market, at least from a Canadian perspective. There could, however, be problems with respect to issues such as jurisdiction, enforcement, permit exchange rates, etc. The 1990 amendments to the U.S. Clean Air Act establish a comprehensive tradeable permits system for SO_2 emissions from electric utilities. If trading were eventually to be allowed between Canadian and U.S. sources, it would make sense to design the Canadian system with the American system in mind.

4.1.2 Ground-Level Ozone – Smog

Background

Smog
Ground-level ozone, a major component of smog, is caused by the interaction of emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs). The reaction is directly related to the amount of sunlight and to temperature, which is why ground-level ozone is prevalent in the summer. The ozone levels that develop depend on the extent to which weather conditions are conducive to ozone build-up, and these conditions vary widely throughout the summer.

During the summer months, more than half the population of Canada is exposed at one time or another to concentrations of ground-level ozone that can harm human health and vegetation. Conditions are particularly severe in three areas – the Lower Fraser Valley of British Columbia, the Windsor-Quebec City corridor, and the Southern Atlantic region. In the Lower Fraser Valley, ground-level ozone originates primarily from local NO_x and VOC emissions sources. In sections of the Windsor-Quebec corridor near the U.S. border, imported pollutants from the U.S. are the primary cause of ground-level ozone, while further along the corridor, domestic sources of NO_x and VOCs become progressively more important. Ozone build-ups in the Southern Atlantic area are caused largely by pollutants transported from the U.S.

Management Plan For Nitrogen Oxides And Volatile Organic Compounds
In October 1988, the Canadian Council of Ministers of the Environment (CCME) ordered the drawing up of a management plan to control NO_x and VOC emissions. As a result the Management Plan for Nitrogen Oxides and Volatile Organic Compounds was developed. In November 1990, CCME approved the Plan in principle and established a target for the concentration of ground-level ozone of no more than 82 parts per billion (per hour) for all regions of Canada by the year 2005. The target is essentially now being met in all but the three problem areas.

Essentially the Management Plan is a strategy for the containment of ground-level ozone in areas where the CCME target is already met, and for reduction of ground-level ozone in problem areas. The Plan is broken into three phases. Phase I of the Plan, covering the period to 1994, was released in November 1990. Phase II will be prepared in 1994 and Phase III, if necessary, in 1997.

Phase I
In Phase I, a national (i.e., nation-wide) prevention program will be introduced to control NO_x and VOC emissions. In addition, interim NO_x and VOC emission targets will be established for the years 1995 and 2000 for the three geographical problem areas mentioned above; remedial measures will be introduced to reduce NO_x and VOC emissions specifically in the problem areas – steps which, together with the measures of the national prevention program, will aim to attain the interim targets; and a program of studies and investigations aimed at providing the information needed to set final NO_x and VOC emission targets for the problem areas for the years 2000 and 2005 will be undertaken.

The Phase I Plan outlines possible initiatives for controlling NO_x and VOC emissions for the Phase I national program, and for reducing emissions in the three geographic problem areas mentioned above. A "base set" of 31 initiatives are proposed for the national program. They include emission limits for transportation sources, energy efficiency standards for equipment and appliances, new-source performance standards for stationary sources of NO_x and VOCs, and measures to reduce emissions from products containing solvents. A set of 27 "illustrative" regional emission reduction initiatives are outlined, and responsible jurisdictions may wish to draw upon these in designing remedial programs for non-attainment areas. These "illustrative" measures include retrofit programs for existing NO_x and VOC sources, the development of environmentally oriented urban transportation systems, and ozone episode management plans to deal with peaking problems.

The initiatives outlined in Phase I – which largely reflect traditional regulatory approaches to addressing environmental problems – are essentially a menu of options for controlling NO_x and VOC emissions. The Management Plan recognizes that there are other approaches that might achieve as good or better ozone control results, and also be more cost-effective (for example, emissions trading). The Phase I Plan therefore provides for the substitution of "environmentally equivalent" measures for those specified. In the *Green Plan*, incidentally, the federal government has undertaken, in cooperation with the provinces, to pursue emissions trading as part of its implementation of the smog control program, and to determine the extent to which emissions trading can be used in those urban centres most affected by smog.

Phases II and III

In Phase II, the final 2000 and 2005 emission targets for NO_x and VOCs will be established for the problem areas, along with a determination of the additional measures needed to achieve those targets. The emission targets for 2005 will be selected to ensure consistent attainment of the goal of 82 parts per billion in all regions of Canada. Areas additional to the three currently identified as ozone non-attainment areas may also be designated as non-attainment areas, and emission targets established for them. An opportunity will be afforded for final adjustments to the 2005 targets and control programs in the third phase of the Plan scheduled for 1997.

Transboundary air quality agreement

Under recent acid rain amendments to the Clean Air Act, the U.S. will undertake major new emission control initiatives to push total annual emissions of NO_x down by two million tons from 1980 levels, and to do so by the year 2000. These initiatives, which are incorporated in the recently signed Canada-U.S. Transboundary Air Quality Agreement, will reduce the U.S. contribution to Canadian ozone concentrations. In addition, the CCME has agreed that bilateral negotiations with the U.S should be pursued to move ozone levels in border states down towards the Canadian objective of 82 parts per billion.

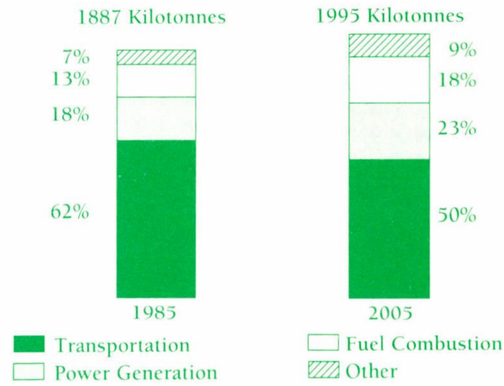
Sources of Emissions

Sources of NO_x emissions

More than 95 per cent of NO_x emissions originate from the combustion of fossil fuels in all sectors of the economy. As illustrated in Figure 8, the major sources of NO_x emissions are, in order of size: the transportation sector; power generation; heating and other fossil fuel combustion in the industrial, commercial and residential sectors; and industrial processes.

The transportation sector accounted for about 62 per cent of NO_x emissions in 1985 and by 2005 it is expected to account for approximately 50 per cent of the total. The expected reduction in the share of emissions generated by transportation will come for the most part from the retirement and replacement of older vehicles

Figure 8
NO_x emission sources



Source: Management Plan for Nitrogen Oxides and Volatile Organic Compounds: Phase I, November, 1990, p. A-5.

(particularly cars) by more energy- efficient, less-polluting vehicles which meet current emission regulations. In terms of absolute volumes, however, total emissions from the transportation sector are expected to increase with an increase in the number of vehicles on the road.

The second largest NO_x emission source is fossil-fuelled power generation plants. This sector accounted for about 18 per cent of total NO_x emissions in 1985, and is expected to account for about 23 per cent in 2005.

The next largest source is the combustion of fuel in the industrial, commercial and residential sectors. Fuel combustion in these sectors accounted for about 13 per cent of total NO_x emissions in 1985. This proportion is expected to increase to about 18 per cent by 2005.

The "other sources" category, comprising for the most part industrial processes, accounts for less than 10 per cent of actual and forecast emissions in 1985 and 2005.

Sources of VOC emissions

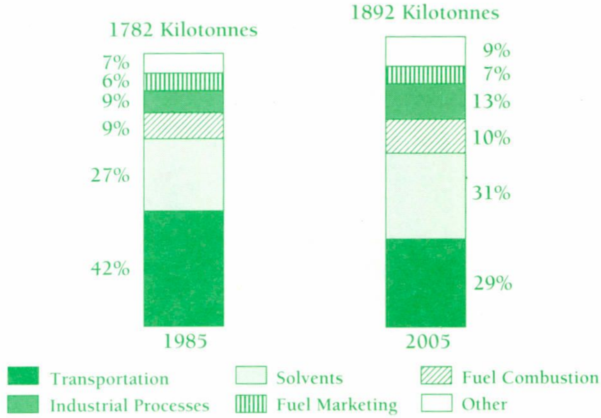
Natural sources, such as forests, generate as much as 85 per cent of VOC emissions in Canada as a whole. However, in urban areas with smog problems, emissions from man-made sources of VOCs can be several times larger than those from natural sources.

The major sources of man-made VOC emissions are illustrated in Figure 9. They include the transportation sector; industrial processes; the evaporation of solvents; the combustion of fossil fuels in the industrial, commercial and residential sectors; and the evaporation of liquid fuels during their production, storage, handling, or final use (fuel marketing).

As with NO_x, the largest source of man-made VOC emissions is the transportation sector. In 1985 this sector accounted for about 42 per cent of VOC emissions. By 2005, it is expected to account for a significantly smaller proportion – in the order of 29 per cent. As in the case of NO_x emissions, the reduction in expected VOC emissions from this sector reflects the expected turnover of existing vehicles.

Figure 9

VOC emission sources



Source: Management Plan for Nitrogen Oxides and Volatile Organic Compounds: Phase I, November, 1990, A-20.

In 1985, the second largest source of VOC emissions was solvents. By 2005 they are expected to be the largest source, accounting for about 30 per cent of emissions.

The next largest sources of VOC emissions in 1985 were fuel combustion (in the industrial, commercial, and residential sectors) and industrial processes, each accounting for about nine per cent of total VOC emissions. By 2005, fuel combustion is expected to account for about the same proportion of total VOC emissions, while the contribution of industrial processes is expected to increase to about 13 per cent.

Fuel marketing accounts for less than 10 per cent of actual and forecast emissions.

Application of Trading Programs to Control NO_X and VOC Emissions

As noted above, the ground-level ozone objective is a concentration of no more than 82 parts per billion by 2005 in all of Canada. Interim emissions targets for NO_X and VOCs – the pollutants that cause ground-level ozone – are being established for the three geographic problem areas (the Lower Fraser Valley, the Windsor-Quebec City corridor, and the Southern Atlantic region) for the years 1995 and 2000 in the first phase of the Management Plan. Final targets or caps for NO_X and VOC emissions for 2000 and 2005, designed to achieve the ozone air quality objective of 82 parts per billion, will be established in Phase II of the Management Plan.

Emissions trading could play a role in attaining the NO_X and VOC emissions targets in the three problem areas and could also be part of the national prevention program. For example, as discussed below, emissions trading programs specific to the problem areas would necessarily focus on large stationary sources in those regions. There could also be emissions trading programs at the national level for sources which could not easily be included in area-specific trading programs. These could complement regional emissions trading, and also prevent ozone problems from arising in areas not now afflicted.

Emissions trading programs for NO_X and VOCs are explored below separately. Both VOC and NO_X emissions could conceivably be included in one trading program, in effect allowing trading between these two pollutants. At this time, however, our scientific understanding of the impact of incremental NO_X and VOC emissions on the formation of ozone is not complete enough to determine an appropriate trading relationship between these pollutants. When our scientific understanding is fuller, separate NO_X and VOC programs could be combined, and should be designed with this possibility in mind.

Design of NO_X Emissions Trading Systems for the Problem Areas

Which sources to include

The potential for use of emissions trading systems in the three problem areas varies according to the NO_X- emission characteristics of the relevant sectors.

In the transportation sector, for instance, the individual sources of NO_X are small, numerous and mobile and it would not be practical to monitor them individually. This would make it very difficult to include the transportation sector in regional emissions trading systems for the three problem areas.

The power generation sector, by contrast, is made up of large, easily identifiable sources. It would therefore be practical to include this sector in an emissions trading program.

In the category of emissions from fuel combustion, sources of emissions vary from the numerous and small (such as residential furnaces and heating boilers in commercial and institutional establishments) to the few and large (e.g., industrial boilers). While residential furnaces and boilers in commercial and institutional establishments may not practically be included in a regional trading program, large industrial boilers could be included.

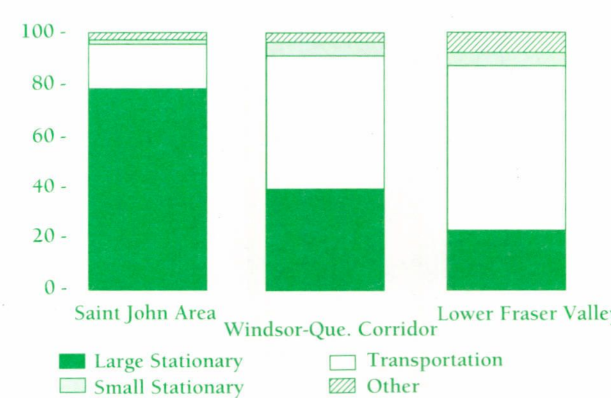
Similarly, NO_X emissions from industrial processes are generated by both small and large sources. Again, the larger sources could be identified and included in a trading program. Large municipal incineration devices could also be included.

Figure 10 illustrates, for the three problem areas, for the year 2005, the proportions of total NO_X emissions that

Figure 10

NO_X emissions in problem areas: 2005

(Percent)



Source: Management Plan for Nitrogen Oxides and Volatile Organic Compounds, Phase I, November, 1990, pp. 47, 56, 62.

are expected to originate in large stationary sources, small stationary sources and the transportation sector. The contribution of the large stationary sources – the sources that could most easily be fitted into an emissions trading program – varies significantly between regions. In the Saint John area, for example, large stationary sources are expected to account for more than three quarters of NO_x emissions generated locally. By contrast, in the Windsor-Quebec City corridor and the Lower Fraser Valley they are expected to account for roughly 40 and 20 per cent of the projected NO_x emissions respectively.

Emissions limit for included sources

The emissions targets to be established for NO_x (and VOCs) will be for emissions from all sources. This means that if emissions trading were to be introduced, emissions limits or caps would have to be established specifically for the large stationary sources included in the program.

In determining the emissions caps for large stationary sources in each region, authorities would need to weigh a number of factors. One would be the expected impact of the measures being taken in other programs to limit NO_x and VOC emissions from the other sources. Another would be the proportion of total NO_x emissions accounted for by the sources included in the program.

Appropriate trading zones

It may not be appropriate to treat the three problem areas as single trading zones. In fact, to achieve the environmental goal of 82 parts per billion throughout each area, it may be necessary to have two or more trading zones in an area. However, there is an important factor that would have to be considered in defining these zones. If a trading program is to work in the sense of minimizing the cost of meeting the environmental targets, each trading zone must contain a number of sources with different abatement costs. This means that zones, ideally, should not be so small that there would be too few diverse sources in each zone to make the system effective. So the number, type and location of sources of NO_x emissions in the problem areas would have to be identified in order to accurately define appropriate trading zones.

A preliminary analysis suggests that, in the Windsor-Quebec City corridor, the number of diverse sources is more than adequate to ensure trading, and to do so without compromising environmental objectives. In the Ontario section of the corridor there are over 200 large stationary emission sources that could be included in a trading program. There are also many large stationary sources in the Quebec section of the corridor. This suggests that the Windsor-Quebec City corridor could be divided into several trading zones if that proved to be necessary to achieve the ozone objective.

In the Lower Fraser Valley of British Columbia, there are over 100 large stationary sources of NO_x emissions that could be included in a trading program. Over 60 per cent of the emissions, however, are generated by just six sources. This suggests that if the region were treated as one trading zone, there would be enough sources to promote trading in the region, but that there is not much scope for dividing the region into more than one zone.

Preliminary analysis indicates that there are far fewer large stationary NO_x sources in the Saint John area. The potential for trading in this area could therefore be more limited, particularly if the region were divided into more than one trading zone.

Seasonal and episodic controls

The need to address seasonal and episodic problems is a design issue specific to the control of ground-level ozone. To begin with, the problem is seasonal – ozone build-ups occur almost entirely in the summer. It is also episodic: ozone formation depends on the occurrence of weather conditions conducive to the build-up of ozone, and these conditions can vary widely within the summer. Because of these factors, it is important that trading programs be so designed that they do not stimulate increased emissions in the summer months.

One way to meet this requirement would be to issue, each year, two types of permits. One type would allow NO_x emissions in the summer months; the other would allow NO_x emissions in the rest of the year. This would entail allocating a two-level annual ceiling on NO_x emissions – one level for the summer and another, higher level for the other months. The summer cap could be determined on the basis of an inventory of historical summer emissions, and on an estimate of the reduction needed to attain air quality goals. The cap on the other months would reflect levels consistent with the prevention of ozone problems in these months. The cap could, in fact, initially be higher than actual emissions.

Sources would be allocated both types of permits. This would allow them to emit a specified amount of NO_x in the summer, and a specified, different amount in the rest of the year. Trading of the summer permits would be allowed in the summer months. The trading of summer permits in the non-summer months when ground-level ozone is less of a problem could also be considered. This could reduce summer emissions below the summer cap, and increase emissions in the other months. The trading of summer permits in the other months could also be considered if it were determined that this would not create ozone problems in the other seasons. Generally speaking this would not be likely to occur since it is unlikely that a large number of summer permits would be traded in the other months, given that the market value of summer permits would probably be significantly higher than the non-summer permits. Trading of non-summer permits would clearly not be allowed in the summer months.

This would take care of the seasonal aspect of the ozone problem. The other requirement would be control of episodic, high ozone build-up. One option for doing so would be through a system of supplementary controls. The Management Plan, for example, proposes episodic control measures in the urban areas, including "restricted activity days" that would require curtailment of certain activities when high ozone levels are forecast. On the very worst ozone days, regulatory authorities could order sources, in particular the largest ones, to curtail emissions. Another option, which would be administratively more complicated, but which would give industry more flexibility, would be to impose episodic limits on the larger sources. These sources would then be allowed to trade among themselves and thus make use of the limited number of permits allowed during the critical period.

Banking

Restrictions may need to be imposed on the banking of permits, particularly summer permits, so as not to negate the goal of controlling summer emissions. One such restriction might be a prohibition on the carry-over of summer permits into the next calendar year. In the interest of flexibility, this restriction could allow for a carry-over into non-summer months of the next year or two but not into the summer months. Similarly, banking of non-summer permits could be allowed. Whether this added flexibility should be allowed would depend on the assessment of the environmental implications.

Trading with the U.S.

As in the case of acid rain, trading between Canadian and U.S. sources could be considered. From an environmental perspective, transboundary trading makes sense in those problem areas in which the concentration of ground-level ozone depends on flows of ozone produced in the major urban centres in the U.S. The potential for trading with the U.S. would need to be explored in the context of emissions trading in the U.S.

Design of Regional Emissions Trading Programs for VOC Emissions

The issues to be addressed in designing a trading program for VOC emissions are similar to those described above for a NO_x trading program. The sources that could practically be included would need to be identified; an emissions limit would need to be established for these sources; the appropriate trading zones would have to be defined; seasonal and episodic management requirements would need to be met, and the issue of the extent to which banking could be allowed would have to be addressed. Two issues unique to VOC emissions trading – the sources to include, and the appropriate trading zones – are outlined below.

Which sources to include

The feasibility of using an emissions trading system to achieve VOC environmental goals varies, as it does with NO_x, by sector.

As in the case of NO_x, it would be difficult to include the transportation sector in emissions trading systems for the three problem areas, again because of the number and mobility of sources.

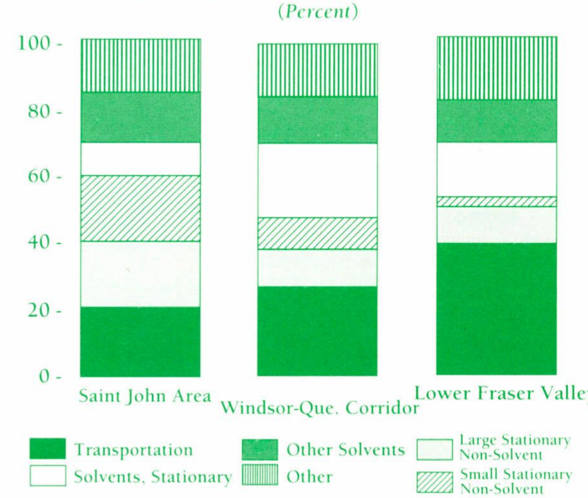
Solvents, however, which constitute one of the most important sources, could be included in part. VOC emissions from solvents vary widely; the points of origin range from numerous consumer products (such as perfumes and cosmetics) and household products (for example, paints) to large stationary sources. The latter include solvent users in commercial/industrial coating application facilities (such as automobile paint shops, and plants for the manufacture of various products), print shops and electronic firms. While consumer and household products could not practically be encompassed in a regional trading program, some of the large sources are potential candidates for inclusion.

A significant share of total VOC emissions originate in industrial processing facilities including petrochemical plants, petroleum refineries, pulp and paper mills, and plastics production installations. These sources could be included in a trading program.

Another source of VOC emissions is fuel combustion in the household, commercial and industrial sectors. While the household and commercial sources are too small and numerous to be easily included in an emissions trading program, the industrial sources (industrial boilers in particular) could practically be included.

For three problem areas, Figure 11 shows the proportion of total VOC emissions that are expected to be released in 2005 from the large stationary non-solvent sources, essentially industrial processes and industrial boilers. It also illustrates the proportion of emissions from stationary solvent sources; not yet identified in the data, some of these sources are large and could be included in an emissions trading program. The large non-solvent stationary sources account for roughly 20 per cent of emissions in the Saint John area, and about 10 to 20 per cent in the other areas.

Figure 11
VOC emissions in problem areas: 2005
(Percent)



Source: Management Plan for Nitrogen Oxides and Volatile Organic Compounds: Phase I, November, 1990, pp. 47, 56, 62.

Trading zones

As in the case of NO_x, the numbers and types of sources of VOC emissions in the problem areas would need to be identified in order to do an effective job of defining trading zones. Preliminary analysis indicates that, in all three regions, the contingent of large stationary non-solvent sources is dominated by a few major sources. In the Lower Fraser Valley, for example, four refineries generate more than 70 per cent of the VOC emissions from large, stationary non-solvent sources. This suggests that, in this area, there is probably not much room for more than one trading zone. However, the inclusion of large stationary solvent sources would add diversity to the program and might add enough sources to improve the prospects for establishing more than one trading zone.

NO_x/VOC Interpollutant Trading

Interpollutant trading would involve allowing sources in the same area to purchase surplus NO_x permits to cover their VOC requirements, and vice versa.

There is some environmental logic to allowing appropriate trading of NO_x and VOC emissions since these two pollutants interact to form ground-level ozone. It would also be economically desirable – interpollutant trading would increase the number of sources that could trade emissions, and would enhance the diversity of sources in an area. This would allow the definition of more trading zones, if deemed desirable from an environmental perspective.

At this time, however, our knowledge of the impact of incremental NO_x and VOC emissions on the formation of ozone is not complete. We do know that the impact of incremental VOC emissions on ozone formation depends on the amount of NO_x emissions present, and vice versa. Reduction in NO_x emissions and an increase in VOC emissions could increase ozone formation in one region. In another, the same change might have the opposite result.

If it is determined, for example, that a reduction in one unit of VOCs is twice as effective in reducing ozone as a reduction in one unit of NO_x, a 2:1 trading relationship could be established between NO_x and VOCs. The trading relationship would need to be assessed periodically, since the interaction of the two pollutants could change as their proportional presence alters through trading. The bottom line is that the ozone-forming interactions of NO_x and VOCs would have to be better understood before interpollutant trading could be permitted.

National Emissions Trading Programs

As noted above, it would be impractical to include the transportation sector, an important source of both NO_x and VOC emissions, in regional emissions trading programs. It would also be difficult to control VOCs from solvents from small sources – an important and growing source of VOC emissions – at the regional level through emissions trading.

These sources could be controlled at the national level, either through complementary regulations, or through emissions trading. Regulations can be and have been effective for the transportation sector. However, emissions trading could add flexibility to the existing regulatory system. Regulations would be very cumbersome to apply to small sources of solvents. There are myriad products with a VOC content, and many difficult and controversial trade-offs to be dealt with in product substitution and reformulation. VOC emissions from small solvent users might be more efficiently controlled through a trading program that limited the amount of solvents available for use in Canada.

Trading programs for transportation emissions

These programs would apply to NO_x and VOC emissions in the transportation sector.

The current regulatory standards for NO_x and VOC emissions fix levels for each vehicle produced by a manufacturer. As a first step to setting up a trading program, the emissions standards would need to be defined on the basis of an average for the fleet or total vehicles produced by a manufacturer. The standard could be specified, for example, on a gram/kilometre basis. Each manufacturer would then be issued permits based on the fleet average standard, and the number of vehicles sold in the previous year or the average over several years.

Manufacturers would be allowed to trade the permits. A manufacturer would have the option of exceeding the fleet average standard as long as it purchased permits for the excess emissions from a company with a fleet average below the standard. Conversely, if a manufacturer had a fleet average lower than the standard, it would be able to sell the rights to the excess emissions to any company requiring additional permits.

The amount of NO_x and VOCs emitted from vehicles is determined not only by the equipment on the vehicles, but also by the composition of fuel. Consideration could therefore be given to a similar trading system for fuel suppliers, which could possibly be integrated with a trading program for vehicle emissions standards described above. As a first step, common emission factors (e.g., on a gram/kilometre basis) would need to be developed for each type of fuel. Each fuel supplier would then be issued permits based on the emissions factors and total sales of each fuel.

Trading program for small sources of solvents

This program would apply to producers and importers of solvents. It would also have to apply to importers of products that contain solvents.

There are about a dozen solvent producers in Canada – a manageable number from an administrative point of view. There is a larger number of importers of solvents and, in particular, importers of products containing solvents. The importers of solvents are already monitored by Canada Customs, although importers of products containing solvents are not. It may be possible to integrate the administration of this part of a trading program with current customs procedures.

Producers and importers of solvents would be required to have permits for their sales of solvents in Canada. For most solvent-related uses, the amount of VOCs in the solvent is very close to the amount emitted. The permits could therefore be denominated in tonnes of VOCs. Importers of products containing solvents would also be required to have permits corresponding to the solvent content of the imported products. Exemptions would be provided for solvents produced in Canada but exported. These exemptions would be made because, in most cases, these solvents would not contribute to VOC emissions in

Canada. The exemptions would help to maintain the international competitiveness of Canadian manufacturers.

The permits would limit the amount of solvents available. The price of solvents would increase to reflect their scarcity. Higher prices for solvents would provide the incentive to producers of products containing solvents to find alternatives to the solvents or to reformulate their products. Other users would have the incentive to recycle solvents.

A number of administrative issues would need to be examined in determining the practical feasibility of such a program. Some solvent uses do not contribute to VOC emissions in Canada – for instance those employed in production processes in which they are largely consumed. In cases where solvents do contribute to VOC emissions, the emissions may already be controlled through other means. For example, VOC emissions from large stationary solvent sources may be included in a regional trading program. Or destructive controls (for example incineration) of solvents may have been instituted by formulators or end users of solvents.

Rules allowing for exemptions and provision of credits would need to be developed to cover such cases. Undoubtedly they would make a trading program more complicated to administer. But even with the complications, such a program might well be less cumbersome to implement than one that set out to control small-source VOC emissions through regulations covering a multitude of solvents and solvent uses. Even if the trading program and regulatory programs turned out to be neck-and-neck in terms of complications, trading might well turn out to be the preferred approach because of other inherent advantages. Notable among these would be superior flexibility in allowing producers and users to develop cost-effective alternatives. Given the wide variations in the difficulty of reducing or eliminating solvents, the potential for cost savings is large.

4.1.3 Global Warming

Background

There is general agreement among scientists that the composition of the atmosphere is changing and that this will lead to changes in the global climatic system. There is a concern that man-made emissions of the so-called greenhouse gases – carbon dioxide, methane, nitrous oxide, ground-level ozone and chlorofluorocarbons (CFCs) – will lead to a major warming of the earth's surface.

The international community is taking action to address the problem of global warming. A number of countries, including Canada, have established national targets for greenhouse gas emissions. International negotiations on a framework convention on climate change commenced in February 1991, and have been a main focus of preparations for the 1992 U.N. Conference on Environment and Development.

Canada's proposed approach to the problem of global warming is set out in the National Action Strategy on Global Warming, developed by the federal, provincial and territorial governments. The National Action Strategy proposes certain principles and plans for action to be implemented by governments and all other sectors. In November 1990, the CCME considered the draft strategy and released it for public discussion.

There are three main elements to the National Action Strategy:

- limiting greenhouse gas emissions;
- adapting to potential changes resulting from global warming; and
- improving scientific understanding of the global warming process.

On the subject of limiting greenhouse gases the Strategy proposes, as a matter of basic principles, that the response be flexible and that it be developed with close attention to the international context. It proposes a phased, progressive approach which involves doing first those things which make sense in their own right.

As a first step towards limiting greenhouse gas emissions, Canada has committed itself to stabilize Canadian CO_2 and other greenhouse gas emissions not controlled under the Montreal Protocol (CFCs) at 1990 levels by the year 2000. The Government of Canada has said it believes that further cuts in greenhouse gas emissions are required, but that they must be based on a program of targets and schedules agreed upon internationally.

In the *Green Plan*, released in December 1990, the federal government announced first measures under the strategy to fulfil Canada's commitment to stabilize greenhouse gas emissions. These measures are either economic in their own right or serve multiple policy objectives. The provinces and territories are developing additional measures within their respective jurisdictions.

The National Action Strategy recognizes that it may take more than these first steps to achieve the stabilization goal, or any more ambitious target that may be adopted as a result of an international agreement. The strategy therefore proposes that governments begin studying potential longer-term, wider-scope measures that may become necessary to reduce emissions. These measures include economic instruments, such as tax strategies and an emissions trading program. They also include measures to make markets work more efficiently, such as regulatory/institutional changes affecting electric and gas utilities, and lifestyle changes, such as increased use of urban transit.

Sources of Emissions

Consistent, reliable data on both national and international emissions of all greenhouse gases are not available. The emissions for which the most reliable data are available are CO_2. Even here, estimates of emissions from certain sectors, such as agriculture, are tentative at best. Data on emissions of other gases – methane and nitrous oxide, in particular – are even less reliable. Work is now in progress to obtain better data on all greenhouse gas emissions. Meanwhile, the best available data indicate that, in 1987, CO_2 accounted for about 66 per cent of Canada's known man-made greenhouse gas emissions. CFCs accounted for 17 per cent, methane 12 per cent, and nitrous oxide five per cent. Estimates for the contribution of ground-level ozone are not available.

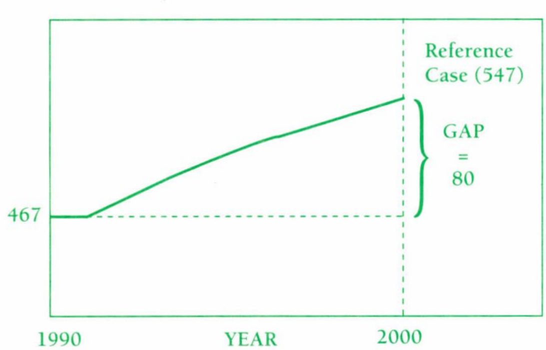
Ideally, from both an environmental and an economic perspective, all the greenhouse gases should be included in a trading program. However, the lack of reliable data on emissions of gases other than CO_2 suggests that, at this stage, it is feasible to examine a trading system only for CO_2. Moreover, the gases for which the best data exist – CFCs and NO_x/VOCs (which, while not themselves greenhouse gases, are precursors to ground-level ozone) – are already targeted by other programs. Canada is introducing measures to eliminate CFCs by the end of 1995 as part of its program to protect the ozone layer. Control of NO_x and VOC emissions is being addressed by the federal/provincial NO_x/VOCs Management Plan. The possible use of a trading program to control NO_x and VOC emissions was discussed earlier in this paper.

Carbon dioxide emissions

Energy consumption and agricultural land use are the two principal man-made sources of CO_2 emissions in Canada. Estimates of emissions from agricultural land use are highly uncertain. Better data are available for other non-energy and energy sources. The energy sector is estimated to account for over 450 million tonnes of CO_2. Non-energy sources other than agriculture, such as cement and ammonia production and incineration, account for about 12 million tonnes per year.

Figure 12 shows a projection of CO_2 emissions to the year 2000, carried out under "business as usual" assumptions. Total CO_2 emissions (other than from agriculture)

Figure 12
Stabilization gap – CO_2
(Megatonnes)



Source: EMR/EC Projection (excludes biomass)

are projected to grow at an average rate of 1.6 per cent over the 1990-2000 period. At this rate, emissions in 2000 would be about 17 per cent higher than in 1990.

The distribution of emissions by sector is shown in Table 2. Transportation was estimated to account for about 27 per cent of CO_2 emissions in 1990, and industry for about 17 per cent. About 23 per cent of emissions was estimated to have resulted from the conversion of fossil fuels to electricity, about 18 per cent was produced by direct fossil fuel consumption in the residential and commercial sectors, and roughly 13 per cent was associated with producer and petrochemical consumption ("other" in Table 2).

Table 2
Projected CO_2 emissions by sector
(In megatonnes, per cent of total figures in brackets)

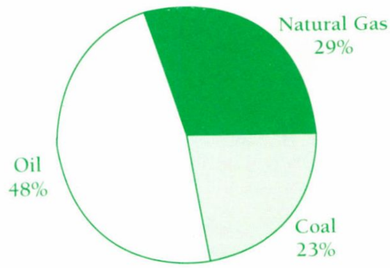
	1990	2000	% Change
Non-Energy	12(3%)	15(3%)	+25%
Energy			
Residential	52(11%)	52(10%)	0%
Commercial	31(7%)	36(7%)	+16%
Industrial	81(17%)	96(18%)	+19%
Transportation	126(27%)	147(27%)	+17%
Conversion Loss	106(23%)	124(23%)	+17%
Other	60(13%)	79(14%)	+32%
Total	467	547	+17%

Source: Environment Canada / EMR

Over the next ten years, most sectors are expected to have a roughly equal rate of growth in greenhouse gas emissions. The exceptions are the residential sector and the producer consumption and petrochemical sectors. Emissions by the residential sector are projected to be virtually flat over the period, primarily because of slow population growth. The producer consumption sector is expected to have the highest growth rate, largely because of emissions generated by increased production of natural gas and oil.

A breakdown of 1990 energy-related CO_2 emissions by fuel is shown in Figure 13. Oil is the single largest source of CO_2 emissions with 48 per cent of the total. Natural gas and coal contributed 29 per cent and 23 per cent, respectively.

Figure 13
Energy CO_2 emissions by Fuel
(1990, per cent of total)

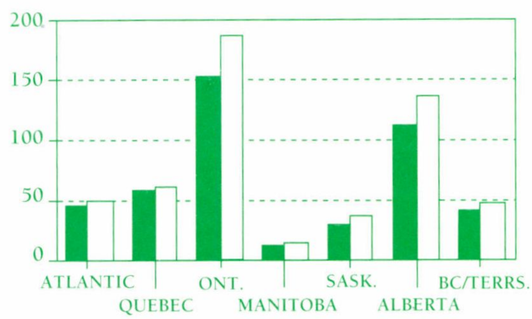


Total: 455 Megatonnes

Source: Environment Canada/EMR

Figure 14 shows the estimated distribution of energy-related CO_2 emissions by province for 1990, and the projected distribution for 2000. Ontario produced the most emissions, followed by Alberta. Together these two provinces accounted for almost 60 per cent of the total energy CO_2 emissions. Ontario and Alberta are also the provinces which, over the coming 10 years, are expected to experience the most rapid growth in emissions. The high projected growth rate is largely based on anticipated increases in the share of electricity in total energy demand, the importance of fossil fuels in electricity generation in the two provinces and, in the case of Alberta, increased heavy oil, tar sands and natural gas production.

Figure 14
Energy CO_2 emissions by Province
(Megatonnes)



Source: Environment Canada/EMR

Design Considerations

Trading zones

An important and distinctive aspect of this environmental problem is that the contribution of greenhouse gas emissions to global warming is not related to the location of the source. (Certain greenhouse gases or precursors, such as ground-level ozone and nitrogen oxides, do indeed have regional impacts, but these are in addition to any global warming effects they may have and constitute a different problem). A tonne of CO_2 emitted in India has the same effect as a tonne emitted in Canada. For this reason, from the point of view of environmental effectiveness, there is no reason to limit the size of the permit trading zone. This suggests that a greenhouse gas trading system in Canada should be national in scope, as opposed to regional/ provincial. A larger trading zone broadens the base of potential participants in the permit trading market, thereby including a greater diversity of emission reduction possibilities, allowing a greater number of sources to benefit from the potential gains from trade, and reducing the possibility of strategic behaviour in the system.

Which sources to include

For administrative reasons, it may not be feasible to include relatively minor sources since the monitoring and enforcement costs might be out of proportion to their contribution to the problem. On the other hand, for the program to have credibility, it should target a significant percentage of emissions.

Transportation

Among the various sectors, transportation is the single largest emitter of energy-related CO_2 emissions, contributing about 27 per cent of the total, but it also has the largest number of small sources. There are a number of reasons why it might not be feasible to impose an emissions cap on these sources. It would be difficult, for example, to decide how to make an initial allocation of permits to a particular source, since emissions depend on a number of factors, such as fuel-efficiency and number of kilometres driven. (It might, however, be possible to impose a cap by restricting the amount of fuel that could be sold to drivers – this possibility is discussed below.) Also, because of the large number of sources, monitoring would be difficult. It may, however, be possible to devise a tradeable permit system specifically for the transportation sector, and a sectoral approach along these lines is discussed below.

Residential and Commercial

There may also be little scope for implementing a tradeable permit system in the residential and commercial sectors – the large number of small sources would make the administrative burden prohibitive. Other programs, however, could help to reduce emissions in these sectors. A number of *Green Plan* initiatives, for example, focus on improving energy efficiency in buildings and equipment.

Industry and Utilities

The remaining sectors are the industrial sector (including the petroleum and petrochemical industries) and the utility/power generation sector. It would be easier to implement a tradeable permit system in these two sectors. In the case of industry, the major sources of energy-generated CO_2 emissions are the pulp and paper industry, the cement industry, the chemical and petrochemical industries, the iron and steel industry, the petroleum industry and the aluminum industry. The Canadian Energy Research Institute (CERI) has looked at this question. In its view, inclusion of only those firms classified as "large industrial energy users" by Statistics Canada would bring in over 200 sources in these sectors, accounting for 75 per cent of industrial energy use. CERI estimates, moreover, that these sources would account for approximately 20 per cent of total CO_2 emissions.[2]

In Canada, utilities account for roughly 23 per cent of CO_2 emissions (with the percentage varying significantly from province to province). The sector consists, basically, of one provincially owned power-generating utility per province (Alberta is the major exception with three utility companies).

By combining the industrial sector and the utility/power generation sector in one permit trading system, a market of 200-300 sources could be created that would account for over 40 per cent of total Canadian emissions. A trading system targeting these two sectors would likely be large enough that strategic (non-competitive) behaviour would not be a problem. At the same time it would not be so large as to buckle under its own administrative weight. It would also probably be a diverse enough market, in terms of emission-reduction possibilities, to offer the prospect of substantial cost savings from trading.

Transportation

A tradeable permit system designed specifically for the transportation sector would target fuel efficiency directly, but could also, indirectly, reduce CO_2 emissions.

Canada's current automobile fuel efficiency program requires car manufacturers to maintain a fleet average fuel efficiency standard for the vehicles they sell. This program could be transformed into a tradeable permit system by allowing any improvements below the required fleet average to be traded to another manufacturer at a mutually agreed price. It may also be necessary to make the program mandatory – currently it is voluntary.

Although this might be a realistic way to apply the tradeable permits approach to reduction of transportation greenhouse gas emissions, the approach has some shortcomings in this context. First, because of the small number of automobile manufacturers, there is an additional risk that firms would engage in strategic, non-competitive behaviour which could offset the potential economic benefits of the system. In addition, since the system targets fuel efficiency and has only an indirect effect on CO_2 emissions, there could be no guarantee that a specified CO_2 reduction target would be reached. To be more specific, the system would not control either the number of vehicles produced or individual driving behaviour such as number of kilometres driven. The system might also need to be adapted to take into account environmental considerations other than fuel economy. An example of such a consideration would be whether a vehicle runs on a type of alternative fuel whose use would lead to a net reduction in greenhouse gas emissions over the life of the fuel. And finally, consideration would have to be given to how imports might be dealt with in this system. (It should be noted that all but the first of these considerations also apply to the regulatory approach.)

Permits for fuels

So far, this discussion has focused on a possible permit trading system, targeted directly on CO_2 emissions. In Canada, however the vast majority of these emissions come from the combustion of fossil fuels. For this reason it might be feasible to allocate permits covering the carbon content of the fuel, rather than for CO_2 emissions directly – in effect, using an "input" rather than an "output" approach. Since in most cases there is a stable relationship between the amount of a given fuel consumed and the CO_2 emissions resulting from fuel combustion, controlling the quantity of fuels consumed is equivalent to controlling CO_2 emissions. It is, however, considerably easier to monitor fuel consumption than emissions, since there are fewer producers and distributors than end users. Applying a permit system to carbon in fuels would allow virtually all CO_2 emissions from fossil fuel combustion to be captured by the system, whereas, as noted above, a permit system applied to emissions directly would have to be limited to certain sectors.

A tradeable permit system based on fuel consumption could be applied either at the consumption level or at the production level. From an administrative viewpoint, it would be easier to apply it at the production level, since there would be fewer sources to contend with. Also, because there would be fewer sources in the market, companies looking to trade permits would require less information; this might encourage trading.

How the system would work

Under such a system, firms seeking to sell fossil fuels into the domestic market would require permits, denominated in tonnes of carbon or CO_2. The dollar price of a permit would depend on market conditions. The number of permits required to sell a unit of a given fuel would be fixed by the regulator and would depend on the carbon content of the fuel. The price to the consumer of the various fuels would increase under the program, reflecting scarcity. The amount of the increase would depend on the number of permits required to sell a unit of the fuel, on the market price of permits, and on demand and supply conditions for the fuel in question. Consumers would have an incentive to reduce their consumption of fossil fuels in general, and to switch to fuels with a lower carbon content. The extent to which consumers switched to lower carbon content fuels and reduced their fossil fuel consumption (which would depend in part on the availability of substitutes) would in turn have a bearing on the price of permits.

The production-level sources to which the permits would be issued would include gas pipelines/distributors or gas producers, and coal producers. Oil-related permits could be

2 *CERI, Emissions Permit Trading: A Policy Tool to Reduce the Atmospheric Concentration of Greenhouse Gases, January 1991.*

issued to crude oil producers or to refiners. There is an advantage to issuing the permits to crude oil producers. By going this route, the permits would also apply to oil used in production, while permits issued to refiners would not. Any trading system would also have to capture imports, including imports of petroleum products.

There are some possible difficulties involved with the issuing of permits for carbon in fuels. One is the possibility of generating financial gains for fossil fuel producers, at the expense of significantly increased costs for certain consumers. The extent to which this would occur would depend on the increase in fossil fuel prices. This would depend in turn on the extent to which it were possible to benefit from technological and behavioral changes, and from opportunities for fuel switching. If necessary, measures could be taken to redistribute any financial gains, or they could be prevented by auctioning the permits. Another potential difficulty with the fuel permit approach is that it could be seen as the rationing of a factor of production.

Inter-gas trading

As noted above, lack of data makes it impractical, at this stage, to establish a tradeable permits system for greenhouse gases other than CO_2. It may nevertheless be desirable to allow firms targeted by a CO_2 trading program to take advantage of specific opportunities for reducing emissions of the other gases. This could help reduce the overall cost of meeting a greenhouse gas reduction target.

A firm targeted by a CO_2 permit system might, for example, find it less costly to reduce methane emissions (from its own or other sources) through a specific investment than by cutting its own CO_2 emissions. Inter-gas trading would allow the firm to receive a credit in terms of CO_2 emissions for a reduction it brought about in methane emissions. In a case where permits were issued for carbon in fuels, the firm would receive a credit in terms of the amount of carbon it was allowed to sell into the domestic market.

Allowing inter-gas trading would require the use of equivalencies (in effect, the basis for an exchange rate) between emissions of the various gases. The equivalencies developed by the Intergovernmental Panel on Climate Change could be used for this purpose. Each trading transaction would also require the approval of the regulatory authority so as to ensure, for example, that the reduction in emissions of the other gas would not have occurred in any event.

Allowance for sinks

Carbon "sinks", essentially, are natural, non-atmospheric storage areas for CO_2. Oceans and forests, for instance serve this purpose, and reforestation is one of the best-known and most readily available ways to create carbon sinks. The issue we address here is whether sinks for CO_2 should be included in a trading system and if so, how.

Allowing carbon sinks to be used in the calculation of greenhouse gas emissions would further increase an emitter's options for the reduction of overall emissions, and therefore would reduce overall costs. For example, an electric utility might find it less costly to engage in tree planting than to decrease its own emissions of CO_2. In addition, increasing the number of trees planted could have other benefits, such as increased aesthetic value, improved wildlife habitat and greater biodiversity.

On the other side of the ledger, the inclusion of sink enhancement through tree planting would cause some complications. First and foremost is the problem of calculating the amount of carbon that would be absorbed by tree planting. Different types of trees have different growth rates, and therefore, different rates of carbon uptake. Also, trees use up different amounts of carbon at different stages of their life cycles. In addition, forests planted for this purpose would have to be maintained over time to preserve their usefulness as carbon sinks. And it must be kept in mind that tree planting creates only a temporary carbon sink, since the carbon in trees will eventually be released into the atmosphere.

There are other methods for recovering and storing carbon that would need to be addressed. For example, CO_2 recovered from flue gases could be injected into less productive oil wells to enhance their productivity, and a credit given for CO_2 permanently recovered and stored. The operative word would be "permanently". If it could be ensured that this CO_2 would not later be released into the atmosphere, this type of option could be included in a tradeable permit system and would probably not be too difficult to incorporate.

International permit trading

If a tradeable permit system for CO_2 emissions were introduced in Canada, it would be necessary to decide whether to allow inter-country trading. From the point of view of controlling global warming there is no reason not to do so, since the global warming impact of a tonne of CO_2 emitted does not depend on the location of the source. Such an approach would be consistent with dealing with a global problem at a global level. From an economic viewpoint, allowing inter-country trading would likely reduce aggregate control costs, since there would be a greater diversity of emission reduction opportunities. Monitoring and enforcement, however, could be more difficult than for a national system, as it would require the establishment of international regulatory/monitoring bodies. A possible first step would be to enter into a CO_2 permit trading system with the U.S., and perhaps Mexico. This would vastly increase the permit market for Canada.

A more general issue concerns the role tradeable permits could play internationally in helping to address the problem of global warming. While Canada is committed to controlling its emissions of greenhouse gases, this country accounts for only about two per cent of world emissions. Canada has been working to achieve a concerted international approach to controlling world greenhouse gas emissions, and is currently playing an active role in international negotiations aimed at formulating a framework convention on climate change. Tradeable permits could help reduce world greenhouse gas emissions in a cost-effective manner by taking account of differences in the costs of reducing emissions in different countries. International permit trading could take place whether or not the international community agrees on a framework convention.

If an agreement on such a convention does emerge, it could include commitments by all countries to individual ceilings for greenhouse gas emissions. A tradeable permits system could be used to implement these commitments – the emission ceilings agreed to would represent the initial allocation of permits among countries. There would need to be an accommodation in the convention for a trading system, as trading could lead to an individual country not strictly meeting its emissions target.

Trading could be incorporated formally or informally in a convention. In a formal arrangement, trades could take place either between countries or firms. Firm-to-firm trading would be more difficult to implement, but could yield greater benefits since there would be a greater number of participants seeking cost-effective emission reduction opportunities. The challenge in either case would be to develop the appropriate institutions and infrastructure to administer such a program at the international level. An informal arrangement would allow countries to "pool" their emission targets, thereby allowing for less structured but more permanent trading arrangements between countries. This may be a more practical solution.

International permit trading could be possible in the absence of a convention. The scope for state-to-state trading would appear to be limited in such a situation, since there would be no agreed-upon benchmarks against which to base emission reductions. Bilateral arrangements might be possible, however, between developed and developing countries. Trading might be more likely to take place on a firm-to-firm basis, requiring that participating countries introduce trading systems domestically. The possibility suggested above of a trading system involving Canada, the U.S. and perhaps Mexico would be an example of such an arrangement. A more limited option would be to trade automobile fuel-efficiency credits between Canadian and American car manufacturers.

Finally, technology transfer could be the basis for a less formal type of trading arrangement between developed and developing countries. A developed country would transfer technology to a developing country in recognition of the fact that emission reductions could be achieved much more cheaply in the developing country. The developed country would view this transfer as a substitution in part for efforts to control its own emissions. In developing such an approach one issue to be addressed would be how a country could get recognition for the emission reductions it achieved abroad through its transfer of technology.

4.1.4 Water Quality

Background

Over the years an increasing variety and volume of the wastes of modern society have been discharged into water bodies in Canada. As a result, the contamination of water has increased to the point where some public beaches have been closed, and lakes and streams have been contaminated by fertilizers, toxic and hazardous substances, and suspended solids.

From the viewpoint of environmental protection, it is important to distinguish between these substances in terms of their persistence and toxicity.

Persistent substances degrade slowly or cannot be broken down at all. *Toxic substances* are substances that pose a threat to natural ecosystems or to human health. Some toxic substances degrade quite rapidly (in other words they are non-persistent) and therefore may not be harmful if discharged in small quantities, or if diluted in large amounts of water. Other toxic substances are persistent – they can accumulate in living organisms such as fish, and cause health risks.

Freshwater bodies can dilute and degrade certain amounts of non-persistent substances, and transform them into harmless or useful biological substances. Non-persistent substances therefore may not be harmful unless the amount discharged exceeds the capacity of the water body to dilute and degrade them. Freshwater bodies cannot, however, assimilate persistent substances. Persistent toxics therefore pose health risks regardless of the amount discharged.

Environmental target

Canada's goal is to protect and enhance the quality of water resources. In order to meet this goal, some control over the amount and types of substances discharged into water bodies is necessary. In the case of persistent toxic substances, Canada's goal is the virtual elimination of their discharge into the environment.

Current regulations and initiatives

The discharge of pollutants into the environment is regulated under the federal Canadian Environmental Protection Act (CEPA), and several other federal and provincial laws including the federal Pest Control Products Act and Fisheries Act. Regulations proposed under CEPA will virtually eliminate the release of persistent dioxins and furans from pulp and paper mills. In addition, a number of other measures are under way to control discharges of pollutants into water. For example, the Great Lakes Water Quality Agreement between Canada and the United States establishes a long-term goal of virtually eliminating discharges of persistent toxic chemicals. Remedial action plans are being developed under this agreement to deal with 17 priority "hot spots" (problem areas) in the Great Lakes. In the St. Lawrence River, the St. Lawrence Action Plan has targeted a 90-per-cent reduction in liquid toxic waste discharges by 1993.

Potential Application of Effluent Trading

Regulations are the most appropriate instrument for controlling discharges of persistent toxic substances into water; these substances cannot be assimilated by water and therefore their discharge should be virtually eliminated. Trading of discharges (effluents) into water, however, could complement regulations in dealing with the problem of persistent toxic substances. Specifically, effluent trading could be used to phase out the discharge of these substances in moving towards the goal of their virtual elimination.

In the case of non-persistent substances that can be assimilated by a water body, regulations may not be the most efficient means of control. Effluent trading could be a more efficient means of getting discharges of these substances down to water-quality target levels. Effluent trading schemes can be used to prevent water quality problems from arising in water bodies, or parts of water bodies, in which problems could possibly develop – for example, rivers and lakes in highly populated and industrial areas, or in the more remote areas in which some industrial plants such as pulp and paper mills are located. Effluent trading could also be used to clean up "hot spots" – areas which do not meet ambient water quality standards – and to prevent problems from recurring in those areas.

Effluent trading requires decision-making on issues that do not arise in the emissions trading examples previously discussed. In those cases, a small number of pollutants were the main cause of the environmental problem. In the water pollution case, a great many different substances are involved, some of them toxic and some not, some persistent and some non-persistent. Moreover, water pollution is more localized than the forms of air pollution discussed above, including ground-level ozone. Different kinds of substances are discharged into different water bodies in varying amounts, and the capacity of each water body, and even parts of a water body, to absorb these pollutants varies widely. Appropriate discharge limits, therefore, may vary widely by location and type of substances discharged.

Effluent trading can accommodate the need to distinguish between local differences in water quality. The trading program can be based on the total amount of pollutants discharged into a water body or part of a water body, as well as the capacity of water to absorb them.

Sources of Discharges

Pollutants are discharged into water bodies from what are known as point and non-point sources. Point sources release discharges through outfalls (pipes), in most cases from municipal wastewater facilities and industrial plants. There is a great variety of industrial sources. They include most industrial plants located on water bodies, such as pulp and paper mills, petroleum refineries, chemical plants, and food processing plants.

Non-point sources are diverse sources from both land and air. Pollutants from these sources enter water bodies through run-off from land and in rain and snow. Land-based activities that generate pollution from run-off include agriculture, forestry harvesting, household garden and lawn care, municipal or industrial landfills, and storm water. Industrial installations are common sources of pollutants that reach the water body through precipitation – acid rain is an example.

Design of Tradeable Effluents Permits Systems for Non-Persistent Substances

Which pollutants to include

A very large number of non-persistent pollutants are discharged into water. They fall into three basic categories:

- *Toxic substances*, such as certain pesticides and oil. These substances can be harmful to health if the discharges are not held to levels that can be assimilated by water bodies they are entering. Sources of toxic discharges include municipal sewage treatment plants, industrial plants, pesticide run-off and precipitation.
- *Nutrients*, for example, carbon, nitrogen, phosphorus. Nutrients are contained in sewage, some industrial plant discharges, and fertilizer run-off. They promote the growth of vegetation and the onset of what is known as eutrophication. Eutrophication is a biological process in which nutrients cause an accumulating growth of aquatic plant and animal organisms. Eventually, a water body can be overrun by vegetation, particularly a form called algae. The bacteria feeding on the dying algae consume large amounts of oxygen, and the subsequent depletion of the oxygen in the water body kills fish and other aquatic life.
- *Sediments*, for example, dust, gravel and other particulates. These substances are contained in run-off from, for example, construction sites, strip mines, and urban and rural areas. Sediments contribute to the depletion of oxygen and food necessary to sustain aquatic life.

In the application of a trading permit system to the three non-persistent categories the following points would have to be considered:

- Discharges of non-persistent toxic substances and of nutrients should be subject to separate trading programs because their environmental impacts are different. Each trading program would appropriately have a separate discharge ceiling. Sediments, to the extent that their sources could practically be included in a trading program, should be subject to a separate program.
- Given the large number and variety of non-persistent toxic substances and nutrients discharged into water, it would be impractical to issue separate permits for each type. In some areas, one particular nutrient or toxic substance would be critical to the water quality in those areas. In interior lakes, for example, discharges of phosphorus often are one of the largest contributors to the growth of algae. In these cases, an effluent trading program could focus on the one critical pollutant.

- In areas where there is no such critical pollutant, it would be necessary to explore the extent to which, from an environmental and administrative viewpoint, it would be appropriate to combine several pollutants into a group and to treat them as a composite.

Discharge limits
The environmental objective is to limit the total amount of pollutant(s) discharged into the water from all sources to a level that can be assimilated by the water. The assimilative capacity of the water depends on many factors including, for example, the size of the water body, the flow of the water, the temperature of the water, and the effluents discharged. Other things being equal, a large water body can absorb more of certain substances than a small water body. Also, discharges of a given volume of organic wastes will pollute a warm water body more than a cool one, and a water body with little flow more than a fast-moving stream or river.

It may not be practical, however, to include all sources of the pollutant(s) in an effluent trading program. In that case, it would be necessary to place a limit on the total discharge from the sources that could be included in the program. The discharge limit for the included sources would likely be based on an estimate of the total amount of the pollutant(s) that can be assimilated, an estimate of the portion of the pollutant(s) entering the water body through the sources not included, the measures undertaken to reduce pollutants from the non-included sources, and how effective these measures are expected to be.

Which sources to include
In the case of discharges of both non-persistent toxic substances and nutrients, some of the sources, namely the municipal sewage treatment plants and industrial plants located at the edge of the water, are easily identifiable. These sources could relatively easily be included in an effluent trading program.

Identifiable industrial plants in the area that emit toxic air pollutants entering the watershed in the form of precipitation ideally should also be included. A trading relationship would need to be established between the direct discharges into the water and the discharges into the air. Alternatively, the air pollutants could be subject to a separate trading program. For example, SO_2 and NO_x emissions, two significant atmospheric pollutants, are being controlled through other measures as discussed in earlier sections.

Sediments from identifiable construction sites and strip mines contained in run-off should also ideally be included, but this may be difficult in practice.

Pollutants and sediments from diverse non-point sources would be very difficult to directly include in a trading program. There is, however, some potential for including them indirectly. This is discussed in the next section.

Non-point sources
Non-point (run-off) sources can account for a large share of total discharges of pollutants into a water body. For example, in some areas more than 30 per cent of phosphorus and 60 per cent of nitrogen comes from urban and agricultural run-off.

Pollutants contained in run-off can be controlled. Phosphorus from urban run-off can, for example, be controlled through settling ponds, sand filters, and by percolating the run-off through unsaturated soil. In the agricultural sector, control options include crop residue management, growing winter cover crops, and creating vegetated buffer strips along stream and ditch banks. In addition, other gains can often be made through improved fertilizer management practices, and the design and construction of livestock manure storage facilities to prevent run-off.

Pollution control measures of this kind can be significantly less costly than the construction or modification of wastewater treatment plants or industrial plants. However, there is little incentive to undertake them. An effluent trading program might provide one by encouraging these sorts of measures, thus further reducing the cost of attaining water quality objectives. For example, the program could be set up so that sources included in an effluent trading program could earn discharge credits for reducing non-point discharges. As with any investment in pollution abatement technology in their own facilities, these sources would be required to maintain the reduction. To encourage a reduction in total discharges, a trading ratio of, say, 2:1 could be established – that is, the point source could be allowed to increase discharges of a pollutant by one unit for every two units reduced through a non-point source application.

Seasonal controls
In harbours and bays, the toxicity of discharges or the impact of nutrients on the oxygen content of the water can vary considerably by season. During the summer months, when water levels are low, the concentration of pollutants and the damage they cause can be increased considerably. In addition, the higher temperatures in summer can increase the environmental impact of pollutants. As discussed in the previous section on smog, which is also in large measure a seasonal problem, special summer permits could be issued to impose additional control over discharges in the summer months.

Hot spots
In some lakes and large rivers, water quality problems do not arise in the entire water body, but in certain problem areas or hot spots, such as the bays and harbours of large cities. An effluent trading system could be designed to focus on these hot spots, with the objective of phasing down discharges to levels consistent with ambient water quality objectives. A target discharge limit would be established, and attained through progressive reductions in allowed discharges.

In most major cities, there are likely to be enough sources of effluent discharge to make a trading program viable in hot spot areas. Even if there were only a few sources, and therefore limited trading, allocation of permits would place a cap on future effluent discharges and promote the clean-up of the areas. Some economic benefits would also be realized.

Trading relationship among sources on a river
In the case of rivers, discharges from different sources may have different impacts on pollution problems. Ideally, from an environmental perspective, equivalency between discharges from various sources should be established in terms of their environmental impact. For example, each unit of discharge from a source say five miles up the river from a problem area may contribute one third as much to the pollution problem as each unit of discharge from another source closer to the problem area. Trading between these sources should ideally reflect this 3:1 ratio – that is, the source up the river would be allowed to increase its discharges by three units for every unit purchased from the other source. While a trading relationship of this kind is desirable from an environmental perspective, establishing it would add to the administrative complexity of the system.

Tradeable Permits System for Persistent Toxic Substances

Persistent toxic substances include, for example, PCBs, mercury, dioxins and furans. Permits to discharge persistent toxic substances could initially be allocated to existing sources on the basis of actual discharges. The discharge ceiling – which would be established by regulations – would be reduced through a predetermined schedule until the persistent toxic substances were virtually eliminated.

Combining effluent trading with regulations in this way would provide industry and individual firms the flexibility to develop alternatives to materials, products and processes that release these substances into the environment while moving towards the goal of virtual elimination.

4.1.5 Stratospheric Ozone

Background

A thin layer of ozone, a naturally produced chemical, lies in the stratosphere between 15 and 40 kilometres above the earth. This layer absorbs most of the sun's ultraviolet radiation, which is harmful to the natural environment and to human health. Emissions of man-made chemicals such as chlorofluorocarbons (CFCs), halons and various other chemicals are depleting the ozone layer. Chlorofluorocarbons (CFCs) are employed in a wide variety of applications, including refrigeration, automobile air conditioning and aerosol propellants. The government's goal is to phase out CFCs by the end of 1995 and other major ozone-depleting substances by the end of 1994.

Targets
In 1987, Canada, and most of the other industrialized countries, signed the Montreal Protocol on Substances that Deplete the Ozone Layer. The protocol commits the signatories to reduce the use of CFCs by 50 per cent of 1986 levels by 1999, and to freeze the use of halons at their 1986 levels by 1992.

The Montreal Protocol was strengthened in June 1990. The strengthened agreement calls for the elimination of CFCs and most other ozone-depleting chemicals by 2000, and the principal remaining chemicals by the year 2005. At that time, Canada and 12 other countries undertook to accelerate their commitment to phase out CFCs by establishing a new deadline of no later than January 1, 1997, three years ahead of schedule. Canada also committed itself to phasing out the other principal ozone-depleting substances by 2000. In March 1992, the Canadian Council of Ministers of the Environment, in response to recent findings on ozone layer depletion, announced that the phase-out of CFCs will be accelerated by a year, and is to be completed no later than the end of 1995. Ministers also agreed to step up the phase-out of other ozone depleting substances.

Legislation
Legislation to control the production of CFCs in Canada, and imports of CFCs into Canada, has been passed. There are two producers and fewer than a dozen importers of CFCs. The legislation sets out a schedule of the maximum allowable quantity of total CFCs that each can import or produce in each year. (The five most damaging CFCs are subject to the schedule.) The schedule reflects the required reduction to meet the commitments of the Montreal Protocol, and will be adjusted to reflect the strengthened Montreal Protocol and the accelerated commitments.

Other legislation has also been passed to limit the use of CFCs in products imported into or produced in Canada.

Potential Application for Trading CFCs

In the *Green Plan*, the federal government has undertaken to seriously consider the use of tradeable permits for CFCs as a mechanism for meeting the target reductions in a cost-effective manner.

In fact, the legislation mentioned above goes a long way towards setting up a trading program. As noted, there are only two producers of CFCs in Canada, and fewer than a dozen importers. Each is allocated a maximum allowable quantity of total CFCs per year, the quantity being based on a percentage of the previous year's actual production or imports. In setting up a trading program, the existing distribution could form the basis of the initial allocations.

The legislation also incorporates some important features of a tradeable permits system. Each producer is allowed to substitute production at any of its facilities, effectively allowing internal trading. In effect, external trades are also possible, since the legislation gives the Minister of the Environment the authority to transfer any unused allocations from one firm to another.

In addition, the legislation in effect allows trading, within firms, between the five types of CFCs subject to the legislation. The allocations are based on total CFCs, weighted by ozone-depletion factors established in the Montreal Protocol. This allows producers and importers the flexibility to vary the production or import levels of the different CFCs as long as in total their ozone-depleting potential is the same.

The Montreal Protocol in effect also allows trading between countries through an industrialization provision which allows the transfer of CFC production rights between countries. Canada and the U.S. have made use of this provision.

In introducing marketable permits, a change that would have to be made in present arrangements would be to issue each producer and importer annual permits according to their allocations. The permit holders would be free to trade unused portions of their permits without ministerial approval. Monitoring and enforcement requirements would essentially be the same as the current system, except that permit holders would also be required to report any trades.

Consideration could be given to whether importers of products containing CFCs could also be included in a trading program. Legislation already exists, or will soon be passed, banning the use of CFCs in most products. By 1995, the only remaining significant use of CFCs is expected to be for refrigeration. The importers of refrigeration-related products could be allocated permits and included in a trading program to ensure that they are not inadvertently given a competitive trade advantage over domestic industries.

In terms of cost effectiveness, there is likely little difference between the current system and one which would incorporate marketable permits. While ministerial approval of trades would no longer be required, government would continue to be involved through administration of the program.

4.2 User Charges

User charges are payments for the use of collective goods and services. Ideally they should reflect the full cost of the resources used in providing the service. Moreover, the charge should be directly related to the amount of the service consumed. If these characteristics are built in, user charges give consumers an incentive not to "overuse" a service, and the result is a more efficient allocation of resources.

Charges are generally levied in Canada for municipal water services and municipal solid waste collection and disposal. Usually, however, they do not reflect the full cost of providing the service, and often do not vary with the amount of water consumed, or waste generated. Moreover, in the case of water, they seldom include a price for the water itself, even in areas of scarcity.

There is therefore considerable scope for applying appropriate user charges to promote the efficient use of water, and to reduce municipal solid waste.

4.2.1 Municipal Water Services

Background

Municipal utilities supply water to most households and commercial establishments and to some industrial plants. They withdraw, treat and distribute water to the users, collect the wastewater, usually subject it to some treatment, and then discharge the wastewater into a water body. Each municipality has its own set of rate schedules, usually embodying different rates for residential, commercial, and industrial customers.

While municipal rates vary, they have common features. In most cases the water charges cover the operating costs incurred in providing the water services but not the infrastructure costs, nor do they generally reflect the cost of system upgrading and expansion. Moreover, a significant majority of municipal rate schedules either charge a fixed amount regardless of how much water is consumed – thereby providing no incentive for efficient water use – or have declining block rates – thereby providing a declining incentive for conservation.

These features of current municipal water rates have resulted in higher levels of water consumption than would otherwise be the case. As a result, Canadian municipalities have faced larger expenditures on distribution and water treatment facilities than is economically efficient. Many of these facilities are rapidly deteriorating and will have to be replaced. Moreover, the revenue shortfall resulting from consumers paying less than the full cost of water services can discourage municipalities from undertaking investments in facilities to treat wastewater. This may have a negative effect on the quality of the water body in which the wastewater is discharged, depending on the assimilative capacity of the water body.

Appropriate Pricing

Charging consumers prices that reflect the full costs of water services would encourage the efficient use of water. Under a user-pay system, the price per unit of water would be based on the full incremental cost of providing water services. Since this varies for different types of customers – industrial wastes, for example, are usually more difficult and costly to treat than household wastes – the unit charge would vary by type of customer. The charge would also vary by season if, for example, a high seasonal demand in the summer requires the construction of a larger infrastructure to meet the summer peak load.

Appropriate user charges would reduce the demand for water, particularly for outdoor water use, such as lawn watering, which is more sensitive to price. One study has estimated that a 10-per-cent increase in the price for water, for instance, would reduce indoor residential use by about three per cent, and outdoor water use by about seven per cent. This cut in consumption would also reduce the need for infrastructure investment. The biggest peak during the year occurs in the summer, when a significant amount of municipally treated water is used for outdoor activities. A large proportion of investment in municipal water services goes toward meeting this peak demand.

An appropriate user charge for water would reflect the incremental capital and operating costs – which vary with the amount of water pumped through the system. The incremental costs would be determined on a per-unit-of-water basis, and the charge applied on a per-unit-of-consumption basis. The charge would have two components – a fixed charge and a commodity charge.

The *fixed charge* would reflect the costs of supplying water that do not vary with the amount of water pumped through the system. These costs include, for example, administrative overhead, regular maintenance, insurance, and billing. All users would pay the same fixed charge per unit of water, regardless of the amount consumed.

The *commodity charge* would reflect the incremental capital and operating costs that vary with the amount of water used. The commodity charge would have two components – a capacity cost component, and a variable operating cost component.

The *capacity cost component* would be based on the capital cost of expanding or replacing the existing system. This component could differentiate between existing users and new users. All users could be charged the cost of replacing the basic infrastructure. Existing users could also be charged the cost of replacing any of the infrastructure that is particular to their needs. New users could be charged the cost of new distribution facilities, and any incremental cost they place on the basic infrastructure.

The capacity cost component could vary between seasons if the utility is subject to a distinct pattern of seasonal peaks in use. Households, as noted above, use more water during the summer months. During the peak period, households could pay an additional capacity charge per unit of water used. This would reflect the incremental costs of building the system large enough to accommodate demand during the peak period. This would have the effect of reducing peak period demand.

The *variable operating cost component* would include those operating costs directly related to water pumpage – for example, electricity, chemicals, and maintenance expenditures. Part of this component could reflect the scarcity value of the water itself, in areas and times of year in which supply was limited. It could also, where required, include a residual component, reflecting any shortfall between the total revenue from user charges raised by the municipality, and the carrying cost of the existing system.

This approach to pricing could lead to different charges for different classes of users. The charge for industrial users, for example, could reflect the fact that the unit costs of delivering water to these users may be lower than it is for households. On the other hand, industrial users could pay a higher charge than households if their wastes are more expensive to treat than household wastes. Some industrial wastes are, in fact, more expensive to treat because they may contain contaminants which are often more complex and difficult to deal with. Municipal waste treatment plants must therefore be not only large enough to deal with the high volume of industrial wastes, but have the necessary equipment to effectively treat them. The user charge for industrial plants would reflect the additional operating and capital costs associated with treating industrial wastes. The charge could also vary according to the volume and type of effluent discharged by an industrial source. This would provide an incentive to the source to reduce the volume of its effluent, to install pre-treatment programs, or to change its industrial process. Whether such a differentiated charge would be feasible or not would depend in part on monitoring costs.

Potential difficulties
The most significant drawback to this approach is that as much as 50 per cent of the water use in many of the larger cities in Canada is not individually metered. The unmetered users include residents of many apartment buildings, condominiums and townhouses, as well as some occupants of houses in the older parts of cities. For these consumers, an increase in the unit price of water would not affect consumption. Overcoming this problem would require the installation of individual metering systems, in some cases at a substantial cost.

In some areas, gains in terms of increased efficiency of water supply may not be enough to offset the costs of installing meters in existing structures. In areas where there is a high percentage of users which are not metered, therefore, it may not be appropriate to apply the pricing structure suggested above. In these areas, however, all new units, including those in apartments, condominiums and townhouses, could be individually metered so that over time the percentage of unmetered users would fall, making the application of the pricing structure described above more appropriate. In areas where a high percentage of users are metered, the suggested pricing structure could be applied to all users of water, metered and unmetered. Some of the increased revenue that would flow into municipal treasuries could be used to help finance the installation of individual meters.

4.2.2 Municipal Solid Waste

Background

Nature of problem
The term "municipal solid waste" generally defines household and light commercial wastes, including household hazardous wastes, and specifically those collected and disposed of, mostly in landfill sites, by municipalities. It also includes waste from commercial establishments, industries, institutions and apartment buildings that is disposed of in municipal landfill sites by private-sector haulers.

Canadians produce over 30 million tonnes of solid waste annually. We recycle only about 10 per cent of our municipal solid waste. Most of the remainder is sent to landfill sites; some is incinerated.

Proper management of waste is important for both environmental and economic reasons. Landfill sites have a number of environmental problems associated with them. All produce leachate, a liquid formed by the breakdown of the waste, supplemented by any rainfall that percolates through the garbage, picking up contaminants as it goes. If not collected, the leachate can pollute streams and underground waters. Landfills also produce "landfill gas" – primarily methane – from the breakdown of organic matter in the garbage. Methane released into the atmosphere is a greenhouse gas which contributes to global warming. Moreover, in this context, the gas contains volatile substances, many of them toxic, which it collects as it rises through the landfill. Landfill sites also use scarce land which could otherwise be used for other purposes. They also generate odours, dust and litter, and they may attract scavenging birds and wildlife.

Other environmental problems are associated with incineration. Burning waste in incinerators can, if the combustion conditions are not properly controlled and if there are no adequate pollution control devices, add significant levels of toxic chemicals to the air. While newer facilities effectively control air emissions, they still produce ash, which is generally contaminated with toxic chemicals and heavy metals.

In addition to these direct environmental problems, it is relevant to note that the production of the components of waste itself (i.e., of the products now discarded), used up valuable resources, such as trees, and likely generated air and water pollution.

Proper management of waste is also important for economic reasons. Waste collection and disposal costs in Canada exceed $1.5 billion per year. Much of these costs are borne by municipal taxpayers, and are paid for out of general revenues. Improving the efficiency with which waste is managed therefore needs to be examined.

In October 1989, the CCME adopted as its goal the reduction of wastes in Canada by 50 per cent by the year 2000. This was complemented by a National Packaging Protocol, announced in April 1990, to reduce the waste from packaging by 50 per cent by the year 2000 (packaging, of which 82 per cent is landfilled and 18 per cent recycled, accounts for about 30 per cent of the municipal solid waste stream).

In the *Green Plan* the federal government announced a number of initiatives to help achieve the 50-per-cent reduction targets for total waste and for packaging. They include the establishment of standards and regulations to minimize waste from packaging and other components of the waste stream, and initiatives to promote the reduction, reuse and recycling of wastes. Strategies to reduce waste are already under way, such as the "blue box" recycling program carried out in many municipalities. Appropriate pricing practices can also play an important role in reducing the amount of municipal solid waste.

Current pricing practices

Economically speaking, the disposal of solid waste is not efficiently managed in Canada. Many municipalities do not recover the full cost of collecting and disposing of household waste through waste charges – often the cost of waste management is subsidized from general tax revenues. Even where municipalities do recover the full cost of garbage collection and disposal through an explicit waste charge component of municipal taxes, there is no direct relation between the volume of waste generated by an individual household and what it costs that household for waste disposal. As a result, there is little financial incentive for a household to cut down on the amount of waste it generates. Moreover, some municipal landfill sites in Canada allow disposal from private haulers for free, or at fees so low that they far from reflect the full costs of landfilling solid waste, and provide little incentive for reduction, reuse or recycling.

These aspects of current municipal waste charging practices have led to more solid waste being generated and landfilled than is economically efficient. Moreover, the revenue shortfall caused by consumers paying less than the full cost of waste management services can limit the ability of municipalities to undertake the necessary investments to dispose of waste in an environmentally sound manner.

Role of User Charges

Overview

User charges for waste collection and disposal are fundamental to efficient management of wastes and the meeting of waste reduction objectives. They would, first of all, provide an economic incentive to households and commercial/industrial generators to reduce the amount of solid waste that is disposed of in municipal landfill sites. They would also make recycling or reuse more economically attractive, thereby further reducing waste.

User charges would cause consumers to bear the full cost of collecting and disposing of the solid waste they generate and would ensure that private-sector haulers pay landfill tipping fees that reflect the full costs of landfilling. These include the cost of the land, siting, management and operating costs, any social costs (traffic, noise, odour, littering), environmental impacts, and the cost of returning the site to a condition suitable for alternative uses at the end of its life as a landfill site. The capital costs involved would be assessed on a replacement cost basis, for example, the cost of a new landfill site. And, to the fullest extent possible, the charges would reflect additional costs for disposing of wastes that are relatively more difficult to manage.

Some municipalities in the United States have successfully implemented user fees for waste, and several Canadian municipalities are considering similar systems.

Possible structure

A full-cost tipping fee for private-sector haulers would be relatively easy to implement. It could, for example, be based on the weight or volume of the load.

There are different ways in which a user charge for households could be structured. It could be based on weight, or alternatively volume, of waste generated. It could constitute a per-unit fee for each container, in which case, for example, the consumers might be required to purchase a special bag, or stickers for a specified size of container. Alternatively, it could take the form of a per-unit fee supplementing a flat fee that would be billed directly or included in taxes.

One way to administer a user charge would be for the municipality to include, as most do today, a specific waste charge in their taxes. But, in contrast to the general current situation, the waste charge would cover the full cost of collecting and disposing of a certain amount of waste, equivalent to a certain number of garbage bags per household per year. That number of garbage bags would then be distributed to each household. Households requiring additional bags could purchase them from the municipality at a predetermined price. Similarly, households with surplus bags could return them to the municipality for reimbursement at the predetermined price, or could sell or give them away to friends or neighbours. Only garbage in the "municipal" bags would be picked up.

Such a system has the advantage of being an adaptation of the one that exists. It would, however, raise a number of administrative questions, such as how many bags to distribute to each household, and whether the number of bags distributed to each household would be related to the number of people in the household. An administratively simpler alternative would be to require households to purchase "municipal" bags for their wastes. The bags could be purchased at city hall or in local stores. The municipality would set the price of the bags by estimating the total number of bags that would be used by residents, and would price them so as to cover waste management costs. In order to be acceptable, this sort of system would need to be combined with a reduction in municipal taxes, since waste management would no longer be financed through property taxes.

Under either system, households could dispose of bulky items, for example, appliances, by purchasing a sticker and attaching it to the item.

Either system might also have to be modified for application to apartment dwellers. The latter do not pay municipal taxes directly, but some are serviced by municipal waste collection services. A system of distributing garbage bags would need to include these tenants. Other apartment dwellers are serviced by private-sector haulers. While increased tipping fees for private haulers would be reflected in the rent paid by these tenants, they would still not have a financial incentive to reduce the amount of waste they generate.

A potential difficulty with a system of user charges for waste is that it might stimulate illegal dumping, increased littering and backyard burning. Experience in the U.S. suggests that these problems are manageable in various ways, for example, through increased enforcement and the banning of backyard burning. Incentives to reduce household waste could also be provided for a transition period by, for example, providing backyard composters at subsidized rates. In addition, illegal dumping would be less likely to occur under the first option for user charge administration discussed above, since the municipality would continue to build a waste charge component into taxes, and households would automatically be issued with a certain number of garbage bags.

4.3 Deposit-Refund Schemes

Under deposit-refund schemes, a charge is imposed on a product at the point of sale. The charge is refunded, or partly refunded, if the product is returned to a collection depot. Deposit-refund schemes can be effective economic instruments for dealing with products which can be reused or recycled and/or which create environmental problems if not disposed of in an acceptable manner.

Applications

Deposit-refund schemes can help reduce waste and/or ensure the proper disposal of potentially hazardous products. Deposit-refund schemes have been applied to various products. In Canada, they have been used primarily for beverage containers. In other countries they have also been used for products such as car hulks and batteries.

Deposit-refund schemes could be applied to other products in Canada. A number of issues would need to be considered in assessing the merits of establishing a deposit-refund scheme for a particular product. For example, in the case of a reusable product, these issues would include the market for the used product, how the product would be collected and distributed, the appropriate deposit and refund, how the scheme would be administered, and the financial viability of the scheme.

One candidate product for a deposit-refund scheme is used lubricating oils. For one thing, used lubricating oils can be reused directly as fuel, or they can be reprocessed or re-refined for use as fuel or lubricants. For another, used oils are potentially hazardous if not disposed of properly, and therefore pose a serious environmental threat. In this regard, the CCME has developed a Code of Practice for Used Oil Management in Canada.

A deposit-refund scheme could contribute to the better management of used oils by discouraging improper disposal. And by promoting recycling, it would also reduce waste.

Considerations for a Deposit-Refund Scheme for Used Oils

Background

About one billion litres of lubricating oil are sold in Canada each year. Approximately 50 per cent is potentially recoverable and reusable, either directly, or after reprocessing or recycling. Forty per cent of the potentially recoverable oil, or about one fifth of the oil sold annually, is currently recovered.

Used oil is generated by two principal sources – the industrial sector and the automotive sector. A large share of the used oil generated by the industrial sector is reused internally (for example as fuel in industrial generators and boilers), or collected for reprocessing or recycling.

The automotive sector includes service stations, fast lube outlets, do-it-yourself oil changers, the farm/rural sector, and small industrial truckers. Some of the used oil generated by this sector, in particular by the larger commercial operations, is now collected for reprocessing or recycling, although a much larger share could be recovered from commercial automotive sources. Most of the used oil generated by the do-it-yourself oil changers and the farm/rural users is being inappropriately discarded. The do-it-yourself oil changers often dispose of their used oil in municipal sewage systems or in garbage bags. While these practices are illegal in many municipalities, the probability of being caught and fined is very low.

Market for used oils

The CCME Code of Practice identifies re-refining and reprocessing as the preferred market for used oils. Used oils contain impurities which arise as a result of contamination and chemical reactions occurring during its use. Reprocessing is undertaken when the goal is to remove the contaminants to make the oil suitable for reuse in industrial applications. Re-refining is carried out to restore the original usefulness of the oil.

CCME also identifies a number of acceptable, but less preferable markets. These include the burning of used oil as fuel in cement kilns, in industrial and utility boilers equipped with flue gas pollution control equipment, and in boilers not equipped with this equipment. The acceptability of these uses is conditional on the used oil meeting specified standards for maximum allowable contaminant levels and minimum heating values. There may be other environmentally acceptable uses which could usefully be explored.

At present, there are seven re-refiners in Canada and several major reprocessors. This may not be enough capacity to absorb all the used oil that could be recovered through a deposit-refund scheme, and in any case the existing system does not service all parts of Canada. It follows then that some thought needs to be given to other environmentally safe options that might fill the regional gaps.

Collection

Several large regional used-oil collectors operate in Canada. In many cases the collection services are operated by re-refiners, either independently or in conjunction with other enterprises.

These collectors service large industrial and large commercial automotive generators of used oils. When oil prices were high, the latter received payment for their used oil. With the lower prices of recent years, these firms have been paying collectors to remove the used oils as a cost of doing business. The collectors do not find it practical to service do-it-yourself oil changers and small commercial generators of oil since these are too dispersed and small to be economically serviced. In other words, the large generators of used oil have access to the collection system; the smaller do not.

A deposit-refund scheme could focus on this smaller sector – on the do-it-yourself oil changers and small commercial generators. One option would be to establish special central collection depots for used oils in local communities. A second would be to use existing service stations and other commercial businesses as collection points.

Under the first option, special depots would be established. These would have the capacity to bring together and accumulate used oils in sufficient quantity to be serviced by the existing collection services. The depots could also serve as collection points for other products. This could reduce the operating costs for all the products involved, and at the same time be more convenient for consumers, making collection potentially more successful for all the products.

Under the second option, collection depots could be established at existing service stations and other lube operations. Some of these outlets may already be serviced by a collection service and be equipped with the necessary holding facilities. For others, the facilities would have to be built. The advantage of the existing-facility option is that it would probably generate a higher recovery rate because it would be more convenient for people to use, and because it could capture more used oil from the smaller commercial establishments that would become a part of the collection system. On the other side of the ledger, a difficulty with this option is that potential collectors and reusers may be discouraged from participation because of worry that they might receive contaminated oil from individuals. This might leave them at risk of being held legally liable for the disposal of the contaminated oil.

The capital and operating costs of both these options would need to be examined.

Appropriate charge/refund

If the deposit-refund scheme were to focus on the do-it-yourself market, consideration could be given to exempting lubricants sold in very large quantities to large industrial and commercial users, since these generators generally already either reuse or collect their used oils. Alternatively, they could get a refund for the used oils they turn over to collection services.

The charge and the refund would need to be high enough to give the do-it-yourself oil changers the financial incentive to return the used oil to the collection depots. The refund may need to be higher in the case of special depots because their locations are not likely to be as convenient as service stations. In cases where the return rate is low, it may be justifiable to provide a refund which is greater than the deposit as a temporary measure to encourage return of the product. Provided the return rate remains below 100 per cent, and given the fact that lubricating oils shrink in volume, this would not necessarily compromise the financial viability of the system.

Since lubricating oils shrink in volume, a system in which the refund was equal to the charge would generate revenues from the charge that exceeded the total refunds. This would be true even if the return rate was 100 per cent. If additional funding were needed to finance the management of the system, the refund could be set at less than the deposit. In addition, the administering authority could, at times, realize proceeds from the sale of used oils. But this source of revenue would not always be available, and when it was, it would fluctuate with the price of oil.

In any case, even with money coming in from such sources, the system may not be self-financing. Additional funding may be required at least initially to cover initial capital costs. One possibility is a joint government/industry arrangement similar to the blue box program.

Finally, variants on a strict deposit-refund system could be considered. For example, a variant could involve using the revenue from deposits to finance the purchase of recycled oils. Do-it-yourself oil changers who returned their used oil to a collection depot would not receive a refund but instead would be allowed to buy recycled oil at, say, half price, in equal quantity to the amount of oil they returned. The advantage of this approach is that it would support the re-refining industry by ensuring a demand for its output as well as a supply of its primary input.

Administration

Deposits collected by retailers from their customers at the time of sale could be managed by a collection authority, which would administer the funds collected, the refunds and the payments to collection agents.

Deposit-refund systems could be operated at the national or provincial level. The latter option may require building safeguards into the system to limit the possibility of consumers claiming refunds for products purchased "out-of-province". Imposing a cap on the daily quantities which could be redeemed per end-user could reduce the opportunities for haulers operating outside the province to take advantage of the system. While this would not address the potential problem of small generators outside the province, it is unlikely that the quantities being returned from this sector would be large enough to pose a serious problem.

5. Tax Instruments

This chapter describes and evaluates three ways in which the tax system could be used to improve environmental decision-making:

- environmental charges;
- tax incentives; and
- combining environmental charges and tax incentives.

In the analysis that follows, we use the assessment criteria presented in Chapter 3 to examine each of these instruments. In each case, we consider the main features that could achieve positive results for the environment, we look at practical experience in Canada and other countries, and we identify some important factors in the design and assessment of these types of initiatives.

Some of the assessment criteria identified in Chapter 3 are of particular importance in determining whether tax instruments would achieve environmental objectives more effectively than other instruments. In this context, one consideration that carries particular importance is the impact on Canadian competitiveness in world markets. Tax options which may be perfectly feasible technically and in other ways would nevertheless require careful assessment with respect to this criterion. Ideally, this assessment would distinguish between a tax measure (an environmental charge for instance) applied unilaterally within Canada and measures taken in conjunction with other countries as part of a coordinated international plan.

Two other essential criteria are the distributional impacts and adjustment costs. As mentioned earlier in this paper, different economic instruments can have different cost and distributional impacts on various firms, sectors, regions and income groups. In situations where a tax instrument would raise concerns about the level or distribution of costs – either in the short term or over time – it may be possible to address these concerns by modifying the design of the tax structure or developing some offsetting measures. Alternatively, a non-tax instrument may be a more acceptable way to achieve the same environmental objective.

5.1 Environmental Charges

As discussed earlier, environmental problems can arise when the market system fails to establish appropriate price signals and incentives in relation to environmental resources. For instance, some of these resources can be used "for free", although their use imposes external costs in the form of water pollution, reduced air quality or other environmental consequences. In some cases, the market price that does prevail covers the private costs of an environmental input but not the external costs incurred by third parties. When environmental resources are underpriced in this way producers and consumers are more likely to make excessive use of these inputs relative to others that are higher-priced. Underpricing also provides insufficient market incentives for the development of new technologies to control environmental problems.

Economic theory holds that an appropriate environmental charge can compensate for these deficient market signals by raising the price of using environmental inputs to a level that better reflects the total economic costs – private and external costs – of these resources. As the charge alters the relative prices paid by producers and consumers, it generates a price incentive for these groups to pay closer attention to environmental costs and benefits when choosing among various courses of action.

One of the main benefits of a well-designed environmental charge is that it confers on producers and consumers the flexibility they need to minimize the costs of achieving a given environmental goal. Faced with an emissions charge, for instance, each firm can compare various ways of reducing emissions and choose the solutions that match its circumstances. The range of possibilities might include changing the product mix, modifying production technologies or installing equipment that can filter or clean the "end-of-pipe" emissions. To the extent that different firms can have different costs for pollution abatement, a charge can encourage firms facing lower abatement costs to go further in cleaning up their operations than firms for whom abatement is more costly. In this way, an overall environmental target can be achieved at lower costs to the economy. By comparison, traditional regulations tend to be more costly to the economy, particularly if all firms are required to adopt the same method of pollution control.

Another major benefit of an environmental charge is that the price incentives it generates are continuing. Therefore, the charge encourages the long-term development and use of "cleaner" processes and products. Regulations offer no comparable incentive for firms to develop and adopt more effective pollution control techniques once the regulatory requirements are met. Moreover, regulated firms may be unwilling to support the development of better abatement technologies because progress in this area could lead to more stringent regulatory requirements.

In some situations, an environmental charge may have advantages over a system of tradeable permits. A charge raises the cost of pollution and leaves the level of pollution to be determined. A permit, by contrast, sets the level of pollution and leaves the costs (in the form of the market price for permits) to be determined. In the case of an environmental charge, therefore, the polluter knows, up front, both the costs of investing in pollution abatement and the tax that is payable on continued levels of pollution. In a tradeable permits system, however, the polluter does not have advance knowledge of the price that the market will eventually assign to the permits.

Key Design Issues

In practice, the prospects of realizing the potential benefits of environmental charges depend on the following technical and design considerations:

- recognizing the basic characteristics of the environmental problem;
- specifying a suitable tax base; and
- setting an appropriate tax rate.

The basic characteristics of the environmental problem

For some environmental problems, an environmental charge is unlikely to be an effective solution. For example, in situations where even small amounts of a dangerous substance can seriously damage the environment and human health, regulatory controls would be the preferred instrument. At most, an environmental charge may serve as an incentive for consumers or producers to speed up their adjustments to regulatory requirements.

In general, environmental charges are best suited to situations where there is a reasonably simple and well-understood relationship between a polluting action and its physical impact on the environment. When the relationship is more complex, the development of effective charges can pose design problems that may result in impractical tax structures. For example, it is difficult to design a simple tax structure to cover situations in which one activity leads to emissions of a number of pollutants, and measures to limit emissions of one pollutant can affect the emissions of the others. Under these conditions, decisions about what constitutes an appropriate charge on one pollutant must take into account measures planned to reduce other emissions.

For an environmental charge to be effective, it is also important to achieve a close link between the charge and decisions that have an important bearing on a given environmental objective. In some situations, the most appropriate tax structure may be a system of charges covering a wide variety of decisions or activities. In other situations, the most promising approach may be to target a charge on a specific problem or area of decision-making that is not being adequately addressed by other measures.

The tax base

The environmental effectiveness of a charge will also depend on whether it is possible to define a suitable base for the charge. In this regard, imposing a charge on certain substances but not on harmful substitutes would raise questions about the environmental implications, economic costs and fairness of the charge. Moreover, the task of determining what should be included in the tax base is difficult when there are major uncertainties regarding the scientific properties, environmental implications and practical applications of various substances and products. This problem, of course, is not restricted to environmental charges; it also comes up in relation to regulations, tradeable permits and other instruments.

Another issue is the administrative difficulty involved in making a clear distinction between what should be subject to the charge and what should be excluded. Experience with the manufacturers' sales tax and, to a lesser extent, with retail sales taxes, has shown that the borderlines for applying a tax will be tested over time by various businesses and taxpayers. The results of these challenges can shift the boundaries of the tax in unintended directions unless it is possible to legally defend the distinction between what should be included in the tax base and what should be excluded.

The tax rate

Setting an appropriate rate for the charge can be a difficult operation. Ideally, the rate should raise the costs of using an environmental resource so that it reflects external costs imposed on third parties. Expressed in more technical terms, the optimal charge rate should modify price signals to correspond to the total costs – private and external – of pollution at the margin. However, as discussed in Chapter 3, this approach rests on the unrealistic assumption that one can identify and assign monetary values to all the externalities linked to the use of an environmental input. A next-best approach is to set the rate according to a predetermined target for the environment and the anticipated response to various changes in price signals. However, information and practical experience related to the impact of environmental charges is still quite limited. Most of the results that are available come from other countries and, often, cannot readily be applied to Canada and to the substantial targets of the *Green Plan*.

In selecting a tax rate, it can also be important to distinguish between charges designed to meet short-term objectives and those aimed at long-term goals. As a rule of thumb, the long-term response to a tax rate is likely to be stronger because it will include the effects of changes in capital stock and durable goods that can benefit the environment. This suggests that an environmental charge that sets out to encourage changes in patterns of production or consumption over a number of years can be effective at a lower tax rate than one intended to achieve major results in the first year or two.

In short, the task of identifying an appropriate tax base and rate for a specific environmental target can be a tricky undertaking. Additional research, however, could make it less so. We need better information about the environmental impacts of certain activities and products and about the short-term and longer-term response to changes in price signals. It is also important to be able to identify groups of substances or products that are similar in terms of their environmental implications; studies in this area could help clear the way for development of simple but effective tax structures. Technical research can also help to identify situations where the environmental effects of a potentially damaging substance are closely linked to certain decisions made by producers or consumers over the life cycle of the substance.

A versatile approach can also make it easier to resolve problematic issues in the design of environmental charges. On this subject, it is useful to bear in mind that charges can be designed to be levied on:

- emissions, effluents or solid waste being released into the environment;
- inputs or materials known to be a source of environmental pressures; or
- final products linked to environmental issues.

The analysis that follows is offered as reference material for use in public consultations about these approaches. It describes the main features of each approach, reviews the experience with practical applications in Canada and elsewhere, and assesses the criteria for feasible and effective options. At the end of the discussion, we review several specific examples of charges to illustrate some key issues in the design and implementation of these types of economic instruments.

5.1.1 Charges on Emissions, Effluents or Solid Waste

Main Features

Environmental charges can be imposed on airborne emissions, water effluents or solid waste at the point of release into the environment. This is the most direct way to apply a charge on harmful pollutants or waste materials. One example of this type of approach would be a charge on the emissions of certain greenhouse gases – such as CO_2, nitrous oxide and methane. Another example would be a charge on SO_2 emissions that contribute to acid rain. For the management of water resources, an example of an effluent charge would be a tax on the discharge of certain chemicals, suspended solids and other substances into rivers, lakes and other bodies of water.

This type of charge can achieve a very close link between the amounts payable under the charge and the use of environmental resources. For producers, the charge would cause an increase in costs at each level of production. Under normal conditions of supply and demand, the charge paid by producers would also move through the price system to product markets. As a result, the prices of final products would better reflect environmental costs and consumers would be encouraged to switch to products that are less harmful to the environment.

This approach has the additional advantage of allowing producers complete flexibility in choosing the most cost-effective method of reducing their discharges – either over the short-term or over longer planning horizons. Therefore, any changes they make to their equipment or production patterns to reduce the pollutants in question can reduce their payments of the charge.

The Experience in Canada and Other Countries

Only a few OECD countries have had much experience with charges on airborne emissions or water effluents. France introduced an emission charge on major producers of SO_2 and NO_x during the 1980s. Since 1981, Germany has been imposing an effluent charge on a list of pollutants that includes mercury, cadmium and oxidizing substances. Effluent charges have also been in operation for several years in France, Italy and the Netherlands.

Unfortunately, the experience accumulated so far in these countries is of limited value to the development of effective incentive-oriented charges in Canada. In particular, studies show that the rates were set too low to provide much of an incentive for improving environmental decision-making. Indeed, the main purpose of these charges has been to raise money for pollution abatement and control programs. Where some incentive effects have been achieved, they have been attributed to a close connection between the charge and regulatory requirements. For example, under the German system, producers who meet certain pollution-reduction standards are permitted to pay a lower rate of charge on their emissions. Those who do not meet the standards for their sector are required to pay the full amount of the charge on all of their discharges.

The design and role of these low-rate charges seem to have been influenced by concerns that charges set at higher rates would require complex tax structures and administrative mechanisms. The low rates have enabled the government to adopt simple estimating procedures for applying the levies. Charges based on actual discharges are considered to involve higher costs of administration and enforcement.

Assessment

In assessing the potential for using emission charges, one can readily identify certain situations in which this type of approach is unlikely to work. In the remaining situations, it is also possible to identify major factors that require consideration.

We can rule out the use of emission charges on measured levels of pollutants when the sources are small, varied and too numerous for individual monitoring and payment of a charge. One example would be the exhaust emissions of motor vehicles. An emissions tax based on measured levels of these emissions would be unworkable because of the costs of measuring and monitoring emissions from each vehicle. Similarly, an emission charge can be ruled out as a way of addressing concerns about ozone-depleting chemicals because CFCs and similar chemicals can escape from many small sources such as refrigerators and other cooling systems. Under these circumstances, the consideration of other types of tax structures is likely to result in options that are more likely to be feasible from a technical perspective.

We would also rule out the application of a general charge where an environmental problem is essentially local. For example, a given level of discharged substances may cause no change in the water quality of a large river, but a major change in a small river or lake. Local problems require locally targeted measures rather than general changes in prices and behaviour. Although a local charge might be an option, applying a nation-wide or province-wide charge to these problems would not be very effective in achieving the environmental objective.

Some environmental problems are transnational or global in scope and may require a concerted international response. Although emission charges may be one option in such cases, their effectiveness and the benefits of other instruments will depend on the actions taken by other countries.

In situations where charges on emissions, effluents or solid waste might be effective in achieving a given environmental objective, the assessment of this approach depends on the other important criteria presented in Chapter 3. For these charges, one of the most important is the impact on international competitiveness. In markets where Canadian producers are competing with foreign suppliers, charges imposed on emissions in Canada but not in other countries can give a competitive advantage to foreign firms. Under such conditions, Canadian consumers can be expected to respond to the price effects of an environmental charge by switching from domestic products to "cheaper" imports. This response would increase environmental problems in other parts of the world while reducing employment opportunities in Canada.

One way in which it may be possible to protect the competitive position of Canadian producers is through the design of the charge – although the possible solutions can be expected to increase the costs of compliance and administration. It may be possible, for example, to provide refunds to Canadian producers to remove the charge from products that are exported. Conversely, it may be possible to impose a comparable charge on imported products that are essentially the same as those produced by domestic firms.

Maintaining international competitiveness may become a more difficult challenge where a charge on emissions, effluents or solid waste would have an indirect effect on the prices of other goods and services. This can happen when firms subject to the charge sell their products as inputs to other producers. In these cases, it would be difficult to remove the indirect effects of the charge from all the final products sold as exports. At the same time, it would be difficult to impose taxes on imported goods and services that would be comparable to the indirect effects the charge could be expected to have on similar goods and services produced in Canada.

In cases where our trading partners and competitors are taking measures to protect the environment, competitiveness issues may be easier to resolve. Where concerns remain, however, other types of taxes may be able to achieve better results. The possibilities include a tax levied on final products or, alternatively, measures that combine two features: a charge, and an incentive which enables firms to reduce or offset the amount of the charge by taking better environmental decisions. Each of these approaches is explored later in this chapter. Also, before deciding on the best course of action for a given environmental goal, the effect of the best tax option would need to be compared with the effects of non-tax instruments and regulation.

Another important consideration in evaluating the merits of charges on emissions, effluents and solid waste is the cost of administration and compliance. As experience in other countries shows, these costs can have a major bearing on the prospects for applying charges at levels high enough to modify behaviour. A key issue in this respect is the physical ability to obtain fair and reliable measurements at reasonable costs.

The issue of enforcement is also crucial. A heavy charge on the disposal of certain substances or materials generates an incentive for polluters to look for ways to avoid paying the charge. Some of these responses can be environmentally damaging – for instance "midnight" or illegal dumping. When this practice involves hazardous wastes, the environmental costs of this form of cheating can be heavy. Controlling these types of environmentally damaging behaviour can require costly enforcement measures that go beyond the administrative procedures of existing tax systems. In some cases, however, suitable enforcement may be consistent with existing systems for provincial or municipal regulation.

As discussed below, one possible way to reduce the costs of administration and enforcement is by applying the charge to inputs or products, rather than to emissions or effluents. Since non-tax instruments can also involve administration, compliance and enforcement costs, selecting the best approach for a given target will require a comparison of estimated benefits and costs, in a given application, between the tax option and other options, including regulation. The results of such a comparison may indicate that the net costs for a tax option are lower than for other potential options.

5.1.2 Charges on Inputs or Materials

Main Features

Where charges on effluents or emissions pose major problems for design or implementation, a charge levied at an earlier stage in the pollution cycle may be the preferable approach. In some situations, it may be more practical to impose the charge on certain inputs or materials. This type of charge may be set according to the potential of the input in question to generate emissions, effluents or solid waste. If some inputs are more damaging than others, it may be possible to develop a set of tax rates that recognize these differences. For example, when leaded gasoline was being phased out, it was taxed at a higher rate than unleaded gasoline because leaded gasoline is more harmful to the environment.

Perhaps the most common example of an input charge is a carbon tax – a charge on fossil fuels set according to the carbon content of each fuel. For the problem of ozone depletion, the most common example of an input charge is a tax on CFCs and other ozone-depleting chemicals during the phase-out period. Examples in the area of waste management might include a tax on materials used for packaging.

Input charges have three important advantages.

First, they do not require monitoring of the levels of emissions, effluents or waste leaving each source of pollution. This means that the costs of implementing and administering an input charge can be modest compared with those for an emissions or effluent charge. For example, the federal excise taxes imposed on automotive fuels at the refinery gate are administratively simple. These levies also provide some price incentive to conserve these fuels and, thus, reduce vehicle exhaust emissions.

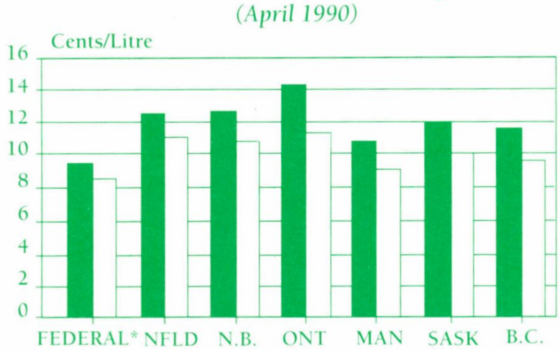
Second, the administrative and compliance costs of an input charge can be lower than those of emission charges because the number of taxpayers is smaller. A charge on emissions, effluents or solid waste would be collected, downstream, from each polluter. An excise tax on pollution-generating inputs, by contrast, can be collected upstream from the producers of the input on the basis of their sales. In the case of carbon dioxide emissions, for example, the number of industrial, transportation and residential emission sources is huge. The number of producers of fossil fuels, however, is relatively small.

Third, by changing the relative prices of various inputs, this approach can encourage firms to use the taxed input more efficiently and to switch to untaxed inputs that are better for the environment. Furthermore the influence is ongoing. Over the years the charge can continue to encourage firms to change their input mix and to invest in the development of environmentally preferable inputs and more efficient technologies.

The Experience in Canada and Other Countries

In Canada, the current excise taxes on motive fuels may be viewed as input charges, since they do provide some price incentive to conserve these fuels. Another example is the tax on leaded gasoline. In April 1989, the federal government imposed an additional excise tax of one cent per litre on leaded gasoline to help accelerate the phasing out of this form of fuel. As shown in Figure 15, six of the provinces also taxed leaded gasoline at a higher rate than unleaded gasoline, with the tax differential ranging from 3 cents per litre in Ontario to 1.5 cents per litre in Newfoundland.

Figure 15
Fuel taxes on leaded and unleaded gasoline
(April 1990)



* *Refers to excise tax on fuel only.*

Carbon taxes have been recently introduced in four European countries: Finland, the Netherlands, Norway and Sweden. These levies demonstrate that a carbon tax can be imposed on the fossil fuels that generate CO_2 – a much simpler proposition than attempting to impose a charge directly on the emissions. In the case of Sweden, a significant carbon tax rate has been imposed. However, an exemption has been provided for fossil fuels used in electricity generating and energy-intensive industries, because of concerns that full application of the tax at this time would hamper Sweden's international competitiveness.

The U.S. and Denmark have recently imposed a tax on the use of CFCs and other types of ozone-depleting chemicals, in the form of an input charge rather than a charge on the emissions. These levies are intended to complement regulations that reduce or phase out the use of these chemicals. The U.S. experience demonstrates that a tax on ozone-depleting chemicals is technically feasible but administratively complex. One challenging area is the tax treatment of recycled chemicals. While it may be appropriate to exempt recycling, there are practical difficulties in distinguishing between new and recycled chemicals for the purposes of administering such an exemption. Another complex question is how to treat imported products containing ozone-depleting chemicals, such as air conditioners using CFCs as refrigerants. Presumably, these imports should be taxed to avoid giving imported goods a competitive advantage. However, applying a suitable charge to each of these products can be a difficult task and one which, ideally, should incorporate technical information about production processes used in other countries.

Assessment

Taxes on environmentally harmful inputs or materials used in production encourage firms to do what needs to be done to lower their tax bills and protect the environment. This they can do in one of two ways. They can cut down on their use of environmentally harmful inputs or switch to better production techniques. What these input charges cannot do is provide an incentive for polluters to develop "end-of-pipe" abatement technologies to reduce the amount of pollutants being discharged into the environment. This suggests that an input charge will not be the most effective approach when "end-of-pipe" technologies are considered necessary for effective control of the pollutant in question.

Taxes on fossil fuels illustrate this limitation. They may achieve some reduction in vehicle emissions such as NO_x, carbon monoxide and hydrocarbons. They can encourage vehicle owners to reduce the amount of driving, switch to alternative fuels and select vehicles that are more fuel-efficient. They may motivate manufacturers to produce more fuel-efficient vehicles or vehicles that can use "cleaner" alternative fuels. But they do not encourage manufacturers to invest in better emissions control systems, and they do not encourage good maintenance of installed equipment.

The potential impact of an input charge also depends upon the availability of substitutes and the nature of demand. If the demand for an input is inelastic and if no substitutes are available, an input charge will not decrease the use of an input in the short run. Under these circumstances, the main function of an input charge would be to collect a fee for the use of the input. Over time, however, this type of charge may encourage the development of new substitutes or better production technologies.

In some circumstances, the demand for inputs can be inelastic. An important example of this is a case in which the input in question accounts for a small proportion of total production costs. In this situation, producers will have less incentive to decrease their use of these inputs or to shift to substitutes. On the other hand, if an input is a major item on the production-cost bill, an input charge may be very effective in changing patterns of production.

Once it has been established that an input charge may be an effective way to achieve an environmental goal, it is still necessary to ensure that this approach will also realize the benefits inherent in economic instruments. This will depend on the extent to which the charge measures up to the other design and assessment criteria presented in Chapter 3. In developing the charge, it may be necessary to weigh the effects of some trade-offs. In support of environmental goals, for example, it may be appropriate to exclude certain recycled substances from an input charge. However, as suggested above, attempting to provide such an exemption may pose major problems in design and administration, particularly when it is difficult to distinguish between new and recycled substances.

It may also be complicated to apply an input charge when some inputs, or uses, are much less damaging than others. Under these circumstances, the most appropriate tax structure would be one with differentiated tax rates. In practice, however, there may have to be some trade-offs between what can be technically designed into the structure of a charge and the ability of the charge to achieve a given environmental target. For example, there are no ozone-depleting chemicals released into the atmosphere during the manufacturing process if these substances are used as feedstocks and entirely consumed in the manufacture of other ozone-depleting chemicals. In such cases, the initial chemicals would be considered benign to the ozone layer and, therefore, not subject to an environmental charge. The U.S. has provided a tax exemption to the feedstocks used in the production of ozone-depleting chemicals. However, the exemption applies only to the transactions where the purchasers and users of the inputs meet strict requirements.

On the matter of international competitiveness, an input charge may create a bias in favour of imports. One way to counteract this effect might be to impose a corresponding charge on the inputs contained in imported products. If technically feasible, this approach should ensure that the tax applies equally to domestic and imported goods. However, it should be recognized that this solution could add considerably to the complexity of the tax system.

Input charges also raise important questions about exports. Although exports are normally exempt from sales and excise taxes, they can carry the indirect effects of a tax that is applied to business inputs. In some cases, the indirect effects of an input charge may represent a significant fraction of the profit margins of Canadian exporters. On the other hand, exempting export goods and services from the input tax could require complex tax structures and administrative procedures.

5.1.3 Charges on Final Products

Main Features

Where it is not feasible to use either input or emission charges, a final-product charge may be appropriate. Indeed, there may be situations in which this type of charge may be the first choice. This might be true, for instance, when the environmental problems being tackled are closely linked to consumer demand for certain final products. In the environmental context, a charge on final products can raise the tax-inclusive price of the product so as to better reflect the total costs associated with the production, consumption or disposal of the product.

Examples of this approach would include imposing a charge on certain commodities that add to the flow of solid waste – such as disposable products that compete with reusable alternatives. An example for global warming would be a charge on automobiles that do not meet certain levels of fuel efficiency. For the problem of ozone depletion, this type of approach would involve designing charges that could be applied to certain products containing CFCs.

Final product charges have a number of potentially useful characteristics. First, they offer a direct way to modify price signals for final products. Second, they impose the levy as close as it is possible to the point at which consumers make their choices. This means that a well-designed product charge may serve as a targeted approach where the main goal is to enhance consumer awareness of the environmental implications associated with the use of various products. At the same time, the incentive effects are flexible enough to enable consumers to respond according to their own preferences and situations. Some may prefer to conserve or reuse existing supplies; others may shift to alternative products that are better for the environment. Over a longer period, final-product charges can also stimulate the development and marketing of better substitutes for the taxable product.

Compared to other types of charges, this type of approach may be easily adapted to address concerns about international competitiveness. If a charge is imposed on a final product, it is quite likely that it can be accompanied by a corresponding charge on imports and an exemption for exports. And this can be done without the complex tax structures needed to achieve similar results through emission or input charges.

The Experience in Canada and Other Countries

In Canada, several provincial governments have recently introduced product taxes on a range of items.

- British Columbia levies a $5 environmental charge on lead-acid batteries and a $3 charge on tires.
- Manitoba applies an environmental protection tax to alcoholic beverage containers that are not returnable for reuse under a deposit-refund system. The charge is 5¢ for each can and most small bottles. For beer bottles and other bottles of 75 ml or more, the charge is 10¢ per container.
- Ontario applies a $5 tax to tires and a 5¢ charge to non-returnable alcoholic beverage containers. The province also introduced a tax on fuel-inefficient automobiles, on July 1, 1989. The tax rate started at $600 for vehicles with a highway fuel consumption rating between 9.5 and 12.0 litres per 100 kilometres, and increased to $3,500 for vehicles with a fuel consumption rating of more than 18 litres per 100 kilometres. More recently, the province has restructured its automobile tax to broaden the tax base, increase the tax rates and introduce a $100 rebate for vehicles with a highway fuel consumption rating of less than 6.0 litres per 100 kilometres.
- Prince Edward Island has a $2 tax on tires.

The federal government has some experience with the use of product taxes to encourage energy conservation. During the mid-1970s, excise taxes were imposed on automobile air conditioners and on heavy automobiles as part of a package of measures to encourage Canadians to make more efficient choices in their use of energy.

- The weight tax currently applies to automobiles weighing more than 2,007 kilograms and to station wagons and passenger vans weighing more than 2,268 kilograms. The tax rate starts at $30 and increases with the weight of the vehicle. Although this levy remains in effect, it now applies to only a few types of vehicles – largely because of the general down-sizing that has occurred since the mid-1970s.
- The tax on automobile air conditioners is set at a rate of $100 per unit and continues to provide a price incentive for consumers not to purchase these units. Although its original purpose was energy conservation, the tax also serves environmental objectives since automobile air conditioners are an important source of CFC emissions.

In other OECD countries, a number of product charges has been introduced over the years in the form of excise taxes. However, the levies have been applied to a quite limited range of products. The main examples include automobiles, lubricant oils, non-returnable beverage containers, batteries, pesticides and fertilizers.

In the case of automobiles, several countries use a combination of subsidies and taxes levied at different rates. Some European countries have used this approach to encourage adjustments to new emission standards and to promote the use of catalytic converters, which reduce the level of hydrocarbons and nitrogen oxides. In the U.S., an excise tax has been imposed on automobiles that do not meet federal standards for fuel efficiency. The American tax was introduced in 1980 and the rates were increased as of January 1, 1991. The current levy starts at a rate of U.S. $1,000 for automobiles that are unable to register a combined city and highway fuel consumption rating of at least 22.5 miles per U.S. gallon (about 10.5 litres per 100 kilometres). The tax rises to U.S. $7,700 for models with a fuel consumption rating of less than 12.5 miles per U.S. gallon (about 19 litres per 100 kilometres).

Charges on lubricant oils, household batteries, and disposable containers have been imposed in response to the disposal problems associated with these products. In effect, they have been functioning as disposal fees because the rates have been too low to reduce consumption.

Some countries are either considering or testing product charges in new areas. In 1989, for example, Italy imposed a tax on plastic shopping bags set at about five times the manufacturing cost. Reports indicate a major reduction in sales of these bags, and some increase in the use of paper bags. In the Netherlands, the government has been examining the merits of imposing incentive charges on disposable products and on products containing certain short-life plastics known as polyvinyl chlorides (PVCs).

There has also been some experience with deposit-refund systems. In the past, this approach has been used primarily to encourage the return of reusable beverage containers. More recently, deposit-refund systems have been used to encourage the proper disposal of lead-acid batteries and automobiles. The government of the Netherlands is also examining their use to encourage the collection of products containing aluminum and certain plastics with long life cycles.

Assessment

Product charges are unlikely to achieve a given environmental target when changes in price do not have much impact on product demand. This applies, for instance, to products that are basic necessities and for which no better alternatives exist. In these situations, even a very high charge would achieve little or no change in behaviour. The only rationale for applying a product charge in this situation would be to raise the costs of using these products to better reflect their environmental costs and, possibly, to encourage the eventual development of substitute products.

The environmental effectiveness of a product charge also depends on the existence of a reasonably close connection between the purchase of certain products and an environmental problem. Where the link is tenuous or variable, the modified price signals generated by a product charge will be poorly targeted and, thus, unlikely to contribute to the environmental goal.

In some instances, changes in the basic structure of the charge may improve its effectiveness in addressing an environmental problem. If, for instance, the goal is to encourage consumers to generate less solid waste, a product charge imposed at the time of sale would serve this goal by encouraging consumers to buy less of the products in question. If the goal is to encourage consumers to use proper disposal practices for certain products, a more effective approach may be to combine the charge with a refund system to provide consumers with a full or partial rebate when the proper method of disposal is used.

Once it has been determined that product charges may be an effective instrument in a given situation, a number of factors will have an important bearing on the development and assessment of options. For the purposes of realizing economic benefits and minimizing the costs of administration and compliance, one of the most important considerations is the ability to establish and maintain a clear distinction between the products that should bear the tax and those that should not. For some types of products, it may be difficult to develop borderlines that are consistent with environmental objectives as well as with the practical demands of tax structure design and administration. In the case of solid waste management, for example, an appropriate structure for a product tax may be one that distinguishes between products made of new materials, recycled materials and various combinations of new and recycled materials. It goes without saying that the development of such a tax structure would raise complex issues in design and implementation.

Product charges imposed on a varied mix of products can also be cumbersome to administer unless some simple way can be found to apply an appropriate charge to each product. Imposing a large number of product charges with a multitude of rates could also be confusing and unacceptable to industry and the public. Therefore, if products cannot fit readily into simple, uniform tax structures, the application of product charges to them should only be considered where complexity can be balanced by substantial benefits for the environment.

5.1.4 Some Specific Examples of Environmental Charges

In this section we offer a more detailed examination of two of the more widely discussed examples of an environmental charge – a carbon tax for the problem of global warming and a tax on ozone-depleting chemicals for the problem of stratospheric ozone depletion. The discussion, in each case, centres on some of the key issues in the design and implementation of these charges.

Global Warming – Carbon Dioxide Emissions

The environmental objective

As mentioned earlier in this paper, man-made CO_2 emissions, most of them caused by the combustion of fossil fuels, account for about 55 per cent of known man-made greenhouse gas emissions. Canada has pledged to stabilize its CO_2 and other greenhouse gas emissions at 1990 levels by the year 2000.

The potential for using a charge

Currently, there are only limited possibilities for cutting down on CO_2 emissions through the use of smokestack or "end-of-pipe" abatement technologies. The only way to reduce these emissions significantly is by reducing fossil-fuel consumption. This suggests that CO_2 emission reduction is a goal for which an input charge on fossil fuels may be an appropriate instrument.

There is a close connection between the carbon content of fossil fuels and the CO_2 emitted when they are burned. Therefore, a tax on the carbon content of the fuel (a "carbon tax") can be closely linked to the amount of carbon dioxide emissions.

Although the primary aim of a carbon tax is to reduce CO_2 emissions, it may also reduce the emissions of other greenhouse gases. For example, a carbon tax would contribute to reduced emissions of nitrous oxide if it encourages power stations to burn less coal or the transportation sector to use fossil fuels more efficiently. A carbon tax may also curb emissions that contribute to other environmental problems. For example, reduced consumption by motor vehicles can reduce emissions of NO_x, a precursor to acid rain and smog.

In weighing the potential usefulness of a carbon tax to reduce the emissions of greenhouse gases, it is important to keep in mind that we are dealing here with a global environmental problem. Canada accounts for only about two per cent of the CO_2 emissions generated by the burning of fossil fuels. In other words, global warming is not a problem that can effectively be addressed by Canada alone, but rather one that requires concerted action by the world community. Mobilization of such an effort raises many complex issues. Prominent among them is the fact that developing countries are expected to increase CO_2 emissions at a faster rate than other countries as they industrialize and as their economic growth rates accelerate. This suggests that cooperative actions with these countries will also be necessary to achieve reductions in greenhouse gas emissions.

Design considerations

The general structure of a carbon tax is relatively simple and straightforward. Information about the carbon content of each fuel is readily available and can provide the necessary basis for a differential rate structure among fossil fuels. Also, a carbon tax approach would be easier for authorities to administer and for taxpayers to comply with than a charge imposed directly on measured levels of CO_2 emissions.

As noted in section 2.5, the general equilibrium environment model developed by the Department of Finance has been used to compare the potential impact of a carbon tax with other types of instruments. The results of this analysis show the carbon tax to be the most cost-effective of the instruments analyzed to achieve the target of stabilizing CO_2 emissions.

However, there are other considerations that have an important bearing on the design and implementation of a carbon tax. One important area is distributional implications. Chapter 2 noted that alternative economic instruments can exert differing impacts on certain industries relative to others, and can affect different regions of the country in different ways. Industrial and regional impacts can also be related to the extent that certain industries are regionally located or employ production techniques that are more sensitive to the effects of environmental policies.

A carbon tax would impose a heavier tax on more carbon-intensive fuels such as coal. About 80 per cent of coal production in Canada originates in Alberta and British Columbia. Virtually all electricity in Saskatchewan and Alberta is fossil-fuel-based. The Atlantic provinces also rely heavily on fossil fuels for power generation. On the other hand, Quebec, Manitoba and British Columbia depend primarily on hydro-electric power and Ontario generates power from a combination of nuclear, hydro and thermal sources. As a result, introducing a carbon tax would be expected to have important regional and sectoral implications.

For example, the analytical work discussed in Chapter 2 has suggested that a carbon tax designed to stabilize carbon dioxide emissions by the year 2000 at 1990 levels would lead to a larger percentage increase in coal prices in Canada than a less directly targeted instrument such as a uniform tax on the price of fossil fuels. The consequences of such a carbon tax for coal-producing and -consuming regions must therefore be given serious consideration. The impact of higher coal prices would be felt directly and indirectly through their impacts on higher electrical rates. These direct and indirect effects could have major impacts on energy-intensive industries such as iron and steel.

Distributional considerations raise the important issue of the relationship between cost-effectiveness and equity concerns. On the one hand, it could be argued that a less directly targeted measure, such as a flat fossil fuel tax, would be less cost-effective but may "spread the burden" of meeting environmental goals across industries and regions. On the other hand, the savings generated by more cost-effective economic instruments could be used to alleviate distributional effects. This is an important issue for further examination.

Another important consideration for a carbon tax is international competitiveness. The taxing of fuels used as business inputs in the production of other goods would raise the price of these domestic goods relative to imports. To avoid creating a competitive advantage for imported products, it may be possible to tax imports according to the amount of fossil fuels used to produce them. Given the widespread use of fossil fuels, however, it is not clear how such a system could be practically implemented. The prospects for raising trade policy issues would also have to be considered.

A carbon tax would also add to the cost of exported goods when producers use fossil fuels. This could place Canadian products at a cost disadvantage in the international markets unless our competitors take similar steps to address global warming.

These factors suggest that the use of a carbon tax would be best considered as part of a concerted international effort to address global warming. In recognition of the sectoral and regional implications of a carbon tax, one approach may be to introduce such a tax at a modest rate to enable industries to adjust over time. The magnitude of the potential revenues from a carbon tax also raises some fundamental questions. For example, how much of the revenues should be used to address the effects on certain sectors or regions? Different options for the use of these potential revenues can have an important impact on the cost-effectiveness of a carbon tax as well as on the distributional implications of this type of initiative.

Stratospheric Ozone

The environmental objective

As mentioned earlier in this paper, emissions of man-made chemicals such as chlorofluorocarbons (CFCs), halons, and various other chemicals contribute to the depletion of the earth's protective ozone layer. Canada has pledged to phase out CFCs by the end of 1995, and the other principal ozone-depleting substances by the end of 1994.

The potential for using a charge

Canada has responded to the Montreal Protocol with regulations. By comparison, the U.S. has imposed an excise tax on CFCs and other ozone-depleting chemicals to complement its regulatory response to the Protocol.

The structure of the U.S. tax provides a useful example of an input charge on ozone-depleting chemicals. The levy is imposed on the sale or use of CFCs, halons, methyl chloroform and carbon tetrachloride. The basic tax rate is scheduled to increase over time – rising from U.S. $1.37 per pound in 1990 to U.S. $4.90 per pound by the end of the decade. The tax rate for each chemical takes account of how damaging the substance is to the ozone layer. Consequently, the tax per unit of halons is much higher than for CFCs. Exemptions can be claimed for ozone-depleting chemicals that are either recycled or used as feedstocks.

To avoid creating a bias in favour of imported goods, the U.S. applies the tax to imported products containing ozone-depleting chemicals (e.g., air conditioners). The tax also applies to imported goods whose manufacture involved the consumption of these chemicals (e.g., substances used as cleaning solvents for electronic parts). Exports are exempt from tax. However, the indirect effects of the tax may be carried by exports that used taxed chemicals in their production.

Design considerations

An input tax on ozone-depleting chemicals would be technically feasible. In Canada, these substances are manufactured by only a small number of firms – there are, for instance, only two domestic producers of CFCs. Taxing these chemicals at the manufacturer's trade level would be reasonably straightforward in terms of design and implementation. Also, without too much difficulty, a differentiated tax rate structure could be designed on the basis of the damage these chemicals cause to the ozone layer.

However, the design of this type of charge for Canada would raise some complex issues. First, there is the matter of recycled chemicals. Ozone-depleting chemicals produced in Canada are often sent to the U.S. for recycling. While environmental objectives suggest that the use of recycled chemicals should be exempt from the charge, it is not clear that it would be feasible to provide such an exemption when recycled substances are imported into Canada. Distinguishing recycled chemicals from new supplies would involve complex tax design and administration procedures.

Second, the treatment of imported products raises a number of practical problems when the exporting countries do not have an input charge for ozone-depleting chemicals. The U.S. has responded to this problem by applying the tax on ozone-depleting chemicals to imported products that make use of these substances. Where possible, the tax is based on the amounts of the chemicals actually used in the production of the imported products. Against the eventuality that importers may not be able to acquire or provide the necessary information, the U.S. Treasury has established an Imported Products Table that contains an extensive list of taxable imports – including refrigerators and freezers, video cassette recorders, radios, television sets, telephones, computers, cash registers, etc. The table also presents estimated amounts of tax for each product based on general information supplied by industry representatives. The widespread application of this type of approach would obviously make the implementation of a well-designed charge more complicated.

5.2 Tax Incentives

Tax incentives subsidize specific groups of taxpayers or specific activities. Incentives provide preferential tax treatment to encourage certain types of investment. Incentives include credits, exemptions or deductions, or tax benefits made available to investors who provide funding for eligible projects or activities. Tax credits reduce tax payable. Tax exemptions and deductions reduce taxable income.

Environmental tax incentives proposed to the government include measures to encourage capital investment in pollution abatement and control equipment (e.g., tax credits, accelerated deductions) and measures to reduce the price of environmentally friendly activities (e.g., recycling rebates) or to lower the cost of funds for investments in environmental projects (e.g., tax-free "green bonds").

5.2.1 Investment Incentives in the Tax System

Major Features

The tax system could encourage environmental investments through deductions, exemptions or credits.

One type of incentive that is sometimes suggested in the pursuit of environmental goals is the accelerated depreciation deduction. The Income Tax Act provides for such a deduction, the Capital Cost Allowance (CCA), in lieu of the accounting depreciation for fixed assets that is calculated for financial statements. Under the CCA system, the deductions used for income tax calculations are based on specified rates of write-off. Generally, machinery and equipment and buildings have a longer life and, consequently, lower rates of depreciation than assets with shorter life spans such as computer software. Accelerated deductions are one way to encourage investment. When a deduction is accelerated, it means that the capital asset may be fully deducted for tax purposes long before the end of its economic life. Although an accelerated deduction is essentially an income tax deferral rather than exemption, it can be valuable to a firm. One important example in the pre-tax reform period was the accelerated allowance for all manufacturing and processing equipment. Most accelerated write-offs were reduced as part of the federal government's reform of the corporate tax system.

Another way to provide investment incentives is through Investment Tax Credits (ITCs). ITCs reduce federal corporate taxes payable by the firm, and therefore reduce the cost of a firm's investment. Before tax reform, firms could earn ITCs on a wide range of qualifying expenditures. The credits can now be earned only on certain types of investments in specific regions or in research and development (R&D). Current ITC rates range from 15 to 30 per cent depending on the region where the investment takes place, and from 20 to 35 per cent for qualified R&D. A qualifying Canadian-controlled private corporation may also receive cash refunds on the investment tax credits it earns on both current and capital scientific research expenditures. Refundable investment tax credits can provide a positive cash flow to a taxpayer who is not currently taxable and who may prefer to take the cash rather than to accumulate credits for future use. Tax credits for R&D may become increasingly important for developing new and better production technologies and abatement techniques. For example, the definition of "scientific research and experimental development" includes experimental development using the results of basic applied research to create new or improved processes. New processes are often more efficient and less polluting.

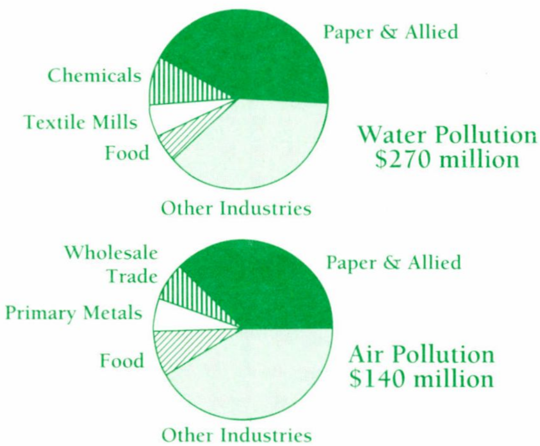
The Experience in Canada and Other Countries

The federal corporate income tax system currently provides for an accelerated capital cost allowance rate (50 per cent straight-line) for qualified water and air pollution control equipment (identified in the Income Tax Regulations as Class 24 and 27, respectively) installed at sites which have been in operation since before 1974. The significance of the "before 1974" stipulation is that stricter regulations controlling effluent emissions were imposed during the early 1970s. Parallel with the introduction of the regulations, accelerated write-offs were made available at plants and other installations that had been in operation before 1974. This was done to reduce the initial impact of the cost of modernizing these older facilities to meet the new regulations. At the time that Classes 24 and 27 were introduced, the cost of controlling effluent emissions at new installations (i.e., those built after 1974) was considered to be part of the normal cost of doing business and they were given no preferential tax treatment.

Class 24 was introduced in 1965 and was originally intended to be a one-year interim provision. It was extended several times and eventually made indefinite. Class 27 was introduced in 1970 and was applied to equipment purchased after 1970 and before 1974. It too was extended indefinitely.

Classes 24 and 27 have not been significant in terms of revenue cost to date. For instance, the combined claims for these classes accounted for about 0.5 per cent of total CCA claimed from 1978 to 1985. Most of the claims have been made by firms in the paper and allied industries sector. (See Figure 16 – Pollution Abatement Deductions.)

Figure 16
Pollution abatement reductions
by Industry Sector (1983-87)



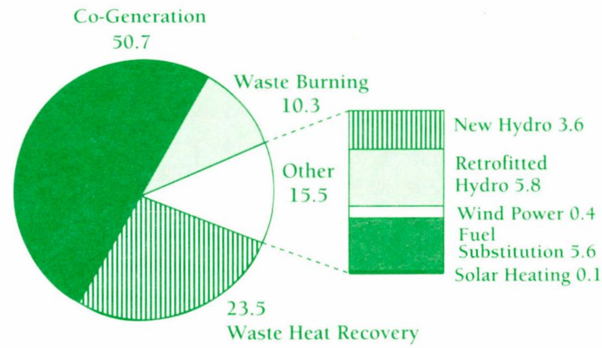
Source: Corporate Taxation Statistics
Statistics Canada #61-208

Eligible energy conservation equipment (Class 34 in the Income Tax Act) also qualifies for the same two-year, 50-per-cent straight-line treatment given to air and water pollution abatement equipment. Eligible assets currently include certain equipment used for the generation of electricity or the production or distribution of heat. These include active solar heating equipment, heat recovery equipment, small-scale hydro-electric projects and wind turbine generator installations (See Figure 17 – Class 34 Claims). Most of the equipment is environmentally friendly in varying degrees. However, some qualifying equipment, particularly that used to produce heat from burning municipal wastes, may not be as desirable from an environmental perspective as other activities.

Proposals have been advanced to the government to expand Class 34 to include other energy efficiency equipment which would have positive environmental impacts. Most notably, proposals have been submitted with respect to assets used in the process of extracting methane from waste sites, geothermal projects and photovoltaics.

Incentives within the income tax system generally reduce provincial taxes payable as well as federal taxes payable. Ontario, Quebec and Alberta, the three provinces which do not participate in the federal/provincial corporate tax collection agreements, follow the federal government's treatment of pollution control equipment for CCA purposes.

Figure 17
Class 34 claims
(by project type, %)



Source: Energy, Mines & Resources Canada

Although not designed for environmental purposes, both Quebec and Ontario offer incentives for the purchase of manufacturing and processing machinery, and these may include certain pollution abatement and control equipment. Quebec's 1988 provincial budget introduced a 100-per-cent write-off in the year of acquisition for manufacturing machinery and equipment acquired for use in Quebec. Since pollution control equipment is often considered to be part of manufacturing equipment, it may qualify for the incentive particularly when its purchase costs are combined with process modification costs. The 1991 Quebec budget made environmental technology innovation projects eligible for special R&D incentives, including a refundable tax credit.

Ontario also provides income tax incentives for investments in both manufacturing and processing and pollution control equipment. The Current Cost Allowance permits companies to deduct a portion of the cost of equipment acquired for use in Ontario from income earned in the year of acquisition. In 1991 the Current Cost Adjustment was 30 per cent. The measure expired on December 31, 1991 for manufacturing equipment but will be continued indefinitely for pollution control equipment. The understanding is that the definitions now used for Classes 24 and 27 will be retained except that the "before 1974" restriction will be eliminated.

Assessment

In the past, tax incentives have been introduced to achieve valid public policy objectives. These have included improved international competitiveness, counter-cyclical stimulation, correction of market failures, ease of adjustment for transitional costs and regional development. Investment incentives could be introduced as a way of offsetting any adverse impact on Canadian competitiveness from the increased costs of complying with new environmental protection regulations. Incentives could also be targeted to specific sectors and/or regions adversely affected by environmental regulations. In the past, incentives have been used to provide transitional relief when new regulations are imposed. Nevertheless, tax incentives are not without a cost.

Many tax incentives were introduced into the Canadian income tax system during the 1970s, including preferential tax rates, tax credits, accelerated depreciation, investment allowances and financing incentives. Although the rationale for their introduction was based on valid public policy objectives, these incentives narrowed the tax base significantly and resulted in wide differences in effective tax rates across sectors and activities in Canada. By the mid-1980s, the consensus was that many of the tax incentives in the system had lost their effectiveness. Additionally, the complexity of the tax system had led many to question its fairness. In response, many tax incentives were either eliminated or reduced in value during the 1987 tax reform exercise.

Before tax reform, an extensive set of tax incentives had existed to encourage investment, including accelerated capital cost allowances and investment tax credits. Retrospective analyses have suggested that these initiatives were not very effective in creating additional investment; in fact any additional investment that was stimulated was often considerably less than the revenues foregone by the federal treasury. At the same time, the general availability of these incentives was responsible for a number of problems in the corporate income tax system. The first was that many profitable corporations were not paying tax. Corporations were rearranging their affairs to ensure that losses were being utilized. Often losses were being used by firms in sectors unrelated to those for which the incentives were made available. The second problem was that government tax revenues from the corporate sector had become highly unstable. This experience suggests that broad-based use of accelerated write-offs and/or investment tax credits for environmental purposes may not be the best solution.

The effectiveness of these tax incentives in terms of encouraging corporate investment is also controversial.[1] Some analyses suggest that tax-based investment incentives are quite effective in stimulating new investment. Other analyses indicate that the benefits offered under these measures have most often been claimed for projects that would have been undertaken anyway, creating a windfall gain to the investors involved without stimulating the additional projects they were designed to encourage. The Department of Finance's analyses of two investment tax credits has supported the latter view (i.e., Cape Breton Investment Tax Credit, Exploration Tax Credit).[2]

As tax incentives are, in effect, indirect subsidies, their effectiveness as a means of achieving environmental goals may be questionable as they may actually encourage more firms to enter an industry thereby increasing pollution levels. In fact, a Conference Board study, *The Market and the Environment*,[3] suggests that the removal of subsidies may prove to be a more effective way to reduce pollution levels particularly in those sectors most favoured by government subsidies. The Conference Board study argues that government subsidies can often encourage the harvesting of renewable resources far beyond levels that would have existed had market forces operated freely. The elimination of preferences and incentives could actually reduce the consumption of environmentally sensitive resources.

International experience with subsidy schemes indicates that they generally support firms that are severely affected by imposed environmental regulations. While subsidies may be used as complements to regulations during the transitional period, over the long term they may discourage the development of new abatement technology.

Additionally, subsidies, including tax incentives, can reduce variances in the costs of curbing pollution between firms, thereby reducing the effectiveness of certain economic instruments such as tradeable permits. For example, wider variances in costs ensure the development of markets for tradeable permits because they generate a stronger incentive to trade. Subsidies can reduce the absolute and, in some cases, the relative differences in costs. It would probably become necessary to reexamine these types of incentives if a tradeable emissions system were introduced.

Evaluating costs and benefits

The direct benefits of incentives within the income tax system may be measured in terms of increased levels of desired activities. The direct costs of incentives are reflected in foregone government revenues. Other direct and indirect costs, however, surface in the form of less efficient allocation of resources, increases in other taxes and/or interest rates to compensate for foregone revenues, increased complexity of the tax system, diminished confidence in the fairness of the tax system, and reduced reliability of tax revenues. Any tax revenues foregone as

1 *Jack Mintz and Douglas Purvis, ed., The Impact of Taxation on Business Activity (Ottawa: John Deutsch Institute, 1985).*

2 *Department of Finance, Tax Measures Evaluation Division, Economic Effects of the Cape Breton Investment Tax Credit: An Evaluation Report, August 1990.*

3 *Brian Hull and Antoine St-Pierre, The Market and the Environment (Ottawa: The Conference Board of Canada, 1990) p.19.*

a result of the direct and indirect costs of providing incentives must be borne by the economy as a whole. Additionally, administrative and compliance costs can be high, particularly if the investment incentives are made transferable among taxpayers. It can also be argued that investment incentives are contrary to the Polluter-Pays Principle since other taxpayers ultimately bear some of the burden of clean-up.

5.2.2 *Financing Incentives in the Tax System*

Major Features

An alternative approach to direct investment incentives (such as accelerated depreciation or ITCs) is to provide financing incentives through the tax system. A financing incentive lowers a firm's cost of capital and may facilitate the raising of risk capital. A financing incentive may also provide for the tax-sheltering of income generated by funds set aside by a firm for future expenditure requirements.

In the past, situations have arisen in which corporations became non-taxpaying. This was true, for instance, for firms in their start-up phase, and for others with high reinvestment ratios that had made use of accelerated depreciation or investment tax credits. Many of these firms were not able to make full use of the tax preferences within the time period allowed under the tax system, and this defeated the purpose of the incentive. Immediate refundability of tax credits gave non-taxpaying firms the same incentive as those taxpaying firms able to make use of the incentive. However, full refundability raises concerns regarding control and the timeliness of delivering incentives.

One example of a financing incentive is the "flow-through" arrangement, so called because it allows the tax deductions associated with a designated activity to "flow through" to the investors. Under such an arrangement a corporation effectively transfers these deductions to investors. A common example is the flow-through share financing mechanism. Investors who enter into flow-through share purchase agreements are entitled to claim deductions as well as receive common shares in consideration of certain expenditures undertaken by the corporation on their behalf using funds provided by the investor pursuant to that agreement.

Similar results can be achieved by providing deductions linked to the cost of shares purchased. In computing taxes, the costs of shares are usually not deducted from current income, but are treated as part of the cost base from which future capital gains (or losses) are measured. However, Quebec provincial income tax rules permit deductions for investments in smaller corporations. These deductions range from 50 to 150 per cent on purchases by individual shareholders. Changes announced in the 1991 Quebec budget expanded eligible activities to include businesses in the environmental sector. Under the regulations, a business in the environmental sector was defined as (a) one in which restoration activities account for more than 50 per cent of its operations or (b) one in which more than 50 per cent of operations consist of reclaiming, transporting or processing various types of hazardous, solid or liquid wastes. The ability to deduct the cost of the shares is an important incentive in the marketing of shares by these small firms.

Another approach is the use of after-tax financing instruments. After-tax financing allows incentives to be transferred to the investor by treating as dividends amounts that might otherwise be regarded as interest. These dividend payments are non-deductible by the payer and generally non-taxable to the recipient. This type of incentive is attractive to firms which do not earn enough income to qualify for preferential tax treatment at the firm level. By allowing such firms to sell their incentives to an investor who can make immediate use of them, the firm benefits to the extent that its financing costs are lower. This is because an investor can achieve a given after-tax return with a lower before-tax return due to the preferential tax treatment accorded to the returns. After-tax financing tends to benefit profitable corporations, particularly financial institutions. Preferred share financing in particular increased the amount of tax-free income received by financial institutions. As a result, the full benefits did not reach the targeted sectors.

Another after-tax financing device that has been advocated is the so-called "green bond". Under this proposal, preferential tax treatment could take the form of reduced tax rates or tax-exempt status. This would occur on project returns, shareholder dividends or bondholder interest earned from investments in environmentally friendly activities. A major problem with this type of instrument is that it is not usually possible to separate and identify income that is exclusively environmentally related.

The Experience in Canada and Other Countries

Flow-through shares in Canada and tax-exempt bonds in the U.S. were not designed specifically for environmental purposes. Nevertheless these two examples provide some indication of the possible usefulness of financing incentives applied to promote environmental aims. It should be noted that some proposals have been made to the government to introduce flow-through shares to promote environmentally friendly activities.

Flow-through shares in Canada

Expenditures incurred in the exploration for mineral resources or the exploration and development of oil and gas resources receive preferential tax treatment in the sense that they are generally deductible for income tax purposes. The flow-through share financing mechanism allows these deductions to be transferred from corporations to other investors, including individuals. Flow-through share financing can only be issued in respect of certain oil and gas or mineral exploration and development expenditures. These allow companies to issue new equity, often at significant premiums over market value, and transfer currently unusable resource deductions to flow-through share subscribers. Income tax deductions that are "flowed" from the company to the flow-through share investor reduce the investor's taxable income and after-tax investment risk.

Flow-through shares help junior resource companies that are in a non-taxpaying position to finance their exploration. At the outset, this was the reason for their introduction.

Flow-through shares also allow investors purchasing them to participate directly in the resource sector. The issuing companies cannot reduce their taxable income by using deductions that they have transferred to investors. For this reason, companies have required a share premium when selling a flow-through share. The amount of the premium is based on how long the companies expect it will take to achieve taxpaying status. Companies in a start-up situation that do not expect to be liable for tax for many years will require smaller share premiums than firms that expect to be taxable in the near future.

Tax-exempt bonds in the U.S.

In the U.S., tax-exempt bonds are obligations issued by state and local governments on which the interest earned is exempt from tax. The bonds are sold by governments to fund the establishment of certain facilities, either by government itself, or on its behalf by private interests. The federal government or, more precisely, taxpayers in general effectively subsidize the cost of local facilities through the tax exemption on the bond interest. Interest on loans made to purchase or carry tax-exempt bonds is not deductible. Prior to tax reform in the U.S., a wide range of facilities, including air and water pollution control facilities, were considered to be exempt.

The main purpose for the U.S. federal income tax exemption for state and local bonds is to lower the cost to state and local governments of financing public facilities. Before U.S. tax reform, exemptions were allowed for a number of types of facilities, including airports, mass commuting systems, parking facilities, sewage disposal, waste disposal, sports facilities, furnishing of electrical energy or gas, furnishing of water, local district heating and cooling facilities, and air or water pollution control facilities. Increasingly, however, state and local governments have used tax-exempt bonds to raise funds for privately financed/constructed facilities. The U.S. Treasury Department has estimated that a total of $58 billion of long-term tax-exempt bonds were issued in 1983 for non-governmental purposes, accounting for 61 per cent of all long-term tax-exempt bonds issued that year.[4] By the early 1980s, this trend had caused a serious erosion of federal revenues, distorted investment decisions and put upward pressure on interest rates for bonds issued to provide financing for state and local governments.

The Environmental Action Foundation (EAF) in the U.S. contended that utilities used 84 per cent of all the money raised by pollution control bonds in the first nine months of 1984. Further, it was estimated that outstanding pollution control bonds cost U.S. taxpayers over $1 billion in 1984 alone, with utilities issuing more than $4.8 billion in bonds. The EAF argued too that pollution control bonds were being used to help finance new facilities rather than to clean up old ones.

The 1986 U.S. Tax Reform eliminated the abuses and amended and tightened rules relating to tax-exempt non-governmental bonds. The availability of tax-exempt bonds for private financing of several activities was repealed. Tax-exempt bonds for pollution abatement and control facilities, an area considered to be particularly abused, were repealed.

Tax-exempt bond issues are still permitted for waste disposal sites developed by private interests. Rationing of the total exempt issues is the responsibility of each state.

Assessment

Most experience indicates that benefits from financing incentives tend to accrue to profitable corporations and high-income individuals. The major conclusion of the U.S. experience with tax-free bonds is that they were not effective in lowering the cost of financing the target facilities. Several other difficulties associated with tax-exempt bonds surfaced in the U.S.

First, their use caused a loss of budgetary control by the federal government. Federal grants to state and local governments are subject to an upper limit on federal spending and there are usually requirements as to where the funds will be spent. Tax-exempt bonds, on the other hand, left decisions about what would be subsidized, and by how much, entirely up to the state and local governments.

Second, tax-exempt bond issues were often unnecessarily and unjustifiably used as a substitute for taxable debt, generating little benefit for federal taxpayers in the process. There were several reasons for this abuse. One was the fact that state and local taxpayers were not responsible for debt service and so perceived the bonds as costless. Another was that the cost of capital was reduced for private firms and individuals in local areas at the expense of federal taxpayers. In addition, elected officials used low-cost capital to attract political support. Finally, because returns on tax-exempt bonds tend to be relatively low, the opportunity existed for the earning of profits through the issue of bonds before the funds were actually required and the subsequent investment of tax-exempt bond proceeds in taxable securities.

4 *Dennis Zimmerman, "Tax-Exempt Bonds: A Sacred Cow that Gave (Some) Milk", National Tax Journal, Vol. XLII, No. 3, pp. 283-291.*

Thirdly, it has been argued that tax-exempt bonds, like investment incentives, are inefficient in the sense that they constitute a high-cost subsidy. Analysis of experience in the U.S. with these bonds showed that the revenue loss to the federal government was considerably larger than the interest savings to the user of the bond proceeds.

Finally, the fact that the holdings of tax-exempt bonds are concentrated in the higher-income groups reduces the progressivity of the income tax system since exemptions have a greater value for those in higher tax brackets. This raised concerns about the impact of tax-exempt bonds on the overall fairness of the distribution of the income tax burden.

The Canadian experience with flow-through shares provides additional insight into the use of financing incentives. The large volume of flow-through share financing in the years 1986 to 1988 was fuelled by several forces. In addition to the tax-sheltering benefits of the resource deductions (including the now-repealed earned depletion allowance), these forces included: the availability of the lifetime capital gains tax exemption; the pre-tax reform existence of higher statutory rates for top bracket individual taxpayers; and buoyant investor expectations for gold issues. Some concerns have been raised as to whether flow-through share purchases were driven too much by tax considerations and not enough by economic factors.

Tax-assisted financing instruments have many of the same problems as investment incentives. These include: high revenue costs, reduced reliability of tax revenues, perceived inconsistency with the Polluter-Pays Principle and cost inefficiency in the sense that they are not successful in triggering marginal investments. Attempts to target financing incentives to incremental investment have not been particularly successful in the past. There are other problems specific to tax-assisted financing. The fairness of the approach is open to question since purchasers tend to be high-income individuals and profitable corporations using the instruments to shelter income from tax. Also, there is a potential for significant leakage of benefits in the form of higher returns to investors and fees to middlemen, both reducing the potential for enhanced activity of the kind desired. Furthermore, it is difficult to link this type of incentive to a specific environmental activity. Producers of pollution may use the benefits of a tax-assisted financing instrument to subsidize their primary production. A final concern is that it is often difficult to ensure that all of the benefit is going towards pollution control and abatement.

5.2.3 *Some Specific Examples of Tax Incentives*

Air and Water Pollution Abatement

The existing accelerated CCA provisions were introduced to soften the initial impact of new environmental regulations. In the case of certain industries, particularly pulp and paper, extension of the limitation date on Classes 24 and 27 ("rejuvenating") may not be necessary, at least with respect to new regulations recently proposed.

According to N.C. Bonsor's study of the pulp and paper industry,[5] all the pulp and paper mills required to make new investments to meet the (proposed) federal regulations have been operating on a site since before 1974. Therefore, the rejuvenation of Classes 24 and 27 is not necessary for this industry. In fact, of the $2.3 billion expected to be expended on meeting the new regulations, it is estimated that only a small portion of those expenditures will not be eligible for accelerated CCA under Classes 24 or 27. However, many of the older facilities are operated by companies which, in current economic conditions, may not be sufficiently profitable to be paying taxes. Thus the benefits of any accelerated CCA are not immediately available in these situations. There are firms in other industries, however, which could become subject to new regulations that may be excluded by the 1974 limitation. Environment Canada is currently reviewing existing regulations applicable to the mining and petroleum refining sectors.

The concern most often raised with respect to Classes 24 and 27 is the ambiguity of the restriction which specifies a "site in Canada at which operations have been carried on by him from a time that is before 1974". Industry has provided examples which suggest that some inequities are inherent in this restriction. One example is a company which has consolidated several plants into one central facility to achieve economies of scale. Suppose that each of these plants has been in operation since before 1974 but that the new central facility has not; should accelerated CCA be permitted? What if the central site has been in operation since before 1974 but none of the consolidated plants have? If a firm decides to expand its pre-1974 plant and builds an addition on a site beside the original plant, is the addition part of the eligible site? What if the expansion occurs on an adjacent property to the original plant? As qualification for the accelerated rate is based upon the site of operations as well as the type of equipment itself, inequities between firms and sectors necessarily arise.

Because of the nature of the equipment which qualifies for Classes 24 and 27 (i.e., end-of-pipe abatement systems), these classes primarily benefit older firms that

5 *Norman C. Bonsor, "Water Pollution and the Canadian Pulp and Paper Industry", Getting It Green: Case Studies in Canadian Environmental Regulation, ed. G. Bruce Doern (Toronto: C.D. Howe Institute, 1990), pp. 155-185.*

must modernize if they are to meet new regulations. Newer plants built to meet existing regulations will not generally benefit from arrangements made to lower the cost of end-of-pipe equipment.

At present, only end-of-pipe equipment costs qualify for accelerated CCA; process modifications specifically do not. Problems of administration and identification make it almost impossible to bring production process alterations into this CCA program, thus making it difficult to encourage this type of investment. Many new production systems are designed primarily to achieve productivity gains with pollution abatement as a secondary objective.

Various firms and industries have proposed that the eligibility criteria be expanded for Classes 24 and 27. The proposals include a broadening of the eligible assets to include process modifications that result in the creation of a more environmentally friendly product. For example, refineries are being required to invest in new equipment and facilities to manufacture cleaner-burning fuels. This investment does not qualify under Class 27.

Encouraging Environmental Stewardship of Natural Resources (Mine Reclamation)

In the past few years the mining industry and governments have become more aware of the environmental ramifications of investing in exploration, development and processing of natural resources. Exploitation of mineral resources involves many processes which can disturb the natural environment, and measures to repair the damage such as neutralizing abandoned mine sites or tailings dumps vary in cost and complexity. Rehabilitating some mine sites requires only surface reclamation and only for a short time until the site becomes self-generating. In contrast, in other cases, rehabilitation is never complete and reclamation never ends.

Several provincial governments have recently experienced or are anticipating environmental problems with abandoned mine sites. These problems have lent new urgency to efforts by the provinces to ensure that the costs of any future reclamation work is adequately funded. Provincial governments do not want to be saddled with any of the costs of mine-site decommissioning. In the past, they have guarded against this eventuality by requiring performance bonds, letters of credit or other financial guarantees to ensure that the money will be there for proper site decommissioning. Recently, some provinces have been examining a new approach, requiring that the companies contribute to provincially mandated trust funds (e.g., B.C., Ontario and Quebec).

Reclamation of a mine site generally involves the dismantling of buildings and structures and the stabilization and revegetation of mine waste dumps and tailings-impound areas. This work may begin during the operating life of the mine and is usually completed within five to 10 years of its closure. These activities represent significant but generally predictable costs for a mining company. However, if circumstances require long-term site management (i.e., acid rock drainage) the company's decommissioning and post-closure obligations may extend for a much longer period. Costs are likely to be higher and cannot be predicted with the same degree of accuracy.

Legal obligations for mining companies vary between provinces and territories. They may include pre-planning of the technical work of reclamation, decommissioning and environmental protection following mine closure and providing financial assurances to the provinces that reclamation work will be carried out to an acceptable standard. Financial assurances have included or may include irrevocable letters of credit, performance bonds, parent-company guarantees, pledging of assets or contributions to third-party trust funds.

In cases where a mine site owned by a single company is likely to be burdened with reclamation requirements for a long time, some provinces now require the firms involved to contribute to trust funds. Some provinces are considering making contributions compulsory for all mines and all mining companies. In any event, these funds will be designed to give provincial governments confidence that sufficient money will be on hand to meet expected reclamation costs.

Contributions to the fund would normally be structured as a series of payments over a specific time period. The rules would require that withdrawals could only be made from the fund to cover reclamation costs. Once reclamation of the site has been satisfactorily completed, any surplus remaining in the fund would be returned to the company.

Under the existing tax treatment of mine reclamation costs, the deduction is allowed after the money has actually been spent. In general, this is the approach taken in the current tax system with respect to other future or contingent costs. Deduction of such costs in advance would create a timing advantage by allowing a deferral of tax. However, mine reclamation costs may be so large that there will not be sufficient income to allow these costs to be fully deducted at the time they are incurred. Single-mine companies could continue to run up substantial reclamation costs after the mine stops earning income. As a result, companies may not be able to match post-closure reclamation costs to income from the mine.

Under current income tax rules, contributions to third-party mine reclamation trust funds do not qualify for a deduction from income because the funds may eventually be returned to the company. In effect the Act treats contributions to mine reclamation funds as a contingency fund. It could be argued that non-deductibility of contributions to mine reclamation funds runs counter to the aim of ensuring that sufficient funds are available for post-closure reclamation.

Provincial Mines' Ministers and industry associations have proposed that the Income Tax Act be amended to allow for the deductibility of contributions to provincially mandated mine reclamation funds.

5.3 *Combining Environmental Charges and Tax Incentives*

5.3.1 *Combining Charges with Investment Incentives*

Major Features

Some environmental charges may lead to unacceptable consequences in terms of competitiveness, distributional impacts or adjustment costs. The problems could include high tax burdens on domestic producers relative to their foreign competitors, windfall gains or losses depending on the ability of producers to shift the burden of taxation, and unfair tax burdens on low-income groups or certain regions of the country.

A system that combines tax incentives with charges (a carrot-and-stick approach) may offset some of these problems. Although this arrangement would be significantly more complex than simple emission charges, there is interest in the approach, and scope for its application.

Such a system would increase marginal (incremental) tax rates on polluting activities, but would leave average tax rates relatively untouched where producers or consumers took steps to reduce environmental damage. Moreover, this approach would avoid some of the drawbacks of pure tax incentives such as high revenue costs and violation of the Polluter-Pays Principle.

Charges could be offset directly through reductions, exemptions or rebates on charges, or indirectly through investment incentives or tax credits under the Income Tax Act. An emission charge, for example, could, in effect, be "recycled" into investment incentives. The charge/incentive approach could also extend into areas not reached by traditional incentives aimed at reducing the cost of end-of-pipe abatement equipment. Eligible investments could include the modernization of older production/combustion processes. If the goal were to reduce CO_2 emissions, the incentive could extend to the encouragement of tree planting to create carbon sinks. Credits could also be used to encourage research and development into cleaner production technologies.

Another important feature of the charge/incentive approach is that it would allow for the matching of polluting activities with clean-up activities. For example, a credit for a tax on SO_2 emissions could be paid when SO_2 stack precipitators are installed. It could also be used to provide transitional relief to various industries. For example, a credit for a tax on NO_x emissions could be paid when coal-burning utilities install new combustion equipment that reduces NO_x emissions.

The Experience in Canada and Other Countries

There has been little experience in Canada or elsewhere with charge/incentive programs, although a few European countries have used them. For example, under the German system of effluent charges, producers that meet certain pollution reduction standards pay a lower rate of charge on their emissions. The charge/incentive feature of the German program is that producers can qualify for a three-year waiver of the charge by installing pollution abatement equipment to reduce their discharges by at least 20 per cent.

In Canada, the deposit-refund systems for soft drink and beer containers administered by the provinces have some charge/incentive characteristics and it may be possible to extend such schemes to include other products that pose waste management problems. As noted in the previous chapter, some European countries have deposit-refund systems for automobile bodies and certain types of batteries. Another possible application might be an excise tax on new tires combined with a corresponding rebate when the tires are recycled.

Another measure which is similar to the charge/incentive system is a sipper/guzzler scheme for automobiles. This type of tax structure usually takes two forms. In one, it taxes various models at different rates. In the other it combines a tax with a corresponding subsidy for vehicles with certain environmentally favourable characteristics. In general this approach is designed to encourage the use of the most efficient technology available and hence speed up the adjustment to new or existing regulatory standards for fuel efficiency or vehicle exhaust emissions. Assessments of such initiatives have generally concluded that they have had some influence on consumer decisions.

Assessment

Although a charge/incentive program has advantages over the separate use of incentives, it will not eliminate the drawbacks associated with tax incentives. Perhaps the most important of these relate to the effectiveness of the incentives. Matching the up-front expenditures incurred by the firm on pollution abatement and control to the flow of pollution charges may also be difficult and the administrative complications could be significant. Moreover, if the incentive took the form of an income tax credit, a scheme of this kind would not compensate non-taxpaying firms for their expenditures on pollution abatement and control.

As discussed below, the incentive component of a charge/incentive scheme could draw from a number of approaches. Past experience suggests that some of these approaches hold little promise. On the other hand, further research and discussion may show that others merit further consideration.

The scope for combining charges with accelerated CCA may be limited. Currently, only stand-alone pollution control equipment qualifies for the accelerated write-off; production process modifications are not eligible. Furthermore, even if the accelerated rate were extended to encompass process modifications, this approach would not always reduce the costs a firm might incur in responding to input charges. The firm might respond to these charges by using substitute materials or by conservation, rather than by installing new capital equipment.

A combined investment tax credit/environmental charge may be one way to alleviate the problem of adverse regional impacts and impaired international competitiveness associated with an unaccompanied environmental charge. Allowing a tax credit on new investments for machinery and equipment, and also possibly for process modifications to reduce pollution, would lower the costs of reducing emissions in response to the charge. The net result would be to increase the marginal tax rate on polluting activities while maintaining average tax rates. This would reduce some of the problems related to distribution and to international competitiveness. In applying this approach, however, important issues would have to be tackled in relation to eligibility criteria and fairness. Under the first heading: should all process modifications be included or only end-of-pipe equipment? If process modifications are included, the criteria for determining the eligibility of projects necessarily become complex. The fairness issue stems from the fact that the ability of the scheme to fully offset charges with credits will differ from one sector to the other.

It was asserted earlier in this paper that investment tax credits for pollution abatement equipment are, in fact, subsidies to polluters. This is because the credits reduce the cost of installing abatement technology. Since most income tax systems are designed to achieve specific revenue targets, all subsidies have to be recovered from other taxpayers. An emissions charge, on the other hand, clearly raises the cost to the polluter of continuing to pollute. By combining incentives with charges it is possible to balance their influences and so send the right economic signals. The charge increases the marginal cost to the polluter of polluting; the incentive encourages the polluter to invest in abatement technology or process modification. If a polluter can make full use of all available credits, it may be possible to reduce the net charge to zero. This is not because the average tax rate on the polluter has changed; on the contrary it has stayed the same. The difference is that the economic signals at the margin are now the right ones. As a result they have induced the desired change in behaviour in a more or less self-financing manner, and other taxpayers have not had to bear the cost of subsidizing the polluter's clean-up activities.

The fact that the net change in average tax burden on an industry sector could be zero has important implications for competitiveness. The combination of a charge with an incentive would reduce, although by no means eliminate, some of the concerns about the negative implication of environmental taxes on the international competitiveness of some key industrial sectors.

The tax credits available under a combined charge and incentive system would accumulate through the payment of the emissions or effluent charge. The credits would be transferable between taxpayers so that they would be more fully utilized and the incentives applied where they make the best economic sense. Another way to deliver the incentive would be to provide an exemption from the charge or a rebate for performance. For example, the charge could be graduated or based on amount of emissions produced per unit of output.

5.3.2 *Specific Examples of Combining Charges with Tax Incentives*

Acid Rain

To illustrate the key issues in a charge/incentive scheme, it is useful to consider the application of this approach to the environmental goal of reducing acid rain. In this case an emission charge could be levied on SO_2 and NO_x emissions at a certain rate per unit of pollutant emitted, thus increasing the cost of emitting these pollutants.

To prevent the average cost of production from rising, firms liable for the emission charge could be eligible for a tax credit for the steps they take to reduce the offending emissions. These measures could range from production process modifications to after-the-fact clean-up. For example, the investment tax credit might apply to the installation of a scrubber to reduce SO_2 emissions as well as to an internalized gas combustion cycle to reduce NO_x and CO_2 emissions.

In effect, polluters would be given back, in the form of credits, the tax dollars they would otherwise pay for polluting – at least to the extent that they use these dollars for anti-pollution measures. The creation of a market for buying and selling credits could also be allowed. Because some environmental issues are global in nature, the possibility might be explored of allowing credits for environmentally positive activities by Canadian firms elsewhere in North America or in other parts of the world.

Waste Management

Another example of a charge/incentive approach would be a system of credits employed to encourage the recycling of materials. This system would be similar to deposit-refund systems but would be more sophisticated in its application, having some of the characteristics of a tradeable discharge permit. Producers of certain materials or products would be required to pay a special charge or tax on each unit sold. The charge could be reduced by a credit earned on each unit of the used commodity reprocessed by the producer. If the target was to reprocess 20 per cent of the volume sold per year, a per-unit input credit five times greater than the charge would result in no net revenue for governments but would create an incentive to recycle. Clearly, an important requirement would be that the charge rates be set to achieve the desired targets.

With this type of charge/incentive system, it would not be necessary for all producers to develop their own recycling facilities. Credits would be bought and sold. For the above example, a producer who chose to use more than 20 per cent of reprocessed materials or products in a facility could sell credits earned but not otherwise usable to another producer.

6. Conclusions

In order to achieve a healthy environment and a sound and prosperous economy, the environment must become an integral part of the decisions made at all levels of society. High-quality, authoritative environmental science, education and information all have a vital part to play in achieving this objective. They are not, however, sufficient in themselves. More direct measures, such as regulations and market incentives, are also required.

As noted at the outset, there has been a strong tradition in Canada, as well as in other countries, of using regulations to achieve environmental objectives. Experience with the use of economic instruments to achieve environmental goals has been limited.

Economic instruments offer a number of potential advantages over the regulatory approach, both in attaining our environmental goals and in ensuring that Canada remains competitive in increasingly global markets. They can be less economically intrusive and distorting, allowing decision-makers the flexibility to find the most cost-effective means of achieving environmental goals. They can also provide an ongoing economic incentive to cut back pollution and to develop and use new technology and processes to control pollution.

If these potential advantages are to be realized, however, it is important that the instruments be the right ones in terms of design and application to specific environmental problems, taking into account the criteria outlined in Chapter 3. As illustrated in Chapters 4 and 5, there is significant scope for the use of a variety of economic instruments to address specific environmental problems. In some cases they could be preferable to traditional regulations. In others, market incentives and regulations may best be used in a complementary manner to address a specific problem. And there are others in which regulations may be the best approach.

The paper also illustrates that, as in the case of traditional regulations, there are a host of practical issues, some very complex, to address in designing economic instruments. It also illustrates that, again as in the case of regulations, there are potential impacts – for example economic, income and regional distributional impacts – to address. These must be fully explored before governments can put economic instruments to use in Canada.

This paper is a first step in exploring these practical issues. One of its main purposes is to stimulate further debate and research into the practical application of economic instruments. Another important purpose is to provide the basis for government consultations with industry, the university community, environmental groups, First Nations, and other interested Canadians – all of which have a contribution to make.

Annex I

Assessing the Economic Effects of Controlling Air Pollutants: The General Equilibrium (GE) Modelling Approach

1. Introduction

In support of the theoretical advantages of economic instruments over traditional regulation, section 2.5 of this document reports empirical estimates for Canada of the effects of environmental policies on various economic and environmental variables. Estimates of the longer-term impacts of economic instruments are based on simulations with a general-equilibrium (GE) model of environment-economy relationships developed by the Government of Canada. This annex explains why the GE methodology can be useful for shedding light on the environment-economy question, and provides information on the structure of the GE model and its applicability to environmental issues.[6]

2. The GE Modelling Approach to Environment-Economy Issues

Analyzing and quantifying the impacts on an economy of a major structural initiative such as environmental protection requires a comprehensive analytical framework that takes into account the complexities of a large number of commodities and commodity prices, a multitude of economic agents and their interactions, and a variety of pollutants. A GE environment model provides such a framework. This type of economic model consists of a set of mathematical equations that can summarize the functioning of an economy, and highlight important interactions between the economy and the environment. To assess the effects of structural changes on economic and environmental behaviour and performance, GE models are simulated both with and without the assumption of the policy change. The economic and environmental impacts of the policy change are then measured by the differences in the simulation results for key economic variables such as real income and real output, and key environmental variables such as pollutant emissions or effluents.

GE models are appropriate tools for analyzing issues of a longer-term nature, such as the environment, for a number of reasons. These models depict economic interrelationships at an economy-wide level in a way that allows an economy to adapt completely to an environmental policy change, once that policy has been fully implemented. GE models can have considerable sectoral detail which is essential in capturing resource reallocation effects resulting from changes in environmental policy. Thus, they are able to examine the longer-term impact of relative price changes on resource allocation (factors of production, industry outputs, consumer demands and trade) and overall real income. The models are designed with the explicit objective of determining efficiency effects of changes in policy. Given this focus on efficiency, GE environment models can be well-suited to analyzing the economic costs of meeting a range of environmental targets using alternative economic instruments. In doing so, they can also take account of the effect of pollutant-abatement technologies and can assess the ability of a single economic instrument to achieve multiple environmental objectives.

3. The Structure of the Environment-Economy GE Model

The specific environment-economy GE model developed by the Government of Canada can evaluate longer-term economic and environmental implications of achieving certain environmental objectives through the use of economic instruments. This can be done as the model provides information on the nature and degree of resource reallocations and real income change that would be necessary to meet exogenously specified reductions in flow rates of pollution. By altering relative commodity and factor prices, alternative policies to achieve an environmental target induce agents to substitute away from more-polluting inputs (notably fossil fuels) in production and consumption, to limit the production of inherently polluting products, and to invest in pollution-control technologies if the technologies are available and are cost-efficient. Flows of all pollutants are consequently altered. The model provides a disaggregated description of the major energy sources and polluting activities in both Canada and the United States and is able to describe such endogenous, optimizing behaviour in considerable detail.

The environment-economy GE model can be conceptualized as consisting of two parts – a traditional GE component and an environmental component. The economic component explicitly represents economic behaviour of producers and consumers in Canada and the United States, while income and activity in the rest of the world are assumed to remain unchanged by Canadian and U.S. actions. Seventeen industries producing 18 commodities (output of the refinery industry consists of both motive fuels and non-motive fuels) are included in each North American economy. Factors of production include

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6 A more detailed description of the GE model is contained in a forthcoming working paper of the Department of Finance entitle "An Environment CGE Model of Canada and the United States."

labour, capital, natural resources in the resource and the electrical utilities industries, and intermediate materials. Factors can be substituted in response to changes in their prices. Labour and capital are mobile across sectors, but only capital is assumed to be mobile internationally. A single "representative" consumer is used to represent final demands for consumption and investment goods. In assessing their economic impacts, government revenues from environmental taxes and charges are given back to the consumer as a lump-sum transfer.

On the environment side of the model, sectoral detail is sufficient for identifying the major industrial and residential sources of pollution. The model, used to provide illustrative evidence on the comparative advantage of economic instruments, deals with the air pollution case and includes five common air pollutants of current concern – specifically, nitrogen oxides, methane, volatile organic compounds, sulphur oxides and carbon dioxide. Pollutant emissions arise from both fossil fuel use and industrial processes, and are associated with air pollution issues of greenhouse warming, acid deposition and smog.

Specific environmental policy options in the model include both economic and non-economic instruments. In terms of economic instruments, the model deals with various taxes on fossil fuels, carbon taxes (a special type of fossil fuel tax in which the rate of tax varies in proportion to the pollution content of fuels) and emission charges. In terms of non-economic instruments, quantitative emission constraints or performance standards (industry-specific and industry-wide) are included. For mixed instruments, tradeable permit systems among industries are represented. Further detail on the environment-economy GE model structure is provided in Table A-1.

The model includes only links running from the economy to the environment. The reverse links from the environment to the economy do not exist in the model for two reasons. First, it is difficult to establish the relationship between emissions, which are flows, to the concentration of pollutants, which are stocks, because of scientific difficulty in developing estimates of "absorption" and "escape" rates. Second, there is very little understanding of how the environment affects the economy. As a result, estimates of the economic benefits of a cleaner environment (or reductions in economic damages), which are extremely difficult to quantify, are not included in the model. This omission, due to environment-to-economy information constraints, has two important implications. First, the model cannot determine whether or not an emission target is appropriate. Second, issues related to sustainable development, which require information on stock variables such as the quality of the environment, cannot be handled. Like most GE models, the environment-economy GE model only deals with pollutant emissions, which are flow variables, not stocks.

Abatement costs and abatement potential for several pollution-control technologies, most descriptive of so-called "end-of-stack" technologies which clean emissions without affecting production processes, are fixed in the environment-economy GE model. Energy-efficiency improvements also proceed at a fixed rate. The assumed constancy of these variables, while often employed in economic models, may underestimate the ability of economic agents to alter their behaviour in response to large environmental policy shocks occurring over a sufficiently long period of time.

Table A-1

Summary Of The Environment-Economy General Equilibrium (GE) Model Structure

The Economic Component	The Environmental Component
General: ❑ single-period model; no capital accumulation through saving ❑ three regions: Canada, the U.S. and the rest of the world ❑ not a world GE model; rest of world not explicitly modelled Production Structure: ❑ 17 industries producing 18 commodities using labour, capital, 7 sector-specific resource factors and 18 intermediate inputs ❑ labour and capital are homogenous and mobile between industries ❑ substitution possible between capital, labour and resource inputs, and between domestic and foreign intermediate inputs Final Demand: ❑ an aggregate of consumption and investment ❑ dependent on income and relative prices ❑ 1 consumer in each region; excess demands for goods (and capital) accommodated by the rest of the world Government ❑ provision of government services part of service industry ❑ indirect taxes, tariffs and subsidies included ❑ net government revenue redistributed to consumers in a non-distortionary manner Foreign Trade Sector: ❑ capital is perfectly mobile among regions at the constant world rental rate ❑ prices for certain resource commodities and all commodities produced in the rest of the world are exogenous ❑ all other domestic commodity prices adjust to equilibrate a region's merchandise trade balance with its service payments on imported capital	Scope: ❑ air pollution issues of greenhouse warming, acid deposition and smog ❑ 5 pollutants modelled: nitrogen oxides, methane, volatile organic compounds, sulphur oxides and carbon dioxide Pollutant Emissions: ❑ arise from the combustion of fossil fuels (in both stationary and mobile sources) and from industrial processes ❑ emissions occur in fixed proportion to the levels of polluting, intermediate use, polluting production and polluting consumption Pollution Reduction: ❑ substitution among relatively "dirty" fuel inputs ❑ decreased production in polluting industries ❑ application of "abatement capital" to reduce emissions from the use of a given fuel or industrial process Economic Instruments for Pollutant Control: ❑ air pollution taxes: ■ various taxes on fossil fuels at uniform rates or at rates proportional to the emission of air pollutants (e.g., a carbon tax) ■ emission charges ❑ performance (emission) standards – economy-wide and industry-specific ❑ tradeable permit systems among industries