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# EXTENDED DESCRIPTION OF OPTION 4: CAP ON CARBON CONTENT OF FOSSIL FUELS PRODUCED AND IMPORTED AND OTHER GREENHOUSE GAS EMISSIONS

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# EXTENDED DESCRIPTION OF OPTION 4: CAP ON CARBON CONTENT OF FOSSIL FUELS PRODUCED AND IMPORTED AND OTHER GREENHOUSE GAS EMISSIONS

## INTRODUCTION

A July 1998 National Round Table on the Environment and the Economy (NRTEE) paper on *Possible Designs for a Domestic Emissions Trading Program for Greenhouse Gases* identified 14 possible designs for a domestic emissions trading program for greenhouse gases (GHGs). Six of those designs were selected for further analysis. The 14 designs and the six selected for further analysis are shown in Table 1.

This paper provides an extended description of Option 4: A Cap on Carbon Content of Fossil Fuels Produced and Other Greenhouse Gases. This paper covers:

- a description of the trading program;
- descriptions of similar existing programs;
- the emissions covered by the trading program;
- the sources required to participate in the program;
- the number of sources involved;
- the share of total emissions covered by participants;
- how the trading program would be administered;
- how emissions would be measured;
- possible complementary policies;
- special issues raised by the design;
- transitional issues related to a change in the policy setting; and
- evaluation of the option using the proposed criteria.

## DESCRIPTION OF THE TRADING PROGRAM

Option 4 is a mandatory cap and trade system for most sources of greenhouse gas emissions complemented by credit trading for sources and sinks not well suited to a cap and trade system. This system is assumed to be implemented to meet a national commitment to limit greenhouse gas emissions.

Energy-related $CO_2$ emissions are addressed by imposing a cap on the carbon content of fossil fuels used in Canada. Fossil fuel producers and importers are required to hold allowances equal to the carbon content of the products sold in Canada.[1] Each producer

[1] Fossil fuels contain elemental carbon and various carbon compounds. The carbon content of coal, crude oil and natural gas at the mine mouth or wellhead varies from source to source and over time, but can be accurately determined through relatively inexpensive chemical analyses. Pipeline-quality natural gas and different petroleum products must meet product specifications that determine the carbon content to very

**Table 1 — Summary of Possible Designs and Recommended Short List**

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

and importer must hold allowances equal to the carbon content of the domestically produced and imported crude oil, natural gas and coal, as well as the imported petroleum products sold. Exporters receive allowances equal to the carbon content of the crude oil, natural gas, coal and petroleum products exported.

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close tolerances. When a fossil fuel is burned to provide energy, the carbon combines with oxygen from the air to form $CO_2$, which is a greenhouse gas. Thus it is possible to accurately determine the energy-related $CO_2$ emissions from the carbon content of fossil fuels. And controlling the carbon content of the fossil fuels used is an effective way to limit the resulting $CO_2$ emissions.

The other gases/sources covered by the cap and trade system are shown in Table 2. Greenhouse gases other than $CO_2$ would be converted to $CO_2$ equivalents using the internationally agreed global warming potential values (GWPs). Descriptions of these emission sources and how they could be incorporated in to the trading system are provided in Issue paper 1, *Potential of Including Non-Combustion Sources of GHG Emissions in a Domestic Emissions Trading Program.*

**Table 2 — Non-Combustion Sources included in the Emissions Trading Program**

| Non-Combustion GHG Source | Gas | No. of Sources | Total (kt $CO_2$ eq) | Emission Rights Trading | Substance Trading |
|---|---|---|---|---|---|
| Landfills | $CH_4$, $CO_2$ | 10,000 | 18,250 | √ | |
| Adipic Acid Production | $N_2O$ | 1 | 10,850 | √ | |
| Aluminum Smelting | $CO_2$ | 11 | 9,600 | √ | |
| Lime & Cement | $CO_2$ | 45 | 7,630 | √ | |
| Fertilizer Use | $N_2O$ | 12 | 4,030 | | √ |
| Ammonia (less Urea) | $CO_2$ | 10 | 3,800 | √ | |
| Magnesium Smelting | $SF_6$ | <10 | 1,890 | | √ |
| Coal Mining * | $CH_4$ | 28 | 1,700 | √ | |
| Nitric Acid Production | $N_2O$ | 9 | 930 | √ | |
| Other Flurocarbons | $SF_6$, PFCs, HFCs | millions | 500 | | √ |

* Fugitive and process emissions from energy production and distribution operations

Credits could be earned for capture of emissions from small landfills, open pit mines, PFCs from aluminum smelting, and for carbon sequestration actions allowed by the international emissions limitation agreement. How best to address emissions from livestock due to enteric fermentation and manure needs further study.

Participants in the trading program would have full access to all international flexibility mechanisms. If the Kyoto Protocol comes into force, this would be joint implementation (Article 6), the clean development mechanism (Article 12) and international emissions trading (Article 17). Participants could purchase allowances or credits created by any of these mechanisms and could sell surplus allowances or credits to other countries.[2]

[2] Given the structure of the domestic trading system, most Canadian participants are likely to hold allowances. Surplus allowances could be exchanged for "assigned amount" and be sold to a buyer in another country under the provisions of Article 17. It is possible that some emission reduction actions could be structured as joint implementation projects and so create emission reduction units that could be exported under the provisions of Article 6. The clean development mechanism (CDM) applies to projects

This design gives rise to two issues for fossil fuel $CO_2$ emissions: how close to the well head to implement the trading system and how to deal with fossil fuels used as non-energy feedstocks. These issues are discussed in turn.

The composition of the oil or gas recovered differs from well to well, and the composition of the oil or gas recovered from a particular well changes over time. Oil recovered from a well includes methane, which is recovered where economically feasible, flared, or released to the atmosphere. Gas recovered from a well includes $CO_2$, which is stripped and released to the atmosphere; impurities, such as hydrogen sulphide, which must be removed; and natural gas liquids, which are recovered and sold to oil refineries.

Implementing the trading system at the wellhead regulates the emissions of methane and $CO_2$ flared or released to the atmosphere. Implementing the trading system further downstream at gas processing plants and oil refineries means that those emissions, which account for about 7% of Canada's total greenhouse gas emissions, have to be addressed by other means.

Considerations in the choice of where to implement the trading program include:

- the number of participants;
- the availability and accuracy of data on the carbon content of the fuel produced; and
- the share of total emissions covered.

There are approximately 55,000 oil wells and 50,000 gas wells in Canada, which are owned by fewer than 600 companies.[3] There are 789 gas plants and 23 oil refineries in Canada, which are owned by approximately 180 companies.[4] There are 29 coal mines in Canada, operated by 12 coal companies. There are estimated to be between 15 and 50 companies that import coal, natural gas or petroleum products and that are not fossil fuel producers. Virtually all fossil fuel exporters are believed to be producers as well. An upstream carbon content trading program would involve between 350 and 700 companies regardless of whether it is implemented at the wellhead or at the initial processing plant.

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implemented in developing countries, so Canadian participants can only purchase (not create) CDM credits.

[3] The Canadian Association of Petroleum Producers (CAPP) has 184 members, which are large and medium-sized companies. The Small Explorers and Producers Association of Canada (SEPAC) has 430 members, many of which are explorers rather than producers. The total is 614 companies, not all of which are producers. Estimates by industry observers suggest that 300 to 400 oil and gas producers, including all CAPP members, are responsible for about 95% of total production.

[4] The 23 refineries are owned by 13 companies and the 789 gas plants are owned by 171 companies. But duplication of ownership reduces the list to fewer than 180 companies.

However, implementing the trading program at the well head would involve more companies and many more control points (wells rather than gas plants and oil refineries). Regulating over 100,000 wells, even if they are owned by fewer than 600 companies, is administratively much more complex than regulating about 800 plants owned by 180 companies.

The second consideration is the ease of determining the carbon content of the fuel produced. If the trading program is implemented at the wellhead, the carbon content of the raw gas or crude oil produced by the well must be determined. This can be calculated from the quantity of oil or gas produced and the composition of the oil or gas stream. The quantity produced by each oil and gas well is metered. The composition of oil or gas produced by each well differs and varies over time. Regulatory agencies, such as the Alberta Energy and Utilities Board, require that wells be tested periodically to determine the composition of the gas stream.

The tests required by regulatory agencies may, or may not, be sufficient to determine the carbon content for the purposes of an emissions trading program. The adequacy of those tests depends upon the frequency of the testing and the likelihood that the composition of the oil or gas stream will change significantly between tests. More research is needed to establish the appropriate testing frequency for purposes of an emissions trading program.

If the trading program is implemented at the gas processing plants and oil refineries, it could be based on the carbon content of the oil or gas received or on the carbon content of the products produced. The composition of the natural gas received by a processing plant and the crude oil received by an oil refinery varies. The composition of the unprocessed natural gas or crude oil received is tested regularly for operational reasons. The carbon content can be determined from these test results. The quantity received by each processing plant and oil refinery is recorded. Thus, the carbon content of the raw gas or oil received by each plant can be determined.

The natural gas produced by a processing plant and the products produced by an oil refinery must meet well-defined specifications and so have a carbon content that varies within a narrow range. Thus the carbon content of the output can be calculated accurately from the product specifications and the quantities produced. The carbon content of imports and exports can also be calculated from the product specifications and the quantities.[5]

If the trading system is implemented at gas processing plants and oil refineries it should probably be based on the carbon content of the gas and oil received rather than on the carbon content of the products produced. Basing the system on the carbon content of the

[5] The carbon content of imported natural gas and petroleum products could be calculated from the product specifications. Imported crude oil might need to be tested to determine the carbon content. This could be done by the importing refinery.

input streams appears to be manageable from an administrative perspective. And basing the trading system on the carbon content of the input streams addresses the emissions associated with processing. But moving the trading upstream to the wellhead will involve a much larger administrative burden.

The third consideration is the share of total emissions covered. Emissions of greenhouse gases due to upstream oil and gas activities and coal mining are estimated to represent over 7% of Canada's national total.[6] This includes fugitive methane emissions from upstream oil and gas activities, $CO_2$ stripped from natural gas, and fugitive methane from coal mining. It is dominated by emissions from upstream oil and gas activities.

Upstream oil and gas activities are defined to include all activities between the wellhead and the point of combustion and hence include transportation and distribution activities downstream of the gas processing plant or oil refinery. However, most of the fugitive emissions occur before the natural gas leaves the processing plant or the petroleum products leave the refinery. $CO_2$ is estimated to represent 7% by weight of the content of unprocessed natural gas, but this varies widely and can range up to 26%.[7] The $CO_2$ stripped from natural gas represents about one-quarter of the total emissions in this category.

In summary, emissions between the wellhead and the gas processing plant or oil refinery are 7% of the national total, less stripped $CO_2$, less producer consumption at the processing plant/refinery, less fugitive emissions from the processing plant/refinery to the burner tip, less fugitive emissions from coal mining. The exact magnitude of these emissions is not known. The Multistakeholder Expert Group recommended implementing the system as close as possible to the wellhead and mine mouth to include as many of these emissions as possible. It should be feasible to implement the trading program at gas processing plants and oil refineries based on the carbon content of the input streams and at the mine mouth based on the composition of the coal produced.[8] Since the number of oil and gas wells is large (over 100,000) and the composition of the raw oil or gas stream varies, the feasibility of implementing a trading program at the wellhead needs further study. Regardless of how an upstream carbon content trading program is implemented, it would probably involve between 350 and 700 companies.

Options for dealing with fossil fuel used as a non-energy feedstock are discussed in NRTEE Issue Paper 5. An upstream carbon content trading program raises the price of all

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[6] A. Jaques, F. Neitzert and P. Boileau, *Trends in Canada's Greenhouse Gas Emissions (1990-1995)*, Environment Canada, Ottawa, April 1997, p. A-3.

[7] Ibid., p. 34.

[8] The composition of coal is analysed by mining companies as it is produced. Purchasers also have the coal analysed, usually at the point of loading. Thus data on the carbon content of the coal produced, exported and imported can be calculated from these analyses and the related quantities.

fossil fuel products downstream of the gas processing plant or oil refinery. Price increases for feedstocks could adversely affect the competitiveness of petrochemical plants, especially if plants in other countries are not affected in the same way. The carbon in some petrochemical products is released to the atmosphere very quickly, while other products sequester the carbon for several decades.

National inventories of greenhouse gas emissions are prepared using methodologies developed by the Intergovernmental Panel on Climate Change (IPCC). Emissions are calculated on the basis of the production of different products. Products that sequester the carbon for at least 20 years are deemed not to create emissions. For products that release the carbon to the atmosphere within 20 years, the emissions are deemed to occur at the time of production. The country where the products are produced is responsible for the emissions even if the products are exported.

The Multistakeholder Expert Group recommended that petrochemical producers participate in the program in the same manner as exporters. Petrochemical products that sequester carbon for at least 20 years do not count as emissions. Producers could receive allowances for the carbon content of such products. They could be sold to organizations required to hold allowances under the trading program to offset the feedstock price increases.

Allowances for greenhouse gas emissions covered by the trading system could be sold at auction or be distributed *gratis*.[9] These options are discussed in NRTEE Issue Papers 6

[9] Regardless of how the allowances are distributed, fossil fuel producers and importers would need to hold allowances equal to the carbon content of their fossil fuel sales. If the fossil fuel importers have to buy the allowances because they are auctioned by the government or distributed gratis to other groups, the prices of the fossil fuel products they sell will rise due to the cost of purchasing the allowances. If the allowances are distributed gratis to the fossil fuel producers and importers, the prices of their products will rise by the same amount even though they have not incurred any expense to acquire the allowances. The reason is that the total quantity of carbon content in fossil fuels is the same in both cases and that fossil fuel producers can do little to reduce the carbon content of their products. Therefore, the prices of fossil fuel products must rise to the point where fuel switching and energy efficiency adjust the demand for fossil fuels so that the carbon content of the fuels used equals the available carbon content. Since the demand and supply of carbon content must be balanced through changes in the prices of fossil fuels, the price increases are approximately the same whether the fossil fuel producers have to buy the allowances or receive them gratis. Of course, if they receive them gratis they experience a windfall profit as a result of the higher prices for their products with no increased costs.

Energy users will bear the initial burden of the price increase. Thus an argument can be made that a more equitable arrangement would be to distribute the allowances gratis to energy users and to require the fossil fuel producers and importers to buy the allowances from the energy users. In that way the payments the energy users receive for the allowances offset the higher energy costs. There are several difficulties with this approach. First, it is administratively complex; 350 to 700 fossil fuel producers and importers would need to buy allowances from tens of thousands of energy users. Second, finding an equitable formula for distributing the allowances to the thousands of energy users that still leaves them with an incentive to use energy more efficiently and to switch to less carbon-intensive energy sources would be difficult. Third, if the energy users increase the prices of their products to reflect the higher energy prices, they can capture the windfall profits.

and 7. The Multistakeholder Expert Group recommended that allowances be sold at auction and further analysis be undertaken of options for using the revenue.[10]

Sources required to hold allowances, such as fossil fuel producers and importers, could purchase allowances at periodic auctions, from brokers in the secondary market, from sources such as landfills, fossil fuel exporters and petrochemical producers that generate credits, and from international sources. Assuming that the rules for the international mechanisms do not restrict the ability to use these instruments, the prices of all of these instruments should be virtually identical.

The upstream carbon content trading program would include elements normally associated with both federal jurisdiction, such as international trade in fossil fuels, and provincial jurisdiction, such as production of fossil fuels. Issues arising from this jurisdictional dichotomy will have significant administrative and policy implications. These are discussed in NRTEE Issue Paper 2, *The Legislative Authority to Implement a Domestic Emissions Trading System.*

The Multistakeholder Expert Group recommended that the trading program be managed by a single agency which would:

- Serve as the regulator
- Determine the monitoring requirements for different sources
- Establish criteria and processes for credit creation by different sources
- Specify reporting systems
- Verify that monitoring systems are functioning properly
- Audit reported emissions
- Enforce penalties for non-compliance
- Conduct periodic auctions of allowances
- Operate or contract for a registry

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Ultimately, the economic burden of limiting GHG emissions is borne by individuals. Thus it can be argued that the allowances should be distributed gratis to individuals to offset the economic burden they bear. Then the 350 to 700 fossil fuel producers and importers would need to purchase the allowances they need from 30 million individuals. An auction with redistribution of some of the revenue to energy users or individuals through the tax system is much easier from an administrative perspective, and it allows the amount distributed to various categories of energy users and individuals to be adjusted to more accurately reflect the burdens they bear.

[10] At $10 per tonne of carbon ($2.72 per tonne of $CO_2$) an auction would raise about $1.5 billion per year under this design. The Multistakeholder Expert Group discussed possible uses of the auction revenue, but did not achieve consensus on those uses. Possible uses include reducing existing taxes, transitional or permanent tax credits to energy-intensive export-oriented industries, and investments in public infrastructure to reduce emissions. NRTEE Issue Paper 7, *Analysis of Options for Distributing Allowances by Auction*, discusses options for use of auction revenue.

Some of those functions could be delegated or contracted to provincial or federal government agencies or private sector entities.

## DESCRIPTIONS OF SIMILAR EXISTING PROGRAMS

This option can best be characterized as a substance trading program. It would involve trading for the carbon content of fossil fuels, the nitrogen used in fertilizers, $SF_6$, HFCs and PFCs which collectively account for most of Canada's greenhouse gas emissions.[11] Both the United States and Canada have implemented substance trading programs for ozone-depleting substances. The methyl bromide part of the Canadian program is noteworthy in that it distributes the allowances to users rather than importers.

### Ozone-Depleting Substances — United States

Trading in production and consumption allowances for ozone-depleting substances was established in the United States in July 1989 to implement commitments under the Montreal Protocol.[12] The Montreal Protocol, which came into force on January 1, 1989, attempts to reduce the use of substances that destroy the stratospheric ozone layer.

The trading program covered five separate groups of ozone-depleting substances. These groups of substances were regulated at different times between 1989 and 1992 and were subject to different phase-out schedules.

Production allowances were allocated to five chlorofluorocarbon (CFC) producers and three halon producers.[13] Consumption allowances were allocated to five CFC producers, three halon producers, 14 CFC importers and six halon importers. A producer needed both production allowances and consumption allowances to produce a regulated substance. Importers only needed consumption allowances to import ozone-depleting substances.

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[11] This option, however, is not *exclusively* a substance trading program. Allowance trading for some greenhouse gas emissions and credit trading for some emissions and for carbon sequestered are also part of this option.

[12] The Montreal Protocol has been amended and supplemented by several other agreements. These agreements and revisions are collectively referred to here as the Montreal Protocol. Consumption is defined as production + imports - exports.

[13] There were only 17 producers of ozone-depleting substances (ODP) in the world when the Montreal Protocol went into effect.

Each participant was allocated allowances for production (consumption) of each substance based on the participant's baseline year market share of the production (consumption) of that substance.[14] The formula for allocating allowances did not change over the life of the program, but the quantity of allowances received by participants each year declined as the production (consumption) cap was phased out. There were no new producers or consumers of ozone-depleting substances over the life of the program. Allowances were substance-specific, but could be traded for other substances within the same group.[15]

The trading program was complemented by a tax on ozone-depleting substances and regulations governing allowable uses for the different substances. As a result of this combination of measures, U.S. consumption of CFCs dropped from about 300,000 tonnes in 1989 to about 40,000 tonnes in 1995. Consumption was well below allowable levels in 1990, 1991, 1992, 1993 and 1995.[16] Nevertheless, about 30% of allowable production was exchanged in intercompany trades.[17]

In summary, the trading programs for ozone-depleting substances used a very simple grandfathering allocation rule — each participant received its share of the baseline (1986 or 1989 depending upon the substance) production (consumption) of each substance. The shares of the allowable production (consumption) did not change over the life of the program.

### Ozone-Depleting Substances — Canada

Canada has used a system of "consumption allowances" to meet its Montreal Protocol commitments. Under this system, Canada's maximum consumption of each group of ozone-depleting substances as established by the Protocol is divided among Canadian companies. Each company receives allowances equal to its share of Canada's consumption of that group of substances during the specified base year. Transfer of consumption allowances between companies has been permitted since 1993.

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[14] The baseline year is 1986 for Groups I and II and 1989 for Groups III, IV and V.

[15] From 1989 through 1991, allowances were denominated in ODP kilograms for Group I and Group II substances (the only substances regulated at the time), so an allowance could be used for production or consumption of any substance in the Group.

[16] Elizabeth Cook, ed., *Ozone Protection in the United States: Elements of Success*, World Resources Institute, Washington, D.C., 1996, Figure 3, p. 5.

[17] Ibid., Figure 1, p. 35.

CFCs and methyl chloroform were the first substances covered by the transferable consumption allowance system. Although there were no restrictions on the transfer of allowances, companies involved in a transfer had to request approval from Environment Canada. The purpose of this approval was to verify that the quantity transferred by a company was indeed still unused and therefore available for the transfer. It also kept Environment Canada informed of the maximum consumption each company was allowed.

Only a few transfers of CFC and methyl chloroform allowances took place between 1993 and 1996, when production and imports of these substances ceased. This was due to the small number of companies involved, about 12 for each category of substances, and the intense competition among the companies. The possibility that the buyer could gain market share from the seller was more important than the revenue from the sale of unused allowances to a competitor.

Methyl bromide allowances were introduced in 1995.[18] In contrast to the other ODS allowances, methyl bromide allowances were distributed to *users* rather than importers. This was done to address the concern that, given the small number of importers (five), they could control the market. Some importers apply the substance themselves and sell it to other applicators, so a distribution to importers might place firms that are only applicators at a disadvantage relative to firms that are both applicators and importers.[19] From a logistical point of view, distribution to users was a viable alternative as the total number of users was relatively small (133).

The hydrochlorofluorocarbon (HCFC) consumption allowance system came into effect on January 1, 1996. In this case, the importers get the allowances. Since Canada's allowable HCFC consumption under the Protocol is based on an estimate of HCFC needs to replace CFCs, and the demand for HCFCs was less than the allowable consumption, Environment Canada distributed consumption allowances equal to about 80% of the allowable consumption. The other 20 % will be distributed based on market demand.

HCFC consumption allowances are divided into categories: refrigeration uses and other uses. Transfers can only take place within a category. No transfers have occurred yet. The reasons are similar to those noted above for CFCs: competition among the small number of firms (about 12) in each category. Concern about possible loss of market share due to a transfer overwhelms the potential revenue.

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

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

In summary, consumption allowances for ozone-depleting substances are grandfathered — allocated on the basis of each participant's base year share of consumption. With the exception of methyl bromide, allowances are issued to importers and producers. Methyl bromide is interesting because the allowances are issued to the users rather then the importers to allay concerns about market power.

## EMISSIONS COVERED BY THE TRADING PROGRAM

Option 4 is a mandatory cap and trade system for most sources of greenhouse gas emissions complemented by credit trading for sources and sinks not well suited to a cap and trade system. Energy-related $CO_2$ emissions are covered by an upstream carbon content trading program for fossil fuel producers and importers. Most other sources of greenhouse gas emissions are also required to participate in the trading program. Sources that are not well suited to emissions trading and sinks would be allowed to create credits.

As discussed earlier, it remains to be determined whether it is feasible to implement the trading system for the carbon content of fossil fuels at the wellhead or at gas processing plants and oil refineries. In the case of HFCs, $SF_6$ and PFCs (other than those from aluminum smelting), producers and importers of the gases would be required to participate in the trading system. Fertilizer manufacturers and importers would be responsible for the nitrogen used in fertilizers sold in Canada. For other sources covered by the trading program, the entity responsible for the emissions would participate. Allowances would be denominated in terms of $CO_2$ equivalents and emissions of other gases would be converted to $CO_2$ equivalents using internationally agreed global warming potential (GWP) values.

Energy-related $CO_2$ emissions account for most of Canada's total greenhouse gas emissions. As a result, there is some concern that the effect of the cap on greenhouse gas emissions in this design is to ration energy use in Canada. Any limit on Canada's greenhouse gas emissions will require measures to reduce energy-related $CO_2$ emissions because they are such a large share of the total. This emissions trading program design offers more flexibility than most other policy options in responding to the limit on greenhouse gas emissions.

The design caps total emissions by sources covered by the trading program; not energy-related $CO_2$ emissions; not $CO_2$ emissions from a particular fossil fuel; and not the energy-related $CO_2$ emissions of a particular company. Energy use could continue to increase if emissions by other sources are reduced by a larger percentage. Fossil fuel producers and importers can also purchase credits from other specified sources, such as landfills and sequestration, to augment the cap. Purchases under one or more of the international cooperative implementation mechanisms also raises the emissions allowed in Canada.

Energy users would face price increases for fossil fuels.[20] These price increases give them an incentive to increase energy efficiency, to conserve energy, and to switch to less carbon-intensive energy sources.[21] All energy users — industrial, commercial, residential and transportation — would face price increases, and therefore have an incentive to reduce energy-related $CO_2$ emissions. The percentage price increases might differ due to taxes, the elasticity of demand for different products, and competition from other energy sources, so the impacts might differ by source category. Consumers of products made with, or containing, other greenhouse gases covered by the trading program would rise for similar reasons.

## SOURCES REQUIRED TO PARTICIPATE IN THE PROGRAM

Entities required to participate in the trading program would include: all fossil fuel producers and importers, large landfills, aluminum smelters, lime and cement producers, fertilizer manufacturers and importers, ammonia producers, magnesium smelters, nitric acid and adipic acid producers, and manufacturers and importers of HFCs, PFCs and $SF_6$. Fossil fuel exporters will need to participate by claiming credits for the carbon content of fossil fuels exported and petrochemical plants will need to claim credits for the carbon sequestered in long-lived products.

Fossil fuel producers and importers include oil and gas producers, coal mines, oil sands plants, and importers of crude oil, refined petroleum products, natural gas and coal. A producer that exports fossil fuels or refined petroleum products could apply the allowances awarded for the exports against the allowances they are required to hold for production of the fossil fuel. Exporters that purchase Canadian fossil fuels or refined petroleum products for sale in another country could sell the allowances awarded for the exports.

Petrochemical plants might participate in the program in the same manner as exporters. Petrochemical products that sequester carbon for at least 20 years do not count as emissions. Producers could receive allowances for the carbon content of such products to offset the feedstock price increases.

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[20] Any emissions trading program, indeed any regulation, that limits energy-related $CO_2$ emissions will lead to price increases downstream of the point of application. Different emissions trading program designs that cover the same energy uses and have the same overall limit on emissions should lead to the same price increases, assuming perfectly competitive markets. However, different emissions trading system designs generally involve different levels of coverage, so the energy price impacts may differ. The price impacts of a trading system implemented upstream of regulated utilities may differ from those for trading systems that involve regulated utilities due to the manner in which their prices are regulated.

[21] The price increases are not the only impacts. Some of the costs of purchasing allowances at auction might be shifted to shareholders through lower profits and share prices, to employees through lower wages, or to suppliers through lower prices for their products.

Sources that are not well suited to emissions trading and sinks would be allowed to create credits. Credits could be earned for capture of emissions from small landfills, open pit mines, PFCs from aluminum smelting, and for carbon sequestration actions allowed by the international emissions limitation agreement.[22] It might also be possible to earn credits through actions to reduce livestock-related emissions from enteric fermentation or manure.

## NUMBER OF SOURCES INVOLVED

In total such a trading program would include approximately 500 to 1,000 participants. This is a manageable number for a trading program. The trading program would include 150 to 250 participants other than fossil fuel producers and importers. The minimum size of landfills required to participate in the trading program is the main determinant of the number of non-fossil participants.

Most of the participants, 350 to 700, would be fossil fuel producers and importers. This includes oil and gas producers; coal mines; oil sands plants; importers of crude oil, refined petroleum products, natural gas and coal; exporters of crude oil, refined petroleum products, natural gas and coal; and petrochemical plants. The number depends on whether the trading program is implemented at gas processing plants and oil refineries or at the wellhead.

Production is already measured at the wellhead, in some collection pipelines, and at the refinery or gas processing plant. The composition of the crude oil and raw gas stream is also currently tested periodically. If the information currently collected is sufficient and sufficiently accurate to support a carbon content trading system at the wellhead, it would involve over 100,000 oil and gas wells. These wells are owned by approximately 600 firms, which would be required to participate in the trading program.

If the trading program can not be implemented at the wellhead, it should be implemented at gas processing plants and oil refineries for the carbon content of the input streams. Application at the wellhead may not be feasible because the cost of testing the raw oil and gas streams wells at regular intervals to calculate the carbon content with sufficient accuracy is too high. Application at the wellhead also may not be feasible because of the

[22] The Multistakeholder Expert Group discussed options that might allow some of these sources to participate in the trading program. For example aluminum smelters might be required to hold allowances for PFC emissions based on a proxy for emissions per tonne of production and smaller landfills might be required to hold allowances for the quantity of waste received. Sources able to demonstrate that their actual emissions were below the proxy values would be required to hold allowances equal to their actual emissions. In the case of enteric fermentation and animal manure emission factors could be established for products such as a litre of milk, a veal calf, a slaughter steer, etc. Purchasers of those products, such as dairies and meat packers, would be required to hold allowances for their purchases. Farmers could earn credits by implementing practices to reduce emissions from those sources. They could sell the credits or transfer them to the purchasers of their products.

extensive record keeping required. If the trading program is implemented at gas processing plants and oil refineries, it would involve approximately 800 plants owned by about 180 companies.

## SHARE OF TOTAL EMISSIONS COVERED BY PARTICIPANTS

Virtually all greenhouse gas emissions except those due to livestock would be covered by this trading program design. Almost all fossil fuel $CO_2$ emissions would be covered by the fossil fuel producers and importers.[23] This includes all stationary and mobile source energy use, other than wood fuels. However, some of the upstream oil and gas and fugitive coal mining emissions are assumed to be outside the trading program. When the industrial sources covered by the program are included, the greenhouse gas emissions covered amount to about 560 to 585 million $CO_2$ equivalent tonnes in 1995.[24] That represents over 90% of total national emissions.

## HOW THE TRADING PROGRAM WOULD BE ADMINISTERED

The Multistakeholder Expert Group recommended that the trading program be managed by a single agency. The process for developing the rules would probably be similar to that used for other environmental regulations. Stakeholders would have an opportunity to comment on the proposed rules before they are adopted.

The regulatory agency would:

- Determine the monitoring requirements for different sources
- Establish criteria and protocols for credit creation by different sources
- Specify reporting systems
- Verify that monitoring systems are functioning properly
- Audit reported emissions
- Enforce penalties for non-compliance
- Conduct periodic auctions of allowances

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[23] The methane ($CH_4$) and nitrous oxide ($N_2O$) emissions associated with energy use are covered by the Kyoto Protocol commitment. Those emissions could be covered by adjusting the carbon content of different fuels to incorporate the associated $CH_4$ and $N_2O$ emissions where they are not addressed separately in the design of the trading system.

[24] The total includes all sources except livestock and manure, soils, prescribed burning, wastewater/ compost, and wood fuels (wood fuels are not covered by the Kyoto Protocol commitment). These exclusions reduce the coverage from the Canadian total of 619 million $CO_2$ equivalent tonnes in 1995 to 593.5 million $CO_2$ equivalent tonnes. This figure must be reduced by some portion of the upstream oil and gas emissions, coal mining emissions and PFCs from aluminum smelting not covered by the trading system, suggesting total emissions covered by the trading program in the range of 560 to 585 million $CO_2$ equivalent tonnes. See A. Jaques, F. Neitzert and P. Boileau, *Trends in Canada's Greenhouse Gas Emissions (1990-1995)*, Environment Canada, Ottawa, April 1997, Table A-4, p. A-6.

- Operate or contract for a registry

Some of those functions could be delegated or contracted to provincial or federal government agencies, such as the National Energy Board or the Alberta Energy and Utilities Board, or private sector entities.

The regulatory agency would need to develop rules for the trading program to cover items such as:

- Allowance use and transfer — sources required to hold allowances, entities allowed to hold allowances, rules for the distribution of allowances (*gratis* or auction), allowance life, banking, distribution of allowances to exporters and petrochemical plants, units of measurement;

- Registry, reporting and monitoring — monitoring requirements, reporting requirements, missing data protocols, notification requirements for transfers of allowances, price information, and public access to information in the registry; and

- Audit and verification — authority of the regulatory agency to require information, order a third party audit, require annual reports, determine compliance, and administer prohibitions, restrictions and penalties.

The rules would be revised periodically based on experience with the program. The registry could be developed and operated by the appropriate government, cooperatively by the federal and provincial governments, or by a qualified organization under contract to the federal and provincial governments.

The Multistakeholder Expert Group made a number of recommendations for the initial program design. Those recommendations are summarized in Table 3.

The Multistakeholder Expert Group recommended that allowances be auctioned.[25] Sources required to hold allowances could purchase them at the auction. It is more likely that they will purchase the allowances they need from brokers who buy them at auction or from other sources.[26] More study is required on how best to conduct the auction and how to use the revenue raised by the auction.

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[25] Among the issues considered to require further study are options such as beginning with a *gratis* distribution and phasing in the auction. This transition could begin before the national commitment comes into force. Assuming the Kyoto Protocol comes into force, for example, this could mean launching the trading program before 2008 (say 2005) with gratis distribution of allowances with a transition to an auction of all of the allowances during the 2008-2012 period.

[26] Firms may prefer to purchase from brokers to keep their actions anonymous if auction results are public. As welt participants in the auction may need to need to demonstrate that they meet certain standards (e.g., creditworthiness) so firms may find it more convenient to buy from a broker. The auction may also use minimum lot sizes (e.g, 1,000 tonnes $CO_2$ equivalent) that are too large for a given firm. A relatively small

## Table 3 — Key Design Issues and Proposed Choices to Address Them

| Issue | Choice | Comments |
|---|---|---|
| Geographic scope | - National program<br>- Tied to international market | - doesn't matter if other countries have completely different approach to emission reductions |
| Basket of gases and sources | - 100% coverage of all emissions from fossil fuels<br>- 100% coverage of other GHG emissions from listed sources | - upstream allowances on carbon content of crude oil, petroleum products, and coal<br>- allowance trading used for all sources marked "emission or substance trading" in Table 2<br>- credit trading for landfills and ruminant $CH_4$ emissions |
| Creation of competitive market | - Allocation of permits through auction<br>- With 500-1,000 sources, shouldn't be a problem | - concern whether sudden implementation of stringent emissions cap would limit supply of permits and hence competitiveness |
| Incorporation of all programs into single market | - all allowances and credits in same units<br>- GWP used to equate gases | |
| Metering & testing for carbon content | - Use company records as first basis | To prevent cheating:<br>- crosscheck company and buyer records<br>- allow for external auditing |
| Liability – seller or buyer? | - Seller for allowances and credits after receiving government approval | - person selling allowances pays penalty if they don't have enough left to cover their own emissions |
| Price disclosure | - automatic at auctions | |
| Transaction costs | - kept low by auction approach | - could be complicated if credits from other systems are taken into account |
| Banking | - post-2008 – yes<br>- pre-2008 through 2008 – maybe | - more analysis needed regarding continuing banking pre-2008 through 2008 |
| Allowance or credit life | - unlimited for now<br>- follow Kyoto rules | |
| Borrowing | - No | - avoid problem of how to deal with companies which go out of business |
| Compliance period | - 1 year | - have 30-60 day grace period at end of accounting year to allow companies over their limit to buy what they need to comply |
| Penalties for non-compliance | - Loss of allowances equal to excess emissions plus financial penalties. | |
| Allocation to new sources / expansion of system | - Allow new companies to participate in next auction | |
| GWP values | - Yes – follow Kyoto | |

number of financial institutions participate in the Treasury Bill auctions. Mutual funds, stockbrokers and other organizations that want Treasury Bills buy them from these institutions. In addition to brokers, a firm could buy allowances from fossil fuel exporters or petrochemical producers, or buy credits from operators of small landfills or sequestration projects, and on the international market.

Exporters of fossil fuels should be allowed to claim allowances for the carbon content of the fossil fuel products exported. The quantity exported should be available from shipping (pipeline, rail and ship) records and invoices. The carbon content of coal or crude oil exported can be obtained from tests already performed by independent laboratories for the buyers and the sellers. The carbon content of other products can be calculated from the product specifications.

Petrochemical producers should be able to claim allowances for the carbon contained in products with a deemed life of at least 20 years. The Multistakeholder Expert Group recommended that the credit creation process follow Option #3 of NRTEE Issue Paper 5 *Design Options in a Domestic Emissions Trading System for the Treatment of Fossil Fuels Used as Feedstocks*. This option places the burden of proof of carbon sequestration on industry. The transaction costs, relative to the market value of the credits, is likely to be small so petrochemical firms will have an incentive to create credits.

Actions to reduce emissions of methane ($CH_4$) from small landfills, open pit mining, enteric fermentation, and animal manure, and PFCs from aluminum smelting should also be allowed to create credits. In these cases, credits should be issued if emitters reduce emissions below baseline levels. These baselines could be established using proxy activity data to estimate emissions. For example, one could use "quantity of waste" as a means to estimate landfill emissions; apply average emission factors to all beef and dairy cattle; and use models to calculate PFC emissions. Criteria for credit creation should be based on international rules. Under this system, credits would be interchangeable with allowances and could be sold for profit.

## HOW EMISSIONS WOULD BE MEASURED

The carbon content of fossil fuels produced, imported and exported would be calculated from the quantity of the fuel and analyses of its composition or an emissions factor as follows:

- Natural gas production — metered production by well and the most recent analysis of the composition of the output of the well. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of payments by gas processing plants to support the metered production. An analysis of the composition by an independent laboratory should be mandatory at appropriate intervals. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Oil production — metered production by well and the most recent analysis of the composition of the output of the well. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of purchases by oil refineries to support the metered production. An

analysis of the composition by an independent laboratory should be mandatory at appropriate intervals. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Coal production — production by mine and the analyses of the composition of the coal during the period. The regulatory authority should also have access to railway records, royalty payment calculations and supporting documents, and records of purchases by customers to support the production records. Company analyses of the composition of the coal should be mandatory at appropriate intervals. The regulator should also have access to analyses performed by purchasers and have the authority to order analyses of the composition by an independent laboratory.

- Oil sands production — production by site and the analyses of the composition of the oil sands produced during the period. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of purchases by customers to support the production records. Company analyses of the composition of the oil sands produced should be mandatory at appropriate intervals. The regulator should also have the authority to order analyses of the composition by an independent laboratory.

- Natural gas imports and exports — documented quantities imported or exported multiplied by an emissions factor. The regulatory authority should also have access to pipeline records and records of purchases and sales to support the quantities reported. An appropriate emissions factor would be established by the regulatory authority. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Crude oil and petroleum product imports and exports — documented quantities imported or exported multiplied by an emissions factor specific to the product. The regulatory authority should also have access to pipeline and shipping company records and records of purchases and sales to support the quantities reported. An appropriate emissions factor would be established by the regulatory authority for each product. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Coal imports and exports — documented quantities imported or exported and analyses of the composition of the coal imported or exported. The regulatory authority should also have access to railway and shipping company records and records of purchases and sales to support the quantity records. Purchaser and seller analyses of the composition of the coal would be used to determine the composition. The regulator should also have the authority to order analyses of the composition by an independent laboratory.

- Petrochemical plants would earn allowances for the carbon content of products that sequester carbon for at least 20 years. The number of allowances earned would be based on records of the quantities of eligible products produced and carbon content factors established by the regulatory authority. The regulatory authority would have access to other records to support the quantity data and have the authority to order analyses of the composition by an independent laboratory to supplement the emissions factors.

- Producers and importers of $SF_6$, HFCs and PFCs would be required to report the quantities of different products produced, imported and exported. The regulatory authority would adopt the internationally agreed Global Warming Potential (GWP) values as the emissions coefficients for these products. The regulator would have authority to audit the reports and other records to support the quantity data.

- Fertilizer manufacturers and importers would be required to report the quantities of different fertilizer products produced, imported and exported. The regulatory authority would establish $N_2O$ emissions coefficients to the different types of fertilizers and use the agreed Global Warming Potential (GWP) value for $N_2O$ to calculate the emissions associated with each product. The regulator would have authority to audit the reports and other records to support the quantity data.

- Aluminum smelters would calculate their $CO_2$ emissions by weighing the carbon anodes. The change in weight would be converted to $CO_2$ emissions. The reports of the change in weight would be supplemented by records on purchases of anodes and other records.

- Large landfills, adipic acid, nitric acid, ammonia, cement and lime plants and other sources covered by the trading program would be required to monitor their actual greenhouse gas emissions using monitoring devices specified by the regulator. The devices would need to be tested at intervals specified by the regulator. The regulator would also adopt missing data protocols to replace missing observations due to equipment failure, repair or other reasons.

## POSSIBLE COMPLEMENTARY POLICIES

Complementary policies are discussed in more detail in NRTEE Issue Paper 11.[27] A trading program for the carbon content of fossil fuels raises the prices of fossil fuels downstream of the sources required to hold allowances. Energy-related $CO_2$ emissions are actually reduced mainly by fossil fuel consumers who improve energy efficiency, reduce energy use, or switch to less carbon-intensive energy sources.

[27] See NRTEE Issue Paper 11, *Policies that could Complement a Domestic Emissions Trading System for Greenhouse Gases.*

Complementary policies should help or encourage fossil fuel consumers to implement such measures. A wide range of complementary policies are possible, including:

- information programs on energy efficiency, energy conservation and fuel switching;
- measures to stimulate development and commercialization of more energy-efficient technologies; and
- changes to the tax code to ensure that different energy sources receive comparable treatment.

Complementary policies can also be implemented to facilitate emission reductions from other sources. If large landfills and waste incinerators are part of the trading program but small landfills are not, other policies are needed to ensure that waste is not diverted to small landfills. Policies may also be able to encourage measures that reduce the use of $SF_6$, HFCs or PFCs in particular applications where suitable substitutes are available.

The method of distributing allowances may also give rise to complementary policies. If the allowances are auctioned as recommended by the Mulitstakeholder Expert Group, the revenue can be used to cushion the economic impacts on the groups most adversely affected, such as large energy consumers, coal mining companies, communities dependent on coal mines and energy-intensive industries, and individuals. Gratis distribution of allowances to fossil fuel producers and importers is likely to lead to windfall profits for such firms. Energy users, in contrast, bear higher energy prices and incur the costs of energy efficiency or fuel switching measures to reduce $CO_2$ emissions. Equity issues such as these will need to be addressed through the distribution of allowances or other policies.

## SPECIAL ISSUES RAISED BY THE DESIGN

The main issue raised by an upstream trading program for the carbon content of fossil fuels is the treatment of petrochemical feedstocks. This is the subject of a separate NRTEE issue paper.[28]

The Multistakeholder Expert Group recommended that treatment of feedstocks follow Option 3 as outlined in the NRTEE Issue Paper. This allows petrochemical plants to earn allowances equal to the carbon content of products that sequester carbon for at least 20 years. The carbon content of such products is considered to be sequestered and hence is not counted as part of the national emissions inventory. The carbon content of products

[28] See NRTEE Issue Paper 5, *Design Options in a Domestic Emissions Trading System for the Treatment of Fossil Fuels Used as Feedstocks.*

with shorter lifetimes is considered to be emitted during the year in which the product is produced. Selling the allowances earned should enable the petrochemical producer to effectively offset the price increases due to the trading system for the feedstocks used in the long-lived products.

## TRANSITIONAL ISSUES RELATED TO A CHANGE IN THE POLICY SETTING

This option assumes that a national commitment to limit greenhouse gas emissions is in force. Participants will be expected to demonstrate compliance annually. If the allowances available during the first year are equal to 20% of the national commitment for the 2008-2012 period, the supply could be substantially below the actual emissions during the previous year. Since it is difficult to achieve large emission reductions in a short time, the price could be very high.

To avoid a disruptive introduction of the trading system, ways of phasing in the system need to be explored.

- The design of the trading system, including the allowance allocation rules, could be announced several years in advance of 2008 to enable the prospective participants to begin to adjust to the likely impacts. This approach might not work very well for this design because the trading program participants are fossil fuel producers and importers while it is the energy consumers that must adjust their energy consumption patterns to reduce the associated emissions. Even given projection of the expected price impacts consumers are unlikely to adjust their energy use until the prices actually change.

- Implementing the trading system before 2008 with an increasingly restrictive cap on emissions is one way to phase-in the trading system and to generate the price signals needed to change energy consumption behaviour. But doing this may create competitiveness problems for industry if other countries do not also start early.

- Another approach is to implement a declining cap on emissions during the 2008-2012 period. This does not create competitiveness problems if other countries do not begin to implement policies to limit greenhouse gas emissions prior to 2008. But it requires that the changes in energy consumption behaviour be achieved during the 2008-2012 period rather than over a longer period of time.

After the national commitment to limit greenhouse gas emissions has come into effect, it could become more stringent over time. Or the commitment could become less stringent, perhaps to the point that no restrictions on greenhouse gas emissions are needed.

If the commitment becomes more stringent, the cap on greenhouse gas emissions covered by the trading program would need to be made correspondingly more stringent to meet the revised commitment. If the commitment becomes less stringent, the cap on greenhouse gas emissions could be relaxed. As compliance with the relaxed cap became easier, the volume of trading activity and prices of allowances could be expected to fall.

## EVALUATION OF THE OPTION USING PROPOSED CRITERIA

The criteria proposed for evaluating proposed greenhouse gas emission trading options are:[29]

*Economic efficiency*
- Cost-effectiveness
- Transactions costs
- Comprehensiveness

*Equity*
- International equity
- Domestic equity
- Industrial equity

*Technical feasibility*
- Technical flexibility
- Timing
- Leakage

*Political feasibility*
- Domestic political compatibility
- International compatibility
- Sovereignty

*Administrative feasibility*
- Measurability
- Verifiability
- Enforceability

***Cost-effectiveness:*** Emissions trading should minimize the cost of reducing greenhouse gas emissions to individuals, firms and society. Cost-effectiveness requires that each source find the lowest cost options to reduce its greenhouse gas emissions, that the marginal cost of reducing greenhouse gas emissions be equalized across all sources, and that the costs of greenhouse gas emissions be reflected in product prices so that the mix of goods and services consumed adjusts to "economize" greenhouse gas emissions to an appropriate degree.

[29] These criteria are drawn from *Analysis of the Potential for a Greenhouse Gas Trading System for North America*, Commission for Environmental Cooperation, Montreal, May 1997, Chapter 3, pp. 32-42. They are described fully there.

This trading program design covers over 90% of Canada's total greenhouse gas emissions. Thus it encourages comparisons of the marginal cost of emission reductions across almost all domestic sources and, through the links to the international flexibility mechanisms, almost all sources globally.[30] In practice this trading program design may not equate marginal costs across sources because the price increases may not strictly reflect the greenhouse gas emissions associated with different products or because some consumers do not respond optimally to the price changes.

This trading program design increases the prices of fossil fuels downstream of the sources participating in the trading program. The price increases may not strictly reflect the greenhouse gas emissions associated with the different products due to taxes, the elasticity of demand for different products, and competition from other energy sources.

The price increases, nevertheless, provide an incentive for energy users to increase energy efficiency, to reduce energy use, and to switch to less carbon-intensive energy sources. However, some consumers do not respond as well as others to changes in energy prices because of market failures.

Since product prices will not accurately reflect the greenhouse gas emissions and since some consumers do not respond optimally to energy price changes, the result will not be fully cost-effective. However, the result is likely to be more cost-effective than for many other trading system designs or for other forms of regulation because of the higher coverage of greenhouse gas emissions.

***Transactions costs:*** Transactions costs for emissions trading programs should be minimized. This trading program design should have relatively low transactions costs.

Much of the information needed to calculate greenhouse gas emissions covered by the program is already collected. The additional monitoring and reporting costs for the program, especially if carbon content is measured for the input to oil refineries and gas processing plants should be relatively low. Additional audits might be needed to assure compliance with the trading program. The allowances are homogeneous, government-issued certificates, so the transactions costs for trading are likely to be relatively low.

If the carbon content is measured at the wellhead, the monitoring and reporting costs could be substantially higher due to the large number of sources involved (over 100,000), although it appears that much of the information needed is already collected. But additional costs would be incurred to manage the emissions between the wellhead and the refineries and processing plants.

[30] Restrictions on the use of the international flexibility mechanisms (supplementarity provisions) could limit the degree to which marginal costs in Canada and marginal costs in other countries are equated.

***Comprehensiveness:*** An emissions trading program should cover as broad a range of greenhouse gas sources and sinks as possible. The proposed design would cover over 90% of Canada's total greenhouse gas emissions.

***International equity:*** An emissions trading program should be fair to developing countries. International equity would be addressed through the agreements that establish the national commitments. The domestic emissions trading program does not affect international equity.

***Domestic equity:*** An emissions trading program should be equitable in terms of its impacts on different income groups and regions. Equity is initially determined by the allocation of allowances in the case of *gratis* distribution, or the use of the revenue in the case of an auction of allowances.[31] But the costs of meeting the limit on greenhouse gas emissions are passed on to consumers, employees, shareholders, and suppliers. Thus the distributional effects of the program depend on how the costs are passed on as well as the distribution of allowances or auction revenue. The Multistakeholder Expert Group recommended the use of an auction for this design, but with further analysis of the auction design and the use of the auction revenue.

***Industrial equity:*** An emissions trading program should treat different industries and sectors fairly (not necessarily equally). Equity is determined by the allocation of allowances in the case of gratis distribution or the use of the revenue in the case of an auction of allowances. The Multistakeholder Expert Group recommended the use of an auction for this design, but recognized the need for further analysis of the use of auction revenue.

Downstream of the trading program, energy users are affected by higher energy prices. Industries and sectors expected to suffer significant disruption due to higher energy prices, could be eligible to receive part of the auction revenue to help finance the necessary adjustments. Petrochemical producers can earn allowances for the carbon content of products that sequester carbon for at least 20 years.

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[31] Gratis distribution of allowances to fossil fuel producers and importers is likely to lead to windfall profits for such firms. Energy users, in contrast, bear higher energy prices and incur the costs of energy efficiency or fuel switching measures to reduce $CO_2$ emissions. Thus, distribution of allowances to energy users or to individuals might be more equitable in the case of a gratis distribution. But the administrative complexity of such distributions suggests an auction with a redistribution of some of the revenue to address equity issues.

If allowances are grandfathered — distributed gratis on the basis of historical production and imports — participants prepared to lose market share domestically can reap windfall profits. Importers reduce their imports and sell their surplus allowances. Producers export more of their production and sell their surplus allowances. The remaining demand would be supplied by additional imports supplied by new firms. As new firms, they would not be allocated allowances under the grandfather rule. Instead they would need to purchase the allowances from the producers (importers) that receive allowances because they operated during the base year and increased their exports (reduced their imports).

***Technical flexibility:*** An emissions trading program should allow maximum flexibility in terms of the choice of reduction or sequestration technology to implement. This emissions trading program design covers all greenhouse gases from most sources in Canada. This allows program participants complete flexibility in the choice of measures to reduce their greenhouse gas emissions.

Downstream of the trading program consumers face price increases for products that generate greenhouse gas emissions. They adjust their consumption patterns in response to the price increases. Energy users, for example, select the energy efficiency, energy conservation or fuel switching measures that are best suited to their circumstances. However, some consumers are not very sensitive to price cahnges and so may not adopt the ideal emission reduction measures.

*Timing:* An emissions trading program should allow maximum flexibility in the timing of reduction or sequestration actions. If banking is allowed, as recommended by the Multistakeholder Expert Group, the proposed trading program design would provide sources with flexibility in the timing of actions to meet the cap established for participants.

*Leakage:* An emissions trading program should minimize increases in emissions elsewhere. The proposed emissions trading program design covers approximately 95% of Canada's greenhouse gas emissions and so virtually eliminates leakage except for activities shifted out of the country. Some leakage due to shifting activities out of the country is inevitable, given national commitments in some countries and no limits on greenhouse gas emissions in other countries. Domestic and international emissions trading help to reduce the extent of such leakage by minimizing the cost of meeting the national commitment.

***Domestic political compatibility:*** An emissions trading program should minimize potential conflicts with existing and future domestic policies. The proposed emissions trading program design would ideally be implemented cooperatively by the federal and provincial governments. Coordinating administration of a single trading program and enforcement of compliance by participants across federal and provincial jurisdictions could be difficult.

***International compatibility:*** An emissions trading program should minimize potential conflicts with existing and future international regimes. Many countries would have national commitments, such as those under the Kyoto Protocol, to limit their greenhouse gas emissions. It is presumed that each country would have considerable latitude to adopt

its preferred policies domestically, and that an upstream carbon content trading program would be an acceptable domestic policy.[32]

It is believed that requiring fossil fuel importers to hold allowances for the carbon content of their products would not create any difficulties under World Trade Organization rules as long as the requirements were the same as those applicable to domestic producers, as proposed.

***Sovereignty:*** An emissions trading program should minimize the need for international oversight and interference. An upstream carbon content trading program should entail no international oversight other than that required to ensure compliance with the national emissions limitation commitment.

***Measurability:*** An emissions trading program should minimize the uncertainty and complexity of measuring emissions reduced or sequestered. The proposed trading program design allows emissions by participants to be measured with a reasonable degree of accuracy with relatively little additional effort.

Energy-related $CO_2$ emissions would be calculated from the carbon content of fuels produced, imported and exported and on analyses of fuels produced and emissions coefficients for products imported or exported. The quantities are already measured and, in most cases, reported. And analyses of fuel composition are already performed by producers or purchasers.

The feasibility of measuring the carbon content at the wellhead, the preferred location, is not yet clear. The administrative burden of testing the composition of the output of more than 100,000 oil and natural gas wells and of calculating the carbon content of the output of each well may be too great. But it is definitely feasible to measure the carbon content of the fossil fuels at the oil refineries and gas processing plants. Thus, carbon content can be measured relatively accurately with little additional effort.

*Verifiability*. An emissions trading program should increase confidence on the part of participants and other stakeholders that the emissions reductions claimed have been achieved.

Reports of the carbon content of fossil fuels produced, imported or exported will depend on the accuracy of the quantities and the accuracy of the analyses of the fuel composition. Independent data are generally available for the quantities produced, imported or exported from transportation companies or purchasers. Independent analyses of the composition are sometimes available as well. If the regulator has access to such independent records and has the authority to order independent analyses of fuel

[32] It can be argued that a design in which credit trading plays a relatively small part is more compatible with the international system. There is a risk that credits will be granted for actions that do not represent incremental emission reductions. That represents a risk that Canada will not meet its national commitment.

composition, it should be able to verify the carbon content with a high degree of confidence.

Reports of the quantities of SF6, HFCs, PFCs and nitrogen fertilizers produced, imported and exported are available and can be verified through access to shipping records, invoices, customs documents, GST returns and other documents. Other emissions would be measured using monitoring equipment specified by the regulatory authorities. The accuracy of the monitoring equipment would need to be tested by independent agencies on a regular basis.

***Enforceability:*** An emissions trading program should maximize compliance with emissions limitation commitments. The proposed trading program design should not pose significant enforcement difficulties. The number of participants is likely to be manageable — 500 to 1,000. Many of the participants are already audited for royalty or other purposes. Thus, effective enforcement should be possible with relatively little additional effort.

**National Round Table on the Environment and the Economy**
**Table ronde nationale sur l'environnement et l'économie**

# Extended Description of Option 4: Cap on Carbon Content of Fossil Fuels Produced and Imported

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# Extended Description of Option 4: Cap on Carbon Content of Fossil Fuels Produced and Imported

## INTRODUCTION

A July 1998 National Round Table on the Environment and the Economy (NRTEE) paper on *Possible Designs for a Domestic Emissions Trading Program for Greenhouse Gases* identified fourteen possible designs for a domestic emissions trading program for greenhouse gases. Six of those designs were selected for further analysis. The fourteen designs and the six selected for further analysis are shown in Table 1.

This paper provides an extended description of one of the options selected; Option 4: A Cap on Carbon Content of Fossil Fuels Produced and Imported with Trading by Producers, Importers and Exporters. This paper covers:

- A description of the trading program
- Descriptions of similar existing programs
- The emissions covered by the trading program
- The sources required to participate in the program
- The number of sources involved
- Share of total emissions covered by participants
- How the trading program would be administered
- How emissions would be measured
- Possible complementary policies
- Special issues raised by the design
- Transitional issues related to a change in the policy setting
- Evaluation of the option using the proposed criteria

## DESCRIPTION OF THE TRADING PROGRAM

Option 4 is a mandatory cap and trade system for fossil fuel producers, importers and exporters. A cap is imposed on the carbon content of fossil fuels used in Canada to help meet a national commitment to limit greenhouse gas emissions.[1] The carbon content of

[1] Fossil fuels contain elemental carbon and various carbon compounds. The carbon content of coal, crude oil and natural gas at the mine mouth or wellhead varies from source to source and over time, but can be accurately determined through relatively inexpensive chemical analyses. Pipeline quality natural gas and different petroleum products must meet product specifications that determine the carbon content to very close tolerances. When a fossil fuel is burned to provide energy, the carbon combines with oxygen from the air to form $CO_2$ which is a greenhouse gas. Thus it is possible to accurately determine the energy-related $CO_2$ emissions from the carbon content of fossil fuels. And controlling the carbon content of the fossil fuels used is an effective way to limit the resulting $CO_2$ emissions.

fossil fuels used in Canada can be controlled by requiring producers to hold allowances for the carbon content of the fuels produced in Canada and issuing allowances for the carbon content of fuels exported from Canada. Importers of fossil fuels would also need to hold allowances for the carbon content of the fuels imported into Canada.

**Table 1: Summary of Possible Designs and Recommended Short List**

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

Thus the carbon content trading program includes all fossil fuel producers, importers and exporters. Each producer and importer must hold allowances equal to the carbon content of the domestically produced and imported crude oil, natural gas, coal, as well as imported petroleum products sold. Exporters receive allowances equal to the carbon content of the crude oil, natural gas, coal and petroleum products exported.

This design is implemented as far "upstream" as possible; as close as possible to the wellhead or mine mouth for producers and to the border for importers and exporters. A key design choice is whether to implement the program at the wellhead or at the initial processing plant for oil and natural gas production. Considerations in the choice of where to implement the trading program include:

- the number of participants;
- the availability and accuracy of data on the carbon content of the fuel produced; and
- the share of total emissions covered.

There are approximately 55,000 oil wells and 50,000 gas wells in Canada which are owned by fewer than 600 companies.[2] There are 789 gas plants and 23 oil refineries in Canada, which are owned by approximately 180 companies.[3] There are 29 coal mines in Canada operated by 12 coal companies. There are estimated to be between 15 and 50 companies that import coal, natural gas or petroleum products that are not fossil fuel producers. Virtually all fossil fuel exporters are believed to be producers as well. Thus an upstream carbon content trading program would involve between 350 and 700 companies.

The composition of the oil or gas recovered from a well differs from well to well and the composition of the oil or gas recovered from a particular well changes over time. Oil recovered from a well includes methane, which is recovered where economically feasible, flared, or released to the atmosphere. Gas recovered from a well includes $CO_2$, which is stripped and released to the atmosphere, impurities, such as hydrogen sulphide, which must be removed and natural gas liquids, which are recovered and sold to oil refineries. Regulatory agencies, such as the Alberta Energy and Utilities Board, require that wells be tested periodically to determine the composition of the gas stream. The quantity produced by each oil and gas well is metered.

The composition of the natural gas received by a processing plant and the crude oil received by an oil refinery varies. The quantity received by each processing plant and oil refinery is recorded. But regular testing would be needed to determine the carbon content of the unprocessed natural gas or crude oil received. The natural gas produced by a processing plant and the products produced by an oil refinery must meet well defined specifications and so have a carbon content that varies within a narrow range. Thus the

[2] The Canadian Association of Petroleum Producers (CAPP) has 184 members, which are large and medium size companies. The Small Explorers and Producers Association of Canada (SEPAC) has 430 members, many of which are explorers rather than producers. The total is 614 companies, not all of which are producers. Estimates by industry observers suggest 300 to 400 oil and gas producers including all CAPP members, which are responsible for about 95% of total production.

[3] The 23 refineries are owned by 13 companies and the 789 gas plants are owned by 171 companies. But duplication of ownership reduces the list to less than 180 companies.

carbon content of the output can be calculated accurately from the product specifications and the quantities produced. The carbon content of imports and exports can also be calculated from the product specifications and the quantities.[4]

The composition of coal is analysed by mining companies as it is produced. Purchasers also have the coal analysed, usually at the point of loading. Thus data on the carbon content of the coal produced, exported and imported can be calculated from these analyses and the related quantities.

Emissions of greenhouse gases due to upstream oil and gas activities and coal mining are estimated to represent over 7% of Canada's national total.[5] This includes fugitive methane emissions from upstream oil and gas activities, $CO_2$ stripped from natural gas, and fugitive methane from coal mining.

Upstream oil and gas activities are defined to include all activities between the wellhead and the point of combustion and hence include transportation and distribution activities downstream of the gas processing plant or oil refinery. However, most of the fugitive emissions occur before the natural gas leaves the processing plant or the petroleum products leave the refinery. $CO_2$ is estimated to represent 7% by weight of the content of unprocessed natural gas, but this varies widely and can range up to 26%.[6] The $CO_2$ stripped from natural gas represents about one-quarter of the total emissions in this category. Fugitive emissions of methane from coal production are only a small share of the total, but vary widely from mine to mine.

In summary, emissions between the wellhead and the output of a gas processing plant or oil refinery are significant. An upstream carbon content trading system should seek to include as many of these sources as possible by measuring emissions as close as possible to the wellhead and mine mouth. While the number of oil and gas wells is large (over 100,000), an upstream carbon content trading program would probably involve between 350 and 700 companies.

Allowances for the carbon content of fossil fuels produced and imported into Canada could be sold at auction or be distributed *gratis*. These options are discussed in NRTEE Issue Papers 6 and 7. Every emissions trading program that distributes allowances *gratis*, gives them to the sources required to hold the allowances, the fossil fuel producers and importers in this case, but they could also be distributed to other groups such as energy

[4] The carbon content of imported natural gas and petroleum products could be calculated from the product specifications. Imported crude oil might need to be tested to determine the carbon content. This could be done by the importing refinery.

[5] A. Jaques, F. Neitzert and P. Boileau, *Trends in Canada's Greenhouse Gas Emissions (1990-1995)*, Environment Canada, Ottawa, April 1997, p. A-3.

[6] Ibid., p. 34.

consumers or the general public.[7] Exporters of fossil fuel would receive allowances equal to the carbon content of the products they export. These allowances could be sold to producers or importers.

Treatment of the fuel used as feedstock also needs further analysis. This issue is addressed in NRTEE Issue Paper 5. An upstream carbon content trading program raises the price of all fossil fuel products downstream of the gas processing plant or oil refinery. Price increases for feedstocks could adversely affect the competitiveness of petrochemical plants, especially if plants in other countries are not affected in the same way. Some petrochemical products sequester the carbon in the feedstock for a few years while others sequester the carbon for several decades. The share of total production exported varies from product to product. To the extent that petrochemical products are exempted because they are exported or sequester carbon for a long time, producers could receive allowances for the carbon content of such products to offset the feedstock price increases.

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[7] Regardless of how the allowances are distributed, assuming *gratis* distribution, the 350 to 700 fossil fuel producers and importers would need to hold allowances equal to the carbon content of their fossil fuel sales. If the fossil fuel importers have to buy the allowances because they are auctioned by the government or distributed *gratis* to other groups, the prices of the fossil fuel products they sell will rise due to the cost of purchasing the allowances. If the allowances are distributed *gratis* to the fossil fuel producers and importers the prices of their products will rise by the same amount even though they have not incurred any expense to acquire the allowances. The reason is that the total quantity of carbon content in fossil fuels is the same in both cases and that fossil fuel producers can do little to reduce the carbon content of their products. So the prices of fossil fuel products must rise to the point where fuel switching and energy efficiency adjust the demand for fossil fuels so that the carbon content of the fuels used equals the available carbon content. Since the demand and supply of carbon content must be balanced through changes in the prices of fossil fuels, the price increases are approximately the same whether the fossil fuel producers have to buy the allowances or they receive them *gratis*. Of course, if they receive them *gratis* they receive a windfall profit as a result of the higher prices for their products with no increased costs.

Energy users will bear the initial burden of the price increase. Thus an argument can be made that a more equitable arrangement would be to distribute the allowances *gratis* to energy users and to require the fossil fuel producers and importers to buy the allowances from the energy users. In that way the payments the energy users receive for the allowances offset the higher energy costs. There are several difficulties with this approach. First, it is administratively complex; 350 to 700 fossil fuel producers and importers would need to buy allowances from several thousand energy users. Second, finding an equitable formula for distributing the allowances to the thousands of energy users that still leaves them with an incentive to use energy more efficiently and to switch to less carbon-intensive energy sources will be difficult. Third, if the energy users increase the prices of their products to reflect the higher energy prices they can capture the windfall profits.

Ultimately, the economic burden of limiting greenhouse gas emissions is borne by individuals. So it can be argued that the allowances should be distributed *gratis* to individuals to offset the economic burden they bear. Then the 350 to 700 fossil fuel producers and importers would need to purchase the allowances they need from 30 million individuals. An auction with redistribution of some of the revenue to energy users or individuals through the tax system is much easier from an administrative perspective and it allows the amount distributed to various categories of energy users and individuals to be adjusted to more accurately reflect the burdens they bear.

The upstream carbon content trading program is assumed to be part of a package of policies covering all gases and sources to meet the national commitment. Sources of other greenhouse gas emissions may also be covered by allowance trading programs which are integrated into a single emissions trading market. Participants in the carbon content trading program could purchase allowances from those other gases/sources or purchase credits from other specified sources, such as landfills and sequestration, to augment the cap.[8] Increasing the emissions allowed in Canada through purchases under one or more of the international cooperative implementation mechanisms can also raise the cap. If a "credit for early action" incentive is established, credits registered under that program might also be eligible for use in the trading program.

The upstream carbon content trading program would include elements normally associated with both federal jurisdiction, such as international trade in fossil fuels, and provincial jurisdiction, such as production of fossil fuels. Issues arising from this jurisdictional dichotomy will have significant administrative and policy implications. These are discussed in NRTEE Issue Paper 2, *Analysis of Legislative Authority to Implement Different Forms of Emissions Trading*.

## DESCRIPTIONS OF SIMILAR EXISTING PROGRAMS

A trading program for the carbon content of fossil fuels is a substance trading program. Both the United States and Canada have implemented substance trading programs for ozone-depleting substances. The methyl bromide part of the Canadian program is noteworthy in that it distributes the allowances to users rather than importers.

### *Ozone-Depleting Substances - United States*

Trading in production and consumption allowances for ozone-depleting substances was established in the United States in July 1989 to implement commitments under the Montreal Protocol.[9] The Montreal Protocol, which came into force on January 1, 1989, attempts to reduce the use of substances that destroy the stratospheric ozone layer.

The trading program covered five separate groups of ozone-depleting substances. These groups of substances were regulated at different times between 1989 and 1992 and were subject to different phase out schedules.

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[8] If credits for emissions reductions prior to 2008 can be used to meet commitments after 2008 owners of such credits could also use them to help achieve compliance.

[9] The Montreal Protocol has been amended and supplemented by several other agreements. These agreements and revisions are collectively referred to here as the Montreal Protocol. Consumption is defined as production + imports - exports.

Production allowances were allocated to five CFC producers and three halon producers.[10] Consumption allowances were allocated to five CFC producers, three halon producers, 14 CFC importers, and 6 halon importers. A producer needed both production allowances and consumption allowances to produce a regulated substance. Importers only needed consumption allowances to import ozone-depleting substances.

Each participant was allocated allowances for production (consumption) of each substance based on the participant's baseline year market share of the production (consumption) of that substance.[11] The formula for allocating allowances did not change over the life of the program, but the quantity of allowances received by participants each year declined as production (consumption) cap was phased out. There were no new producers or consumers of ozone-depleting substances over the life of the program. Allowances were substance specific, but could be traded for other substances within the same group.[12]

The trading program was complemented by a tax on ozone depleting substances and regulations governing allowable uses for the different substances. As a result of this combination of measures U.S. consumption of CFCs dropped from about 300,000 tonnes in 1989 to about 40,000 tonnes in 1995. Consumption was well below allowable levels in 1990, 1991, 1992, 1993, and 1995.[13] Nevertheless, about 30% of allowable production was exchanged in inter-company trades.[14]

In summary, the trading programs for ozone depleting substances used a very simple grandfathering allocation rule -- each participant received its share of the baseline (1986 or 1989 depending upon the substance) production (consumption) of each substance. The shares of the allowable production (consumption) did not change over the life of the program.

### *Ozone-Depleting Substances - Canada*

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[10] There were only 17 producers of ozone depleting substances in the world when the Montreal Protocol went into effect.

[11] The baseline year is 1986 for Groups I and II and 1989 for Groups III, IV and V.

[12] From 1989 through 1991 allowances were for denominated in ODP kilograms for Group I and Group II substances (the only substances regulated at the time) so an allowance could be used for production or consumption of any substance in the Group.

[13] Cook, 1996, Figure 3, p. 5.

[14] Ibid., Figure 1, p. 35.

Canada has used a system of "consumption allowances" to meet its Montreal Protocol commitments. Under this system, Canada's maximum consumption of each group of ozone-depleting substances as established by the Protocol is divided among Canadian companies. Each company receives allowances equal to its share of Canada's consumption of that group of substances during the specified base year. Transfer of consumption allowances between companies has been permitted since 1993.

CFCs and methyl chloroform were the first substances covered by the transferable consumption allowance system. Although there were no restrictions on the transfer of allowances, companies involved in a transfer had to request approval from Environment Canada. The purpose of this approval was to verify that the quantity transferred by a company was indeed still unused and therefore available for the transfer. It also kept Environment Canada informed of the maximum consumption each company was allowed.

Only a few transfers of CFC and methyl chloroform allowances took place between 1993 and 1996 when production and imports of these substances ceased. This was due to the small number of companies involved, about 12 for each category of substances, and the intense competition among the companies. The possibility that the buyer could gain market share from the seller was more important than the revenue from the sale of unused allowances to a competitor.

Methyl bromide allowances were introduced in 1995.[15] In contrast to the other ODS allowances, methyl bromide allowances were distributed to *users* rather than importers. This was done to address the concern that, given the small number of importers (5), they could control the market. Some importers apply the substance themselves and sell it to other applicators, so a distribution to importers might place firms that are only applicators at a disadvantage relative to firms that are both applicators and importers.[16] From a logistical point of view, distribution to users was a viable alternative as the total number of users was relatively small (133).

The HCFC consumption allowance system came into effect on January 1, 1996. In this case, the importers get the allowances. Since Canada's allowable HCFC consumption under the Protocol is based on an estimate of HCFC needs to replace CFCs and the demand for HCFCs was less than the allowable comsumption, Environment Canada distributed consumption allowances equal to about 80% of the allowable consumption. The other 20 % will be distributed based on market demand.

HCFC consumption allowances are divided into categories; refrigeration uses and other uses. Transfers can only take place within a category. No transfers have occurred yet. The

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

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

reasons are similar to those noted above for CFCs, competition among the small number of firms (about 12) in each category. Concern about possible loss of market share due to a transfer overwhelms the potential revenue.

In summary, consumption allowances for ozone-depleting substances are grandfathered; allocated on the basis of each participant's base year share of consumption. With the exception of methyl bromide, allowances are issued to importers and producers. Methyl bromide is interesting because the allowances are issued to the users rather then the importers to allay concerns about market power.

## EMISSIONS COVERED BY THE TRADING PROGRAM

An upstream carbon content trading program would cover virtually all energy-related $CO_2$ emissions in Canada. Virtually all of the carbon in fossil fuels is converted to $CO_2$ emissions when the fuel is burned. A carbon content trading program would establish a cap for the carbon content of the fossil fuels used in Canada. Thus, it effectively sets a cap on energy-related $CO_2$ emissions in Canada.

The cap on energy-related $CO_2$ can be increased if sources purchase allowances for other gases/sources covered participating in the trading program. In other words, energy-related $CO_2$ emissions can be increased if other greenhouse gas emissions are reduced by a larger percentage. Sources can also purchase credits from other specified sources, such as landfills and sequestration, to augment the cap. Increasing the emissions allowed in Canada through purchases under one or more of the international cooperative implementation mechanisms can also raise the cap.

Energy users would face price increases for fossil fuels. These price increases give them an incentive to increase energy efficiency, to conserve energy, and to switch to less carbon-intensive energy sources. All energy users -- industrial, commercial, residential and transportation -- would face price increases, and so have an incentive to reduce energy-related $CO_2$ emissions. The percentage price increases might differ due to taxes, the elasticity of demand for different products, and competition from other energy sources so the impacts might differ by source category.

## SOURCES REQUIRED TO PARTICIPATE IN THE PROGRAM

All fossil fuel producers and importers would be required to hold allowances for the carbon content of the fossil fuels they produced or imported. This would include oil and gas producers, coal mines, oil sands plants, and importers of crude oil, refined petroleum products, natural gas and coal.

Exporters of fossil fuels would be awarded allowances for the carbon content of fossil fuels exported from Canada. A producer that exports fossil fuels or refined petroleum products could apply the allowances awarded for the exports against the allowances they

are required to hold for production of the fossil fuel. Exporters that purchased fossil fuels or refined petroleum products for sale in another country could sell the allowances awarded for the exports to producers or importers.

Petrochemical plants might participate in the program in the same manner as exporters. To the extent that petrochemical products are exempted because they are exported or sequester carbon for a long time, producers could receive allowances for the carbon content of such products to offset the feedstock price increases.

## NUMBER OF SOURCES INVOLVED

An upstream carbon content trading program would probably involve between 350 and 700 companies. This includes oil and gas producers; coal mines; oil sands plants; importers of crude oil, refined petroleum products, natural gas and coal; exporters of crude oil, refined petroleum products, natural gas and coal; and petrochemical plants. This is a manageable number for a trading program.

The trading program should measure the carbon content of the fuel as close as possible to the wellhead and mine mouth. Since there are over 100,000 oil and gas wells, large oil and gas producers will be faced with a large measurement and reporting obligation. Production is already measured at the wellhead, in some collection pipelines, and at the refinery or gas processing plant. The composition of the crude oil and raw gas stream is also presently tested periodically.

Thus, the basis for measuring emissions at the wellhead and mine mouth already exists. Further work is needed to determine whether the information currently collected is sufficient and sufficiently accurate to support a carbon content trading system at the wellhead and mine mouth. If the carbon content of oil and gas wells can not be measured with sufficient accuracy at the wellhead because of the large number of wells, then the carbon content trading system should be implemented at the oil refineries and natural gas processing plants.[17] Alternative approaches to regulating the emissions between the wellhead and the processing plants would need to be implemented.

## SHARE OF TOTAL EMISSIONS COVERED BY PARTICIPANTS

Virtually all fossil fuel $CO_2$ emissions would be covered by an upstream carbon content trading program.[18] This includes all stationary and mobile source energy use, other than

[17] Note that the total number of firms required to hold allowances for the carbon content of the fossil fuels they sell does not change appreciably. In both cases 350 to 700 firms are required to hold allowances for the carbon content of the fossil fuels they sell. The only difference is in the point at which the carbon content is measured. The preferred option is to measure the carbon content at the wellhead. If That is not practical, it can be measured at the oil refinery and gas processing plant.

[18] This option focuses on energy-related $CO_2$ emissions. The methane ($CH_4$) and nitrous oxide ($N_2O$) emissions associated with energy use are covered by the Kyoto Protocol commitment. Those emissions

wood fuels, as well as the upstream oil and gas and coal mining emissions.[19] Together these emissions amounted to 462.8 million tonnes of $CO_2$ equivalent emissions in 1995. That represents 82.8% of total national emissions.[20]

## HOW THE TRADING PROGRAM WOULD BE ADMINISTERED

An upstream carbon content trading program would be mandatory for sources required to hold allowances for the carbon content of fossil fuels, that is the producers and importers. Participation by exporters and petrochemical plants would be voluntary, but participation rates are likely to be high given the financial value of the allowances they would receive.

The rules governing the trading program would be promulgated by the appropriate federal and/or provincial agencies, such as the National Energy Board and the Alberta Energy and Utility Board. The process for developing the rules would probably be similar to that used for other environmental regulations. Stakeholders would have an opportunity to comment on the proposed rules before they are adopted.

The rules for the trading program would cover items such as the following:

- Allowance use and transfer - sources required to hold allowances, entities allowed to hold allowances, rules for distribution of allowances (*gratis* or auction), allowance life, banking, distribution of allowances to exporters and petrochemical plants, units of measurement;

- Registry, reporting and monitoring - monitoring requirements, reporting requirements, missing data protocols, notification requirements for transfers of allowances, price information, and public access to information in the registry;

- Audit and verification - authority of the regulatory agency to require information, order a third party audit, require annual reports, determine compliance, and administer prohibitions, restrictions and penalties.

The rules would be revised periodically based on experience with the program.

The registry could be developed and operated by the appropriate government, cooperatively by the federal and provincial governments, or by a qualified organization under contract to the federal and provincial governments.

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could be addressed separately or be covered by adjusting the carbon content of different fuels to incorporate the associated $CH_4$ and $N_2O$ emissions.

[19] Wood fuels are not covered by the Kyoto Protocol commitment.

[20] A. Jaques, F. Neitzert and P. Boileau, *Trends in Canada's Greenhouse Gas Emissions (1990-1995)*, Environment Canada, Ottawa, April 1997, Table A-4, p. A-6.

## HOW EMISSIONS WOULD BE MEASURED

The carbon content of fossil fuels produced, imported and exported would be calculated as from the quantity of the fuel and analyses of its composition or an emissions factor as follows:

- Natural gas production - metered production by well and the most recent analysis of the composition of the output of the well. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of payments by gas processing plants to support the metered production. An analysis of the composition by an independent laboratory should be mandatory at appropriate intervals. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Oil production - metered production by well and the most recent analysis of the composition of the output of the well. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of purchases by oil refineries to support the metered production. An analysis of the composition by an independent laboratory should be mandatory at appropriate intervals. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Coal production - production by mine and the analyses of the composition of the coal during the period. The regulatory authority should also have access to railway records, royalty payment calculations and supporting documents, and records of purchases by customers to support the production records. Company analyses of the composition of the coal should be mandatory at appropriate intervals. The regulator should also have access to analyses performed by purchasers and have the authority to order analyses of the composition by an independent laboratory.

- Oil sands production - production by site and the analyses of the composition of the oil sands produced during the period. The regulatory authority should also have access to pipeline records, royalty payment calculations and supporting documents, and records of purchases by customers to support the production records. Company analyses of the composition of the oil sands produced should be mandatory at appropriate intervals. The regulator should also have the authority to order analyses of the composition by an independent laboratory.

- Natural gas imports and exports - documented quantities imported or exported multiplied by an emissions factor. The regulatory authority should also have access to pipeline records and records of purchases and sales to support the quantities reported. An appropriate emissions factor would be established by the regulatory authority. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Crude oil and petroleum product imports and exports - documented quantities imported or exported multiplied by an emissions factor specific to the product. The regulatory authority should also have access to pipeline and shipping company records and records of purchases and sales to support the quantities reported. An appropriate emissions factor would be established by the regulatory authority for each product. The regulator should also have the authority to order an analysis of the composition by an independent laboratory.

- Coal imports and exports - documented quantities imported or exported and analyses of the composition of the coal imported or exported. The regulatory authority should also have access to railway and shipping company records and records of purchases and sales to support the quantity records. Purchaser and seller analyses of the composition of the coal would be used to determine the composition. The regulator should also have the authority to order analyses of the composition by an independent laboratory.

If petrochemical plants are awarded allowances for feedstock uses, the quantity would also be based on records of the relevant quantities and emissions factors established by the regulatory authority. The quantities could be purchases of petrochemical feedstocks or sales, perhaps differentiated for domestic and export markets, of specific products depending on the nature of the treatment accorded petrochemical plants. The regulatory authority would have access to other records to support the quantity data and have the authority to order analyses of the composition by an independent laboratory to supplement the emissions factors.

## POSSIBLE COMPLEMENTARY POLICIES

A trading program for the carbon content of fossil fuels raises the prices of fossil fuels downstream of the sources required to hold allowances. Energy related $CO_2$ emissions are actually reduced mainly by fossil fuel consumers who improve energy efficiency, reduce energy use, or switch to less carbon-intensive energy sources.

Complementary policies should help or encourage fossil fuel consumers to implement measures to implement such measures. A wide range of complementary policies are possible including:

- Information programs on energy efficiency, energy conservation and fuel switching;

- Measures to stimulate development and commercialization of more energy-efficient technologies;

- Changes to the tax code to ensure that different energy sources receive comparable treatment; and

- Taxes or royalties on carbon-intensive fuels to provide a stronger financial incentive to implement measures that reduce energy-related greenhouse gas emissions.

The method of distributing allowances may also give rise to complementary policies. If the allowances are auctioned, the revenue can be used to cushion the economic impacts on the groups most adversely affected, such as large energy consumers, coal mining companies, communities dependent on coal mines and energy-intensive industries, and individuals. *Gratis* distribution of allowances to fossil fuel producers and importers is likely to lead to windfall profits for such firms. Energy users, in contrast, bear higher energy prices and incur the costs of energy efficiency or fuel switching measures to reduce $CO_2$ emissions. Equity issues, such as these will need to be addressed through the distribution of allowances or other policies.

Complementary policies are discussed in more detail in a separate issue paper.[21]

## SPECIAL ISSUES RAISED BY THE DESIGN

The main issue raised by an upstream trading program for the carbon content of fossil fuels is the treatment of petrochemical feedstocks. This is the subject of a separate NRTEE issue paper.[22] To the extent that feedstocks are exempted or that production of specific products for the domestic or export markets is exempted, allowances can be awarded on the basis of their carbon content. This should effectively offset the price increases for the relevant feedstocks due to the trading system.

## TRANSITIONAL ISSUES RELATED TO A CHANGE IN THE POLICY SETTING

This option assumes that a national commitment to limit greenhouse gas emissions is in force. That commitment could become more stringent over time. Or the commitment could become less stringent, perhaps to the point that no restrictions on greenhouse gas emissions are needed.

If the commitment becomes more stringent, the cap on energy-related $CO_2$ emissions would need to be made correspondingly more stringent to meet the revised commitment. If the commitment becomes less stringent, the cap on energy-related $CO_2$ emissions could be relaxed. As compliance with the relaxed cap became easier, the volume of trading activity and prices of allowances could be expected to fall.

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[21] See NRTEE Issue Paper 11, *Evaluation of Possible Complementary Policies.*

[22] See NRTEE Issue Paper 5, *Options for Treatment of Fossil Fuels used as Feedstocks.*

## EVALUATION OF THE OPTION USING PROPOSED CRITERIA

The criteria proposed for use in the evaluation of the emissions trading options are summarized in Table2. These criteria are drawn from *Analysis of the Potential for a Greenhouse Gas Trading System for North America*, Commission for Environmental Cooperation, Montreal, May 1997, chapter 3, pp. 32-42, and are described fully there.

**Table 2: Criteria for Evaluating Proposed Greenhouse Gas Emissions Trading Systems**

Economic efficiency
- Cost-effectiveness
- Transactions costs
- Comprehensiveness

Equity
- International equity
- Domestic equity
- Industrial equity

Technical feasibility
- Technical flexibility
- Timing
- Leakage

Political feasibility
- Domestic political compatibility
- International compatibility
- Sovereignty

Administrative feasibility
- Measurability
- Verifiability
- Enforceability

***Cost-effectiveness***. Emissions trading should minimize the cost of reducing greenhouse gas emissions to individuals, firms and society. The trading program for the carbon content of fossil fuels increases the prices of fossil fuels downstream of the sources participating in the trading program. The price increases provide an incentive for energy users to increase energy efficiency, to reduce energy use, and to switch to less carbon-intensive energy sources. In principle, the price signals should encourage adoption of the most cost-effective options for reducing energy-related $CO_2$ emissions. However, some sources do not respond as well as others to changes in energy prices so the result will not be fully optimal.

***Transactions costs***. Transactions costs for emissions trading programs should be minimized. An upstream trading program for the carbon content of fossil fuels should have relatively low transactions costs. If the carbon content is measured at the wellhead the monitoring and reporting costs could be relatively high due to the large number of sources involved (over 100,000) although it appears that much of the information needed is already collected. If the carbon content is measured at the oil refinery and gas processing plant, the monitoring and reporting costs are lower. But additional costs would be incurred to manage the emissions between the wellhead and the refineries and processing plants. Additional audits might be needed to assure compliance with the trading program. The allowances are homogeneous, government-issued certificates so the transactions costs for trading are likely to be relatively low.

***Comprehensiveness***. An emissions trading program should cover as broad a range of greenhouse gas sources and sinks as possible. The upstream carbon content trading program should provide comprehensive coverage of energy-related $CO_2$ emissions. Sources participating in the trading program are likely to represent virtually 100% of energy-related $CO_2$ emissions and over 82% of total greenhouse gas emissions.

***International equity***. An emissions trading program should be fair to developing countries. International equity would be addressed through the agreements that establish the national commitments. The domestic emissions trading program does not affect international equity.

***Domestic equity***. An emissions trading program should be equitable in terms of its impacts on different income groups and regions. Equity is determined by the allocation of allowances in the case of *gratis* distribution or the use of the revenue in the case of an auction of allowances.[23] *Gratis* distribution of allowances to fossil fuel producers and importers is likely to lead to windfall profits for such firms. Energy users, in contrast, bear higher energy prices and incur the costs of energy efficiency or fuel switching measures to reduce $CO_2$ emissions. Distribution of allowances to energy users or to individuals might be more equitable in the case of a *gratis* distribution. But the administrative complexity of such distributions suggests an auction with a redistribution of some of the revenue to address equity issues.

***Industrial equity***. An emissions trading program should treat different industries and sectors fairly (not necessarily equally). Equity is determined by the allocation of allowances in the case of *gratis* distribution or the use of the revenue in the case of an auction of allowances. The rules for *gratis* distribution of allowances or distribution of

[23] If allowances are grandfathered -- distributed on the basis of historic production and imports -- participants prepared to lose market share domestically can reap windfall profits. Importers reduce their imports and sell their surplus allowances. Producers export more of their production and sell their surplus allowances. The remaining demand would be supplied by additional imports supplied by new firms. As new firms, they would not be allocated allowances under the grandfather rule. Instead they would need to purchase the allowances from the producers (importers) that receive allowances because they operated during the base year and increase their exports (reduce their imports).

auction revenue should ensure that participants in the trading program are treated fairly. Downstream of the trading program energy users are affected by higher energy prices. Industries and sectors that are expected to suffer significant disruption due to higher energy prices, such as petrochemical producers, can be addressed through credit allocations or distribution of auction revenue.

***Technical flexibility***. An emissions trading program should allow maximum flexibility in terms of the choice of reduction or sequestration technology to implement. An upstream carbon content trading program allows energy users complete flexibility in the choice of measures to reduce $CO_2$ emissions. Energy users select the energy efficiency, energy conservation or fuel switching measures that are best suited to their circumstances. However, some energy users are not very sensitive to energy prices and so may not adopt the ideal emission reduction measures.

***Timing***. An emissions trading program should allow maximum flexibility in the timing of reduction or sequestration actions. If banking is allowed, as is proposed in the NRTEE paper on Issue 8, an upstream carbon content trading program would provide sources with flexibility in the timing of actions to meet the cap established for participants.

***Leakage***. An emissions trading program should minimize increases in emissions elsewhere. An upstream carbon content trading program covers virtually 100% of energy-related $CO_2$ emissions in Canada and so eliminates leakage except for activities shifted out of the country. Some leakage due to shifting activities out of the country is inevitable given national commitments in some countries and no limits on greenhouse gas emissions in other countries. Domestic and international emissions trading help to reduce the extent of such leakage by minimizing the cost of meeting the national commitment.

***Domestic political compatibility***. An emissions trading program should minimize potential conflicts with existing and future domestic policies. An upstream carbon content trading program would probably need to be implemented cooperatively by the federal and provincial governments. Coordinating administration of a single trading program and enforcement of compliance by participants across federal and provincial jurisdictions could be difficult.

***International compatibility***. An emissions trading program should minimize potential conflicts with existing and future international regimes. Many countries would have national commitments, such as those of the Kyoto Protocol, to limit their greenhouse gas emissions. It is presumed that each country would have considerable latitude to adopt its preferred policies domestically, and that an upstream carbon content trading program would be an acceptable domestic policy. It is believed that requiring fossil fuel importers to hold allowances for the carbon content of their products would not create any difficulties under World Trade Organization rules as long as the requirements were the same as those applicable to domestic producers as proposed.

***Sovereignty***. An emissions trading program should minimize the need for international oversight and interference. An upstream carbon content trading program should entail no

international oversight other than that required to ensure compliance with the national emissions limitation commitment.

***Measurability***. An emissions trading program should minimize the unceratinty and complexity of measuring emissions reduced or sequestered. An upstream carbon content trading program would rely on quantities of fuels produced, imported and exported and on analyses of fuels produced and emissions coefficients for products imported or exported. The quantities are already measured and, in most cases, reported already. And analyses of fuel composition are already performed by producers or purchasers.

The feasibility of measuring the carbon content at the wellhead, the preferred location, is not yet clear. The administrative burden of testing the composition of the output of more than 100,000 oil and natural gas wells and of calculating the carbon content of the output of each well may be too great. But it is definitely feasible to measure the carbon content of the fossil fuels at the oil refineries and gas processing plants. At that point accurate emissions coefficients for natural gas and petroleum products can be developed with little difficulty. Thus, carbon content can be measured relatively accurately with little additional effort.

***Verifiability***. An emissions trading program should increase confidence on the part of participants and other stakeholders that the emissions reductions claimed have been achieved. Reports of the carbon content of fossil fuels produced, imported or exported will depend on the accuracy of the quantities and the accuracy of the analyses of the fuel composition. Independent data are generally available for the quantities produced, imported or exported from transportation companies or purchasers. Independent analyses of the composition are sometimes available as well. If the regulator has access to such independent records and has the authority to order independent analyses of fuel composition, it should be able to verify the carbon content with a high degree of confidence.

***Enforceability***. An emissions trading program should maximize compliance with emission limitation commitments. An upstream carbon content trading program should not pose significant enforcement difficulties. The number of participants is likely to be manageable -- 350 to 700. Many of the participants are already audited for royalty or other purposes. Thus, effective enforcement should be possible with relatively little additional effort.