Sustainable Prosperity

EMERGING ISSUES

Options for Managing Industrial Air Pollution in Canada: The Use of Market-Based Instruments[1]

Sustainable Prosperity is a national research and policy network, based at the University of Ottawa. SP focuses on market-based approaches to build a stronger, greener, more competitive economy. It brings together business, policy and academic leaders to help innovative ideas inform policy development.

Key Messages

- Improving air quality continues to be a challenge in Canada, especially in urban and industrial areas. Industrial emitters are responsible for a large proportion of emissions of smog and acid-rain-causing pollutants.
- The current approach to reducing the emissions of air pollutants at the provincial/territorial level in Canada largely consists of command and control regulations, with some exceptions; this suggests that there is scope for the greater adoption of economic instruments for air quality management.
- Command and control mechanisms may be necessary for some pollutants, such as volatile organic compounds (VOCs) and particulate matter (PM), due to human health considerations. However, sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) emissions can be cost-effectively managed through emissions trading systems. Another option not yet explored in Canada, though in place in several countries in Europe, is emissions charges.
- Various approaches to air quality management can achieve the desired air quality outcomes with the right design elements in place, though market-based approaches may do so at a lower cost.

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The Issue

Air quality in Canada remains a threat to human health and the environment, which suggests that there may be room for examining and improving current air quality management approaches. Given the relatively low level of policy experience in Canada with market-based instruments, this Brief will look at the potential this policy approach has to address air pollution.

The Knowledge Base

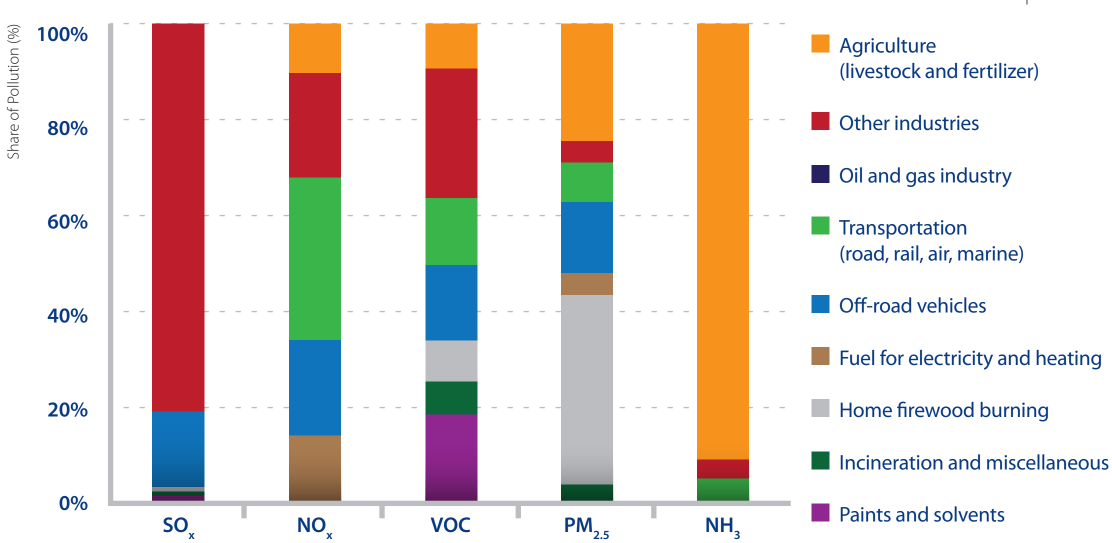
Air Quality Trends in Canada

The main air pollutants of concern to human health and the environment are sulphur dioxide (SO_2)[2], oxides of nitrogen (NO_x), particulate matter (PM) and Volatile Organic Compounds (VOCs).[3] NO_x and SO_2 are associated with acid rain, while PM and VOCs are associated with smog. All of these pollutants contribute to poor air quality.

The main air pollutants of concern to human health and the environment are sulphur dioxide (SO_2), oxides of nitrogen (NO_x), particulate matter (PM) and Volatile Organic Compounds (VOCs).

Industrial emitters, along with transportation, are responsible for a significant portion of Canada's air pollution, as shown in figure 1.

Figure 1: Sources of Air Pollution in Canada (2008)

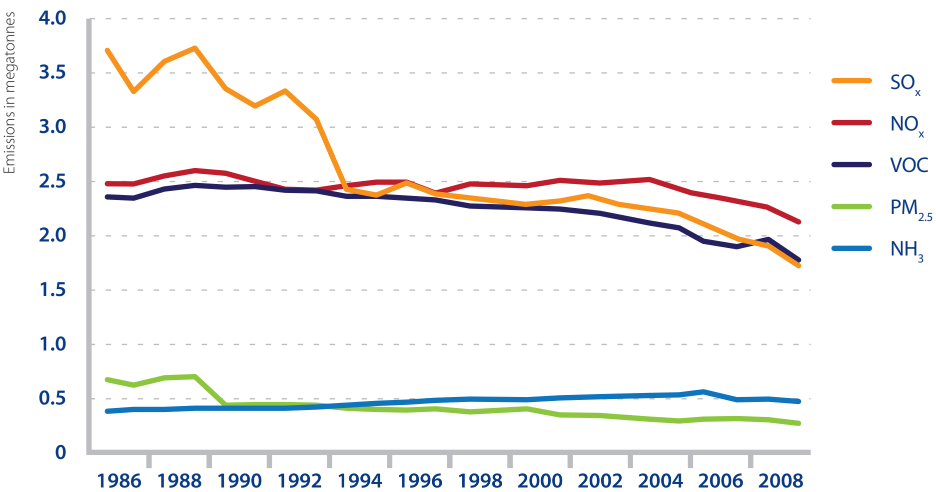


Source: Environment Canada[4]

2 SO_2 is the main chemical compound, together with SO_3, that creates sulphur oxides (SO_x).
3 CO_2, the major contributor to climate change, is also a concern, though it is not addressed in this policy brief.
4 Available at http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=ADF1A74C-1

Key ambient air pollutants are particulate matter and ozone. Particulate matter arises both from the direct emissions of PM and from the reaction of other pollutants, most notably sulphur dioxide (SO_2) and oxides of nitrogen (NO_x), in the atmosphere. Ground level ozone arises from the reaction between volatile organic compounds (VOCs) and NO_x in sunlight.[5] On the national level, most major air pollutants (NO_x, SO_2, VOCs and PM) have decreased since 1985, as shown in figure 2, though air quality is worsening in certain regions, as described below.

Figure 2: Main air pollutants emissions trends for Canada (1985-2008)



Source: Air Pollutant Emissions Summaries and Trends, National Pollutant Release Inventory, Environment Canada[6]

Environment Canada has carried out analysis on the causes of the declines in various air pollutants and found that reductions in these pollutants have been driven by various policies and actions. For example, the significant decline in SO_x emissions is attributed to Canada/U.S. agreements to cap sulphur dioxide (SO_2) emissions.[7] Despite these declines, ambient air quality remains a significant concern in Canada.

When weighted by population, levels of ground level ozone in certain regions in Canada have risen between 11 and 16 per cent (depending on the region) in the past 18 years.[8] At the local level, air pollution also remains a challenge. For example, PM and ozone levels in many cities are consistently above the Canada-Wide Standards (CWS). (The CWS are explained in more detail below on page 5). In the period from 2003 to 2005, at least 30 per cent of Canadians lived in communities with $PM_{2.5}$ levels above the CWS; for ozone, the figure is 40 per cent.[9] Key contributors to ambient concentrations include both local emissions sources, as well as transboundary pollution from the United States.

5 Environment Canada. July 18, 2006. "Smog." Available at http://www.ec.gc.ca/cleanair-airpur/Smog-WS13D0EDAA-1_En.htm

6 Environment Canada. 2010. "National Air Pollutant Emissions." Available at: http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=E79F4C12-1.

7 Environment Canada. 2010. "National Air Pollutant Emissions." Available at: http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=E79F4C12-1.

8 Environment Canada. 2011. "Regional Air Quality." Available at: http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=89B1C598-1.

9 Canadian Council of Ministers of the Environment. November 2006. "Canada-wide Standards for Particulate Matter and Ozone: Five Year Report: 2000-2005." Page 20. Available at: http://www.ccme.ca/assets/pdf/cams_proposed_framework_e.pdf.

Effects of Air Pollution on Human Health and the Environment

The Canadian Medical Association has found that the value of human health damages from air pollution exceeds $8 billion each year.[10] Chronic exposure to PM can contribute to an increased chance of respiratory disease and lung cancer. In addition, PM is a "non-threshold" substance, that is, there is no level of exposure that is not associated with some health impacts. Ozone, above certain concentrations, can also present significant health impacts: it can cause breathing problems, trigger asthma and contribute to lung disease.[11]

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On the environmental side, PM increases the acidity of lakes and streams, impacts nutrient levels in soils, and damages forests and crops.[12] Ozone can impact the ability of sensitive plants to produce and store food, and can reduce forest growth and crop yields, both of which can, in turn, reduce ecosystem diversity.[13]

Canada: Ambient Air Quality Standards

Both the federal and provincial/territorial governments play a role in air quality management in Canada. Historically, the federal government, in partnership with provincial and territorial governments, has set ambient air quality objectives through the introduction of National Ambient Air Quality Objectives (NAAQOs) and Canada-Wide Standards (CWS). Provincial and territorial governments then apply these objectives using a wide variety of environmental management tools. Provincial governments also often set their own ambient air quality standards, though many of these follow the federal standards. A recent proposal by the Canadian Council of Ministers of the Environment will further the cooperative relationship between federal and provincial governments in setting ambient air quality standards with the added involvement of stakeholders, and again the responsibility to apply these standards will sit primarily in the hands of provincial governments.

National Ambient Air Quality Objectives

The Government of Canada, in partnership with the provinces, developed the National Ambient Air Quality Objectives (NAAQOs). The NAAQOs prescribe goals for air quality based on the risk to key biological receptors (humans, plants, animals, and materials).

10 Canadian Medical Association. 2008. "No Breathing Room: National Illness Costs of Air Pollution." Available at: http://www.cma.ca/icap.

11 World Health Organization. August 2008. "World Health Organization fact sheet No. 313 – Air Quality and Health." Available at: http://www.who.int/mediacentre/factsheets/fs313/en/index.html.

12 United States Environmental Protection Agency. May 9, 2008. "Health and Environment – Particular Matter." Available at http://www.epa.gov/air/particlepollution/health.html.

13 United States Environmental Protection Agency. May 9, 2008. "Health and Environment – Ozone." Available at http://www.epa.gov/air/ozonepollution/health.html

While the NAAQOs are intended to be primarily effects-based, they also reflect the incorporation of technological, economic and societal information.[14]

Although the NAAQOs are federally set objectives, provincial governments can adopt and implement them as they see fit. The primary distinction between the NAAQOs and the Canada-Wide Standards is that the NAAQOs apply to a broader range of substances and use different metrics for assessment. Specifically, NAAQOs exist for NO_2, SO_2, total suspended particulate, Ozone and Carbon Monoxide, and set hourly, 8-hour, daily and/or annual thresholds depending on the pollutant.[15]

Canada-Wide Standards

Additionally, the Canadian Council of Ministers of the Environment (CCME) – a council that includes the Ministers of the Environment from all provinces, territories, and the federal government – has developed national air pollution standards. The current national standards, called the Canada-Wide Standards (CWS) for Particulate Matter and Ozone, "represent a balance between the desire to achieve the best health and environmental protection possible in the relative near-term and the feasibility and costs of reducing the pollutant emissions that contribute to elevated levels of PM and ozone in ambient air."[16] These standards outline guidelines for governments to achieve a level of 65ppb for ozone[17] and $30 \mu g/m^3$ for $PM_{2.5}$[18] by 2010.[19] As the federal ambient air quality standards are in fact guidelines, the onus is on each of the provinces to choose which management tools they use to ensure the standards are met.

The Comprehensive Air Management System

The CCME has recently agreed to implement a new air quality management system, with air quality standards and consistent industrial emissions standards across the country.[20] The proposal is based on three main pillars – the development of Canadian Ambient Air Quality Standards (CAAQS), Air Management Zones and Base-Level Industrial Standards (BLIERS). The CAAQS will set ambient air quality standards starting with PM and ozone, then move on to address other key pollutants. The standards will be set through a time-limited process led by

14 Health Canada. 2006. "National Ambient Air Quality Objectives." Available at: http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg-eng.php#a3

15 Ibid.

16 Canadian Council of the Ministers of the Environment. 2000. "Canada Wide Standards for Particulate Matter and Ozone." Available at http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf.

17 8-hour averaging time, achievement to be based on the 4th highest measurement annually, averaged over 3 consecutive years.

18 24 hour averaging time, achievement to be based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years.

19 Canadian Council of the Ministers of the Environment. 2000. "Canada Wide Standards for Particulate Matter and Ozone." Available at http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf.

20 Comprehensive Air Management System (CAMS) Steering Committee. October 20, 2010. "Comprehensive Air Management System: A Proposed Framework to Improve Air Quality Management." Available at: http://www.ccme.ca/assets/pdf/cams_proposed_framework_e.pdf

the federal government, which will involve all major stakeholders including provinces and territories. The standards are intended to be more stringent than the current CWS, and reporting against the standards will begin in 2015. Air Management Zones will establish place-based emissions management, which will be led by provinces and territories with the intention of ensuring ambient air quality standards are achieved. The BLIERs are industrial standards that will provide a base level of emissions performance for industries across the country. However, they are not intended as a primary tool to ensure air quality standards are met, and management within air management zones may require further reductions from industry to ensure air quality standards can be achieved.

While both the federal and provincial governments have the legal and constitutional authority to manage air emissions at the source level, the provinces have traditionally taken on that responsibility.

Emissions Management Tools

Air emissions originate from point and non-point sources. Point sources include large industrial facilities, which can be directly targeted for emissions reductions. Non-point sources include vehicle emissions and emissions from heating residential and commercial buildings. Non-point source emissions are traditionally more difficult to manage, and require the imposition of energy efficiency, fuel economy, and other standards. Finally, due to the United States' contribution to Canada's air pollution, managing air quality in certain regions in Canada may involve negotiations at the international level.

Federal, provincial and territorial governments can use a range of management tools to control emissions of precursors to PM and ozone, mainly emissions of NO_x, SO_2, PM and VOCs. While both the federal and provincial governments have the legal and constitutional authority to manage air emissions at the source level, the provinces have traditionally taken on that responsibility. In 2007, the federal government introduced the *Turning the Corner*[21] plan, a federal regulatory proposal to manage smog related air emissions, and climate change, through a national cap-and-trade emissions system. Though not implemented, it did represent a significant shift in thinking about Canadian environmental governance with regards to air pollution.

Traditionally, governments seeking to prevent and manage air pollution relied almost entirely on coercive policy instruments, namely command and control regulations. However, other options, such as emissions trading and emissions charges, may be less costly and more effective, as explored below. The following examples focus on emissions management systems that can be used to address emissions from large point sources, recognizing that additional policies need to be pursued to manage non-point sources and transboundary contributions to air quality.

21 In media releases, the plan, while officially called the Clean Air Regulatory Framework, is referred to as the Turning the Corner Plan. See News Release: Canada's New Government Announces Mandatory Industrial Targets to Tackle Climate Change and Reduce Air Pollution, April 26, 2007 at http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=4F2292E9-3EFF-48D3-A7E4-CEFA05D70C21

Emissions Standards

The most common approach to managing industrial air emissions in Canada is through the use of emission standards, often known as command and control regulations. Emission standards can prescribe a specific limit on the amount of a particular pollutant that can be released into the natural environment. Emission standards can also require regulated parties to install a particular control technology.

The most common approach to managing industrial air emissions in Canada is through the use of emission standards, often known as command and control regulations.

There are two main ways a government can impose emission standards:

- **Performance-based standards,** which define a specific emission performance objective, but enable the regulated party to determine the technologies and approaches it will take to achieve compliance;
- **Technology specifications,** which prescribe a specific emission control technology or equipment to be used to control emissions by a regulated party.

Command and control regulations offer both strengths and weaknesses for managing industrial air emissions. These are summarized in Table 1.

Table 1: The strengths and weaknesses of command and control regulations to manage industrial air emissions in Canada

Strengths	Weaknesses
• Emission standards have long been used by provincial governments in Canada to manage air emissions, therefore offering familiarity. • They can be effective in ensuring an environmental outcome is achieved. • They ensure that reductions are achieved at the facility level, which can be critical for pollutants that affect human health directly in the vicinity of industrial facilities. • Emission standards can provide regulatory clarity and certainty. • Performance-based standards can be applied consistently across individual facilities and sectors. • When paired with emission monitoring technologies, governments can efficiently and effectively monitor compliance with performance-based standards.	• Emission standards are often considered to be economically inefficient, as they often cost more for the government to implement, and for companies to address. • They typically limit continuous improvement as they do not provide an incentive to go above and beyond regulatory compliance. • They are sometimes considered to be rigid and slow to adapt to changing contexts (technologies, ambient air quality, etc.). • They can be administratively onerous to impose on a large number of facilities. • Technology-based standards provide no flexibility to regulated parties on how to comply.

Source: Sustainable Prosperity

One example of the implementation of a command and control system is the air management system in Alberta. In this case the province regulates air emissions from industrial sources by setting standards based on:

- The baseline (existing) ambient air quality;
- Ambient air quality guidelines or prescribed ambient levels;
- Source emission standards based on the nature of the air contaminant, the process industry and best available demonstrated or best available air pollution technology; and,
- The results of air dispersion modelling which takes into account the local meteorology and terrain, and surrounding emission sources.[22]

The federal Comprehensive Air Management System includes source-based performance requirements that include, to some extent, elements of a command and control system. In this case the federal government will set quantifiable requirements at the facility or equipment level that regulated entities must meet, to go into force by 2015. The BLIERS are expected to be enforced primarily by the provinces using whatever tools they feel are appropriate, with the federal government providing regulatory assurance to ensure the standards are met. The proposal allows for some flexibility in the achievement of the BLIERS. However, the use of economic instruments, such as emissions trading, to meet the BLIERs is limited to use within air zones or within areas where air quality is affected by the facilities, and provided there is a clear timeline for when BLIERs will be physically implemented. Economic instruments may be more widely applied in the management of emissions in established air zones where reductions in emissions that go above and beyond the BLIERS may be required.[23]

Emissions Trading

An emissions trading program is an economic instrument that governments can use to manage industrial air emissions by pricing air pollution. The application of an emissions trading program requires a regulatory agency to set a collective emission target, or individual facility emissions intensity targets for regulated entities.

There are two primary types of emissions trading systems: "cap-and-trade" and "baseline-and-credit" systems.

22 Air Emissions Branch, Air and Water Approvals Division, Environmental Services, Alberta Environmental Protection and Air Issues and Monitoring Branch, Chemicals Assessment and Management Division, Environmental Services, Alberta Environmental Protection. 1998. "Air Toxics Management Program in Alberta." Available at: http://environment.gov.ab.ca/info/library/6654.pdf.

23 Comprehensive Air Management System (CAMS) Steering Committee. October 20, 2010. "Comprehensive Air Management System: A Proposed Framework to Improve Air Quality Management." Available at: http://www.ccme.ca/assets/pdf/cams_proposed_framework_e.pdf

Cap-and-Trade System

In a cap-and-trade system, the total volume of emissions from all regulated parties is established by the government; this represents the "cap." The government then makes available a total number of permits equal to this cap. These permits are either allocated to facilities for free (called "grandfathering") and/or auctioned off to emitters. At the end of each compliance period, usually a year, each facility must remit to the government one permit for each unit of emissions emitted by that facility in that year.

In a cap-and-trade system where emissions permits are allocated for free, facilities with low abatement costs may reduce their emissions below their allocated permit levels. They can then sell any excess permits to those emitters that face high emissions abatement costs or, if the system allows it, bank these permits for use in future years. Where emissions are auctioned, those emitters will pursue onsite reductions available at costs lower than the auction price, and will purchase from the auction the remaining permits necessary to cover their emissions.

Baseline-and-Credit System

In a baseline-and-credit system, each regulated party is assigned a baseline, which represents its allowable emissions intensity. If the facility's emissions intensity is below its baseline, it generates credits. These credits can then be sold to other emitters or, if allowable, banked for future use. If the regulated party's emissions are above its baseline, it must then purchase the required number of credits (the difference between the baseline and actual emissions) to ensure compliance.

Both types of systems can allow emissions credits to be created by facilities outside of the covered emitters, called offsets. For example, emissions-reduction credits can be created by renewable energy systems or improvements that increase energy efficiency at residential or commercial buildings. There are both strengths and weakness associated with using an emissions trading system to manage industrial air emissions. These are summarized in Table 2.

Table 2: The strengths and weaknesses of emissions trading to manage industrial air emissions in Canada

Strengths	Weaknesses
• Emissions trading programs can offer significant compliance cost saving opportunities for regulated parties, relative to a command and control regulation. • They can provide an incentive for regulated parties to go beyond compliance. • They can be designed to attain an emissions objective with certainty. • The system can provide regulatory clarity and certainty. • Targets can be applied consistently across individual facilities and sectors. • When paired with emissions monitoring technologies, governments can efficiently and effectively monitor compliance with the system.	• Emissions trading programs can result in the creation of "hot spots," where emitters in an area purchase emissions permits or credits rather than reducing their emissions, leading to deteriorating air quality in that area. For pollutants that affect regional air quality, this can be avoided by restricting trading to within a particular airshed. However, for pollutants that damage the local environment emissions trading may be inappropriate. • The approach to the allocation (auction/grandfathering) affects whether emitters must pay the full price of their emissions or whether they simply pay the price of reducing emissions similar to a command and control system. • The emissions target must be set to achieve the desired level of air quality in order to be effective. • Setting the emissions target can be challenging for regulatory agencies, especially if they lack data and information regarding the emissions reduction potential of the various facilities and their associated abatement costs. • If the emissions target is not set appropriately the system can induce volatile emissions prices. • If the target is set too high, the price may not be high enough to incent the desired level of emissions reductions. • If the target is set too low the emissions price may be very high, and potentially, in a cap-and-trade system, incent the reduction of output to meet emissions targets with resulting economic consequences. • Emissions trading systems can be complex to design and implement. • The characteristics of the emissions trading markets, for example the question of whether offsets are allowed, can dramatically influence the price of credits and therefore influence a system's efficiency and effectiveness.

Source: Sustainable Prosperity

There are two notable air pollution emissions trading systems that have been developed in Canada. In 2006, Alberta implemented a baseline-and-credit system to manage NO_x and SO_2 emissions from thermal generation power plants. The system complements the province's regulatory improvement requirements outlined in each facilities approval by providing flexibility in the time period before physical requirements must be met. The system was not put in place to address any particular air quality problem, but rather to enable regulated facilities to meet future regulatory requirements in the most cost-effective manner possible.[24] The majority of the reductions from this trading program and regulated emission performance requirement are expected after 2020. Therefore, it is difficult to assess the costs/benefits and effectiveness of the program at this time.

24 Clean Air Strategic Alliance Electricity Project Team, Clean air Strategic Alliance. 2003. "An Emissions Management Framework for the Alberta Electricity Sector – Report to Stakeholders."

In 2001, the Government of Ontario established a cap-and-trade system for nitrogen oxides (NO_x) and sulphur dioxide (SO_2). The system currently requires electricity, iron and steel, cement, petroleum refining, pulp and paper, glass and carbon black industries to lower their emissions in stages. The system caps total emissions from these industries and allocates allowances to all major emitters, which can be traded. In addition, emissions reduction credits can be created by "non-capped" entities and sold to those entities in need of emissions reductions credits or permits to meet their obligations.[25] Ontario decreased its NO_x emissions by 32 per cent between 1999 and 2008, and its SO_2 emissions by 54 per cent between 2000 and 2009.[26] Some, though not all, of these reductions are attributable to the existence of the trading program; other initiatives, such as the phase out of coal-fired power plants and reductions from vehicular emissions resulting from the phase in of new vehicles with lower emissions, have also contributed to the reductions.

Emissions Charges

An emissions charge is a payment or fee that is based on the quantity of pollutants that are released into the environment. Based on the value of the emissions charge, regulated parties self-determine if it is more cost effective to pay the emissions charge, install abatement control technologies, or decrease their output to reduce their emissions and thus avoid the charge.

Emissions charge programs impose a direct cost upon regulated parties to internalize the social costs of their air pollution, in an effort to incent emission reductions. Therefore, emissions charge systems require government agencies to appropriately set the value of the emissions charge to ensure that the regulated parties optimize their emissions performance to a level that assures air quality outcomes are met. It is important to note that the price of the charge can be designed to escalate if facilities in a region exceed a pre-defined emissions threshold.

There are both strengths and weaknesses associated with the use of emission charges to manage industrial air emissions. These are summarized in Table 3.

An emissions charge is a payment or fee that is based on the quantity of pollutants that are released into the environment.

25 Ontario Ministry of the Environment. May 11th, 2005. "Emissions Trading Fact Sheet." Available at: http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079108.pdf

26 Ontario Ministry of the Environment. 2009. "Air Quality in Ontario: 2009 Report." Available at: http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_081228.pdf

Table 3: The strengths and weaknesses of emission charges to manage industrial air emissions in Canada

Strengths	Weaknesses
• Emissions charge systems can provide an effective means to internalize the social costs of air pollution. • Emissions charge systems can be relatively simple to design and implement. • Emissions charges support the "Polluter Pays Principle." • Emissions charges provide a continuous incentive to encourage regulated parties to reduce emissions. • Emissions charge systems provide compliance flexibility to regulated parties. • If the charge is set appropriately, emissions charge systems can offer an economically efficient means to reduce air pollutant emissions. • The system can provide clarity and certainty about the price of compliance for emitters. • The system allows a consistent price to be applied across individual facilities and sectors. • When paired with emissions monitoring technologies, governments can efficiently and effectively monitor compliance with the system. • Emissions charge systems can generate revenues for governments. These revenues can support further reductions in air pollution, or be used to alleviate the cost burden of the system on emitters.	• Emissions charges do not ensure that a specific emissions level will be met. • Setting the price of the charge can be challenging for regulatory agencies, especially if they lack data and information of the abatement costs of regulated parties. • If an emissions charge is set too low, it will undermine the environmental effectiveness of the system. In other words, the charge is insufficient to influence the performance of the regulated party. • If the charge is too high, it could lead to significant output changes and result in negative economic impacts. • Emissions charge systems can be perceived as a government "tax grab."

Source: Sustainable Prosperity

The International Knowledge Base

The following outlines a selection of command and control, emissions trading and emissions charge systems that have been implemented at the international level.

United States

Command and control

A good example of a command and control approach to managing air pollution is the "New Source Review" (NSR) program in the United States. Under this program, companies that are planning to build a new plant or make significant modifications to an existing plant are required to get an NSR permit. Sources may be required to meet different standards depending on the air quality in the area where the source is located.

There are three types of standards applied in the U.S.:

- **Best Available Control Technology (BACT)** is required on major new or modified sources in clean areas (i.e., attainment areas).
- **Reasonably Available Control Technology (RACT)** is required on existing sources in areas that are not meeting national ambient air quality standards.
- **Lowest Achievable Emission Rate (LAER)** is required on major new or modified sources in non-attainment areas.[27]

These standards are determined on a case-by-case basis, and are generally applied by state or local permitting agencies. The U.S. Environmental Protection Agency (EPA) maintains a database of appropriate emissions control technologies and provides guidance on how facility-level assessments of BACT, RACT and LAER standards should be applied.

Cap-and-trade system

In 1974, the U.S. Environmental Protection Agency (EPA) began implementing emissions trading programs to improve local air quality and control the levels of CO, SO_2, particulates and NO_x.[28] The first emissions trades occurred in the 1970s under a program commonly known as the "bubble policy". Under this policy, firms were able to control the mix of emissions within the bubble (a number of sources or smokestacks) as long as the overall reduction requirements were satisfied.

In 1990, the *Clean Air Act Amendments* offered an opportunity to innovate and evolve existing trading programs and regulations. The most popular innovation has been the SO_2 trading program, or "Acid Rain Program," which was applied to United States' largest electrical power producers. The SO_2 trading program allocates a fixed number of permits to industry, and companies are required to surrender one permit for each ton of SO_2 emitted by their plants. A main element of the Acid Rain Program is the annual cap on average aggregate emissions. In this cap-and-trade system, the emissions are fixed and the permit prices fluctuate. Companies are also able to transfer allowances among facilities or to other firms and to bank their allowance permits for use in future years. Since emission banking is permitted under the Acid Rain Program, aggregate industrial emissions must be equal to or less than the number of permits allocated for the year plus any surplus accrued from previous years.

The EPA set the cap for the SO_2 trading Program at 8.95 million tons of SO_2 per year. Reductions to achieve the 8.95 million ton cap took place in two phases. Phase I began in 1995 and affected the 110 most emission-intensive coal-fired electricity generating

27 U.S. Environmental Protection Agency. 2007. "Technology Transfer Network Clean Air Technology Center – RACT/BACT/LAER Clearinghouse – Basic Information." Available at http://www.epa.gov/ttncatc1/rblc/htm/welcome.html.

28 Hahn, Robert and Gordon Hester. 1989. "Where Did All the Markets Go – An Analysis of EPA's Emissions Trading Program." Yale Journal on Regulation.

facilities. Phase II, which started in 2000, covered coal-fired electricity generating facilities with a generating capacity greater than 25 MW.

The Acid Rain Program is generally considered to be highly successful relative to traditional command and control regulations. By 2000, total SO_2 emissions were almost 40 per cent below 1980 levels.[29] Studies found that the program may have resulted in cost savings of 43 to 55 per cent versus a traditional command and control approach.[30]

The U.S. also has a number of emissions trading systems to address regional air quality problems. For example, in 1994, the Regional Clean Air Incentives Market (RECLAIM) system was put in place to manage NO_x and SO_x emissions from a number of large industrial emission sources in the Los Angeles area. The system is divided into two zones and trading is restricted between zones to ensure trades don't contribute to increased downwind pollution.[31]

Studies found that the program may have resulted in cost savings of 43 to 55 per cent versus a traditional command and control approach.

Sweden and France

Emissions charges

In 1992, Sweden imposed a NO_x charge on energy producers, pulp and paper mills, food, manufacturing and incineration facilities that have an electrical generating capacity greater than 10 megawatts and produce over 50 gigawatt hours of power. When the program was implemented the charge was valued at approximately CAD $6,000/t NO_x and was applied to approximately 120 facilities.[32] This price is very high when compared to, for example, NO_x permits prices in the U.S. programs which are usually in the hundreds of dollars, although they can be higher.[33]

The Swedish NO_x charge was unique because it combined the charge with a refund system. Under this system all funds collected by the charge, with the exception of a small administrative charge, were refunded to those that paid the charge on the basis of energy input. In this way, those emitters with above average emissions intensities would see a net cost, but those with below average emissions intensity could actually benefit from the charge. As a result, the high level of the charge could be imposed without negatively impacting the emitters from a trade perspective. This feature of the system encourages targeted facilities to reduce their emissions per unit of energy significantly. The system has proven successful, resulting in mean emissions rates decreasing by 40 per cent between 1992 and 2000.[34]

29 Burtraw, Dallas and Sarah Jo Szambelan. 2009. "U.S. Emissions Trading Markets for SO_2 and NO_x." Resources for the Future. Available at: http://www.rff.org/documents/RFF-DP-09-40.pdf.

30 Ibid.

31 U.S. Environmental Protection Agency. 2006. "An Overview of the Regional Clean Air Incentives Market (RECLAIM)." Available at: http://www.epa.gov/airmarkets/resource/docs/reclaimoverview.pdf.

32 The charge has remained constant in nominal terms since its introduction.

33 Sterner, Thomas and Lena Hoglund Isaksson. 2006. "Refunded emission payments theory, distribution of costs, and Swedish experience of NO_x abatement." Ecological Economics 57, pages 100-102.

34 Ibid.

France introduced an SO_2 emissions charge in 1985 and a NO_x charge in 1990. French law requires all large combustion facilities to remit the charge. Approximately 75 per cent of the funds collected is rebated to those that paid the charge based on abatement activities pursued by the firms, while the remaining 25 per cent is invested in surveillance activities. Subsidies were granted as a percentage of the capital cost of emission reductions according to the innovative character of the investment:

- 15 per cent for standard technologies;
- 25 per cent for innovative technologies; and,
- 35 per cent for very innovative technologies.[35]

Policy Options

Based on the review of each management option presented, one may conclude that there is an opportunity to enhance the effectiveness, fairness and efficiency of the current model. Command and control systems can be effective, but they are administratively onerous and may not be the most cost-effective mechanism to achieve emissions reduction goals. Due to the scope of future reductions that will be necessary to bring national ambient concentrations below the CWS and to continue to improve air quality, in particular for non-threshold substances such as PM, it may be important to seek the most cost-effective mechanisms to ensure these reductions occur.

Emissions pricing systems, such as a cap-and-trade system or in particular emissions charges, potentially offer a more economically efficient mechanism for achieving emissions reductions.

Emissions trading can in theory provide a more cost-effective means to achieve a given emissions reduction goal. However, given the variability in levels of air quality across the country, it is important that any emissions trading systems in place in Canada be designed to address the air quality in specific regions. In order for an emissions trading system to be effective, there needs to be a sufficient number of emitters in the system to create a marketplace for emissions. That is, given that emissions trading systems are designed such that an emissions price arises through a competitive market for emissions permits, a market will only arise if there are sufficient different players such that no one buyer or seller can exert significant influence on the price of permits. Compared to the United States, Canada is not a large country, and many areas where air quality is of concern may not have enough large emitters to make a regional air quality market feasible. As a result, while effective in theory, emissions trading systems may not provide the appropriate economic instrument to manage regional air quality in all parts of Canada.

35 Millock, Katrin and Celine Nauges.2006. "Ex Post Evaluation of an Earmarked Tax on Air Pollution." Land Economics, pages 70-71.

An emissions charge system could be used to manage industrial air emissions in a cost-effective manner. An emissions charge can be used to manage regional emissions regardless of the number of emitters in a particular region. Emissions charges are also administratively simple and straightforward to design. Finally, when coupled with revenue recycling mechanisms, emissions charges can also ensure an appropriate price signal is applied to emitters, while providing an effective means of minimizing any adverse cost impacts of the system. Following on the Swedish experience, an emissions charge can be largely recycled, reducing the cost of the system to one that is cheaper than a command and control system designed to achieve the same level of reductions. The emissions charge can also be designed to escalate where air quality is deteriorating to ensure more stringent actions are taken in regions with worse air quality. Finally, emissions charge systems can be implemented in conjunction with elements of a command and control system. For example, a regulator can impose emissions charges to reduce emissions; where ambient air quality levels rise above the ambient air quality standards, regulators can choose not to license new facilities until emissions from the remaining facilities have been reduced to the point that the standards are no longer being exceeded.

Further work is necessary to design an appropriate system of charges and revenue recycling for application in the Canadian context. In general, emissions charges should be set slightly above the marginal cost of abatement, and a graduated charge may be necessary to manage a diversity of air quality issues. The means of imposing the charges will need to be further explored as they may differ between pollutants. In general, NO_x charges must be imposed on emissions (rather than fuel), whereas SO_2 charges can be levied either on the sulphur content of fuel or emissions, as well as on industrial processes. Finally, revenue recycling based on output, as in the Swedish system, can be complicated for some industries, and as a result other means of revenue recycling may need to be explored. Despite the lingering questions regarding emissions charges, this system may provide an effective means for governments across the country to ensure regional air quality is managed in an efficient and effective manner.

Implications for policy-makers:

1. There are a number of mechanisms that Canadian governments can choose from to implement an air quality management program, and there is a wealth of experience globally with these mechanisms that can provide guidance to Canada.

2. Command and control mechanisms may be necessary for some pollutants, such as VOCs and PM, due to human health considerations. However, they may be an overly expensive and administratively burdensome means of addressing the regional impacts of NO_x and SO_2 emissions. Emissions pricing systems, such as a cap-and-trade system or in particular emissions charges, potentially offer a more economically efficient mechanism for achieving emissions reductions.