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Greenhouse Gas Reduction Technologies: Industry Expenditures and Business Opportunities

2000 and 2002

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Rowena Orok

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Symbols

The symbols described in this document apply to all data published by Statistics Canada from all origins including surveys, censuses and administrative sources, as well as straight tabulations and all estimations.

- . not available for any reference period
- .. not available for a specific reference period
- ... not applicable
- 0 true zero or a value rounded to zero
- 0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
- P preliminary
- r revised
- x suppressed to meet the confidentiality requirements of the *Statistics Act*
- E use with caution
- F too unreliable to be published

1. Introduction

The ratification of the Kyoto Protocol made greenhouse gas (GHG) reduction technologies more prominent on Canada's public policy agenda. The government has made a commitment to stimulate the development, commercialization and adoption of GHG reduction technologies as part of the strategy to meet Canada's Kyoto target (Text Box 1). This paper evaluates the state of GHG reduction technology adoption and availability in Canada by addressing these questions:

- How heavily have Canadian businesses invested in GHG reduction technologies to reduce their emissions?
- How successful are Canadian suppliers of GHG reduction technologies? Have they been able to access both domestic and international markets?
- How extensive are business activities in research and development and innovation related to GHG reduction technology development?

1.1 Setting the scope and identifying main data sources

The GHG reduction technologies covered in this paper are listed in Text Box 2. The two surveys involved, the Survey of Environmental Protection Expenditures (SEPE) and the Environment Industry Survey (EIS), are described in detail in Text Box 3. Beginning in 2002, both surveys collected information on GHG reduction technologies to fill some of the data gaps in this area. The 2002 data can serve as baseline information when evaluating government programs and business initiatives to reduce GHG emissions.

The following sections discuss issues related to GHG reduction technology development: industry spending and investment, market opportunities for GHG reduction technology suppliers, innovation, research and development (R&D), and obstacles or barriers firms are facing.

2. Industry expenditures on GHG reduction technologies

Canada's economic structure is energy-intensive.¹ It is characterized by energy-intensive industries, significant production and refining of natural resources, and reliance on export markets.² Given the correlation between energy use and levels of GHG emissions, it is not surprising that Canada's total domestic GHG emission levels are higher than those of European countries that have less energy-intensive economies, such as the United Kingdom, Germany, France and Italy.³

Industry response to reducing GHG emissions is closely tied to energy conservation and energy efficiency strategies, including investments in systems and equipment to reduce GHG emissions. Canadian businesses in primary and manufacturing industries spent \$1.1 billion on GHG reduction technologies in 2002 (Table 1). The bulk of GHG reduction technology expenditures were made by three energy-intensive industries—oil and gas extraction (\$244.9 million), pulp, paper and paperboard mills (\$241.8 million), and electric power generation, transmission and distribution (\$203.7 million). Identified in the list of large industrial emitters and therefore targeted for GHG

1. Energy intensity is the ratio of energy consumption to output.

2. Environment Canada, 2001, *Canada's Third National Report on Climate Change: Actions to Meet Commitments Under the United Nations Framework Convention on Climate Change*, Catalogue no. En21-125/2001E, p. 11, Ottawa.

3. *Ibid.*

emission reductions, these industries clearly benefit from investing in GHG reduction technologies. They improve energy efficiency in their production processes, and reduce their overall energy intensity.¹

Just over one-half of the total GHG reduction technology expenditures, \$583.3 million, went to capital, mostly imported systems and equipment. This amount made up only 1.1% of the \$55 billion in total capital expenditures by these industries in that year.² The oil and gas extraction industry accounted for close to 40% of these GHG reduction technology capital expenditures. This industry installed \$230.9 million worth of GHG reduction technologies in 2002 for the following applications: solar energy, cogeneration, alternative fuel and waste-to-energy (Table 2).

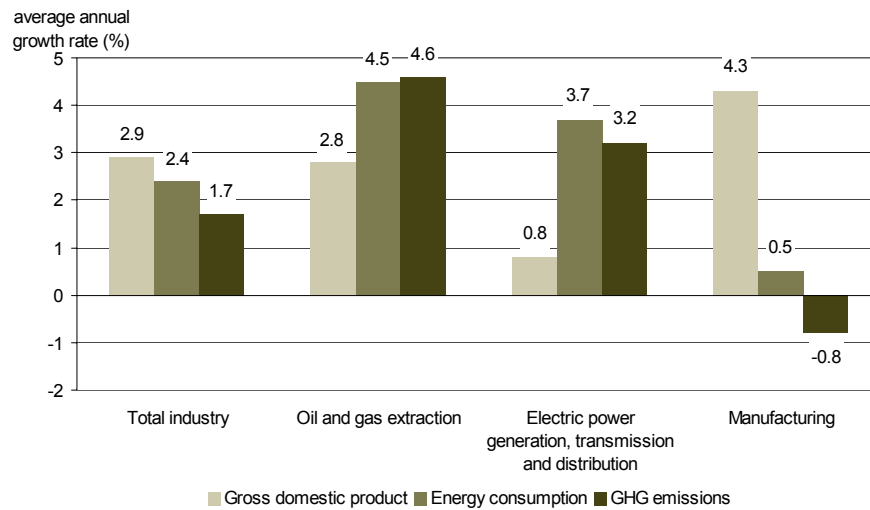
GHG reduction technology operating expenditures—spending on labour, energy use and water use—reached \$523.0 million in 2002. The pulp, paper and paperboard mills industry reported the highest GHG-related operating expenditures, \$175.9 million. The main GHG-related spending of this industry was for operating, repairing and maintaining three technologies: cogeneration, waste-to-energy and fuel substitution. The electric power generation, transmission and distribution industry also had significant GHG-related operating expenditures, \$104.9 million, mostly for small-scale hydro-electric systems.³ Like pulp and paper mills, electric power generation firms also spent money on operating costs for cogeneration, waste-to-energy and fuel substitution technologies.

The GHG-reduction technology investments made in 2002 may not have substantial effect in reducing an industry's energy consumption in the short term: the impacts may be spread over several years. However, Canada's commitment under the Kyoto Protocol is to reduce, by 2012, absolute annual GHG emissions, by an average of 6% below emission levels in 1990.⁴ Therefore, continued investment in GHG reduction technologies is crucial if Canada is to meet its Kyoto target. Given the growth in energy consumption and in GHG emissions since 1990, the challenge to reduce GHG emissions is still considerable.

From 1990 to 2000, Canadian industries consumed more energy and increased their GHG emissions. Among all Canadian industries during that period, the average annual growth rate⁵ of energy consumption was 2.4%, and of GHG emissions, 1.7% (Figure 1). In some energy-intensive industries, energy consumption and GHG emissions grew more rapidly than the average growth rates for all industries. Such was the case in oil and gas extraction and electric power generation, transmission and distribution, where the growth rates in energy consumption and GHG emissions were higher than the all-industry average. In contrast, the manufacturing sector, despite the 0.5% average annual increase in energy consumption, reduced its GHG emissions by an annual average of 0.8% throughout the period.

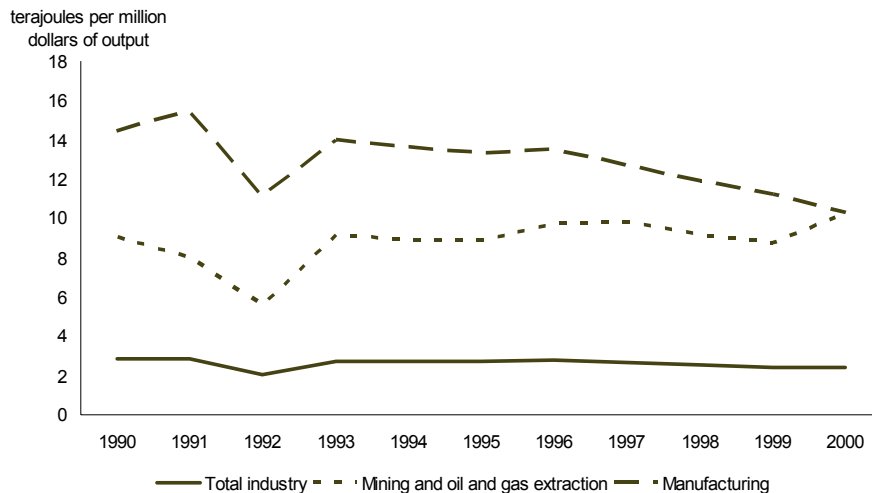
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1. Projections show that large industrial emitters could produce about half of Canada's total GHG emissions by 2010. Large industrial emitters are primarily in the oil and gas, electricity, mining and manufacturing sectors. The mining and manufacturing sectors include these industries: chemicals; fertilizers; pulp and paper; mining; smelting and refining (including aluminum); steel; cement; lime; and glass. According to the Climate Change Plan for Canada, large industrial emitters are to reduce their emissions by 55 megatonnes of carbon dioxide equivalent. See Natural Resources Canada, Large Final Emitters Group, www.nrcan-ncan.gc.ca (accessed January 13, 2005).
 2. Statistics Canada, CANSIM, Table 029-0005, "Capital and Repair Expenditures by Sector and Province".
 3. In Canada, small-scale hydro-electric systems are defined as 'micro' (100 kilowatts or less, which can supply one or two houses); 'mini' systems, (100 kilowatts to 1 megawatt, which typically supplies a small factory or isolated community); and 'small' systems, (1 to 30 megawatts, which are at the low end for supply to a regional or provincial power grid).
 4. Organisation for Economic Co-operation and Development, 1999, *STI - Science, Technology and Industry Review*, no. 25, "Technology, Prices and Energy Efficiency," Paris.
 5. Average annual growth rates and rates of increases/decreases quoted throughout the article are calculated based on a compounding rate of growth for a discontinuous variable (time periods). It follows the basic structure $v=a(1+r)^x$.

Figure 1. Average annual growth rate of gross domestic product, energy consumption and GHG emissions, selected industries, 1990 to 2000



Source:
 Statistics Canada, CANSIM, tables 153-0032, 153-0034 and 128-0002.

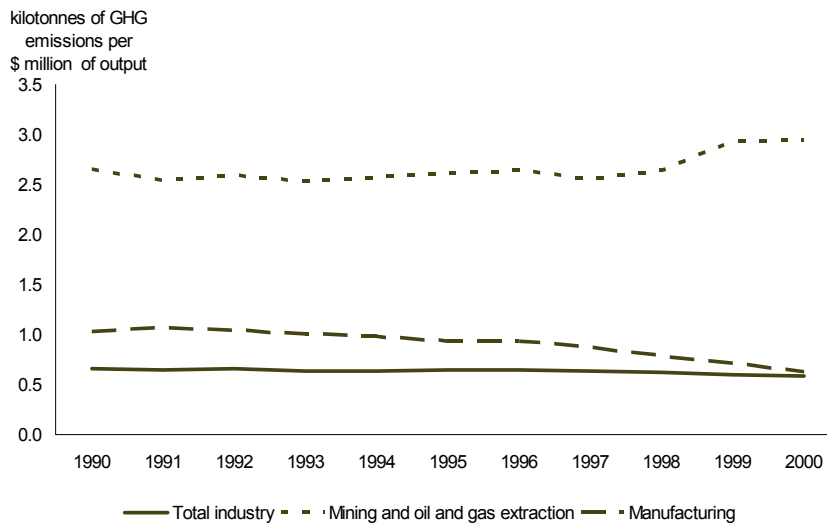
Figure 2. Energy intensity of selected industries, 1990 to 2000



Sources:
 Statistics Canada, Environment Accounts and Statistics Division, and CANSIM, tables 379-0017 and 128-0002.

Measuring an industry's emissions alone is not a complete analysis, because different industries have different output levels. Calculating energy intensity and emission intensity takes into account the level of industry output. Energy intensity is the ratio between energy consumption and output, whereas emission intensity represents the ratio of emissions per unit of output. For the Canadian industry as a whole, there were only slight decreases in both types of intensities due to increases seen in industries such as mining and oil and gas extraction. However, the manufacturing sector saw a notable improvement: it cut both its energy intensity and emission intensity from 1990 to 2000 (Figures 2 and 3) by adopting integrated process systems and equipment.

Figure 3. Emission intensity of selected industries, 1990 to 2000



Sources:
 Statistics Canada, Environment Accounts and Statistics Division, and CANSIM, tables 379-0017 and 128-0002.

3. Business opportunities for suppliers of GHG reduction technologies

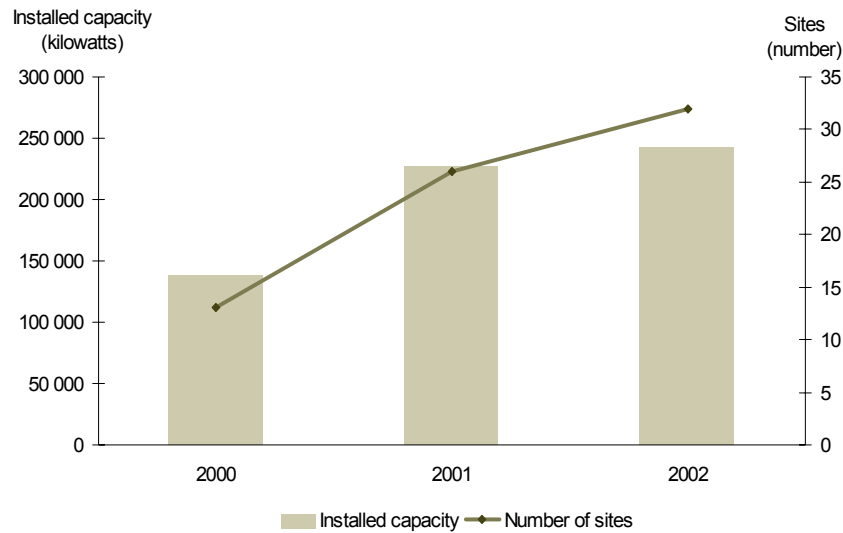
Are Canadian businesses taking advantage of the domestic and international markets for GHG reduction technologies? It is not possible now to fully evaluate the success of Canadian GHG reduction technology suppliers because of the lack of time-series data on GHG reduction technology revenues. However, the available data show that Canadian businesses have started earning revenues from GHG reduction technologies, some of which have not been fully commercialized until recently.

In 2002, for example, environmental businesses earned \$364.3 million from the sales of technologies to reduce GHG emissions: small establishments earned more than half of these revenues (Table 3).¹ This was much less revenue than that earned from other traditional types of environmental goods and services such as recyclable materials, waste management, water pollution control and air pollution control. But spurred by domestic and international demand, the market for GHG reduction technologies offers more room for growth. From 2000 to 2002, revenues from GHG reduction technologies rose 28%, surpassing the revenue gains in the more established markets for water and air pollution controls.

Some GHG reduction technologies that started out as demonstration projects have since been transformed into viable revenue producers with both domestic and international commercial applications. In 2002, revenues from fuel cell and alternative fuel technologies accounted for \$118.0 million of the revenues from GHG reduction technologies (Table 4). Fuel cell and alternative fuel producers, parts and systems suppliers and infrastructure developers located in Ontario and British Columbia accounted for more than 80% of these revenues. Small firms in Quebec, Alberta and Manitoba contributed the remainder.²

1. Statistics Canada, 2004, *Environment Industry Survey: Business Sector 2002*, Catalogue no. 16F0008XIE, Ottawa.
 2. *Ibid.*

Figure 4. Canada's wind farms, number of sites and installed capacity, 2000 to 2002



Source:
Canadian Wind Energy Association.

The combined revenues from sales of solar and wind energy systems and equipment climbed from \$78.3 million in 2000 to \$111.7 million in 2002. The growth was mainly because of rising sales of wind energy systems and equipment. In 2000, Canada had 13 wind farms or sites with total installed capacity of 138 090 kilowatts. By 2002, the number of sites more than doubled to 32, and the total installed capacity rose to 242 210 kilowatts (Figure 4).

Methane capture or landfill gas recovery and utilization is another GHG reduction technology that has been developed over the past decade. This technology captures methane gas from landfills by drilling deep into landfill sites and pumping the gas out through a system of pipes. The gas is either burned off or used as fuel to produce electricity or heat buildings.¹ In 2002, the waste management industry earned revenues of \$3.7 million from the sale of methane or energy derived from recovered landfill gases.²

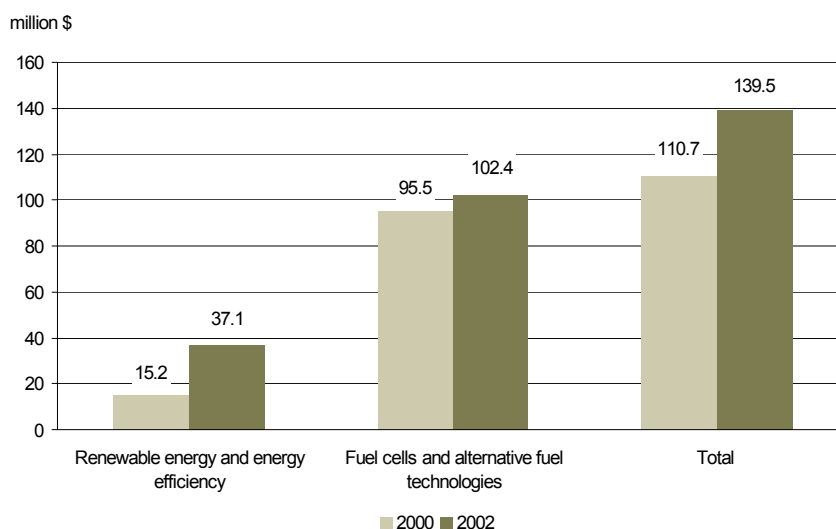
Approximately 38% of GHG reduction technology revenues were earned in international markets. GHG reduction technology export revenues reached \$139.5 million in 2002, up 26% from 2000 (Figure 5). Export markets provide opportunities for Canadian businesses to both develop niche markets and facilitate the transfer of Canadian technology abroad. This was the case, for instance, in fuel cell and alternative fuel technologies, where \$102.4 million, or 87% of 2002 environmental revenues was derived from exports.

4. GHG reduction technology development

Information on business R&D and innovation activities is needed to evaluate Canada's commitment to developing and promoting GHG reduction technologies. Monitoring these activities also supports the government's broader objective of turning Canada into one of the top five R&D performers and one of the most innovative countries in the world.³

1. Statistics Canada, 2002, *Human Activity and the Environment: Annual Statistics 2002*, Catalogue no. 16-201-XPE, Ottawa.
2. Statistics Canada, Environment Accounts and Statistics Division, 2002 Waste Management Industry Survey, Business Sector.
3. Government of Canada, 2002, *Achieving Excellence: Investing in People, Knowledge and Opportunity: Canada's Innovation Strategy*, Ottawa.

Figure 5. Exports of GHG technologies, by type of technology, 2000 and 2002



Source:
 Statistics Canada, Environment Accounts and Statistics Division, Environment Industry Survey.

As a relatively new technology area, it is difficult to measure the extent of R&D and innovation activities related to GHG reduction technology development. The available data provide some baseline information that could help governments and businesses in their efforts to promote research collaboration, to facilitate networking and to diffuse GHG reduction technologies. Results of future data collection will be critical in assessing the trends in GHG reduction technology development.

4.1 Research and development

R&D involves generating new ideas and is the first step in the innovation process.¹ Historically, businesses have been the largest R&D performers. In 2002, for example, total R&D expenditures by businesses reached \$12.4 billion, accounting for 55% of the total gross domestic R&D spending for that year (\$22.4 billion).²

How much of business R&D expenditures are dedicated to GHG reduction technology development? In 2002, R&D expenditures on renewable resources and energy conservation made up 30% of total energy R&D spending (Table 5). GHG reduction technologies continue to compete with conventional technologies such as fossil fuels and energy transportation and transmission for R&D funding. For example, from 2000 to 2002, businesses increased their R&D expenditures on renewable resources and spent less on R&D for energy conservation. In the same period, R&D aimed at increasing fossil fuel supply rose from \$161 million to \$209 million, making it the most significant technology area for energy R&D expenditures in 2002. Improving the knowledge base on R&D related to GHG reduction technology development-which industries to target, what funding mechanisms to promote, and other issues-would help governments identify the policy levers that could redirect business R&D activities away from conventional technologies and toward GHG reduction technologies.

1. For details on the definition, scope, classification and methodology for data collection of R&D activities, refer to Organisation for Economic Co-operation and Development, 2002, *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, ISBN-92-64-19903-9.
 2. Statistics Canada, 2005, *Industrial Research and Development-2004 Intentions*, Catalogue no. 88-202-XIE, Ottawa.

R&D activities tend to occur within clusters of interrelated firms-similar companies, specialized suppliers, service providers and firms in related industries.¹ The industry groups most active in GHG reduction technology R&D in 2002 were management, scientific and technical consulting services; scientific R&D services; architectural and engineering services; and machinery manufacturing.

More than half of the environmental firms that carried out R&D for GHG reduction technology development conducted only in-house R&D (Table 6). While parent and affiliated firms tend to be the major source of industrial R&D funding, the financial support for GHG reduction technology development in 2002 came primarily from the federal government. Ottawa has implemented R&D funding support programs for GHG reduction technology development and demonstration such as the Technology Early Action Measures Program and the National Fuel Cell Research and Innovation Initiative. Several tax incentive programs have also been put in place, including those for flare gas generation, renewable energy and energy efficiency.²

4.2 Innovation

New ideas and inventions are generated through R&D; innovation is the commercialization of those new inventions.³ GHG-related product innovation refers to new or significantly improved goods or services to reduce GHG emissions. This type of innovation ensures the availability of leading-edge systems and equipment.

Another area of interest is innovation associated with the adoption of GHG reduction technologies by businesses. From 2000 to 2002, 24% of firms in 16 primary and manufacturing industries used GHG-related innovative systems and equipment.⁴ In many instances, businesses cited sufficient return on investment as their main motivation for adopting innovative GHG reduction technologies (Table 7). Corporate policy, culture, awareness and regulations were other frequently reported incentives.

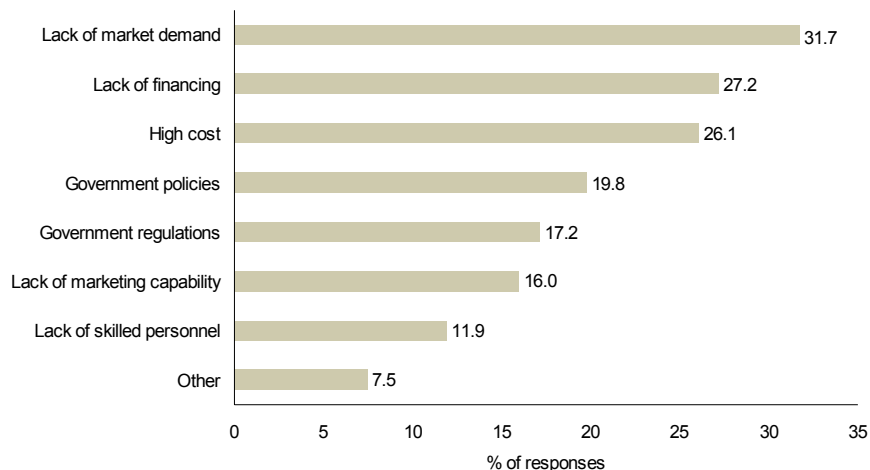
4.3 Problems and obstacles

Knowledge of the problems and obstacles to the commercialization, transfer and adoption of GHG reduction technologies helps both suppliers and buyers of these technologies make rational decisions. Technology developers can make realistic assumptions when evaluating market barriers and can plan to overcome these barriers. At the same time, potential buyers of these technologies can better analyse the costs and benefits when choosing the appropriate technology.

Wind energy, for example, has been cited as one of the fastest-growing forms of renewable energy in the world.⁵ Suppliers of wind technology need to consider the ability to offer competitive electricity costs, prospects for good wind sources, access to transmission infrastructure, availability of land to install wind turbines, and ways of minimizing the impact on wildlife (mainly the threat to birds). In some cases, members of the public may object because of aesthetic impacts.⁶

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1. Organisation for Economic Co-operation and Development, 1999, *STI - Science, Technology and Industry Review*, no. 25, "Technology and Sustainable Development," Paris.
 2. Environment Canada, 2001, *Canada's Third National Report on Climate Change: Actions to Meet Commitments Under the United Nations Framework Convention on Climate Change*, Catalogue no. En21-125/2001E, Ottawa.
 3. For details on the definition, scope, classification and methodology for data collection of innovation activities, see Organisation for Economic Co-operation and Development, 1992, *Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*.
 4. Statistics Canada, Environment Accounts and Statistics Division, 2002 Survey of Environmental Protection Expenditures.
 5. Canadian Wind Energy Association, n.d., *Quick Facts About Wind Energy*, www.canwea.ca/en/QuickFacts.html (accessed November 9, 2004).
 6. Globe Foundation, March 31 to April 2, 2004, Globe 2004 Trade Fair and Conference presentations, Vancouver.

Figure 6. Problems and obstacles to the provision of GHG technologies, 2002



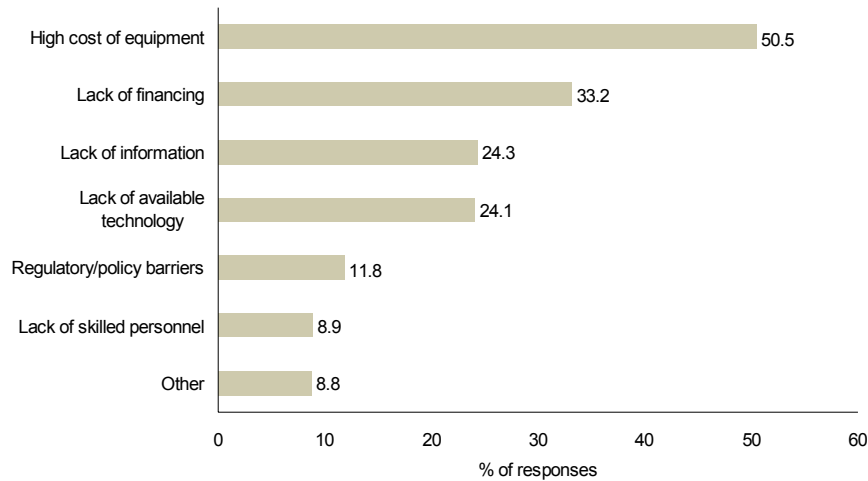
Source:
Statistics Canada, Environment Accounts and Statistics Division, Environment Industry Survey.

Most suppliers of environmental goods and services cited lack of market demand, lack of financing and high cost of technology development as the most common problems and obstacles in developing GHG reduction technologies (Figure 6). This could partly explain the low innovation rate among GHG reduction technology developers. Demand volatility, the dominance of small firms and limited applications for some technologies contribute to the relatively high uncertainty in producing and marketing GHG reduction technologies. Firms were more likely to take the risks involved in technology development if they had achieved prior success. Almost three-quarters of firms that still had unsuccessful or outstanding projects at the end of 2002 also had successfully completed and introduced other GHG reduction technology product innovations in that year.¹

The problems and obstacles faced by GHG reduction technology producers and developers were reflected in the perspectives of the consumers of these technologies. An OECD progress report on sustainable development indicates that the adoption of GHG reduction technologies is slow. Long lead times are needed to refine and commercialize new technology and higher investments are needed to deploy the technology.² The 2002 survey results identified three most common barriers to the adoption of innovative GHG reduction technologies: high equipment costs, lack of financing and lack of available technology (Figure 7).³ Costs include not only the initial investment to install the system or equipment but also the cost to operate it. The issue of technology availability, or the lack thereof, is more or less associated with how readily applicable the GHG reduction technologies are to a firm's production process.

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1. Statistics Canada, Environment Accounts and Statistics Division, 2002 Environment Industry Survey.
 2. Organisation for Economic Co-operation and Development, 1999, *STI - Science, Technology and Industry Review*, no. 25, "Technology and Sustainable Development," Paris.
 3. Based on the results of the Survey of Environmental Protection Expenditures, as reported by firms in 16 primary and manufacturing industries.

Figure 7. Obstacles to the adoption of GHG technologies, 2002



Source:
 Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures.

5. Conclusions

In light of the significance of GHG reduction technologies to Canada's GHG emissions-reduction plan and the public policy agenda, this article evaluated the state of GHG reduction technology adoption and availability in Canada. It addressed several policy-related issues concerning businesses' investments in GHG reduction technologies, domestic and international market access for Canadian GHG reduction technology producers and the process of innovation for GHG reduction technology development. The main research findings are summarized in this section. These findings respond to the questions asked in Section 1.

How heavily have Canadian businesses invested in GHG reduction technologies to reduce their emissions?

- Industry spending on GHG reduction technology made up a relatively small proportion of total expenditures in 2002.
- Canadian businesses in 16 primary and manufacturing industries spent \$1.1 billion on GHG reduction technologies in 2002. The bulk of expenditures were made by three large industrial emitters: oil and gas extraction; pulp, paper and paperboard mills; and electric power generation, transmission and distribution.
- Examples of the most common GHG reduction technologies adopted by businesses were: solar energy, cogeneration, alternative fuel and waste-to-energy.

How successful are Canadian suppliers of GHG reduction technologies? Have they been able to access both domestic and international markets?

- GHG reduction technology suppliers form a relatively new segment of the environment industry. Some GHG reduction technologies, including fuel cells and methane capture systems, started out as demonstration projects and have become viable revenue sources with both domestic and international applications.
- Businesses earned \$362.3 million in revenues from the sales of GHG reduction technologies in 2002, much less than from other traditional environment industry segments, such as recyclable materials, waste management, water pollution control and air pollution control.

- Between 2000 and 2002, the 28% increase in GHG reduction technology revenues surpassed the revenue increases in other well-established markets, such as water and air pollution control, illustrating that the GHG reduction technology market is less saturated and offers room for growth.
- Canadian suppliers have started tapping into international markets for GHG reduction technologies. Exports of \$139.5 million accounted for 38% of GHG reduction technology revenues in 2002.
- Domestic markets continue to provide opportunities for Canadian GHG reduction technology producers. Businesses that invested in GHG reduction technologies imported most of their GHG systems and equipment.

How extensive are business R&D and innovation activities that are related to GHG reduction technology development?

- In 2002, R&D expenditures on renewable resources and energy conservation made up 30% of total R&D spending on energy. GHG reduction technologies must compete with conventional technology areas such as fossil fuels as well as energy transportation and transmission for a share of this spending.
- R&D for GHG reduction technology development was carried out mainly by these industries: management, scientific and technical consulting services; scientific R&D services; architectural and engineering services; and machinery manufacturing.
- Financial support for R&D to develop GHG reduction technology originated mainly from the federal government, while the parent and affiliated firms tend to be the major source of industrial R&D funding.
- From 2000 to 2002, only 2% of firms involved in the production of environmental goods and services were GHG product innovators.
- Primary and manufacturing businesses cited the high cost of equipment, lack of financing, and lack of available technology as the three most common barriers to the adoption of GHG reduction technologies. These barriers help to explain the most common obstacle faced by environmental firms that were involved in GHG reduction technology development—the lack of market demand.
- Other common problems and obstacles for environmental firms involved in GHG reduction technology development were lack of financing and the high cost of developing the technology. These translate to the relatively high degree of uncertainty in producing and marketing GHG reduction technologies. This could be why most firms that carried out GHG reduction technology innovation activities in 2002 had already enjoyed some success in previous attempts at GHG reduction technology innovation.

Statistical monitoring of GHG reduction technologies is still relatively new. The current data collected by the Survey of Environmental Protection Expenditures and Environment Industry Survey serve as benchmark information to evaluate GHG reduction technology adoption and availability in Canada. Future survey results will be critical in assessing Canada's progress in supporting the development, commercialization and adoption of GHG reduction technologies.

Text Box 1. Canada's Kyoto target

The "greenhouse effect" is the name given to a complex system involving a number of gases in the atmosphere that regulates the Earth's temperature at a level that makes it a liveable planet. Enhanced GHG concentrations could increase temperatures and have far-reaching and unpredictable environmental, social and economic consequences.

In 1992, the United Nations Framework Convention on Climate Change set out a framework for action aimed at stabilizing global GHG emissions at a level to prevent human-induced actions from leading to "dangerous interference" in the climate system. The 1997 Kyoto Protocol addresses the human impact on climate change by committing developed countries to collectively reduce GHG emissions to 5.2% below 1990 levels by the period 2008-2012. There are essentially two ways to achieve this goal: emit fewer greenhouse gases into the atmosphere or sequester more GHG from the atmosphere. Global and national policy responses have, so far, focused primarily on reducing GHG emissions from anthropogenic sources such as automobiles and coal-fired power plants.¹ Anthropogenic sources of GHG emissions (mainly CO₂ emissions) are easier to identify, verify and control than some of the natural processes that cause GHG emissions.

Upon the ratification of the Kyoto Protocol, Canada has committed to a 6% reduction in GHG emissions below the 1990 levels within the 2008-2012 commitment period. In order to achieve the Kyoto target, part of the strategy is to make Canada a less carbon-intensive economy. In this regard, GHG emissions reduction strategies are closely tied with government energy policies such as policies aimed at developing alternative energy sources and improving energy efficiency. At the same time, the targeted sectors for emissions reduction clearly include the most energy-intensive sectors of the economy. The Climate Change Plan for Canada, for example, targets the largest industrial emitters including upstream and downstream oil and gas sectors, electricity generation, and mining and manufacturing such as cement plants and iron and steel mills.

The role of technology

There is international consensus that technology plays a key role in reducing GHG emissions and addressing climate change. In Canada, the 2004 Speech from the Throne laid out the government's plan to turn Canada into "a world leader in developing and applying path-breaking technologies of the 21st century."² Environmental technologies are featured prominently in various policy agendas, along with biotechnology, information and communications technologies, health technologies and nanotechnology. GHG technologies, a subset of environmental technologies, are essential to Canada's implementation strategy to reduce GHG emissions.³ This strategy includes the refinement of existing GHG technologies and the development and commercialization of new GHG technology solutions.

Technological solutions are attractive for two reasons: first, technology offers promise to key industries or sectors of the economy which are required to reduce their GHG emissions because of the potential impact on costs and the ease of technology adoption. For example, the electricity and transportation sectors plan their GHG reductions based on evaluation of existing and emerging technologies. These include renewable energy alternatives for the electricity sector and alternative fuel systems or low-emissions hybrid vehicles for the transportation sector.

Second, technology improves market opportunities for businesses and suppliers that sell the so-called "GHG technology solutions." For these firms, continued technology development is critical to maintaining competitiveness. Technology also supports the development of niche markets and facilitates access to domestic and international markets.

1. For details on the greenhouse effect and climate change, refer to Environment Canada, n.d., *The Green Lane : Climate Change - Overview*, www.ec.gc.ca/climate/overview_science-e.html (accessed September 27, 2004).

2. Parliament of Canada, *Speech from the Throne to Open the Third Session of the Thirty-Seventh Parliament of Canada*, Catalogue no. SO1-1/2004, Ottawa.

3. Promoting technology development and innovation is one of the five major themes for Phase One of Canada's National Implementation Strategy on Climate Change. Refer to *Canada's Third National Report on Climate Change*, Catalogue no. En21-125/2001E, Ottawa.

Text Box 2. List of GHG technologies

GHG technologies are defined as systems, equipment or processes that reduce or prevent the release of greenhouse gases in the earth's atmosphere - carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The list below highlights the GHG technologies covered in two environmental surveys, the Survey of Environmental Protection Expenditures and the Environment Industry Survey.

The Survey of Environmental Protection Expenditures collected information on the use or adoption of one or more of the following systems or equipment related to reducing GHG emissions:

1. Cogeneration
2. Small, mini and micro-hydroelectricity
3. Solar energy
4. Wind energy
5. Waste-to-energy
6. Other renewable energy
7. Alternative fuel technology
8. Fuel substitution
9. Other systems, equipment or employee training that improved energy efficiency

The Environment Industry Survey collected information on the revenues earned from the production, sales or marketing of one or more of the following GHG technologies:

1. Solar energy
2. Waste-to-energy
3. Wind energy
4. Small, mini and micro hydroelectricity
5. Fuel cells (transportation and stationary)
6. Alternative fuel technologies (other than fuel cells)
7. Cogeneration
8. Methane capture or use from landfill sites or agricultural sources
9. Clean technologies and related components
10. Other renewable energy (wave, tidal, ocean thermal energy conversion)
11. Other systems or equipment for energy conservation and efficiency

Source:

Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures and Environment Industry Survey.

Text Box 3. Information on two environmental surveys: Survey of Environmental Protection Expenditures and Environment Industry Survey

The Survey of Environmental Protection Expenditures (SEPE) provides a measure of expenditures made by industry for environmental protection in Canada in response to Canadian and international environmental regulations, conventions and voluntary agreements. The survey also aims to identify environmental management practices and technologies used in Canadian industry for the purpose of preventing or abating pollution. For the 2002 survey cycle, the SEPE collected the following information related to GHG technologies:

- Adoption or use of systems or equipment to reduce GHG emissions, as listed in Text Box 2;
- Amount of operating, capital and total expenditures on GHG technologies;
- Proportion of capital machinery and equipment expenditures on GHG technologies that was manufactured in Canada;
- Innovation activities, i.e., adoption of new or significantly improved systems or equipment that reduced GHG emissions and the overall impact of these innovative GHG technologies on GHG emissions;
- Obstacles and drivers to the adoption of innovative GHG technologies;
- Use of systems or equipment to reduce fugitive or vented GHG emissions; and
- Use of systems or equipment to reduce GHG emissions from electricity generation

The Environment Industry Survey (EIS) collects data on the revenues earned by Canadian businesses from the production of environmental goods, the provision of environmental services and the undertaking of environment-related construction activities. In addition, the survey collects data on exports of environmental goods and services. During the 2002 survey cycle, the EIS collected the following information on GHG technologies:

- Revenues realised from the production, sales or marketing of GHG technologies, as listed in Text Box 2;
- Environmental export revenues from GHG technologies;
- Research and development (R&D) activities of firms related to GHG technologies (type of R&D activities and sources of R&D funding);
- Innovation activities of firms related to GHG technologies (product innovation, process innovation);
- Information on unsuccessful or incomplete projects to develop or introduce new or significantly improved goods and/or services to reduce GHG emissions; and
- Problems and obstacles to the provision of goods and services to reduce GHG emissions.

Exclusions and data limitations

Information on the following systems or equipment to reduce GHG emissions were not collected through the SEPE and EIS:

- Large-scale hydroelectricity
- Nuclear energy/power
- Energy efficient building technologies and retrofits for residential buildings and institutional buildings
- Intelligent transport systems, mass transit systems and advanced vehicles
- Alternative fuels (for example: reformulated and oxygenated fuels) bought and sold at the pump
- Adaptation technologies

Source:

Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures and Environment Industry Survey.

Table 1. Operating, capital and total expenditures on GHG technologies, by industry, 2002

Industry	Operating expenditures	Capital expenditures	Total expenditures
	\$ millions		
Logging	15.4	3.0	18.4
Oil and gas extraction	13.9	230.9	244.9
Mining	14.4	7.3	21.7
Electric power generation, transmission and distribution	104.9	98.8	203.7
Natural gas distribution	5.5	6.8	12.3
Food	11.6	10.4	22.0
Beverage and tobacco products	1.0	3.3	4.3
Wood products	84.0	19.3	103.3
Pulp, paper and paperboard mills	175.9	65.8	241.8
Petroleum and coal products	2.5	25.7	28.2
Chemicals	40.8	6.4	47.2
Non-metallic mineral products	2.8	31.0	33.8
Primary metals	7.8	33.8	41.6
Fabricated metal products	6.6	1.4	8.0
Transportation equipment	26.3	7.2	33.4
Pipeline transportation	9.6	32.0	41.6
Total	523.0	583.3	1 106.3

Note:

This table excludes the 'other manufacturing' industry.

Source:

Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures.

Table 2. Energy conservation processes and technologies, by industry, 2002

Industry	Cogeneration	Small, mini, or micro hydro-electric facility	Solar energy systems or equipment	Wind energy systems or equipment	Waste-to-energy systems or equipment	Other renewable energy systems or equipment	Alternative fuel systems or equipment	Fuel substitution	Other ¹	Total ²
	percent ³									
Logging	2	6	3	0	19	2	6	6	10	36
Oil and gas extraction	19	11	49	8	12	6	13	11	34	75
Mining	3	6	17	0	9	6	4	8	24	48
Electric power generation, transmission and distribution	22	24	11	14	15	13	12	14	31	58
Natural gas distribution	10	0	27	0	10	0	40	42	33	69
Food	2	0	0	0	5	1	2	5	18	20
Beverage and tobacco products	2	0	0	0	3	0	0	2	17	21
Wood products	8	0	1	0	41	8	3	11	16	52
Pulp, paper and paperboard mills	32	9	0	0	58	16	10	18	29	81
Petroleum and coal products	12	0	3	0	9	3	3	22	32	53
Chemicals	12	0	0	0	5	2	4	6	15	26
Non-metallic mineral products	0	0	0	0	7	1	3	8	13	8
Primary metals	2	2	0	0	4	1	4	4	25	32
Fabricated metal products	3	0	0	1	1	0	0	0	7	10
Transportation equipment	2	0	3	0	1	1	1	5	34	33
Pipeline transportation	10	0	29	0	5	2	8	8	48	74
Total	9	3	6	1	14	4	5	8	22	40

Notes:

This table includes reported data only.

1. Includes establishments reporting they used energy conservation processes or technologies not elsewhere specified.

2. Number of establishments reporting they used at least one energy conservation process or technology, expressed as a percentage of the total number of establishments that provided a response.

that provided a response.

3. Number of establishments reporting they used the process or technology as a percentage of all establishments that provided a response.

Source:

Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures.

Table 3. Environmental revenues, by category of environmental goods, Canada, 2000 and 2002

Environmental goods	2000	2002
	\$ millions	
Water	1.0	1.0
Air	507.4	542.7
Waste	451.7	669.5
Technologies to reduce greenhouse gas emissions	284.7	364.3
Analytical	173.4	221.5
Recyclable materials	3.0	3.0
All other environmental goods	396.7	316.7
Total	6.0	6.0

Note:

Figures may not add up to totals because of rounding.

Source:

Statistics Canada, Environment Accounts and Statistics Division, Environment Industry Survey.

Table 4. Revenues from sales of GHG technologies, 2000 and 2002

GHG technology	2000	2002
	\$ millions	
Solar and wind energy	76.7	111.7
Fuel cells and alternative fuel technologies	5.9	118.0
Cogeneration, methane capture, waste-to-energy	x	8.6
Other renewable energy	115.9	30.1
Clean technologies and related components	14.5	13.1
Other systems or equipment for energy and efficiency	x	82.8
Total	284.7	364.3

Note:

x suppressed to meet the confidentiality requirements of the *Statistics Act*

Source:

Statistics Canada, Environment Accounts and Statistics Division, Environment Industry Survey.

Table 5. Energy R&D expenditures, by area of technology, 2000 and 2002

Area of technology	2000	2002	2000	2002
	\$ millions		% of total	
Renewable resources	78	95	11	13
Energy conservation	208	120	29	17
Transportation and transmission	157	85	22	12
Fossil fuels	161	209	23	29
Nuclear	47	95	7	13
Other	33	86	5	12
Total	711	721	100	100

Source:

Statistics Canada, 2005, *Industrial Research and Development 2004 Intentions*, Catalogue no. 88-202-XIE, Ottawa.

Table 6. Environmental firms undertaking research and development activities aimed at developing GHG technologies, 2002

	Firms undertaking research and development activities %
By type of R&D activity	
Only in-house R&D	55.3
Only R&D contracted out to other firms	1.4
Only R&D carried out jointly with another firm	3.4
Both in-house R&D and R&D contracted out to other firms	8.7
Both in-house R&D and R&D carried out jointly with another firm	19.2
Both R&D contracted out to other firms and R&D carried out jointly with another firm	0.5
In-house R&D, R&D contracted out to other firms, and R&D carried out jointly with another firm	11.5
By number of R&D funding sources	
1	47.8
2	31.4
3	16.4
4 or more	4.3
By type of R&D funding source	
Canadian federal government (grants or tax credits)	60.4
Parent, affiliated or subsidiary firms	39.1
Provincial/territorial government	23.7
R&D contract work conducted for other firms	20.8
Universities	10.6
Other	22.7

Source:
Statistics Canada, Environment Accounts and Statistics Division, Environment Industry Survey.

Table 7. Factors that drove the adoption of new or significantly improved systems to reduce greenhouse gas emissions, by industry, 2000 to 2002

Industry	Sufficient return on investment	Regulations	Voluntary agreement	Public relations	Corporate policy/ culture/ awareness	Other ¹	No factors	Total ²
					% of all establishments that responded			
Logging	36.2	29.8	10.6	25.5	31.9	0.0	48.9	69.1
Oil and gas extraction	78.3	72.5	62.3	63.8	73.9	2.9	7.2	88.5
Mining	47.3	28.6	18.7	24.2	41.8	5.5	26.4	79.1
Electric power generation, transmission and distribution	39.4	48.5	33.3	48.5	48.5	3.0	34.8	84.6
Natural gas distribution	60.0	30.0	70.0	50.0	80.0	20.0	10.0	62.5
Food	39.7	39.0	12.8	19.1	39.0	0.7	36.9	84.9
Beverage and tobacco products	48.1	32.7	13.5	11.5	42.3	7.7	38.5	85.2
Wood products	50.0	34.6	16.2	23.1	35.4	1.5	31.5	81.3
Pulp, paper and paperboard mills	73.6	51.9	24.5	27.4	52.8	8.5	10.4	86.2
Petroleum and coal products	65.5	51.7	58.6	34.5	48.3	0.0	20.7	78.4
Chemicals	48.1	44.3	24.3	22.7	42.7	5.4	22.2	83.0
Non-metallic mineral products	49.2	34.9	20.6	23.8	33.3	4.8	23.8	84.0
Primary metals	58.6	39.3	32.1	24.3	45.0	2.9	16.4	79.1
Fabricated metal products	52.2	36.2	11.6	20.3	27.5	4.3	30.4	84.1
Transportation equipment	54.5	33.8	13.0	15.6	35.1	7.8	35.1	77.0
Pipeline transportation	87.5	42.5	72.5	62.5	82.5	5.0	2.5	95.2
Total	53.5	41.0	25.3	27.3	44.0	4.2	25.4	82.1

Notes:

This table includes reported data only.

1. Includes establishments reporting factors not elsewhere specified.

2. Number of establishments reporting at least one factor, expressed as a percentage of the total number of establishments that provided a response.

Source:

Statistics Canada, Environment Accounts and Statistics Division, Survey of Environmental Protection Expenditures.

Annex A : Questionnaires



Environment Industry Survey, 2002

Confidential when completed
Collected under authority of *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19.

Si vous préférez ce questionnaire en français, veuillez cocher

Correct as required

Company name

 Establishment name

 C/O

 Address

 City

 Province/Territory Postal code
 _____ _____

Please read before completing

PURPOSE OF THE SURVEY

This survey collects data on the revenues of environmental goods and services. These data will be aggregated with information from other sources to produce official estimates of national and provincial economic activity of the environment industry. Information from the survey can be used by businesses for market analysis, by trade associations to study the performance of the Environment Industry, by governments to develop national and regional policies, and by other users involved in research and policymaking. For a definition of the Environment Industry, refer to page 1 of the *Guide on Definitions and Classification Details*.

The results of this survey will be published in the Statistics Canada publication, *Environment Industry 2002*, Catalogue no. 16F0008XIE.

CONFIDENTIALITY

Statistics Canada is prohibited by law from publishing any statistics which would divulge information obtained from this survey that relates to any identifiable respondent, without previously written consent. The data reported will be treated in strict confidence, used for statistical purposes only and published in aggregate form. The confidentiality provisions of the *Statistics Act* are not affected by either the *Access to Information Act* or any other legislation.

AUTHORITY

This survey is conducted under the authority of the *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19. **COMPLETION OF THIS QUESTIONNAIRE IS A LEGAL REQUIREMENT UNDER THE STATISTICS ACT.**

INQUIRIES

If you require assistance in completing this questionnaire or if you have any questions or comments regarding this survey, please refer to the *Guide* or contact:

**Operations and Integration Division
Statistics Canada
Ottawa, Ontario K1A 0T6**

Telephone (toll-free): **1-800-387-0479 (within Canada)**
 Fax: **1-800-755-5514 (within Canada)**
 Email: **enviro.oid.ind@statcan.ca**

In all correspondence concerning this questionnaire, please quote the identification number that appears on the address label.

IMPORTANT

Please read the General Instructions on page 2 before answering.

Please return this questionnaire within 30 days of receipt.

If you are unable to do so, kindly inform Operations and Integration Division of the expected completion date.

Statistics Canada use only

Rec.			
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Ed.			
D	M	Y	

Kyd.			
D	M	Y	

Bat.			
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Coll.

FSC	
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General instructions

1. Please complete and return this form in the envelope provided.
2. Please refer to the accompanying **Guide on Definitions and Classification Details** for more information.
3. If this establishment is involved in a combination of environmental activities (*producing environmental goods, providing environmental services or undertaking environment-related construction*), please ensure that the relevant portion(s) of Section B are completed.
4. When precise figures are not available, please provide your best estimates.
5. Please report all dollar amounts in **CANADIAN DOLLARS**.
6. If your response for an item is zero, please write "0" in the corresponding box rather than leaving the cell blank.

SECTION A - Information on this establishment

A1. This questionnaire should be completed for your company's establishment in one province or territory that produces environmental goods or offers environmental services or environment-related construction. **If you operate more than one establishment that produces environmental goods or offers environmental services or environment-related construction you should fill out separate questionnaires for each of these establishments in each province or territory.** You may wish to photocopy this questionnaire or you may call us toll-free at 1-800-387-0479 to request additional questionnaires.

Province/territory for which this questionnaire applies:

400

A2. Did your company operate environmental establishments in more than one province or territory in 2002?

Environmental establishments refer to those establishments that produced environmental goods or offered environmental services or environment-related construction.

401 Yes No ➤ Go to question A4.

A3. In order to update your company profile, please indicate where you operated other environmental establishments in this province or territory or elsewhere in Canada in 2002.

Establishment Name	Address	Phone Number	Contact
40101	40102	40103	40104
40105	40106	40107	40108
40109	40110	40111	40112
40113	40114	40115	40116

A4. Reporting year:

1. The report must cover your most recent fiscal year ending between April 1, 2002 and March 31, 2003.

From:		
Day	Month	Year
403	404	405

To:		
Day	Month	Year
406	407	408

2. Did your company operate this establishment for the full year?

409 Yes ➤ Please go to Question B1, Section B - Revenues and classification

No ➤ Please check the appropriate box(es) below

411 Seasonal operation ➤

From:		
Day	Month	Year
412		

414 New business (please provide date of start) _____

416 Change of fiscal year end (please provide the new end date) _____

418 Change of ownership (please provide the date) _____

420 Ceased operations (please provide the date) _____

422 Temporarily closed (please specify the closing date and reason for closing) _____

424

To:		
Day	Month	Year
413		
415		
417		
419		
421		
423		

425 Other (please specify) ➤

SECTION B - Revenues and classification

Revenues - If precise figure is not available, your best estimate is acceptable

B1. What were this establishment's total revenues in 2002?	Canadian dollars (omit cents)
	101

B2. Of this establishment's total revenues reported in Question B1, please report the revenues from the sale of environmental goods or services, or revenues from environment-related construction.	102
---	-----

Classification

The purpose of this section is to measure the environmental revenues received by this establishment by types of environmental goods, services and environment-related construction provided. Please classify the environmental revenues reported in Question B2 according to the applicable categories of environmental goods, environmental services and environment-related construction. Examples for each category are provided in the **Guide on Definitions and Classification Details** enclosed with this form.

Environmental goods

B3. Did this establishment receive revenues from the sale of environmental goods in 2002? Refer to page 1 of the **Guide** for a description of environmental goods.

¹⁰³ Yes ➤ Go to question B4.

No ➤ Go to question B5.

B4. Please report this establishment's 2002 revenues received from the sale of environmental goods. If this establishment's environmental goods do not fall in any stated categories, please use the "Other, specify" category. Refer to page 2 of the **Guide** for examples of each category.

	Canadian dollars (omit cents)
1. Air pollution control systems or equipment	105
2. Water supply and conservation systems or equipment	106
3. Wastewater management and sewage treatment systems or equipment	107
4. Hazardous and non-hazardous waste management systems or equipment	108
5. Systems or equipment for remediation/treatment of soil, surface water, seawater and groundwater	109
6. Noise/Vibration abatement systems or equipment	110
7. Environmental monitoring, analysis or assessment systems or equipment	111
Systems or equipment for energy conservation and efficiency:	
8. Solar energy systems or equipment	113
9. Waste-to-energy systems or equipment	114
10. Wind energy systems or equipment	115
11. Small, mini and micro hydro systems or equipment	800
12. Fuel cells (transportation and stationary source)	801
13. Alternative fuel technologies (other than fuel cells)	117
14. Cogeneration	802
15. Equipment for methane capture or use from landfill sites or agricultural sources	803
16. Clean technologies and related components	118
17. Other renewable energy systems or equipment	116
18. Any other systems or equipment for energy conservation and efficiency	112
19. Other, specify ¹²¹	119
Total environmental goods	120

Environmental services

B5. Did this establishment receive revenues from the provision of environmental services in 2002? Refer to page 1 of the Guide for a description of environmental services.

¹²² Yes ➤ Go to question B6.1. No ➤ Go to question B7.

B6.1 Please report this establishment's 2002 revenues received from the provision of environmental services. If this establishment's environmental services do not fall in any stated category, please use the "Other, specify" category. Refer to page 3 of the Guide for examples of each category.

	Canadian dollars (omit cents)
20. Air pollution control and monitoring services	124
21. Water supply and conservation services	125
22. Wastewater management and sewage treatment services	126
23. Hazardous and non-hazardous waste management services	127
24. Services for remediation/treatment of soil, surface water, seawater and groundwater	128
25. Noise/Vibration abatement services	129
26. Environmental research and development services	130
27. Energy efficiency and renewable energy services	131
28. Environmental education, training and information	132
29. Management consulting and legal services (including environmental impact assessments)	133
30. Environmental Management Systems (EMS)	856
31. Other consulting engineering, analytical services, data collection and analysis	135
32. Other, specify ¹³⁸	136
Total environmental services	137

B6.2 Did this establishment receive revenues from the provision of environmental services related to the reduction of greenhouse gas emissions in 2002? Please refer to page 1 of the Guide for the definition of technologies and services to reduce greenhouse gas emissions.

⁸⁰⁵ Yes ➤ Go to question B6.3. No ➤ Go to question B7.

B6.3 Please report the percentage of Total environmental services (Box 137, Question B6.1) derived from services related to the reduction of greenhouse gas emissions in 2002.

Percentage
807

B6.4 Please specify the type of services related to the reduction of greenhouse gas emissions.

⁸⁰⁸

Environment-related construction

B7. Did this establishment receive revenues from environment-related construction projects in 2002?

¹³⁹ Yes ➤ Go to question B8. No ➤ Go to question C1, Section C - Client Base.

B8. Please report this establishment's 2002 revenues received from environment-related construction projects. If this establishment's environment-related construction projects do not fall in any stated category, please use the "Other, specify" category. Refer to page 5 of the Guide for examples of each category.

	Canadian dollars (omit cents)
33. Air pollution control	141
34. Water supply and conservation	142
35. Wastewater management and sewage treatment	143
36. Hazardous and non-hazardous waste management	144
37. Remediation/Treatment of soil, surface water, seawater and groundwater	145
38. Noise/Vibration abatement	146
39. Renewable energy production facilities	857
40. Other, specify ¹⁴⁹	147
Total environment-related construction	148

SECTION C - Client base	SECTION D - Client location		
<p>C1. Please report this establishment's environmental revenues reported in Question B2 according to the type of client to whom the environmental goods or services were delivered or for whom the environment-related construction projects were completed.</p>		<p>D1. Please report this establishment's environmental revenues reported in Question B2 according to the location of the client to whom the environmental goods or services were delivered or for whom the environment-related construction projects were completed.</p>	
	Canadian dollars (omit cents)		Canadian dollars (omit cents)
	150		164
Local government		Newfoundland and Labrador	
	151		165
Federal/Provincial/Territorial governments		Prince Edward Island	
	152		166
Agriculture and agri-food products		Nova Scotia	
	153		167
Forestry and pulp and paper		New Brunswick	
	154		168
Fish and fish products <i>(Including aquaculture)</i>		Quebec	
	155		169
Mining and related products, metal and mineral products		Ontario	
	156		170
Crude petroleum and natural gas, refined petroleum and related products		Manitoba	
	157		171
All other manufacturing		Saskatchewan	
	158		172
Business services		Alberta	
	159		173
Gas distribution and electric power systems		British Columbia	
	160		174
Individuals and households		Yukon Territory, Northwest Territories, and Nunavut	
	161		175
Other, <i>specify</i> ¹⁶³		Outside Canada (exports)	
	162		176
Total environmental revenues (must equal the value reported in Question B2)		Total environmental revenues (must equal the value reported in Question B2)	
		Did you report revenues in Box 175?	
		⁸⁶⁰ <input type="radio"/> Yes ➤ Go to question E1.	
		<input type="radio"/> No ➤ Go to question F1.	

SECTION E - Environmental export revenues

E1. Please report a breakdown, by region, of this establishment's 2002 environmental revenues from OUTSIDE CANADA (exports) reported in Box 175, Question D1.

	Canadian dollars (omit cents)
United States	177
Mexico	178
Other Central America	179
South America	180
Europe	181
Middle East	182
Africa	183
China	184
Japan	185
Other Asia	186
Australia	187
Other foreign (<i>specify</i>) <input type="text" value="190"/>	188
Total environmental exports	189

E2. Did the amount reported in Box 189, Question E1, include any revenues from the export of goods and/or services related to the reduction of greenhouse gas emissions in 2002? Please refer to page 1 of the Guide for the definition of technologies and services to reduce greenhouse gas emissions.

- 809 Yes ➤ Go to question E3. NO ➤ Go to question F1.

E3. Please report the percentage of Total environmental exports (Box 189, Question E1) derived from the export of goods and/or services related to the reduction of greenhouse gas emissions.

Percentage
811

E4. Please report the type of technologies and/or services related to the reduction of greenhouse gas emissions exported by this establishment in 2002.

Please check all that apply.

- 813 Solar energy systems or equipment
- 814 Waste-to-energy systems or equipment
- 815 Wind energy systems or equipment
- 816 Small, mini and micro hydro systems or equipment
- 817 Alternative fuel technologies (other than fuel cells)
- 818 Other renewable energy systems or equipment
- 819 Fuel cells (transportation and stationary source)
- 820 Cogeneration
- 821 Equipment for methane capture or use from landfill sites or agricultural sources
- 822 Clean technologies and related components
- 812 Any other systems or equipment for energy conservation and efficiency
- 823 Energy efficiency and conservation services
- 824 Renewable energy services
- 825 Other goods or services related to the reduction of greenhouse gas emissions

SECTION F - Research and Development (R&D) on goods/services related to the reduction of greenhouse gas emissions

F1. During the past three years, 2000 to 2002, did this establishment undertake research and development (R&D) activities aimed at developing goods and services related to the reduction of greenhouse gas emissions? Please refer to page 1 of the **Guide** for the definition of research and development (R&D) on goods and services that reduce greenhouse gas emissions.

⁸²⁶ Yes ➤ Go to question F2.

No ➤ Go to question G1.

Type of R&D Activities

	Yes	No
F2. Was R&D carried out in-house?	⁸²⁷ <input type="radio"/>	<input type="radio"/>
F3. Was R&D contracted out to other firms?	⁸²⁹ <input type="radio"/>	<input type="radio"/>
F4. Was R&D carried out jointly with another firm?	⁸³¹ <input type="radio"/>	<input type="radio"/>

Sources of R&D Funding

F5. Please report the sources of funding for this establishment's R&D activities.

Please check all that apply.

⁸³³ Parent, affiliated or subsidiary firms

⁸³⁴ Canadian federal government (grants or tax credits)

⁸³⁵ Provincial/territorial government

⁸³⁶ R&D contract work conducted for other firms

⁸³⁷ Universities

⁸³⁸ Other, specify ⁸³⁹ _____

SECTION G - Innovation

Please refer to page 5 of the **Guide** for the definition of new or significantly improved goods or services related to the reduction of greenhouse gas emissions.

	Yes	No
G1. During the last three years, 2000 to 2002, did this establishment produce or market new or significantly improved goods and/or services related to the reduction of greenhouse gas emissions?	⁸⁴⁰ <input type="radio"/>	<input type="radio"/>
G2. During the last three years, 2000 to 2002, did this establishment adopt new or significantly improved technologies or processes that reduced greenhouse gas emissions?	⁸⁴² <input type="radio"/>	<input type="radio"/>
G3. During the last three years, 2000 to 2002, did this establishment have any unsuccessful or not yet completed projects to develop or introduce new or significantly improved goods and/or services related to the reduction of greenhouse gas emissions?	⁸⁴⁴ <input type="radio"/>	<input type="radio"/>

SECTION H - Problems and obstacles

H1. Which of the following, if any, were obstacles to the provision of goods or services related to the reduction of greenhouse gas emissions? Please refer to page 1 the Guide for the definition of technologies and services to reduce greenhouse gas emissions.

Please check all that apply.

- 846 Lack of skilled personnel
- 847 High cost
- 848 Lack of financing
- 849 Lack of market demand
- 850 Lack of marketing capability (including trade barriers)
- 851 Government regulations
- 852 Government policies
- 853 Other, specify
- 855 None

SECTION I - Environmental employment

I1. Please report the total number of persons usually employed by this establishment during the reporting period.

Full-time employees - regular employees who worked 30 or more hours per week	193
Part-time employees - those employees who worked less than 30 hours per week	194
Total employment	196


I2. Of the total employment reported in Box 196, Question I1, please estimate the **proportion** of your employees who spent **any time** in the production/provision of environmental goods and services, or environmental-related construction services. Your best estimate is acceptable.

Proportion of total employment involved in environment-related projects	207	%
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SECTION J - Certification and comments

Certification

J1. I certify that to the best of my knowledge, the information provided in this questionnaire is correct and complete

Signature 	Date 15 Day Month Year
Name of person completing this questionnaire (type or print) 12	Telephone 16
Title 13	Fax 17
Year this establishment started operations 14	Email address 18

J2. Approximately how long did it take to collect the data and complete this survey? hours

Comments

We invite your comments or suggestions on the following or any other topics related to the Environment Industry Survey.
We appreciate your assistance.

- | | |
|---|---|
| <ul style="list-style-type: none"> ➤ Questionnaire content ➤ New questions of interest to your industry ➤ Clarity of questions and provision of sufficient examples ➤ Order and flow of questions | <ul style="list-style-type: none"> ➤ Timing of receipt of questionnaire and the period given for response ➤ Alternative sources of information to further reduce response burden ➤ Potential for electronic data reporting |
|---|---|

For information only

If you have any questions, please contact us.
Telephone (toll free) 1-800-387-0479 (within Canada)
Fax: 1-800-755-5514 (within Canada)
Email: enviro.oid.ind@statcan.ca

Please return this
questionnaire in the
envelope provided

Thank you for your cooperation !



Environment Accounts and Statistics Division

Survey of Environmental Protection Expenditures, 2002

Confidential when completed

Collected under the authority of the *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19.

Si vous préférez ce questionnaire en français, veuillez cocher

Correct as required

Company name

Establishment name

C / O

Address

City

Province/Territory

Postal code



Please read before completing

PURPOSE OF THE SURVEY

This survey provides a measure of the expenditures made by industry for environmental protection in Canada in response to Canadian and international environmental regulations, conventions and voluntary agreements. The survey also aims at identifying environmental management practices and technologies used in Canadian industry for the purpose of preventing or abating pollution. These data will be aggregated with information from other sources to produce official estimates of environmental protection expenditures.

The results of this survey will be published in the Statistics Canada publication *Environmental Protection Expenditures in the Business Sector, 2002*, Catalogue No. 16F0006XIE.

CONFIDENTIALITY

Statistics Canada is **prohibited by law** from publishing any statistics which would divulge information obtained from this survey that relates to any identifiable respondent, without the previous written consent of that respondent. The data reported will be treated in strict confidence, used for statistical purposes and published in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the *Access to Information Act* or any other legislation.

AUTHORITY

This survey is conducted under the authority of the *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19.

COMPLETION OF THIS QUESTIONNAIRE IS A LEGAL REQUIREMENT UNDER THE STATISTICS ACT.

INQUIRIES

If you require assistance in completing this questionnaire or if you have any questions or comments regarding this survey, please refer to the *Guide to Definitions and Classification Details* or contact:

**Operations and Integration Division
Statistics Canada
Ottawa, ON, Canada, K1A 0T6**

Telephone (toll-free): **1-800-255-7726**

Fax: **1-800-755-5514**

Email: **enviro.oid.exp@statcan.ca**

The questionnaire is available in an electronic spreadsheet format. Please contact the Operations and Integration Division if you prefer to use this reporting option.

In all correspondence concerning this questionnaire, please quote the identification number that appears on the address label.

Important: Please read the *Guide to Definitions and Classification Details* included with this form before answering. If your response for an item is zero, please write "0" in the corresponding box rather than leaving the cell blank.

Please return this questionnaire within 30 days of receipt.

If you are unable to do so, kindly inform the Operations and Integration Division of the expected completion date.

For Statistics Canada use only

Rec.			
D	M	Y	

Ed.			
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Kyd.			
D	M	Y	

Bat.			

Coll.	

FSC	

4-2300-2.1: 2002-11-15 STC / NAD - 475-04244

Please report in thousands of Canadian dollars

1. Reporting year

Report must cover your most recent fiscal year that ended at any time between **April 1, 2002 and March 31, 2003.**

Day	Month	Year	Day	Month	Year
010	020	030	040	050	060

From to

2. Environmental monitoring

If the expenditure is zero, please write "0" in corresponding box.

Include

- ◆ Expenditures related to equipment, supplies, labour and purchased services required for monitoring pollutants emitted by this establishment. Expenditures associated with participation in the National Pollutant Release Inventory (NPRI) and other similar programs are to be included

Operating expenses	Capital expenditures	Total
\$ 000	\$ 000	\$ 000
100	110	120

3. Environmental assessment and audits

If the expenditure is zero, please write "0" in corresponding box.

Include

- ◆ Expenditures for reviews of current operations for compliance with regulations (audits)
- ◆ Expenditures to evaluate the environmental impact of proposed programs or projects (assessments)
- ◆ Expenditures for associated legal and consulting costs

Operating expenses	Capital expenditures	Total
\$ 000	\$ 000	\$ 000
130	140	150

4. Site reclamation and decommissioning

If the expenditure is zero, please write "0" in corresponding box.

a) Expenditures on site reclamation made during the fiscal year 2002 for any active site belonging to your establishment

Operating expenses	Capital expenditures	Total
\$ 000	\$ 000	\$ 000
161	171	181

b) Expenditures on site decommissioning made during the fiscal year 2002 following the closing down of a site (even if closing occurred before 2002)

Operating expenses	Capital expenditures	Total
\$ 000	\$ 000	\$ 000
162	172	182

Exclude

- ◆ Fines or compensation for environmental damage (this is to be reported in Question 8)
- ◆ Provisions for future environmental liability

Please report in thousands of Canadian dollars

5. Protection and restoration of wildlife and habitat

If the expenditure is zero, please write "0" in corresponding box.

Include

- ◆ Expenditures made to protect or restore wildlife and habitat that could be or have been adversely affected by this establishment's operations

Exclude

- ◆ Expenditures for site reclamation and decommissioning which are already reported in Question 4
- ◆ Expenditures for aesthetic purposes

Operating expenses \$ 000	Capital expenditures \$ 000	Total \$ 000
190	200	210

6. Pollution abatement and control (end-of-pipe processes) and waste management

Abatement and control of pollution are performed using end-of-pipe equipment or installations. **These end-of-pipe processes are not an integral part of production;** their sole purpose is to abate or to control undesirable substances resulting from normal production. **Refer to page 3 of the Guide.**

a) Pollution abatement and control and waste management expenditures

If the expenditure is zero, please write "0" in corresponding box.

Include

- ◆ Expenditures for equipment or facilities that are separately identifiable and that have been installed exclusively to reduce or eliminate pollutants resulting from production
- ◆ Expenditures related to waste collection, removal and treatment done by your establishment's or company's employees not already reported in Question 4 or 5
- ◆ Purchases of waste services not already reported in Question 4 or 5. Any sewerage management services or any other purchase of services reported in Question 11

Exclude

- ◆ Expenditures specific to workers' health and safety
- ◆ Expenditures on waste management or services reported in Question 4 or 5
- ◆ Expenditures for on-site recycling (Question 7)

Operating expenses \$ 000	Capital expenditures \$ 000	Total \$ 000
250	260	270

b) Did you report capital expenditures in Question 6a (cell 260)?

Yes No ²⁷⁵ ► Go to Question 7

1. What proportion of capital expenditures reported in cell 260 was spent on reducing or abating each of the following? Refer to page 3 of the Guide.

Substances released to air %	Substances released to surface waters %	On-site releases to land/ underground injection %	Noise, vibration or radiation %
280	290	300	310

= 100%

Please report in thousands of Canadian dollars

7. Pollution prevention

"Pollution prevention is the use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste, and reduce overall risk to human health or the environment."

Pollution Prevention - A Federal Strategy for Action, Government of Canada (1995)

This question identifies expenditures and methods used for the purpose of preventing or minimizing pollution and waste, or promoting resource conservation. **Refer to page 3 of the Guide.**

a) Expenditures on pollution prevention

If the expenditure is zero, please write "0" in corresponding box.

Include

- ◆ Expenditures for equipment or facilities integrated to a production process that avoid or minimize the production of pollutants and waste
- ◆ Expenditures for equipment or facilities related to leak and spill prevention. They may include expenditures on the following: spill containments; dyke extensions; and accessories (valves, pumps)
- ◆ Expenditures for equipment or facilities used for conserving energy or water
- ◆ Expenditures for equipment or facilities associated with recirculation, recovery, reuse and **on-site** recycling of materials or substances

Exclude

- ◆ Expenditures specific to worker's health and safety
- ◆ Expenditures already included in Questions 2 to 6

Operating expenses		Capital expenditures		Total
\$ 000		\$ 000		\$ 000
500	+	510	=	520

b) Did you report capital expenditures in Question 7a (cell 510)?

Yes
 No ⁵²⁵
 ▶ Go to Question 7c

1. What proportion of capital expenditures reported in cell 510 was spent on preventing or minimizing each of the following? Refer to Question 6b, page 3 of the Guide.

Substances released to air		Substances released to surface waters		On-site releases to land/underground injection		Noise, vibration or radiation		Other	
%		%		%		%		%	
530	+	540	+	550	+	560	+	570	= 100 %

Please report in thousands of Canadian dollars

7. Pollution prevention (Concluded)

c) Pollution prevention methods

If you have prevented or reduced waste, pollutants or conserved resources in fiscal year 2002, please indicate how it was achieved by checking the appropriate box(es). Please include all projects regardless of whether they are required by regulation, convention or voluntary agreement. Refer to pages 3 and 4 of the **Guide** for a description of each method.

	Yes	No
Product design or reformulation	810 <input type="checkbox"/>	<input type="checkbox"/>
Equipment or process modifications (integrated process)	830 <input type="checkbox"/>	<input type="checkbox"/>
Recirculation, on-site recycling or reuse or recovery of materials or substances	850 <input checked="" type="checkbox"/>	<input type="checkbox"/>
Materials or feedstock substitution, solvent reduction, elimination or substitution	870 <input checked="" type="checkbox"/>	<input type="checkbox"/>
Improved inventory management or purchasing techniques	875 <input type="checkbox"/>	<input type="checkbox"/>
Prevention of leaks and spills	880 <input type="checkbox"/>	<input type="checkbox"/>
Good operating practices or pollution prevention training	885 <input type="checkbox"/>	<input type="checkbox"/>
Other (Please specify)	890 <input type="checkbox"/>	<input type="checkbox"/>

8. Environmental charges

If the expenditure is zero, please write "0" in corresponding box.

\$ 000

760

Include

- ◆ Permits, fees, levies, special assessment and related fees
- ◆ Any fines, penalties, or damage awards paid to government agencies or to individuals
- ◆ Other charges paid to regulating bodies in order to allow operations to take place at this establishment

9. Other environmental protection expenditures

If the expenditure is zero, please write "0" in corresponding box.

\$ 000

770

Include

- ◆ The operating costs of administrating your environmental program
- ◆ Environmental training and information programs
- ◆ Any other additional expenditures that are required to comply with environmental regulations, conventions or voluntary agreements

Exclude

- ◆ Research and development expenditures

Please report in thousands of Canadian dollars

10. Total expenditures on environmental protection

If the expenditure is zero, please write "0" in corresponding box.

Cell 801: includes total from operating expenses reported in questions 2 to 9.
 Cell 802: includes total from capital expenditures reported in questions 2 to 7.
 They should also include all data for which breakdowns were not available.

Operating expenses \$ 000	Capital expenditures \$ 000	Total \$ 000
801	802	803

11. Purchase of environmental services

Of the total operating expenses and capital expenditures on environmental protection reported in Question 10, what proportions were purchased from a private contractor or government? Your best estimate is acceptable. If the proportion is zero, please write "0" in corresponding box.

Include

- ◆ All expenditures associated with the use of waste collection and treatment service or a sewerage service provided by a private contractor or a federal, provincial/territorial or local government
- ◆ Any other purchase of environmental services provided by a private contractor or a federal, provincial/territorial or local government (examples include the purchase of environmental monitoring services; environmental assessment and audit services; construction and engineering services associated with the installation, repair or maintenance of pollution prevention, abatement and control infrastructure or equipment)

Exclude

- ◆ Any expenditures for environmental services provided by your establishment's or company's employees (own-account work)
- ◆ Expenditures for on-site recycling

% of total operating expenses

301	%
-----	---

% of total capital expenditures

502	%
-----	---

12. Environmental Processes and Technologies

a) Did this establishment extract, refine, transport or distribute fossil fuels (coal, bitumen, crude oil or natural gas) in fiscal year 2002?

Yes Go to Question 12b No 2000 Go to Question 12c

b) Did this establishment use systems or equipment to reduce fugitive or vented greenhouse gas emissions in fiscal year 2002? Refer to page 4 of the **Guide** for definition of fugitive greenhouse gas emissions and related technologies.

Yes No 2001

Did this establishment use systems or equipment to reduce greenhouse gas emissions other than fugitive or vented emissions (e.g. from the combustion of fossil fuels)?

Yes No 2002

c) Did this establishment use systems or equipment to reduce greenhouse gas emissions from the generation of electricity in fiscal year 2002? Refer to pages 4 and 5 of the **Guide** for examples and the definition of fugitive greenhouse gas emissions and related technologies.

Yes No 2003

Please report in thousands of Canadian dollars

12. Environmental Processes and Technologies (Continued)

d) Did you use one or more of the following systems or equipment in fiscal year 2002? Please check the appropriate boxes.

Refer to pages 5 and 6 of the **Guide** for a description of each technology or process.

- | | Yes | No |
|---|-------------------------------|--------------------------|
| 1. Cogeneration. | 1282 <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Small, mini and micro-hydroelectric facility. | 2004 <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Solar energy systems or equipment. | 1288 <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Wind energy systems or equipment. | 1289 <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Waste-to-energy systems or equipment. | 1285 <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Other renewable energy systems or equipment. | 2005 <input type="checkbox"/> | <input type="checkbox"/> |
- Please specify most important
- _____
- _____
- _____

- | | | |
|--|-------------------------------|--------------------------|
| 7. Alternative fuel systems or equipment. | 2006 <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Fuel substitution. | 1284 <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Other systems, equipment or employee training that improved energy efficiency. | 1292 <input type="checkbox"/> | <input type="checkbox"/> |
- Please specify most important
- _____
- _____
- _____

e) Did you answer "Yes" to any part of Questions, 12b, 12c or 12d?

Yes Go to Question 12f No 2007 Go to Question 12h

f) What were your operating expenses and capital expenditures in fiscal year 2002 on the systems or equipment reported in Question 12b, 12c or 12d? (Please report in thousands of Canadian dollars. If the expenditure is zero, please write "0" in the corresponding box). Your best estimate is acceptable. Please exclude fuel costs.

Operating expenses \$ 000	Capital expenditures \$ 000	Total \$ 000
2008 <input style="width: 150px; height: 25px;" type="text"/>	+ 2009 <input style="width: 150px; height: 25px;" type="text"/>	= 2010 <input style="width: 150px; height: 25px;" type="text"/>

g) What proportion of your capital expenditures in fiscal year 2002 on machinery and equipment that reduced your greenhouse gas emissions was manufactured in Canada? (If the proportion is zero, please write "0" in the corresponding box) Your best estimate is acceptable.

2011 %

12. Environmental Processes and Technologies (Continued)

h) During the last three years, 2000 to 2002, did this establishment put into operation new or significantly improved systems or equipment that reduced greenhouse gas emissions?
 Refer to page 6 of the **Guide** for a description of "new or significantly improved".

Yes No 2012 Go to Question 12i

Rank the overall impact of these new or significantly improved systems or equipment to reduce greenhouse gas emissions. (Please check the appropriate box)

- 2013 Small
- 2014 Medium
- 2015 Large

i) Obstacles and drivers

During the last three years, 2000 to 2002, which of the following factors were obstacles or drivers to the adoption of new or significantly improved systems or equipment to reduce greenhouse gas emissions? Refer to page 6 of the **Guide**.

Please check all that apply

Possible obstacles

- 1. Lack of information or knowledge related to new or significantly improved systems or equipment 2016
- 2. Lack of available new or significantly improved systems or equipment. 2017
- 3. Lack of skilled personnel to put new or significantly improved systems or equipment into operation 2018
- 4. High cost of equipment 2019
- 5. Lack of financing (internal, private or government) 2020
- 6. Regulatory/policy barriers 2021
- 7. Other (Please specify) _____ 2022
- 8. None 2023

Possible drivers

- 1. Sufficient return of investment 2024
- 2. Regulations 2025
- 3. Voluntary agreement 2026
- 4. Public relations 2027
- 5. Corporate policy/culture/awareness 2028
- 6. Other (Please specify) _____ 2029
- 7. None 2030

12. Environmental Processes and Technologies (Concluded)

j) Environmental biological treatment

Did you use biotechnology to abate, prevent or manage pollution or waste resulting from normal production in fiscal year 2002? Refer to pages 6 and 7 of the **Guide**.

Yes No 1400 Go to Question 13

If yes, please indicate which biotechnology was used by checking the appropriate box(es).

- Microbiologically enhanced recovery of material(s) 1401
- Phytoremediation 1402
- Bioremediation 1403
- Biofiltration 1404
- Natural or constructed wetland 1405
- Bioleaching 1406
- Bio-pulping 1407
- Bio-bleaching 1408
- Biodesulphurization 1409

- Other (Please specify) _____ 1410

13. Environmental Management Practices

Please indicate the environmental management practices adopted or utilized by this establishment in fiscal year 2002 to avoid or minimize pollution or to conserve resources. Refer to pages 7 and 8 of the **Guide** for a description of each practice.

- | | Yes | No |
|--|------------------------------|--------------------------|
| a) Did this establishment use an environmental management system? | 951 <input type="checkbox"/> | <input type="checkbox"/> |
| b) Did this establishment use Life Cycle Management, Life Cycle Assessment or Design for Environment for decision making? | 965 <input type="checkbox"/> | <input type="checkbox"/> |
| c) Was this establishment ISO 14000 certified? | 953 <input type="checkbox"/> | <input type="checkbox"/> |
| d) Did this establishment implement any environmental voluntary agreement, or did it participate in any voluntary environmental program? | 955 <input type="checkbox"/> | <input type="checkbox"/> |
- Examples include Accelerated Reduction/Elimination of Toxics (ARET) or Voluntary Challenge and Registry (VCR).
If yes, please list programs, accords or agreements.

13. Environmental Management Practices (Concluded)		Yes	No
e) Did this establishment have a "green" procurement policy?	957	<input type="checkbox"/>	<input type="checkbox"/>
f) Were any of the goods produced by this establishment certified by an environmental program, such as the "Enviro Choice Program" operated by Terrachoice Inc.?	959	<input type="checkbox"/>	<input type="checkbox"/>
g) Did this establishment publish or contribute to annual or other reports on its environmental performance or sustainable development?	963	<input type="checkbox"/>	<input type="checkbox"/>
h) Did this establishment experience any cost savings as a result of implementing any of the environmental management practices outlined in this question or environmental technologies outlined in Question 12 or pollution prevention methods outlined in Question 7?	969	<input type="checkbox"/>	<input type="checkbox"/>
i) Other (Please specify)	967	<input type="checkbox"/>	<input type="checkbox"/>
<hr/> <hr/> <hr/> <hr/>			

Certification

I certify that, to the best of my knowledge, the information provided in this questionnaire is correct and complete.

900	Signature X	Date (D / M / Y)	940	Title
905	Name of person completing this questionnaire (type or print)	915	Telephone No.	920 Fax No.
925	Email address	930	Web site address	

Approximately how long did it take to collect the data and to complete this survey? hours

Comments

Please provide any comments you may have about this survey (e.g., length, ease of completion, suggestions for future questions, suggestions about the format). Also, please use this space if you wish to provide additional information about your environmental protection activities.

If you have any questions, please contact us.
Telephone (toll free) 1-800-255-7726
Fax: 1-800-755-5514
Email: enviro.oid.exp@statcan.ca

PLEASE RETURN THIS QUESTIONNAIRE IN THE ENVELOPE PROVIDED

Thank you for your cooperation