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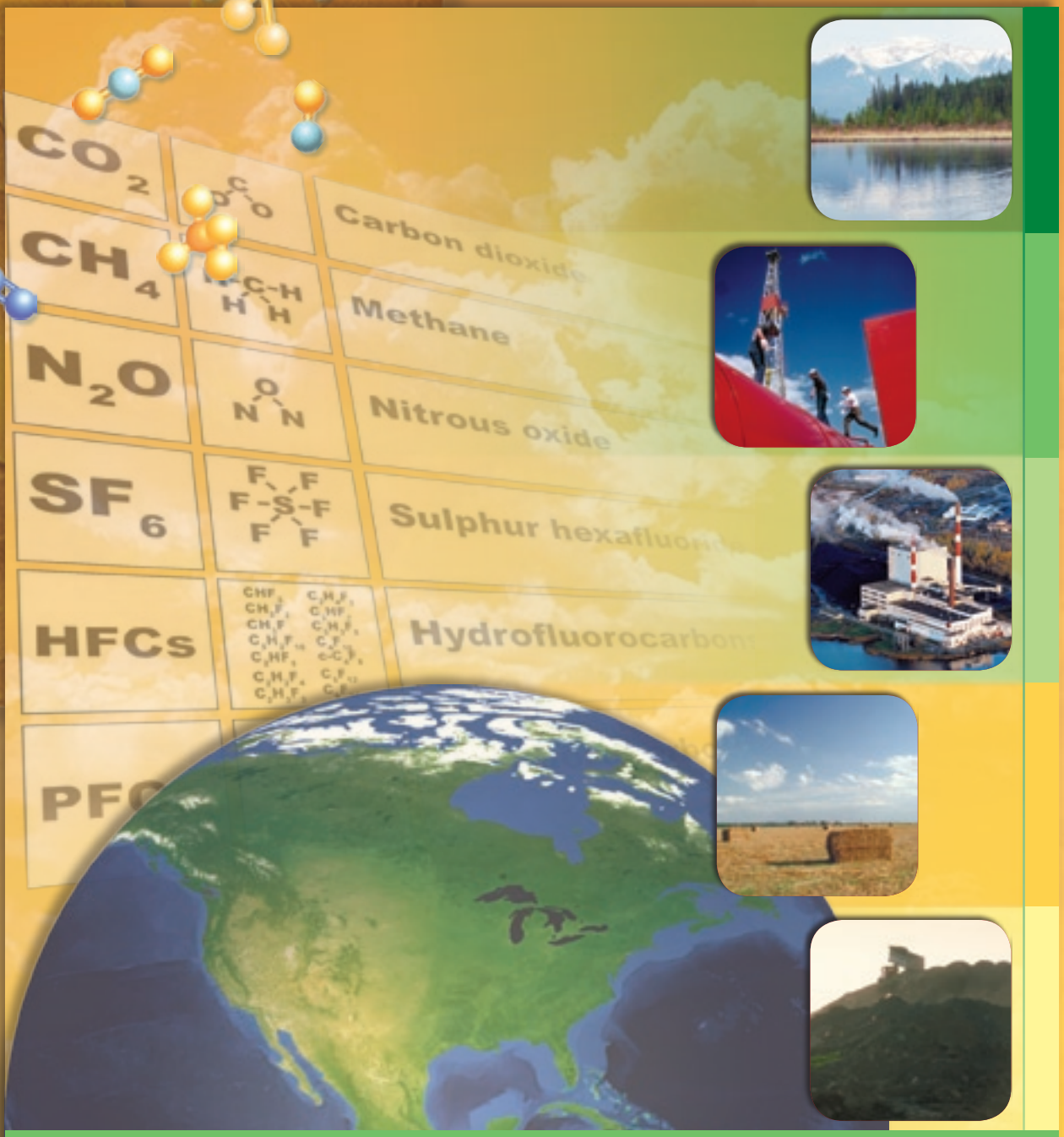

Trends in GHG Sources and Sinks in Canada 1990–2004

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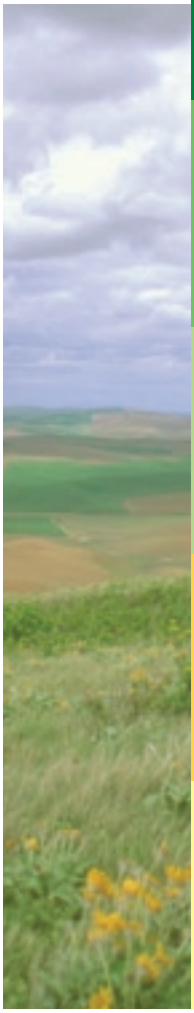
Canada's National Inventory

As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), Canada is obliged to submit an inventory of its greenhouse gas (GHG) emissions to the UNFCCC on an annual basis. The UNFCCC submission (which includes the National Inventory Report and Common Reporting Format tables) is developed, compiled, and reported annually by the Greenhouse Gas Division of Environment Canada in accordance with UNFCCC requirements, particularly Decisions 3/CP.5, 18/CP.8, and 13/CP.9, which state that Annex I Parties should annually submit national inventories in accordance with the UNFCCC Guidelines on such inventories.

Inventory estimates are determined by methods and models developed in-house by engineering and scientific staff, as well as from published data, data developed by industry, and methods and guidance developed by the Intergovernmental Panel on Climate Change (IPCC).

The year 2006 marks the submission of Canada's 12th National Inventory Report to the UNFCCC Secretariat, and the second inventory report since the Kyoto Protocol came into force. The inventory reporting format is based on international reporting methods agreed to by the Parties to the UNFCCC and according to the procedures of the IPCC. The inventory uses an internationally agreed upon reporting format that groups emissions into the following six sectors: Energy; Industrial Processes; Solvent and Other Product Use; Agriculture; Land Use, Land-Use Change and Forestry; and Waste. The GHGs that have been estimated in the national inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

This overview document presents the latest information on Canadian GHG emissions and removals derived from the most recent national inventory, using a modified sector approach to facilitate the use of information by the public. This examination of GHGs groups national emission data that may otherwise appear in separate IPCC categories into Canadian industrial sectors. In the upstream fossil fuel industry for example, emissions associated with stationary- and transport-related (such as off-road vehicles) fuel combustion, process-related, and fugitives are combined, and overall industry emission totals are provided in order to present data in the industrial sector in which they occur. This is particularly evident in the Electricity & Fossil Fuel Industries and Mining and Manufacturing Industries sectors. Also, stationary and transport related emissions from off-road vehicles and machineries associated with the Agriculture and Forestry industry have been combined in Other Industries.



In 2004, Canadians contributed about 758 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) of GHGs to the atmosphere, an increase of 0.6% over the 754 Mt recorded in the year 2003.[1] This is considerably less than the 3.9% increase that occurred between 2002 and 2003. Canada's economic GHG intensity — the amount of GHGs emitted per unit of economic activity, or total GHG emissions divided by gross domestic product (GDP) — was 2.6% lower in 2004 than in 2003.

Between 2003 and 2004, there were increases in some sectors (notably Industrial Processes and Agriculture), but the overall growth was minor due mainly to significantly reduced emissions from electricity production (less coal and more nuclear generation) and, to a lesser extent, a reduced demand for heating fuel because of a warmer winter.

Between 1990 and 2004, Canada's total GHG emissions rose by approximately 27%. This increase in GHG emissions during the 14-year period outpaced increases in population (which totalled 15%) and approximately equalled the increase in energy use (which was 26%). However, the growth in total emissions was well short of the 47% growth in GDP between 1990 and 2004. As a result, economic GHG intensity has decreased by a total of 14% over the period, an average of 1% per year.

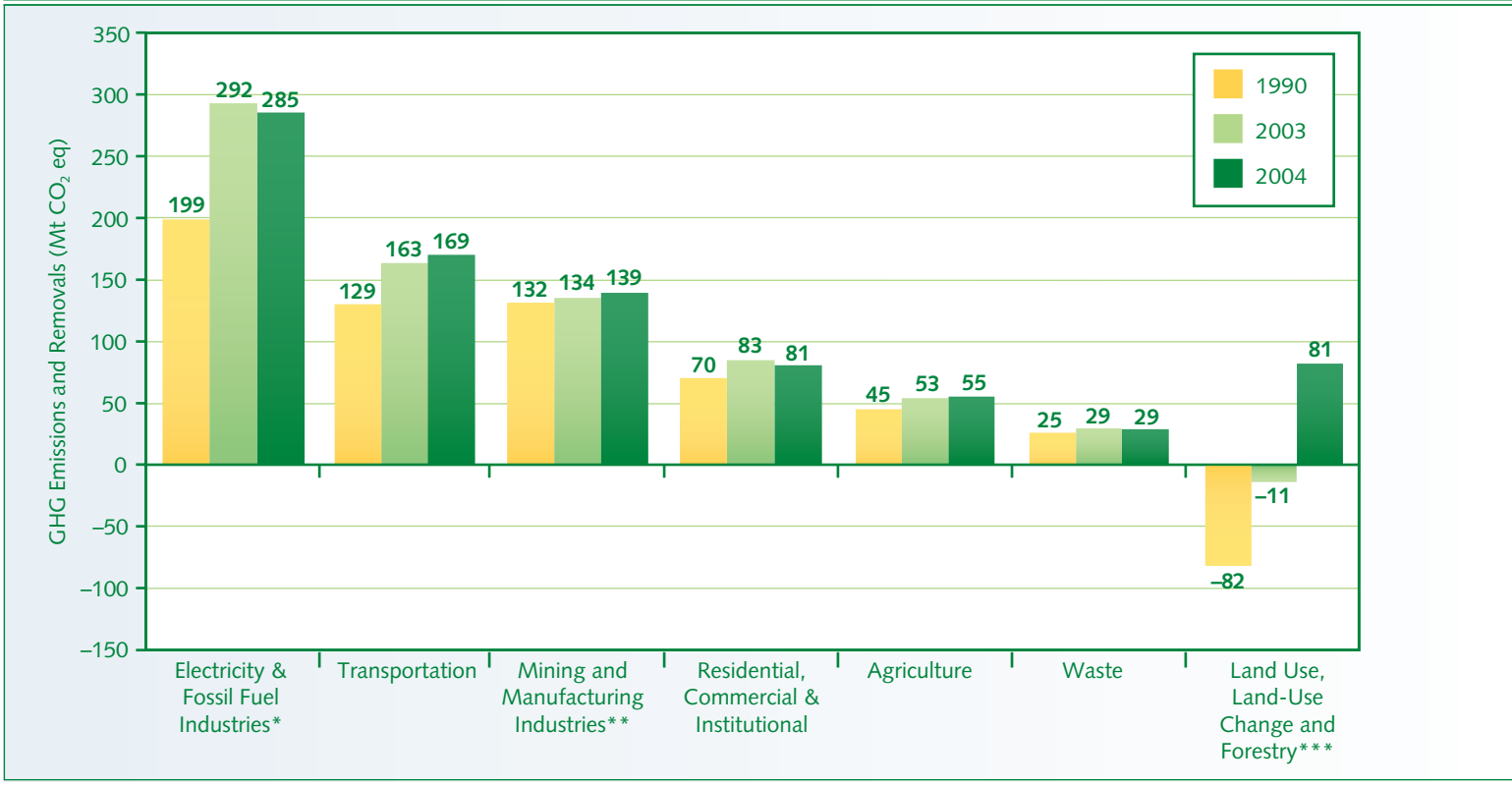
In addition:

- Approximately 73% of total GHG emissions in 2004 resulted from the combustion of fossil fuels. Another 9% were from fugitive sources, with the result that 82% of emissions were from the Energy Sector.

1 Unless otherwise indicated, all emission estimates given in Mt represent emissions of GHGs in Mt CO_2 eq. For brevity, this has been shortened to Mt. This concept provides a relative measure of the impacts of different GHGs on global warming, with the effect of CO_2 being equal to 1.

- On an individual GHG basis, CO_2 contributed the largest share of 2004 emissions, at 78% (about 593 Mt), while CH_4 accounted for 15% (110 Mt). N_2O accounted for 6% of the emissions (44 Mt), while PFCs, SF_6, and HFCs constituted the remaining 1% (11 Mt).
- The greatest contributions to emissions in 2004 were from the Electricity & Fossil Fuel Industries, which accounted for 38% of total national emissions (285 Mt), and the Transportation sector, which contributed 22% (169 Mt). These sectors are also responsible for nearly all of the growth in Canadian emissions since 1990 (Figure 1). This growth is mainly the result of an increase in fossil fuel consumption for electricity generation, a rise in transportation energy consumption, and growth in fossil fuel production (largely for export).
- For the Mining and Manufacturing Industries sector, there has been an overall emissions growth of 7.5 Mt between 1990 and 2004. This growth is the net effect of emission increases and decreases of various subsectors. For instance, there has been a progressive replacement of CFCs by HFCs and a growing use of fossil fuels for non-energy purposes, both of which contributed to emission increases. Despite the overall sectoral emission increase, some industries have shown significant emission reductions. Between 1990 and 2004, aluminium producers reduced their PFC emissions using emission control technologies. Also, the installation of an emission abatement system in Canada's only adipic acid plant resulted in considerable decreases in N_2O emissions.
- Other sectors, such as the Residential, Commercial & Institutional, Agriculture, and Waste sectors, contributed 16% to total emissions growth over the period.
- Net emissions in the Land Use, Land-Use Change and Forestry Sector amounted to 81 Mt in 2004; note that these emissions are not currently included in the national inventory totals.

FIGURE 1: Canadian GHG Emissions and Removals, 1990, 2003 and 2004



Notes:

* Electricity industries include emissions from the power utilities as well as emissions from steam and electricity production in the manufacturing industry.

** Values presented include emissions from the Solvent and Other Product Use Sector.

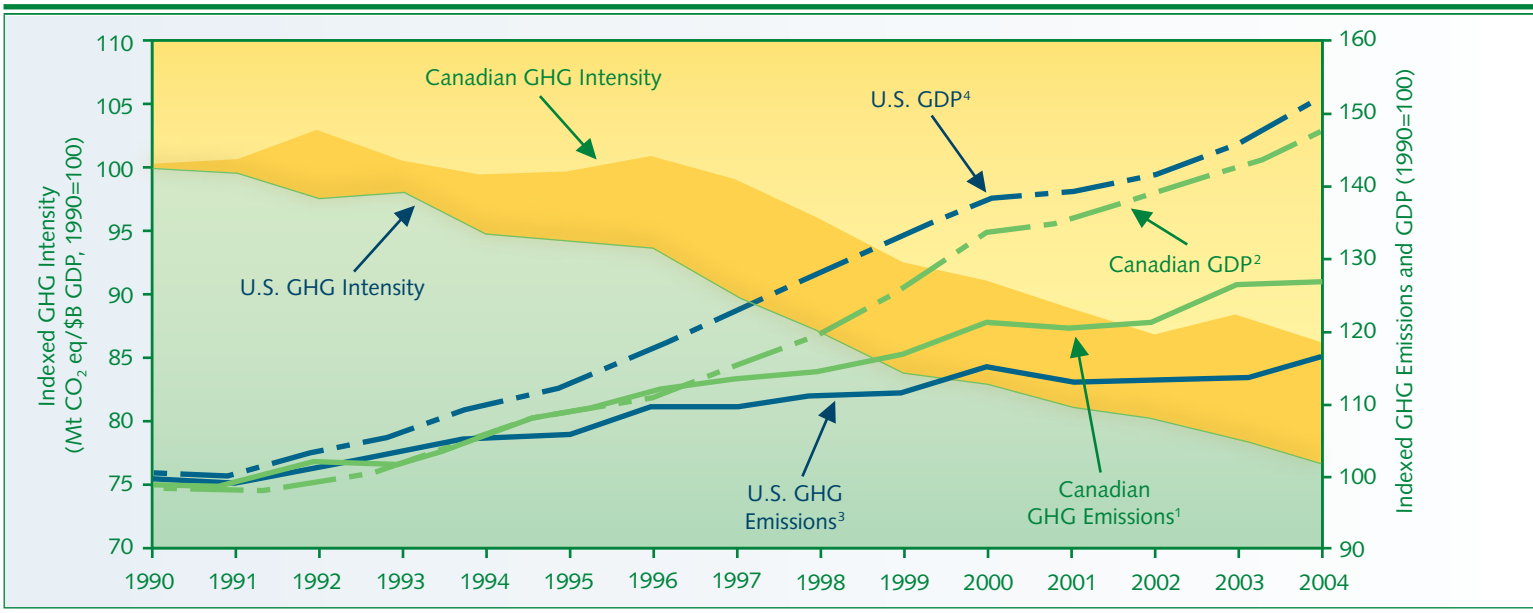
*** Emissions from the Land Use, Land-Use Change and Forestry Sector are not included in the national inventory totals.

National Trends

Table 1 summarizes Canada's GHG emissions by sector for the period 1990–2004. Total emissions of all GHGs in 2004 (758 Mt) were 27% above the 1990 level of 599 Mt. Although emissions have been rising since 1990, annual emissions growth peaked at almost 3.9% in 2000 and 2003. The 0.6% increase in Canada's GHG emissions from 2003 to 2004 was primarily due to mining activity, increases in beef cattle populations, increased use of fossil fuels as feedstock in chemical manufacturing, and the continuation of a long-term trend in road transport–related emissions. However, the overall growth was minor due mainly to significantly reduced emissions from electricity production (less coal and more nuclear generation) and, to a lesser extent, a reduced demand for heating fuel because of a warmer winter.

Figure 2 compares the trends in GHG emissions, GDP, and GHG intensity for Canada and the United States between 1990 and 2004. Both countries experienced a reduction in GHG intensity over the period. For example, Canada's GHG emissions per unit of GDP decreased by 13.8%, while the United States registered a 20.1% reduction. It must be noted that a reduction in GHG intensity does not necessarily reflect a reduction in emissions; it can also indicate changes in the structure of the economy. A closer examination of the trends in emissions and GDP for the two countries reveals that Canada's emissions are growing faster and our GDP is growing at a slower pace than those of the United States.

FIGURE 2: Trends in GHG Emissions, GDP, and GHG Intensity for Canada and the United States, 1990–2004



Sources:

1 Canadian GHG: Environment Canada (2006), *National Inventory Report — Greenhouse Gas Sources and Sinks in Canada: 1990–2004*.

2 Canadian GDP: Informetrica Limited (2006), *Gross Domestic Product (Million 1997 Chained Dollars)*, January 11, 2006.

3 U.S. GHG: U.S. Environmental Protection Agency (2006), *The U.S. Inventory of Greenhouse Gas Emissions and Sinks: 1990–2004*.

4 U.S. GDP: U.S. Department of Commerce (2006), *Real Gross Domestic Product Billions of Chained (2000) Dollars*, Bureau of Economic Analysis.

Factors that affected Canadian emissions growth included increases in fossil fuel consumption for electricity generation, increased energy consumption in the transportation sector, and growth in fossil fuel production (largely for export).

In fact, growth in oil and gas exports (primarily to the United States) contributed significantly to emissions growth between 1990 and 2004 (Table 2). In this period, net oil exports (exports minus imports) grew by 513% to 1572 petajoules (PJ) (almost 10 times the rate of growth of oil production), while net exports of natural gas increased 138% to 3600 PJ (almost twice the rate of growth of natural gas production). Over the period, the sum total of net oil and gas energy exports increased by 192%. The portion of emissions from all oil and gas production, processing, and transmission activities that is attributable to net exports rose from about 22 Mt in 1990 to 48 Mt in 2004 (a 123% increase).

A closer examination of the trends in emissions and GDP for the two countries reveals that Canada's emissions are growing faster and our GDP is growing at a slower pace than those of the United States.

The 0.6% increase in Canada's GHG emissions from 2003 to 2004 was primarily due to mining activity, increased use of fossil fuels in manufacturing, and growth in agricultural and road transportation activities. Significantly reduced emissions from electricity production and a reduced demand for heating fuel because of a warmer winter resulted in minor overall emissions growth.

Annual Growth in GHG Emissions and GDP, 1991–2004

Year	Annual Growth in GHG Emissions (%)	Annual Growth in GDP (%) *
1991	–1.1%	–1.9%
1992	2.9%	0.7%
1993	0.2%	2.4%
1994	3.3%	4.5%
1995	2.8%	2.7%
1996	2.7%	1.4%
1997	2.0%	4.1%
1998	0.9%	4.0%
1999	1.8%	5.6%
2000	3.8%	5.5%
2001	–0.9%	1.7%
2002	0.9%	2.9%
2003	3.9%	2.4%
2004	0.6%	3.3%

Source:

* Informetrica Limited, *Gross Domestic Product (Million 1997 Chained Dollars)*, January 11, 2006.

TABLE 1: Canada's GHG Emissions Summary by Sector, 1990, 2003 and 2004

Greenhouse Gas Source/Sink Categories	GHG Emissions ($Mt CO_2$ equivalent)		
	1990	2003	2004
TOTAL[1]	599	754	758
Electricity & Fossil Fuel Industries	**199**	**292**	**285**
Electricity and Heat Generation[2]	95.3	139	130
Upstream Fossil Fuel Industry[3]	83.9	131	133
Crude Oil Production Industry[4]	22.5	see note 4	50.2
Natural Gas Industry	26.8	36.3	34.2
Other – Oil Sands, Coal, and Coke Production[5]	23.5	see note 5	34.3
Natural Gas Transmission	11.2	14.8	14.2
Downstream Fossil Fuel Industry	19.5	21.7	21.7
Petroleum Refining Industry	16.7	18.3	18.3
Natural Gas Distribution	2.8	3.4	3.4
Transportation	**129**	**163**	**169**
Domestic Aviation	6.4	7.3	7.8
Light-Duty Gasoline Vehicles	53.8	49.4	49.8
Light-Duty Gasoline Trucks	21.7	41.9	43.6
Heavy-Duty Gasoline Vehicles	3.14	4.14	4.21
Motorcycles	0.23	0.23	0.22
Light-Duty Diesel Vehicles	0.67	0.72	0.77
Light-Duty Diesel Trucks	0.59	0.80	0.89
Heavy-Duty Diesel Vehicles	24.5	42.3	44.9
Propane & Natural Gas Vehicles	2.2	0.82	0.87
Railways	7	6	6
Domestic Marine	5.0	6.1	6.6
Off-Road Gasoline	1	1	0
Off-Road Diesel	3	3	3
Mining and Manufacturing Industries[6]	**131**	**133**	**139**
Mining[7]	8.47	18.2	17.8
Smelting and Refining Industries	15.6	13.3	12.7
Pulp and Paper and Saw Mills	13.6	9.01	9.31
Primary & Other Steel Industries	13.5	13.4	14.7
Cement	9.02	11.0	11.4
Industrial Chemical Industries	27.7	18.3	21.8
Other Manufacturing[8]	28.7	34.6	35.3
Other Industries[9]	14.5	15.5	15.6
Solvent & Other Product Use	**0.42**	**0.48**	**0.48**
Residential, Commercial & Institutional	**70**	**83**	**81**
Residential	44	45	43
Commercial & Institutional	25.8	37.9	37.9
Agriculture	**45**	**53**	**55**
Enteric Fermentation	18.4	22.6	24.0
Manure Management	6.7	8.1	8.4
Agricultural Soils – Direct Sources	11	11	12
Agricultural Soils – Pasture, Range, and Paddock Manure	3	4	4
Agricultural Soils – Indirect Sources	6	6	7
Waste	**25**	**29**	**29**
Solid Waste Disposal on Land	23	27	27
Wastewater Handling	1.1	1.2	1.2
Waste Incineration	0.40	0.24	0.25
Land Use, Land-Use Change and Forestry[10]	**–82**	**–11**	**81**
Forest Land	–109	–20	73
Cropland	14	0.8	0
Grassland	NE	NE	NE
Wetlands	6	1	1
Settlements	8	7	7

Notes:

NE = not estimated

1 Due to rounding, individual values may not add up to totals.
2 Includes both utility and industrial generation and commercial steam generation.
3 Includes combustion, process, and fugitive emissions associated with conventional and unconventional production of oil and gas.
4 Crude Oil Production Industry includes emissions associated with conventional crude oil and thermal heavy synthetic oil production. The emissions total for the Crude Oil Production Industry and Other – Oil Sands, Coal, and Coke Production could not be accurately separated in 2003 due to data limitations. The 2003 total for these two sectors was 80.2 Mt CO_2 eq.
5 Other – Oil Sands, Coal, and Coke Production also includes emissions from combined oil and gas production and emissions associated with oil sands mining equipment.
6 Includes combustion and process emissions.
7 Mining excludes off-road emissions from oil and gas production.
8 Other Manufacturing includes emissions associated with product use (such as HFCs, PFCs, and SF_6) and emissions from the food production industry, vehicle and vehicle parts production, textiles, plastics, pharmaceuticals and medicine, etc.
9 Other Industries includes the construction, agriculture, and forestry subsectors.
10 National totals exclude all GHGs from the Land Use, Land-Use Change and Forestry Sector.

TABLE 2: Energy Production, Export, and GHG Emission Trends, 1990–2004

	Year			
	1990	2003	2004	Long-Term Trend (1990–2004)
GHG Emissions[1] (Mt CO_2 eq)	599	754	758	26.6%
GDP[2] – Expense (Millions of 1997$)	712 019	1 012 635	1 045 643	46.9%
Domestic Energy Consumption[3] (PJ)	9 230	11 479	11 618	25.9%
Energy Production[3] (PJ)	7 746	12 492	12 784	65.0%
Energy Exported[3] (PJ)	3 063	7 473	7 798	155%
Net Energy Exported[3,4] (PJ)	1 769	4 958	5 172	192%
Emissions Associated with Exports[4,5] (Mt CO_2 eq)	28	69	73	161%
Emissions Associated with Net Exports[4,5] (Mt CO_2 eq)	22	46	48	123%

Notes: PJ = petajoule (10^{15} joules)

Sources:

1 Environment Canada (2006), *National Inventory Report — Greenhouse Gas Sources and Sinks in Canada: 1990–2004*.

2 Informetrica Limited (2006), *Gross Domestic Product (Million 1997 Chained Dollars)*, January 11, 2006.

3 Statistics Canada (2004), *Report on Energy Supply–Demand in Canada*, Catalogue No. 57-003.

4 Natural gas and crude oil only.

5 For the years 1990–1995, values were taken from T.J. McCann and Associates (1997), *Fossil Fuel Energy Trade & Greenhouse Gas Emissions: A Quantitative Assessment of Emissions Related to Imports and Exports*, Prepared for Environment Canada. Years 1996–2004 values were extrapolated from the report.

Sector Trends in Canada's GHG Emissions and Removals: 1990–2004

Electricity & Fossil Fuel Industries

The electricity and fossil fuel industries contributed 285 Mt, or 38%, of Canada's GHG emissions in 2004. GHG emissions grew by about 43% on a sectoral basis, with electricity emissions increasing by 36% and upstream and downstream fossil fuel industry emissions increasing by 58% and 12%, respectively, since 1990.

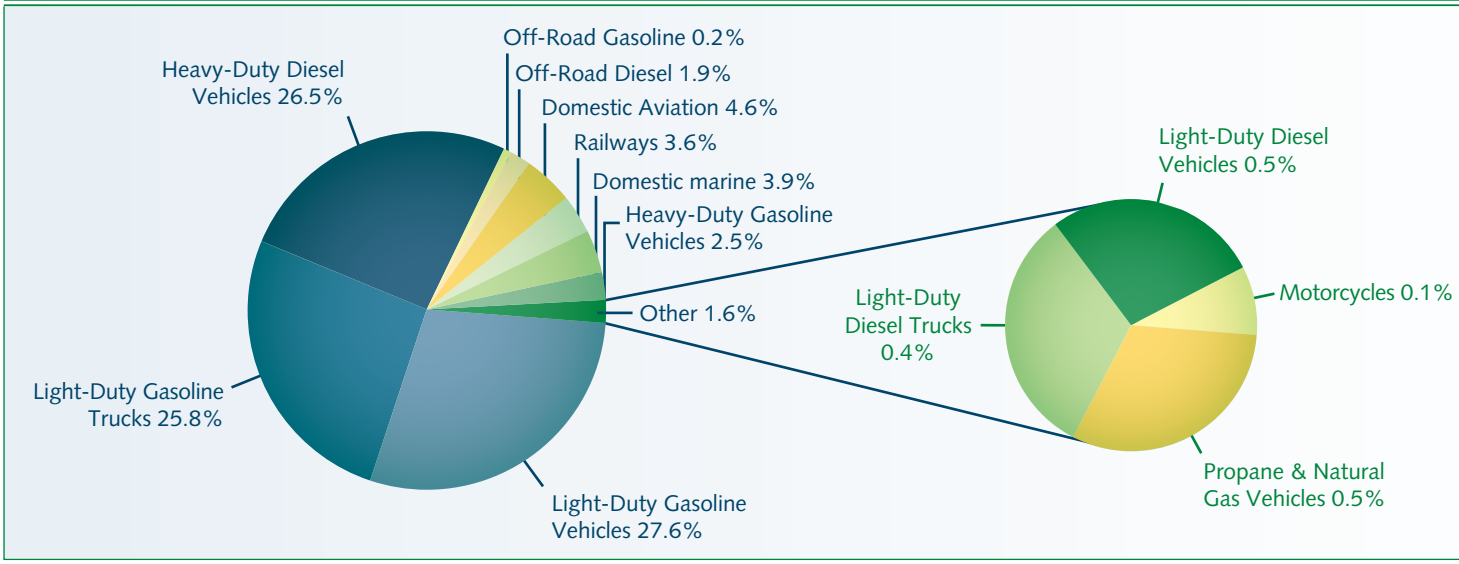
- In 2004, the electricity and heat generation industry contributed 130 Mt (17%) to Canada's GHG emissions.
  - Since 1990, electricity and heat generation has increased by about 23% and emissions have grown by 37%. This is due primarily to an increase in the percentage of electricity generated by natural gas and a decrease in the amount generated by hydro sources in the overall makeup of electricity generation within Canada.
- In 2004, the fossil fuel industry as a whole contributed 155 Mt (about 20%) of Canada's total GHG emissions, of which the upstream and downstream petroleum sectors contributed 133 Mt and 21.7 Mt, respectively.
  - From an economic standpoint, the fossil fuel industry's GDP grew by 52% between 1990 and 2004, with a 192% rise in net energy exports. GHG emissions also increased as a result of growing foreign sales, with an increase of 48 Mt (123%) in GHG emissions associated only with those exports.
  - Since well before 1990, easily removable reserves of conventional crude have been falling and energy consumption per unit of conventional oil produced has been increasing. Between 1990 and 2000, the energy requirements per barrel of conventional light/medium oil extracted nearly doubled, while at the same time highly energy- and GHG-intensive synthetic oil production (i.e., from oil sands) has become increasingly competitive with conventional oil extraction. These trends contribute significantly to the rapidly rising emission increases in the fossil fuel industry over the 1990–2004 period.
- Since 1990, the upstream fossil fuel industry has experienced a 56% growth in GDP and a 58% (49 Mt) increase in GHG emissions.
  - Increasing foreign energy demands between 1990 and 2004 resulted in a 46 Mt increase in GHG emissions from the upstream petroleum industry.
  - Since 1990, emissions from the transmission of natural gas increased by 3.0 Mt (27%), while GDP for this subsector grew by 103%.
- The downstream petroleum industry has experienced a 32% growth in GDP with a 12% increase in GHG emissions since 1990.
  - Combustion and process emissions associated with the downstream petroleum refining industries increased by 1.6 Mt, while fugitive emissions from the distribution of natural gas increased by 0.6 Mt.

The transportation sector (excluding pipelines and industrial off-road emissions) represents one of the largest sources of emissions in Canada, accounting for 22.3% of Canada's total emissions in 2004 (169 Mt).

Transportation

- The transportation sector (excluding pipelines and industrial off-road emissions) represents one of the largest sources of emissions in Canada, accounting for 22.3% of Canada's total emissions in 2004 (169 Mt). Off-road emissions associated with oil sands mining, forestry, and agriculture are included in the Fossil Fuel Industries and the Mining and Manufacturing Industries sectors.
- Emissions increased 31% (40 Mt) between 1990 and 2004. On-road transportation was the largest contributor to emissions in this sector, at 85.9% in 2004. Nearly all emissions growth can be attributed to light-duty gasoline trucks, or LDGTs (these include sport utility vehicles, or SUVs, and minivans), which contributed 55% or 22 Mt of this sector's growth, and heavy-duty diesel vehicles, which accounted for 51% or 20.4 Mt of the growth. The sum is greater than 100%, as emissions decreased for Light-Duty Gasoline Vehicles (LDGVs), or cars, Propane & Natural Gas Vehicles, Railways, and Off-Road Gasoline. Figure 3 provides a breakdown of emissions from the different modes of transportation for 2004.
- The long-term trend (1990–2004) shows an increase in emissions from LDGTs, while emissions from LDGVs are decreasing. This can be explained by the increase in purchases of LDGTs (SUVs, minivans) instead of cars for personal transportation.

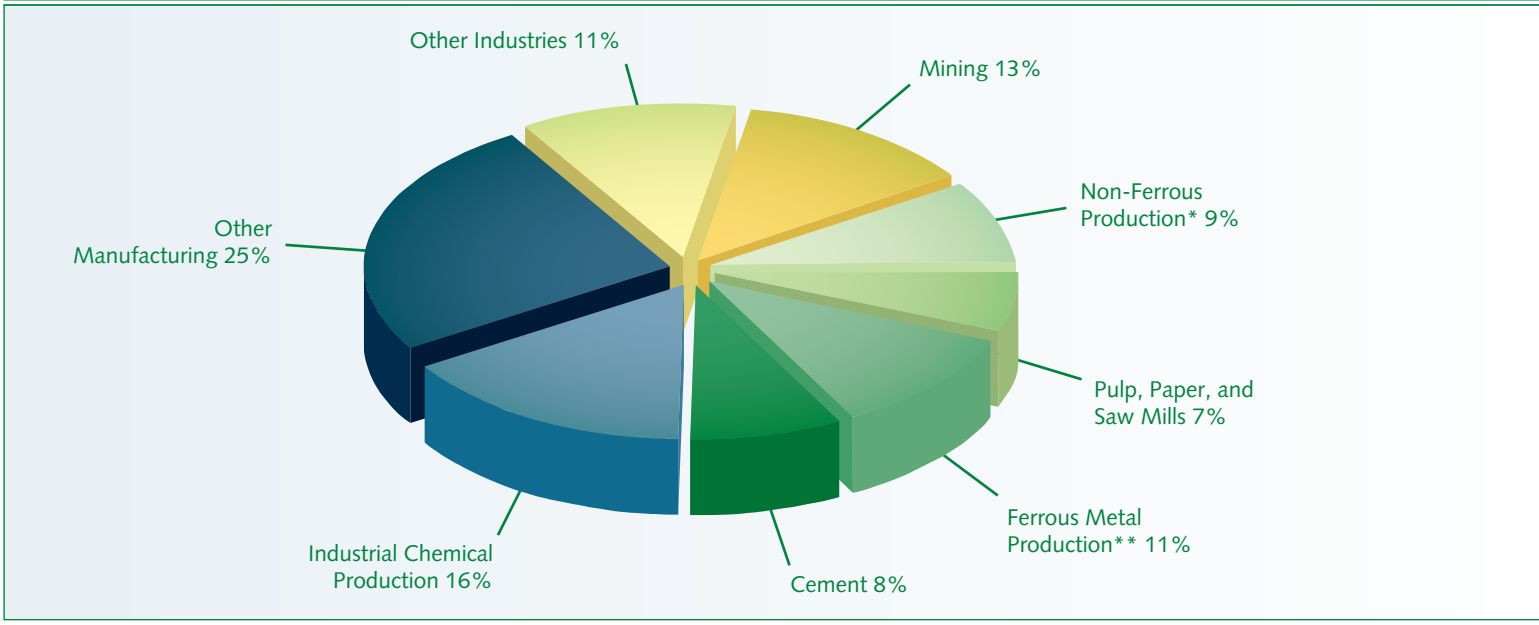
FIGURE 3: Canada's GHG Emissions from Transportation Sources in 2004



Mining and Manufacturing Industries

- Mining and Manufacturing Industries together contributed 18% (139 Mt) to Canada's total GHG emissions in 2004. Of these emissions, combustion emissions accounted for about 61% and process emissions approximately 39%.
- As depicted in Figure 4, the Other Manufacturing subsector accounted for one-quarter (35 Mt) of the total GHG emissions from the Mining and Manufacturing Industries in 2004. This subsector encompasses all manufacturing activities not captured under any of the other specific categories. This includes food manufacturing, plastics and rubber manufacturing, and lime and gypsum products manufacturing, to name just a few. The GHG emissions in this subsector are primarily combustion emissions (60%), with the industrial process emissions making up the balance.
- The mining subsector accounted for 2.3% (17.8 Mt) of Canada's GHG emissions in 2004. Between 1990 and 2004, the industry observed a 48% increase in sector GDP, while GHG emissions rose by 9.3 Mt. Owing to increasing demand for natural gas (which grew by 243% over 1990–2004), combustion emissions increased by about 110% over the same period.

FIGURE 4: Breakdown of Canada's 2004 GHG Emissions in the Mining and Manufacturing Industries by Industrial Subsector



Notes:

* Non-ferrous production refers to the Smelting and Refining Industries.

** Ferrous metal production refers to the Primary & Other Steel Industries.

- The non-ferrous metal production (smelting and refining) subsector contributed 9% (12.7 Mt) to Mining and Manufacturing Industry emissions in 2004. The bulk of these emissions are due to the release of gases with high global warming potentials, originating from aluminium and magnesium production processes. Between 1990 and 2004, the non-ferrous smelting and refining industry experienced growth in sector GDP of 98%, while GHG emissions decreased by 19%. Process emissions from primary aluminium and magnesium production decreased by 22% and 30%, respectively. These reductions were due to better control of anode events in smelters and the progressive replacement of SF_6 with alternative cover gases.
- In 2004, the ferrous metal production (Primary & Other Steel Industries) subsector represented 2% (14.7 Mt) of Canada's total GHG emissions, contributing 10.6% to mining and manufacturing industry emissions. Stationary fuel combustion and process-related sources accounted for 45% (6.55 Mt) and 55% (8.2 Mt) of the GHG emissions for this subsector, respectively.
- The cement subsector accounted for 8% (11.4 Mt) of the Mining and Manufacturing Industries' GHG emissions in 2004, which represents 1.5% of Canada's total GHG emissions. Approximately 62% of the emissions are a result of the clinker production process, while the balance is attributable to fuel combustion.
- For 2004, GHG emissions from Industrial Chemical Industries are estimated at 21.8 Mt, or 16% of the Mining and Manufacturing Industries' totals. This represents 2.9% of Canada's overall GHG emissions. Over 71% of the GHG emissions from Industrial Chemical Industries are process emissions, which have decreased about 25% since 1990. Process emissions from this subsector include CO_2 emissions from the steam reforming of natural gas in ammonia production and N_2O generated as a by-product during the production of adipic and nitric acids. The process emissions decrease can mostly be explained by the installation of emission abatement equipment in Canada's only adipic acid plant. When combustion emissions are factored in, Canadian chemical industries have exhibited a 21% decrease in GHG emissions between 1990 and 2004.

- Between 1990 and 2004, GHG emissions and GDP for the Mining and Manufacturing Industries sector grew by 5.7% (7.5 Mt) and 40% ($78.6 billion), respectively. The overall economic GHG intensity of this broad sector was 0.51 Mt per billion dollars, 30% below the Canadian average of 0.725 Mt per billion dollars.

Solvent and Other Product Use

- The Solvent and Other Product Use Sector was a minor contributor to Canada's emissions total, as it was responsible for less than 1 Mt of GHGs. Emissions from this sector — N_2O emissions from the use of anaesthetics and propellants — have increased by 15.3% since 1990.

Residential and Commercial/ Institutional Subsectors

- The residential and commercial/institutional subsectors contributed 81 Mt or 11% of Canada's GHG emissions in 2004. The residential subsector alone contributed about 43 Mt (5.7% of the Canadian total), while the commercial and institutional subsector contributed 38 Mt (5.0% of the Canadian total).
- Commercial and institutional emissions increased by 12 Mt (47%) between 1990 and 2004 due to a 25% increase in commercial and institutional building floor space. Energy demand in commercial buildings is also influenced by weather. In relation to the number of heating degree-days, 2004 was 8% colder than 1990.

Agriculture

- In 2004, GHG emissions from the Agriculture Sector totalled 55 Mt and contributed 7.3% of total national emissions. This sector accounted for 64% of Canada's total emissions of N_2O and 25% of CH_4 emissions.
- On a category basis, agricultural soils contributed 40% of the sector's emissions (23 Mt) in 2004. The balance of emissions in this sector originate from domestic animal enteric fermentation (44% or 24 Mt) and manure management (15% or 8.4 Mt).
- Total sector emissions rose 23% between 1990 and 2004. Emissions from manure management increased by 26% and those from enteric fermentation by 30%. N_2O emissions from soils rose 14% over the same period.

Land Use, Land-Use Change and Forestry (LULUCF)

- In 2004, the LULUCF Sector was a net source of 81 Mt of GHG emissions to the atmosphere. This estimate represents the sum of the net CO_2 flux and non-CO_2 (CH_4 and N_2O) emissions. The net CO_2 flux alone amounted to a source of 59 Mt, while emissions of non-CO_2 gas added up to 22 Mt.
- With the 2006 submission, Canada has begun the implementation of a multi-year effort to substantially improve its estimates for the LULUCF Sector. In addition to new estimates being reported for wetlands and N_2O from land conversion to cropland, all LULUCF categories except Grasslands represent completely revised and expanded estimates.
- The time series of the net LULUCF flux over the 1990–2004 period is heavily influenced by the high variability in the impact of natural disturbances on forest land, notably fires. As a result, the entire LULUCF Sector can be either a source (as in 1995, 1998, and 2004) or a sink (as in 1997, 2000, and 2001).
- Excluding natural disturbances, the trends observed in the LULUCF Sector largely reflect the changing levels of industrial forestry activity during the 1990s. Accounting for the carbon stored in harvested wood products would significantly reduce the apparent impact of industrial activity on LULUCF Sector emissions and removals.
- The natural variability of forest disturbances will remain a major challenge in the projection of annual emissions and removals in the LULUCF Sector.

Waste

- The Waste Sector contributed 29 Mt or 3.8% to Canada's GHG emissions in 2004. Solid waste disposal on land accounted for more than 95% (27 Mt) of Waste Sector GHG emissions, while wastewater handling and waste incineration accounted for 4% (1.2 Mt) and 1% (0.3 Mt), respectively.
- In 2004, CH_4 captured by landfill gas collection systems contributed to a 21% (6.5 Mt) reduction in direct atmospheric emissions of CH_4 from municipal solid waste. This resulted in a net release of 22 Mt. CH_4 captured by landfill gas collection systems has increased by 48% (2.1 Mt) since 1990.

Provincial and Territorial GHG Emissions

Table 3 provides a summary of GHG emissions by province and territory for 1990 and 2004 by sector (as defined by UNFCCC sector and not by modified Canadian industrial sector as in the previous trend analysis and discussion). Although the UNFCCC Guidelines on annual inventories require only that national-level detail be reported, it is considered important to provide these details due to the distinct regional differences in emission levels and trends that exist within Canada. Also, it must be noted that provincial and territorial emission estimates do not sum exactly to the national totals. The differences are due to two factors: rounding of the emissions data and suppression of some confidential provincial/territorial activity data.

GHG emissions are not distributed evenly across Canada. Regional differences in factors such as climate, resources available for energy production and/or industry, and travel patterns all contribute to different levels and trends of emissions.

GHG emissions are not distributed evenly across Canada. Regional differences in factors such as climate, resources available for energy production and/or industry, and travel patterns all contribute to different levels and trends of emissions. Figure 5 illustrates the provincial and territorial contributions to Canada's total emissions in 2004. The largest provincial contributors were Alberta, with 31% of Canada's total emissions (235 Mt), and Ontario, which accounted for 27% of the national total (203 Mt). The next largest contribution to national emissions was from Quebec, at 12%, while Saskatchewan and British Columbia contributed 9.2% and 8.9%, respectively. The remainder of the emissions in 2004 were from Manitoba, Nova Scotia, and New Brunswick (each accounting for about 3%). Newfoundland and Labrador added 1.4%, while Prince Edward Island and the territories together contributed less than 1% to total national emissions in 2004.

FIGURE 5: Relative Provincial and Territorial Contributions to Canada's GHG Emissions in 2004

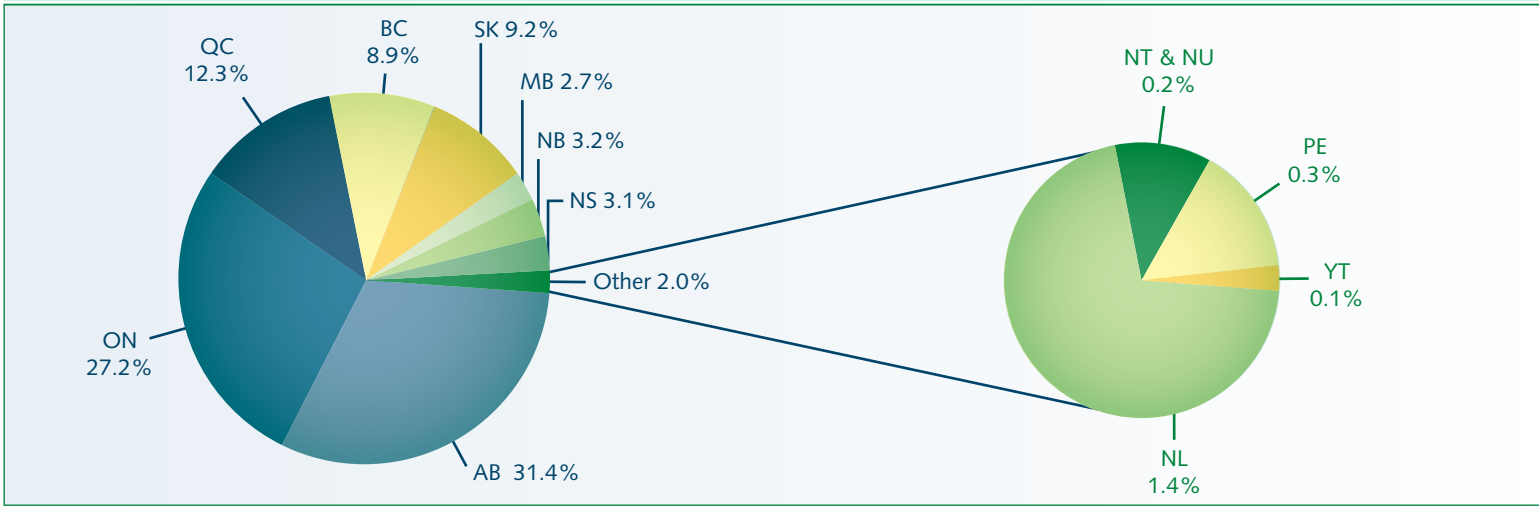


TABLE 3: Summary of Provincial and Territorial GHG Emissions by Sector, 1990 and 2004

	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC	NT & NU	YT
1990 GHG Emissions by Sector[1,2,3]	**kt CO_2 equivalent**											
Energy	8 840	1 460	17 800	14 700	58 700	134 000	12 400	35 000	146 000	41 400	1 520	504
Industrial Processes	75.3	2.82	272	152	12 900	26 100	504	280	8 080	3 090	2.88	0.85
Solvent and Other Product Use	8.7	2.0	14	11	110	160	17	15	38	50	0.89	0.42
Agriculture	49	460	510	460	7 200	10 000	4 400	6 800	13 000	2 100	–	–
Land Use, Land-Use Change and Forestry[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waste	1 100	170	1 200	1 100	7 700	6 100	610	620	1 500	4 900	21	10
Total	**10 100**	**2 100**	**19 700**	**16 400**	**86 600**	**177 000**	**18 000**	**42 700**	**168 000**	**51 500**	**1 540**	**515**
2004 GHG Emissions by Sector[1,2,3]	**kt CO_2 equivalent**											
Energy	9 470	1 630	21 300	22 300	66 200	164 000	12 300	56 400	203 000	55 200	1 570	403
Industrial Processes	23.4	2.52	301	298	9 800	21 400	468	1 400	12 700	3 170	5.38	0.49
Solvent and Other Product Use	7.8	2.1	14	11	110	190	18	15	48	63	1.1	0.47
Agriculture	44	510	500	490	7 300	10 000	6 400	10 000	17 000	2 500	–	–
Land Use, Land-Use Change and Forestry[4]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waste	950	170	910	1 100	8 400	7 400	910	920	2 200	5 900	32	14
Total	**10 500**	**2 310**	**23 000**	**24 100**	**91 800**	**203 000**	**20 000**	**69 100**	**235 000**	**66 800**	**1 600**	**418**
Absolute Change in Emissions (kt), 1990–2004	**440**	**212**	**3 250**	**7 700**	**5 270**	**26 500**	**2 050**	**26 400**	**66 300**	**15 400**	**61**	**–98**
Relative Change in Emissions (%), 1990–2004	4%	10%	17%	47%	6%	15%	11%	62%	39%	30%	4%	–19%
Relative Contribution to Absolute Growth in Emissions (%)	**0.3%**	**0.1%**	**2.1%**	**5.0%**	**3.4%**	**17.3%**	**1.3%**	**17.2%**	**43.2%**	**10.0%**	**0.0%**	**–0.1%**
2004 GHG Emissions Per Capita[1,5,6] (tonnes GHGs/person)	**21.9**	**16.7**	**24.2**	**28.6**	**12.4**	**17.1**	**16.7**	**66.8**	**72.9**	**15.4**	**52.9**	**6.0**
2004 GHG Intensity of GDP[1,7,8] (kt CO_2 eq/$Million GDP)	0.87	0.73	1.00	1.17	0.43	0.49	0.61	2.28	1.83	0.52	0.29[9]	

Notes:

1 GHG Emissions: Environment Canada (2006), *National Inventory Report — Greenhouse Gas Sources and Sinks in Canada: 1990–2004*.

2 Due to confidentiality and rounding, individual values may not add up to totals (zero values may represent estimated quantities too small to display).

3 Emissions associated with the use of HFCs, PFCs, ammonia, limestone, and soda ash are reported in the national total.

4 All GHG emissions or removals in the LULUCF Sector are excluded from totals and reported only at the national level.

5 Population data: Statistics Canada (2003), *Demographic Statistics*, Catalogue No. 91-213-XIB.

6 National average: 23.39 tonnes per person.

7 GDP data: Informetrica Limited (2006), *Gross Domestic Product (Million 1997 Chained Dollars)*, January 11, 2006.

8 National value: 0.72.

9 GHG Intensity of GDP reported for total territories due to data availability.

kt: kilotonne; N/A: not applicable

In terms of emissions growth, all provinces and territories except the Yukon (–19%) experienced an increase in their emissions over the 1990–2004 period. During this 14-year period, four provinces were responsible for 88% of the total national growth in emissions — Alberta accounted for 43% of total growth, while Ontario and Saskatchewan both contributed 17%, and British Columbia added 10%.

Excluding CO_2 fluxes from agricultural soils, total emissions from the Agriculture Sector increased by 22% between 1990 and 2004 (from 45 Mt to 55 Mt). On a provincial basis, CH_4 and N_2O emissions increased steadily, from 4.4 to 6.4 Mt in Manitoba, from 6.8 to 10.3 Mt in Saskatchewan, and from 12.5 to 16.7 Mt in Alberta. There has been very little change in CH_4 and N_2O emissions in British Columbia, Ontario, Quebec, and the Atlantic region of Canada. The increased emissions from the Prairie provinces have mainly resulted from livestock expansion and higher synthetic nitrogen fertilizer consumption. Collectively, these provinces have contributed to most of the growth in Canada's non-CO_2 GHG emissions from the Agriculture Sector since 1990. The increased non-CO_2 emissions from the Prairies are offset by increasing removals of CO_2 because of increasing storage of soil organic carbon through adoption of no-tillage and reduction of summerfallow.

The largest provincial contributors were Alberta, with 31% of Canada's total emissions (235 Mt), and Ontario, which accounted for 27% of the national total (203 Mt).

References

Environment Canada (2006), *National Inventory Report — Greenhouse Gas Sources and Sinks in Canada: 1990–2004*, Environment Canada, Ottawa, Ontario, Canada.

Informetrica Limited (2006), *Gross Domestic Product (Million 1997 Chained Dollars)*, January 11, 2006.

Informetrica Limited and Statistics Canada, *Industrial GDP at Basic Prices by NAICS Code in 1997 Dollars: 1981–2003*.

Natural Resources Canada (1990–2004), *Canadian Minerals Yearbook, Annual Editions*, Natural Resources Mining Sector.

Natural Resources Canada (2004), *Energy Efficiency Trends in Canada, 1990 to 2002*, Office of Energy Efficiency, Natural Resources Canada, Ottawa, Ontario, Canada, Catalogue No. M141-1/2002 (http://oee.nrcan.gc.ca/neud/dpa/data_e/Trends04/Trends2004.pdf).

Natural Resources Canada (2005), *Energy Efficiency Trends in Canada, 1990–2003*, Office of Energy Efficiency, Natural Resources Canada, Ottawa, Ontario, Canada.

Nyboer, J. and K. Tu (2006), *GHG Emission Trend Analysis in the Fossil Fuel Production Industries* (Draft), Canadian Industrial Energy End-Use Data and Analysis Centre, Simon Fraser University, Burnaby, British Columbia, Canada.

Statistics Canada, *Cement, 1990–2004* (Monthly), Catalogue No. 44-001-XIB (discontinued).

Statistics Canada, *Primary Iron and Steel, 1990–2004* (Monthly), Catalogue No. 41-001-XIB.

Statistics Canada (2003), *Demographic Statistics* (Annual), Catalogue No. 91-213-XIB.

Statistics Canada (2004), *Report on Energy Supply–Demand in Canada* (Annual), Catalogue No. 57-003.

T.J. McCann and Associates (1997), *Fossil Fuel Energy Trade & Greenhouse Gas Emissions: A Quantitative Assessment of Emissions Related to Imports and Exports*, Prepared for Environment Canada.

U.S. Census Bureau (2004), *Table 8: Annual Estimates of the Population for the United States, Regions, and Divisions: April 1, 2000 to July 1, 2004* (NST-EST2004-08) (http://quickfacts.census.gov/qfd/states/00000.html).

U.S. Department of Commerce (2006), *Real Gross Domestic Product Billions of Chained (2000) Dollars*, Bureau of Economic Analysis (www.bea.gov/bea/dn/gdplev.xls).

U.S. Environmental Protection Agency (2006), *The U.S. Inventory of Greenhouse Gas Emissions and Sinks: 1990–2004*, April (http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR6P5M5M/$File/06FastFacts.pdf).

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This document is also available on Environment Canda's Green Lane at

www.ec.gc.ca/ghg-ges

For a complete summary of provincial and territorial emissions for the years 1990 through 2004 inclusive, consult Environment Canada's Greenhouse Gas Emissions web site at www.ec.gc.ca/ghg-ges.