

INFORMATION ON GREENHOUSE GAS SOURCES AND SINKS

Canada's 2007 Greenhouse Gas Inventory – A Summary of Trends

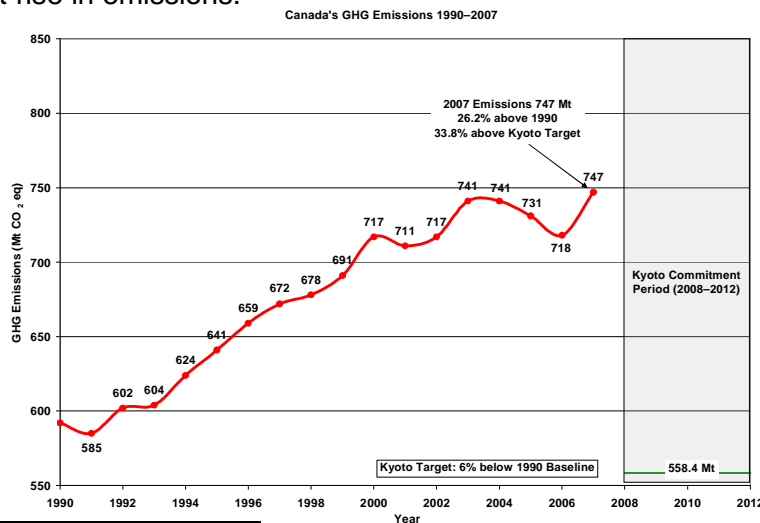
2007 Greenhouse Gas Emission Trends

Every year, Canada prepares a national inventory of human-induced greenhouse gas emissions from sources (e.g. fuel combustion, industrial processes) and removals by sinks (e.g. growing trees).

Total greenhouse gas (GHG) emissions in Canada in 2007 were 747 megatonnes of carbon dioxide equivalent¹ (Mt of CO₂ eq), an increase of 4.0% from 2006 levels, and of 0.8% from 2004 levels. Overall, the long-term trend indicates that emissions in 2007 were about 26% above the 1990 total of 592 Mt. This trend shows a level 33.8% above Canada's Kyoto target of 558.4 Mt.

The fluctuation in emissions since 2003/2004 is due primarily to changes in the mix of sources used for electricity production (coal use grew in some provinces, but varied in Ontario with the availability of hydro and nuclear generation); changing emissions from fossil fuel production (as a result of the level of petroleum extraction activities); and varying demand for heating fuels for winters which warmed steadily from 2004 to 2006 but then grew much colder (by ~10%) in 2007.

Nevertheless, long-term growth remains significant. Between 1990 and 2007, large increases in oil and gas production—much of it for export—as well as a large increase in the number of motor vehicles and greater reliance on coal electricity generation, have resulted in a significant rise in emissions.



National Inventory

As an Annex I Party (Developed Countries) to the United Nations Framework Convention on Climate Change (UNFCCC), Canada is required on an annual basis to prepare and submit a national inventory of human-induced greenhouse gas emissions from sources (e.g. fuel combustion, industrial processes) and removals by sinks (e.g. growing plants and trees) in the form of a National Inventory Report (NIR) and a set of Common Reporting Format (CRF) tables. The National Inventory must meet international reporting guidelines and quality standards, and is reviewed annually by a UN Expert Review Team.

In addition, Annex I Parties are required to continuously improve the quality of their national greenhouse gas (GHG) inventory. As new information and data become available and more accurate methods are developed, previous estimates are updated to provide a consistent and comparable trend in emissions and removals.

This year's inventory covers the period from 1990 to 2007 and incorporates updates to previous years' submissions, based in large part on recommendations provided by the UN Expert Review Team that undertook an in-depth review in the fall of 2007.

¹ Each greenhouse gas has a different potential to contribute to warming. Scientists assign each gas a “global warming potential” (GWP), based on the gas' ability to contribute to climate change. Carbon dioxide is set as the baseline with a global warming potential of 1 (for example, the GWP for methane (CH₄) is 21).

Short-Term Comparisons

Since 2004, total Canadian greenhouse gas emissions have increased by 6.2 Mt (0.8%). Although there were some large increases in areas such as road transportation and mining, these were offset by declines in most of the Industrial Processes subsectors and all Agriculture subsectors, as well as combustion emissions from both the Pulp and Paper industries, and “Commercial & Institutional” subsectors.

- Though between 2004 and 2007, greenhouse gas emissions from electricity and heat generation shrank slightly, they fluctuated by about 10 Mt. Against a backdrop of increasing coal power usage in some areas, fossil fuel generation varied with the availability of electricity from hydro, nuclear and, to some extent, wind power sources. Indeed, hydroelectric power generation increased throughout Canada as a result of higher water levels (precipitation in each of 2004, 2005 and 2006 was greater than the 30-year average) and increased hydro-generating capacity. At the same time, efforts have been made in Ontario to decrease coal generation and bring more nuclear plants back on line. These efforts were more successful in 2006 than 2007, when some nuclear outages necessitated increased coal generation (and hence, emissions).
- Fossil fuel production,² consisting of oil, gas and coal production, refining and transmission, showed a 7.4 Mt increase (4.6%) in greenhouse gas emissions between 2004 and 2007. During the same period, crude oil exports increased by 12%, while crude oil production increased by 8%. In contrast, domestic consumption of crude decreased by approximately 4%. At the same time, the average annual price of crude almost doubled.
- Emissions associated with Mining and Oil and Gas Extraction alone increased by 56.7% (8.4 Mt) between 2004 and 2007, largely due to increased activity at the Alberta oil sands. This was partially offset by a flattening of Canadian natural gas production and decreasing conventional petroleum production.
- On average, Canadian homes and businesses required lower amounts of energy for heating each successive year between 2004 and 2006 because of generally milder winter temperatures. In 2007, heating degree-days, an indicator of the necessity for space heating in reaction to the severity of cold weather, were up almost 10% over 2006 on a national basis. This fact almost certainly had an impact on fossil fuel consumption, in particular in the Residential and Commercial & Institutional sectors, where emissions have increased by a total of 5.5 Mt or 7.5% since 2006.
- These contributing factors led to low emissions in 2006, followed by a strong increase in 2007.

Trends in Emissions and Emissions Intensities for Selected Years (1990–2007)

	1990	1995	2000	2003	2004	2005	2006	2007
Total GHG (Mt)	592	641	717	741	741	731	718	747
<i>Change since 1990 (%)</i>	NA	8.3	21.2	25.1	25.2	23.5	21.4	26.2
<i>Annual Change (%)</i>	NA	NA	NA	NA	0.0	-1.3	-1.7	4.0
<i>Average Annual Change (%)*</i>	NA	1.7	2.1	1.9	1.8	1.6	1.3	1.5
GDP (Billions 2002\$)	825	899	1,101	1,175	1,211	1,246	1,285	1,320
<i>Change since 1990 (%)</i>	NA	8.9	33.3	42.3	46.8	51.0	55.7	59.9
<i>Annual Change (%)</i>	NA	NA	NA	NA	3.1	2.9	3.1	2.7
GHG Intensity (Mt/\$B GDP)	0.72	0.71	0.65	0.63	0.61	0.59	0.56	0.57
<i>Change since 1990 (%)</i>	NA	-0.5	-9.1	-12.1	-14.7	-18.2	-22.0	-21.1
<i>Annual Change (%)</i>	NA	NA	NA	NA	-3.0	-4.1	-4.7	1.3

GDP: Canada - Gross Domestic Product – expenditure based, chained 2002 dollars – Statistics Canada, 2008.

*Average annual change since 1990.

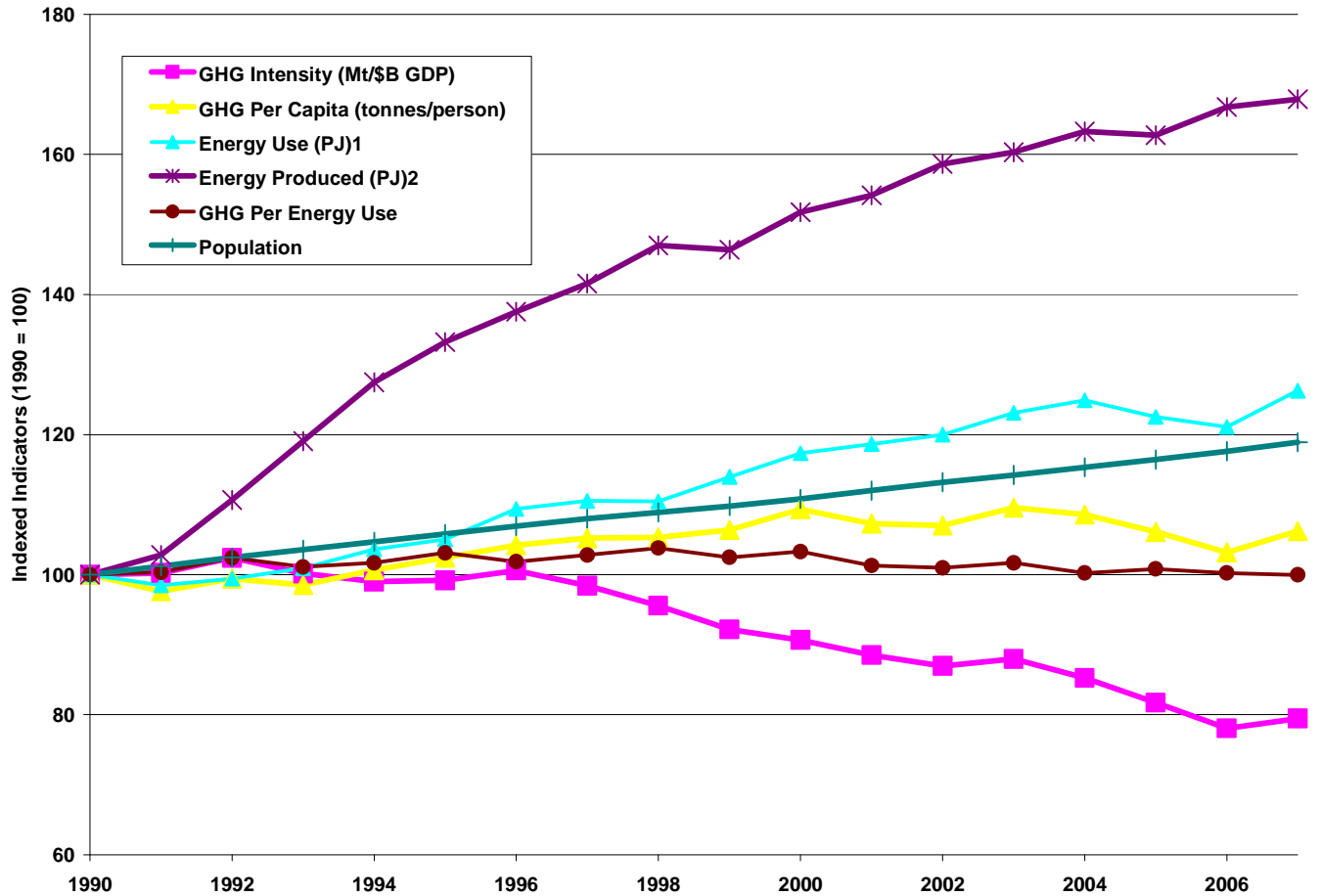
NA = Not Applicable.

2. Sum of Mining and Oil and Gas Extraction, Fossil Fuel Industries, Pipelines (Transportation) and Fugitive releases.

Long-Term Comparisons by Sector: 1990–2007

Sector Trends

- Between 1990 and 2007, the net increase in Canada's annual greenhouse gas emissions totalled about 155 Mt. Over the same period, emissions from the energy industries (fossil fuel production and electric power) and transportation areas increased by about 143 Mt, accounting for most of the overall increase.



¹ Statistics Canada's *Report on Energy Supply and Demand In Canada 2007* (57-003), Table S, Line 2 (Availability – Total Primary).

² Statistics Canada's *Report on Energy Supply and Demand In Canada 2007* (57-003), Natural Gas and Crude Oil.

- Within these two energy areas, the greatest contributors to the overall increase were the 117% increase from Light-duty Gasoline Trucks, the 32% increase from Electricity and Heat Generation, and the 94% increase from Heavy-duty Diesel Vehicles. Much of the increase in fossil fuel production is attributable to the rapid growth in crude oil and natural gas exports to the United States over the period.
- The Industrial Processes, Agriculture and Waste sectors contributed to changes in emissions levels; they showed a 3.4 Mt decrease, a 11.2 Mt increase and a 2.5 Mt increase, respectively, since 1990.

Energy Industries

- Emissions from the energy industries (including Electricity and Heat Generation, Fossil Fuel Industries, combustion emissions from Pipelines and Fugitive releases) rose by about 74 Mt between 1990 and 2007. Over half of that increase (43.9 Mt) was from the Fossil Fuel Industries, Pipelines and Fugitive categories, a product of the increase in oil and gas production over the period. The remainder of the increase in the energy industries (30.5 Mt) was in Electricity and Heat Generation, a result of greater electricity demand, coupled with

continuing increases in the use of coal-fired power generation since 1990.

- Mining emissions have risen 17.1 Mt or 276% since 1990. While this subsector does include emissions for non-energy related mining, an increasing proportion is represented by those emissions from the activities associated with Canada's oil sands, which saw four new projects commence operations in 2007.
- Fugitive releases (e.g. venting and flaring from oil production, methane leaks from pipelines) by themselves contributed significantly to greenhouse gas emissions. The current estimates show an increase of 22.2 Mt between 1990 and 2007, a growth of about 52%. Much of this increase is the result of higher crude oil and natural gas exports.

Transportation

- Emissions in the Transportation subsector rose by about 54.5 Mt, or 37.5% from 1990 to 2007. Of particular note in this sector is a 24.3 Mt-increase (more than 117%) in the emissions from light-duty gasoline trucks, reflecting the growing popularity of sport utility vehicles.
- Emissions from heavy-duty diesel vehicles increased 19.4 Mt over the period, indicative of greater heavy-truck transport. Offsetting these increases were reductions of 4.7 Mt from gasoline-fuelled cars and 1.4 Mt from alternatively fuelled cars.

Residential

- Residential emissions were essentially the same in 2007 as they were in 1990 (up 0.2% or 0.1 Mt). Here, the impact of the long-term trend of improved energy standards for homes and the adoption of higher-efficiency furnaces and other improved appliances has served to reduce emissions.

Industrial Processes Sector

- Emissions in the Industrial Processes Sector witnessed an overall decrease of 3.4 Mt, or 6.2%, from 1990 to 2007. Although some subsectors within this group did show significant increases (e.g. emissions from use of hydrofluorocarbons in refrigeration and air conditioning, which are substitutes to ozone-depleting substances, have grown by 4.5 Mt since 1995—an almost 1000% increase), there were some significant reductions to make up for them.
- Emissions of the greenhouse gas nitrous oxide (N₂O)—from Canada's sole adipic acid manufacturing plant—decreased by 9.2 Mt after the installation of N₂O abatement technology. Also, process emissions from the aluminium industry decreased by 2.0 Mt, or 21.7%, from 1990 to 2007 because of improved perfluorocarbon emission control technologies.

Agriculture Sector

- In the Agriculture Sector, the expansion of the beef cattle, swine and poultry industries, along with increases in the application of synthetic nitrogen fertilizer in the Prairies, resulted in a long-term greenhouse gas emission growth of 11.2 Mt. This 23.1% increase for the Agriculture Sector contributed the equivalent of 7.2% to the overall national increase.

Waste Sector

- From 1990 to 2007, greenhouse gas emissions from the Waste Sector increased by about 2.5 Mt, or 13.4%—lower than the population growth of approximately 19%. This appears largely due to the generation of increasing amounts of waste in landfills. This increase would have been larger but for the implementation of landfill gas recovery projects and waste diversion programs (composting and recycling) in Canada.

Land Use, Land-Use Change and Forestry Sector (not included in national totals)

- The trend in emissions from sources and removals by sinks in Land Use, Land-Use Change and Forestry (i.e. agricultural soils, managed forests, wetlands and land-use change) shows that the whole sector can be either a sink or a source, which means that this whole sector can either emit greenhouse gases to the atmosphere, or remove greenhouse gases from the atmosphere (sinks remove carbon dioxide from the atmosphere). In 2007, this sector amounted to a net source of emissions of 45 Mt. Trends in the sector are primarily driven by changes occurring in the forests. Changes are dominated by the erratic pattern of forest fires, which can hide human-associated activities, such as the harvesting of wood. For example, over the last 10 years, an average 48 Mt of carbon was removed annually from the forests in harvested wood, an increase of 19% since the early 1990s. Nevertheless, the impact of major forest disturbances in recent years, notably the mountain pine beetle infestation in Western Canada and large areas burned by wildfires in 1995, 1998 and 2002, undoubtedly dominates the greenhouse gas emission and removal patterns in managed forests.
- The Cropland category includes the effect of agricultural practices on carbon dioxide emissions and removals from arable soils (soils suitable for growing crops) and the impact of converting forest and grassland to cropland. In 2007, carbon sequestration in arable soils more than made up for emissions from lands converted to cropland with, as a result, a net sink of 3.4 Mt. The continued adoption of no-till and reduced-tillage practices and the reduction of summer fallow have resulted in a steadily increasing ability of cultivated soils to behave like sinks.
- Forest land converted to cropland, wetlands and settlements amount to additional emissions of about 20 Mt in 2007, down from 27 Mt in 1990. The conversion of forest and grassland to cropland alone shows a steady decrease in GHG emissions from 15 Mt in 1990 to 8 Mt in 2007.

Sectoral Greenhouse Gas Emission Summary

Source Categories	1990	2004	2006	2007	2006 to 2007		1990 to 2007	
					Change	%	Change	%
	kt CO ₂ eq				Absolute	%	Absolute	%
TOTAL¹	592 000	741 000	718 000	747 000	28 863	4.0	155 249	26.2
ENERGY	469 000	603,000	581,000	614,000	33 461	5.8	144 799	30.8
a. Stationary Sources	281 000	349,000	324,000	350,000	26 004	8.0	68 104	24.2
Electricity and Heat Generation	95 000	127 000	117 000	126 000	8 990	7.7	30 513	32.0
Fossil Fuel Industries	51 000	72 000	66 000	70 000	3 779	5.7	18 757	36.5
Mining and Oil and Gas Extraction	6 200	14 900	16 800	23 300	6 473	38.5	17 108	276.4
Iron and Steel	6 480	6 460	6 220	6 640	427	6.9	163	2.5
Non Ferrous Metals	3 190	3 230	3 230	3 380	151	4.7	196	6.1
Chemical	7 140	6 830	6 820	6 680	- 147	-2.2	- 468	-6.6
Pulp and Paper	13 730	9 400	5 860	5 770	- 92	-1.6	-7 956	-58.0
Cement	3 830	4 620	5 070	4 910	- 165	-3.2	1 076	28.1
Other Manufacturing	20 600	20 900	19 800	20 600	767	3.9	- 97	-0.5
Construction	1 870	1 340	1 300	1 290	- 12	-0.9	- 581	-31.1
Commercial & Institutional	25 700	37 700	33 400	35 200	1 731	5.2	9 469	36.8
Residential	43 000	43 000	40 000	44 000	3 773	9.5	74	0.2
Agriculture & Forestry	2 390	2 090	1 910	2 240	328	17.2	- 150	-6.3
b. Transportation	145 000	188 000	191 000	200 000	8 408	4.4	54 500	37.5
Domestic Aviation	6 400	7 800	7 700	7 800	119	1.5	1 451	22.8
Gasoline Automobile	45 800	41 100	39 900	41 100	1 203	3.0	-4 683	-10.2
Light-duty Gasoline Trucks	20 700	42 000	43 600	45 000	1 380	3.2	24 260	117.2
Heavy-duty Gasoline Vehicles	7 810	6 400	6 430	6 640	212	3.3	-1 173	-15.0
Motorcycles	146	245	256	265	9	3.5	118	80.7
Diesel Automobiles	355	431	435	450	16	3.6	96	27.0
Light-duty Diesel Vehicles	710	1 990	2 230	2 330	98	4.4	1 620	229.2
Heavy-duty Diesel Vehicles	20 680	36 470	38 940	40 090	1 148	2.9	19 404	93.8
Propane & Natural Gas Vehicles	2 210	860	790	830	43	5.5	-1 381	-62.4
Railways	7 000	6 000	6 000	7 000	402	6.3	- 165	-2.4
Domestic Marine	5 000	6 600	5 800	6 100	357	6.2	1 073	21.3
Off-road Gasoline	6 700	7 700	6 700	7 400	709	10.6	756	11.4
Off-road Diesel	15 000	22 000	23 000	25 000	2 526	11.1	10 175	67.7
Pipelines	6 850	8 470	9 610	9 800	185	1.9	2 950	43.1
c. Fugitives	42 700	65 600	65 800	64 800	- 951	-1.4	22 195	52.0
Coal Mining	1 900	700	700	800	55	7.8	-1 150	-60.1
Oil	4 180	5 940	5 720	5 820	100	1.7	1 636	39.1
Natural Gas	12 900	20 400	21 400	21 300	- 159	-0.7	8 356	64.8
Venting	19 300	33 000	32 000	31 700	- 240	-0.7	12 482	64.8
Flaring	4 400	5 600	6 000	5 300	- 707	-11.8	872	19.8
INDUSTRIAL PROCESSES	54 800	55 400	54 600	51 400	-3 182	-5.8	-3 400	-6.2
a. Mineral Production	8 300	9 500	9 600	9 400	- 182	-1.9	1 138	13.7
b. Chemical Industry	16 700	11 200	9 000	8 900	- 153	-1.7	-7 860	-47.0
c. Metal Production	19 500	16 700	16 800	13 800	-2 983	-17.7	-5 630	-28.9
d. Consumption of Halocarbons	2 300	5 500	6 500	6 200	- 347	-5.3	3 885	168.5
e. Other & Undifferentiated Production	8 000	13 000	13 000	13 000	483	3.8	5 066	63.1
SOLVENT & OTHER PRODUCT USE	170	210	320	320	- 3	-0.9	144	82.6
AGRICULTURE	48 000	62 000	61 000	60 000	-1 177	-1.9	11 187	23.1
a. Enteric Fermentation	17 000	23 000	23 000	23 000	- 466	-2.0	5 707	33.7
b. Manure Management	6 000	8 000	8 000	7 800	- 156	-2.0	1 811	30.2
c. Agriculture Soils	26 000	30 000	30 000	29 000	- 555	-1.9	3 668	14.4
WASTE	19 000	21 000	22 000	21 000	- 236	-1.1	2 519	13.4
a. Solid Waste Disposal on Land	18 000	20 000	20 000	20 000	- 260	-1.3	2 479	14.0
b. Wastewater Handling	740	900	910	930	17	1.9	192	26.0
c. Waste Incineration	400	230	240	250	8	3.3	- 152	-37.9
LAND USE, LAND-USE CHANGE AND FORESTRY	-52 000	117 000	41 000	45 000	4 086	9.9	97 019	-188.1
a. Forest Land	-79 000	107 000	33 000	38 000	5 471	16.6	117 057	-148.7
b. Cropland	12 700	-1 000	-2 300	-3 400	-1 060	45.5	-16 057	-126.8
c. Grassland	0	0	0	0	0	NA	NA	NA
d. Wetlands	5 000	3 000	3 000	3 000	- 175	-6.2	-2 307	-46.5
e. Settlements	10 000	8 000	8 000	8 000	- 150	-1.9	-1 674	-17.6

Notes:

NA = Not Applicable

1. National totals exclude all GHGs from the Land Use, Land-use Change and Forestry Sector.

2. Absolute and percent changes shown are based on UNROUNDED values.

3. Due to rounding, totals may not add up.