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National Inventory Report

1990–2011

GREENHOUSE GAS SOURCES
AND SINKS IN CANADA

The Canadian Government's Submission
to the UN Framework Convention on Climate Change

Executive Summary



Canada 

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Executive Summary

ES.1 Canada's Greenhouse Gas Inventory: Context

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. In support of this goal the Convention commits all Parties to develop, periodically update, publish and make available to the Conference of the Parties national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol. Development, publication and maintenance of a national inventory is a key obligation of UNFCCC signatories.

Canada's National Inventory Submission is the annual communication through which Canada meets its annual reporting obligations under the Convention and serves as the authoritative indicator and basis of comparison of national performance. It is a source of reliable, detailed information for Canadians on key emission trends for specific sources, sectors and regions; and provides a core set of data for setting baseline emissions and further analysis.

Canada's 2013 National Inventory Submission to the UNFCCC, which consists of the National Inventory Report (NIR) and the Common Reporting Format (CRF) Tables, has been prepared in accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories."

Canada is committed to tackling climate change through sustained action to build a low-carbon economy that includes reaching a post-2020 global climate change agreement, working with our North American partners and taking action domestically. Under the Copenhagen Accord, Canada has committed to reducing its GHG emis-

sions to 17% below the 2005 level by the year 2020.¹ As the underlying data and methodology for estimating emissions are revised over time, emissions levels in all years are subject to change as both data and methods are improved.

ES.2 Summary of National GHG Emissions and Trends

In 2011, the most recent annual dataset in this report, Canada's total greenhouse gas emissions were estimated to be 702 megatonnes carbon dioxide equivalent (Mt CO₂ eq²), an increase of approximately 1 Mt (0.14%) from the 2010 level of 701 Mt. Since 2005, Canadian GHG emissions have decreased by 36 Mt (4.8%).

Changes in emission trends since the early 2000s can be attributed to increases in efficiency, the modernization of industrial processes, and structural changes in the composition of the economy, which are long-term trends that have had an increased impact on emissions since the late 1990s.

The change in the rate of growth in emissions in Canada since about 2000 is notable and can be attributed to the following factors:

- A levelling off of emissions from electric power generation, which had been rising rapidly until then. In 2000, coal generation was at or close to its highest level ever. Since then, the contribution of coal-fired generation to the electricity supply mix has been declining (Statistics Canada 2011a).
- The increased prevalence of energy efficiency and emission reduction programs, including federal measures such as regulations for light-duty vehicles and provincial and territorial actions such as Alberta's *Specified Gas Emitters Regulation*.
- Structural changes involving a shift from an industrial-oriented economy to a more service-based economy. Between 2000 and 2008, the gross domestic product (GDP) of the service industries rose by 32%, while heavy industries and manufacturing together grew by only 3%. Service industries are less emission intensive than goods-producing industries, so this ongoing change has lowered Canadian GHG emissions.
- The peak in the production of conventional oil in 1998 in Canada and the levelling off of gas production in

¹ See <http://climatechange.gc.ca/cdp15-cop15/default.asp?lang=En&n=970E8B07-1>

² Unless explicitly stated otherwise, all emission estimates given in Mt represent emissions of GHGs in Mt CO₂ equivalent.

Figure S–1 Canadian Emissions in 1990–2011

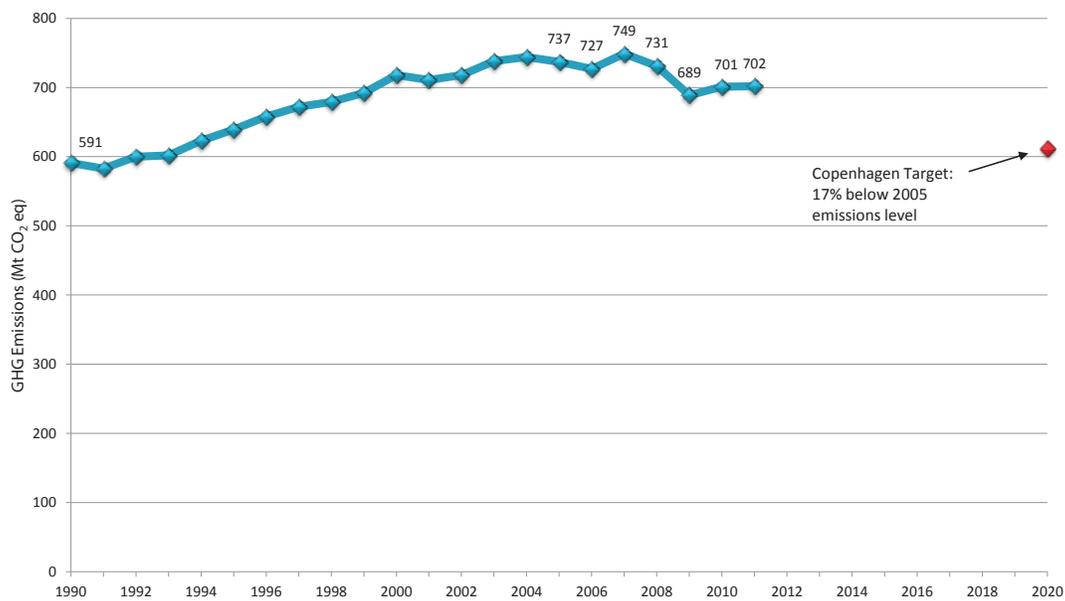
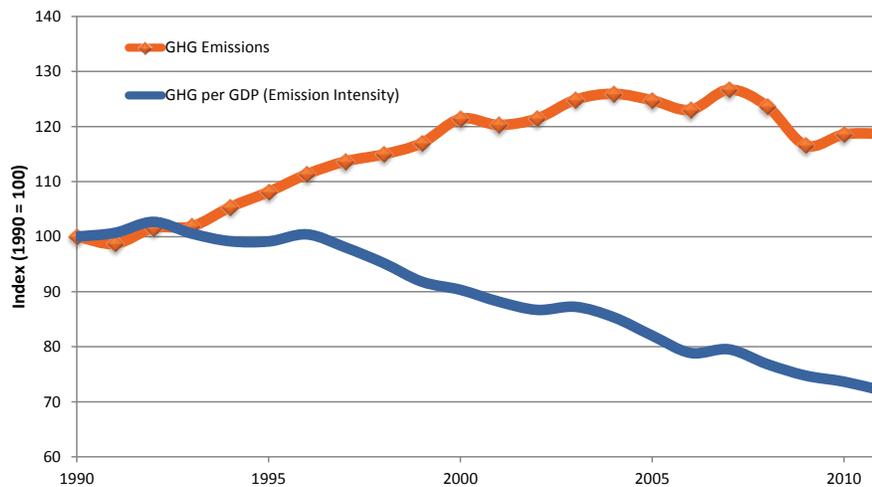


Figure S–2 Indexed Trend in GHG Emissions and GHG Emissions Intensity, 1990–2011



2002 (Statistics Canada 2011b). In both cases, this was the result of limited conventional reserves. More recently, conventional oil and natural gas production has fallen, which has reduced fugitive emissions and has offset the impact of rising non-conventional production to some extent.

Together, efficiency increases and technological and structural changes have resulted in a continuing weakening of the link between GDP growth and emissions, so that the GHG emissions per unit of GDP (or “GHG intensity of the economy”) have decreased on average by 2% per year

since 1996 (Figure S–2). This has resulted in the decoupling of economic growth and emissions.

While Canada represented only about 2% of total global GHG emissions in 2005 (CAIT 2012), it is one of the highest per capita emitters, largely as a result of its size, climate (i.e. climate-driven energy demands), and resource-based economy. In 1990, Canadians released 21.3 tonnes (t) of GHGs per capita. In 2005, this had risen to 22.9 t of GHGs per capita; however, by 2011, it had dropped to 20.4 t of GHGs per capita (Statistics Canada 2012) (Figure S–3).

Figure S-3 Canadian per Capita Emissions 1990–2011

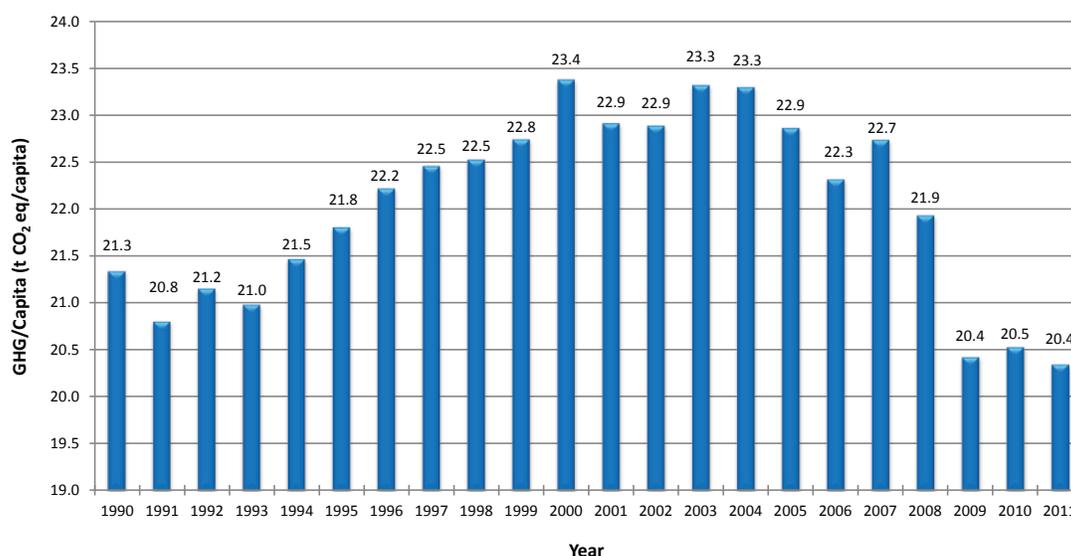
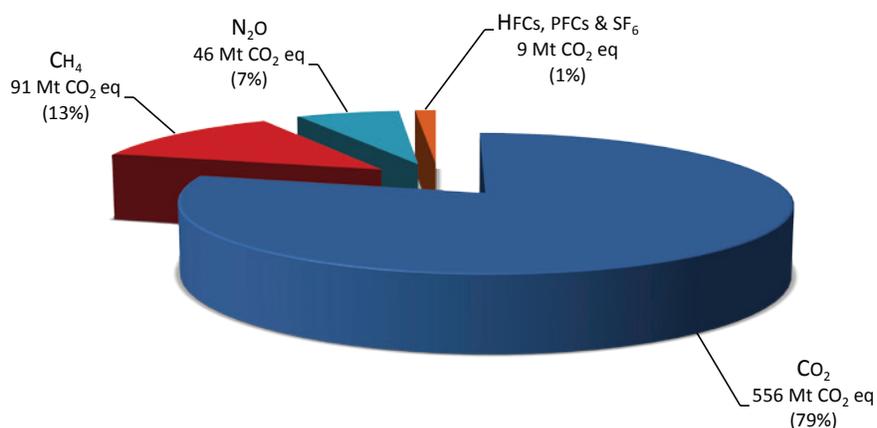


Figure S-4 Canada's Total Emissions Breakdown 2011, by Greenhouse Gas (Total = 702 Mt)



ES.3 Overview of Source and Sink Category Emissions and Trends

The primary GHG emitted from anthropogenic activities in 2011 was CO₂, which contributed 79% of Canada's total emissions (Figure S-4 and Table S-1). The majority of these emissions result from the combustion of fossil fuels. Methane (CH₄) accounted for 13% of Canada's total emissions, resulting from activities in the IPCC sectors of Agriculture and Waste, as well as fugitive emissions from oil and natural gas systems. Nitrous oxide (N₂O) emissions from activities such as agriculture soil management and transport accounted for 7% of the emissions. Perfluorocarbons

(PFCs), sulphur hexafluoride (SF₆) and hydrofluorocarbons (HFCs) constituted the remainder of the emissions (slightly more than 1%).

Using the definitions based on the IPCC categorization,³ the Energy Sector produced the majority of Canada's GHG total emissions in 2011, at 81% or 572 Mt, with emissions in this sector resulting from stationary combustion sources, transport and fugitive sources. The remaining 19% of total emissions was largely generated by sources within the Agriculture Sector (8% of total emissions) and Indus-

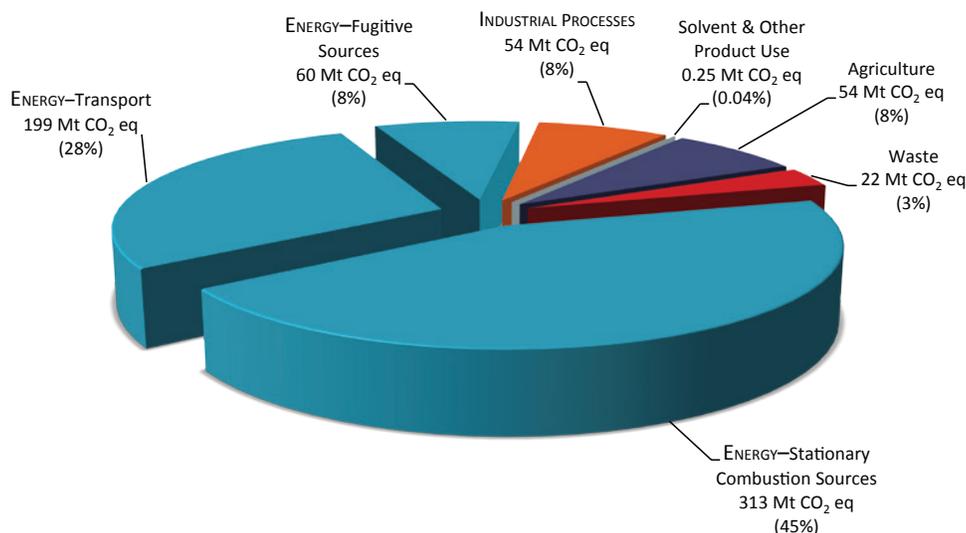
³ Throughout this report, the word "Sector" generally refers to the activity sectors as defined by the Intergovernmental Panel on Climate Change (IPCC) for national greenhouse gas inventories. Exceptions occur when the expression "economic sectors" are used in reference to the Canadian context.

Table S-1 Canada's GHG Emissions 1990–2011, by Greenhouse Gas

Greenhouse Gases	1990	2000	2005	2007	2008	2009	2010	2011
<i>Mt CO₂ equivalent</i>								
National GHG Total	591	718	737	749	731	689	701	702
CO ₂	459	565	579	595	577	542	554	556
CH ₄	72	94	98	96	94	91	90	91
N ₂ O	49	49	50	49	52	47	47	46
HFCs, PFCs & SF ₆	11	10	10	8	9	9	9	9

Note: Totals may not add up due to rounding.

Figure S-5 Canada's Emissions Breakdown 2011, by IPCC Sector (Total = 702 Mt)



Industrial Processes Sector (8%), with minor contributions from the Waste Sector (3%) and Solvent and Other Product Use Sector (Figure S-5 and Table S-2). The Land Use, Land-use Change and Forestry (LULUCF) Sector was a net source of 87 Mt in 2011, largely because of emissions from natural disturbances such as forest fires. However, in accordance with UNFCCC reporting guidelines, these emissions are excluded from national inventory totals. Table S-2 provides additional details about Canada's emissions and removals by IPCC sector for the years 1990, 2000, 2005 and 2007–2011. Further breakdowns by subsector and gas and a complete time series can be found in Annex 12.

To the extent possible, emissions are also allocated on the basis of the economic sector from which they originate, for the purposes of analyzing trends and policies (Figure S-6 and Table S-3). For example, emissions are categorized by economic sectors for the report *Canada's Emissions Trends*

(Environment Canada 2012),⁴ which provides emissions projections for Canada to the year 2020.

More information on the IPCC and economic sector definitions and trends, as well as a detailed cross-walk between categories, is provided in Chapter 2, Table 2-14.

ES.3.1 1990–2011 Trends Overview, IPCC Sectors

Almost all of the emission changes over the long term are attributable to six major areas: the fossil fuel (coal, oil and gas) industries,⁵ transport,⁶ electricity generation,

4 Canada's Emissions Trends 2012 report is available online at: <http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=253AE6E6-5E73-4AFC-81B7-9CF440D5D2C5>

5 "Fossil fuel industries" comprise the sum of the subsectors of Mining and Oil and Gas Extraction, Fossil Fuel Production and Refining, Pipelines (Transportation), and Fugitive Releases.

6 The "Transport" subsector refers to Transportation minus Pipelines.

Table S–2 Canada's GHG Emissions 1990–2011, by IPCC Sector

Greenhouse Gas Categories		1990	2000	2005	2007	2008	2009	2010	2011
		<i>Mt CO₂ equivalent</i>							
TOTAL^{1,2}		591	718	737	749	731	689	701	702
ENERGY		469	589	597	610	592	560	570	572
a.	Stationary Combustion Sources	281	346	341	352	336	315	316	313
	Electricity and Heat Generation	94	129	123	122	115	100	101	93
	Fossil Fuel Production and Refining	51	67	71	72	67	67	65	62
	Mining & Oil and Gas Extraction	6.6	12.1	18.9	28.9	30.0	31.7	35.0	36.4
	Manufacturing Industries	55.8	55.6	48.6	47.6	45.1	40.3	41.1	42.7
	Construction	1.9	1.1	1.4	1.4	1.4	1.2	1.5	1.3
	Commercial & Institutional	25.7	33.3	31.9	30.2	29.6	29.4	28.0	29.9
	Residential	43	45	44	47	46	44	41	44
	Agriculture & Forestry	2.4	2.5	2.1	2.6	2.6	2.5	2.9	3.6
b.	Transport	146	180	193	195	194	186	196	199
	Civil Aviation (Domestic Aviation)	7.1	7.4	7.6	7.7	7.3	6.4	6.4	6.0
	Road Transportation	97	118	130	133	132	132	134	135
	Railways	7.0	7.0	7.0	7.0	8.0	5.0	7.0	7.0
	Navigation (Domestic Marine)	5.0	5.1	6.7	6.8	6.5	6.7	7.0	6.0
	Other Transportation	30	43	41	41	41	36	42	45
c.	Fugitive Sources	42	63	63	63	62	59	59	60
	Coal Mining	2.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0
	Oil and Natural Gas	40.2	62.1	62.4	62.0	61.0	57.9	57.6	58.7
INDUSTRIAL PROCESSES		56.0	52.1	60.5	59.8	58.5	50.8	53.3	54.3
a.	Mineral Products	8.4	9.8	9.9	9.8	9.0	7.0	7.6	7.7
b.	Chemical Industry	16.0	8.0	9.3	7.9	9.4	7.1	6.5	7.0
c.	Metal Production	22.6	22.5	19.7	18.9	18.5	15.4	15.8	16.6
d.	Production and Consumption of Halocarbons and SF ₆	1.0	3.2	5.5	5.7	5.8	6.5	7.3	7.7
e.	Other & Undifferentiated Production	7.6	8.6	16.0	17.0	16.0	15.0	16.0	15.0
SOLVENT & OTHER PRODUCT USE		0.18	0.45	0.38	0.33	0.34	0.26	0.24	0.25
AGRICULTURE		47	56	58	58	59	56	56	54
a.	Enteric Fermentation	16	20	22	21	20	19	19	18
b.	Manure Management	5.7	7.0	7.5	7.2	6.9	6.7	6.5	6.4
c.	Agriculture Soils	25	29	29	30	31	30	30	30
d.	Field Burning of Agricultural Residues	0.21	0.12	0.04	0.04	0.05	0.04	0.03	0.03
WASTE		19	20	21	21	21	21	22	22
a.	Solid Waste Disposal on Land	17	18	20	20	20	20	20	20
b.	Wastewater Handling	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
c.	Waste Incineration	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7
Land Use, Land-use Change and Forestry		-62	-52	63	52	-11	-10	100	87
a.	Forest Land	-88	-64	54	45	-18	-15	99	83
b.	Cropland	12	0	-4	-6	-7	-7	-8	-8
c.	Grassland	-	-	-	-	-	-	-	-
d.	Wetlands	5	3	3	3	3	3	3	3
e.	Settlements	9	8	9	10	10	9	9	9

Notes:

1. National totals exclude all GHGs from the Land Use, Land-use Change and Forestry Sector.
2. These summary data are presented in more detail in Annex 12.

manufacturing,⁷ commercial/institutional and agriculture. The relative contribution of each of these has varied somewhat, depending on the time period. The long-term trend of emission growth has been driven primarily by the fossil fuel industries and transport whereas the short-term

(2005–2011) emission decline has been driven by electricity generation and manufacturing.

Between 1990 and 2011 the fossil fuel industries and transport were responsible for about 51% and 49%, respectively, of the total 111-Mt growth in emissions. Major increases in oil and gas production (much of it for export),

⁷ "Manufacturing" includes the Manufacturing Industries subsector (in the Energy Sector) and the Industrial Processes Sector.

Figure S–6 Canada's Emissions Breakdown 2011, by Economic Sector (Total = 702 Mt)

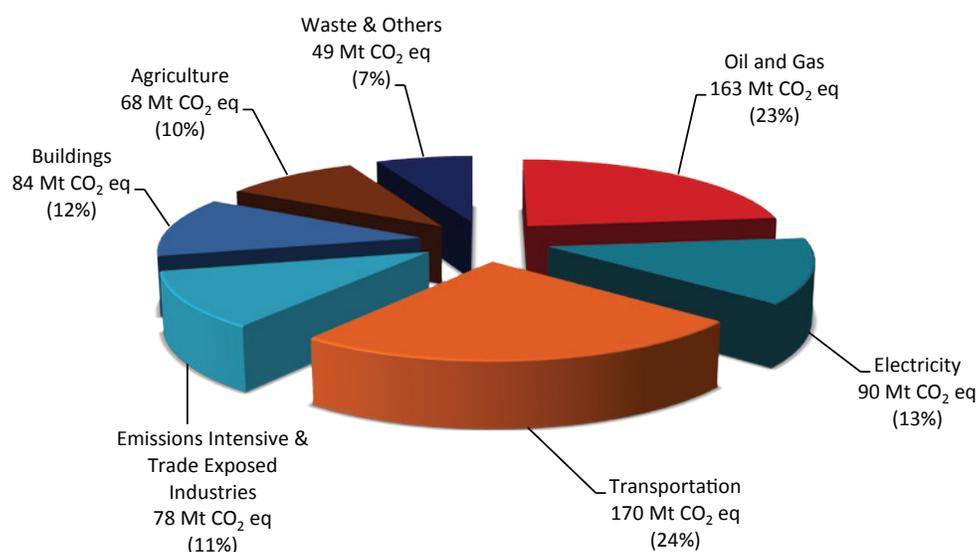


Table S–3 Canada's GHG Emissions 1990–2011, by Economic Sector

Greenhouse Gases	1990	2000	2005	2007	2008	2009	2010	2011
	<i>Mt CO₂ equivalent</i>							
National GHG Total	591	718	737	749	731	689	701	702
Oil and Gas	101	150	162	170	164	162	164	163
Electricity	94	129	121	120	112	97	99	90
Transportation	128	155	168	169	166	163	167	170
Emissions Intensive & Trade Exposed Industries ¹	93	85	87	89	86	74	75	78
Buildings	70	82	84	84	83	82	79	84
Agriculture	54	66	68	69	71	67	69	68
Waste & Others ²	50	51	49	48	49	46	48	49

Note: Totals may not add up due to rounding.

Estimates presented here are under continual improvement. Historical emissions may be changed in future publications as new data become available and methods and models are refined and improved. Recalculations resulting from methodological improvements are presented in Chapter 9, and recalculations resulting from changes to underlying activity data are presented in the chapter(s) associated with the sector where the changes occurred (Chapters 3-8).

1. The Emissions Intensive & Trade Exposed Industries represent emissions arising from mining activities, smelting and refining, and the production and processing of industrial goods such as paper or cement.
2. "Others" includes Coal Production, Light Manufacturing, Construction & Forest Resources.

as well as a large increase in the number of motor vehicles, especially light-duty gasoline trucks (vans, SUVs and pickups) and heavy-duty diesel vehicles (commercial transport trucks), have contributed to the significant rise in GHG emissions.

Emissions from the manufacturing area fell by about 15 Mt (13%), counteracting the dominant rising trend. Fuel-switching, efficiency and technology improvements,

and reductions in manufacturing output (especially in the Pulp and Paper and Other Manufacturing subsectors) resulted in the emission reductions.

Though in 2011 emissions from electricity generation were almost identical to what they were 20 years ago, they rose until 2003 and then fell rapidly to current levels. During the same period, electricity generation rose significantly. However, the amount of coal-based electricity within the

Table S-4 Trends in Emissions and Economic Indicators, Selected Years

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Total GHG (Mt)	591	639	718	737	727	749	731	689	701	702
Change Since 2005 (%)	NA	NA	NA	NA	-1.4	1.5	-0.9	-6.6	-5.0	-4.8
Change Since 1990 (%)	NA	8.1	21.4	24.8	23.0	26.7	23.7	16.6	18.6	18.7
GDP (Billions 2007\$)	983	1072	1321	1495	1533	1566	1582	1533	1582	1620
Change Since 2005 (%)	NA	NA	NA	NA	2.5	4.7	5.8	2.5	5.8	8.4
Change Since 1990 (%)	NA	9.1	34.4	52.1	56.0	59.3	60.9	55.9	61.0	64.8
GHG Intensity (Mt/\$B GDP)	0.60	0.60	0.54	0.49	0.47	0.48	0.46	0.45	0.44	0.43
Change Since 2005 (%)	NA	NA	NA	NA	-3.8	-3.0	-6.3	-8.9	-10.2	-12.2
Change Since 1990 (%)	NA	-0.9	-9.7	-18.0	-21.1	-20.5	-23.2	-25.2	-26.3	-28.0

GDP Data Source: Statistics Canada. Table 380-0106 - Gross domestic product at 2007 prices, expenditure-based, annual (dollars), CANSIM (database).

generation mix grew rapidly at first and then fell (most significantly after 2004), resulting in virtually zero net emissions growth.

Agriculture was responsible for a 7-Mt increase in emissions since 1990, largely the result of increasing use of fertilizers and larger populations of beef cattle and swine.

Though greenhouse gas emissions rose by 19% over the last two decades, Canada's economy grew much more rapidly, with GDP rising by 65% (Table S-4). As a result, the emission intensity for the whole economy (GHG per GDP) has improved considerably, dropping by 28%. There have been some variations over time, however.

In the early 1990s, energy prices were low (EIA 2004) and this significantly limited the economic incentives to improve energy efficiency. Between 1990 and 1994, emission intensity remained stable (see Figure S-2), with emissions rising nearly in step with economic growth (which was strengthening after a recession). In this time frame, emissions and GDP rose by about 5% and 6%, respectively. Beginning in 1995, however, there was a decoupling of GDP and emissions.

The trend in the years since the late 1990s demonstrates a decline in the rate of increase of GHG emissions (even if the steep drop in 2009 is ignored). For a decade the average annual growth in emissions was 2.0%, while in contrast, between 2000 and 2008, the average annual emission growth was close to 0.2% and between 2008 and 2011, the rate dropped to -1.3%.

ES.3.2 2005–2011 Trends Overview, IPCC Sectors

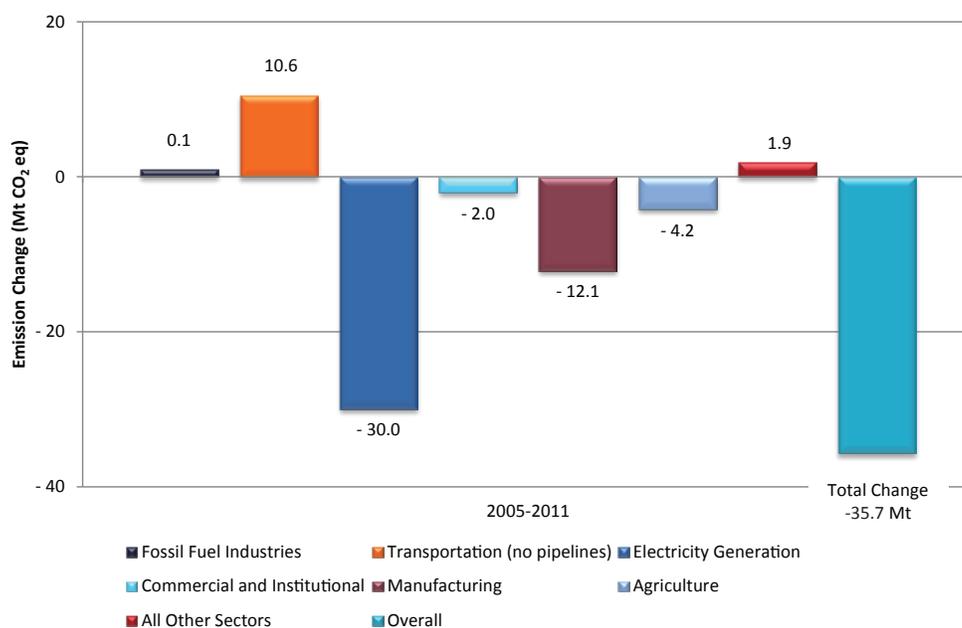
Since 2005, total Canadian GHG emissions have decreased by 35.7 Mt (4.8%). Fluctuations in emission levels since 2005 are due primarily to changes in the mix of sources used for electricity production, changing emissions from fossil fuel production, and varying demand for heating fuels.

Figure S-7 shows the major contributors to emission trends. Emissions from electricity and heat generation have been the largest driver of the overall downward trend, dropping by 30 Mt since 2005, primarily the result of reduced generation by coal, switching to renewable resources and improved efficiencies in combustion generation. Ontario has contributed significantly to this trend through efforts to reduce coal-fired generation of electricity: in 2005, Lakeview generating station was shut down and by the end of 2011, six units at other stations had also been permanently taken out of service.⁸ At the same time, fossil fuel generation varied with the availability of electricity from hydro, nuclear and, to some extent, wind power and solar energy sources. Overall, small-scale renewable energy sources are becoming more prevalent: by 2011 wind, tidal and solar power plants in Canada produced a total of about 10 000 GWh of electricity, or 1.7% of total generation.⁹

8 By December 31, 2011, 10 of 19 operating coal units in Ontario had been shut down ("Ontario Shutting Down Two More Coal Units", Ontario Government website, Dec. 1, 2011, Available online at <http://news.ontario.ca/mei/en/2011/12/ontario-shutting-down-two-more-coal-units.html>, accessed on February 24, 2013).

9 Source: Statistics Canada, CANSIM 127-0007 (2005–2010), accessed on Feb 24, 2013.

Figure S–7 Emission Trends for 2005–2011, Broken Down by Major Sector



Emissions from manufacturing decreased by 12.1 Mt (11%) between 2005 and 2011, due to significantly lowered production. Over the same period, emissions in the commercial and institutional subsector fell by about 2 Mt. In 2011, heating degree-days, an indicator of the necessity for space heating in response to the severity of cold weather, were down about 1.3% as compared to 2005.¹⁰ This served to reduce fossil fuel consumption and the emissions associated with it.

In contrast to these reductions, transport (not including pipelines) GHG emissions rose by 10.6 Mt (5.8%) between 2005 and 2011. The emission reductions brought on by reduced commercial vehicle activity in 2008–2009 were almost completely negated as increased economic activity brought emission levels back close to 2007 levels. In fact, emissions rose by about 3 Mt between 2010 and 2011. Most of this increase occurred in diesel transport, namely heavy-duty diesel on-road vehicles for shipping, and off-road industrial vehicles.

Although there was virtually no change in emissions from the fossil fuel industries (0.1% increase) between 2005 and

2011, there were significant changes in subsectors of the industry. For example, a decrease in natural gas production along with a reduction in conventional crude oil production contributed to emission decreases, but these were offset by emission growth from the increase in production of crude bitumen and synthetic crude oil from Canada's oil sands.¹¹

ES.3.3 IPCC Subsectors

Energy—2011 GHG Emissions (572 Mt)

Short-term Trends

In 2011, GHG emissions from the IPCC Energy Sector declined by 26 Mt (about 4.3%) when compared to 2005. Similar to the national trend, this decline was primarily driven by Electricity and Heat Generation and the Manufacturing Industries.

Public Electricity and Heat Generation¹² emissions shrank by 30 Mt (about 24%) from 2005 levels. Between 2005 and 2011, however, there were fluctuations in emissions, largely as a result of changes in the mix of electricity

10 Source: Adapted from a) Environment Canada, National Climate Data and Information Archive, available online at http://climate.weatheroffice.gc.ca/advanceSearch/searchHistoricData_e.html?timeframe=1&Prov=XX&StationID=9999&Year=2009&Month=12&Day=16 and b) Statistics Canada, 2006 Census data products, available online at <http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/index-eng.cfm>; see Chapter 2.

11 Source: Alberta Energy Resources Conservation Board, ST98; see Chapter 2.

12 Public Electricity and Heat Generation includes all utility generation (as reported to Statistics Canada). As defined by the IPCC, this category does not include industrial cogeneration.

generation sources¹³ (see “ES.2 Summary of National GHG Emissions and Trends”). Decreased electricity demand contributed significantly to the decrease in emissions between 2008 and 2009.

GHG emissions from Manufacturing Industries dropped by 5.9 Mt (12%) between 2005 and 2011, due to significantly lowered production.

Long-term Trends

By far the largest portion of Canada’s total emission growth is observed in the Energy Sector. The long-term Sector emission trends (1990–2011) showed both declines and increases, for a net growth of 102 Mt, or 22%. As described above in Section ES.2, most of the growth in national emissions is observed in the fossil fuel industries and transportation, which fall under the Energy Sector. The fossil fuel industries (consisting of coal mining and the production, transmission, processing, refining and distribution of all oil and gas products) registered a net increase of about 56 Mt of GHG emissions from 1990 to 2011 (51% growth).

By 2011, total production of crude oil and natural gas had increased by 66% over 1990 levels. However, the oil sands industry has been reducing its per-unit emissions, and in 2011 intensity was 26% lower than in 1990. This reduction in GHG intensity is significant, as larger and larger portions of production are derived from oil sands.

Most transportation emissions in Canada are related to Road Transport, which dominated the GHG growth trend in this area. Emissions from Road Transport rose by 38.5 Mt (40%) between 1990 and 2011.

The primary source of this net trend of rising emissions is the increase in the number of passenger-kilometres travelled (more people drove further) (NRCAN 2009). However, the use of light trucks increased much more rapidly than cars. Since light trucks have less favourable fuel consumption than cars, this shift also drove emission increases (NRCAN 2009).

Emissions from heavy-duty diesel vehicles (large freight trucks) rose by 21.8 Mt (109%) between 1990 and 2011. Growth in emissions reflected a 137% increase in tonne-kilometres shipped by for-hire trucking between 1990 and 2003 (Statistics Canada 2013a). The quantity of goods

shipped by truck (as opposed to other transport modes) resulted in turn from customer requirements for just-in-time delivery and cross-border freight (NRCAN 2009). Between 2004 and 2010, tonne-kilometres shipped oscillated between +4% (2004–2005) and -7% (2008–2009) and ultimately resulted in zero growth across the 6-year period (Statistics Canada 2013b).

Industrial Processes—2011 GHG Emissions (54 Mt)

The Industrial Processes Sector covers GHG emissions arising from non-energy sources such as limestone calcination (CO₂) in cement production, or the use of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as replacement refrigerants for ozone-depleting substances (ODSs). The Sector has declined 1.7 Mt since 1990. In 2011 there was an increase of 1.9% from the 2010 level. Production increases were observed in the iron and steel and cement industries. Of note in this sector is the rapid increase in emissions from the use of HFCs as refrigerants in place of ODSs, an increase of 2.4 Mt (45%) since 2005.

In the Metal Production category, CO₂ emissions from production of iron and steel have been decreasing since the early 1990s, despite moderate increases in steel production in Canada. Reductions in emission intensities achieved by the steel industry in the period from 1990 to 2008 have been maintained. This is primarily due to increased use of recycled steel in the production process. The year 2009 saw a significant decline in production, followed by a partial comeback in 2010, and an almost complete recovery in 2011. The aluminium industry, while increasing its production by almost 100% since 1990, shows a reduction of its process emissions by 29%. The 57% reduction achieved overall in the GHG emissions from industrial chemical processes between 1990 and 2011 is primarily the result of the closure of the adipic acid plant in Ontario. Decreases were partly offset by increases in emissions from the Ammonia Production and Nitric Acid Production categories.

Agriculture—2011 Emissions (54 Mt)

Canadian agriculture can be differentiated into livestock and crop production components. The livestock industry is dominated by beef but also has large swine, dairy and poultry components. Crop production is mainly dedicated to the production of cereal and oil seeds. A wide variety of specialty crops and animals are produced, but represent a very small portion of the overall agricultural economy.

¹³ The mix of electricity generation sources is characterized by the amount of fossil fuel vs hydro, other renewable and nuclear sources. In general, only fossil fuel sources generate net GHG emissions.

Emissions directly related to animal and crop production accounted for 54 Mt CO₂ eq or 8.0% of total 2011 GHG emissions for Canada, an increase of 7 Mt CO₂ eq or 15% since 1990. Agriculture accounts for 23% and 72% of the national CH₄ and N₂O emissions, respectively.

The main drivers of the emission trend in the Agriculture Sector are the expansion of the beef cattle and swine populations, and increases in the application of synthetic nitrogen fertilizers in the Prairies.

Overall, the relative proportion of emissions coming from livestock has remained above 60% of total agricultural emissions, except very recently. From 2005 to 2008, emissions from the Agriculture Sector stabilized, with declines in emissions from livestock production being compensated for by increases in emissions from crop production. With the continued decline in livestock populations since 2008 and low crop yields in 2011, agriculture emissions are approximately 4 Mt CO₂ eq lower than the average level of emissions from 2005 to 2008.

Land Use, Land-use Change and Forestry—2011 (Net Source of 87 Mt)

The Land Use, Land-use Change and Forestry (LULUCF) Sector reports GHG fluxes between the atmosphere and Canada's managed lands, as well as those associated with land-use change. In contrast with other inventory estimates, GHG emissions and removals from Canada's managed lands can include very large fluxes from non-anthropogenic events. All emissions and removals in the LULUCF Sector are excluded from the national totals.

In this sector, the net GHG flux is calculated as the sum of CO₂ emissions to, and removals from, the atmosphere, plus non-CO₂ emissions. In 2011, this net flux amounted to emissions of 87 Mt CO₂ eq, which would have increased the total Canadian GHG emissions by about 12%. Trends in the LULUCF Sector are primarily driven by those in forest land, cropland and forest conversion.

The net flux in forest land displays an important inter annual variability due to the erratic pattern of forest wildfires, which masks underlying patterns of interest in the Sector. Important subsectoral trends associated with human activities in managed forests include a 28% increase in the carbon removed in harvested wood between 1990 and the peak harvest year of 2004. Since then, significant reductions in forest management activities have occurred, with a 33% decline in harvest levels,

which in 2009 reached their lowest point for the 22-year period covered by this report (30 Mt C). Nonetheless, the immediate and long-term effect of major natural disturbances in managed forests, notably the Mountain Pine Beetle infestation in western Canada, will undoubtedly continue to dominate the apparent trend.

The steady decline in emissions from cropland is noteworthy, from 12 Mt CO₂ eq in 1990 to a net removal of 8 Mt CO₂ eq in 2011. This pattern largely results from changing agricultural land management practices in western Canada, such as the extensive adoption of conservation tillage practices (over 13 Mha of cropland since 1990), reduction in summerfallow by 68% and an increase in perennial forage crops. The net CO₂ removals due to the management of mineral soils increased from 2.1 Mt in 1990 to 14 Mt in 2011. A decline in the conversion of forest land to cropland has also contributed to this trend.

Waste—2011 Emissions (22 Mt)

The primary source category in the Waste Sector consists of CH₄ Emissions from Solid Waste Disposal on Land, which accounted for about 92% of the emissions for this sector. The CH₄ emissions from publicly and privately owned municipal solid waste landfills make up the bulk of emissions in the Solid Waste Disposal on Land category (about 88%). A smaller part (about 12%) comes from pulp and paper and sawmill industries that landfill wood residues on-site; this practice is declining as markets for wood residues build up.

Since 1990, the overall emissions from the Sector grew by 14%, mostly from increases in emissions from landfill operations. The amount of landfill gas (LFG) captured increased by 81% to 349 kt of CH₄ in 2011. The LFG utilized in energy applications formed 51% of the overall total, and the rest was flared. The number of landfill sites with LFG capture systems is rapidly rising in Canada, with 68 such systems in operation in 2011 (about a 45% increase since 2005).

Wastewater treatment and waste incineration facilities in Canada are minor sources of CH₄ and N₂O emissions and have generally stayed stable.

ES.4 Provincial and Territorial GHG Emissions

While Ontario, with its large manufacturing base, started off as the largest-emitting province in 1990, it has been surpassed by Alberta in more recent years

(see Figure S–8). The province of Alberta has seen a 46% increase in its emissions since 1990, mostly driven by the enhanced production of petroleum resources for export markets.

In general, the year 2011 witnessed an increase in demand for industrial output when compared to 2010, and hence an increase in GHG emissions from manufacturing, particularly in Ontario. However, over the same period emissions from the electricity sector in Ontario decreased by 4.8 Mt (24%). Overall, Ontario's electricity sector experienced a decrease of 19 Mt (56%) from its 2005 emissions—largely due to the closures of coal plants.

In 2011, the combined emissions from Alberta and Ontario contributed 59% (35% and 24%, respectively) to the national total of 702 Mt. The provinces of Quebec and British Columbia, which rely on abundant hydroelectric resources for their electricity production, show more stable emission patterns across the time series, while Quebec exhibited a moderate decrease from its 1990 level. The latter profiles are more or less applicable to other Canadian provinces, except for Saskatchewan, where activities in the oil and gas industry, as well as potash and uranium mining, increased emissions by 67% between 1990 and 2011.

Finally, increases in transportation emissions were salient particularly in provinces that saw their population grow, i.e., Ontario, Alberta and British Columbia; transport

emissions in these provinces together increased by 38% between 1990 and 2011.

ES.5 National System and Quality Management

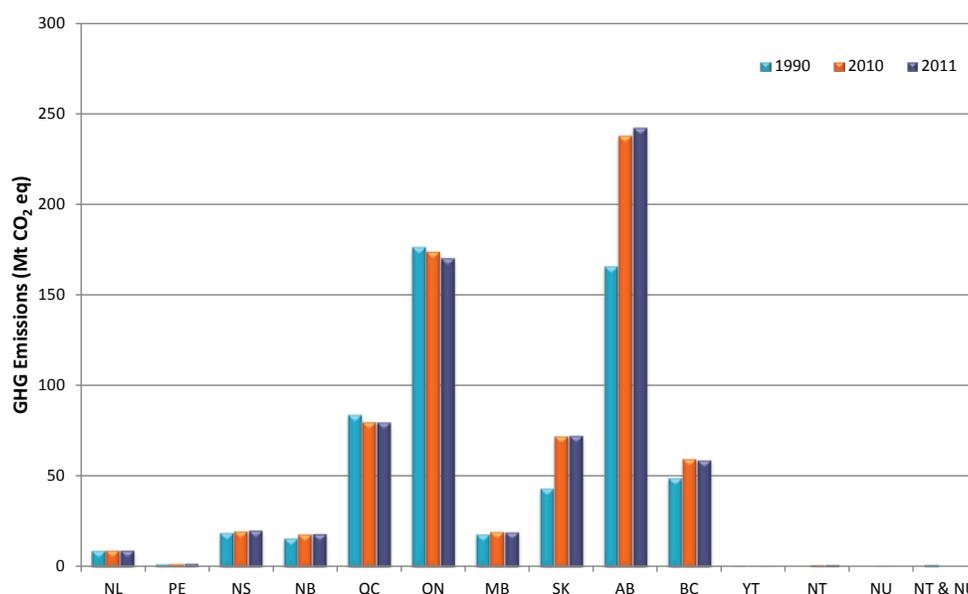
The *Canadian Environmental Protection Act, 1999* (Canada 1999) provides the legislative authority to designate Environment Canada as the single national entity with responsibility for the preparation and submission of the National Inventory Submission to the UNFCCC and for the establishment of a national system. Canada's national system covers the institutional arrangements for the preparation of the inventory, including

- the roles and responsibilities of the inventory agency and of the various players involved;
- the processes for inventory preparation, data collection and estimates development;
- quality management of the inventory; and
- the procedures for official approval of the inventory.

Submission of information to the national system, including details on institutional arrangements for inventory preparation, is also an annual requirement under the UNFCCC reporting guidelines on annual inventories (see Section 1.2).

Quality assurance and quality control (QA/QC) is an integral part of the preparation of this inventory

Figure S–8 Emissions by Province in 1990, 2010 and 2011



(see Annex 6). Canada's quality system includes a QA/QC plan, an archiving system, documented processes for data collection and estimate development, identification of key sources through analysis (Annex 1), quantitative uncertainty assessments (Annex 7), and a process of performing recalculations for improvement of the inventory (Chapter 9). Recalculations resulting from changes to underlying activity data are presented in the chapter(s) associated with the sector where the changes occurred (Chapters 3–8).

Of particular note for this year's inventory, the revised 2010 estimate for Canada has increased by about 9 Mt from 692 Mt CO₂ eq. This revision is mainly due to refinements in underlying energy data and reflects updates in the consumption of natural gas for oil and gas operations. Details of this revision are presented in Chapter 3.

ES.6 Structure of Submission

The UNFCCC requirements include both the annual compilation and submission of the National Inventory Report (NIR) and Common Reporting Format (CRF) tables. The CRF tables are a series of standardized data tables, containing mainly numerical information, which are submitted electronically. The NIR contains the information to support the CRF tables, including a comprehensive description of the methodologies used in compiling the inventory, the data sources, the institutional structures and quality assurance and quality control procedures.

Part 1 of the NIR includes Chapters 1 to 9. Chapter 1 (Introduction) provides an overview of Canada's legal, institutional and procedural arrangements for producing the inventory (i.e. the national inventory system) as well as a description of Canada's facility emission-reporting system. Chapter 2 provides an analysis of Canada's GHG emission trends in accordance with the UNFCCC reporting structure as well as a breakdown of emission trends by Canadian economic sectors. Chapters 3 to 8 provide descriptions and additional analysis for each broad emission and removal category according to UNFCCC CRF requirements. Chapter 9 presents a summary of recalculations and planned improvements.

Part 2 of the NIR consists of Annexes 1 to 10, which provide a key category analysis, detailed explanations of estimation methodologies, a comparison of the sectoral and reference approaches in the Energy Sector, quality assurance and quality control procedures, completeness

assessments, inventory uncertainty, emission factors, rounding procedures, and a summary of ozone and aerosol precursors.

Part 3 comprises Annexes 11 to 13, which present summary tables of GHG emissions for each provincial and territorial jurisdiction, sector and gas, as well as additional details on the GHG intensity of electricity generation.

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www.ec.gc.ca

Additional information can be obtained at:

Environment Canada

Inquiry Centre

10 Wellington Street, 23rd Floor

Gatineau QC K1A 0H3

Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800

Fax: 819-994-1412

TTY: 819-994-0736

Email: enviroinfo@ec.gc.ca