Environment and Climate Change Canada
Environnement et Changement climatique Canada

National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada

Canada's Submission to the United Nations Framework Convention On Climate Change

1990–2014

Executive Summary

Canada

Cat. No. : En81-4/1E-PDF
ISSN: 2371-1329

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Executive Summary

ES.1 Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty established in 1992 to cooperatively address climate change issues. The ultimate objective of the UNFCCC is to stabilize atmospheric greenhouse gas (GHG) concentrations at a level that would prevent dangerous interference with the climate system. Canada ratified the UNFCCC in December 1992, and the Convention came into force in March 1994. At the 15th session of the Conference of the Parties (COP15) to the UNFCCC in 2009, Canada committed to reducing its GHG emissions to 17% below the 2005 level by the year 2020.[1] In May 2015, Canada indicated its intent to reduce GHG emissions by 30% below 2005 levels by 2030. In December 2015 at COP 21, Canada, alongside the countries of the world, reached an ambitious and balanced agreement to fight climate change.

To achieve its objective and implement its provisions, the UNFCCC lays out several guiding principles and commitments. Specifically, Articles 4 and 12 commit all Parties to develop, periodically update, publish and make available to the COP their national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol.[2]

Canada's National Inventory is prepared and submitted annually to the UNFCCC by April 15 of each year, in accordance with revised *Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories* (UNFCCC Reporting Guidelines). The annual inventory submission consists of the National Inventory Report (NIR) and the Common Reporting Format (CRF) tables.

This inventory submission follows the revised UNFCCC Reporting Guidelines, adopted through Decision 24/CP.19 at COP 19 in Warsaw in 2013.

The inventory GHG estimates include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) in the following five sectors defined by the Intergovernmental Panel on Climate Change (IPCC): Energy, Industrial Processes and Product Use, Agriculture, Waste, and Land Use, Land-Use Change and Forestry (LULUCF). The GHG emission and removal estimates contained in Canada's GHG inventory are developed using methodologies consistent with the 2006 IPCC inventory guidelines. In line with the principle of continuous improvement, the underlying data and methodology for estimating emissions are revised over time; hence, total emissions in all years are subject to change as both data and methods are improved.

Section ES.2 of this Executive Summary summarizes the latest information on Canada's net anthropogenic GHG emissions over the period 1990–2014 and links this information to relevant indicators of the Canadian economy. Section ES.3 outlines the major trends in emissions from each of the IPCC sectors.

There are several methods to categorize the sources of GHG emissions. For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the economic sector from which they originate. Section ES.4 presents Canada's emissions by the following economic sectors: Oil and Gas, Electricity, Transportation, Emissions-Intensive and Trade-Exposed Industries, Buildings, Agriculture, Waste and Others. This breakdown is also used for reporting against Canada's 2020 target[3] in the annual *Canada's Emissions Trends* report (Environment Canada 2014a) and in *Canada's Sixth National Communication and First Biennial Report* (Environment Canada 2014b). Throughout this report, the word "sector" generally refers to activity sectors as defined by the IPCC for national GHG inventories; exceptions occur when the expression "economic sectors" is used in reference to the Canadian context. Section ES.4 also presents a synopsis of GHG emissions by economic sector, consistent with that submitted to the UNFCCC.

Canada is a federation composed of a federal government, 10 provincial governments, and 3 territorial governments. Section ES.5 details GHG emissions for Canada's 13 sub-national jurisdictions.

Canada's annual inventory submission to the UNFCCC embodies almost two decades of learning and improvements. Section ES.6 provides some detail on the components of this submission and outlines key elements of its preparation.

ES.2 Overview, National GHG Emissions

In 2014, the most recent annual dataset in this report, Canada's total GHG emissions were estimated to be 732 megatonnes of

1 See http://unfccc.int/meetings/copenhagen_dec_2009/items/5264.php.

2 Under the United Nations Environment Programme (UNEP), the Montreal Protocol on Substances that Deplete the Ozone Layer is an international agreement designed to reduce the global consumption and production of ozone-depleting substances.

3 See http://unfccc.int/meetings/copenhagen_dec_2009/items/5264.php.

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carbon dioxide equivalent (Mt CO_2 eq[4]), excluding Land Use, Land-Use Change and Forestry (LULUCF) estimates.[5]

The Energy Sector (consisting of Stationary Combustion Sources, Transport, and Fugitive Sources) accounted for the majority of Canada's total GHG emissions in 2014, at 81% or 594 Mt (Figure S–1). The remaining emissions were largely generated by the Agriculture (8% of total emissions) and Industrial Processes and Product Use (7%) sectors, with minor contributions from the Waste Sector (4%). The LULUCF Sector emitted 72 Mt in 2014; these emissions are excluded from national inventory totals.

In 2014, CO_2 accounted for 78% of Canada's total emissions (Figure S–2). The majority of these emissions result from the combustion of fossil fuels. CH_4 accounted for 15% of Canada's total emissions, largely from fugitive emissions from oil and natural gas systems, as well as domestic livestock and landfills. N_2O emissions, largely from agricultural soil management and

4 Unless explicitly stated otherwise, all emission estimates given in Mt represent emissions of GHGs in Mt CO_2 equivalent.

5 Throughout this report data are presented as rounded figures. However, all calculations (including percentages) were performed using unrounded data.

Figure S–1 Canada's Emissions Breakdown by IPCC Sector (2014)*

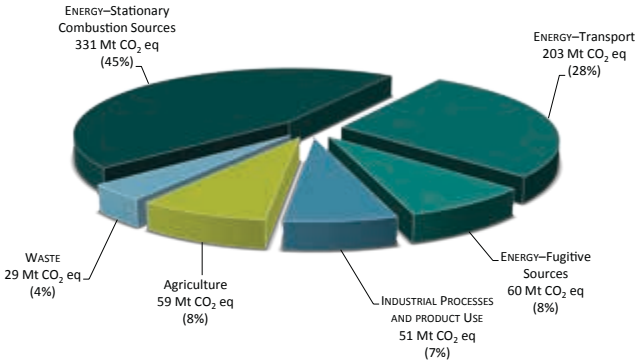
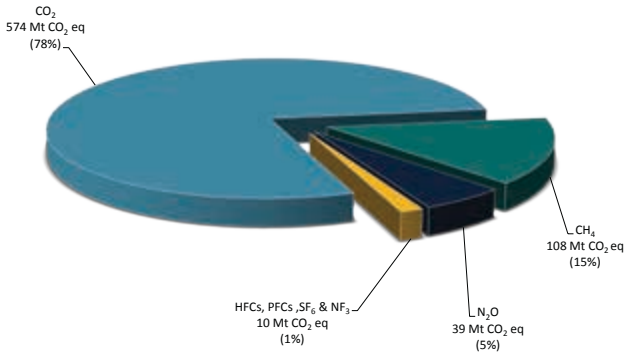


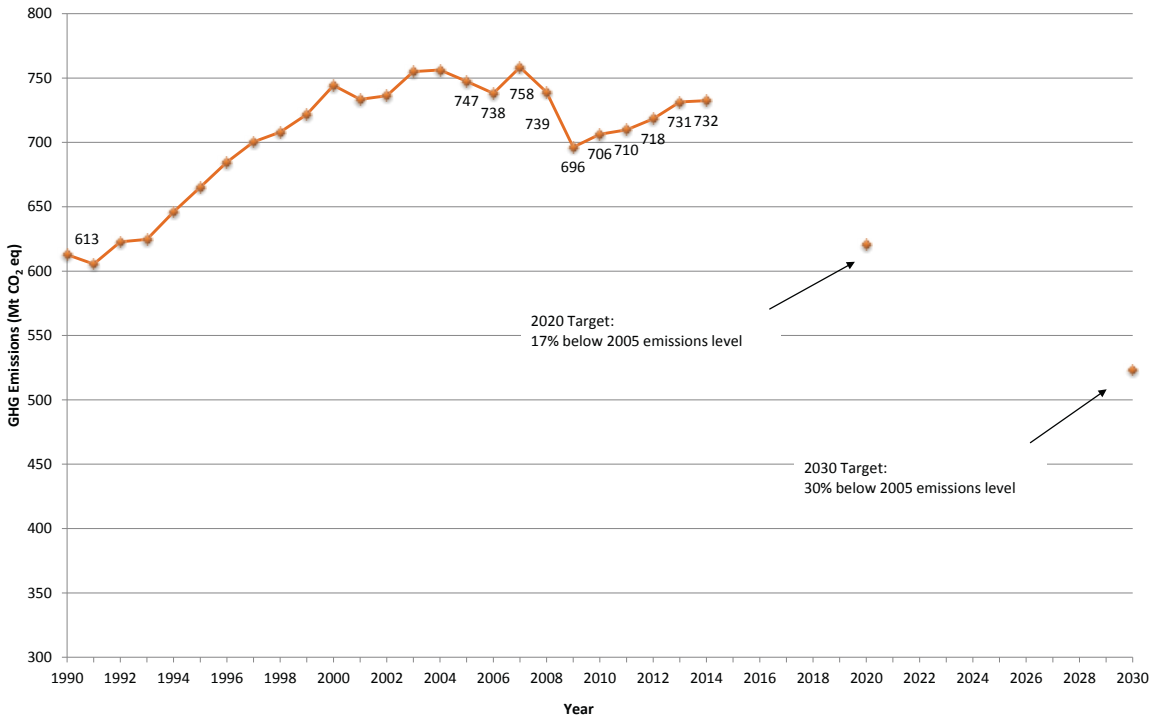
Figure S–2 Canada's Emissions Breakdown by GHG (2014)*



Total: 732 Mt CO_2 eq

*Note: Totals may not add up due to rounding.

Figure S–3 Canadian GHG Emissions Trend (1990–2014), 2020 Target, 2030 Target



transportation, accounted for 5% of emissions. Emissions of the synthetic gases (HFCs, PFCs, SF_6 and NF_3) constituted the remainder (slightly more than 1%).

Canada's emissions in 2014 were 120 Mt (20%) above the 1990 total of 613 Mt (Figure S–3). Steady increases in annual emissions characterized the first 10 years of this period, followed by fluctuating emission levels between 2000 and 2008, a steep drop in 2009, and a gradual increase thereafter. From 2005 to 2009, emissions decreased by 51 Mt (6.8%), and from 2009 to 2014, emissions increased by 36 Mt (5.2%), resulting in an overall decrease of 15 Mt between 2005 and 2014.

Though GHG emissions have risen by 20% since 1990, Canada's economy grew more rapidly, with the gross domestic product (GDP) rising by 75%. As a result, the emission intensity for the entire economy (GHG per GDP) has declined by 32% (Figure S–4 and Table S–1). Early in the period, emissions rose nearly in step with economic growth, with their paths beginning to diverge in 1995 (Figure S–4). This pattern can be attributed to fuel switching, increases in efficiency, the modernization of industrial processes, and structural changes in the economy. These long-term trends have led to continued reduction in emissions intensity since the late 1990s. Section ES.3 provides more information on trends in GHG emissions.

Although Canada represented approximately 1.6% of total global GHG emissions in 2012 (CAIT 2015), it is one of the highest per capita emitters. In 1990, Canadians released 22.1 tonnes (t) of GHGs per capita. In 2000, this indicator had risen to 24.3 t; however, by 2009, it had dropped to 20.7 t and has remained at historic lows ever since (Figure S–5).

ES.3 Emissions and Trends by IPCC Sectors

Overall Trends in Emissions

Over the period 1990–2014, total emissions grew by 120 Mt or 20%.

Figure S–4 Indexed Trend in GHG Emissions and GHG Emissions Intensity (1990–2014)

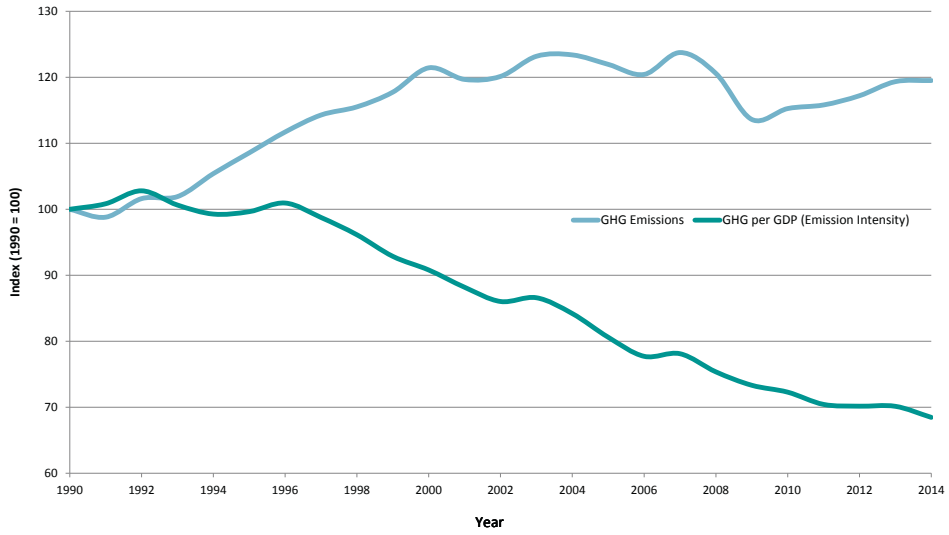


Table S–1 Trends in Emissions and Economic Indicators, Selected Years

Year	1990	2005	2009	2010	2011	2012	2013	2014
Total GHG (Mt)	**613**	**747**	**696**	**706**	**710**	**718**	**731**	**732**
Change Since 2005 (%)	NA	NA	-6.8%	-5.5%	-5.0%	-3.9%	-2.1%	-2.0%
Change Since 1990 (%)	NA	22.0%	13.6%	15.3%	15.8%	17.2%	19.3%	19.5%
GDP (Billions 2007$)	**993**	**1 503**	**1 539**	**1 584**	**1 633**	**1 659**	**1 690**	**1 734**
Change Since 2005 (%)	NA	NA	2.4%	5.4%	8.6%	10.4%	12.4%	15.4%
Change Since 1990 (%)	NA	51.4%	55.0%	59.5%	64.5%	67.1%	70.2%	74.6%
GHG Intensity (Mt/$B GDP)	**0.62**	**0.50**	**0.45**	**0.45**	**0.43**	**0.43**	**0.43**	**0.42**
Change Since 2005 (%)	NA	NA	-9.0%	-10.3%	-12.6%	-12.9%	-13.0%	-15.1%
Change Since 1990 (%)	NA	-19.4%	-26.7%	-27.7%	-29.6%	-29.8%	-29.9%	-31.6%

GDP data source: Statistics Canada (2015a) Table 380-0106 - Gross domestic product at 2007 prices, expenditure-based, annual (dollars), CANSIM (database)

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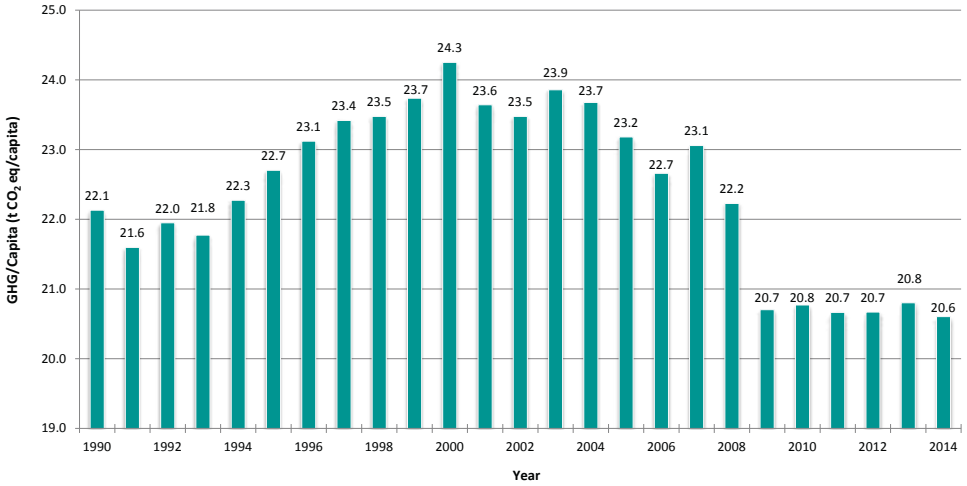
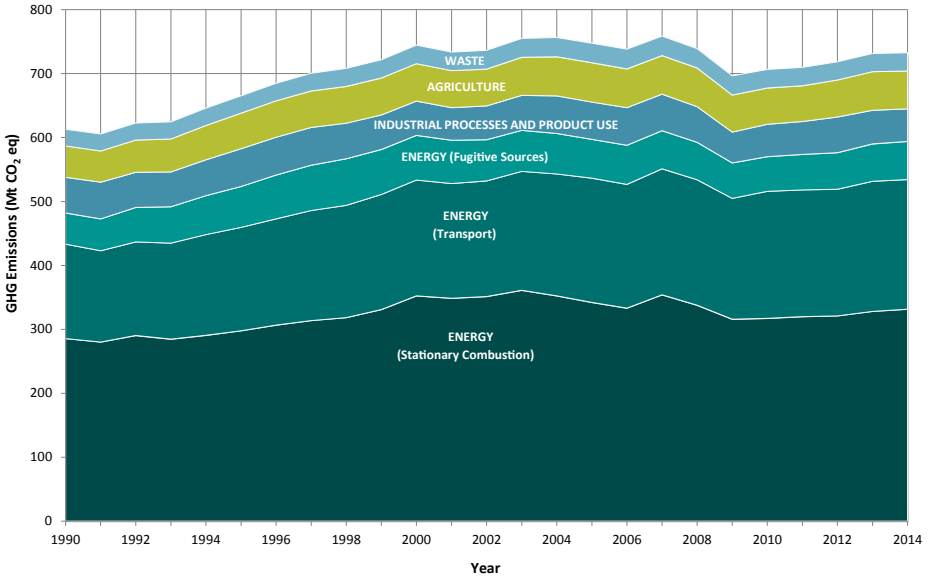
Figure S–5 Canadian per Capita GHG Emissions (1990–2014)



Population data source: Statistics Canada (2015b).

Figure S–6 Trends in Canadian GHG Emissions by IPCC Sector (1990–2014)



The Energy Sector dominated the long-term trend, with increases of 55 Mt in Transport, 46 Mt in Stationary Combustion and 11 Mt in Fugitive Sources (Table S–2). There were also increases of 10 Mt (21%) in the Agriculture Sector and 2 Mt in the Waste Sector. Over the same period, the Industrial Processes and Product Use Sector saw a decrease of 5 Mt .

Table S–2 provides additional details about Canada's emissions and removals by IPCC sector for the years 1990, 2005 and (2009–2014). Further breakdowns by subsector and gas, and a complete time series, can be found in Annex 9.

In contrast to the increase in emissions over the longer term (1990–2014), total Canadian GHG emissions have decreased overall by 15 Mt since 2005. Over this time period, emissions from different source categories exhibit different patterns that can mutually offset each other. For example, the 11-Mt decrease in emissions from Stationary Combustion Sources since 2005 are offset by a similar increase in emissions from Transport sources (Figure S–7). In addition, emissions from Industrial Processes and Product Use, Agriculture, and Waste have decreased by 7 Mt, 2 Mt and 2 Mt, respectively, since 2005.

The principal drivers of the upward trend in emissions since 2009 are energy consumption in Mining and Upstream Oil and Gas Production (an increase of 23 Mt since 2009) and manufacturing industries (6-Mt increase), the consumption of diesel fuel for off-road mobile equipment (9-Mt increase), and fugitive emissions in Oil and Gas (4-Mt increase).

Chapter 2 provides more information on trends in GHG emissions and their drivers.

Table S–2 Canada's GHG Emissions by IPCC Sector, Selected Years

Greenhouse Gas Categories		1990	2005	2009	2010	2011	2012	2013	2014
		Mt CO_2 equivalent							
TOTAL[1,2]		**613**	**747**	**696**	**706**	**710**	**718**	**731**	**732**
ENERGY		**482**	**597**	**560**	**570**	**574**	**576**	**590**	**594**
a.	Stationary Combustion Sources	285	342	316	317	320	321	328	331
	Public Electricity and Heat Production	95	124	100	102	95	92	88	86
	Petroleum Refining Industries	17	20	19	18	18	19	18	17
	Mining and Upstream Oil and Gas Production	41	68	78	80	82	91	99	101
	Manufacturing Industries	56	49	40	41	45	44	45	46
	Construction	2	1	1	2	1	1	1	1
	Commercial & Institutional	26	32	30	28	30	28	29	31
	Residential	46	45	45	42	46	42	44	46
	Agriculture & Forestry	2	2	3	3	3	4	4	4
b.	Transport	148	195	189	199	199	198	204	203
	Domestic Aviation	7	8	6	6	6	7	8	7
	Road Transportation	100	136	140	142	140	141	144	140
	Railways	7	7	5	7	8	8	7	8
	Domestic Navigation	5	6	6	7	6	6	5	5
	Other Transportation	29	38	31	37	39	37	39	43
c.	Fugitive Sources	49	61	55	54	55	57	58	60
	Coal Mining	3	1	1	1	1	1	2	1
	Oil and Natural Gas	46	59	54	53	54	56	57	58
d.	CO_2 Transport and Storage	-	0	0	0	0	0	0	0
INDUSTRIAL PROCESSES AND PRODUCT USE		**56**	**58**	**48**	**50**	**51**	**56**	**53**	**51**
a.	Mineral Products	8	10	7	8	8	8	8	8
b.	Chemical Industry	17	9	6	5	6	6	6	6
c.	Metal Production	24	20	16	16	17	17	15	15
d.	Production and Consumption of Halocarbons, SF_6 and NF_3	1	6	7	7	8	8	9	9
e.	Non-Energy Products from Fuels and Solvent Use	5	12	12	13	12	15	15	13
f.	Other Product Manufacture and Use	0	1	0	0	0	1	1	0
AGRICULTURE		**49**	**61**	**58**	**57**	**56**	**58**	**60**	**59**
a.	Enteric Fermentation	23	31	27	26	25	25	25	25
b.	Manure Management	8	10	9	8	8	8	8	8
c.	Agricultural Soils[3]	17	19	20	21	20	22	24	23
d.	Liming, Urea Application and Other Carbon-containing Fertilizers	1	1	2	2	2	2	3	3
WASTE		**26**	**31**	**30**	**29**	**29**	**28**	**28**	**29**
a.	Solid Waste Disposal	24	28	27	26	26	26	26	26
b.	Biological Treatment of Solid Waste	1	1	1	1	1	1	1	1
c.	Wastewater Treatment and Discharge	1	1	1	1	1	1	1	1
d.	Waste Incineration and Open Burning of Waste	1	1	1	1	1	1	1	1
LAND USE, LAND-USE CHANGE AND FORESTRY		**-87**	**1**	**-40**	**55**	**69**	**41**	**-30**	**72**
a.	Forest Land and Harvested Wood Products	-108	-0	-38	56	71	41	-29	72
b.	Cropland	10	-9	-10	-9	-9	-9	-9	-8
c.	Grassland	1	1	0	0	1	2	1	1
d.	Wetlands	6	4	4	4	4	4	4	3
e.	Settlements	4	4	4	4	4	4	4	4

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 9
3. Includes emissions from Field Burning of Agricultural Residues

Sectors shaded in green represent those sectors with significant contributions to trends as described in Section ES.3

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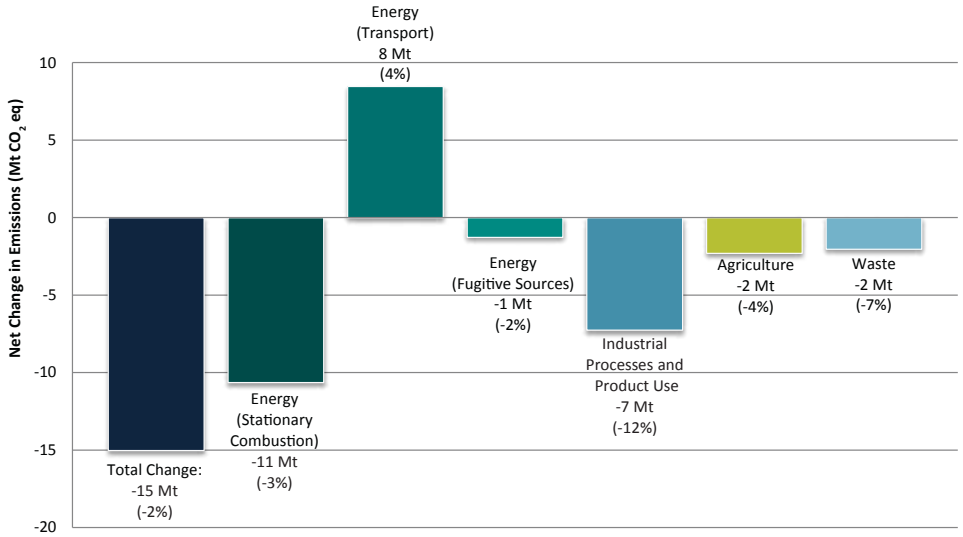
Figure S–7 Short-term Emission Trends by IPCC Sector (2005–2014)



The following describes the emissions and trends of each IPCC sector in further detail.

Energy—2014 GHG Emissions (594 Mt)

Short-term Trends

In 2014, GHG emissions from the IPCC Energy Sector (594 Mt) were very close to 2005 levels (597 Mt). Within the Energy Sector, the 34-Mt increase in emissions from Mining and Upstream Oil and Gas Production was offset by a 39-Mt decrease in emissions from Public Electricity and Heat Production.

Decreasing energy generation from coal and oil, accompanied by an increase in hydro, nuclear and wind generation, was the largest driver of the 31% decrease in emissions associated with Electricity Production between 2005 and 2014. The permanent closure of all coal generating stations in the province of Ontario by 2014 was the determinant factor.[6] However, emissions fluctuated over the period, largely as a result of changes in the mix of electricity generation sources.[7]

GHG emissions from Manufacturing Industries decreased by 2.9 Mt between 2005 and 2014, consistent with both a 6% decrease in energy use and an observed decline in output[8] in these industries.

Long-term Trends

The long-term emission trends in the Energy Sector (1990–2014) show a net growth of 112 Mt or 23%. The majority of the increase has taken place in Mining and Upstream Oil and Gas Production (60 Mt) and Road Transportation (41 Mt). The largest decreases in Energy Sector emissions were observed in the Manufacturing Industries (10 Mt), followed by Public Electricity and Heat Production (9 Mt).

In 2014, emissions from Mining and Upstream Oil and Gas Production were more than twice their 1990 values. This trend is consistent with a 91% increase in total production of crude oil and natural gas over the period, largely for export, which has grown by over 200%.

Oil production has been driven primarily by a rapid rise in the extraction of bitumen and synthetic crude oil from Canada's oil sands. In addition, per-barrel GHG emissions from oil and gas production have been rising, due to an increase in the complexity of techniques used to produce conventional oil and the increasing proportion of synthetic crude oil produced from the oil sands. Since 2004 however, the emissions intensity from oil sands operations has remained fairly static.

The majority of transport emissions in Canada are related to Road Transportation, which contributed 74% of the net increase in total transport GHG emissions since 1990. The primary source of this net trend of rising emissions is the increase in the vehicle population and total vehicle kilometres travelled despite a reduction in average kilometres driven per vehicle. In addition, vehicles are becoming more efficient, and the 43% increase in emissions since 1990 remains lower than the 47% increase in vehicle kilometres travelled.

6 Ontario Power Generation News, April 15, 2014; http://www.opg.com/news-and-media/news-releases/Pages/news-releases.aspx?year=2014, accessed January, 2016)

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

8 See, for example, Energy Consumption by the Manufacturing Sector, 2014, Statistics Canada Daily, November 2, 2015; http://www.statcan.gc.ca/daily-quotidien/151102/dq151102a-eng.htm (accessed January 25, 2016).

The most significant sources of emissions in road transportation are light-duty (i.e. passenger) vehicles and heavy-duty diesel vehicles for freight transport. Within the light-duty vehicle[9] segment, the use of sport-utility vehicles, pickups and minivans increased much more rapidly than cars. These vehicles typically have higher fuel consumption ratios than cars, therefore influencing overall emission rates for light-duty vehicles.

Emissions from heavy-duty diesel vehicles (large freight trucks) rose by 28 Mt (142%) between 1990 and 2014. Growth in emissions reflected a substantial increase in the use of heavy trucks, which are primarily used to transport freight between urban centres (NRCan 2015). As with the light-duty vehicle segment, improvements to fuel consumption ratios in this segment were offset by large increases in vehicle kilometres travelled.

Industrial Processes and Product Use—2014 GHG Emissions (51 Mt)

The Industrial Processes and Product Use Sector covers non-energy GHG emissions from industrial sources, such as limestone calcination (CO_2) in cement production and the use of HFCs and PFCs as replacement refrigerants for ozone-depleting substances (ODSs). Since 1990, emissions have fluctuated, with peaks in 1996 and 2004. In 2014, emissions were 9% (5 Mt) below their 1990 level and 12% (7 Mt) below the 2005 level.

Emissions of most industries decreased in 2008 and 2009 and have remained at similar levels since then. A notable exception includes the 3.3-Mt (59%) increase in emissions from the use of HFCs since 2005.

The aluminium industry, while increasing its production by over 80% since 1990, shows a 4.5-Mt (43%) decrease in its process emissions, largely due to emission control technology introduced to mitigate PFC emissions. The 65% overall decrease in GHG emissions from Chemical Industries between 1990 and 2014 is primarily a result of the closure in 2009 of an adipic acid plant in Ontario.

Agriculture—2014 GHG Emissions (59 Mt)

Emissions directly related to animal and crop production accounted for 59 Mt or 8.0% of total 2014 GHG emissions for Canada, an increase of 10 Mt or 21% since 1990. Agriculture accounts for 27% and 70% of the national CH_4 and N_2O emissions, respectively. Livestock emissions currently account for 62% of total agricultural emissions.

The main drivers of the trend in emissions in the Agriculture Sector since 1990 are sustained increases in the application of inorganic nitrogen fertilizers, mainly on the Prairies, and the intensification, expansion and then subsequent decline of the beef cattle and swine industries.

From 1990 to 2005, fertilizer and livestock emissions increased by 1.3 and 12 Mt, respectively. Since 2005, fertilizer use continued to increase, but by 2011 livestock populations had decreased sharply. Emissions reached 59 Mt in 2014 as livestock populations have remained stable since 2011, while fertilizer use and crop production were higher than in 2011.

Waste—2014 GHG Emissions (29 Mt)

The primary source of emissions in the Waste Sector is CH_4 from Solid Waste Disposal, which accounts for about 91% of emissions for this sector. The CH_4 emissions from publicly and privately owned municipal solid waste landfills (MSW) make up the bulk of emissions from Solid Waste Disposal (approximately 84%). The remainder (approximately 16%) originates from on-site industrial landfills of wood residues; such landfills are declining in number as markets for wood residues grow.

Since 1990, overall emissions from the Waste Sector have grown by 10%, mostly from increases in emissions from landfill operations. Emission releases in this sector are significantly mitigated by the growing volumes of landfill gas (LFG) captured and combusted at the landfill sites. While the CH_4 emissions generated by all MSW landfills increased by 37% to 33 Mt, the amount of CH_4 captured increased by 134% to 11 Mt in 2014. Of the overall CH_4 captured, 49% was combusted for energy recovery applications and the remainder was flared. The number of landfill sites with LFG capture systems is rapidly rising in Canada, with 81 such systems operating in 2014.

Land Use, Land-use Change and Forestry—2014 (Net Emissions of 72 Mt)

The Land Use, Land-use Change and Forestry (LULUCF) Sector reports GHG fluxes between the atmosphere and Canada's managed lands, including those associated with land-use change and emissions from harvested wood products (HWP) which are closely linked to forest land. All emissions and removals in the LULUCF Sector are excluded from the national totals.

In this sector, the net GHG flux is the net sum of CO_2 emissions to and removals from the atmosphere, plus emissions of non-CO_2 gases. In 2014, this net flux amounted to emissions of 72 Mt, which, if included, would increase the total Canadian GHG emissions by about 9.8%.

Trends in emissions/removals from LULUCF are primarily driven by those in Forest Land in conjunction with HWP. In contrast with other inventory estimates, GHG emissions and removals from Canada's managed lands can include very large fluxes from non-anthropogenic events, such as wildfires and insect epidemics in

9 Light-duty vehicles (LDVs) include all light-duty vehicles and trucks regardless of fuel type.

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Forest Land. The net flux from Forest Land is dominated by inter-annual variability and trends due to natural disturbances, which mask the impact of human activities in managed forests. For example, between 1990 and the peak harvest year of 2004, there was a 24% increase in the carbon removed in harvested wood. Since then, significant reductions in forest harvest have occurred, reaching a 25-year low in 2009, with levels in 2014 still at 25% below their peak. Nevertheless, the immediate and long-term effect of major natural disturbances in managed forests, notably the mountain pine beetle infestation in western Canada and periodic wildfires, dominate the apparent trend of emissions and removals from Forest Land. The area burned by wildfires in 2014 was significantly larger than in 2013 (1.3 million ha compared to 0.5 in 2013), which resulted in higher wildfire emissions (175 Mt compared to 66 Mt in 2013).

Emissions from HWP fluctuate between 128 Mt in 2009, the year of the lowest harvest rates, and peaks of 160 Mt in 1995 and 2000. HWP emissions are mainly influenced by recent harvest trends but also by the long-term impact of forest harvesting that occurred before 1990, since a significant proportion of emissions result from the decay of long-lived wood products reaching the end of their economic life decades after the wood was harvested.

The conversion of forests to other land uses is a prevalent, yet declining, practice in Canada, mainly due to forest conversion to settlements for resource extraction and cropland expansion. Emissions from forest conversion totalled 12 Mt in 2014, down from 19.2 Mt in 1990.

The net flux in emissions from cropland shows a steady decline in the period 1990–2006, from 10 Mt in 1990 to net removals of 9.9 Mt in 2006. This trend is a result of changes in agricultural land management practices, mainly in western Canada, including the adoption of conservation tillage practices (≈17 million hectares of cropland since 1990), an 81% reduction in summerfallow, as well as a decline in the conversion of forest land to cropland. However, since 2006, net removals have gradually declined to 8.4 Mt as a result of the soil sink approaching equilibrium and an observed increase in conversion of perennial to annual crops, a trend that is consistent with the increasing N_2O emissions from crop production observed in the Agriculture Sector.

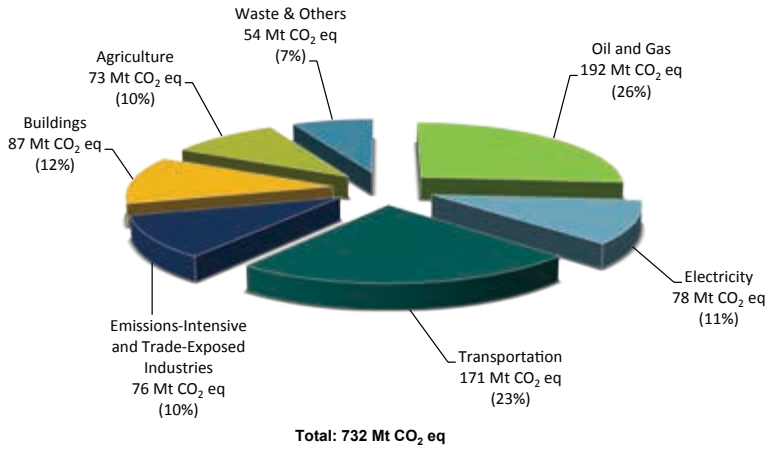
ES.4 Economic Sectors

For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the economic sector from which the emissions originate. These emissions are presented in Figure S–8 and Table S–3. In general, a comprehensive emission profile for a specific economic sector is developed by reallocating the relevant proportion of emissions from various IPCC subcategories. This reallocation simply re-categorizes emissions under different headings and does not change the overall magnitude of Canadian emissions estimates.

Similar to the trends under IPCC sectors, the increase in GHG emissions between 1990 and 2014 was driven by growth in the oil and gas and transportation sectors. Increased production of crude oil as well as the expansion of the oil sands resulted in an increase in emissions of 85 Mt in the oil and gas sector. In the transportation sector, changes in subsectors such as light-duty and heavy-duty vehicles caused an increase in emissions of 42 Mt when compared to 1990 levels. These increases were offset by decreases in emissions in the Electricity and Emissions Intensive and Trade Exposed Industries, where emissions fell 17 Mt and 19 Mt, respectively.

Further information on trends can be found in Chapter 2. Additional information on the IPCC and economic sector definitions, as well as a detailed cross-walk between IPCC and economic sector categories, can be found in Part 3.

Figure S–8 Canada's Emissions Breakdown by Economic Sector (2014)



Note: Totals may not add up due to rounding.

Table S–3 Canada's GHG Emissions by Economic Sector, Selected Years

	1990	2005	2009	2010	2011	2012	2013	2014
				Mt CO_2 equivalent				
NATIONAL GHG TOTAL	**613**	**747**	**696**	**706**	**710**	**718**	**731**	**732**
Oil and Gas	107	159	160	162	164	176	187	192
Electricity	95	118	94	95	87	83	80	78
Transportation	129	171	168	173	170	171	174	171
Emission Intensive and Trade Exposed Industries[1]	95	88	72	74	79	79	77	76
Buildings	73	85	83	81	86	84	85	87
Agriculture	57	70	67	68	69	70	73	73
Waste & Others[2]	49	48	52	53	53	53	54	54

Notes: 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 8, and recalculations resulting from changes to underlying activity data are presented in the chapter(s) associated with the sector where the changes occurred (Chapters 3-7).

1. The Emissions Intensive and Trade Exposed Industries represent emissions arising from non-coal, -oil and -gas 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.

ES.5 Provincial and Territorial GHG Emissions

Emissions vary significantly by province, due to factors such as population, energy sources and economic structure. All else being equal, economies based on resource extraction will tend to have higher emission levels than service-based economies. Likewise, provinces that rely on fossil fuels for their electricity generation will have higher emissions than those that rely more on hydroelectricity.

Historically, Alberta has been one of the highest emitting province; its emissions increased from 233 Mt in 2005 to 274 Mt in 2014 (17%), primarily due to the expansion of oil and gas operations (Figure S–9 and Table S-4). In contrast, Ontario's emissions have steadily decreased since 2005 (by 40 Mt or 19%), primarily due to the closure of coal-fired electricity generation plants.

Quebec and British Columbia, which rely on abundant hydroelectric resources for their electricity production, show more stable emission patterns across the time series and a decreasing pattern since 2005. Quebec experienced a 7.8% (7.0 Mt) decrease from its 2005 emissions level, while British Columbia had a decline of 3.4% (2.2 Mt). Emissions in Nova Scotia, New Brunswick and Prince Edward Island have also decreased since 2005, especially in Nova Scotia (29% reduction).

Figure S–9 Emissions by Province in 1990, 2005 and 2014

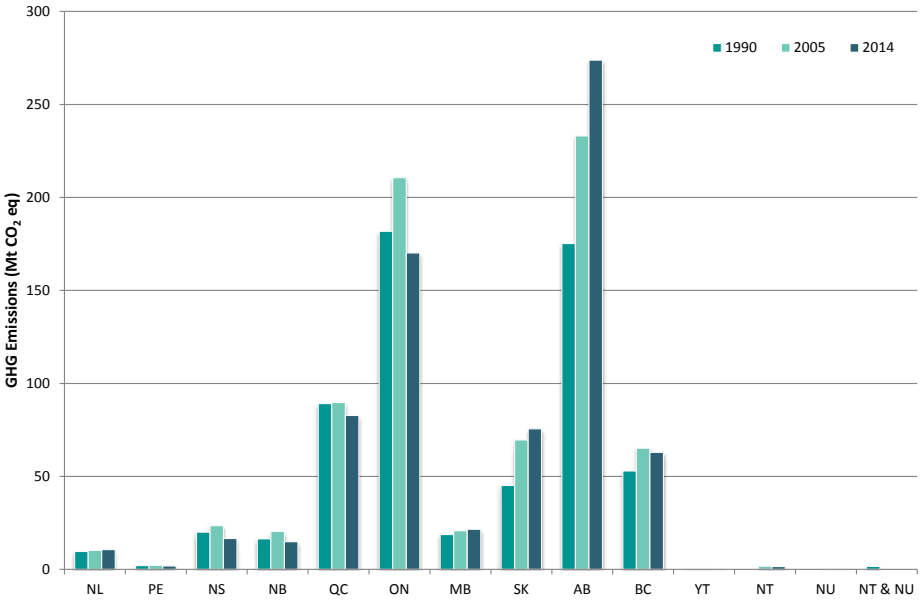


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Table S–4 GHG Emissions Provinces / Territories, Selected Years

	GHG Emissions (Mt CO_2 eq)								Change (%)
Year	1990	2005	2009	2010	2011	2012	2013	2014	1990-2014
GHG Total (Canada)	**613**	**747**	**696**	**706**	**710**	**718**	**731**	**732**	**20%**
NL	9.6	10.2	10.1	10.3	10.3	9.8	9.6	10.6	10%
PE	2.0	2.1	1.9	2.0	2.1	2.1	1.8	1.8	-8%
NS	20	23	21	20	21	19	18	17	-17%
NB	16	20	19	19	19	17	15	15	-9%
QC	89	90	87	82	84	82	83	83	-7%
ON	182	211	171	179	175	171	171	170	-6%
MB	19	21	20	20	19	21	21	21	15%
SK	45	70	70	70	69	72	74	76	68%
AB	175	233	234	242	246	260	272	274	56%
BC	53	65	61	61	61	63	63	63	19%
YT	0.5	0.5	0.3	0.3	0.4	0.4	0.4	0.3	-50%
NT[2]	NA	1.7	1.2	1.4	1.4	1.5	1.4	1.5	-
NU[2]	NA	0.3	0.4	0.4	0.2	0.2	0.2	0.3	-
NT&NU[2]	1.6	NA	NA	NA	NA	NA	NA	NA	-

Notes:
1. Totals may not add up due to rounding.
2. To account for the creation of Nunavut in 1999, a time series from 1999–2014 is provided for both Nunavut and the Northwest Territories and the years 1990–1998 are presented as a combined region (see Annex A11 for more information).

Emissions in Saskatchewan increased by 8.6% (6.0 Mt) between 2005 and 2014, as a result of activities in the oil and gas industry as well as potash and uranium mining. Emissions in Manitoba and Newfoundland and Labrador have also increased since 2005 but to a lesser extent.

ES.6 National Inventory Arrangements

Environment and Climate Change Canada is the single national entity with responsibility for preparing and submitting the National Inventory to the UNFCCC and for managing the supporting processes and procedures. Canada's arrangements for the estimation of anthropogenic emissions from sources and removals by sinks of all GHGs not controlled by the Montreal Protocol encompass the institutional, legal and procedural arrangements necessary to ensure that it meets its reporting obligations.

The inventory arrangements consist of institutional arrangements for the preparation of the inventory, including: formal agreements supporting data collection and estimate development; a quality management plan, including an improvement plan; the ability to identify key categories and generate quantitative uncertainty analysis; a process for performing recalculations for improvement of the inventory; procedures for official approval; and a working archives system to facilitate third-party review.

Submission of information regarding the national inventory arrangements, including details on institutional arrangements for inventory preparation, is also an annual requirement under the UNFCCC reporting guidelines on annual inventories (see Chapter 1, Section 1.2).

Structure of Submission

The UNFCCC requirements include the annual compilation and submission of both the National Inventory Report (NIR) and the 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 the quality assurance and quality control procedures.

Part 1 of the NIR includes Chapters 1 to 8. Chapter 1 (Introduction) provides an overview of Canada's legal, institutional and procedural arrangements for producing the inventory (i.e. the national inventory arrangements), quality assurance and quality control procedures 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 7 provide descriptions and additional analysis for each sector, according to UNFCCC reporting requirements. Chapter 8 presents a summary of recalculations and planned improvements.

Part 2 of the NIR consists of Annexes 1 to 7, which provide a key category analysis, inventory uncertainty assessment, detailed

explanations of estimation methodologies, Canada's energy balance, completeness assessments, emission factors and information on ozone and aerosol precursors.

Part 3 comprises Annexes 8 to 13, which present rounding procedures, summary tables of GHG emissions at the national level and 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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