Environment Canada Environnement Canada

National Inventory Report

1990–2013

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 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 signed the Copenhagen Accord, under which Canada has committed to reducing its GHG emissions to 17% below the 2005 level by the year 2020.[1]

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 recently 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 report represents Canada's first inventory submission to the UNFCCC following the recently revised UNFCCC Reporting Guidelines, adopted through Decision 24/CP.19 at COP 19 in Warsaw in 2013. It includes recalculations of previously reported estimates due to the use of the 2006 methodological guidance developed by the Intergovernmental Panel on Climate Change (IPCC) and updated global warming potentials (GWPs) from the IPCC Fourth Assessment Report as well as to the reporting of several new GHGs (Chapter 1 – Table 1.1 provides a complete list of GHGs to be reported and their GWPs).

Of particular significance, the GWP of methane has increased from 21 to 25; this change contributed to the upward recalculation of Canada's total emissions over the 1990-2012 period. For example, the recalculated total emissions for 2012 have increased by 16.6 Mt (2.4%) (Chapter 8 provides more details on recalculations). Inventory reports must also describe the formal arrangements for the preparation of inventories and indicate significant changes to inventory preparation and submission procedures. This inventory report complies with the most recent UNFCCC reporting guidelines for national GHG inventories.

The inventory 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 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 inventory guidelines prepared by the IPCC. 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 1990–2013 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 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 Copenhagen 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 three territorial governments.

1 See www.climatechange.gc.ca/default.asp?lang=En&n=AA3F6868-1 .

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 www.climatechange.gc.ca/default.asp?lang=En&n=AA3F6868-1.

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Section ES.5 details GHG emissions for Canada's 13 sub-national jurisdictions.

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

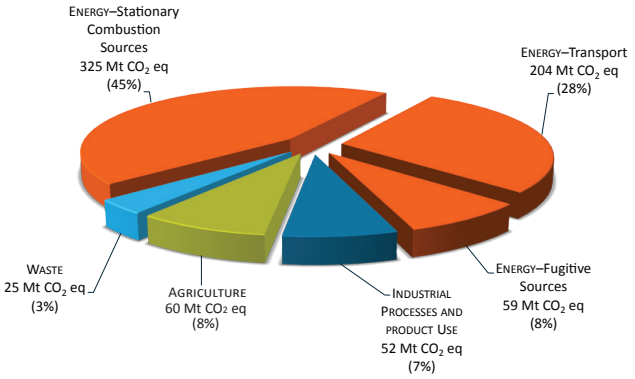
ES.2 Overview, National GHG Emissions

In 2013, the most recent annual dataset in this report, Canada's total GHG emissions were estimated to be 726 megatonnes of carbon dioxide equivalent (Mt CO_2 eq[4]), excluding Land Use, Land-Use Change and Forestry estimates. The Energy Sector (consisting of the Stationary Combustion Sources, Transport, and Fugitive Sources subsectors) accounted for the majority of Canada's total GHG emissions in 2013, at 81% or 588 Mt (Figure S–1). The remaining emissions were largely generated by Agriculture (8% of total emissions) and Industrial Processes and Product Use (7%), with minor contributions from Waste (3%). The LULUCF Sector was a net removal of 15 Mt in 2013; in accordance with UNFCCC reporting guidelines, these emissions are excluded from national inventory totals.

In 2013, CO_2 contributed 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 transportation, accounted for 6% of emissions. Emissions of the synthetic gases (HFCs, PFCs, SF_6 and NF_3) constituted the remainder (slightly more than 1%).

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

Figure S–1 Canada's Emissions Breakdown by IPCC Sector (2013)*



Total: 726 Mt CO_2 eq

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

Figure S–2 Canada's Emissions Breakdown by Greenhouse Gas (2013)

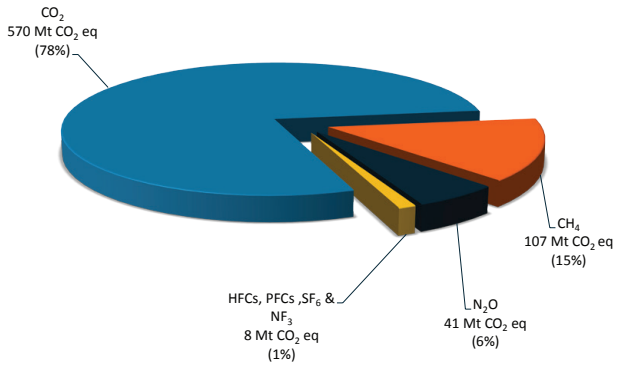
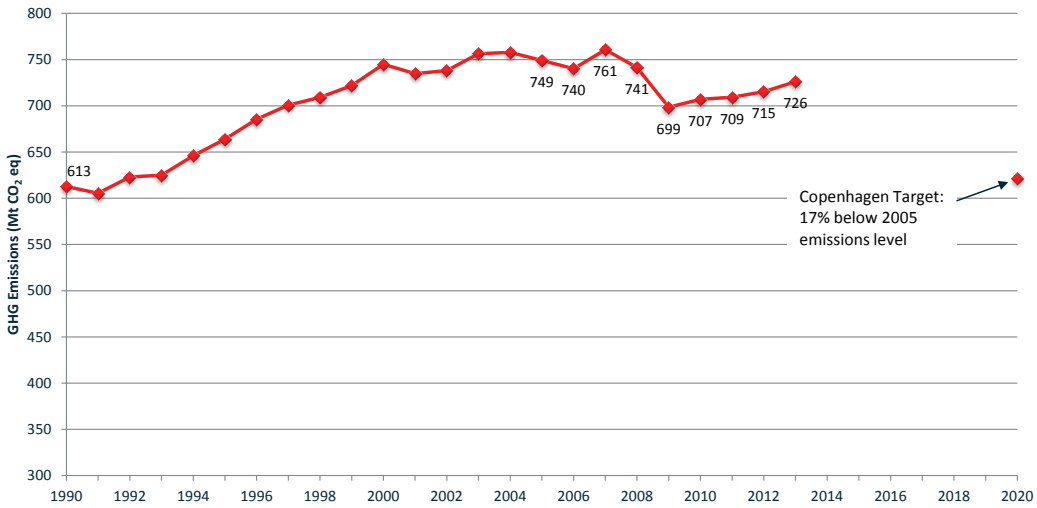


Figure S–3 Canadian GHG Emissions Trend (1990–2013) and Copenhagen Target



Canada's emissions in 2013 were 113 Mt (18%) above the 1990 total of 613 Mt (Figure S–3). Steady increases in annual emissions characterized the first 15 years of this period, followed by fluctuating emission levels between 2005 and 2008, a steep drop in 2009, and a slight increase thereafter. Between 2005 and 2013, emissions decreased by 23 Mt (3%), primarily due to decreases in emissions from Public Electricity and Heat Production (Table S–2).

Though GHG emissions have risen by 18% since 1990, Canada's economy grew much more rapidly, with the gross domestic product (GDP) rising by 71%. As a result, the emission intensity for the entire economy (GHG per GDP) has improved considerably, dropping by 31% (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). In 1995, GHG emissions started to decouple from economic growth, a shift that can be attributed to increases in efficiency, the modernization of industrial processes, and structural changes in the economy.

These long-term trends have led to continued improvement in emissions intensity since the late 1990s. However, emissions intensity seems to have stabilized in the last few years. Section ES.3 provides more information on trends in GHG emissions.

In general, Canada represents less than 2% of total global GHG emissions (CAIT 2015), although 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 22.1 tonnes (t) of GHGs per capita. In 2005, this indicator had risen to 23.2 t; however, by 2009, it had dropped to 20.8 t and has remained at historic lows ever since (Figure S–5).

Figure S–4 Indexed Trend in GHG Emissions and GHG Emissions Intensity (1990–2013)

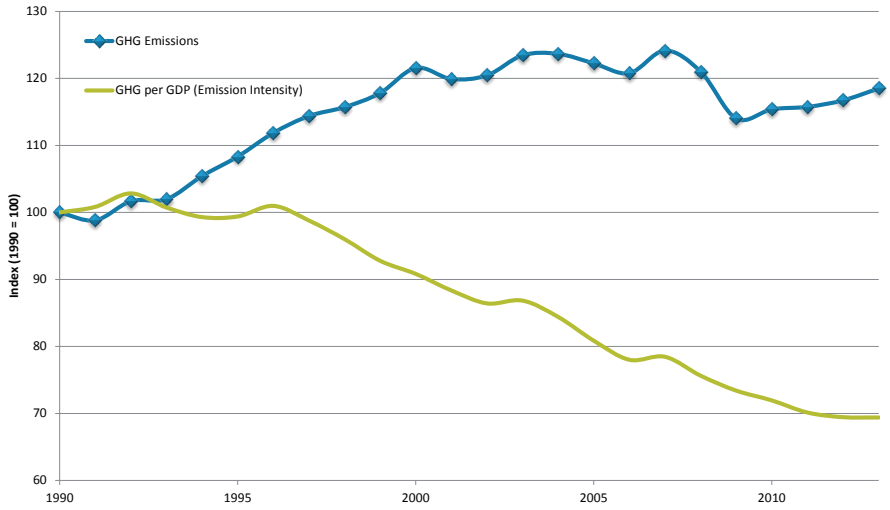


Table S–1 Trends in Emissions and Economic Indicators, Selected Years

Year	1990	2000	2005	2009	2010	2011	2012	2013
Total GHG (Mt)	613	745	749	699	707	709	715	726
Change Since 2005 (%)	NA	NA	NA	-6.7%	-5.6%	-5.3%	-4.5%	-3.1%
Change Since 1990 (%)	NA	21.6%	22.2%	14.0%	15.4%	15.7%	16.7%	18.5%
GDP (Billions 2007$)	989	1 324	1 496	1 537	1 587	1 633	1 663	1 689
Change Since 2005 (%)	NA	NA	NA	2.7%	6.1%	9.2%	11.2%	12.9%
Change Since 1990 (%)	NA	33.8%	51.2%	55.3%	60.4%	65.0%	68.1%	70.7%
GHG Intensity (Mt/$B GDP)	0.62	0.56	0.50	0.45	0.45	0.43	0.43	0.43
Change Since 2005 (%)	NA	NA	NA	-9.2%	-11.0%	-13.3%	-14.1%	-14.2%
Change Since 1990 (%)	NA	-9.2%	-19.2%	-26.6%	-28.1%	-29.9%	-30.6%	-30.6%

GDP Data Source: Statistics Canada (2014a).

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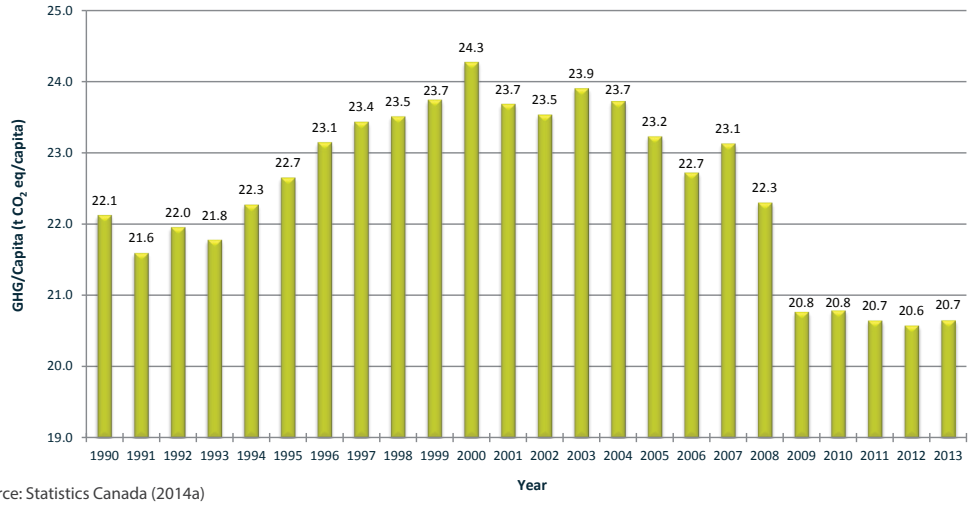
Figure S–5 Canadian per Capita Greenhouse Gas Emissions (1990–2013)



Population data source: Statistics Canada (2014a)

ES.3 Emissions and Trends by IPCC Sectors

Overall Trends in Emissions

Over the period 1990–2013, total emissions grew by 113 Mt or 18%. The Energy Sector dominated the long-term trend, with increases of 56 Mt (38%) in Transport and 37 Mt (13%) in Stationary Combustion. There was an increase of 11 Mt CO_2 eq (23%) in the Agriculture Sector as well. The Industrial Processes and Product Use Sector saw a decrease of 3 Mt CO_2 eq (5%) between 1990 and 2013, although emissions fluctuated over this period (Figure S–6 and Table S–2).

Table S–2 provides additional details about Canada's emissions and removals by IPCC sector for the years 1990, 2000, 2005 and 2009–2013. Further breakdowns by subsector and gas, and a complete time series, can be found in Annex 9.

In contrast to the increase of emissions over the longer term (1990–2013), total Canadian GHG emissions have decreased by 23 Mt (3%) since 2005. Stationary Combustion Sources within the Energy Sector have been the largest driver of the overall downward trend, dropping by 19 Mt (6%) since 2005 (Figure S–7), with the largest contributor to this decrease being from Public Electricity and Heat Production, where emissions fell 37 Mt (29%). Since 2005, emissions from Industrial Processes and Product Use, Waste, Fugitive Sources within the Energy Sector, and Agriculture

Figure S–6 Trends in Canadian GHG Emissions by IPCC Sector (1990–2013)

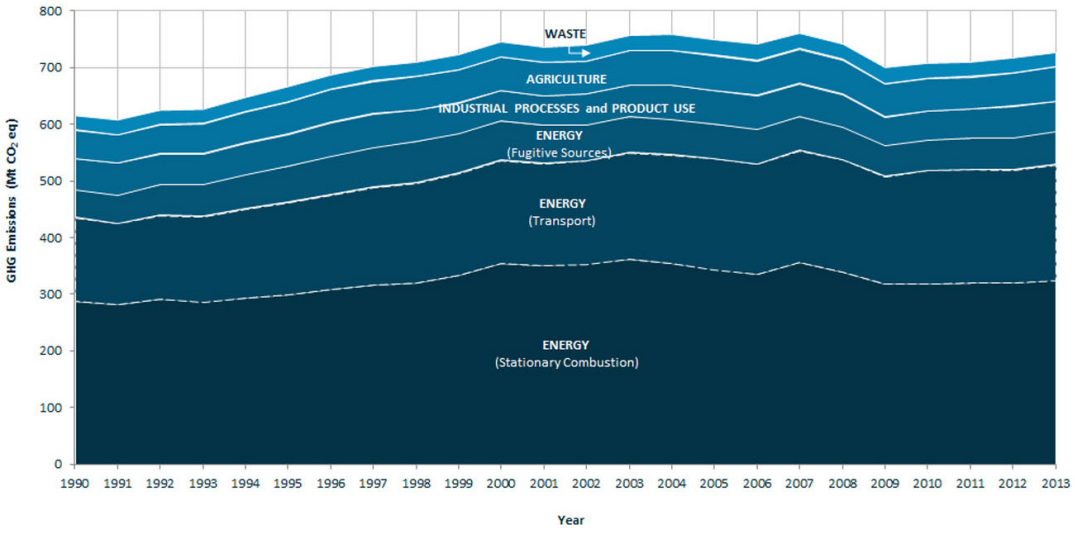


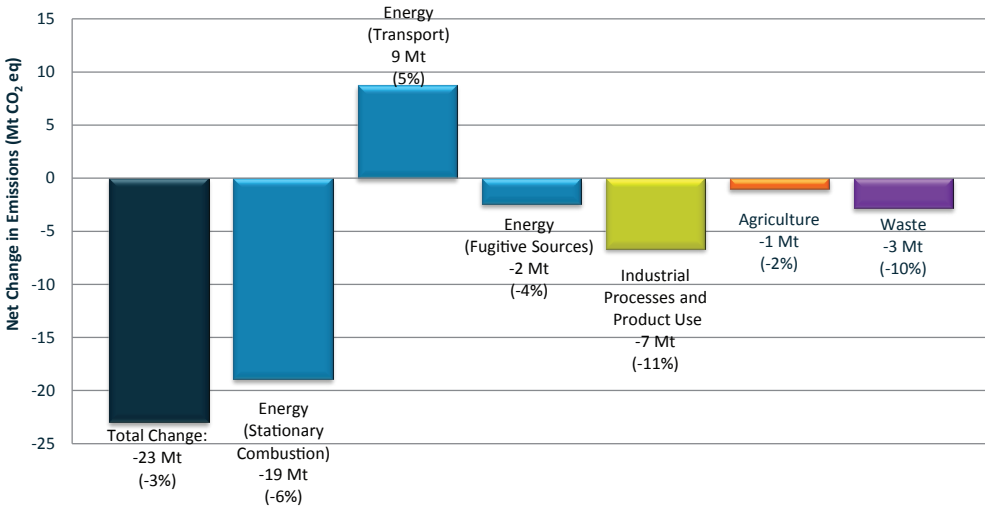
Table S–2 Canada's GHG Emissions by IPCC Sector (1990–2013)

Greenhouse Gas Categories		1990	2000	2005	2009	2010	2011	2012	2013
		Mt CO_2 equivalent							
TOTAL[1,2]		613	745	749	699	707	709	715	726
ENERGY		485	606	601	563	573	576	577	588
a.	Stationary Combustion Sources	288	355	344	318	318	321	320	325
	Public Electricity and Heat Production	95	131	124	100	102	95	89	88
	Petroleum Refining Industries	17	17	20	19	18	17	19	18
	Mining and Upstream Oil and Gas Production	41	63	68	78	80	82	91	94
	Manufacturing Industries	56	56	49	40	41	45	45	46
	Construction	2	1	1	1	2	1	1	1
	Commercial & Institutional	26	33	32	30	28	30	28	29
	Residential	49	50	48	47	45	48	44	46
	Agriculture & Forestry	2	3	2	3	3	3	4	4
b.	Transport	148	182	195	190	200	199	199	204
	Domestic Aviation	7	8	8	6	6	6	7	8
	Road Transportation	98	119	132	133	135	134	134	137
	Railways	7	7	7	5	7	8	8	7
	Domestic Navigation	5	5	7	7	7	6	6	5
	Other Transportation	31	43	43	38	44	46	45	47
c.	Fugitive Sources	49	70	61	56	55	56	57	59
	Coal Mining	3	2	2	1	2	2	2	2
	Oil and Natural Gas	46	68	59	54	53	54	56	57
d.	CO_2 Transport and Storage	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDUSTRIAL PROCESSES AND PRODUCT USE		55	53	59	49	51	51	55	52
a.	Mineral Products	9	10	10	7	8	8	9	8
b.	Chemical Industry	14	5	7	4	4	4	4	5
c.	Metal Production	23	23	20	16	16	17	17	14
d.	Production and Consumption of Halocarbons, SF_6 and NF_3	1	4	5	6	6	6	6	7
e.	Non-Energy Products from Fuels and Solvent Use	7	11	16	16	17	15	19	18
f.	Other Product Manufacture and Use	0.2	0.4	0.4	0.3	0.2	0.3	0.3	0.3
AGRICULTURE		49	59	62	58	57	56	58	60
a.	Enteric Fermentation	23	28	31	27	26	25	25	25
b.	Manure Management	8	9	10	9	9	8	8	8
c.	Agriculture Soils[3]	17	19	19	20	21	21	22	24
d.	Liming, Urea Application and Other Carbon-containing Fertilizers	1	2	1	2	2	2	2	3
WASTE		24	26	28	28	27	26	26	25
a.	Solid Waste Disposal on Land	22	25	26	27	25	25	24	24
b.	Wastewater Handling	1	1	1	1	1	1	1	1
c.	Waste Incineration	1	1	1	1	1	1	1	1
LAND USE, LAND-USE CHANGE AND FORESTRY		-87	-77	16	-8	81	82	60	-15
a.	Forest Land and Harvested Wood Products	-109	-83	16	-8	81	81	58	-16
b.	Cropland	10	-2	-8	-9	-8	-8	-8	-7
c.	Grassland	1	1	1	0	0	1	2	1
d.	Wetlands	6	4	4	4	4	4	4	4
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

Figure S–7 Short-term Emission Trends by IPCC Sector (2005–2013)



have also decreased (by 7 Mt, 3 Mt, 2 Mt and 1 Mt respectively), while emissions from Transport have increased by 9 Mt (5%) over the same period.

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

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

Energy—2013 GHG Emissions (588 Mt)

Short-term Trends

In 2013, GHG emissions from the IPCC Energy Sector were 13 Mt (2%) below 2005 levels. Similar to the national trend, this decline was primarily driven by a decline in fossil fuel consumption for 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 a 37-Mt (about 29%) decrease in emissions associated with Electricity Production between 2005 and 2013. The permanent closure, at the end of 2013, of all but one coal generating station in the province of Ontario was a determinant factor. However, there were some fluctuations in emissions over the period, largely as a result of changes in the mix of electricity generation sources.[5]

GHG emissions from Manufacturing Industries decreased by 2.6 Mt (5%) between 2005 and 2013. While industries continue to recover from the 2009 decrease in production, emissions still remain below 2005 levels.

In contrast, emissions from Mining and Upstream Oil and Gas Production increased by 26 Mt, consistent with continued growth in oil and gas extraction activities (see *Long-term Trends*).

Long-term Trends

The long-term emission trends in the Energy Sector (1990–2013) show a net growth of 103 Mt or 21%. The majority of the increase has taken place in Mining and Upstream Oil and Gas Production and Road Transportation, which both fall under the Energy Sector. The largest decreases in Energy Sector emissions were observed in the Manufacturing Industries (10 Mt), followed by Public Electricity and Heat Production (7 Mt).

In 2013, emissions from Mining and Upstream Oil and Gas Production were more than twice their 1990 values. This trend is consistent with a 79% increase in total production of crude oil and natural gas over the period, largely for export.

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 is a significant contributor to the long-term increase in emissions (representing 38.9 Mt or 69% of the net increase in total transport GHG emissions). The primary source

5 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.

of this net trend of rising emissions is the increase in the vehicle population and the associated vehicle kilometres travelled. However, vehicles are becoming more efficient, and the 3.7% increase in emissions since 2005 remains lower than the 12.5% increase in vehicle kilometres travelled.

The most significant sources of emissions in transportation are light-duty (i.e. passenger) vehicles and heavy-duty diesel vehicles for freight transport. Within the light-duty vehicle[6] segment, the use of light trucks—a vehicle class that includes sport-utility vehicles, pickups and minivans—increased much more rapidly than cars. Light trucks 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 22.7 Mt (112%) between 1990 and 2013. Growth in emissions reflected a 137% increase in tonne-kilometres shipped by trucks between 1990 and 2003 (Statistics Canada 2013a). Between 2004 and 2011, tonne-kilometres shipped varied within a range of +4% to -7%, and ultimately resulted in zero growth across the seven-year period (Statistics Canada 2013b). 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—2013 GHG Emissions (52.2 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 2013, emissions were 5.2% (2.9 Mt) below their 1990 level, and 11.2% (7 Mt) below the 2005 level. 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 1.1 Mt (22%) since 2005.

In Metal Production, CO_2 emissions from production of iron and steel have been fairly stable since the early 1990s, despite moderate increases in steel production, indicating the effect of increased use of recycled steel in Canadian steelmaking operations. The year 2009 saw a significant decline in production, followed by a gradual recovery from 2010 to 2012, and then a drop of 2.3 Mt (23%) between 2012 and 2013 due to a decrease in production. The aluminium industry, while increasing its production by almost 100% since 1990, shows a 3.6 Mt (35%) decrease in its process emissions, largely due to emission control technology introduced to mitigate PFC emissions. The 68% overall decrease in GHG emissions from Chemical Industries between 1990 and 2013 is primarily a result of the closure of an adipic acid plant in Ontario. Decreases were partly offset by increases in emissions from Ammonia Production.

Agriculture—2013 GHG Emissions (60 Mt)

Canadian agriculture can be differentiated into livestock (enteric fermentation and manure management) and crop production components (agricultural soils, lime and fertilizers). The livestock industry is dominated by beef, but also has significant swine, dairy and poultry components. Crop production is mainly dedicated to the production of cereals and oilseeds. A wide variety of specialty crops and animals are produced, but represent a very small portion of the overall agricultural economy.

Emissions directly related to animal and crop production accounted for 60 Mt or 8.3% of total 2013 GHG emissions for Canada, an increase of 11 Mt or 23% since 1990. Agriculture accounts for 27% and 70% of the national CH_4 and N_2O emissions, respectively.

The main drivers of the trend in emissions in the Agriculture Sector since 1990 are the intensification, expansion and then decline of the beef cattle and swine industries and continued increases in the application of inorganic nitrogen fertilizers, mainly on the Prairies. From 1990 to 2005, the proportion of agricultural emissions associated with livestock increased from 68% to 73% of total emissions, but has since declined to only 61% of total agricultural emissions.

From 2005 to 2011, livestock populations decreased. Until 2008, declines in emissions from livestock production were compensated for by increases in emissions from crop production. However, from 2008 to 2011, livestock populations continued to decrease sharply and combined with lower crop production, total agricultural emissions decreased by 6 Mt from their peak emissions of 62 Mt in 2005. In 2012 and 2013 livestock populations stabilized, fertilizer use has once again increased sharply and crop production in 2013 was higher than any year in the reporting period; as a result, emissions have increased by 4 Mt since 2011.

Waste—2013 GHG Emissions (25 Mt)

The primary source of emissions in the Waste Sector is CH_4 from Solid Waste Disposal, which accounts for about 94% 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 82%). The remainder (approximately 18%) 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 Waste grew by 6%, mostly from increases in emissions from landfill operations. Emission

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

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 35% to 1302 kilotonnes (kt), the amount of CH_4 captured increased by 144% to 470 kt in 2013. 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 2013.

Wastewater treatment and waste incineration facilities in Canada are minor sources of CH_4 and N_2O emissions and have generally remained stable.

Land Use, Land-use Change and Forestry—2013 (Net Removal of 15 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 such as wildfires and insect epidemics. All emissions and removals in the LULUCF Sector are excluded from the national totals.

In this sector, the net GHG flux is the sum of CO_2 emissions to, and removals from, the atmosphere, plus emissions of non-CO_2 gases. In 2013, this net flux amounted to removals of 15 Mt, which would have decreased the total Canadian GHG emissions by about 2.1% but does include non-anthropogenic sources, specifically wildfires and insect infestations in the Forest Land subsector. Trends in the LULUCF Sector are primarily driven by those in Forest Land, Cropland and Forest Conversion. Emissions in the new category of Harvested Wood Products (HWP) originate from the burning or eventual disposal of domestically harvested wood and are therefore closely associated with current and past forest management activities.

The net flux in forest land is dominated by inter-annual variability due to the erratic pattern of forest wildfires, which masks the impact of forest harvest. However, important harvest trends have occurred; between 1990 and the peak harvest year of 2004, there was a 28% increase in the carbon removed in harvested wood. Since then, significant reductions in forest management activities have occurred, with harvest levels 27% below the peak harvest year, reaching a 24-year low in 2009 (30 Mt carbon) for the period covered by this report.

Emissions from HWP fluctuate between 134 Mt in 2009, the lowest harvest year, and 168 Mt in 2000, one of the peak harvest years. Emissions from HWP are influenced by the trend in forest harvest rates during the reporting period and by the long-term impact of forest harvest and forest conversion levels that occurred before 1990. Nonetheless, the immediate and long-term effect of major natural disturbances in managed forests, notably the Mountain Pine Beetle infestation in western Canada and periodic wild fires, will undoubtedly continue to dominate the apparent trend of emissions and removals from forest lands. Emissions in Harvested Wood Products only partly reflect current forest management activities, since a significant proportion of emissions result from the decay of long-lived wood products reaching the end of their economic lives decades after the wood was harvested.

The net flux in cropland shows a steady decline in the period 1990–2006, from emissions of 10 Mt in 1990 to net removals of 9.6 Mt in 2006. This trend is a result of changes in agricultural land management practices in western Canada, the adoption of conservation tillage practices (over 13 million hectares of cropland since 1990) and a 79% reduction in summer fallow, as well as a decline in the conversion of forest land to cropland. However, since 2006, net removals have gradually declined to 7.4 Mt as a result of the soil sink approaching equilibrium and an observed increase in conversion of perennial to annual crop consistent with the increasing N_2O emissions from crop production in agriculture.

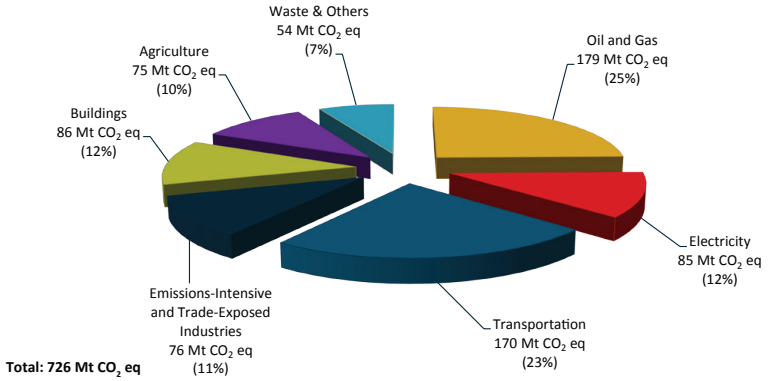
ES.4 Economic Sectors

As previously noted, there are several methods to categorize the sources of GHG emissions that arise across Canada. For the purposes of analyzing 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 2013 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 72 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 40 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 10 Mt and 19 Mt, respectively.

Further information on the IPCC and economic sector definitions and trends, as well as a detailed cross-walk between IPCC and economic sector categories, can be found in Chapter 2, Table 2–15.

Figure S–8 Canada's Emissions Breakdown by Economic Sector (2013)



Note: Totals may not add up due to rounding.

Table S–3 Canada's GHG Emissions by Economic Sector (1990–2013)

Greenhouse Gases	1990	2000	2005	2009	2010	2011	2012	2013
				Mt CO_2 equivalent				
NATIONAL GHG TOTAL	613	745	749	699	707	709	715	726
Oil and Gas	107	158	157	158	160	161	174	179
Electricity	95	130	121	98	99	91	86	85
Transportation	130	157	169	164	169	167	168	170
Emission Intensive & Trade Exposed Industries[1]	95	92	89	73	75	79	77	76
Buildings	76	88	87	85	82	87	85	86
Agriculture	57	69	71	68	70	70	72	75
Waste & Others[2]	54	52	54	52	53	53	53	54

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 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 & Trade Exposed Industries represent emissions arising from non 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 and socio-economic circumstances and economic structure. Provinces where the economy is oriented more toward resource extraction will tend to have higher emission levels, while service-based economies tend to have lower emission levels. Electricity generation sources also vary, with provinces that rely on fossil fuels for their electricity generation having higher emissions than provinces relying more on hydroelectricity.

Although Ontario, with its large manufacturing base, started off as the largest-emitting province in 1990, as of 2005 it had been surpassed by Alberta (see Figure S–9), where emissions have increased 53% since 1990—mostly driven by the enhanced production of petroleum resources.

Since 2005, Ontario's electricity sector saw its emissions decrease by 23.6 Mt (68%)—largely due to the closures of coal-fired electricity generation plants. By the close of 2013, all but one of these had been taken out of service.

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 an 8.4% (7.5 Mt) decrease from its 2005 emissions level, while British Columbia had a decline of 2.6% (1.7 Mt). In contrast to these decreases, emissions in Saskatchewan increased by 7.6% (5.3 Mt) between 2005 and 2013, as a result of activities in the oil and gas industry as well as potash and uranium mining.

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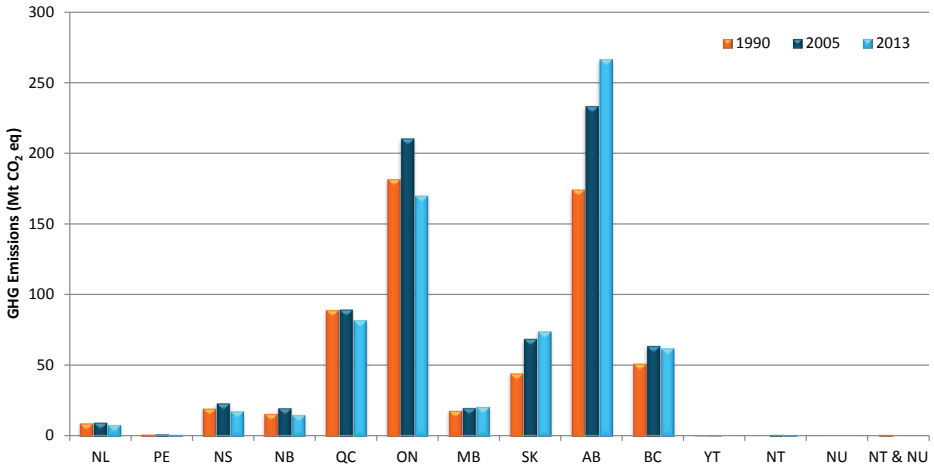
Figure S–9 Emissions by Province in 1990, 2005 and 2013



ES.6 National Inventory Arrangements

Environment Canada is the single national entity with responsibility for the preparation and submission of 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 Canada 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 both the annual compilation and submission of the National Inventory Report and Common Reporting Format 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 a summary of ozone and aerosol precursors.

Part 3 comprises Annexes 8 to 11, which present rounding procedures, summary tables of GHG emissions at the national level 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**

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