Environment and Climate Change Canada
Environnement et Changement climatique Canada

NATIONAL INVENTORY REPORT
1990-2015:
GREENHOUSE GAS SOURCES AND SINKS IN CANADA

CANADA'S SUBMISSION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

EXECUTIVE SUMMARY

Canada

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

Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-997-2800
Toll Free: 1-800-668-6767 (in Canada only)
Email: ec.enviroinfo.ec@canada.ca

Aussi disponible en français

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.

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 Conference of the Parties (COP) their national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol.[1]

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), adopted through Decision 24/CP.19 at COP 19 in Warsaw in 2013. The annual inventory submission consists of the National Inventory Report (NIR) and the Common Reporting Format (CRF) tables.

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.

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. Since 2005 was adopted as a base year for both Canada's 2020 and 2030 targets, many of the metrics within this report are presented in that context, in addition to the 1990 base year required by the UNFCCC Reporting Guidelines.

1 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.

E

THE PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE

Established on December 9, 2016, the Pan-Canadian Framework on Clean Growth and Climate Change is a comprehensive plan to reduce emissions across all sectors of Canada's economy, as well as to stimulate clean economic growth, and build resilience to the impacts of climate change. The actions outlined in the Pan-Canadian Framework will enable Canada to meet or exceed its target to reduce emissions to 30% below 2005 levels by 2030.

The Framework was developed in collaboration with Canada's provinces and territories. It builds on the early leadership of provinces and territories and the diverse array of policies and measures already in place across Canada to reduce greenhouse gas emissions in all sectors of the economy. Many of the policies and measures in the Framework are intended to be scalable to enable increasing ambition over time, and will be subject to rigorous and ongoing evaluation in order to ensure that Canada is well-positioned to meet its current and future climate change commitments. Canada's GHG inventory plays a key role in keeping Canadians informed of progress made in reducing GHG emissions. Section ES.6 presents a pathway for Canada to meet its international emissions reduction target, based on the measures included in the Pan-Canadian Framework.

Pricing carbon pollution is central to Canada's plan. The Government of Canada has outlined a benchmark for pricing carbon pollution that will build on existing provincial systems and ensure a minimum price of $10 CAD per tonne is in place across Canada by 2018, rising to $50 CAD per tonne by 2022. Carbon pricing will help influence investment and purchase decisions towards less carbon-intensive options.

In addition to carbon pricing, the complementary mitigation measures included in the Framework will enable Canada to achieve emissions reductions across all sectors, both in the near-term and as part of a longer-term strategy. Expanding the use of clean electricity and low-carbon fuels are foundational actions that will reduce emissions across the economy. Canada will also take action to reduce energy use by improving energy efficiency, encouraging fuel switching and supporting innovative alternatives. In the built environment sector, this will include developing "net-zero energy ready" building codes.

Actions in the transportation sector include increasingly stringent emission standards for light- and heavy-duty vehicles, as well as taking action to improve efficiency and support fuel switching in the rail, aviation, marine, and off-road sectors. Zero-emissions vehicles will be supported through development of a national strategy and through investments in supportive infrastructure such as charging stations. To reduce emissions from industrial sectors, Canada is developing regulations to achieve a reduction of methane emissions from the oil and gas sector, including offshore activities, by 40-45 percent by 2025, and Canada has also committed to finalizing regulations to phase down the use of hydrofluorocarbons in line

with the Kigali Amendment to the Montreal Protocol.

The Pan-Canadian Framework also recognizes the importance of building climate resilience and sets out measures to help Canadians understand, plan for, and take action to adapt to the unavoidable impacts of climate change. A number of measures are being developed in this area with a focus on infrastructure, information and capacity building, and health. This includes a particular focus on supporting Canada's Indigenous Peoples and northern and remote communities, which are particularly vulnerable to the effects of climate change.

The Framework also includes support for clean technology and innovation, including for early-stage technology development, establishing international partnerships, and encouraging "mission-oriented" research to help generate innovative new opportunities to reduce emissions.

Section ES.2 of this Executive Summary summarizes the latest information on Canada's net anthropogenic GHG emissions over the period 2005–2015 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.

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, Heavy Industry, Buildings, Agriculture, Waste, and Others. This breakdown is also used in *Canada's Second Biennial Report on Climate Change* (ECCC 2016). 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.5 details GHG emissions for Canada's 13 sub-national jurisdictions. Finally, as Canada's annual inventory submission to the UNFCCC embodies almost two decades of learning and improvements, Section ES.7 provides some detail on the components of this submission and outlines key elements of its preparation.

ES.2 Overview, National GHG Emissions

In 2015, the most recent annual dataset in this report, Canada's GHG emissions were 722 megatonnes of carbon dioxide equivalent (Mt CO_2 eq),[2] a net decrease of 16 Mt in total emissions or 2.2% from 2005 emissions (Figure S–1).[3] Annual emissions fluctuated between 2005 and 2008, dropped in 2009, and gradually increased thereafter.

In 2015, the Energy Sector (consisting of Stationary Combustion Sources, Transport, and Fugitive Sources) emitted 587 Mt of greenhouse gases, or 81% of Canada's total GHG emissions (Table S–3). The remaining emissions were largely generated by the Agriculture (8%) and Industrial Processes and Product Use (7%) sectors, with minor contributions from the Waste Sector (3%). The LULUCF Sector was a sink in 2015, with net removals of 34 Mt, a 3-Mt reduction from the net removals of 37 Mt in 2005.

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

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

Figure S–1 Canadian GHG Emissions Trend (2005–2015) (excluding LULUCF)

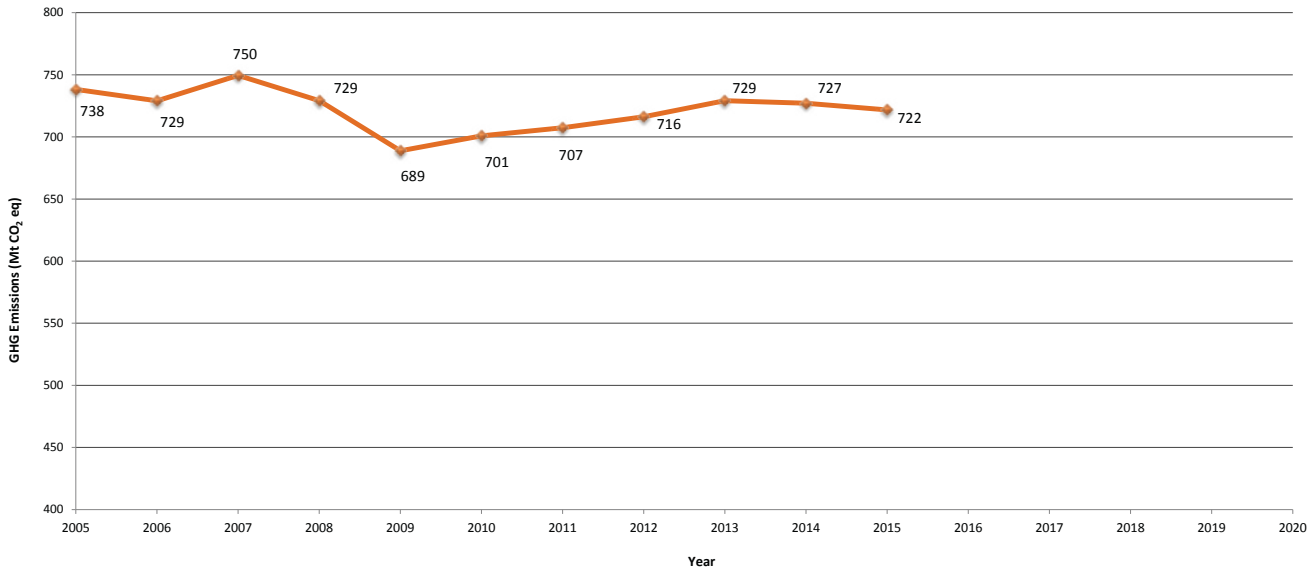


Figure S–2 Canada's Emissions Breakdown by IPCC Sector (2015)*

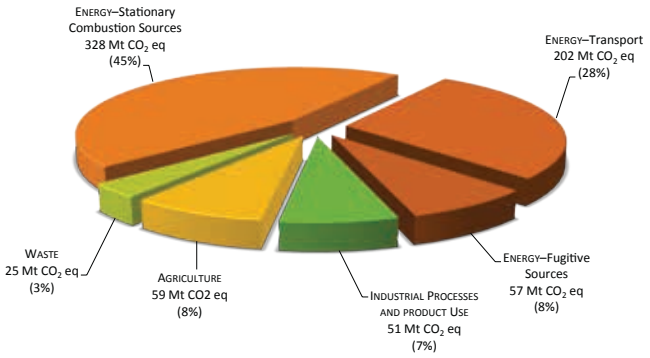
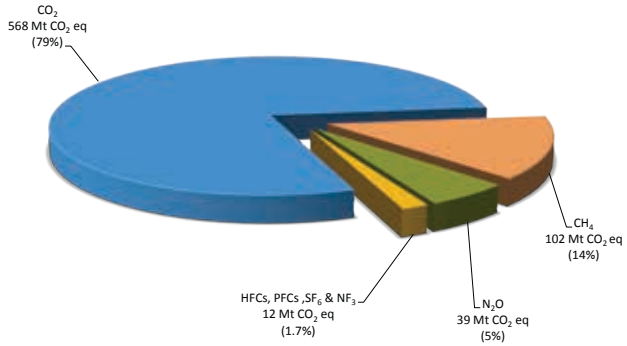


Figure S–3 Canada's Emissions Breakdown by GHG (2015)*



Total: 722 Mt CO_2 eq

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

Canada's emissions profile is similar to that of most industrialized countries. Carbon dioxide (CO_2) is the largest contributor to Canada's GHG emissions, accounting for 568 Mt or 79% of total emissions in 2015 (Figure S–3). The majority of the CO_2 emissions in Canada result from the combustion of fossil fuels. CH_4 emissions in 2015 amounted to 102 Mt or 14% of Canada's total. These emissions consist largely of fugitive emissions from oil and natural gas systems, agriculture and landfills. N_2O emissions arise from activities such as agricultural soil management and transport, and accounted for 39 Mt or 5.4% of Canada's emissions in 2015. Emissions of synthetic gases (HFCs, PFCs, SF_6 and NF_3) constituted slightly less than 2%.

Over the last decades Canada's economy has grown more rapidly than its GHG emissions. As a result, the emission intensity for the entire economy

Figure S–4 Indexed Trend in GHG Emissions and GHG Emissions Intensity (1990–2015)

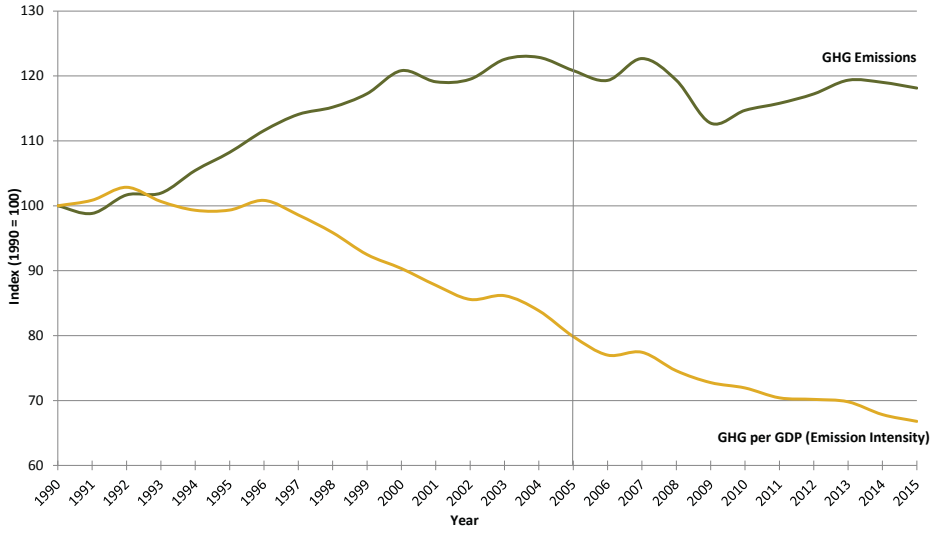
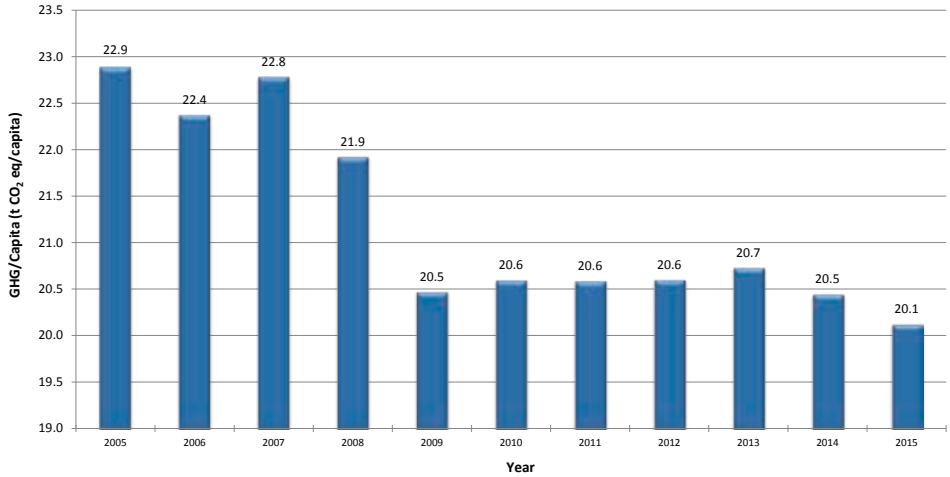


Table S–1 Trends in Emissions and Economic Indicators, Selected Years

Year	2005	2010	2011	2012	2013	2014	2015
Total GHG (Mt)	**738**	**701**	**707**	**716**	**729**	**727**	**722**
Change since 2005 (%)	NA	-5.1%	-4.2%	-3.0%	-1.2%	-1.5%	-2.2%
GDP (Billion 2007$)	**1 503**	**1 584**	**1 633**	**1 659**	**1 698**	**1 742**	**1 757**
Change since 2005 (%)	NA	5.4%	8.7%	10.4%	13.0%	16.0%	16.9%
GHG Intensity (Mt/$B GDP)	**0.49**	**0.44**	**0.43**	**0.43**	**0.43**	**0.42**	**0.41**
Change since 2005 (%)	NA	-9.9%	-11.8%	-12.1%	-12.6%	-15.1%	-16.4%

GDP data source: Statistics Canada (no date(a)) Table 380-0106 - Gross domestic product at 2007 prices, expenditure-based, annual (dollars). CANSIM (database).

Figure S–5 Canadian per Capita GHG Emissions (2005–2015)



Population data source: Statistics Canada. No date(b). Table 051-0001: Estimates of Population, by Age Group and Sex for July 1, Canada, Provinces and Territories, Annual (persons unless otherwise noted) CANSIM (database).

(GHG per GDP) has declined by 16.4% since 2005 (Figure S–4 and Table S–1). A divergence of emissions and emissions intensity began in the early 1990s (Figure S–4) and 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. Section ES.3 provides more information on trends in GHG emissions.

Canada represented approximately 1.6% of total global GHG emissions in 2013 (CAIT 2017), although it is one of the highest per capita emitters. Canada's per capita emissions have dropeed substantially since 2005, when this indicator was 22.9 t. By 2009, it had dropped to 20.5 t and has remained at historic lows ever since, with 2015 seeing the smallest per capita emissions yet at 20.1 t (Figure S–5).

ES.3 Emissions and Trends by IPCC Sectors

Trends in Emissions

Over the period 2005–2015, total emissions decreased by 16 Mt or 2.2% (Figure S–6). The Energy Sector dominated the long-term trend, with emission decreases of 11 Mt (3%) in Stationary Combustion Sources and 4 Mt (7%) in Fugitive Sources (Table S–2). In addition, the IPPU and Waste Sectors each saw decreases of 3 Mt (6% and 10% respectively), while emissions from Agriculture decreased by 2 Mt (3%). Over the same period, emissions from Transport increased by 7 Mt (4%) partially offsetting the decreases from the other sectors (Figure S–7)

Increases in emissions since 2009 can be attributed to increases in energy consumption and

Figure S–6 Trends in Canadian GHG Emissions by IPCC Sector (2005–2015)

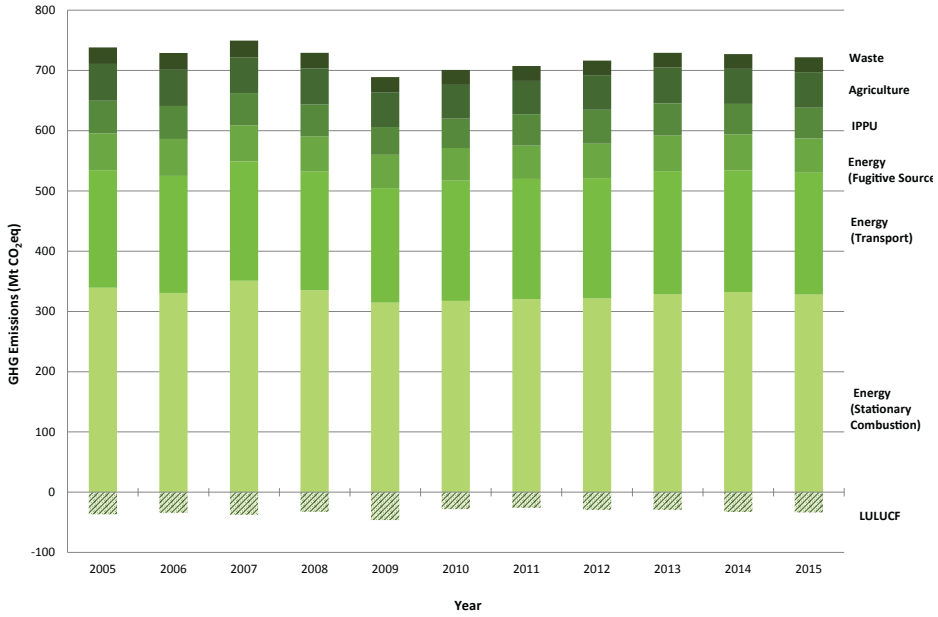
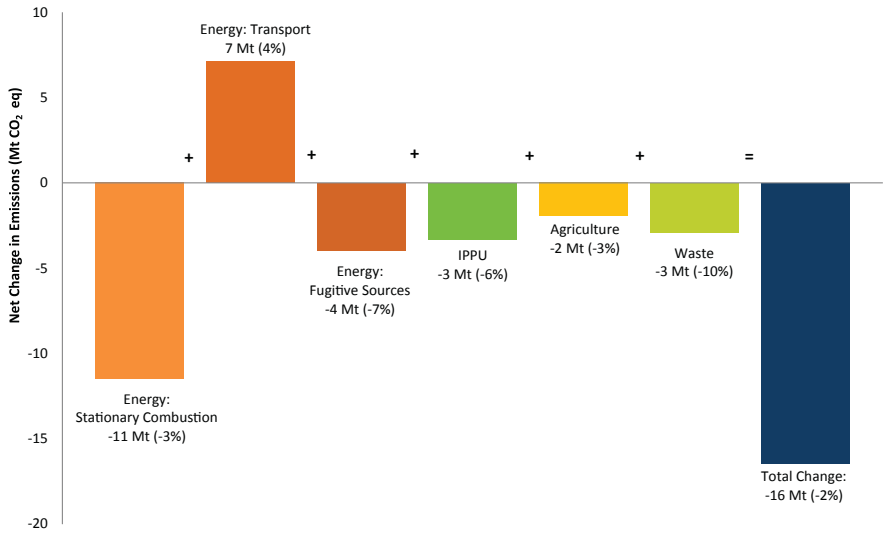


Table S–2 Canada's GHG Emissions by IPCC Sector, Selected Years

Greenhouse Gas Categories	2005	2009	2010	2011	2012	2013	2014	2015
				Mt CO_2 equivalent				
TOTAL[1,2]	**738**	**689**	**701**	**707**	**716**	**729**	**727**	**722**
ENERGY	**595**	**560**	**571**	**575**	**578**	**592**	**594**	**587**
a. Stationary Combustion Sources	339	315	318	320	322	329	332	328
Public Electricity and Heat Production	122	99	101	94	91	88	85	84
Petroleum Refining Industries	20	19	19	19	20	19	18	17
Mining and Upstream Oil and Gas Production	68	78	81	82	91	99	102	105
Manufacturing Industries	48	40	41	44	44	45	45	43
Construction	1	1	2	1	1	1	1	1
Commercial and Institutional	32	30	28	30	28	30	32	31
Residential	46	45	43	46	42	44	46	43
Agriculture and Forestry	2	3	3	4	4	4	4	4
b. Transport	195	190	199	200	200	204	202	202
Domestic Aviation	8	6	6	6	7	8	7	7
Road Transportation	134	136	142	143	144	147	144	144
Railways	7	5	7	8	8	7	8	7
Domestic Navigation	6	6	7	6	6	5	5	4
Other Transportation	41	36	38	38	36	37	38	39
c. Fugitive Sources	61	55	54	55	57	59	60	57
Coal Mining	1	1	1	1	1	2	1	1
Oil and Natural Gas	59	54	53	54	56	57	58	56
d. CO_2 Transport and Storage	0	0	0	0	0	0	0	0
INDUSTRIAL PROCESSES AND PRODUCT USE	**54**	**46**	**48**	**52**	**56**	**54**	**51**	**51**
a. Mineral Products	10	7	8	8	8	8	8	8
b. Chemical Industry	9	6	5	6	6	6	6	7
c. Metal Production	20	16	16	17	17	15	15	14
d. Production and Consumption of Halocarbons, SF_6 and NF_3	5	7	8	9	9	9	10	11
e. Non-Energy Products from Fuels and Solvent Use	9	10	11	12	15	15	12	11
f. Other Product Manufacture and Use	1	0	0	0	0	0	0	0
AGRICULTURE	**61**	**57**	**56**	**55**	**57**	**60**	**58**	**59**
a. Enteric Fermentation	31	27	26	25	25	25	25	25
b. Manure Management	10	9	8	8	8	8	8	9
c. Agricultural Soils	18	20	20	20	21	23	22	23
d. Field Burning of Agricultural Residues	0	0	0	0	0	0	0	0
e. Liming, Urea Application and Other Carbon-containing Fertilizers	1	2	2	2	2	3	2	3
WASTE	**28**	**26**	**25**	**25**	**24**	**24**	**25**	**25**
a. Solid Waste Disposal	25	23	22	22	22	22	22	22
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. Incineration and Open Burning of Waste	1	1	1	1	1	1	1	1
LAND USE, LAND-USE CHANGE AND FORESTRY	**-37**	**-46**	**-28**	**-26**	**-30**	**-29**	**-33**	**-34**
a. Forest Land	-183	-166	-159	-160	-164	-163	-166	-164
b. Cropland	-10	-12	-12	-12	-12	-11	-11	-11
c. Grassland	1	0	0	1	2	1	1	1
d. Wetlands	3	3	3	3	3	3	3	3
e. Settlements	4	4	4	4	4	4	4	4
f. Harvested Wood Products	149	125	136	138	137	138	137	135

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

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



fugitive emissions in oil and gas operations (29 Mt),[4] increases in the number of heavy-duty diesel vehicles in operation (8 Mt), increased consumption of halocarbons (4 Mt), and continuous increases in the application of inorganic nitrogen fertilizers (3 Mt). During the same period, there was a 15-Mt decrease in emissions from electricity generation, which partly offset emission growth.

The measures established through the Pan-Canadian Framework on Clean Growth and Climate Change will set emissions on a downward trajectory in all sectors. Carbon pricing will play a central and cross-cutting role, while complementary mitigation actions across all sectors will support additional emissions reductions. This will include a broad suite of measures to: further decarbonize Canada's electricity sector; reduce emissions from fuels used in transportation, buildings and industry; improve the efficiency of transportation systems, buildings and industrial operations; and, protecting and enhancing Canada's carbon sinks. In addition, support for clean technology and innovation will support new emission reduction opportunities across all sectors.

Chapter 2 provides more information on trends in GHG emissions from both 1990 and 2005 and their drivers[5]. Further breakdowns of emissions by subsector and gas, and a complete time series can be found in Annex 9.

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

Energy—2015 GHG Emissions (587 Mt)

In 2015, GHG emissions from the IPCC Energy Sector (587 Mt) were 1.4% lower than in 2005 (595 Mt). Within the Energy Sector, the 37-Mt increase in emissions from Mining and Upstream Oil and Gas Production was offset by a 38-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

4 Energy consumption and fugitive emissions from oil and gas operations is the sum of emissions from: Petroleum Refining Industries, Mining and Upstream Oil and Gas Production, Pipeline Transport (under *Other Transportation*) and Fugitive Sources (see Table S–2).

5 The complete NIR can be accessed here: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php.

Electricity Production between 2005 and 2015. The permanent closure of all coal generating stations in the province of Ontario by 2014 was the determinant factor.[6] Emission fluctuations over the period reflect variations in the mix of electricity generation sources.[7]

GHG emissions from Manufacturing Industries decreased by 5.0 Mt between 2005 and 2015, consistent with both a 16% decrease in energy use and an observed decline in output[8] in these industries.

Oil production has been driven primarily by a rapid rise in the extraction of bitumen and synthetic crude oil from Canada's oil sands operations, where total output has increased by 140% since 2005. This has contributed to the 37 Mt increase in emissions between 2005 to 2015 from Mining and Upstream Oil and Gas Production. However, from 2010 to 2015 the emission intensity of oil sands operations themselves have dropped by approximately 16% as a result of technological and efficiency improvements, less venting emissions and reductions in the percentage of crude bitumen being upgraded to synthetic crude oil.

The majority of transport emissions in Canada are related to Road Transportation, which includes personal transportation (light-duty vehicles and trucks) and heavy duty trucks. The growth in road transport emissions is largely due to more driving. Despite a reduction in kilometres driven per vehicle, the total vehicle fleet has increased by 19% since 2005, most notably for trucks (both light-and heavy-duty), leading to more kilometres driven overall.

Industrial Processes and Product Use — 2015 GHG Emissions (51 Mt)

The Industrial Processes and Product Use Sector covers non-energy GHG emissions that result from manufacturing processes and use of products, such as limestone calcination in cement production and the use of HFCs and PFCs as replacement refrigerants for ozone-depleting substances (ODSs). Emissions from the IPPU Sector contributed 51 Mt (7%) to Canada's 2015 emissions.

Emissions of most industries decreased in 2008 and 2009 and have remained at similar levels since then. A notable exception includes the 5.9 Mt (116%) increase in emissions from the use of HFCs since 2005.

The aluminium industry has decreased its process emissions, largely due to technological improvements introduced to mitigate PFC emissions. The overall decrease in GHG emissions from chemical industries is primarily a result of the closure in 2009 of the sole Canadian adipic acid plant located in Ontario.

Agriculture — 2015 GHG Emissions (59 Mt)

The Agriculture Sector covers non-energy GHG emissions relating to the production of crops and livestock. Emissions from Agriculture accounted for 59 Mt, or 8% of total GHG emissions for Canada in 2015, down 2 Mt from their peak in 2005.

In 2015, Agriculture accounted for 28% of national CH_4 emissions and 71% of national N_2O emissions.

The main drivers of the emission trend in the Agriculture Sector are the fluctuations in livestock populations and application of inorganic nitrogen fertilizers in the Prairie Provinces. Since 2005, fertilizer use has increased, while livestock populations peaked in 2005 and decreased sharply to 2011. In 2015, emissions from livestock digestion (enteric fermentation) accounted for 42% of total agricul-

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, 2015, Statistics Canada Daily, October 31, 2016; http://www.statcan.gc.ca/daily-quotidien/161031/dq161031d-eng.pdf (accessed January 24, 2017).

tural emissions, and the application of inorganic nitrogen fertilizers accounted for 22% of total agricultural emissions.

Waste — 2015 GHG Emissions (25 Mt)

The Waste Sector includes GHG emissions from the treatment and disposal of liquid and solid wastes. Emissions from Waste contributed 25 Mt (3.4%) to Canada's total emissions in 2015 and 28 Mt (3.7%) in 2005.

The primary source of emissions in the Waste Sector is Solid Waste Disposal, which includes municipal solid waste (MSW) landfills (19 Mt in 2015) and wood waste landfills (4 Mt in 2015). In 2015, Solid Waste Disposal accounted for 90% of Waste emissions, while Biological Treatment of Solid Waste (composting), Wastewater Treatment and Discharge, and Incineration and Open Burning of Waste contributed 3.8%, 4.3% Mt and 2.2%, respectively.

Methane emissions from publicly and privately owned municipal solid waste landfills (MSW) make up 86% of emissions from Solid Waste Disposal. The remainder originate from on-site industrial landfills of wood residues; such landfills are declining in number as markets for wood residues grow.

Methane emissions from MSW landfills decreased 11% between 2005 and 2015. Of the 30 Mt CO_2 eq of CH_4 generated by MSW landfills in 2015, only 19 Mt (or 62% of generated emissions) were actually emitted to the atmosphere. The other 11 Mt were captured and combusted at 81 landfill gas collection sites. The quantity of captured CH_4 increased from 27% in 2005 to 38% in 2015. Of the total amount of CH_4 collected in 2015, 51% (5.6 Mt) was utilized for various energy purposes and the remainder was flared.

Land Use, Land-use Change and Forestry — 2015 (Net GHG Removals of 34 Mt)

The Land Use, Land-use Change and Forestry (LULUCF) Sector reports anthropogenic 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.

In this sector, the net flux is calculated as the sum of CO_2 and non-CO_2 emissions to the atmosphere and CO_2 removals from the atmosphere. In 2015, this net flux amounted to removals of 34 Mt, which, if included, would decrease the total Canadian GHG emissions by 4.6%. New this year, the LULUCF estimates now exclude the impact of significant natural disturbances in managed forests (wildfires and insects), revealing more meaningful trends associated with anthropogenic activities. Additional information on the changes made this year can be found in Chapter 6.

The trend in net removals is mainly driven by a decrease in net CO_2 removals from Forest Land combined with HWP, partially attenuated by an increase in net CO_2 removals in Cropland and reduced emissions from the conversion of forests to other land use.

Net removals from Forest Land decreased from 180 Mt in 2005 to 165 in 2015, fluctuating in recent years between removals of 160 to 170 Mt as forests recover from peak harvest rates and insect disturbance in the mid-2000s. Over this same period emissions from Harvested Wood Products (HWP) originating from Canada fluctuated between 150 Mt in to 2005, to a low of 125 Mt in 2009 (the year of the lowest harvest rates), and have since increased to 135 Mt in 2015. A significant proportion of HWP emissions result from the decay of long-lived wood products reaching the end of their economic life decades after the wood was harvested. Harvested Wood Product emissions like

Forest Land emissions and removals are influenced by recent forest management trends, but also by the long-term impact of forest management that occurred in past decades.

Since 2005, net removals from Cropland have increased slightly from 10.3 to 10.9 Mt. However removals actually peaked in 2009 at 11.7 Mt and have since declined as a result of an increase in the conversion of perennial to annual crops on the prairies, the declining effect of conversion to conservation tillage and slower rates of agricultural expansion onto forest land.

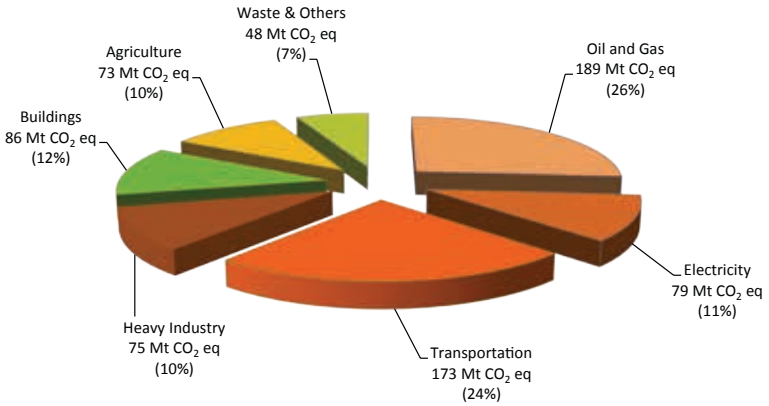
The conversion of forests[9] to other land uses is a prevalent, yet declining, practice in Canada and is mainly due to forest conversion to settlements for resource extraction and cropland expansion. Emissions due to forest conversion fell from 16 Mt in 2005 to 14 Mt in 2015.

ES.4 Canadian Economic Sectors

For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the

9 Forest conversion emissions are incorporated within sums of emissions of other land-use categories; therefore, the values of 14 and 16 Mt reported here are included in the sums associated with the other land-use category totals.

Figure S–8 Canada's Emissions Breakdown by Economic Sector (2015)



Note: Totals may not add up due to rounding.

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

	2005	2009	2010	2011	2012	2013	2014	2015
				Mt CO_2 equivalent				
NATIONAL GHG TOTAL	738	689	701	707	716	729	727	722
Oil and Gas	158	158	160	161	174	185	190	189
Electricity	117	95	96	89	85	82	80	79
Transportation	163	163	171	171	173	176	173	173
Heavy Industry[1]	86	71	73	80	79	77	77	75
Buildings	85	84	81	87	85	85	88	86
Agriculture	74	70	70	70	71	74	72	73
Waste & Others[2]	54	49	50	50	49	49	48	48

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.

1. Heavy Industry 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.

economic sector from which the emissions originate. 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.

GHG emissions trends in Canada's economic sectors from 2005 to 2015 are consistent with those described for IPCC sectors, with the Oil and Gas and Transportation economic sectors showing emission increases of 20% and 6% respectively over the last decade (Figure S–8 and Table S–3) These increases have been more than offset by emission decreases in Electricity (33%), Heavy Industry (13%) and Waste & Others (13%).

Further information on economic sector 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 of this report.

ES.5 Provincial and Territorial GHG Emissions

Emissions vary significantly by province as a result of 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 emit relatively more greenhouse gases than those that rely more on hydroelectricity.

Historically Alberta and Ontario have been the highest emitting provinces. Since 2005, emission patterns in these two provinces diverged. Emissions in Alberta increased from 233 Mt in 2005 to 274 Mt in 2015 (18%), primarily as a result of 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 38 Mt or 19%), owing primarily to the closure of coal-fired electricity generation plants.

Electricity production in Quebec and British Columbia relies on abundant hydroelectric

Figure S–9 Emissions by Province in 2005, 2010 and 2015

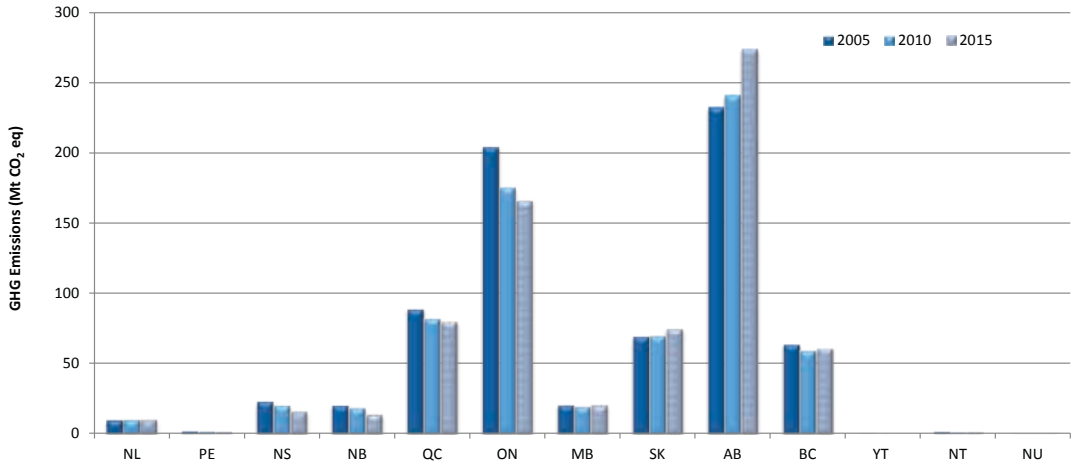


Table S–4 GHG Emissions by Provinces / Territories, Selected Years

	GHG Emissions (Mt CO_2 eq)							Change (%)
Year	2005	2010	2011	2012	2013	2014	2015	2005-2015
Total (Canada)	738	701	707	716	729	727	722	-2.2%
NL	10.1	10.3	10.3	9.9	9.6	10.6	10.3	2.1%
PE	2.1	2.0	2.2	2.1	1.8	1.8	1.8	-14%
NS	23	20	21	19	18	16	16	-30%
NB	20	19	19	17	15	14	14	-31%
QC	89	82	84	81	82	80	80	-10%
ON	204	175	175	171	171	168	166	-19%
MB	21	20	19	21	21	21	21	0.7%
SK	70	70	69	72	74	75	75	7.8%
AB	233	241	246	260	272	276	274	18%
BC	64	59	60	61	62	61	61	-4.7%
YT	0.4	0.4	0.4	0.4	0.4	0.3	0.3	-43%
NT	1.6	1.3	1.4	1.5	1.4	1.3	1.4	-12%
NU	0.5	0.5	0.5	0.6	0.6	0.7	0.6	38%

Notes:
1. Totals may not add up due to rounding.

resources, resulting in more stable emission patterns across the time series. Quebec experienced a 9.8% (8.7 Mt) decrease from its 2005 emissions level, while British Columbia had a decline of 4.7% (3.0 Mt).

Emissions in Saskatchewan increased by 7.8% (5.5 Mt) between 2005 and 2015 as a result of activities in the oil and gas industry, potash and uranium mining and transportation. Emissions in Manitoba and Newfoundland and Labrador have also increased since 2005, but to a lesser extent (0.7% and 2% respectively). Provinces which have seen more significant decreases in emissions include New Brunswick (31% reduction, or 6.2 Mt), Nova Scotia (30% reduction, or 7.0 Mt), and Prince Edward (14% reduction, or 0.3 Mt).

ES.6 Pathway to Canada's 2030 target

To achieve its target, Canada must reduce its total economy-wide emissions to 523 Mt in 2030. The Government of Canada uses a recognized energy and macroeconomic modeling framework to produce emissions projections to 2030, which are published on an annual basis. The most recent emissions projections, published in December 2016 (https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=1F24D9EE-1), indicate that with federal, provincial and territorial policies and measures that have legislated or funding certainty and were in place as of November 1st, 2016, (just prior to the Pan-Canadian Framework) total Canadian GHG emissions would be 742 megatonnes of carbon dioxide equivalent (Mt CO_2eq) in 2030.

Figure S–10 Pathway to Canada's 2030 target

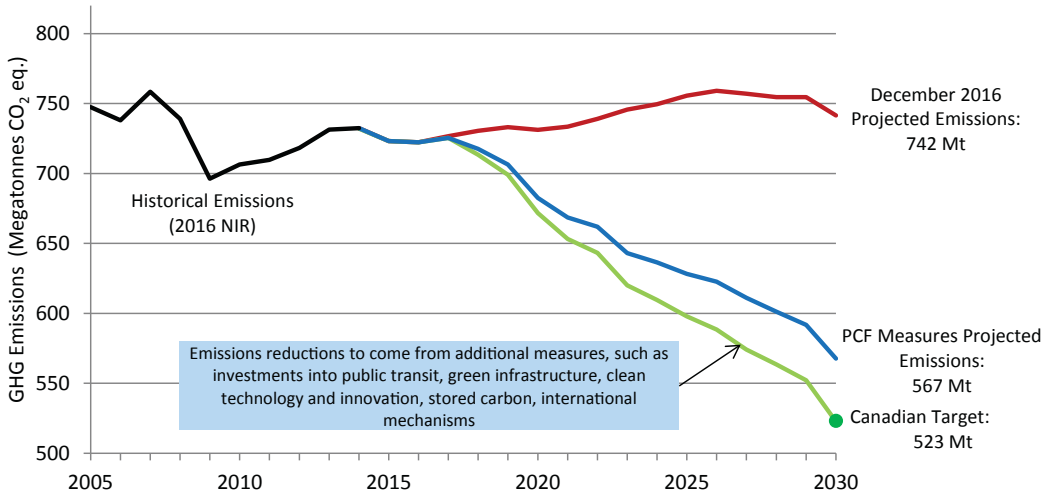
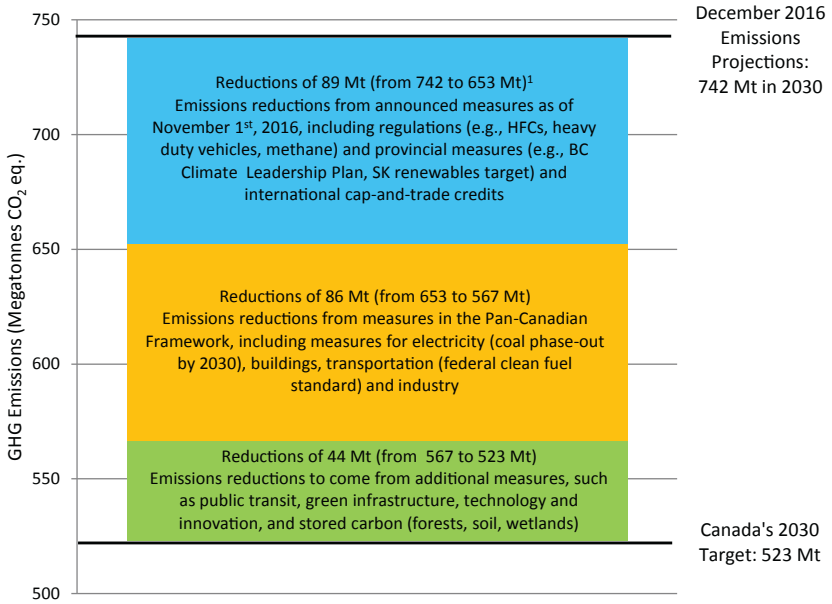


Figure S–11 Emissions Reductions from the Pan-Canadian Framework



Note: Reductions from carbon pricing are built into the different elements depending on whether they are implemented, announced, or included in the Pan-Canadian Framework. The path forward on pricing will be determined by the review to be completed by early 2022.

1. Estimates assume purchase of carbon allowances (credits) from California by regulated entities under Quebec and Ontario's cap-and-trade system that are or will be linked through the Western Climate Initiative.

ES.7 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.

The institutional arrangements for the preparation of the inventory include: 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 due to improvements; procedures for official approval; and a working archive 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. Detailed GHG data is also available on the Government of Canada's Open Data website: http://open.canada.ca/data/en/dataset/779c7bcf-4982-47eb-af1b-a33618a05e5b.

E

REFERENCES

[CAIT] Climate Analysis Indicators Tool. 2017. Washington (DC): World Resources Institute. Available online at: http://cait.wri.org.

[ECCC] Environment Canada and Climate Change. 2016. *Canada's Second Biennial Report on Climate Change*. Available online at: http://www.ec.gc.ca/GES-GHG/02D$_{095}$CB-BAB$_{0}$-40D$_{6}$-B$_{7}$F$_{0}$-828145249AF$_{5}$/3001%20UNFCCC%202nd%20Biennial%20Report_e_v7_lowRes.pdf.

Statistics Canada. No date(a). *Table 380-0106 Gross Domestic Product at 2007 Prices, Expenditure-based, Annual (dollars)* (table). CANSIM (database). [updated 2016 Nov 29, accessed 2017 Jan 4]. Available online at: http://www5.statcan.gc.ca/cansim/380-0106.

Statistics Canada. No date(b). *Table 051-0001: Estimates of Population, by Age Group and Sex for July 1, Canada, Provinces and Territories, Annual (persons unless otherwise noted)* (table). CANSIM (database) [updated 2016 Sep 27, accessed 2016 Jan 15]. Available online at: http://www5.statcan.gc.ca/cansim/051-0001.

Additional information can be obtained at:

Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Email: ec.enviroinfo.ec@canada.ca