

# NATIONAL INVENTORY REPORT 1990–2018: GREENHOUSE GAS SOURCES AND SINKS IN CANADA

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

## Executive Summary



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# EXECUTIVE SUMMARY

## ES.1. Key Points

- After hovering between 700 and 720 megatonnes of carbon dioxide equivalent (Mt CO<sub>2</sub> eq) in recent years, in 2018 (the most recent annual dataset in this report) Canada's greenhouse gas (GHG) emissions increased to 729 Mt CO<sub>2</sub> eq. This increase is attributed to higher fuel consumption for transportation, winter heating and oil and gas extraction.
- Over the long term, Canada's economy has grown more rapidly than its GHG emissions: the emissions intensity for the entire economy (GHG per Gross Domestic Product [GDP]) has declined by 36% since 1990 and 20% since 2005.
- Emission trends since 2005 remain consistent, with emission increases in the Oil and Gas and Transportation sectors being offset by decreases in other sectors, notably Electricity and Heavy Industry.
- The Pan-Canadian Framework on Clean Growth and Climate Change (adopted in 2016) puts Canada on the path towards meeting our Paris Agreement GHG emissions reduction target of 30% below 2005 levels by 2030. The Framework is a comprehensive plan to reduce emissions across all sectors of Canada's economy, stimulate clean economic growth and build resilience to the impacts of climate change. Canada is committed to continue implementing the Framework, while working to exceed its 2030 emissions reduction goal, and developing a plan to achieve net-zero emissions by 2050.

## ES.2. 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 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

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their national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol.<sup>1</sup>

Canada's National Greenhouse Gas Inventory is prepared and submitted annually to the UNFCCC by April 15 of each year, in accordance with the 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 in 2013. The annual inventory submission consists of the National Inventory Report (NIR) and the Common Reporting Format (CRF) tables.

The GHG inventory includes emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>) in the following five sectors: Energy; Industrial Processes and Product Use (IPPU); 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 Intergovernmental Panel on Climate Change's (IPCC) 2006 Guidelines for the preparation of National GHG Inventories. 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. Canada later confirmed this target in its Nationally Determined Contribution (NDC) to the Paris Agreement. Since 2005 was adopted as a base year for Canada's targets many of the metrics in this report are presented in that context, in addition to the 1990 base year as required by the UNFCCC Reporting Guidelines.

<sup>1</sup> 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.

## The Pan-Canadian Framework on Clean Growth and Climate Change

The Pan-Canadian Framework on Clean Growth and Climate Change (PCF) was adopted on December 9, 2016 as Canada's plan to take ambitious action to fight climate change, build resilience to a changing climate, and drive clean economic growth. It is the first climate change plan in Canada's history to include joint and individual commitments by federal, provincial and territorial levels of government, and to have been developed with input from Indigenous Peoples, businesses, non-governmental organizations, and Canadians from across the country. The PCF is built on four pillars: pricing carbon pollution, complementary actions to reduce emissions across the economy, adaptation and climate resilience, and clean technology, innovation, and jobs. It includes more than fifty concrete actions that cover all sectors of the Canadian economy.

Canada's most recent GHG emissions projections<sup>2</sup> estimate that Canada's GHG emissions in 2030 will be 227 million tonnes lower than projected prior to the PCF or 19% below 2005 levels. This improvement, equivalent to approximately a third of Canada's emissions in 2005, is widespread across all economic sectors, reflecting the breadth and the depth of the PCF.

Canada now has a price on carbon pollution across the country. In 2018, the Greenhouse Gas Pollution Pricing Act was passed. Carbon pollution pricing systems are now in place in all provinces and territories across Canada (either provincial/territorial systems or the federal system). Between 2015 and 2019, the Government of Canada invested \$60 billion to drive down greenhouse gas emissions, generate clean technologies, help Canadians and communities adapt to a changing climate, and protect the environment.

Other key measures in the PCF include:

- Regulating methane emissions in the oil and gas sector, which will reduce carbon pollution by about 16.5 million tonnes in 2030;
- Accelerating the phase-out of coal-fired electricity generation by 2030, as part of our efforts to have 90 percent of electricity from non-emitting sources, and supporting workers and communities in the transition to a low-carbon economy;
- Investing in zero-emission vehicle purchase incentives to make it easier for Canadians to reduce their transportation emissions;
- Developing net-zero energy ready building codes to ensure new homes are ready for a low-carbon future;
- Adopting a Climate Lens to ensure that future climate impacts are considered and addressed in all federally funded infrastructure projects; and
- Establishing a new Canadian Centre for Climate Services, giving Canadians better access to climate science and information.

Canada is committed to exceeding its 2030 emissions reduction target, putting Canada on a path to a prosperous net-zero emissions future. This involves continued implementation of the PCF, while strengthening existing measures and introducing new GHG reducing measures. Canada also committed to develop a plan to achieve a net-zero emissions economy by 2050. This includes setting legally-binding, five-year emissions-reduction milestones based on advice of experts and consultations with Canadians. These ambitious goals will be supported by a continued commitment to ensuring a price on carbon pollution is in place everywhere in Canada, as well as prioritization of measures including green buildings and communities, support for zero-emission vehicles, clean electricity, clean technology, and nature-based climate solutions including a commitment to planting 2 billion trees in the coming years.

Canada's National Inventory Report, along with other reports such as Canada's National Communications and Biennial Reports, and the Greenhouse Gas and Air pollutant Emissions Projections (also submitted to the UNFCCC) and the annual synthesis reports on the status of implementation of the PCF, allows Canada to assess its progress in reducing emissions and combatting climate change.

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<sup>2</sup> BR4 <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/fourth-biennial-report-climate-change.html>

Section ES.3 of this Executive Summary summarizes the latest information on Canada's net anthropogenic (i.e. human-induced) GHG emissions over the 2005–2018 period and links this information to relevant indicators of the Canadian economy. Section ES.4 outlines the major trends in 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.5 presents Canada's emissions by the following economic sectors: Oil and Gas, Electricity, Transportation, Heavy Industry, Buildings, Agriculture and Waste & Others. 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.6 details GHG emissions for Canada's 13 sub-national jurisdictions. Finally, section ES.7 provides some detail on the components of this submission and outlines key elements of its preparation.

### ES.3. Overview, National GHG Emissions

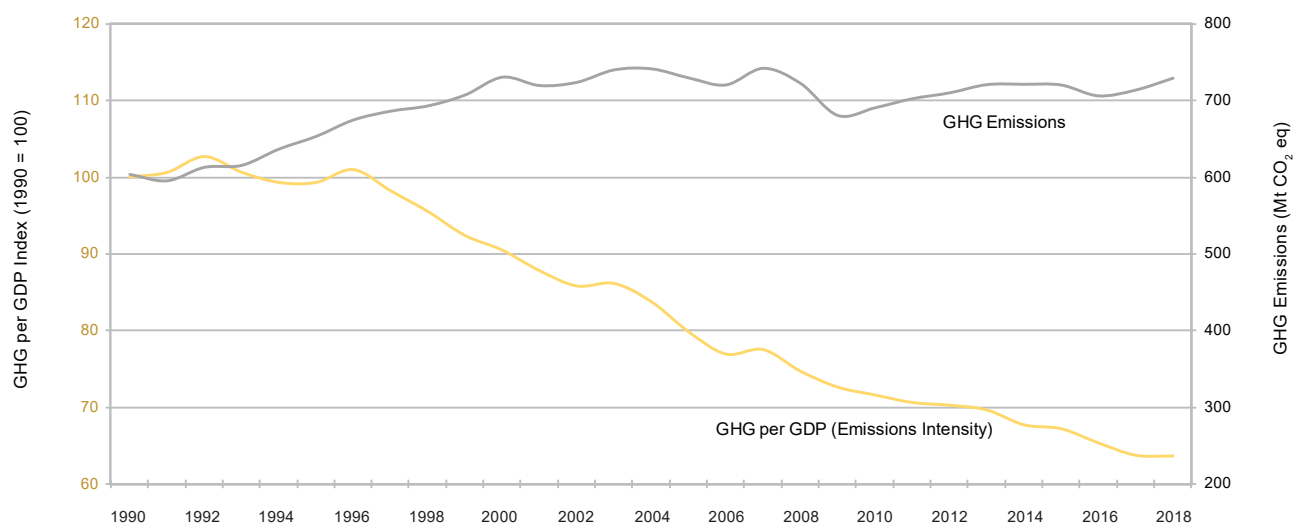
After hovering for several years between 700 and 720 megatonnes of carbon dioxide equivalent (Mt CO<sub>2</sub> eq)<sup>3</sup>, in 2018 (the most recent annual dataset in this report) Canada's greenhouse gas (GHG) emissions increased to 729 Mt CO<sub>2</sub> eq (Figure ES–1).<sup>4</sup>

The 15 Mt increase in 2018 is due to the combined effect of multiple factors, including: an increase in fuel consumption by vehicles on and off-road (+7.8 Mt between 2017 and 2018); colder winter weather, which influences emissions related to heating (+5.1 Mt between 2017 and 2018); increased production of oil and gas in 2018 (+4.1 Mt between 2017 and 2018); variations in production levels and a rise in the use of fossil fuels in industrial sectors (+2.0 Mt between 2017 and 2018); and an increase in import and stocks of HFCs (+1 Mt between 2017 and 2018). These emission increases were partially offset by a reduction of coal in the mix of fuels combusted to produce electricity and heat (-6 Mt between 2017 and 2018).

<sup>3</sup> Unless explicitly stated otherwise, all emission estimates given in Mt represent emissions of GHGs in Mt CO<sub>2</sub> eq.

<sup>4</sup> Throughout this report, data are presented as rounded figures. However, all calculations (including percentages) have been performed using unrounded data.

Figure ES–1 Canadian GHG Emissions and Indexed Trend Emission Intensity (excluding LULUCF)



**Notes:**

Emissions do not yet reflect the impact of the most recent mitigation policies. Total emissions fall within a 2% uncertainty range.

GDP Data Source: StatCan a

In general, year-to-year fluctuations are superimposed over actual trends observed over a longer time period. During the period covered in this report, Canada's economy has grown more rapidly than its GHG emissions. As a result, the emissions intensity for the entire economy (GHG per GDP) has declined by 36% since 1990 and 20% since 2005 (Figure ES-1 and Table ES-1). The decline in emissions intensity can be attributed to fuel switching, increases in efficiency, the modernization of industrial processes and structural changes in the economy.

The emissions trends and their drivers are summarized in the remainder of this Executive Summary and described in greater detail in Chapter 2 of this report.

In 2018, the Energy sector (consisting of Stationary Combustion, Transport and Fugitive Sources) emitted 596 Mt of greenhouse gases, or 82% of Canada's total GHG emissions (Figure ES-2). The remaining emissions were largely generated by the

Agriculture and IPPU sectors (approximately 8% each), with minor contributions from the Waste sector (2%). In 2018, the LULUCF sector removed 13 Mt of CO<sub>2</sub> from the atmosphere.

Canada's emissions profile is similar to that of most industrialized countries, in that CO<sub>2</sub> is the largest contributor to total emissions, accounting for 80% of total emissions in 2018 (Figure ES-3). The majority of the CO<sub>2</sub> emissions in Canada result from the combustion of fossil fuels. CH<sub>4</sub> emissions in 2018 amounted to 91 Mt or 13% of Canada's total. These emissions consist largely of fugitive emissions from oil and natural gas systems, agriculture and landfills. N<sub>2</sub>O emissions mostly arise from agricultural soil management and transport, and accounted for 38 Mt or 5.2% of Canada's emissions in 2018. Emissions of synthetic gases (HFCs, PFCs, SF<sub>6</sub> and NF<sub>3</sub>) constituted slightly less than 2% of national emissions.

Table ES-1 Trends in Emissions and Economic Indicators, Selected Years

Year	2005	2013	2014	2015	2016	2017	2018
<b>Total GHG (Mt)</b>	<b>730</b>	<b>721</b>	<b>721</b>	<b>720</b>	<b>706</b>	<b>714</b>	<b>729</b>
Change since 2005 (%)	NA	-1.2%	-1.2%	-1.3%	-3.2%	-2.2%	-0.1%
<b>GDP (Billion 2012\$)</b>	<b>1 654</b>	<b>1 871</b>	<b>1 926</b>	<b>1 938</b>	<b>1 953</b>	<b>2 024</b>	<b>2 071</b>
Change since 2005 (%)	NA	13%	16%	17%	18%	22%	25%
<b>GHG Intensity (Mt/\$B GDP)</b>	<b>0.44</b>	<b>0.39</b>	<b>0.37</b>	<b>0.37</b>	<b>0.36</b>	<b>0.35</b>	<b>0.35</b>
Change since 2005 (%)	NA	-13%	-15%	-16%	-18%	-20%	-20%

Notes:  
GDP data source: StatCan a  
NA not applicable

Figure ES-2 Breakdown of Canada's Emissions by IPCC Sector (2018)

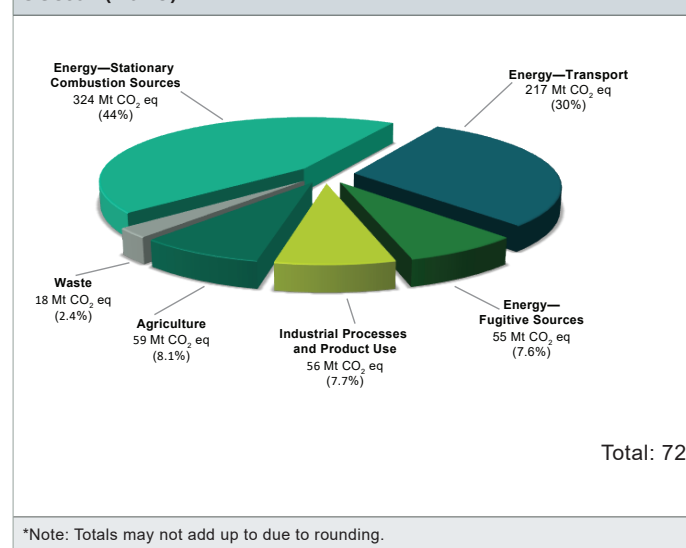
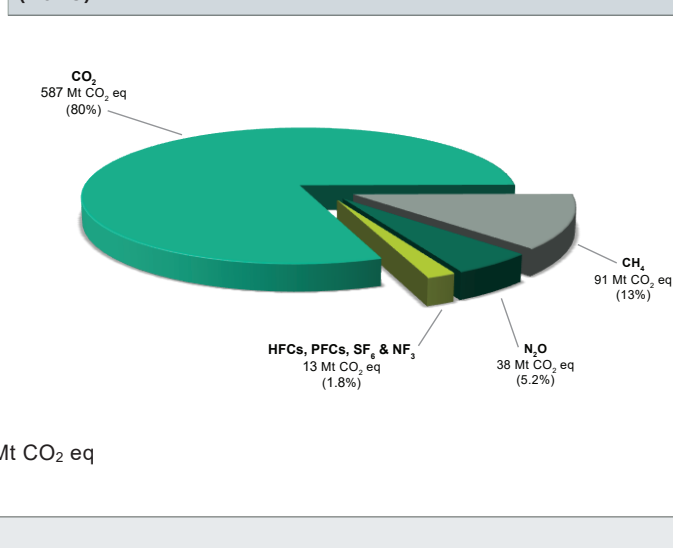


Figure ES-3 Breakdown of Canada's Emissions by GHG (2018)



Canada represented approximately 1.6% of global GHG emissions in 2016 (CAIT 2017), although it is one of the highest per capita emitters. Canada's per capita emissions have dropped since 2005, when this indicator was 22.6 t CO<sub>2</sub> eq/capita, reaching new lows between 19.5–19.7 t CO<sub>2</sub> eq/capita since 2016 (Figure ES–4).

## ES.4. Emissions and Trends by IPCC Sectors

### Trends in Emissions

Over the 2005–2018 period, total emissions decreased by 0.4 Mt or 0.1% (Figure ES–5). Two sources of the Energy sector dominated this trend, with emission decreases of 18 Mt (5%) in Stationary Combustion Sources and 5.4 Mt (9%) in Fugitive Sources (Table ES–2). Over the same period, emissions also decreased by 0.2 Mt (0.4%) in the IPPU sector and 2.2 Mt (11%) in the Waste sector. However, emissions from Transport (also in the Energy sector) increased by 26 Mt (14%) partially offsetting the decreases from the other categories (Figure ES–6).

Since 2009, when emissions were at their lowest in the latest decade, emission increases are driven by growth in Oil and Gas Extraction (34 Mt); in the number of light-duty gasoline trucks (12 Mt) and heavy-duty diesel vehicles in operation (12 Mt); in the production and consumption

of halocarbons, SF<sub>6</sub> and NF<sub>3</sub> (5.6 Mt); and in the application of inorganic nitrogen fertilizers (3.6 Mt). During the same period, there was a 30 Mt decrease in emissions from electricity generation, which partly offset the growth in emissions.

Chapter 2 provides more information on trends in GHG emissions from both 1990 and 2005 and their drivers.<sup>5</sup> Further breakdowns of emissions and a complete time series can be found at [open.canada.ca](http://open.canada.ca).

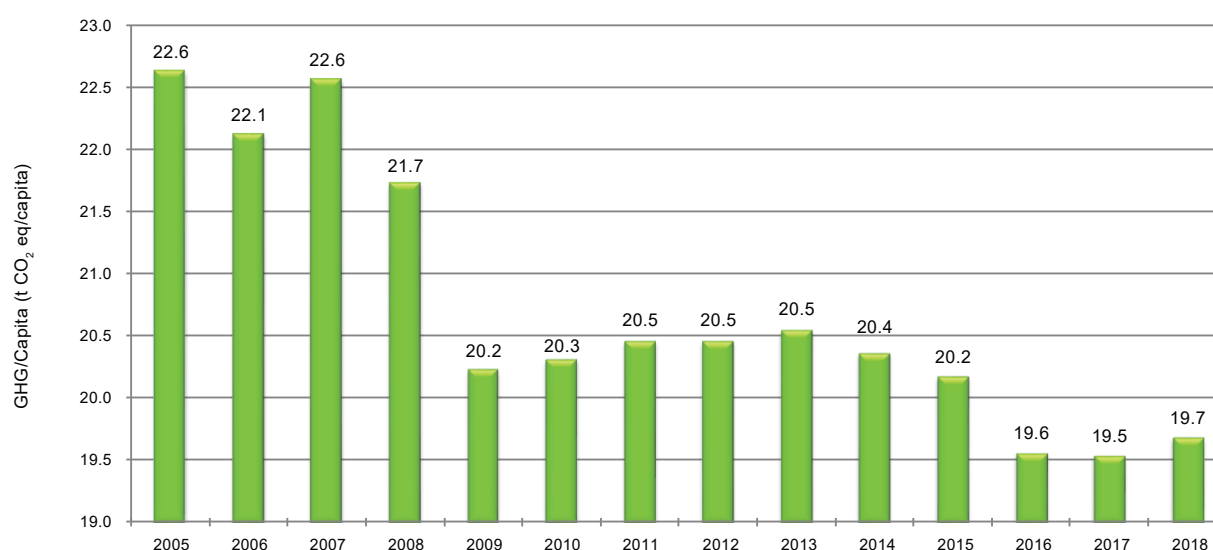
The following describes the emissions and trends of each IPCC sector since 2005 in further detail.

### Energy—2018 GHG Emissions (596 Mt)

In 2018, GHG emissions from the IPCC Energy sector (596 Mt) were 0.4% higher than in 2005 (593 Mt). Within the Energy sector, a 43 Mt increase in combustion emissions from Oil and Gas Extraction and a 24 Mt growth in Road Transport emissions were largely offset by a 55 Mt decrease in emissions from Public Electricity and Heat Production and a 4 Mt drop in emissions from Manufacturing.

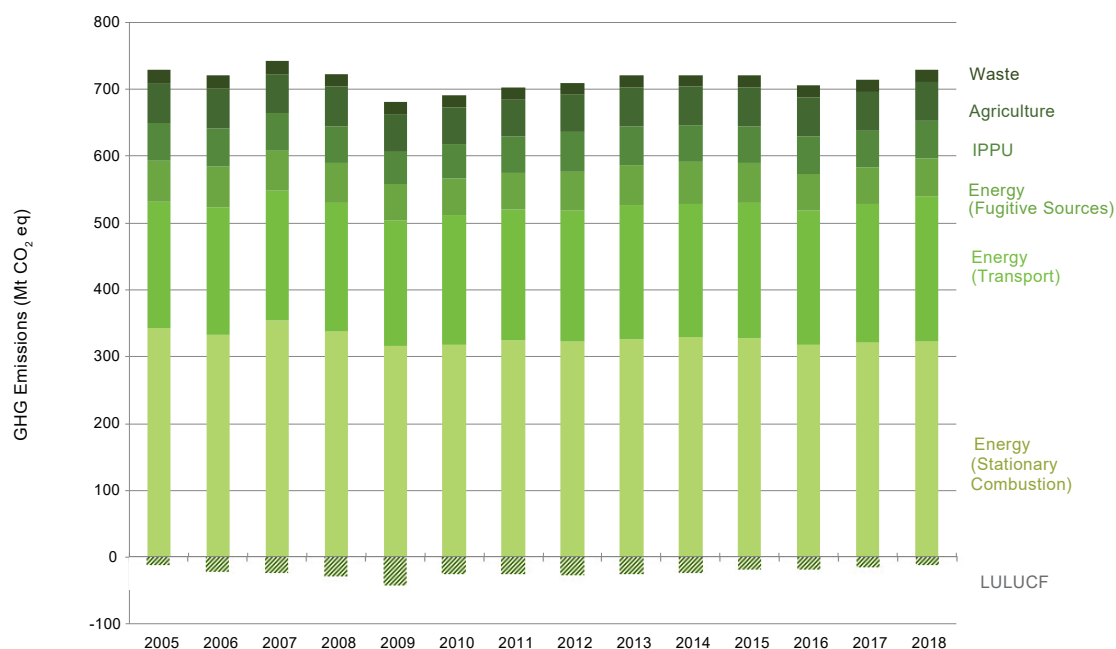
<sup>5</sup> The complete NIR can be accessed here: <http://www.publications.gc.ca/site/eng/9.506002/publication.html>

Figure ES–4 Canadian per Capita GHG Emissions (2005–2018)



Note: Population data source: StatCan b

Figure ES-5 Trends in Canadian GHG Emissions by IPCC Sector (2005–2018)



### Stationary Combustion (324 Mt)

Decreasing electricity generation from coal and oil (50% and 73% decrease, respectively) was a large driver of the 55 Mt decrease in emissions associated with Electricity and Heat Production between 2005 and 2018. The permanent closure of all coal generating stations in Ontario by 2014 contributed 50% of the decreased coal consumption,<sup>6</sup> and reduced coal consumption in Alberta contributed an additional 43%. Reduced coal consumption also occurred in Nova Scotia (15%), New Brunswick (24%), Manitoba (98%) and Saskatchewan (10%). Decreased oil consumption for electricity generation in New Brunswick (89%) and Nova Scotia (88%), offset by increased consumption in Newfoundland and Labrador (40%) accounts for 99% of the reduced oil consumption. Minor emission fluctuations over the period reflect variations in the mix of electricity generation sources.<sup>7</sup>

The 43 Mt increase in emissions from stationary fuel consumption in Oil and Gas Extraction is consistent with a 190% rise in the extraction of bitumen and synthetic crude oil from Canada's oil sands operations since 2005.

GHG emissions from Manufacturing Industries decreased by 4.0 Mt between 2005 and 2018, consistent with both a 12% decrease in energy use and an observed decline in output<sup>8</sup> in these industries.

### Transport (217 Mt)

The majority of transport emissions in Canada are related to Road Transportation, which includes personal transportation (light-duty vehicles and trucks) and heavy-duty vehicles. The growth in road transport emissions is largely due to more driving, exemplified by increases in the supply of diesel, in gasoline retail pump sales as well as in the number of vehicles on and off-road. Despite a reduction in kilometres driven per vehicle, the total vehicle fleet has increased by 40% since 2005, most notably for trucks (both light- and heavy-duty), leading to more kilometres driven overall.

6 Ontario Power Generation News, April 15, 2014; <http://www.opg.com/news-and-media/news-releases/Pages/news-releases.aspx?year=2014>, accessed 2018 January).

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, Table 25-10-0025-01 Manufacturing industries, total annual energy fuel consumption in gigajoules, 31-33; <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002501> (accessed 2019 December 16).

Table ES-2 **Canada's GHG Emissions by IPCC Sector, Selected Years**

Greenhouse Gas Categories		2005	2013	2014	2015	2016	2017	2018
		Mt CO <sub>2</sub> Equivalent						
<b>TOTAL<sup>a, b</sup></b>		<b>730</b>	<b>721</b>	<b>721</b>	<b>720</b>	<b>706</b>	<b>714</b>	<b>729</b>
<b>ENERGY</b>		<b>593</b>	<b>587</b>	<b>591</b>	<b>590</b>	<b>574</b>	<b>584</b>	<b>596</b>
a.	Stationary Combustion Sources	342	326	329	328	318	321	324
	Public Electricity and Heat Production	125	88	84	87	81	78	70
	Petroleum Refining Industries	20	18	18	18	18	16	16
	Oil and Gas Extraction	63	91	96	97	99	102	106
	Mining	4.3	5.4	5.1	4.6	4.3	4.7	4.9
	Manufacturing Industries	48	45	45	44	42	42	44
	Construction	1.5	1.3	1.3	1.3	1.3	1.3	1.4
	Commercial and Institutional	33	30	31	30	30	32	33
	Residential	46	44	46	43	39	41	45
	Agriculture and Forestry	2.2	3.8	3.8	3.6	3.8	3.7	3.8
b.	Transport	191	201	199	201	201	207	217
	Domestic Aviation	7.6	7.6	7.2	7.1	7.1	7.4	8.0
	Road Transportation	130	144	142	143	145	148	154
	Railways	6.6	7.3	7.5	7.1	6.5	7.5	7.6
	Domestic Navigation	4.8	4.3	4.1	3.9	3.9	4.0	4.0
	Other Transportation	42	38	39	40	39	40	44
c.	Fugitive Sources	61	61	63	60	55	55	55
	Coal Mining	1.4	1.5	1.3	1.1	1.3	1.2	1.3
	Oil and Natural Gas	60	59	62	59	54	54	54
d.	CO <sub>2</sub> Transport and Storage	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
<b>INDUSTRIAL PROCESSES AND PRODUCT USE</b>		<b>57</b>	<b>57</b>	<b>55</b>	<b>54</b>	<b>55</b>	<b>54</b>	<b>56</b>
a.	Mineral Products	10	7.8	7.8	8.1	7.9	8.5	8.9
b.	Chemical Industry	10	7.3	7.2	7.6	7.7	6.9	7.7
c.	Metal Production	20	15	15	14	15	15	15
d.	Production and Consumption of Halocarbons, SF <sub>6</sub> and NF <sub>3</sub>	5.1	10	11	11	11	12	13
e.	Non-Energy Products from Fuels and Solvent Use	10	16	13	13	12	11	12
f.	Other Product Manufacture and Use	0.54	0.56	0.48	0.57	0.63	0.66	0.74
<b>AGRICULTURE</b>		<b>60</b>	<b>59</b>	<b>58</b>	<b>58</b>	<b>59</b>	<b>58</b>	<b>59</b>
a.	Enteric Fermentation	31	25	24	24	24	24	24
b.	Manure Management	8.8	7.8	7.7	7.8	7.9	7.9	7.9
c.	Agricultural Soils	19	24	23	24	25	24	25
d.	Field Burning of Agricultural Residues	<0.05	0.05	0.05	0.06	0.05	0.05	0.05
e.	Liming, Urea Application and Other Carbon-containing Fertilizers	1.4	2.7	2.5	2.6	2.5	2.5	2.6
<b>WASTE</b>		<b>20</b>	<b>17</b>	<b>17</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>18</b>
a.	Solid Waste Disposal	14	12	12	12	12	12	12
b.	Biological Treatment of Solid Waste	0.29	0.44	0.46	0.45	0.45	0.45	0.45
c.	Wastewater Treatment and Discharge	1.0	1.1	1.2	1.2	1.1	1.1	1.1
d.	Incineration and Open Burning of Waste	0.58	0.32	0.36	0.40	0.39	0.39	0.39
e.	Industrial Wood Waste Landfills	4.3	3.8	3.7	3.6	3.5	3.5	3.4
<b>LAND USE, LAND-USE CHANGE AND FORESTRY</b>		<b>- 13</b>	<b>- 25</b>	<b>- 25</b>	<b>- 18</b>	<b>- 19</b>	<b>- 16</b>	<b>- 13</b>
a.	Forest Land	- 145	- 150	- 150	- 143	- 144	- 143	- 140
b.	Cropland	- 11	- 10	- 9.5	- 8.6	- 7.7	- 6.8	- 6.2
c.	Grassland	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
d.	Wetlands	3.1	3.1	3.1	2.9	2.9	3.0	2.6
e.	Settlements	2.1	2.3	2.3	2.2	2.1	1.9	1.8
f.	Harvested Wood Products	139	130	129	128	128	129	129

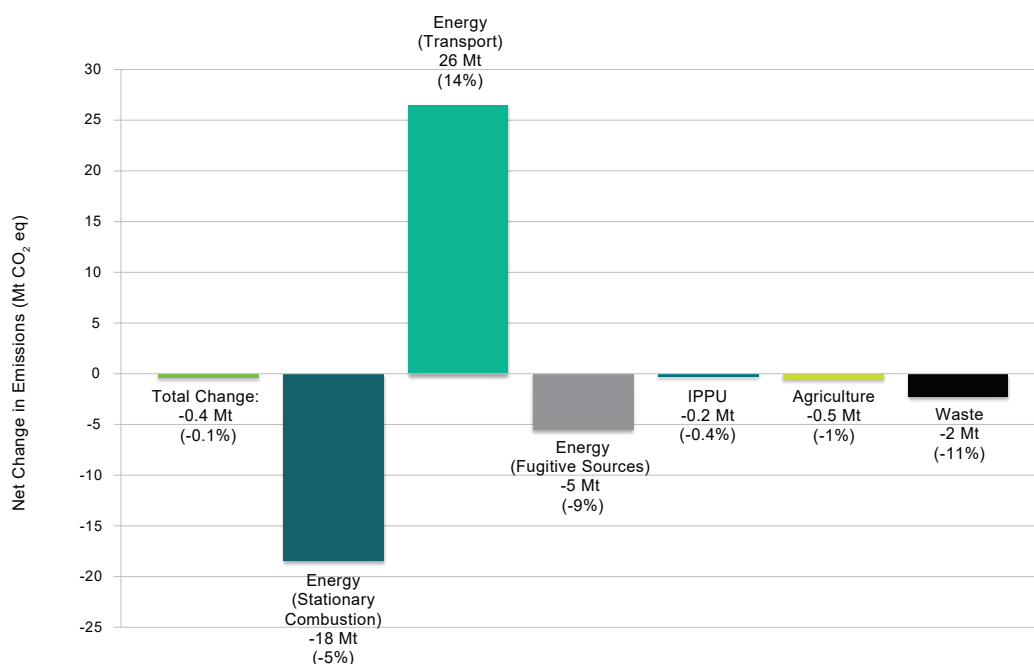
**Notes:**

Totals may not add up due to rounding.

a. National totals calculated in this table do not include removals reported in LULUCF.

b. This summary data is presented in more detail at [open.canada.ca](http://open.canada.ca).

Figure ES-6 **Changes in Emissions by IPCC Sector (2005–2018)**



### *Fugitive Sources (55 Mt)*

Since 2005, fugitive GHG emissions from fossil fuel production (coal, oil and natural gas) have decreased by 5.4 Mt, largely the result of provincial regulations to increase conservation of natural gas which is mainly comprised of methane (CH<sub>4</sub>).

### **Industrial Processes and Product Use—2018 GHG Emissions (56 Mt)**

The IPPU 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 56 Mt (7.7%) to Canada's 2018 emissions.

Between 2005 and 2018, process emissions from most IPPU categories decreased. A notable exception is the 7.4 Mt (146%) increase in emissions from the use of HFCs.

The aluminium industry has decreased its process emissions by 3.2 Mt (-37%) since 2005, largely due to implementation of technological improvements to mitigate PFC emissions and shutting down of older

smelters using Söderberg technology. For example, the last Söderberg smelter was closed in 2015. Closure of primary magnesium plants in 2007 and 2008 also contributed to 1.0 Mt of the overall process emission drop (-5.3 Mt or -26%) seen in Metal Production between 2005 and 2018.

The overall decrease in GHG emissions from chemical industries since 2005 is primarily the result of the closure in 2009 of the sole Canadian adipic acid plant located in Ontario. Variations throughout the time series in petrochemical industry-related emissions can be attributed to facility closures and changes in production capacities at existing facilities, such as the closure of two methanol facilities in 2005 and 2006, and the noted increase in ethylene production in 2016.

### **Agriculture—2018 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 8.1% of total GHG emissions for Canada in 2018.

In 2018, Agriculture accounted for 31% of national CH<sub>4</sub> emissions and 76% of national N<sub>2</sub>O emissions.

The main drivers of the emission trend in the Agriculture sector are the fluctuations in livestock populations and the application of inorganic nitrogen fertilizers to agricultural soils in the Prairie provinces. Since 2005, fertilizer use has increased by 72%, while major livestock populations peaked in 2005, then decreased sharply until 2011. In 2018, emissions from livestock digestion (enteric fermentation) accounted for 41% of total agricultural emissions, and the application of inorganic nitrogen fertilizers accounted for 23% of total agricultural emissions.

### **Waste—2018 GHG Emissions (18 Mt)**

The Waste sector includes GHG emissions from the treatment and disposal of liquid and solid wastes. Emissions from Waste contributed 18 Mt (2.4%) to Canada's total emissions in 2018 and 20 Mt (2.7%) in 2005.

The primary sources of emissions in the Waste sector are municipal solid waste (MSW) disposal in landfills (12 Mt in 2018) and Industrial Wood Waste Landfills (3.4 Mt in 2018). In 2018, these landfills combined accounted for 89% of Waste emissions, while Biological Treatment of Solid Waste (composting), Wastewater Treatment and Discharge, and Incineration and Open Burning of Waste together contributed the remaining 11%.

CH<sub>4</sub> emissions from MSW landfills make up 63% of emissions from SWD; these emissions decreased by 11% between 2005 and 2018. Of the 26 Mt CO<sub>2</sub> eq of CH<sub>4</sub> generated by MSW landfills in 2018, only 12 Mt CO<sub>2</sub> eq (48%) were actually emitted to the atmosphere. A significant portion (46% or 11 Mt CO<sub>2</sub> eq) of the generated CH<sub>4</sub> was captured by landfill gas collection facilities and flared or used for energy—compared with 36% in 2005.

### **Land Use, Land-Use Change and Forestry—2018 (Net GHG Removals of 13 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<sub>2</sub> and non-CO<sub>2</sub> emissions to the atmosphere and CO<sub>2</sub> removals from the atmosphere. In 2018, this net flux amounted to net removals of 13 Mt.

Net removals from the LULUCF sector have fluctuated over recent years, increasing from 13 Mt in 2005 to 42 Mt in 2009 and have since again decreased to 13 Mt in 2018. Fluctuations are driven mainly by variations in emissions from HWP and removals from Forest Land that are closely tied to harvest rates.

The Forest Land estimates are split between emissions and removals resulting from significant natural disturbances on managed forests (wildfires and insects), and anthropogenic emissions and removals associated with forest management activities. Net anthropogenic removals in Forest Land have fluctuated between 150 Mt and 140 Mt over the period between 2005 and 2018, as forests recover from peak harvest rates and low-level insect disturbances occurring in the early 2000s. Over this same period, emissions from HWP originating from domestic harvest declined from 140 Mt in 2005 to 130 Mt in 2018. Approximately 30% of HWP emissions result from long-lived wood products reaching the end of their economic life decades after the wood was harvested. Hence emission and removal patterns in both HWP and Forest Land are influenced by recent forest management trends and by the long-term impact of forest management that occurred in past decades.

After peaking in the years 2006-2011, current net removals from Cropland are 6.2 Mt, 5 Mt lower than in 2005, mainly as a result of increased conversion of perennial to annual crops on the Prairies and the declining effect of the adoption of conservation tillage on cropland.

The conversion of forests<sup>9</sup> to other land uses is a prevalent, yet declining, practice in Canada and is mainly due to forest conversion for resource extraction and cropland expansion. Emissions due to forest conversion fell from 16 Mt in 2005 to 14 Mt in 2018.

## **ES.5. Canadian 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. 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 recategorizes emissions under different headings and does not change the overall magnitude of Canadian emissions estimates.

GHG emissions trends in Canada's economic sectors are consistent with those described for IPCC sectors, with the Oil and Gas and Transportation economic

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<sup>9</sup> 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.

sectors showing emission increases of 22% and 16% respectively since 2005 (Figure ES–7 and Table ES–3). These increases have been more than offset by emission decreases in Electricity (46%), Heavy Industry (10%) and Waste & Others (9.3%).

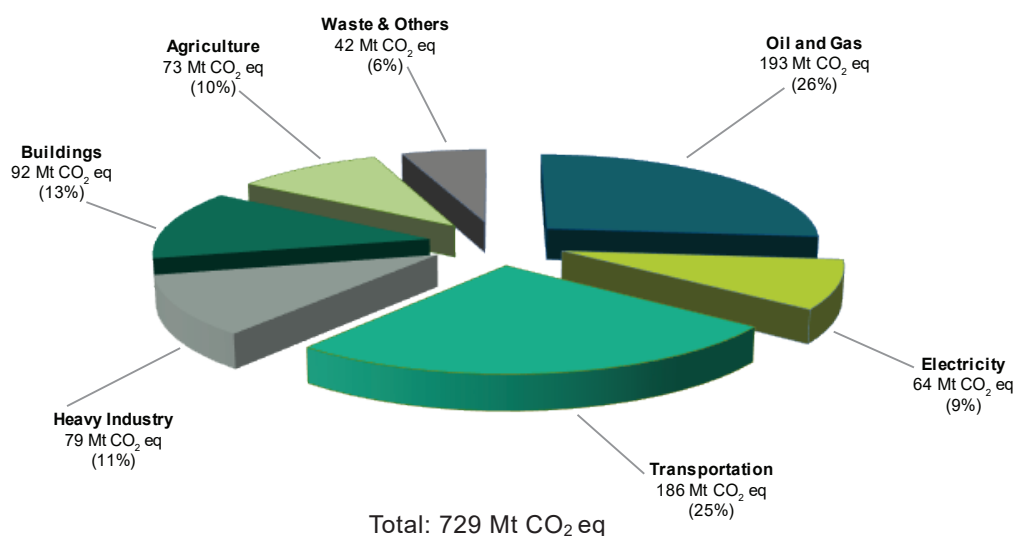
Further information on economic sector trends can be found in Chapter 2. Additional information on the IPCC and economic sector definitions, as well as a detailed crosswalk table between IPCC and economic sector categories can be found in Part 3 of this report.

## ES.6. Provincial and Territorial GHG Emissions

Emissions vary significantly by province as a result of factors like 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 have diverged. Emissions in Alberta increased

Figure ES–7 Breakdown of Canada's Emissions by Economic Sector (2018)



Note: Totals may not add up due to rounding.

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

	1990	2005	2013	2014	2015	2016	2017	2018
	Mt CO <sub>2</sub> equivalent							
<b>NATIONAL GHG TOTAL</b>	<b>603</b>	<b>730</b>	<b>721</b>	<b>721</b>	<b>720</b>	<b>706</b>	<b>714</b>	<b>729</b>
Oil and Gas	106	158	185	191	191	187	188	193
Electricity	95	119	81	77	81	75	73	64
Transportation	121	161	174	172	172	174	179	186
Heavy Industry <sup>a</sup>	97	87	79	80	79	77	76	78
Buildings	74	86	86	89	86	82	85	92
Agriculture <sup>b</sup>	57	72	73	71	71	72	71	73
Waste & Others <sup>c</sup>	53	46	43	41	41	41	42	42

Notes:

Totals may not add up due to rounding.

Estimates presented here are under continuous improvement. Historical emissions may be changed in future publications as new data becomes available and methods and models are refined and improved.

a. Heavy Industry represents emissions arising from non-coal, -oil and -gas mining activities, smelting and refining, and the production and processing of industrial goods such as fertilizer, paper or cement.

b. Emissions associated with the production of fertilizer are reported in the Heavy Industry sector.

c. "Others" includes Coal Production, Light Manufacturing, Construction & Forest Resources.

by 41 Mt (18%) since 2005, primarily as a result of the expansion of oil and gas operations (Figure ES–8 and Table ES–4). In contrast, Ontario’s emissions have decreased by 38 Mt (19%) since 2005, owing primarily to the closure of coal-fired electricity generation plants.

Saskatchewan’s emissions increased by 8.4 Mt (12%) between 2005 and 2018 and those in British Columbia increased by 3.5 Mt (5.6%) over the same time period. Emissions in Manitoba as well as Newfoundland and

Labrador have also increased since 2005, but to a lesser extent (1.7 Mt or 8.3% and 0.6 Mt or 5.3%, respectively). Provinces that have seen significant decreases in emissions include New Brunswick (6.7 Mt or a 34% reduction), Nova Scotia (6.1 Mt or a 26% reduction), Quebec (3.5 Mt or a 4.1% reduction) and Prince Edward Island (0.4 Mt or a 19% reduction).

Figure ES–8 Emissions by Province and Territory in 2005, 2010 and 2018

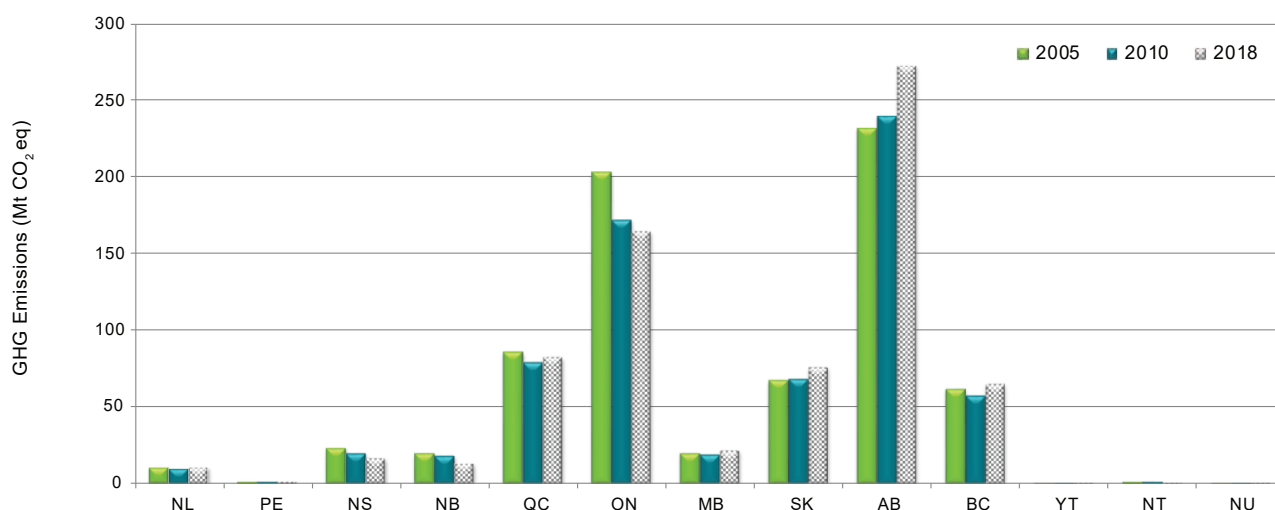


Table ES–4 GHG Emissions by Province/Territory, Selected Years

Year	GHG Emissions (Mt CO <sub>2</sub> eq)								Change (%)
	1990	2005	2013	2014	2015	2016	2017	2018	2005–2018
<b>GHG Total (Canada)</b>	<b>603</b>	<b>730</b>	<b>721</b>	<b>721</b>	<b>720</b>	<b>706</b>	<b>714</b>	<b>729</b>	<b>-0.1%</b>
NL	9.8	10	10	11	11	11	11	11	5.3%
PE	2.0	2.1	1.8	1.7	1.6	1.7	1.7	1.7	-19%
NS	20	23	18	17	17	16	16	17	-26%
NB	16	20	15	14	14	14	14	13	-34%
QC	87	86	80	78	79	78	80	83	-4.1%
ON	179	203	167	165	163	160	155	165	-19%
MB	18	20	21	21	21	21	21	22	8.3%
SK	44	68	72	75	77	75	77	76	12%
AB	173	232	272	277	276	265	272	273	18%
BC	52	62	60	60	59	62	63	66	5.6%
YT	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.6	14%
NT	NA	1.6	1.3	1.5	1.7	1.6	1.3	1.2	-22%
NU	NA	0.6	0.8	0.7	0.6	0.7	0.7	0.7	24%

Notes:

NA Not applicable

Totals may not add up due to rounding.

## ES.7. National Inventory Arrangements

Environment and Climate Change Canada is the single national entity with responsibility for preparing and submitting the National GHG Inventory to the UNFCCC and for managing the supporting processes and procedures.

The institutional arrangements for the preparation of the inventory include formal agreements on 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, an 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: at [open.canada.ca](https://open.canada.ca).

## Executive Summary References

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[StatCan] Statistics Canada. No date (a). Table 36-10-0369-01 (formerly CANSIM 380-0106): Gross domestic product, expenditure-based, at 2012 constant prices, annual (x 1,000,000). (accessed December 05, 2019). Available online at: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610036901>.

[StatCan] Statistics Canada. No date (b). *Table 17-10-0005-01 (formerly CANSIM 051-0001): Population estimates on July 1st, by age and sex.* (accessed December 05, 2019). Available online at: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000501>.