NATIONAL INVENTORY REPORT 1990–2019: GREENHOUSE GAS SOURCES AND SINKS IN CANADA

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

Executive Summary

Environment and Climate Change Canada
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EXECUTIVE SUMMARY

ES.1. Key Points

- After fluctuations in recent years, in 2019 (the most recent dataset in this report) Canada's greenhouse gas (GHG) emissions were 730 megatonnes of carbon dioxide equivalent (Mt CO_2 eq), about a 1 Mt or 0.2% increase from 2018 emissions and a net decrease of 9 Mt or 1.1% from 2005 emissions.
- Emission trends since 2005 have remained consistent with previous editions of the inventory; emission increases in the Oil and Gas and Transport sectors being offset by decreases in other sectors, notably Electricity and Heavy Industry.
- During the period covered in this report, Canada's economy grew more rapidly than its GHG emissions. As a result, the emissions intensity for the entire economy (GHG per Gross Domestic Product [GDP]) has declined by 37% since 1990 and by 23% since 2005.
- Continuous improvement is a key principle upon which Canada's annual greenhouse gas inventory is developed. Important method improvements are being implemented in this edition of the NIR (methane emissions from landfills) and will be implemented in its 2022 edition (fugitive methane emissions from upstream oil and gas). The enhanced methods use Canadian-specific studies and knowledge, facilitate the adoption of new scientific data, and better capture the impact of improvements in technologies and industry practices on emissions.
- The government's strengthened climate plan, *A Healthy Environment and a Healthy Economy*, builds on the Pan-Canadian Framework on Clean Growth and Climate Change, which has resulted in emissions in 2030 being projected to be 227 million tonnes lower than before it was adopted. Before the Pan-Canadian Framework, absolute emissions in 2019 were forecasted to be 764 Mt (Second Biennial Report, 2015), which is 34 Mt higher than this year's 2019 data. Once fully implemented, the strengthened climate plan is expected to reduce Canada's emissions by at least an additional 85 million tonnes, enabling Canada to exceed its current 2030 target. In partnership with provinces and territories, and working with the private sector and others, Canada can strive for a range of 32-40% below 2005 levels and the Government of Canada is committed to bringing forward an updated Nationally Determined Contribution (NDC) before the 26th Conference of the Parties (COP26). Looking beyond 2030, Canada is also committed to reaching net-zero emissions by 2050, and the *Canadian Net-Zero Emissions Accountability Act* will establish a legally binding process of interim targets, plans and reports toward this objective.

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 sets 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 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 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_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)

1 The Montreal Protocol on Substances that Deplete the Ozone Layer is an international environmental agreement designed to reduce the global production and consumption of ozone depleting substances. The United Nations Environment Programme (UNEP) is assisting the Parties in the achievement of the Montreal Protocol objectives. (UNEP, n.d.)

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 National Greenhouse Gas 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.

Significant improvements to NIR estimates are anticipated in the 2022 edition of this report, following the implementation of a new fugitive emission model to estimate CO_2 and CH_4 emissions from pneumatic devices, compressor seals and equipment leaks in the upstream oil and gas industry. The new model will use Canadian-specific studies and knowledge, will facilitate the adoption of new scientific data, and better capture the impact of improvements in technologies and industry practices on emissions.

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 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.

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 50 concrete actions that cover all sectors of the Canadian economy.

Actions under the PCF, supported by historic federal investments, are well advanced as governments enter the fifth year of implementation. Notably, Canada now has a price on carbon pollution across the country. Under the *Greenhouse Gas Pollution Pricing Act* passed in 2018, carbon pollution pricing systems were put in place in all provinces and territories across Canada (either provincial/territorial systems or the federal system). Other key mitigation measures include phasing out traditional coal-fired electricity by 2030 and a commitment to reduce emissions of methane in the oil and gas sector by 40-45% below 2012 levels by 2025. Between 2015 and 2019, the Government of Canada invested $60 billion to drive down GHG emissions, generate clean technologies, help Canadians and communities adapt to a changing climate, and protect the environment.

The 2016 Pan-Canadian Framework has been effective in limiting emissions in recent years while Canada's economy continued to grow. Before the Pan-Canadian Framework, absolute emissions in 2019 were forecasted to be 764 Mt (Second Biennial Report, 2015), which is 34 Mt higher than this year's 2019 data. Emissions projections included as part of the Pan-Canadian Framework in late 2016 forecasted that in 2019 Canada's emissions would be 733 Mt, which is very close to the 730 Mt reported in the 2021 NIR. In the absence of national minimum carbon pollution pricing from April – December of 2019, Canada's GHG emissions were forecasted to be higher than this year's 2019 data. In addition, early modelling for 2020 shows that as a result of the policies under the Pan-Canadian Framework and the Strengthened Climate Plan, absolute emissions in Canada are projected to decrease annually starting in 2020, reaching 503 Mt by 2030.

Canada's Strengthened Climate Plan: A Healthy Environment and a Healthy Economy

Recognizing that additional action is needed, in December 2020, the Government of Canada released *A Healthy Environment and a Healthy Economy*, Canada's plan to build a better future with a healthier economy and environment. This plan builds on the work done to date and efforts that are already underway under the PCF, and will enable us to exceed our current 2030 emissions reduction target under the Paris Agreement.

This includes federal policies, programs and $15 billion in investments, in addition to the Canada Infrastructure Bank's $6 billion for clean infrastructure announced this past fall, to accelerate the fight again against climate change, create new jobs, make life more affordable for households, and build a better future, including steps to:

- make the places Canadians live and gather more affordable by cutting energy waste;
- make clean, affordable transportation and power available in every Canadian community;
- continue to ensure pollution isn't free and households get more money back;
- build Canada's clean industrial advantage; and,
- embrace the power of nature to support healthier families and more resilient communities.

Under these pillars, some specific measures include a continued commitment to pricing carbon pollution with a proposed price trajectory set to the year 2030, support for innovation, zero emission vehicles and energy efficiency retrofits for buildings, and measures to support the achievement of Canada's existing methane reduction commitment and pursue deeper reductions in methane by 2030.

Projected Emissions Reductions

Before the Paris Agreement and Canada's National Determined Contribution (2015), Canada's national GHG emissions were projected to increase 12% above 2005 levels by 2030 (815 Mt). Driven by mitigation measures in the Pan-Canadian Framework, Canada's December 2019 GHG emissions projections estimated that Canada's GHG emissions in 2030 would be 227 million tonnes lower than projected prior to the PCF, or 19% below 2005 levels. Canada's 2020 Emissions Projections Report confirms the new commitments from Canada's Strengthened Climate Plan put Canada on a path to exceed its 2030 target of 30% below 2005 levels, projecting a 31% reduction in 2030, due to at least 85 million tonnes beyond the reductions in the PCF. In partnership with provinces and territories, and working with the private sector and others, Canada can strive for a range of 32–40% below 2005 levels. The Government of Canada is committed to bringing forward an updated NDC before COP26.

Canadian Net-Zero Emissions Accountability Act

Looking beyond 2030, the Government of Canada recently tabled legislation to help ensure Canada achieves net-zero emissions by 2050. Bill C-12, the proposed *Canadian Net-Zero Emissions Accountability Act* (CNZEAA), would codify the Government's commitment for Canada to achieve net-zero emissions by 2050 and require the government to set national emissions reduction targets at five-year intervals for 2030, 2035, 2040 and 2045. Once the bill becomes law, the government will be required to develop an emission reduction plan for each target and explain how that plan will contribute to reaching net-zero in 2050. The Act would also require interim progress reports on implementation and effectiveness, as well as final assessment reports on the achievement of on each target. For missed targets, the government would be required to address the relevant assessment report, including an explanation of the reasons why the target was missed, and a description of any planned corrective actions that will be taken to address the failure.

The Bill also requires that Canada's Commissioner of the Environment and Sustainable Development examine and report on implementation of the measures intended to achieve the target, at least once every five years. It also requires that provinces and territories, Indigenous peoples, stakeholders, and experts be given the opportunity to provide input into this process, and establishes an independent expert Advisory Body to advise the Government on the best pathways to growing the economy while reducing emissions.

Net-Zero Advisory Body

In February 2021, the Minister of Environment and Climate Change launched the Net-Zero Advisory Body. The advisory body will report regularly to the Minister of Environment and Climate Change and to the public on the most likely pathways for Canada to achieve net-zero emissions by 2050. It will provide ongoing, evergreen advice that is forward-looking but grounded in the current realities of socio-economic circumstances, available technologies, and global trends. The initial members bring together a diverse range of expertise and experience, including in science, business and finance, labour, clean-technology, policy-making, rural economic development, and Indigenous governance. The advisory body will draw on existing and emerging research, analysis, and technical expertise and will establish a robust and inclusive engagement process. As part of its initial mandate, the advisory body will provide advice on actions Canada can take now to ensure a strong economic recovery while laying the foundation for net-zero emissions by 2050.

Conclusion

Canada's National Inventory Report, along with other reports such as Canada's National Communications and Biennial Reports, the greenhouse gas and air pollutant emissions projections (also submitted to the UNFCCC), annual synthesis reports on the status of implementation of the PCF, and future legislated reports, all support Canada's assessment of its progress in reducing emissions and combatting climate change.

Section ES.3 of this Executive Summary provides the latest information on Canada's net anthropogenic (i.e. human-induced) GHG emissions over the 2005–2019 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, Transport, Heavy Industry, Buildings, Agriculture, and Waste and others.[2] 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 fluctuations in recent years, in 2019 (the most recent dataset in this report) Canada's GHG emissions were 730 Mt CO_2 eq,[3] a net decrease of 9 Mt or 1.1% from 2005 emissions (Figure ES–1).[4] Emission trends since 2005 have remained consistent with previous editions of the NIR, with emission increases in the Oil and Gas and Transport sectors being offset by decreases in other sectors, notably Electricity and Heavy Industry.

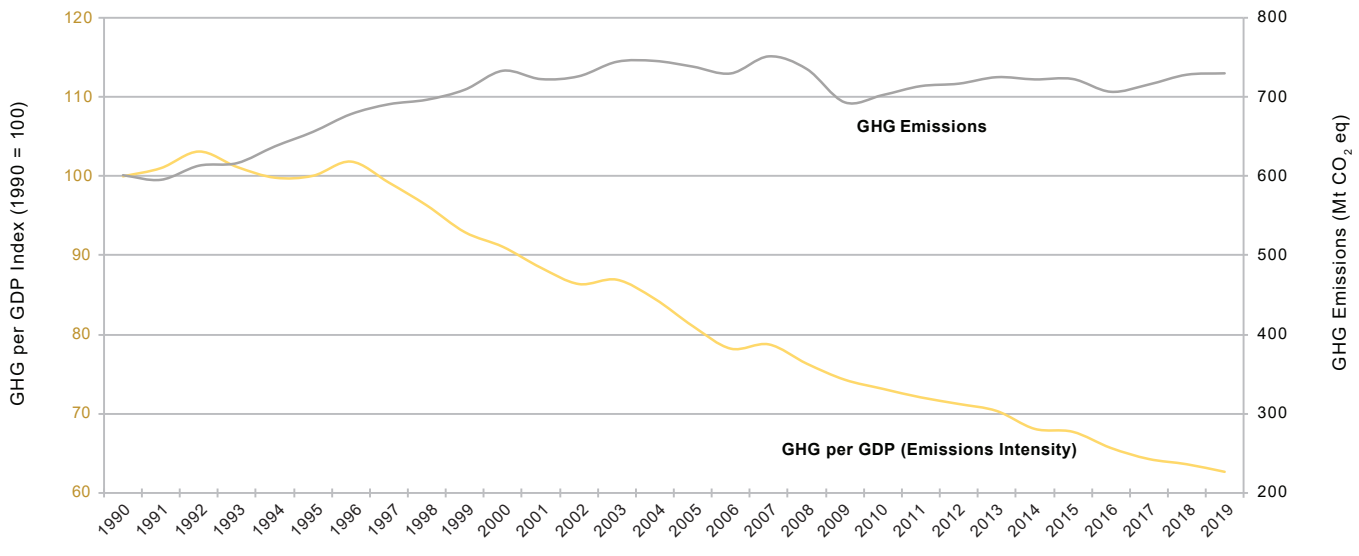
In general, year-to-year fluctuations are superimposed over actual trends observed over a longer time period. During the period covered in this report, Canada's economy has grown more rapidly than its GHG emissions. As a result, the emissions intensity for the entire economy (GHG per GDP) has declined by 37% since 1990 and by 23% 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.

2 Others includes Coal Production, Light Manufacturing, Construction and Forest Resources.

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

4 Throughout this report, data are presented as rounded figures. However, all calculations (including the ones to obtain percentages) have been performed using unrounded data.

Figure ES–1 **Canadian GHG Emissions and Indexed Trend Emission Intensity (excluding Land Use, Land-Use Change and Forestry)**



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 (n.d.[a])

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 2019, the Energy sector (consisting of Stationary Combustion, Transport and Fugitive Sources) emitted 589 Mt, or 81% of Canada's total GHG emissions (Figure ES–2). The remaining emissions were largely generated by the Agriculture and IPPU sectors (8% and 7%, respectively), with contributions from the Waste sector (4%). In 2019, the LULUCF sector emitted 9.9 Mt to the atmosphere.

Canada's emissions profile is similar to that of most industrialized countries, in that CO_2 is the largest contributor to total emissions, accounting for 80% of total emissions in 2019 (Figure ES–3). The majority of CO_2 emissions in Canada result from the combustion of fossil fuels. CH_4 emissions in 2019 amounted to 98 Mt or 13% of Canada's total. These emissions consist largely of fugitive emissions from oil and natural gas systems, agriculture, and landfills. N_2O emissions mostly arise from agricultural soil management and transport and accounted for 37 Mt or 5.0% of Canada's emissions in 2019. Emissions of synthetic gases (HFCs, PFCs, SF_6 and NF_3) accounted for slightly less than 2% of national emissions.

Canada accounted for approximately 1.5% of global GHG emissions in 2017 (Climate Watch, 2020), although it is one of the highest per capita emitters. Canada's per capita emissions have declined since 2005 from 22.9 t CO_2 eq/capita to a new low of 19.4 t CO_2 eq/capita in 2019 (Figure ES–4).

Table ES–1 **Trends in GHG Emissions and Economic Indicators, Selected Years**

Year	2005	2014	2015	2016	2017	2018	2019
Total GHG (Mt)	**739**	**723**	**723**	**707**	**716**	**728**	**730**
Change since 2005 (%)	NA	-2.2%	-2.1%	-4.3%	-3.1%	-1.4%	-1.1%
GDP[a] (Billion 2012$)	**1 654**	**1 926**	**1 938**	**1 953**	**2 022**	**2 078**	**2 115**
Change since 2005 (%)	NA	16%	17%	18%	22%	26%	28%
GHG Intensity (Mt/$B GDP)	**0.45**	**0.38**	**0.37**	**0.36**	**0.35**	**0.35**	**0.35**
Change since 2005 (%)	NA	-16%	-16%	-19%	-21%	-22%	-23%

Notes:

NA = Not applicable

a. Data source – StatCan (n.d.[a])

Figure ES–2 **Breakdown of Canada's Emissions by Intergovernmental Panel on Climate Change Sector (2019)**

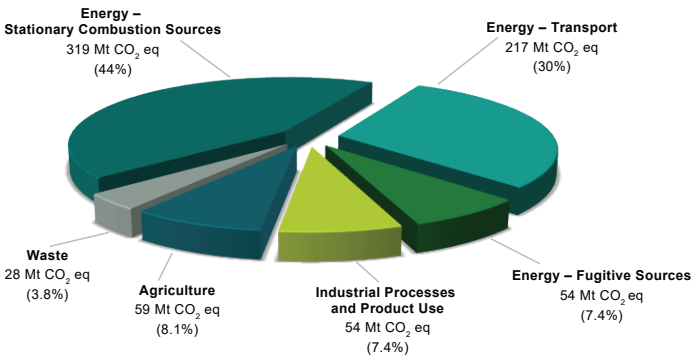
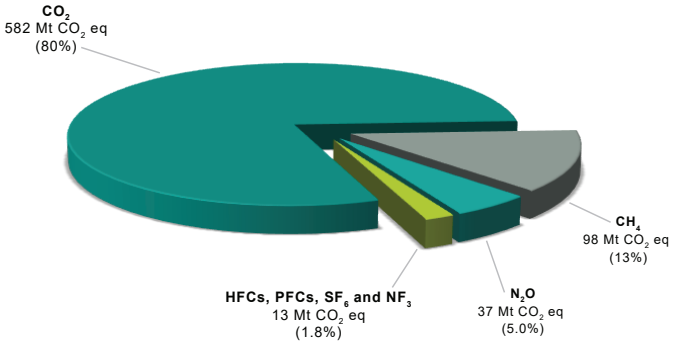


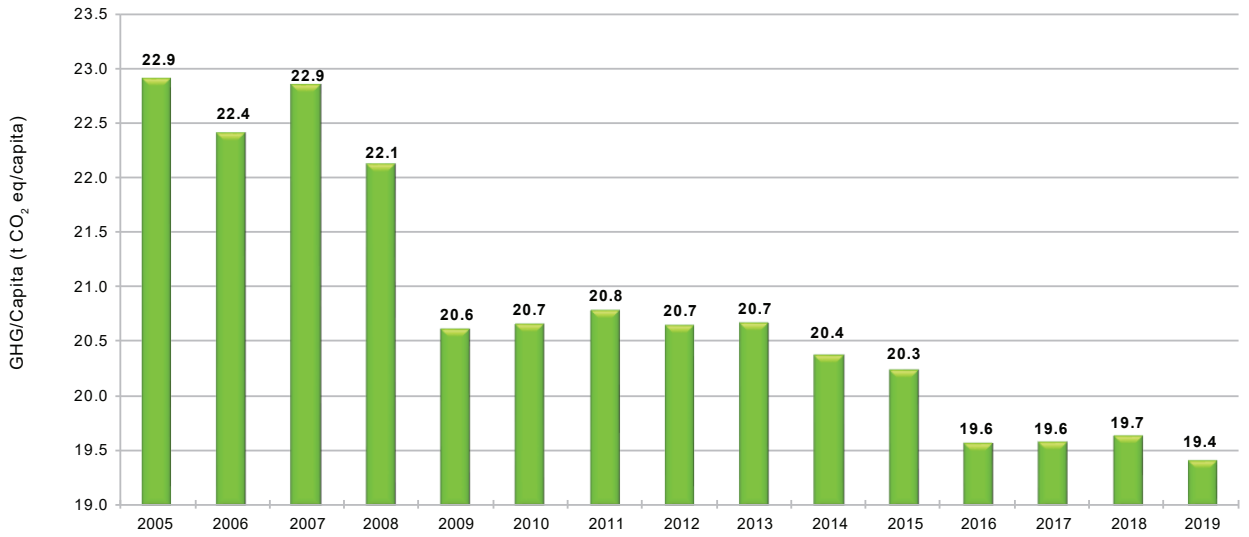
Figure ES–3 **Breakdown of Canada's Emissions by GHG (2019)**



Total: 730 Mt CO_2 eq

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

Figure ES–4 **Canadian per Capita GHG Emissions (2005–2019)**



Note: Population data source – StatCan (n.d.[b])

ES.4. GHG Emissions and Trends by Intergovernmental Panel on Climate Change Sector

Trends in Emissions

Over the 2005–2019 period, total emissions have decreased by 9 Mt or 1.1 % (Figure ES–5). Two sources of the Energy sector dominated this trend, with emission decreases of 22 Mt (6.4%) in Stationary Combustion Sources and 7.1 Mt (12%) in Fugitive Sources (Table ES–2). Over the same period, emissions have decreased by 3.4 Mt (11%) in the Waste sector and 2.3 Mt (4.1%) in the IPPU sector. However, emissions from Transport (also in the Energy sector) have increased by 27 Mt (14%), partially offsetting the decreases from the other categories (Figure ES–6).

Emission increases since 2009, when emissions were at their lowest in the latest decade, have been driven by growth in Oil and Gas Extraction (27 Mt), in the number of light-duty gasoline trucks (13 Mt) and heavy-duty diesel vehicles in operation (12 Mt), in the production and consumption of halocarbons, SF_6 and NF_3 (5.5 Mt), and in the application of inorganic nitrogen fertilizers (3.5 Mt). During the same period, there was a 32 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.[5] Further breakdowns of emissions and a complete time series can be found at open.canada.ca.

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

Energy – 2019 GHG Emissions (589 Mt)

In 2019, GHG emissions from the IPCC Energy sector (589 Mt) were 0.3% lower than in 2005 (591 Mt). Within the Energy sector, a 42-Mt increase in combustion emissions from Oil and Gas Extraction and a 24-Mt growth in Road Transportation emissions were largely offset by a 56-Mt decrease in emissions from Public Electricity and Heat Production and a 5.6-Mt drop in emissions from Manufacturing.

Stationary Combustion (319 Mt)

Decreasing electricity generation from coal and oil (decreases of 53% and 78%, respectively) was a large driver of the 56-Mt decrease in emissions associated with Public Electricity and Heat Production between 2005 and 2019. The permanent closure of all coal generating stations in Ontario by 2014[6] contributed 48% of the decreased coal consumption, and reduced coal consumption in Alberta contributed an additional 44%. Reduced coal

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

6 Ontario Power Generation News. 2014. April 15. [accessed 2018 Jan]. Available online at: http://www.opg.com/news-and-media/news-releases/Pages/news-releases.aspx?year=2014.

Figure ES–5 **Trends in Canadian GHG Emissions by Intergovernmental Panel on Climate Change Sector (2005–2019)**

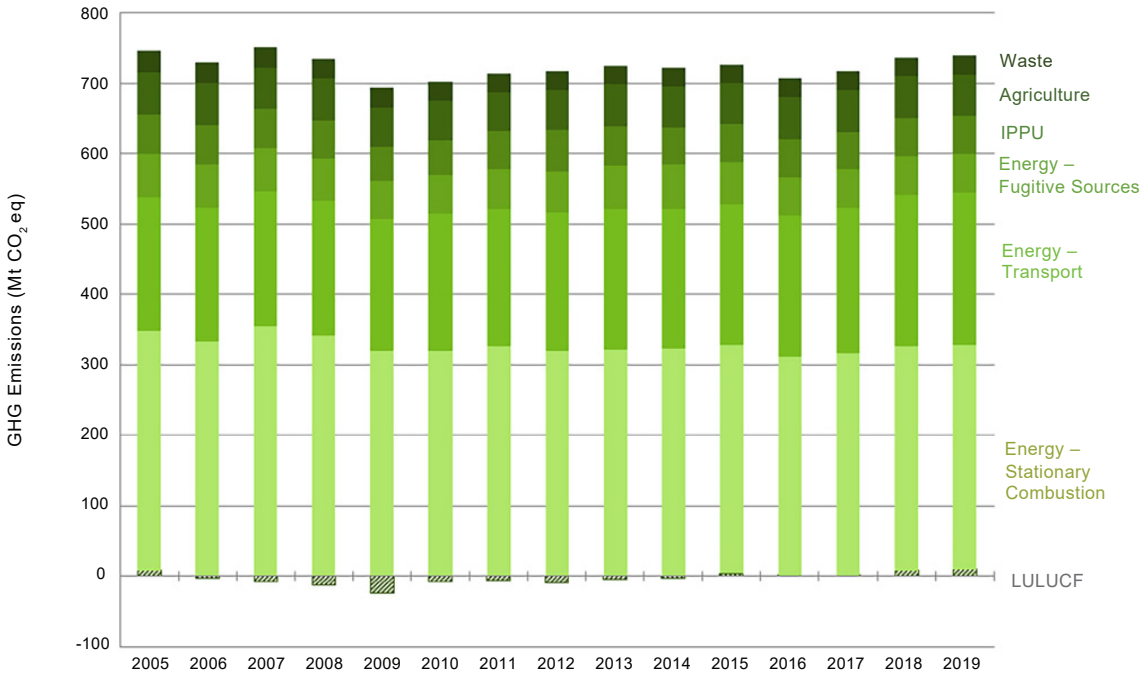


Figure ES–6 **Changes in GHG Emissions by Intergovernmental Panel on Climate Change Sector (2005–2019)**

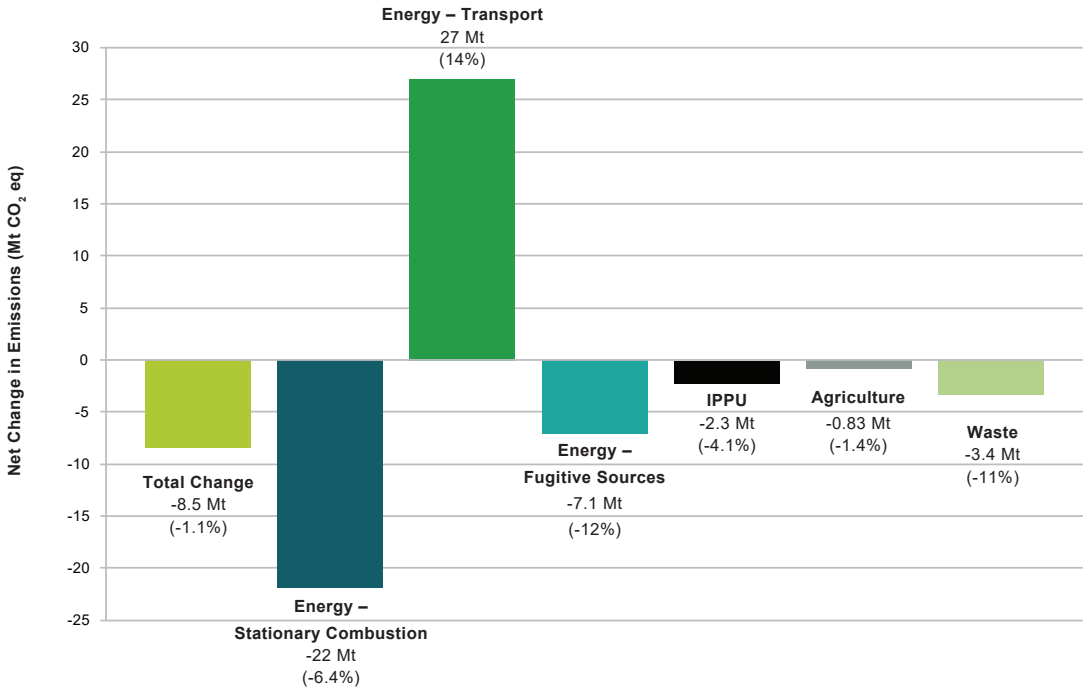


Table ES–2 **Canada's GHG Emissions by Intergovernmental Panel on Climate Change Sector, Selected Years**

Greenhouse Gas Categories		2005	2014	2015	2016	2017	2018	2019
		Mt CO_2 Equivalent						
TOTAL[a, b]		**739**	**723**	**723**	**707**	**716**	**728**	**730**
ENERGY		**591**	**584**	**585**	**566**	**578**	**588**	**589**
a.	Stationary Combustion Sources	341	323	324	311	316	318	319
	Public Electricity and Heat Production	125	84	87	81	78	70	69
	Petroleum Refining Industries	20	16	16	16	14	15	15
	Oil and Gas Extraction	63	95	97	94	97	104	105
	Mining	4.3	5.1	4.6	4.3	4.9	6.3	6.4
	Manufacturing Industries	48	45	43	42	42	42	42
	Construction	1.5	1.3	1.3	1.3	1.3	1.4	1.4
	Commercial and Institutional	33	31	30	30	32	33	34
	Residential	44	41	40	39	41	42	42
	Agriculture and Forestry	2.2	3.8	3.6	3.8	3.7	3.8	3.7
b.	Transport	190	199	201	201	207	215	217
	Aviation	7.7	7.6	7.6	7.5	7.9	8.7	8.5
	Road Transportation	130	142	143	145	148	152	153
	Railways	6.6	7.5	7.1	6.5	7.5	7.6	7.7
	Marine	4.0	3.5	3.4	3.5	3.6	3.8	4.4
	Other Transportation	42	39	40	39	40	43	43
c.	Fugitive Sources	61	63	59	54	55	55	54
	Coal Mining	1.4	1.3	1.1	1.3	1.2	1.3	1.4
	Oil and Natural Gas	60	61	58	53	54	53	52
d.	CO_2 Transport and Storage	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
INDUSTRIAL PROCESSES AND PRODUCT USE		**57**	**54**	**53**	**54**	**53**	**54**	**54**
a.	Mineral Products	10	7.8	8.0	7.9	8.6	8.7	8.8
b.	Chemical Industry	10	6.4	6.7	7.0	6.4	6.8	6.8
c.	Metal Production	20	15	14	15	15	15	14
d.	Production and Consumption of Halocarbons, SF_6 and NF_3	5.1	11	11	11	12	13	12
e.	Non-Energy Products from Fuels and Solvent Use	10	13	13	12	11	11	12
f.	Other Product Manufacture and Use	0.54	0.48	0.57	0.62	0.66	0.73	0.75
AGRICULTURE		**60**	**58**	**58**	**59**	**58**	**59**	**59**
a.	Enteric Fermentation	31	24	24	24	24	24	24
b.	Manure Management	8.8	7.7	7.8	7.9	7.9	7.9	7.9
c.	Agricultural Soils	19	23	24	25	24	25	24
d.	Field Burning of Agricultural Residues	<0.05	0.05	0.06	0.05	0.05	0.05	0.05
e.	Liming, Urea Application and Other Carbon-Containing Fertilizers	1.4	2.5	2.6	2.5	2.4	2.6	2.6
WASTE		**31**	**27**	**27**	**27**	**27**	**27**	**28**
a.	Solid Waste Disposal (Landfills)	25	22	22	22	22	23	23
b.	Biological Treatment of Solid Waste	0.24	0.31	0.31	0.31	0.32	0.37	0.38
c.	Wastewater Treatment and Discharge	0.94	1.0	1.0	1.0	1.0	1.0	1.0
d.	Incineration and Open Burning of Waste	0.34	0.17	0.20	0.20	0.19	0.18	0.19
e.	Industrial Wood Waste Landfills	4.4	3.5	3.4	3.3	3.2	3.1	3.0
LAND USE, LAND-USE CHANGE AND FORESTRY		**8.2**	**-3.5**	**4.0**	**0.10**	**0.70**	**8.4**	**9.9**
a.	Forest Land	-134	-141	-134	-136	-136	-133	-133
b.	Cropland	-10	-8.1	-7.0	-6.3	-5.7	-4.8	-4.2
c.	Grassland	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
d.	Wetlands	3.1	3.1	2.9	2.9	3.0	2.7	2.6
e.	Settlements	1.7	2.3	2.6	2.4	2.2	2.4	2.2
f.	Harvested Wood Products	148	140	139	137	137	141	143

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.

consumption also occurred in Nova Scotia (16%), New Brunswick (36%), Manitoba (100%) and Saskatchewan (12%). Decreased oil consumption for electricity generation in New Brunswick (94%) and Nova Scotia (95%), offset by increased consumption in Newfoundland and Labrador (40%) accounts for 99% of the reduced oil consumption. Emission fluctuations over the period reflect variations in the mix of electricity generation sources; over the time period, the amount of low-emitting generation in the mix has increased.[7]

The 42-Mt increase in emissions from stationary fuel consumption in Oil and Gas Extraction is consistent with a 200% rise in the extraction of bitumen and synthetic crude oil from Canada's oil sands operations since 2005.

GHG emissions from Manufacturing Industries have decreased by 5.6 Mt between 2005 and 2019, consistent with both a 12% decrease in energy use and an observed decline in output in these industries (StatCan, n.d.[c]).

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 on-road vehicles. Despite a reduction in kilometres driven per vehicle, the total vehicle fleet has increased by 42% since 2005, most notably for trucks (both light- and heavy-duty), leading to more kilometres driven overall.

Fugitive Sources (54 Mt)

Since 2005, fugitive GHG emissions from fossil fuel production (coal, oil and natural gas) have decreased by 7.1 Mt, largely the result of provincial regulations to increase conservation of natural gas, which is mainly comprised of CH_4.

Industrial Processes and Product Use – 2019 GHG Emissions (54 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 54 Mt (7.4%) to Canada's 2019 emissions.

Between 2005 and 2019, process emissions from most IPPU categories decreased. A notable exception is the 7.3 Mt (143%) increase in emissions from the use of HFCs to replace CFCs and HCFCs before the gradual phase out of HFCs mandated under the Kigali Amendment to the Montreal Protocol, which came into force in 2019.

The aluminium industry has decreased its process emissions by 3.4 Mt (-39%) since 2005, largely due to the implementation of technological improvements to mitigate PFC emissions and the shutdown of older smelters using Søderberg technology, the last of which 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 (-6.4 Mt or -32%) seen in Metal Production between 2005 and 2019.

The overall decrease of 3.6 Mt (35%) of GHG emissions from chemical industries since 2005 is primarily the result of the 2009 closure of the sole Canadian adipic acid plant located in Ontario. N_2O emissions abatement installations at a nitric acid production facility are responsible for a smaller proportion (0.9 Mt) of the decrease. 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 – 2019 GHG Emissions (59 Mt)

The Agriculture sector covers non-energy GHG emissions related to the production of crops and livestock. Emissions from Agriculture accounted for 59 Mt, or 8.1% of total GHG emissions for Canada in 2019.

In 2019, Agriculture accounted for 29% of national CH_4 emissions and 78% of national N_2O 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 71%, while major livestock populations peaked in 2005, then decreased sharply until 2011. In 2019, 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 – 2019 GHG Emissions (28 Mt)

The Waste sector includes GHG emissions from the treatment and disposal of liquid and solid wastes. Emissions from Waste contributed 28 Mt (3.8%) to Canada's total emissions in 2019 and 31 Mt (4.2%) in 2005.

The primary sources of emissions in 2019 for the Waste sector are municipal solid waste (MSW) disposal in landfills (23 Mt) and Industrial Wood Waste Landfills (3.0 Mt). In 2019, these landfills combined accounted for 94% 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 6%.

In 2019, CH_4 emissions from MSW landfills made up 83% of all waste emissions; these emissions decreased by 8.4% between 2005 and 2019. Of the 37 Mt CO_2 eq of CH_4 generated by MSW landfills in 2019, only 23 Mt CO_2 eq (62%) were actually emitted to the atmosphere,

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

with a large portion (31% or 12 Mt CO_2 eq) being captured by landfill gas collection facilities and flared or used for energy, as compared to 21% in 2005.

Land Use, Land-Use Change and Forestry – 2019 (Net GHG Emissions of 9.9 Mt)

The 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 2019, this net flux amounted to net emissions of 9.9 Mt that, when included with emissions from other sectors, increases Canada's total GHG emissions by 1.4%.

Net emissions/removals from the LULUCF sector have fluctuated over recent years, switching from a net source of 8.2 Mt in 2005 to a net sink of 24 Mt in 2009 and subsequently back to a net source of 9.9 Mt in 2019. 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 130 Mt and 140 Mt over the period between 2005 and 2019, as forests recover from peak harvest rates in the early 2000s and continue to be impacted by low-level insect disturbances. Over this same period, emissions from HWP originating from domestic harvest declined from 150 Mt in 2005 to 140 Mt in 2019.

Approximately 30% of HWP emissions result from long-lived wood products reaching the end of their economic life decades after the wood was harvested. Emission and removal patterns in both HWP and Forest Land have therefore been influenced by recent forest management trends and by the long-term impact of forest management practices in past decades.

After peaking in the years 2006 to 2011, current net removals from Cropland are 4.2 Mt, 6.2 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 that mainly occurred in the 1980s and 90s.

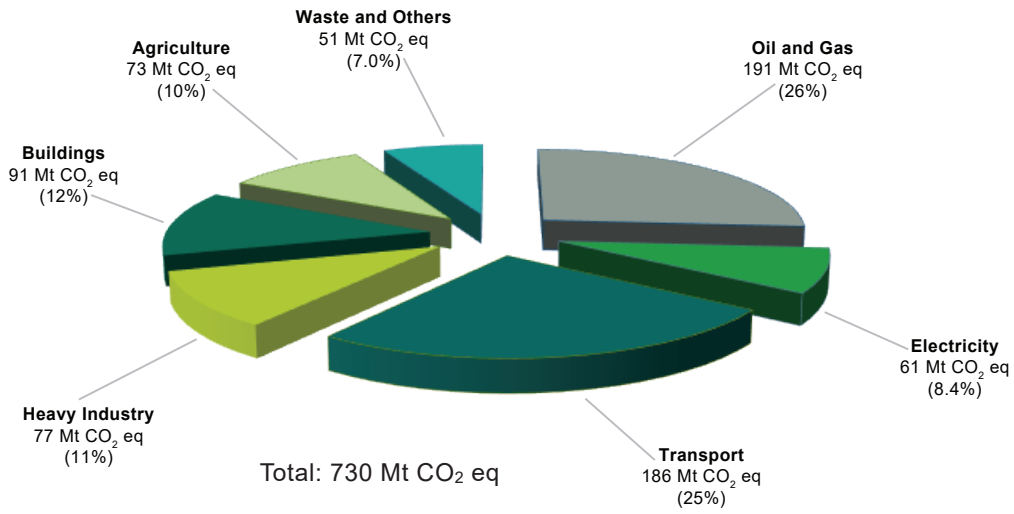
The conversion of forests[8] to other land uses is still a prevalent practice in Canada and is mainly due to resource extraction and cropland expansion. Emissions due to forest conversion in the years 2005 to 2019 have fluctuated around 16 Mt.

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.

8 Forest conversion emissions are incorporated within sums of emissions of other LULUCF categories; therefore, the values reported here are included in the sums associated with the other category totals.

Figure ES–7 **Breakdown of Canada's GHG Emissions by Economic Sector (2019)**



Note: Totals may not add up due to rounding.

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

	2005	2014	2015	2016	2017	2018	2019
	Mt CO_2 equivalent						
NATIONAL GHG TOTAL	**739**	**723**	**723**	**707**	**716**	**728**	**730**
Oil and Gas	160	190	190	181	183	191	191
Electricity	118	76	79	74	72	62	61
Transport	160	171	172	174	179	184	186
Heavy Industry[a]	87	79	77	76	75	77	77
Buildings	84	85	83	81	86	90	91
Agriculture[b]	72	71	71	72	71	73	73
Waste and Others[c]	57	50	50	50	50	51	51

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 assoicated with the production of fertilizer are reported in the Heavy Industry sector.

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

GHG emissions trends in Canada's economic sectors are consistent with those described for IPCC sectors, with the Oil and Gas and Transport economic sectors showing emission increases of 20% and 16% respectively since 2005 (Figure ES–7 and Table ES–3). These increases have been more than offset by emission decreases in Electricity (48%), Heavy Industry (12%), and Waste and others (10%).

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 and territory as a result of factors such as population, energy sources and economic structure. All else being equal, economies based on resource extraction will tend to have higher emission levels than service-based economies. Likewise, provinces that rely on fossil fuels for electricity generation emit relatively more GHG 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 have increased by 40 Mt (17%) 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 42 Mt (21%) since 2005, owing primarily to the closure of coal-fired electricity generation plants.

Saskatchewan's emissions have increased by 7.0 Mt (10%) between 2005 and 2019 and those in British Columbia have also increased by 2.7 Mt (4.3%) over the same time period. Emissions in Manitoba and Newfoundland and Labrador have also increased since 2005, but to a lesser extent (2.0 Mt or 9.8% and 0.6 Mt or 5.4%, respectively). Provinces that have seen significant decreases in emissions include New Brunswick (7.6 Mt or a 38% reduction), Nova Scotia (6.9 Mt or a 30% reduction), Quebec (3.9 Mt or a 4.4% reduction) and Prince Edward Island (0.3 Mt or a 14% reduction).

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 (see Chapter 1, section 1.2).

Figure ES–8 **GHG Emissions by Province and Territory in 2005, 2010 and 2019**

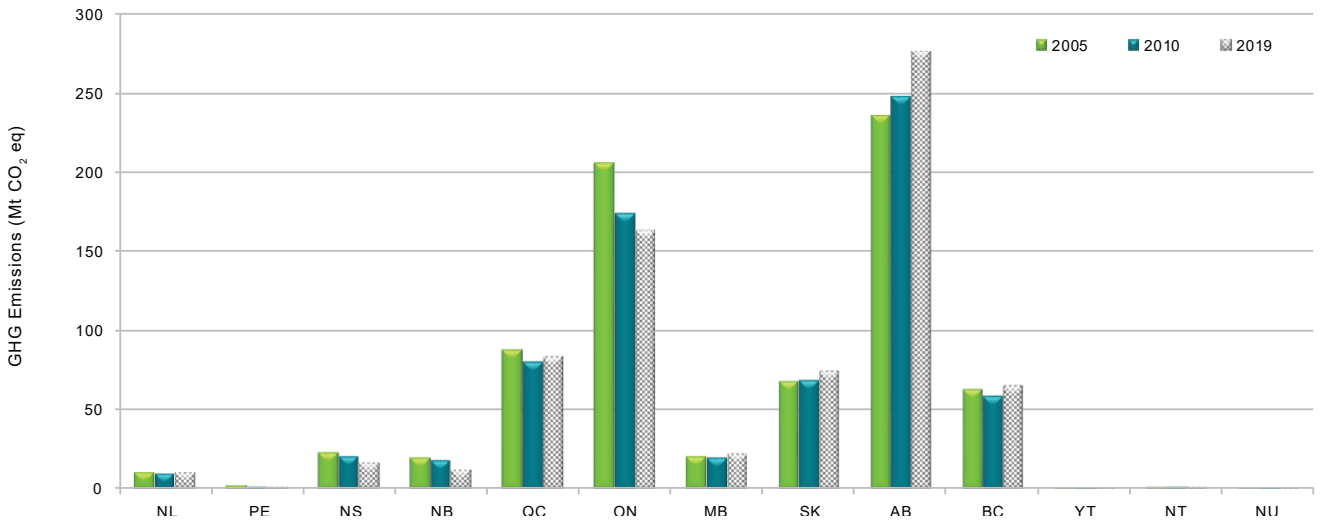


Table ES–4 **GHG Emissions by Province and Territory, Selected Years**

	GHG Emissions (Mt CO_2 eq)							Change (%)
Year	2005	2014	2015	2016	2017	2018	2019	2005–2019
GHG Total (Canada)	**739**	**723**	**723**	**707**	**716**	**728**	**730**	**-1.1%**
NL	11	11	11	11	11	11	11	5.4%
PE	2.0	1.7	1.7	1.7	1.7	1.7	1.8	-14%
NS	23	17	17	16	16	17	16	-30%
NB	20	13	14	14	13	13	12	-38%
QC	88	79	79	79	81	83	84	-4.4%
ON	206	164	163	161	158	163	163	-21%
MB	21	21	21	21	22	23	23	10%
SK	68	74	76	74	76	76	75	10%
AB	235	278	278	264	271	272	276	17%
BC	63	60	59	62	63	66	66	4.3%
YT	0.57	0.50	0.53	0.53	0.56	0.64	0.69	22%
NT	1.6	1.5	1.7	1.6	1.3	1.4	1.4	-16%
NU	0.58	0.70	0.64	0.74	0.75	0.75	0.73	25%

Note: Totals may not add up due to rounding.

Structure of Submission

The UNFCCC requirements include the annual compilation and submission of both the NIR and the CRF tables. The CRF tables are a series of standardized data tables containing mainly numerical information that 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, and 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 and 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.

Executive Summary References

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