NATIONAL INVENTORY REPORT 1990–2020: 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 fluctuations in recent years, Canada's greenhouse gas (GHG) emissions decreased to 672 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) in 2020 (the most recent year for which data are available for this report), net decreases of 66 Mt or 8.9% from 2019 and 69 Mt or 9.3% from 2005.
- The year 2020 was marked by the COVID-19 pandemic, coinciding with a decrease in emissions of 66 Mt or 8.9% across numerous sectors. Notable examples include Transport (-27 Mt or -12%) largely due to fewer kilometers driven and a decrease in air traffic; and Public Electricity and Heat Production (-7.4 Mt or -11%) due to decreased coal consumption partially offset by an increase in natural gas consumption.
- During the period covered by this report (1990–2020), 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 39% since 1990 and by 26% since 2005. 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 drivers for these changes include continued implementation and strengthening of efforts to reduce emissions by all levels of government within Canada.
- Continuous improvement is a key principle underlying Canada's annual greenhouse gas inventory. Important methodological improvements are being implemented in this edition of the National Inventory Report (NIR) (e.g. fugitive methane emissions from upstream oil and gas and emissions from agricultural soils), and additional improvements are being considered for future editions (e.g. emissions and removals from managed forest land, and emissions from transport). 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.

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, with the exception of hydrofluorocarbons (HFCs).[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 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), HFCs, sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) 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 future editions of this report, notably related to emissions and removals from managed forest land, and emissions from on-road and off-road transport. For more details on planned inventory improvements, please refer to Chapter 8.

In 2021, Canada formally submitted its enhanced Nationally Determined Contribution (NDC) to the United Nations, committing Canada to cut its GHG emissions to 40-45% below 2005 levels by 2030. This target represents a significant increase in ambition over its previous NDC, submitted in 2015, of reducing emissions to 30% below 2005 levels by 2030. 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.

Section ES.3 of this Executive Summary provides the latest information on Canada's net anthropogenic GHG emissions over the 2005–2020 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 broken down 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.

Canada's Action on Climate Change

Canada is on a path to significantly reduce greenhouse gas (GHG) emissions, through the raising of climate and economic ambition since 2015 supported by extensive national climate efforts—including the Pan-Canadian Framework on Clean Growth and Climate Change* (2016), the Strengthened Climate Plan (2020), Canada's enhanced 2030 target (2021), and the enactment of the *Canadian Net-Zero Emissions Accountability Act* (2021). Prior to these efforts, Canada's emissions were on a steady upwards climb and were projected to increase 12% above 2005 levels by 2030. The Government of Canada was required under the Act to establish the 2030 Emissions Reduction Plan (ERP) by the end of March 2022, to outline Canada's approach to reaching a reduction of 40-45% below 2005 levels by 2030, as committed to in Canada's NDC, and setting Canada on a path to reaching net-zero emissions by 2050.

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.)

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

Pan-Canadian Framework on Clean Growth and Climate Change

Canada's first-ever national climate plan, the Pan-Canadian Framework on Clean Growth and Climate Change (PCF), was adopted in 2016. The PCF was developed in collaboration with Canada's provinces and territories, and in consultation with national Indigenous organizations, stakeholders, and Canadians.

In addition to the price on carbon pollution—among the most stringent in the world—the PCF included more than 50 measures to drive down Canada's emissions, help build resilience across the country, and support climate innovation for clean economic growth. Progress on implementation of these measures has been reported through annual Synthesis Reports.

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

In December 2020, the Government of Canada introduced its Strengthened Climate Plan – *A Healthy Environment and a Healthy Economy*.** This strengthened climate plan detailed a series of commitments, building on PCF measures, to reduce emissions to 31% below 2005 levels by 2030.

Significant investments have been made to support the implementation of measures in the PCF and the Strengthened Climate Plan. This includes $15 billion in additional funding for public and active transportation announced in February 2021, and an additional $17.6 billion committed to through Canada's federal Budget 2021 in support green economic recovery, while helping to address emissions from heavy industry and from buildings.

Canadian Net-Zero Emissions Accountability Act (CNZEAA)

While Canada has made significant progress in reducing emissions to 2030, it has also laid a strong foundation for the deeper reductions needed to achieve net-zero emissions by 2050.

With the enactment of the CNZEAA in June 2021, Canada has now put in place the legislative requirements that will underpin a transparent and accountable process to long-term emissions reduction planning, an approach that will incorporate consultation with Canadians, provinces and territories, and Indigenous Peoples, and be informed by expert advice.

Emissions Reduction Plan

Pursuant to the CNZEAA, the Emissions Reduction Plan (ERP) includes key measures the Government intends to take to achieve the 2030 target, an interim GHG emissions objective for 2026, an overview of relevant sectoral strategies, and a projected timetable for implementation of measures. The Government engaged with provinces, territories, Indigenous Peoples, the Net-Zero Advisory Body, and interested Canadians to identify what is needed to reach Canada's climate objectives. Full participation from Canadians and all sectors of the economy is essential for building an effective pathway to achieve Canada's 2030 and 2050 climate goals and a prosperous economy.

Net-Zero Advisory Body

On February 25, 2021, the Minister of Environment and Climate Change launched the Net-Zero Advisory Body (NZAB), an independent group of experts with a mandate to provide independent advice with respect to achieving Canada's target of net-zero emissions by 2050. Further information on the NZAB's current activities and forward-looking plans can be found on its website: nzab2050.ca.

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.

* https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

** https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html

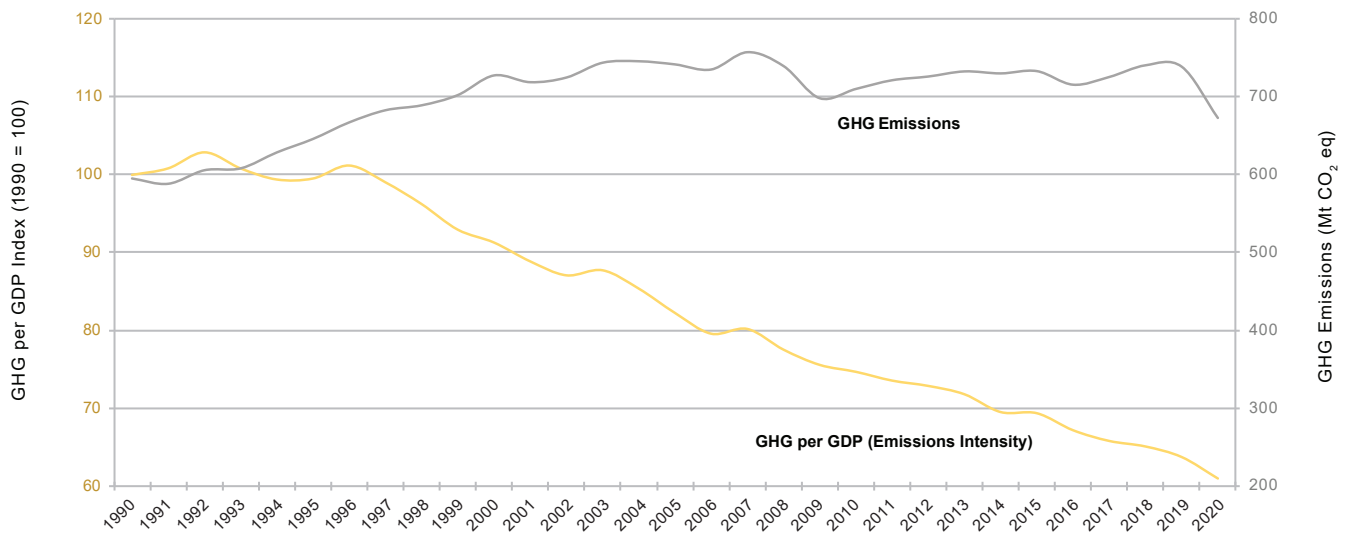
ES.3. Overview, National GHG Emissions

After fluctuations in recent years, Canada's GHG emissions were 672 Mt CO_2 eq[3] in 2020 (the most recent year for which data are available for this report), a net decrease of 69 Mt or 9.3% 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 grew more rapidly than its GHG emissions. As a result, the emissions intensity for the entire economy (GHG per GDP) has declined by 39% since 1990 and by 26% 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.

Of note is a decrease of 66 Mt between the years 2019 and 2020, coinciding with the first year of the COVID-19 pandemic. This decrease occurred in numerous sectors, most notably Transport (-27 Mt or -12%), Stationary Combustion (-22 Mt or -6.8%), and Fugitive Sources (-17 Mt or -25%). The decrease in Transport emissions includes decreases in Light-Duty Gasoline Vehicles and Trucks (-15 Mt or -17%) and domestic Aviation (-3.8 Mt or -44%). These are linked to a decrease in the vehicle kilometres traveled (VKT) in the light-duty vehicles and trucks categories, and a decrease in air traffic in 2020 relative to 2019. Fugitive sources includes emissions decreases from venting (-11 Mt), and leaks from oil (-3 Mt) and natural gas production and processing facilities (-2 Mt). Within Stationary Combustion Sources, decreases in Public Electricity and Heat Production (-7.4 Mt or -11%) were due to decreased coal consumption partially offset by an increase in natural gas consumption; decreases in Manufacturing Industries (-4.5 Mt or -11%) can be partially attributed to plants that closed, temporarily and permanently, during the first year of the pandemic. Temporary shut-down of some plants can also only partially explain the decrease in the Industrial and Processes and Product Use sector (-3.1 Mt or -6.0%) between 2019 and 2020.

Figure ES–1 **Canadian GHG Emissions and Indexed Trend Emissions 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])

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.

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

In 2020, the Energy sector (consisting of Stationary Combustion, Transport and Fugitive Sources) emitted 540 Mt, or 80% of Canada's total GHG emissions (Figure ES–2). The remaining emissions were largely generated by the Agriculture and IPPU sectors (8.2% and 7.5%, respectively), with contributions from the Waste sector (4.1%) and the LULUCF sector removed 6.8 Mt from the atmosphere.

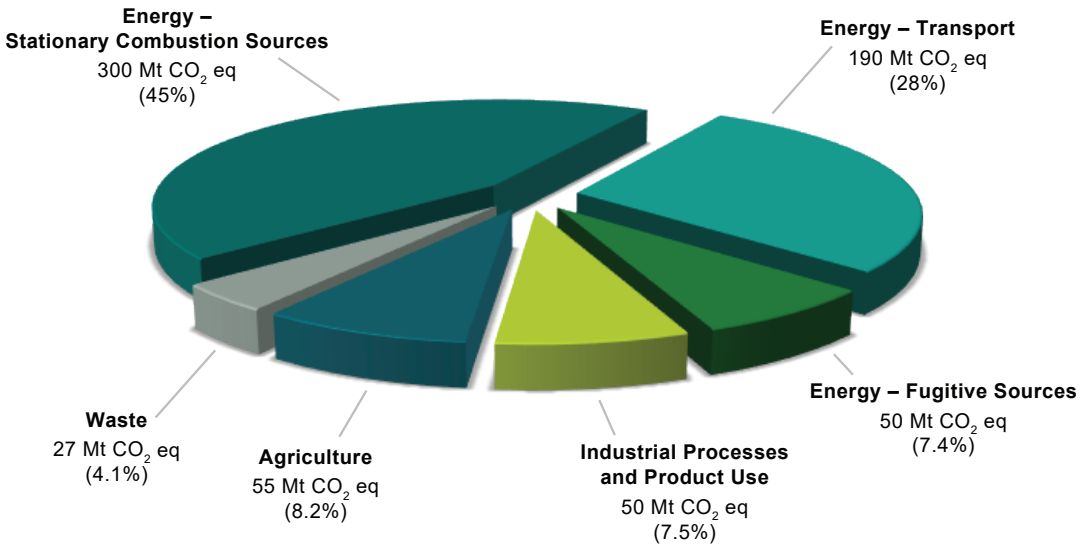
Canada's emissions profile is similar to that of most industrialized countries, in that CO_2 is the largest contributor to total emissions, accounting for 535 Mt or 80% of total emissions in 2020 (Figure ES–3). The majority of CO_2 emissions in Canada result from the combustion of fossil fuels. CH_4 emissions in 2020 amounted to 92 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 mostly arise from agricultural soil management and accounted for 33 Mt or 4.9% of Canada's emissions in 2020. Emissions of synthetic gases (HFCs, PFCs, SF_6 and NF_3) accounted for slightly less than 2% of national emissions.

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

Year	2005	2015	2016	2017	2018	2019	2020
Total GHG (Mt)	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Change since 2005 (%)	NA	-1.2%	-3.5%	-2.2%	-0.2%	-0.4%	-9.3%
GDP[a] (Billion 2012$)	**1 654**	**1 938**	**1 953**	**2 022**	**2 086**	**2 126**	**2 024**
Change since 2005 (%)	NA	17%	18%	22%	26%	29%	22%
GHG Intensity (Mt/$B GDP)	**0.45**	**0.38**	**0.37**	**0.36**	**0.35**	**0.35**	**0.33**
Change since 2005 (%)	NA	-16%	-18%	-20%	-21%	-23%	-26%

Notes:
NA = Not applicable
a. Data source = StatCan (n.d.[a])

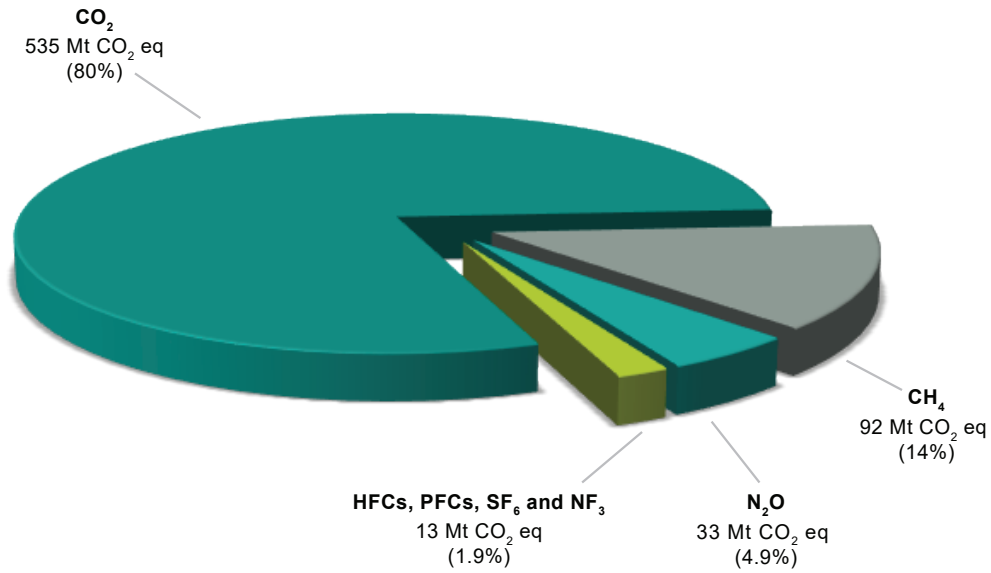
Figure ES–2 **Breakdown of Canada's Emissions by Intergovernmental Panel on Climate Change Sector (2020)**



Note: Totals may not add up due to rounding.

Canada accounted for approximately 1.6% of global GHG emissions in 2018 (Climate Watch, 2021), although it is one of the highest per capita emitters. Canada's per capita emissions have declined since 2005 from 23.0 t CO_2 eq/capita to a new low of 17.7 t CO_2 eq/capita in 2020 (Figure ES–4).

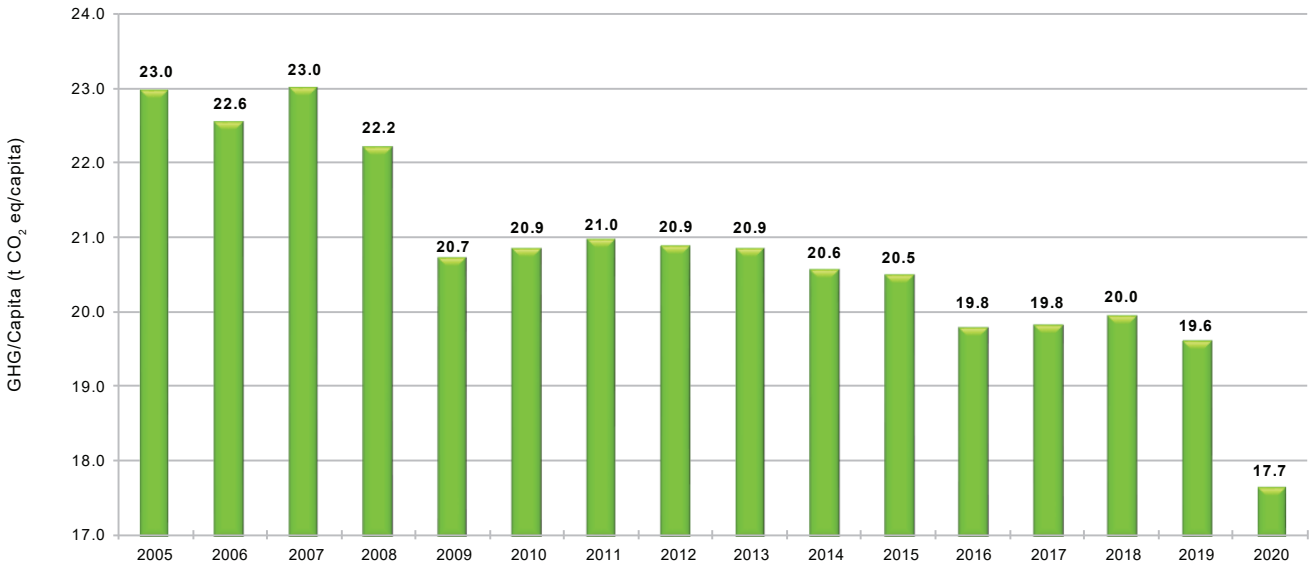
Figure ES–3 **Breakdown of Canada's Emissions by GHG (2020)**



Total: 672 Mt CO_2 eq

Note: Totals may not add up due to rounding.

Figure ES–4 **Canadian per Capita GHG Emissions (2005–2020)**



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 2005–2020 period, total emissions have decreased by 69 Mt or 9.3% (Figure ES–5). Two sources of the Energy sector dominated this trend, with emission decreases of 23 Mt (32%) in Fugitive Sources and 39 Mt (12%) in Stationary Combustion Sources (Table ES–2). Over the same period, emissions have decreased by 6.3 Mt (11%) in the IPPU sector and 1.4 Mt (4.8%) in the Waste sector. Moreover, emissions from Transport (also in the Energy sector) have generally increased from 2005 to 2019 and decreased between 2019 and 2020, bringing the 2020 emissions to a level similar to 2005 (0.07 Mt or 0.0% increase). The Agriculture sector emissions have remained relatively stable with 0.98 Mt or 1.8% increase (Figure ES–6).

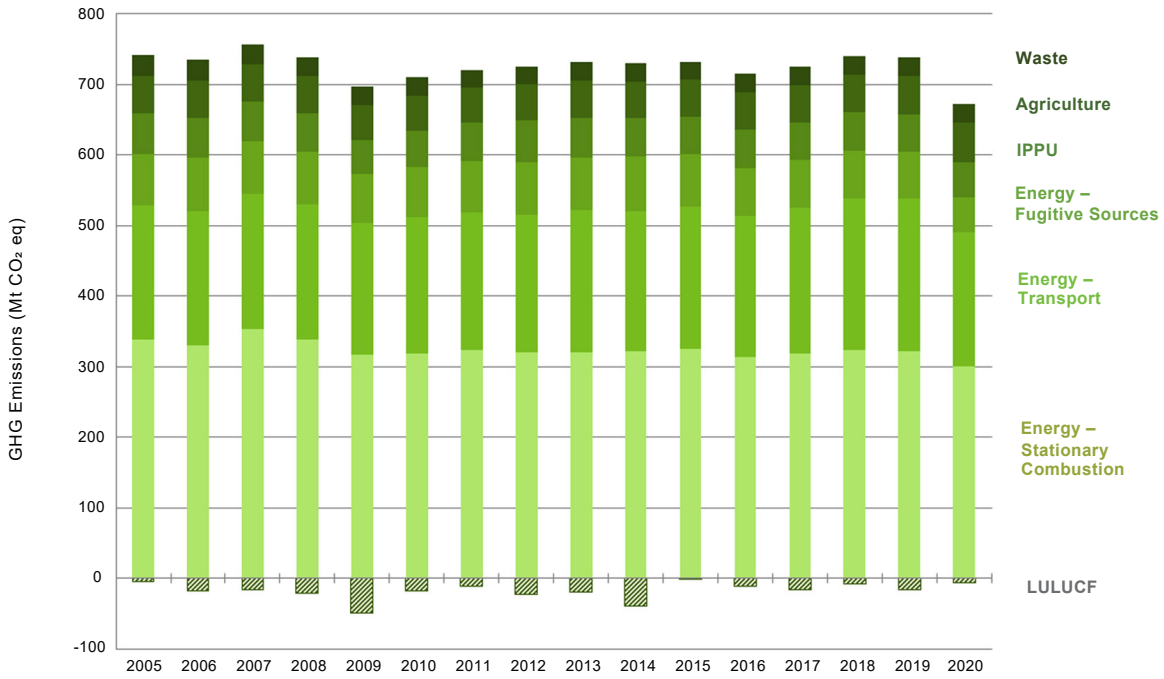
Chapter 2 provides more information on GHG emissions trends since 1990 and 2005 and their drivers.[5] Further breakdowns of emissions and a complete time series can be found at open.canada.ca.

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

Energy – 2020 GHG Emissions (540 Mt)

In 2020, GHG emissions from the IPCC Energy sector (540 Mt), or 80% of Canada's total GHG emissions, were 10% lower than in 2005 (602 Mt). Within the Energy sector, a 37 Mt increase in combustion emissions from Oil and Gas Extraction and a 1.5 Mt increase in Road Transportation emissions were largely offset by a 63 Mt decrease in emissions from Public Electricity and Heat Production, a 9.1 Mt decrease in emissions from stationary fuel consumption in Manufacturing Industries, a 5.6 Mt decrease in emissions from Petroleum Refining and a 5.3 Mt decrease in emissions in the Residential sector.

Figure ES–5 **Trends in Canadian GHG Emissions by Intergovernmental Panel on Climate Change Sector (2005–2020)**



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

Stationary Combustion Sources (300 Mt)

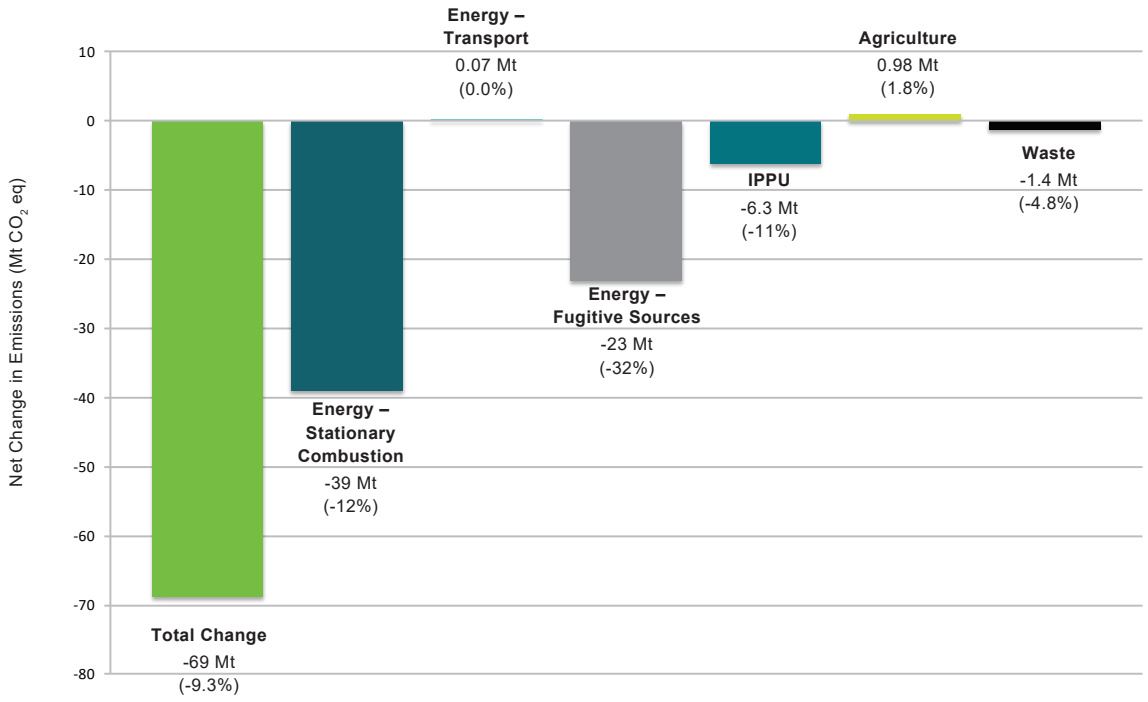
Decreasing electricity generation from coal and oil (decreases of 62% and 86%, respectively) was a large driver of the 63 Mt decrease in emissions associated with Public Electricity and Heat Production between 2005 and 2020. The permanent closure of all coal generating stations in Ontario by 2014 (Ontario Power Generation Inc. [OPG], 2015) accounted for 41% of the decreased coal consumption, and reduced coal consumption in Alberta and Saskatchewan accounted for an additional 45% and 9%, respectively. Reduced coal consumption also occurred in Nova Scotia (25%), New Brunswick (58%) and Manitoba (100%). Decreased oil consumption for electricity generation in New Brunswick (97%) and Nova Scotia (97%), offset by increased consumption in Newfoundland and Labrador (11%), accounted for 98% 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.[6]

The 37 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.

Since 2005, four petroleum refineries have permanently closed or converted to terminal facilities including one each in Ontario (2005), Quebec (2010), Nova Scotia (2013) and Newfoundland and Labrador (2020) contributing to the 5.6 Mt decrease in emissions from this sector.

GHG emissions from Manufacturing Industries decreased by 9.1 Mt between 2005 and 2020, consistent with a 19% decrease in energy use (StatCan, n.d.[c]). This includes a decrease of -5.0 Mt between 2005 and 2019, and an additional -4.5 Mt between 2019 and 2020. While the decrease between 2005 and 2019 is based on decreases in certain sectors (-3.4 Mt from Other Manufacturing, -1.4 Mt in both Cement, and Pulp, Paper and Print), offset by increases in others (1.4 Mt in Chemicals), the decrease between 2019 and 2020 occurred in all Manufacturing Industries. The largest decreases are from Iron and Steel (-1.4 Mt); Other Manufacturing (-1.0 Mt) and Cement (-0.9 Mt).

Figure ES–6 **Changes in GHG Emissions by Intergovernmental Panel on Climate Change Sector (2005–2020)**



6 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.

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

GHG Categories		2005	2015	2016	2017	2018	2019	2020
		Mt CO_2 Equivalent						
TOTAL[a, b]		**741**	**733**	**715**	**725**	**740**	**738**	**672**
ENERGY		**602**	**600**	**581**	**594**	**606**	**604**	**540**
a.	Stationary Combustion Sources	339	325	313	318	323	322	300
	Public Electricity and Heat Production	125	88	81	79	71	70	62
	Petroleum Refining Industries	20	16	16	15	15	16	14
	Oil and Gas Extraction	63	98	94	98	104	104	100
	Mining	4.4	4.6	4.4	5.0	6.5	6.4	6.0
	Manufacturing Industries	48	44	42	43	43	43	39
	Construction	1.4	1.3	1.3	1.3	1.4	1.4	1.4
	Commercial and Institutional	32	30	32	34	36	38	36
	Residential	43	41	38	40	44	41	38
	Agriculture and Forestry	2.2	3.0	3.2	3.1	3.2	3.5	3.1
b.	Transport	190	201	200	208	215	216	190
	Aviation	7.7	7.6	7.5	7.9	8.7	8.6	4.8
	Road Transportation	130	142	145	148	152	153	131
	Railways	6.6	7.1	6.5	7.5	7.6	7.7	7.2
	Marine	4.0	3.4	3.5	3.6	3.8	4.4	4.2
	Other Transportation	42	41	38	41	43	43	43
c.	Fugitive Sources	73	74	68	68	68	66	50
	Coal Mining	1.4	1.1	1.3	1.2	1.3	1.4	1.1
	Oil and Natural Gas	71	73	67	67	67	65	49
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**	**55**	**53**	**54**	**53**	**50**
a.	Mineral Products	10	8.0	7.9	8.6	8.6	8.8	8.1
b.	Chemical Industry	10	6.8	7.0	6.4	6.8	6.7	6.6
c.	Metal Production	20	14	15	15	15	14	13
d.	Production and Consumption of Halocarbons, SF_6 and NF_3	5.1	11	11	11	12	12	12
e.	Non-Energy Products from Fuels and Solvent Use	10	13	12	11	11	11	10
f.	Other Product Manufacture and Use	0.54	0.54	0.60	0.63	0.70	0.66	0.73
AGRICULTURE		**54**	**52**	**53**	**52**	**53**	**53**	**55**
a.	Enteric Fermentation	31	24	24	24	24	24	24
b.	Manure Management	8.7	7.7	7.8	7.9	7.8	7.8	7.8
c.	Agricultural Soils	13	18	18	17	19	19	21
d.	Field Burning of Agricultural Residues	<0.05	0.06	0.05	0.05	0.05	0.05	0.05
e.	Liming, Urea Application and Other Carbon-Containing Fertilizers	1.4	2.6	2.5	2.4	2.6	2.7	3.0
WASTE		**29**	**26**	**26**	**27**	**27**	**27**	**27**
a.	Solid Waste Disposal (Landfills)	23	21	21	21	22	22	22
b.	Biological Treatment of Solid Waste	0.24	0.31	0.32	0.33	0.36	0.36	0.36
c.	Wastewater Treatment and Discharge	1.9	2.6	2.4	2.5	2.5	2.5	2.5
d.	Incineration and Open Burning of Waste	0.35	0.20	0.20	0.19	0.18	0.18	0.16
e.	Industrial Wood Waste Landfills	3.3	2.5	2.4	2.4	2.3	2.2	2.2
LAND USE, LAND-USE CHANGE AND FORESTRY		**- 4.2**	**- 0.08**	**- 11**	**- 17**	**- 8.5**	**- 16**	**- 6.8**
a.	Forest Land	-135	-135	-136	-137	-134	-138	-130
b.	Cropland	-22	-10	-17	-23	-19	-14	-9.6
c.	Grassland	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
d.	Wetlands	3.1	3.0	3.1	3.1	2.8	2.9	2.9
e.	Settlements	1.7	2.5	2.5	2.4	2.2	2.2	2.2
f.	Harvested Wood Products	148	140	137	137	140	131	128

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.

In the Residential category, decreasing consumption of light fuel oil in all provinces and territories, except Newfoundland and Labrador (4% increase) between 2005 and 2020 is the largest driver of the 5.3 Mt decrease in emissions. Quebec and Ontario account for 88% of the decrease in emissions from light fuel oil, with the remaining provinces and territories making up the remaining 12%.

Transport (190 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 transportation emissions is largely due to more driving, exemplified by increases in the supply of diesel, in gasoline retail pump sales, and 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.

From 2005 to 2019, emissions from Transport have generally increased. From 2019 to 2020, Transport emissions decreased 27 Mt, bringing 2020 Transport emissions back to 2005 levels.

Fugitive Sources (50 Mt)

Since 2005, fugitive GHG emissions from fossil fuel production (coal, oil and natural gas) have decreased by 23 Mt. This includes a 6.5 Mt decrease between 2005 and 2019 that is largely the result of provincial regulations to increase conservation of natural gas (comprised mainly of CH_4) as well as a 16.6 Mt decrease between 2019 and 2020 that coincides with federal regulations to reduce methane emissions from the upstream oil and gas industry and equivalent provincial regulations in Saskatchewan, Alberta and British Columbia.

Industrial Processes and Product Use – 2020 GHG Emissions (50 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 50 Mt (7.5%) to Canada's 2020 emissions.

Between 2005 and 2020, process emissions from most IPPU categories decreased. A notable exception is the 6.8 Mt (134%) increase in emissions from the use of HFCs to replace CFCs and HCFCs before the gradual phase down of HFCs mandated under the Kigali Amendment to the Montreal Protocol, which came into force in 2019.

Temporary shut downs of some industrial facilities in 2020 caused process emission decreases of 0.50 Mt (-7.0%) for Cement Production and of 0.15 Mt (-11%) for Lime Production, when compared to the 2019 emission values.

Since 2005, process emissions for the iron and steel industry have reduced by 3.3 Mt (-32%) primarily due to decline in use of metallurgical coke as reductant during the pig iron production process and drop in pig iron production in 2020. The aluminium industry has also decreased its process emissions by 2.8 Mt (32%) 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 accounted for 1.1 Mt (92%) of the overall process emission drop (-7.2 Mt or -36%) seen in Metal Production between 2005 and 2020.

The overall decrease of 3.8 Mt (37%) 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 (1.0 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 an increase in ethylene production in 2016.

Agriculture – 2020 GHG Emissions (55 Mt)

The Agriculture sector covers non-energy GHG emissions related to the production of crops and livestock. Emissions from Agriculture accounted for 55 Mt, or 8.2% of total GHG emissions for Canada in 2020.

In 2020, Agriculture accounted for 30% of national CH_4 emissions and 75% 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 89%, while major livestock populations peaked in 2005, then decreased sharply until 2011. In 2020, emissions from livestock digestion (enteric fermentation) accounted for 43% of total agricultural emissions, and the application of inorganic nitrogen fertilizers accounted for 21% of total agricultural emissions.

Waste – 2020 GHG Emissions (27 Mt)

The Waste sector includes GHG emissions from the treatment and disposal of liquid and solid wastes. Emissions from Waste contributed 27 Mt (4.1%) to Canada's total emissions in 2020 and 29 Mt (3.9%) in 2005.

The primary sources of emissions in 2020 for the Waste sector are disposal in landfills including municipal solid waste (MSW) (22 Mt) and industrial wood waste landfills (2.2 Mt). In 2020, 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 accounted for the remaining 11%.

In 2020, CH_4 emissions from MSW landfills made up 81% of all waste emissions; these emissions decreased by 3.6% between 2005 and 2020. Of the 35 Mt CO_2 eq of CH_4 generated by MSW landfills in 2020, 22 Mt CO_2 eq (62%) were actually emitted to the atmosphere, with a large proportion (30% or 10 Mt CO_2 eq) being captured by landfill gas collection facilities and flared or used for energy, as compared to 25% in 2005.

Land Use, Land-Use Change and Forestry – 2020 (Net GHG Removals of 6.8 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 2020, this net flux amounted to net removals of 6.8 Mt that, when included with emissions from other sectors, decreases Canada's total GHG emissions by 1.0%.

Net removals from the LULUCF sector have varied over recent years fluctuating between removals of 0.1 Mt in 2015 to 49 Mt and 39 Mt in 2009 and 2014, respectively. Fluctuations are driven by the variability in crop yields and by variations in emissions from HWP and removals from Forest Land, which are closely tied to harvest rates.

Estimates from the Forest sector are split between emissions from HWP, emissions and removals resulting from significant natural disturbances on managed forests (wildfires and insects) and anthropogenic emissions and removals associated with forest management activities. The combined net flux from Forest Land and Harvested Wood Products—from forest harvest—fluctuated from a net source of 9.4 Mt in 2005 to a net sink of 22 Mt in 2009 (lowest harvest year), and was observed to be a net sink of 6.5 Mt in 2020. Approximately 33% 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.

Cropland has contributed to net removals in the land sector over the reporting period, with the exception of drought years on the prairies in early 2000s that result in a peak in net emissions in 2003 (7.6 Mt). Interannual variability is high throughout the time series, reflecting weather-related impacts to crop production. Net removals have increased, on average, as a result of improved soil management practices including conservation tillage and an overall gradual increase in crop productivity resulting from increased fertilization and reduced use of summerfallow. Since 2005, the decline in net removals that results from a decrease in perennial land cover has largely offset removals resulting from increasing yields and there is subsequently no clear trend. Recent trends are impacted by peak yields and subsequently peak removals in 2009 (-36 Mt) and 2014 (-44 Mt).

The conversion of forests[7] to other land uses is a prevalent practice in Canada and is mainly due to resource extraction and cropland expansion. Emissions resulting from forest conversion in the years 2005 to 2020 have fluctuated around 16 Mt.

ES.5. Canadian Economic Sectors

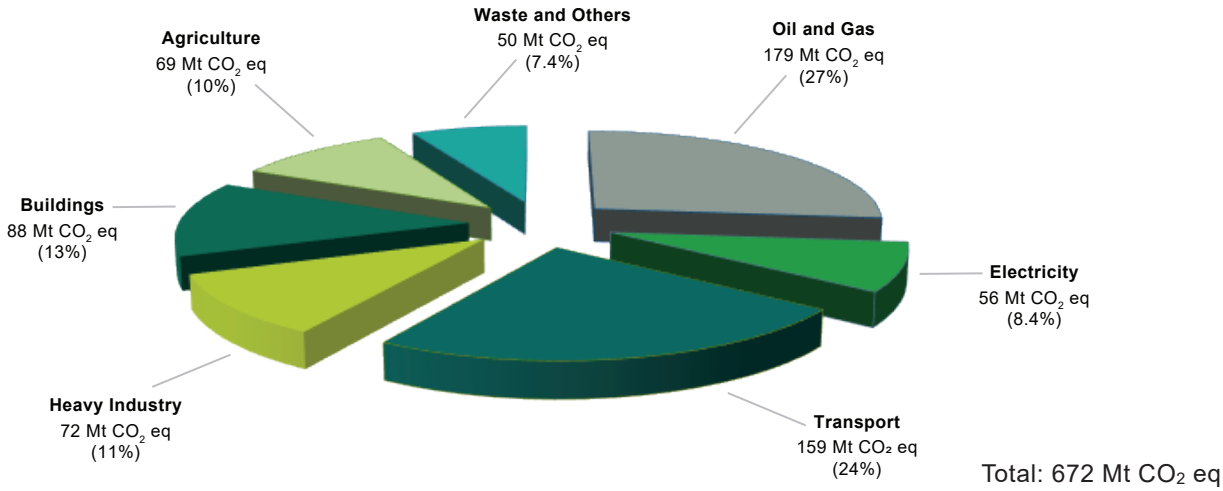
For the purposes of analyzing economic trends and policies, it is useful to allocate emissions to the economic sector from which they originate. In general, a comprehensive emission profile for a specific economic sector is developed by reallocating the relevant proportion of emissions from various IPCC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

7 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.

GHG emissions trends in Canada's economic sectors are consistent with those described for IPCC sectors, with the Oil and Gas and Buildings economic sectors showing emission increases of 7.5 Mt or 4.4% and 4.1 Mt or 4.9%, respectively, since 2005 (Figure ES–7 and Table ES–3). These increases have been more than offset by emission decreases in Electricity (-61 Mt or -52%), Heavy Industry (-15 Mt or -18%), and Waste and others (-5.0 Mt or -9.0%). Since 2005, Transport emissions have generally increased; emissions in 2020 dropped and are comparable to 2005 levels (-0.93 Mt or -0.6% since 2005). Between the years 2019 and 2020, Oil and Gas emissions have decreased significantly (-25 Mt or -12%), coinciding with federal regulations to reduce methane emissions from the upstream oil and gas industry and equivalent provincial regulations in Saskatchewan, Alberta and British Columbia.

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.

Figure ES–7 **Breakdown of Canada's GHG Emissions by Economic Sector (2020)**



Note: Totals may not add up due to rounding.

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

	2005	2015	2016	2017	2018	2019	2020
	Mt CO_2 equivalent						
NATIONAL GHG TOTAL	**741**	**733**	**715**	**725**	**740**	**738**	**672**
Oil and Gas	171	205	194	196	205	203	179
Electricity	118	80	74	73	63	62	56
Transport	160	172	173	179	184	185	159
Heavy Industry[a]	87	78	76	76	77	77	72
Buildings	84	84	82	87	93	92	88
Agriculture[b]	66	65	65	64	66	67	69
Waste and Others[c]	55	50	50	50	51	52	50

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 and Forest Resources.

ES.6. Provincial and Territorial GHG Emissions

Emissions vary significantly by province and territory as a result of such factors 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 higher amounts of GHGs 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 19 Mt (8.2%) 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 55 Mt (27%) since 2005, owing primarily to the closure of the last coal-fired electricity generation plants in 2014.

Quebec's emissions decreased by 10 Mt (12%) between 2005 and 2020 and those in Saskatchewan and British Columbia also decreased by 5.4 Mt (7.6%) and 1.8 Mt (2.9%), respectively, over the same time period. Emissions in Manitoba have increased since 2005, (1.1 Mt or 5.6%). Other provinces that have seen significant decreases in emissions include New Brunswick (7.3 Mt or a 37% reduction), Nova Scotia (8.4 Mt or a 36% reduction), Newfoundland and Labrador (1.0 Mt or a 9.1% reduction) and Prince Edward Island (0.29 Mt or a 15% reduction). Furthermore, emissions in the Northwest Territories have also decreased (0.32 Mt or 19%), and Yukon and Nunavut have seen increases in emissions (0.03 Mt or 5.6%, and 0.02 Mt or 3.2%, respectively).

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; identifying key categories and generating 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).

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 are also available on the Government of Canada's Open Data website at open.canada.ca.

Figure ES–8 **GHG Emissions by Province and Territory in 2005, 2010 and 2020**

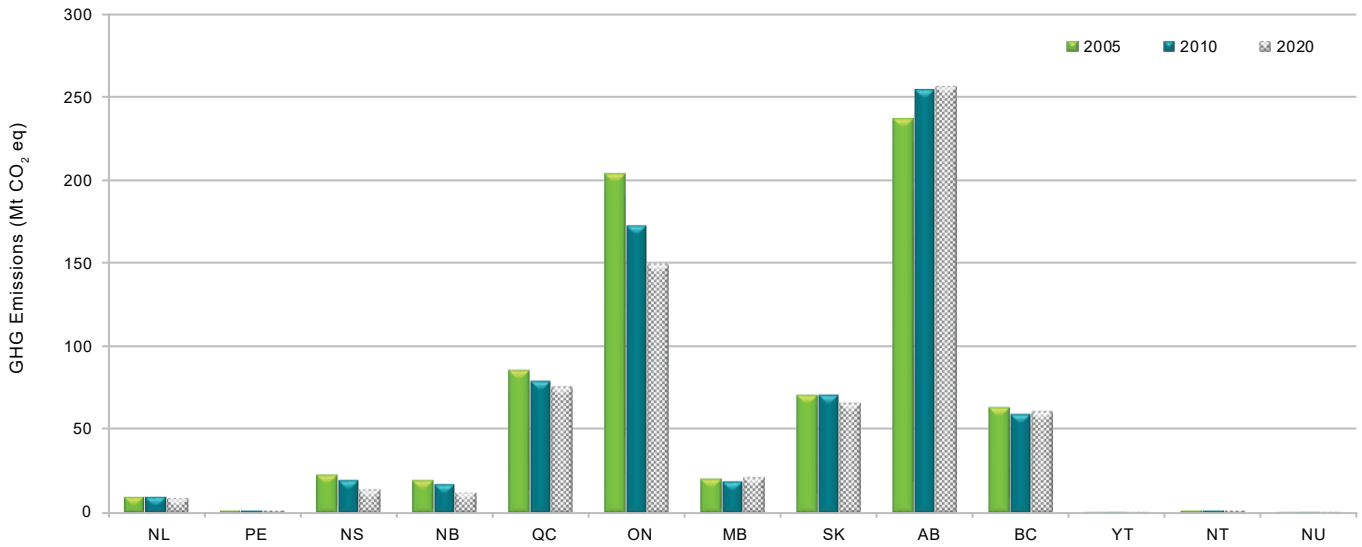


Table ES–4 **GHG Emissions by Province and Territory, Selected Years**

	GHG Emissions (Mt CO_2 eq)							Change (%)
Year	2005	2015	2016	2017	2018	2019	2020	2005–2020
GHG Total (Canada)	**741**	**733**	**715**	**725**	**740**	**738**	**672**	**-9.3%**
NL	10	11	11	11	11	11	9.5	-9.1%
PE	1.9	1.6	1.6	1.6	1.6	1.7	1.6	-15%
NS	23	17	15	16	17	16	15	-36%
NB	20	14	15	14	14	13	12	-37%
QC	86	79	78	80	82	84	76	-12%
ON	204	164	162	159	167	166	150	-27%
MB	21	21	21	22	23	22	22	5.6%
SK	71	79	77	79	80	78	66	-7.6%
AB	237	284	268	276	277	279	256	8.2%
BC	64	60	62	63	66	65	62	-2.9%
YT	0.57	0.53	0.53	0.56	0.65	0.69	0.60	5.6%
NT	1.7	1.6	1.5	1.6	1.6	1.6	1.4	-19%
NU	0.58	0.65	0.74	0.75	0.74	0.73	0.60	3.2%

Note: Totals may not add up due to rounding.

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). [last updated 2021 Nov 30; accessed 2021 Dec 29]. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610036901.

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[StatCan] Statistics Canada. No date (c). Table 25-10-0025-01 (formerly CANSIM 128-0006): Manufacturing industries, total annual energy fuel consumption in gigajoules, 31-33. [accessed 2022 Jan 6]. Available online at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002501.

[UNEP] UN Environment Programme. No date. The Montreal Protocol. [accessed 2021 Jan 8]. Available online at: https://www.unenvironment.org/ozonaction/who-we-are/about-montreal-protocol.