Environment and Climate Change Canada
Environnement et Changement climatique Canada

GREENHOUSE GAS EMISSIONS

CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

Canada

Suggested citation for this document: Environment and Climate Change Canada (2024) Canadian Environmental Sustainability Indicators: Greenhouse gas emissions. Consulted on *Month day, year*. Available at: www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html.

Cat. No.: En4-144/18-2023E-PDF
ISBN: 978-0-660-48131-9
Project code: EC24019

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor Fontaine Building
200 Sacré-Coeur Blvd
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-938-3860
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

GREENHOUSE GAS EMISSIONS

May 2024

Table of contents

List of Figures

List of Tables

Greenhouse gas emissions

Climate change is one of the most important environmental issues of our time. Climate change is caused by the increase in concentrations of greenhouse gases (GHGs) in the atmosphere. These increases are primarily due to GHG emissions resulting from human activities such as the use of fossil fuels. This changing climate has impacts on the environment, human health and the economy. The indicators report estimates of Canada's emissions of GHGs over time.

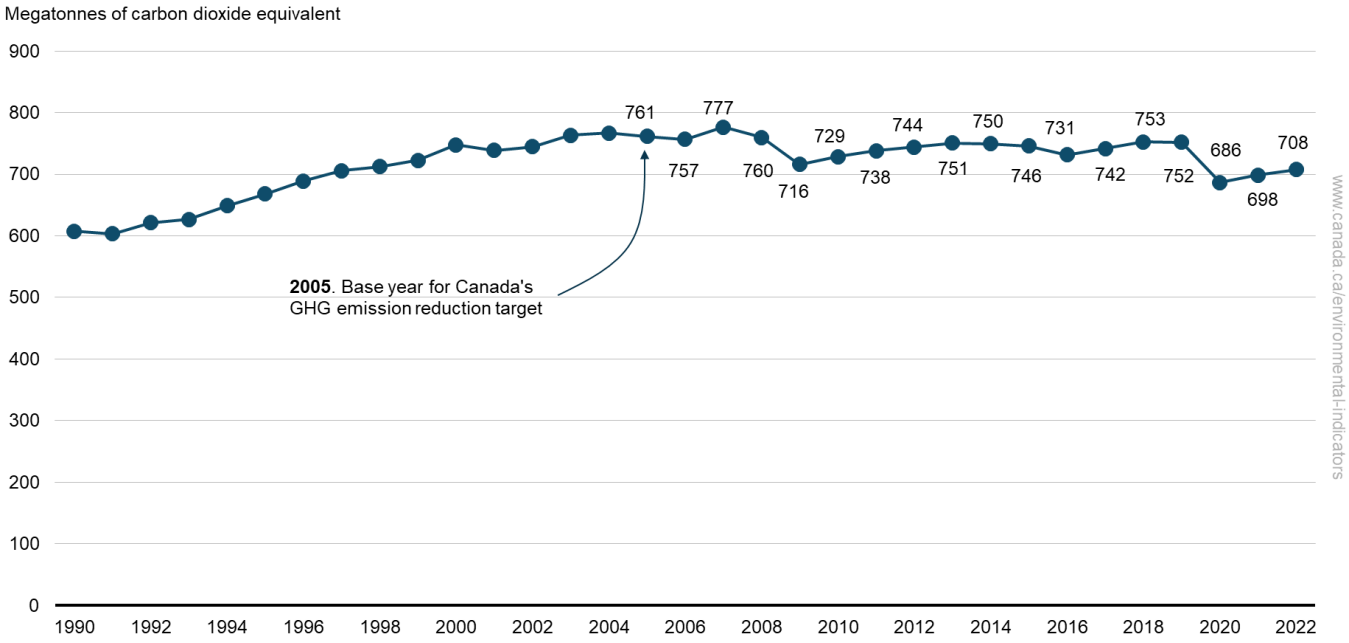
Since 2015 and the signing of the Paris Agreement, Canada adopted 2005 as the base year for its GHG emission reduction target. In 2021, Canada committed to reduce its GHG emissions by 40-45 percent below 2005 levels by 2030. In the 2030 Emissions Reductions Plan, released in March 2022, Canada announced an interim objective to reduce GHG emissions by 20% below 2005 levels by 2026. Historically, following the Kyoto Protocol, the base year was 1990.

National greenhouse gas emissions

Key results

- Canada's total GHG emissions in 2022 were 708 megatonnes of carbon dioxide equivalent (Mt CO_2 eq), a 1.3% increase from 698 Mt CO_2 eq in 2021
- From 2005 to 2022, Canada's GHG emissions decreased by 7.1% (54 Mt CO_2 eq)
- Between 1990 and 2022, Canada's GHG emissions increased by 16.5% (100 Mt CO_2 eq)

Figure 1. Greenhouse gas emissions, Canada, 1990 to 2022



Data for Figure 1

Note: Data are presented as rounded figures. The national indicator tracks 7 greenhouse gases released by human activity: carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons, hydrofluorocarbons and nitrogen trifluoride. Emission levels for some years have been revised in light of improvements to estimation methods and availability of new data. Emissions and removals from the land use, land use change and forestry sector (LULUCF) are excluded from national totals to allow for a focus on greenhouse gas released from human activity only. Consult the interactive figures to explore the national results in a dynamic and customizable format.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

While the overall trend between 1990 and 2022 was an increase in GHG emissions, some sectors saw a decrease. Canada's overall emissions growth over the 1990 to 2022 period was driven primarily by increased

emissions from the oil and gas as well as the agriculture and transport sectors. The 7.1% decrease in GHG emissions between 2005 and 2022 was mainly a result of emission reductions from the electricity and heavy industry sectors.

The effects of the pandemic created an industrial slowdown and significant reductions in trade and travel by air and land. These impacts contributed to the GHG emission decrease, especially in the transport sector where a 16% decrease was observed between 2019 and 2020. Following the partial recovery of economic activities in 2021, a rebound in emissions was observed compared to 2020 (+12 Mt CO_2 eq) and a continuing increase in emissions in 2022 (+9 Mt CO_2 eq). The emissions observed in 2022 remained below the pre-pandemic level of 2019.

According to the greenhouse gas equivalencies calculator developed by Natural Resources Canada, the 54 Mt CO_2 eq emission reduction for the period from 2005 to 2022 is equivalent to:

- removing around 16 500 000 gas-powered passenger vehicles from the roads for 1 year, or
- the energy-based emissions from around 12 600 000 homes for 1 year

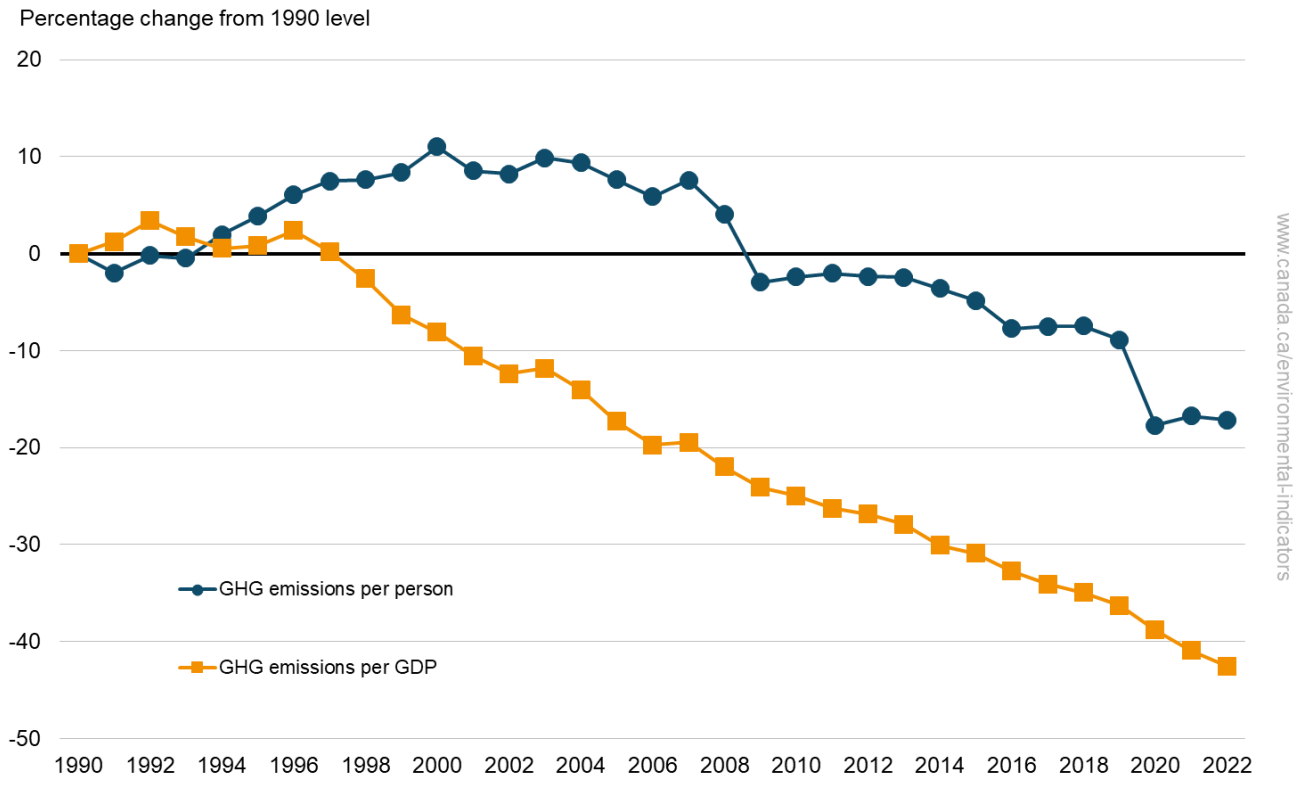
Greenhouse gas emissions per person and per unit of GDP

While the overall value of GHG emitted is important to measure, the relationship between GHG emissions and economic activity and/or population is useful to monitor the transition to a low-carbon economy. These indicators present the GHG emission intensities relative to Canada's population and its economic activity. GHG emission intensity compares the amount of GHGs emitted per unit of activity or any other specific metric. Decreasing trends mean that less GHGs are emitted for one unit of the selected metric.

Key results

- Between 1990 and 2022, the amount of GHGs emitted per person decreased 17% from 21.9 to 18.2 tonnes of carbon dioxide equivalent (CO_2 eq) per person
- Over the same period, 43% less GHGs were emitted to produce 1 billion dollars worth of goods and services (from 0.53 to 0.30 megatonnes CO_2 eq per billion dollars of GDP)

Figure 2. Indexed trend in greenhouse gas emissions per person and per unit of GDP, Canada, 1990 to 2022



Data for Figure 2

Note: The chart presents the ratio of annual GHG emissions per person and per unit of GDP relative to those values in 1990 (that is the values are indexed to 1990). Greenhouse gas emissions per unit of GDP is calculated using real inflation-adjusted GDP in 2017 dollars. Emission levels for some years have been revised in light of improvements to estimation methods and availability of new data.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada. Statistics Canada (2024) Table 17-10-0005-01 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual. Statistics Canada (2024) Table 36-10-0369-01 - Gross domestic product, expenditure-based, at 2017 constant prices, annual.

The general decreasing trends in GHG emissions per person and per unit of GDP are attributable to a number of factors. More efficient industrial processes, a shift to a more service-based economy and a decrease in the emissions associated with electricity generation are all contributing to these decreases.

Between 2021 and 2022, both GHG emissions per person and GHG emissions per unit of GDP decreased, with -0.5% and -2.7%. This corresponds to GHG emissions increasing at a lower rate than population and GDP growth.

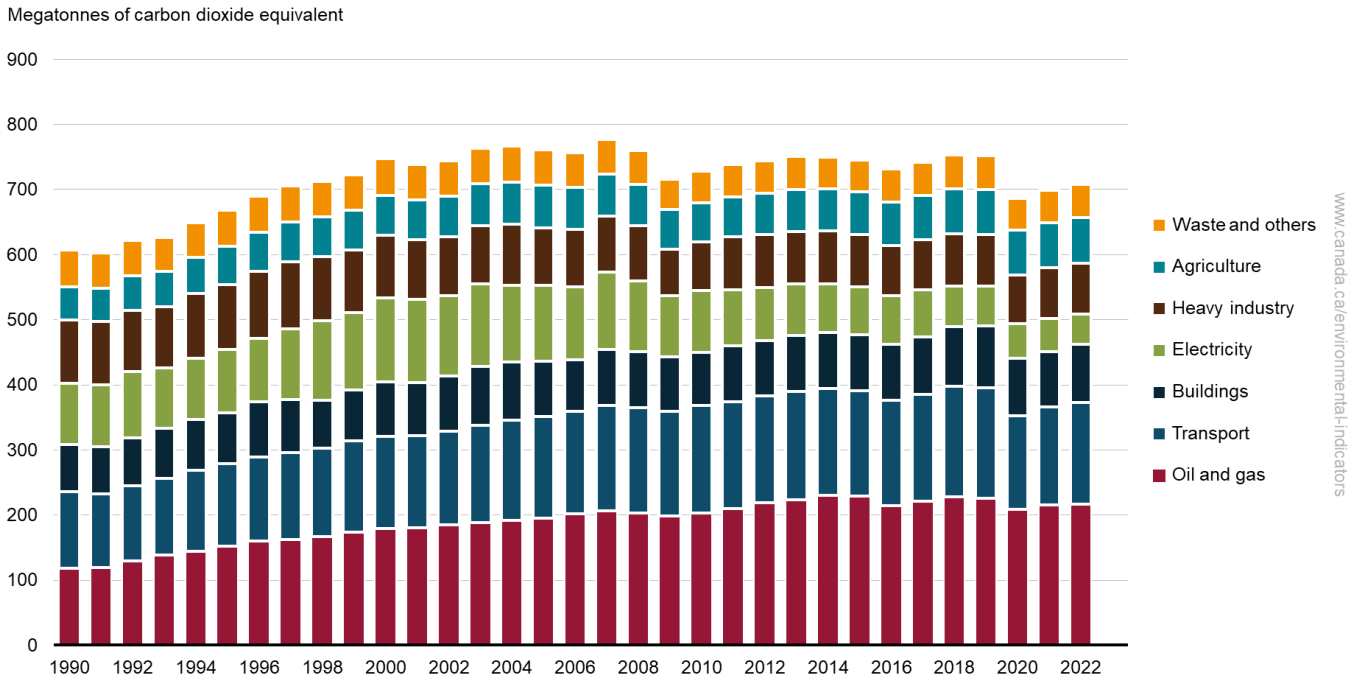
Greenhouse gas emissions by economic sector

This indicator shows GHG emissions reported by the economic sector in which they are generated. Indicators focusing specifically on the oil and gas, transport, agriculture and electricity sectors follow.

Key results

- In 2022, the oil and gas sector and transport sector were the largest GHG emitters in Canada, accounting for 31% and 22% of total emissions, respectively
- From 2021 to 2022, except for the electricity sector (-7.7%), GHG emissions from all sectors grew by 0.3% to 4.2%
- From 1990 to 2022:
    - an increase in emissions was observed for the oil and gas (+83%), transport (+33%), buildings (+23%) and agriculture sectors (+39%)
    - a decrease in emissions was observed for the electricity (-50%), heavy industry (-19%) and "waste and others" (-12%) sectors

Figure 3. Greenhouse gas emissions by economic sector, Canada, 1990 to 2022



Data for Figure 3

Note: "Others" in the Waste and others sector consists of emissions from light manufacturing, construction, forest resources and coal production. The Heavy industry sector consists of emissions from mining, smelting and refining, pulp and paper, iron and steel, cement, lime and gypsum, and chemicals and fertilizers. Consult the interactive figures to explore the sectoral results in a dynamic and customizable format.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Between 1990 and 2022, the increase in total GHG emissions observed was mostly due to a 83% (99 Mt CO_2 eq) increase in emissions from the oil and gas sector and a 33% (38 Mt CO_2 eq) increase from the transport sector. These increases were partially offset by a 47 Mt CO_2 eq decrease in emissions from the electricity sector and a 19 Mt CO_2 eq decrease in emissions from heavy industry.

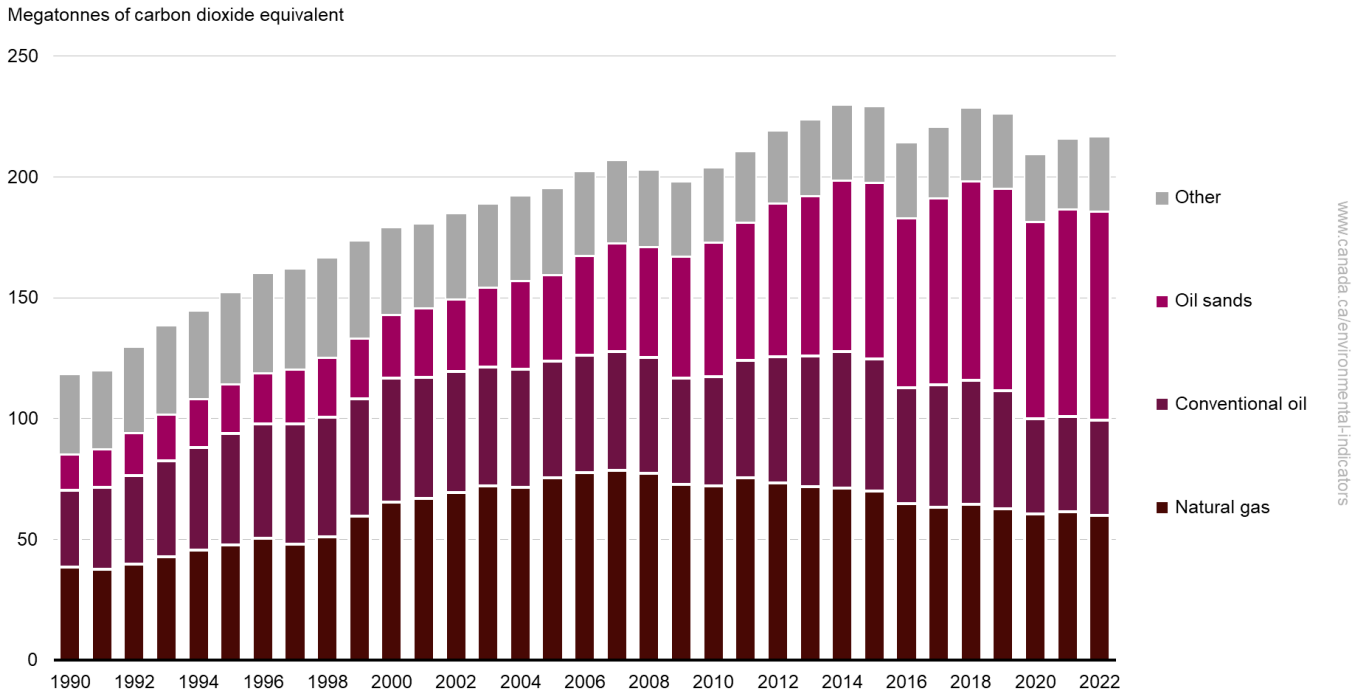
Between 2005 and 2022, the overall 54 Mt CO_2 eq decrease resulted mainly from a 69 Mt CO_2 eq. (-59%) reduction in emissions from the electricity sector and a 10 Mt CO_2 eq. (-11%) reduction from the heavy industry sector. Over that period, GHG emissions have also decreased for the waste and others (-8%) sectors, while emissions increased for the oil and gas (+11%), agriculture (+7%) and buildings (+5%) sectors. Emissions from the transport showed limited variation with a +0.1 Mt CO_2 eq change.

Greenhouse gas emissions from the oil and gas sector

Key results

- In 2022, the oil and gas sector was Canada's largest source of GHG emissions, accounting for 31% of total national emissions with 217 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) emitted
- In 2022, the sector's GHG emissions were 0.4% higher than in 2021
- Over the period from 1990 to 2022, the sector's GHG emissions have increased by 83%

Figure 4. Oil and gas sector greenhouse gas emissions, Canada, 1990 to 2022



Data for Figure 4

Note: Conventional oil includes production from frontier, light and heavy oil fields. The Other category includes downstream oil and gas emissions (combustion and fugitive emissions from the production of refined petroleum products and the distribution of natural gas to end consumers) and oil, natural gas and CO_2 transmission emissions (combustion and fugitive emissions from transmission, storage and delivery activities).
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Between 1990 and 2022, total crude oil production more than doubled in Canada. This was mostly driven by a rapid increase in production from the oil sands, which are more GHG-intensive than conventional sources (that is, more GHGs are emitted per unit cubic meters of oil produced). This change thus had a major impact on total GHG emissions from the sector.

From 1990 to 2022, GHG emissions from conventional oil production have increased by 24%, while emissions from oil sands production have increased by 467%. More than half of the increase in emissions from oil sands production over this period came from the growth of on site (*in situ*) production. Over the same period, GHG emissions related to the production of natural gas from unconventional sources, such as those requiring the use of multi-stage fracturing techniques, also increased significantly (+56%).

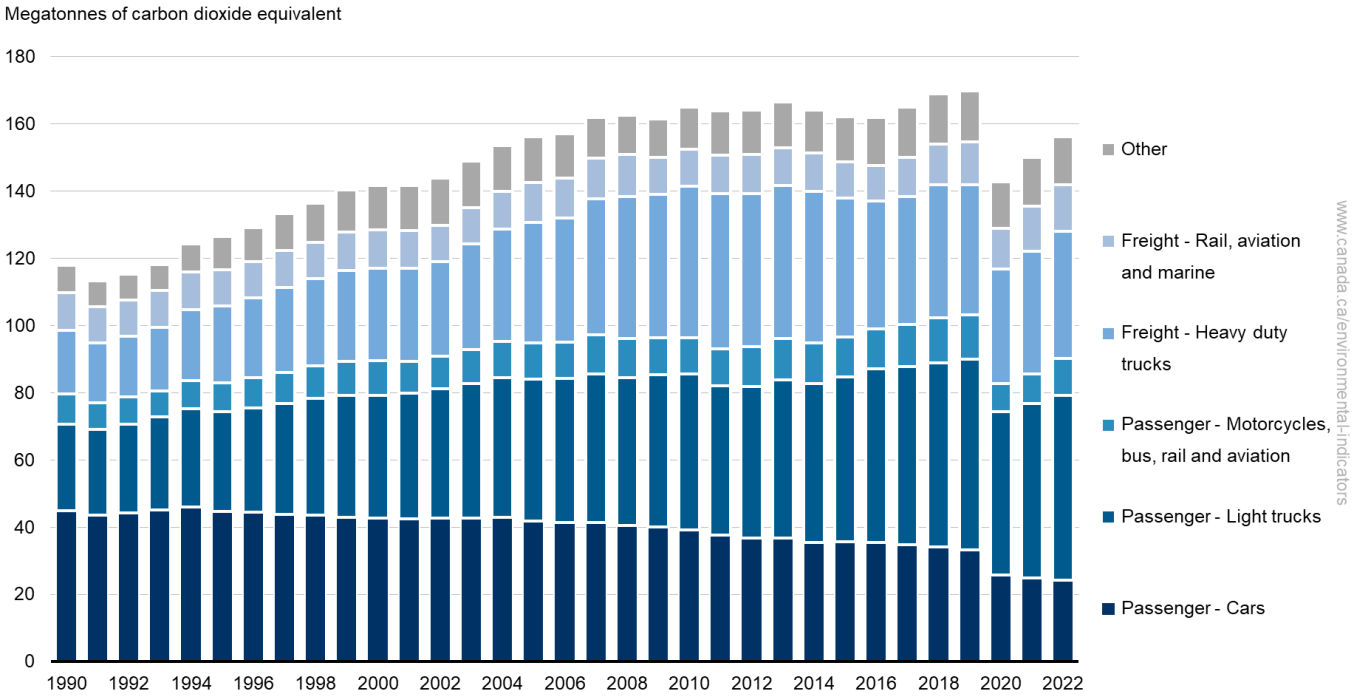
From 2005 to 2022, emissions from the oil and gas industry increased by 11% . However, emissions from natural gas and conventional oil production decreased by 20% and 19%, respectively. Emissions from those activities have shown decreasing trends in the past decade.

Greenhouse gas emissions from the transport sector

Key results

- In 2022, the transport sector was the second largest source of GHG emissions, accounting for 22% of total national emissions with 156 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) emitted
- In 2022, the sector GHG emissions were 4.2% higher than in 2021 (+6.2 Mt CO_2 eq)
- Between 1990 and 2022, GHG emissions from the transport sector grew by 33%. The growth in emissions was mostly driven by increases from freight heavy-duty trucks and passenger light trucks

Figure 5. Transport sector greenhouse gas emissions, Canada, 1990 to 2022



Data for Figure 5

Note: The Other category includes other recreational, commercial and residential uses. Categories have been adapted from the classification used in Annex 10 of the National Inventory Report. For more details, please consult the "Methods" section.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Between 1990 and 2022, part of the GHG emissions increase was due to a higher number of vehicles on the road and to changes in vehicle type used. Although total emissions from passenger transport grew by 13%, emissions from cars declined by 47%, while emissions from light trucks (including trucks, vans and sport utility vehicles) more than doubled. Emissions from freight transport grew by 72% between 1990 and 2022. Specifically, emissions from freight heavy-duty trucks doubled and emissions from other modes of freight transport increased by 23%.

Emissions from passenger and freight transport are influenced by a variety of factors, including population and economic growth, vehicle type, fuel efficiency and fuel type. Changes in the mix of vehicle type used, such as the increasing preference of passenger vehicle owners for light trucks rather than more fuel-efficient passenger cars, played an important role in shaping the evolution of GHG emissions.

Since 1990, the number of light trucks increased much faster than the increase of other passenger on-road vehicles. While there have been continual improvements in the fuel efficiency of both passenger cars and light

trucks over the last few decades,[1] these improvements were not sufficient to offset the increases in emissions due to the change in composition of the vehicle fleet.

Between 2005 and 2022, GHG emissions from the transport sector remained stable at 156 Mt CO_2 eq. However, emissions increased by 14 Mt CO_2 eq. between 2005 and 2019 before being more than completely offset by a 27 Mt CO_2 eq. reduction between 2019 and 2020. This is the highest annual decrease since 1990 and was influenced by the impacts of the COVID-19 pandemic on the transport sector (fewer kilometres driven and a decrease in air traffic). Between 2020 and 2022, emissions from the transport sector increased by 13 Mt CO_2 eq. following recovery of economic activities and the resumption of travel. Note that GHG emissions from the passenger travels in 2022 were still below pre-pandemic levels, while emissions from freight transport were above.

[1] Natural Resources Canada (2023) Energy efficiency for transportation and alternative fuels.

Greenhouse gas emissions from the agriculture sector

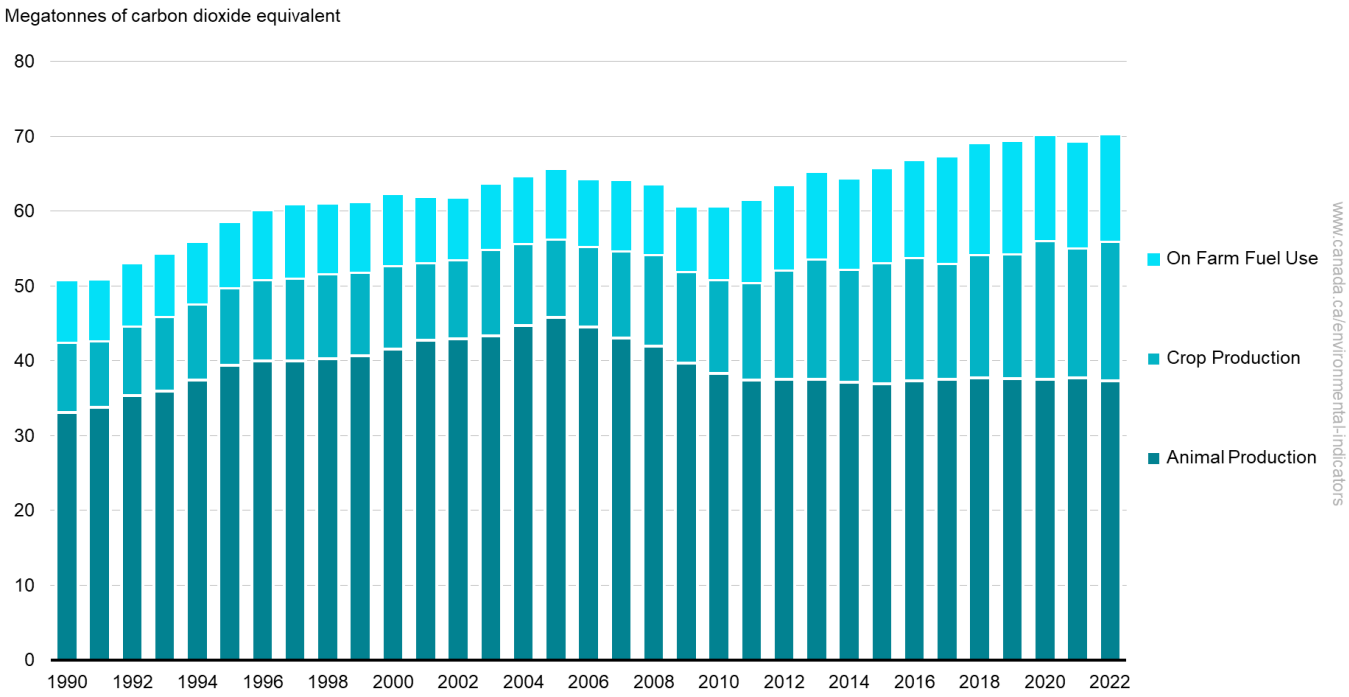
Greenhouse gas emissions from the agriculture sector are essentially attributable to the crop production (such as cereals and oilseeds), and animal production (beef, dairy, poultry and swine). Activities resulting in emissions include:

- Crop production: application of biosolids and inorganic nitrogen fertilizers, decomposition of crop residues, loss of soil organic carbon, cultivation of organic soils, indirect emissions from leaching and volatilization, field burning of agricultural residues, liming, and urea application
- Animal production: animal housing, manure storage, manure deposited by grazing animals, and application of manure to managed soils

Key results

- In 2022, the agriculture sector was the 5th largest source of GHG emissions, accounting for 10% of total national emissions with 70 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) emitted
- In 2022, the sector's GHG emissions were 1.4% higher than in 2021, mostly driven by an increase in crop production emissions
- Between 1990 and 2022, GHG emissions from the agriculture sector grew by 39%, mostly driven by an increase in crop production emissions

Figure 6. Agriculture sector greenhouse gas emissions, Canada, 1990 to 2022



Data for Figure 6

Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Between 1990 and 2022, emissions increased from 51 Mt CO_2 eq to 70 Mt CO_2 eq. This increase is primarily attributable to the doubling of crop production emissions. Even though emissions from animal production have always represented at least half of the total agriculture GHG emissions, since 2005, the proportion of emissions from crop production has risen, reaching its highest level in 2020. The drivers of the change are a reduction of cattle populations combined with a continued increase of crop production and fertilizer use.

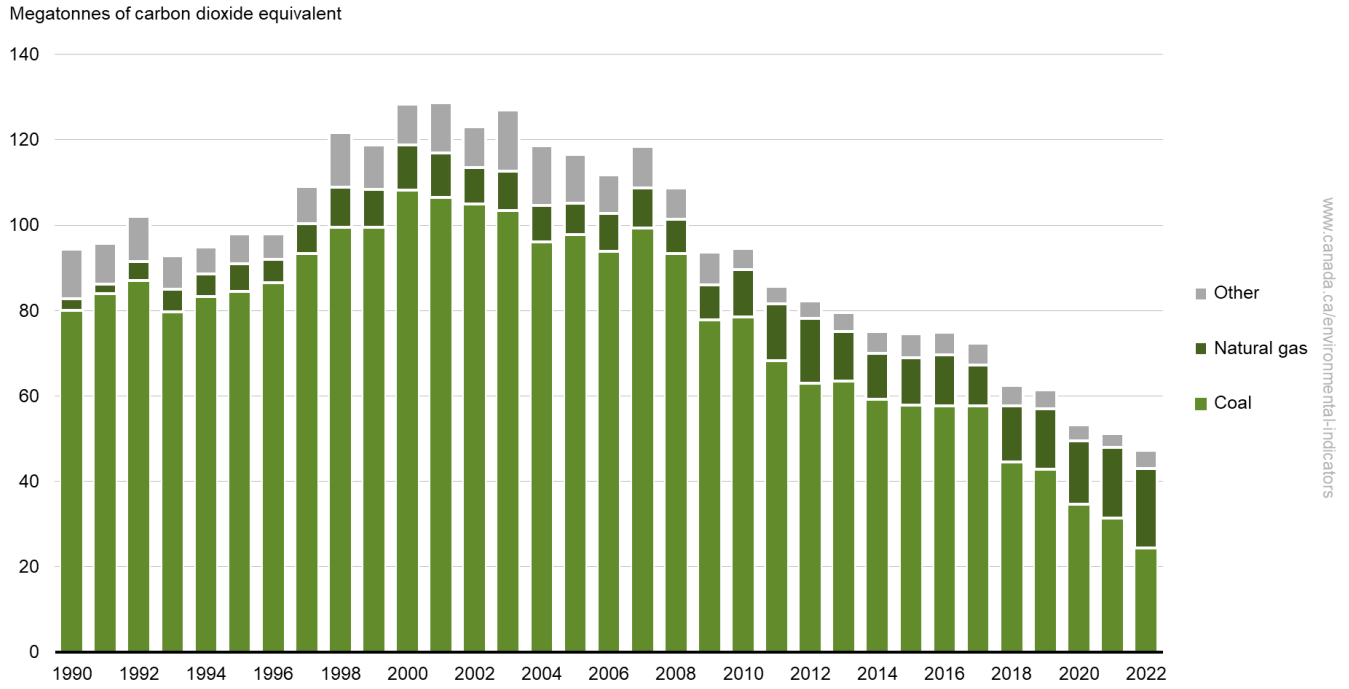
Between 2005 and 2022, GHG emissions from the agriculture sector showed a similar trend with an increase of 7%.

Greenhouse gas emissions from the electricity sector

Key results

- In 2022, the electricity sector was the 7th largest source of GHG emissions, accounting for 6.7% of total national emissions with 47 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) emitted
- In 2022, the sector's GHG emissions were 8% lower than in 2021, 59% lower than in 2005, and 50% lower than in 1990

Figure 7. Electricity sector greenhouse gas emissions, Canada, 1990 to 2022



Data for Figure 7

Note: The Other category includes diesel fuel oil, heavy fuel oil, light fuel oil, motor gasoline, petroleum coke, own use of primary electricity, solid wood waste, still gas and non-fuel related emissions.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Greenhouse gas emissions from combustion-based electricity generation have decreased from 94 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) in 1990 to 47 Mt CO_2 eq in 2022. The growing share of electricity generated from low-GHG-emitting sources (such as hydro, other renewables and nuclear) and from fuels less GHG-intensive than coal contributed to the decline in GHG emissions from electricity generation. This transition can be observed in the fuel type shares, with coal's share of all combustion emissions having decreased from 85% in 1990 to 52% in 2022, while natural gas' share increased from 3% to 39%. Similar trends were observed between 2005 and 2022, leading to a 59% decrease from 117 Mt CO_2 eq. to 47 Mt CO_2 eq.

Electricity generation technologies have various levels of GHG emission intensity (which is defined as the quantity of GHGs emitted per unit of electricity produced). Hydroelectricity and nuclear power are low emitters of GHGs, while coal-burning power plants have a higher GHG intensity than natural gas-burning power plants. The general decline in the GHG intensity of electricity generation of public electric utilities can be attributed partly to a reduction in the use of coal and increases in other power plant types.

The electricity sector's GHG emissions were 8% lower in 2022 than in 2021. This decrease is mainly driven by the decommissioning of 2 coal-burning power plants in Alberta in 2021.

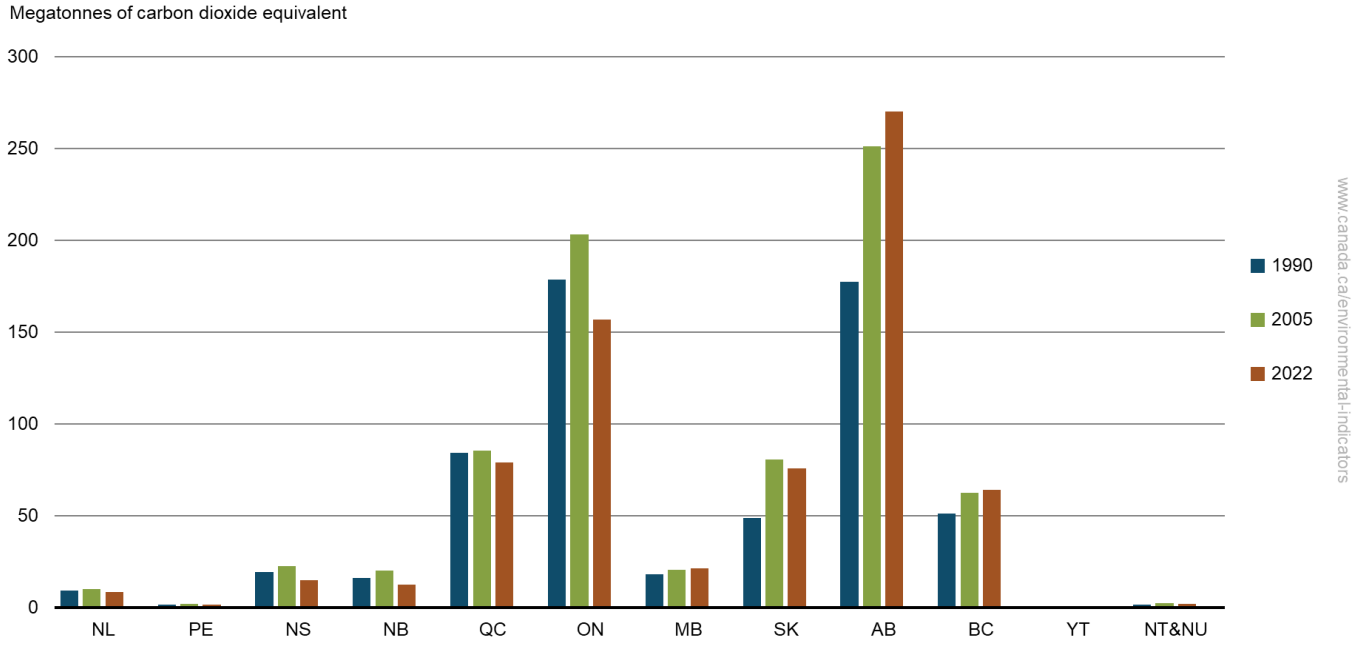
Greenhouse gas emissions by province and territory

Emissions vary significantly by province. The level of emissions depends on factors such as population, climate, energy sources and economic base. Provinces and territories that are the most populated, have economies based on resource extraction, or rely on fossil fuels to generate electricity will tend to have higher emission levels.

Key results

- In 2022, the top 5 emitters (Alberta, Ontario, Quebec, Saskatchewan and British Columbia) together released 91% of Canada's national total GHG emissions
- Of the top 5 emitters, GHG emissions were lower in 2022 than in 1990 for Ontario (-12%) and Quebec (-6%)

Figure 8. Greenhouse gas emissions by province and territory, Canada, 1990, 2005 and 2022



Data for Figure 8

Note: The years selected correspond to the first (1990) and last (2022) years of the dataset and to the base year (2005) for Canada's GHG emission reduction targets. Consult the interactive figures to explore the regional results in a dynamic and customizable format.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Between 1990 and 2005, GHG emissions increased in all provinces and territories. In 1990, Ontario's emissions were higher than those from the other provinces because of its large manufacturing industry. Alberta's emissions subsequently surpassed Ontario's and increased by 52% over the period from 1990 to 2022, primarily due to the increasing activity of the oil and gas industry.

Of the top 5 emitters, GHG emissions were lower in 2022 than in 2005 for Ontario (-23%), Quebec (-8%), and Saskatchewan (-6%). The main drivers for the decreases are presented below.

- Ontario's emissions decrease was primarily driven by the closure of coal-fired electricity generation plants
- Quebec had a 6.5 Mt CO_2 eq decrease from its 2005 emissions level mainly attributable to decreasing emissions from the residential sector, aluminium production and petroleum refining industries
- Emissions in Saskatchewan decreased by 4.6 Mt CO_2 eq; primarily due to emission reductions from the oil and gas sector (-28% or 10.7 Mt CO_2 eq)

Over the first year of the pandemic, from 2019 to 2020, a reduction in GHG emissions was observed for all provinces and territories. From 2020 to 2022, emissions from most provinces and territories increased, except in

Newfoundland and Labrador. Emission levels in 2022 were below the pre-pandemic levels observed in 2019 with the exception of British Columbia.

About the indicators

What the indicators measure

These indicators show trends in anthropogenic (human-made) greenhouse gas (GHG) emissions. This includes emissions for 7 greenhouse gases (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons, hydrofluorocarbons and nitrogen trifluoride). Emissions are presented:

- at the national level (total emissions, emissions per person and emissions per unit of gross domestic product)
- by economic sector
- at the provincial/territorial level

The indicators do not capture:

- emissions from natural processes (for example, material decay, plant and animal respiration, volcanic and thermal venting)
- removal of emissions from the atmosphere by natural sinks (for example, forests, oceans)

Why these indicators are important

Greenhouse gases trap heat in the Earth's atmosphere, just as the glass of a greenhouse keeps warm air inside. Human activity increases the amount of GHGs in the atmosphere, contributing to a warming of the Earth's surface. This is called the enhanced greenhouse effect.

Over the past 200 years in particular, humans have released GHGs into the atmosphere primarily from burning fossil fuels. As a result, more heat is being trapped and the temperature of the planet is increasing. Sea levels are rising as the Arctic ice melts, and there are changes to the climate, such as more severe storms and heat waves. All of this impacts the environment, the economy and human health.

The Greenhouse gas emissions indicators are used to track the progress of Canada's efforts to lower emissions and reach environmental performance objectives. They also support decision making on sustainable development.

As a signatory to the United Nations Framework Convention on Climate Change and the Paris Agreement, Canada is required to prepare and submit a national inventory of anthropogenic sources and sinks of GHGs on an annual basis.

Related initiatives

These indicators track progress on the 2022 to 2026 Federal Sustainable Development Strategy, supporting the target: Achieve 40 to 45% greenhouse gas emission reductions below 2005 levels by 2030, and achieve net-zero greenhouse gas emissions by 2050. The most recent data available shows that, in 2022, emissions were 7.1% lower than 2005 emissions. This decrease was driven by emission reductions from the electricity and heavy industry sectors.

In addition, the indicators contribute to the Sustainable Development Goals of the 2030 Agenda for Sustainable Development. They are linked to Goal 9, Industry, Innovation and Infrastructure and Goal 13: "Climate Action"; more specifically to Target 9.4, "By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities" and Target 13.2, "Integrate climate change measures into national policies, strategies and planning."

Related indicators

The Greenhouse gas emissions from large facilities indicator reports GHG emissions from the largest GHG emitters in Canada (industrial and other types of facilities).

The Greenhouse gas emissions projections indicator provides an overview of Canada's projected GHG emissions up to 2035.

The Global greenhouse gas emissions indicator provides a global perspective on Canada's share of global GHG emissions.

The Carbon dioxide emissions from a consumption perspective indicator shows the impact of Canada's consumption of goods and services, regardless of where they are produced, on the levels of carbon dioxide released into the atmosphere.

The Land-based greenhouse gas emissions and removals indicator tracks exchanges of greenhouse gas emissions and removals between the atmosphere and Canada's managed lands.

The Greenhouse gas concentrations indicators present atmospheric concentrations as measured from sites in Canada and at a global scale for 2 greenhouse gases: carbon dioxide and methane.

Data sources and methods

Data sources

The Greenhouse gas emissions indicators are based on greenhouse gas (GHG) emissions data taken from Environment and Climate Change Canada's National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

More information

Data used to develop the emission and removal estimates presented in the National Inventory Report are drawn from published and unpublished sources from various government departments, industry sources and scientific papers.

Greenhouse gas emission estimates are provided at the national level, by activity sectors as defined by the Intergovernmental Panel on Climate Change, by economic sectors and at the provincial/territorial level. The greenhouse gas emission estimates are compiled annually and reported for the period from 1990 to 2022. Complete details of the temporal coverage for each data source used for the indicators can be found in chapters 3 through 7 of the National Inventory Report.

Preparation of the GHG emissions inventory takes almost 16 months from the end of the reporting year because of the time needed to collect, validate, calculate and interpret the data. Between November and January, emission estimates are prepared by Environment and Climate Change Canada's Pollutant Inventories and Reporting Division with input from numerous experts and scientists across Canada. From January through March, the National Inventory Report text and accompanying emissions data tables are developed. This material is reviewed by external experts and Environment and Climate Change Canada officials, and finally submitted electronically to the United Nations Framework Convention on Climate Change, by mid-April.

Methods

The National Inventory Report estimates the emissions by combining activity data with the activity's emissions factor. It provides estimates at a sectoral and provincial/territorial level without attribution to individual emitters. The emissions estimates are developed using guidelines produced by the Intergovernmental Panel on Climate Change. Annex 3 of the National Inventory Report describes the methods used to estimate Canada's GHG emissions.

More information

Since direct measurement of emissions from all sources is not possible, the reporting requirements demand that countries develop, update, publish and maintain national inventories using internationally

approved and comparable emissions and removals estimation methods for 7 GHGs (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons, hydrofluorocarbons and nitrogen trifluoride). Canada's inventory is developed in accordance with the Modalities, procedures and guidelines for the Enhanced Transparency Framework of the Paris Agreement which require the use of the 2006 methodological guidance developed by the Intergovernmental Panel on Climate Change. The Intergovernmental Panel on Climate Change guidelines are based on the best available science and developed through an international process that involves testing of methods through ongoing inventory development, country studies, technical and regional workshops, and national and international experts consultations.

Emissions calculation

In general, GHG emissions are estimated by multiplying activity data by the associated emission factor.

Emissions = activity data × emission factor

Activity data refer to the quantitative amount of human activity resulting in emissions during a given time period. The annual activity data for fuel combustion sources, for example, are the total amounts of fuel burned over a year.

Emission factors are based on samples of measurement data, and are representative rates of emissions for a given activity level under a given set of operating conditions. It is the estimated average emission rate of a given pollutant for a given source, relative to units of activity.

Guidelines produced by the Intergovernmental Panel on Climate Change for countries reporting to the United Nations Framework Convention on Climate Change provide various methods for calculating GHG emissions from a given human activity. The methods for estimating emissions are divided into "tiers," each encompassing different levels of activity and technological detail. The same general structure is used for all tiers, while the level of detail at which the calculations are carried out can vary. Annex 3 of the National Inventory Report describes the methods used to estimate Canada's GHG emissions and illustrates that the selection of Intergovernmental Panel on Climate Change method type is highly dependent on the importance of each category and the availability of data. Annex 6 of the National Inventory Report presents the emission factors (EF) used to estimate Canada’s GHG emissions.

Carbon dioxide equivalents

Greenhouse gas emissions are reported in carbon dioxide equivalents (CO_2 eq), determined by multiplying the amount of emissions of a particular greenhouse gas by the global warming potential of that gas. Greenhouse gases differ in their ability to absorb heat in the atmosphere due to their differing chemical properties and atmospheric lifetimes. For example, over a period of 100 years, methane's potential to trap heat in the atmosphere is 28 times greater than carbon dioxide's potential. Therefore, methane is considered to have a global warming potential of 28.

The Intergovernmental Panel on Climate Change (IPCC) publishes the global warming potentials and atmospheric lifetimes for each GHG; these can be found in Table 1-1 of the National Inventory Report. Note that the global warming potentials in this indicator have been updated and now correspond to the values as presented in IPCC’s Fifth Assessment Report. In previous editions, global warming potentials from the Fourth Assessment Report were used.

Greenhouse gas emissions by economic sector

The Greenhouse gas emissions by economic sector indicator represents a different classification than the activity sector emissions prescribed by the Intergovernmental Panel on Climate Change's methodological guidance and United Nations Framework Convention on Climate Change's reporting guidelines. Instead of reporting on Canada's emissions by activity, GHG emissions have been allocated to the economic sector in which they are generated (for example, transport emissions directly supporting an industrial activity, like off-road trucks in mining activities, have been allocated to the economic sector in which they are generated rather than to the transportation "activity" sector). A comprehensive detailing of the emissions reported by economic sector can be found in Chapter 2 and Annex 10 of the National Inventory Report.

Greenhouse gas emissions from the transport sector

The Greenhouse gas emissions from the transport sector indicator was calculated using a classification adapted from the one presented in Annex 10 of the National Inventory Report.

For the passenger transport, National Inventory Report's "Cars, light trucks and motorcycles" category was split into 2 separate categories ("Cars" and "Light trucks"), and the "Motorcycles" data were combined with the existing "Bus, rail and aviation" category.

For the freight transport, National Inventory Report's "Heavy duty trucks and rail" category was split into 2 separate categories. "Rail" data were then combined with the existing "Aviation and marine" category.

No change was made to the "Other: recreational, commercial and residential" category.

Greenhouse gas emissions from the agriculture sector

The Greenhouse gas emissions from the agriculture sector indicator was calculated based on emissions of 3 gases (carbon dioxide, methane, nitrous oxide) as they cover all sources of emissions from the sector:

- methane (CH_4) emissions from enteric fermentation
- CH_4 and nitrous oxide (N_2O) emissions from manure management and field burning of agricultural residues
- N_2O emissions from agricultural soils (direct emissions, indirect emissions and animal manure emissions on pasture, range and paddock)
- carbon dioxide (CO_2) emissions from agricultural use of lime and urea

Quality assurance, quality control and uncertainty

Quality assurance and quality control procedures are an essential requirement of the GHG inventory development and submission process. Quality assurance and quality control procedures ensure and improve transparency, consistency, comparability, completeness and confidence in the national emissions for the purpose of meeting Canada's reporting commitments to the United Nations Framework Convention on Climate Change. Chapter 1 (section 1.3) of the National Inventory Report provides a complete description of the quality assurance and quality control procedures.

Uncertainty analysis helps to prioritize improvements and to guide decisions on methodological choices. Annex 2 of the National Inventory Report presents the uncertainty assessment for Canada's GHG emissions. Further details on uncertainty related to specific sectors can be found in the uncertainty sections of Chapters 3 through 7 of the National Inventory Report.

Recent changes

Recalculations are performed annually on Canada's previously reported greenhouse gas emissions estimates to reflect updates to source data and estimation methodology. Recalculations in this latest release of the indicator have resulted in upward revisions to emissions for all years (+3.2% to +4.5%). This upward revision is mainly driven by the use of updated global warming potentials as published in IPCC’s Fifth Assessment report and methodological improvements implemented in the upstream oil and gas sector. The changes in global warming potentials accounts for 31% to 49% of the increase. Chapter 8 of the National Inventory Report provides a summary of the recalculations that occurred due to methodological changes and/or refinements since the previous submission. The summary includes:

- brief description, justification and summary of individual impacts on previously reported emission estimates
- details on specific inventory improvements implemented in 2024 as well as planned improvements

Caveats and limitations

The Greenhouse gas emissions indicators are comprehensive but some emission sources have not been included in the indicators because they are not reported in the National Inventory Report. Owing to their relatively small contributions to the total emissions, these excluded sources do not significantly affect the overall

completeness of the inventory. A detailed explanation of the excluded emission sources can be found in Annex 5 of the National Inventory Report.

Although reported in the National Inventory Report, emissions and removals from the land use, land use change and forestry sector are excluded from national totals and subsequently not reported as part of the Greenhouse gas emissions indicators.

Resources

References

Environment and Climate Change Canada (2024) Greenhouse gas sources and sinks: executive summary 2024. Retrieved on May 2, 2024.

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Related information

Canada's action on climate change

Climate change

Guidelines for National Greenhouse Gas Inventories

Annex

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Greenhouse gas emissions, Canada, 1990 to 2022

Year	Total greenhouse gas emissions (megatonnes of carbon dioxide equivalent)
1990	608
1991	603
1992	622
1993	627
1994	649
1995	668
1996	689
1997	706
1998	712
1999	723
2000	748
2001	739
2002	745
2003	763
2004	767
2005	761
2006	757
2007	777
2008	760
2009	716
2010	729
2011	738
2012	744
2013	751
2014	750
2015	746
2016	731
2017	742
2018	753
2019	752
2020	686
2021	698
2022	708

Note: Data are presented as rounded figures. The national indicator tracks 7 greenhouse gases released by human activity: carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons, hydrofluorocarbons and nitrogen trifluoride. Emission levels for some years have been revised in light of improvements to estimation methods and availability of new data. Emissions and removals from the land use, land use change and forestry sector (LULUCF) are excluded from national totals to allow for a focus on greenhouse gas released from human activity only.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.2. Data for Figure 2. Indexed trend in greenhouse gas emissions per person and per unit of GDP, Canada, 1990 to 2022

Year	Greenhouse gas emissions per person (tonnes of carbon dioxide equivalent per person)	Indexed greenhouse gas emissions per person (percentage change from 1990 level)	Greenhouse gas emissions per unit of gross domestic product (megatonnes of carbon dioxide equivalent per billion dollars gross domestic product)	Indexed greenhouse gas emissions per unit of gross domestic product (percentage change from 1990 level)
1990	21.9	0.0	0.53	0.0
1991	21.5	-2.0	0.53	1.2
1992	21.9	-0.2	0.54	3.4
1993	21.8	-0.5	0.54	1.7
1994	22.4	2.0	0.53	0.5
1995	22.8	3.9	0.53	0.8
1996	23.3	6.1	0.54	2.4
1997	23.6	7.5	0.53	0.2
1998	23.6	7.6	0.51	-2.6
1999	23.8	8.3	0.49	-6.3
2000	24.4	11.0	0.48	-8.1
2001	23.8	8.5	0.47	-10.5
2002	23.7	8.2	0.46	-12.4
2003	24.1	9.9	0.46	-11.8
2004	24.0	9.4	0.45	-14.0
2005	23.6	7.6	0.43	-17.3
2006	23.2	5.9	0.42	-19.8
2007	23.6	7.6	0.42	-19.5
2008	22.8	4.1	0.41	-22.0
2009	21.3	-3.0	0.40	-24.1
2010	21.4	-2.4	0.39	-25.0
2011	21.5	-2.0	0.39	-26.3
2012	21.4	-2.4	0.38	-26.9
2013	21.4	-2.5	0.38	-27.9
2014	21.2	-3.6	0.37	-30.1
2015	20.9	-4.8	0.36	-30.9
2016	20.3	-7.7	0.35	-32.8
2017	20.3	-7.5	0.35	-34.1
2018	20.3	-7.5	0.34	-35.0
2019	20.0	-8.9	0.34	-36.3
2020	18.0	-17.8	0.32	-38.8
2021	18.3	-16.8	0.31	-40.9
2022	18.2	-17.2	0.30	-42.5

Note: Data are presented as rounded figures. However, all calculations have been performed using unrounded data. The table presents the ratio of annual greenhouse gas emissions per person and per unit of gross domestic product relative to those values in 1990 (that is the values are indexed to 1990). Greenhouse gas per unit of gross domestic product is calculated using real inflation-adjusted gross domestic product in 2017 dollars. Emission levels for some years have been revised in light of improvements to estimation methods and availability of new data.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada. Statistics Canada (2024) Table 17-10-0005-01 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual. Statistics Canada (2024) Table 36-10-0369-01 - Gross domestic product, expenditure-based, at 2017 constant prices, annual.

Figure 3. Greenhouse gas emissions by economic sector, Canada, 1990 to 2022

Year	Oil and gas (megatonnes of carbon dioxide equivalent)	Transport (megatonnes of carbon dioxide equivalent)	Buildings (megatonnes of carbon dioxide equivalent)	Electricity (megatonnes of carbon dioxide equivalent)	Heavy industry (megatonnes of carbon dioxide equivalent)	Agriculture (megatonnes of carbon dioxide equivalent)	Waste and others (megatonnes of carbon dioxide equivalent)
1990	118.2	117.9	72.4	94.4	96.8	50.7	57.5
1991	119.7	113.2	71.7	95.7	96.6	50.8	55.4
1992	129.4	115.3	73.6	102.1	94.1	53.0	54.0
1993	138.3	118.3	77.2	92.9	93.5	54.3	52.2
1994	144.4	124.3	77.5	94.9	98.9	55.9	53.0
1995	152.1	126.4	78.3	98.0	99.7	58.5	55.0
1996	160.2	129.1	84.5	97.9	102.6	60.1	54.8
1997	162.0	133.4	82.0	109.1	102.5	60.9	55.6
1998	166.5	136.4	73.6	121.7	98.9	60.9	54.1
1999	173.7	140.5	77.5	118.8	96.6	61.2	54.6
2000	179.0	141.6	84.1	128.4	96.2	62.2	56.3
2001	180.6	141.7	80.7	128.7	90.9	61.9	54.5
2002	184.8	143.9	85.0	123.1	91.3	61.8	54.8
2003	188.8	148.9	90.3	126.9	90.0	63.6	54.6
2004	192.2	153.6	88.8	118.7	93.0	64.6	55.7
2005	195.4	156.2	84.9	116.6	88.0	65.6	54.8
2006	202.3	157.1	79.8	111.9	88.1	64.3	53.5
2007	206.7	162.0	85.7	118.5	86.3	64.1	53.1
2008	202.9	162.6	85.6	108.7	84.6	63.6	51.6
2009	198.1	161.5	84.0	93.7	71.5	60.6	46.9
2010	203.7	165.0	81.6	94.5	74.7	60.6	48.5
2011	210.5	163.9	86.1	85.7	80.9	61.5	49.8
2012	219.0	164.1	84.5	82.3	80.8	63.4	49.7
2013	223.5	166.6	85.6	79.6	79.8	65.2	50.6
2014	229.8	164.2	86.1	75.1	81.9	64.3	48.3
2015	229.1	162.2	85.2	74.7	79.5	65.7	49.4
2016	214.1	162.0	86.0	75.0	76.6	66.7	50.7
2017	220.7	165.0	88.2	72.3	77.4	67.3	51.1
2018	228.5	169.0	92.2	62.5	79.8	69.0	51.7
2019	226.1	169.8	94.2	61.4	79.3	69.3	51.9
2020	209.2	142.9	88.6	53.2	74.3	70.1	48.1
2021	215.8	150.1	85.3	51.3	77.7	69.2	49.2
2022	216.7	156.3	88.8	47.3	77.9	70.2	50.5

Note: Data are presented as rounded figures. "Others" in the Waste and others sector consists of emissions from light manufacturing, construction, forest resources and coal production. The Heavy industry sector consists of emissions from mining, smelting and refining, pulp and paper, iron and steel, cement, lime and gypsum, and chemicals and fertilizers.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.3. Data for Figure 4. Oil and gas sector greenhouse gas emissions, Canada, 1990 to 2022

Year	Natural gas (megatonnes of carbon dioxide equivalent)	Conventional oil (megatonnes of carbon dioxide equivalent)	Oil sands, mining and extraction (megatonnes of carbon dioxide equivalent)	Oil sands, in situ (megatonnes of carbon dioxide equivalent)	Oil sands, upgrading (megatonnes of carbon dioxide equivalent)	Other (megatonnes of carbon dioxide equivalent)
1990	38.4	31.7	2.3	4.6	8.4	32.8
1991	37.6	34.0	2.4	4.4	9.0	32.4
1992	39.6	36.7	2.5	4.3	11.0	35.3
1993	42.7	39.8	2.6	4.4	12.1	36.7
1994	45.4	42.6	2.8	4.6	12.7	36.4
1995	47.7	46.0	3.0	5.0	12.5	37.9
1996	50.5	47.3	3.0	5.3	12.6	41.4
1997	47.8	49.8	3.0	7.5	12.3	41.6
1998	51.0	49.5	3.1	9.2	12.7	41.1
1999	59.5	48.5	3.3	8.5	13.4	40.4
2000	65.5	51.3	3.3	9.2	13.7	36.0
2001	66.8	50.2	4.4	9.5	15.1	34.7
2002	69.4	50.0	4.5	9.4	16.1	35.3
2003	72.1	49.2	5.5	10.6	16.9	34.5
2004	71.4	48.9	6.1	11.8	18.9	35.2
2005	75.4	48.4	5.8	12.7	17.2	35.8
2006	77.5	48.6	6.4	14.7	20.3	34.8
2007	78.6	49.1	7.0	16.4	21.6	34.0
2008	77.3	48.0	7.3	18.9	19.5	31.8
2009	72.7	43.9	7.9	21.0	21.6	30.9
2010	72.2	45.2	8.6	24.1	22.9	30.7
2011	75.5	48.4	8.7	25.9	22.6	29.4
2012	73.4	52.3	9.1	30.9	23.5	29.7
2013	71.9	54.0	9.8	32.5	24.0	31.4
2014	71.1	56.5	10.4	36.8	23.9	31.1
2015	69.9	54.6	11.1	38.9	23.3	31.3
2016	64.8	48.0	11.4	38.0	20.9	31.2
2017	63.3	50.7	13.1	41.8	22.4	29.4
2018	64.5	51.4	15.1	43.6	23.7	30.2
2019	62.5	48.9	15.7	43.5	24.5	31.0
2020	60.4	39.6	15.2	41.7	24.7	27.7
2021	61.5	39.3	15.6	45.2	25.2	29.0
2022	60.0	39.2	16.5	45.1	24.9	31.0

Note: Data are presented as rounded figures. Conventional oil includes production from frontier, light and heavy oil fields. The Other category includes downstream oil and gas emissions (combustion and fugitive emissions from the production of refined petroleum products and the distribution of natural gas to end consumers) and oil and gas transmission emissions (combustion and fugitive emissions from transmission, storage and delivery activities).
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.4. Data for Figure 5. Transport sector greenhouse gas emissions, Canada, 1990 to 2022

Year	Passenger - Cars (megatonnes of carbon dioxide equivalent)	Passenger - Light trucks (megatonnes of carbon dioxide equivalent)	Passenger - Motorcycles, bus, rail and aviation (megatonnes of carbon dioxide equivalent)	Freight - Heavy duty trucks (megatonnes of carbon dioxide equivalent)	Freight - Rail, aviation and marine (megatonnes of carbon dioxide equivalent)	Other (megatonnes of carbon dioxide equivalent)
1990	44.9	25.8	9.0	18.8	11.3	8.1
1991	43.5	25.5	8.0	17.9	10.7	7.7
1992	44.3	26.4	8.0	18.0	10.9	7.6
1993	45.2	27.7	7.8	18.9	10.9	7.8
1994	46.0	29.3	8.2	21.2	11.3	8.3
1995	44.6	29.8	8.6	22.8	10.9	9.7
1996	44.3	31.1	9.1	23.6	10.8	10.2
1997	43.9	32.8	9.4	25.4	11.0	11.0
1998	43.6	34.7	9.7	25.9	10.8	11.8
1999	43.0	36.2	10.1	27.2	11.3	12.7
2000	42.6	36.6	10.3	27.7	11.4	13.1
2001	42.5	37.3	9.6	27.7	11.3	13.4
2002	42.7	38.5	9.6	28.2	10.9	13.9
2003	42.8	40.0	10.2	31.3	10.9	13.7
2004	42.9	41.6	10.7	33.5	11.2	13.7
2005	41.8	42.2	10.8	35.9	11.8	13.6
2006	41.3	42.9	10.9	36.8	12.0	13.2
2007	41.4	44.2	11.6	40.4	12.2	12.1
2008	40.4	44.2	11.7	42.2	12.4	11.7
2009	40.0	45.3	11.0	42.6	11.1	11.4
2010	39.2	46.4	10.7	45.2	11.0	12.5
2011	37.7	44.4	11.0	46.1	11.6	13.1
2012	36.6	45.3	11.8	45.6	11.7	13.2
2013	36.7	47.1	12.3	45.5	11.4	13.6
2014	35.4	47.4	12.1	45.1	11.4	12.9
2015	35.7	49.0	12.0	41.3	10.9	13.5
2016	35.4	51.6	12.0	38.1	10.5	14.4
2017	34.7	53.0	12.6	38.2	11.7	14.9
2018	34.1	54.9	13.4	39.6	12.0	15.1
2019	33.3	56.6	13.2	38.8	12.8	15.1
2020	25.7	48.6	8.4	34.1	12.1	14.0
2021	24.8	52.0	8.7	36.5	13.4	14.6
2022	24.1	55.1	11.0	37.9	13.9	14.4

Note: Data are presented as rounded figures. However, all calculations have been performed using unrounded data. The Other category includes other recreational, commercial and residential uses. Categories have been adapted from the classification used in Annex 10 of the National Inventory Report. For more details, consult the "Methods" section.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.5. Data for Figure 6. Agriculture sector greenhouse gas emissions, Canada, 1990 to 2022

Year	On farm fuel use (megatonnes of carbon dioxide equivalent)	Crop production (megatonnes of carbon dioxide equivalent)	Animal production (megatonnes of carbon dioxide equivalent)
1990	8.2	9.4	33.1
1991	8.1	8.9	33.7
1992	8.4	9.2	35.3
1993	8.5	9.9	35.9
1994	8.3	10.1	37.4
1995	8.7	10.3	39.4
1996	9.3	10.9	39.9
1997	9.8	11.1	40.0
1998	9.3	11.4	40.2
1999	9.4	11.2	40.6
2000	9.5	11.1	41.5
2001	8.7	10.4	42.8
2002	8.3	10.5	43.0
2003	8.8	11.5	43.3
2004	9.0	10.9	44.7
2005	9.4	10.5	45.8
2006	9.0	10.8	44.5
2007	9.5	11.6	43.0
2008	9.4	12.3	41.9
2009	8.6	12.2	39.7
2010	9.8	12.5	38.3
2011	11.0	13.0	37.5
2012	11.3	14.5	37.6
2013	11.6	16.0	37.6
2014	12.1	15.1	37.1
2015	12.6	16.1	36.9
2016	13.0	16.4	37.4
2017	14.3	15.5	37.5
2018	14.9	16.5	37.7
2019	15.0	16.7	37.6
2020	14.1	18.5	37.5
2021	14.1	17.4	37.7
2022	14.3	18.7	37.3

Note: Data are presented as rounded figures.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.6. Data for Figure 7. Electricity sector greenhouse gas emissions, Canada, 1990 to 2022

Year	Coal (megatonnes of carbon dioxide equivalent)	Natural gas (megatonnes of carbon dioxide equivalent)	Other (megatonnes of carbon dioxide equivalent)
1990	80.1	2.7	11.5
1991	84.0	2.2	9.4
1992	87.0	4.4	10.7
1993	79.6	5.4	7.8
1994	83.4	5.3	6.3
1995	84.5	6.4	7.0
1996	86.5	5.5	5.9
1997	93.4	6.9	8.8
1998	99.6	9.3	12.9
1999	99.4	8.9	10.4
2000	108.3	10.5	9.6
2001	106.6	10.3	11.8
2002	105.0	8.5	9.6
2003	103.5	9.2	14.2
2004	96.1	8.5	14.1
2005	97.9	7.3	11.5
2006	93.8	9.0	9.0
2007	99.4	9.3	9.8
2008	93.3	8.0	7.3
2009	77.8	8.3	7.6
2010	78.5	11.0	4.9
2011	68.2	13.3	4.1
2012	63.1	15.0	4.2
2013	63.4	11.7	4.5
2014	59.3	10.7	5.0
2015	57.8	11.2	5.7
2016	57.8	11.9	5.3
2017	57.7	9.7	5.0
2018	44.6	13.0	4.8
2019	42.8	14.3	4.3
2020	34.6	14.9	3.6
2021	31.4	16.6	3.3
2022	24.4	18.6	4.3

Note: Data are presented as rounded figures. The Other category includes diesel fuel oil, heavy fuel oil, light fuel oil, motor gasoline, petroleum coke, own use of primary electricity, solid wood waste, still gas and non-fuel related emissions.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Table A.7. Data for Figure 8. Greenhouse gas emissions by province and territory, Canada, 1990, 2005 and 2022

Province or territory	1990 greenhouse gas emissions (megatonnes of carbon dioxide equivalent)	2005 greenhouse gas emissions (megatonnes of carbon dioxide equivalent)	2022 greenhouse gas emissions (megatonnes of carbon dioxide equivalent)
Newfoundland and Labrador (NL)	9.5	10.3	8.6
Prince Edward Island (PE)	1.8	1.9	1.6
Nova Scotia (NS)	19.6	22.8	14.8
New Brunswick (NB)	16.2	20.1	12.5
Quebec (QC)	84.4	85.6	79.1
Ontario (ON)	178.4	203.0	157.0
Manitoba (MB)	18.2	20.6	21.6
Saskatchewan (SK)	49.0	80.5	75.9
Alberta (AB)	177.2	251.1	269.9
British Columbia (BC)	51.1	62.7	64.3
Yukon (YT)	0.5	0.6	0.7
Northwest Territories (NT)	1.8[A]	1.7	1.4
Nunavut (NU)[A]	n/a	0.6	0.6

Note: [A] 1990 emissions data for the Northwest Territories include emissions for Nunavut, which was part of the Northwest Territories until 1999. n/a = not applicable. Data are presented as rounded figures. However, all calculations have been performed using unrounded data. The years selected correspond to the first (1990) and last (2022) years of the dataset and to the base year (2005) for Canada's GHG emission reduction targets.
Source: Environment and Climate Change Canada (2024) National Inventory Report 1990-2022: Greenhouse Gas Sources and Sinks in Canada.

Additional information can be obtained at:

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor Fontaine Building
200 Sacré-Coeur Blvd
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-938-3860
Email: enviroinfo@ec.gc.ca