

CANADA'S AIR POLLUTANT EMISSIONS INVENTORY REPORT

1990–2023



Environment and
Climate Change Canada

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Rapport d'inventaire des émissions de polluants atmosphériques du Canada 1990–2023

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LIST OF COMMON ABBREVIATIONS, CHEMICAL FORMULAS AND UNITS

Abbreviations

APEI.....	Air Pollutant Emissions Inventory
CAC	criteria air contaminant
CEIP.....	Centre on Emission Inventories and Projections
CEPA 1999.....	<i>Canadian Environmental Protection Act, 1999</i>
CLRTAP	Convention on Long-range Transboundary Air Pollution
D/F	dioxins and furans
ECCC.....	Environment and Climate Change Canada
EEA.....	European Environment Agency
EF	emission factor
EMEP.....	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe or European Monitoring and Evaluation Programme
LPG.....	liquefied petroleum gas
LTO	landing and takeoff
MOVES	MOtor Vehicle Emission Simulator
NAICS	North American Industry Classification System
NFR.....	Nomenclature for Reporting
NG	natural gas
NPRI	National Pollutant Release Inventory
PAH.....	polycyclic aromatic hydrocarbon
PM	particulate matter
PM ₁₀	particulate matter less than or equal to 10 microns in diameter
PM _{2.5}	particulate matter less than or equal to 2.5 microns in diameter
POP	persistent organic pollutant
QA.....	quality assurance
QC	quality control
SOMA.....	sulphur Oxides Management Area
TPM	total particulate matter
UNECE.....	United Nations Economic Commission for Europe
VKT	vehicle kilometres travelled
VOC	volatile organic compound

Chemical Formulas

B(a)p	benzo(a)pyrene
B(b)f	benzo(b)fluoranthene
B(k)f	benzo(k)fluoranthene
Cd	cadmium
CO	carbon monoxide
HCB	hexachlorobenzene
Hg	mercury
I(cd)p.....	indeno(1,2,3-cd)pyrene
NH ₃	ammonia
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
Pb	lead
SO ₂	sulphur dioxide
SO _x	sulphur oxides

Units

g.....	gram
gTEQ.....	gram of toxic equivalent
kg	kilogram
kt.....	kilotonne
Mt.....	megatonne
t.....	tonne

EXECUTIVE SUMMARY

Canada's Air Pollutant Emissions Inventory (APEI) is a comprehensive inventory of anthropogenic emissions of 17 air pollutants at the national, provincial and territorial levels. This inventory fulfills Canada's international reporting obligations under the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP or Air Convention) of the United Nations Economic Commission for Europe (UNECE). The Air Convention has been supplemented by several protocols, the most active being the Gothenburg, Heavy Metals, and Persistent Organic Pollutants (POPs) protocols. Canada has ratified all the protocols except for the 1991 Protocol on Volatile Organic Compounds (VOCs). The requirements under that Protocol are obsolete given that Canada now has commitments on VOCs under the Gothenburg Protocol. The Air Convention protocols aim to reduce three main types of air pollutants included in this report. The first are criteria air contaminants, which include emissions of particulate matter less than or equal to 2.5 microns in diameter (PM_{2.5}), sulphur (expressed as sulphur dioxides or SO₂),¹ nitrogen oxides (NO_x), and VOCs. The second type is selected heavy metals: lead (Pb), cadmium (Cd), and mercury (Hg). Finally, the third type of air pollutants are POPs, which include dioxins and furans, hexachlorobenzene (HCB), and four types of polycyclic aromatic hydrocarbons (PAHs). The APEI also reports emissions of additional air pollutants including total particulate matter (TPM), particulate matter less than or equal to 10 microns in diameter (PM₁₀), carbon monoxide (CO) and ammonia (NH₃).² Canada's annual official submission to the UNECE comprises an air pollutant dataset submitted by February 15 and its accompanied report by March 15.

In addition, the APEI supports monitoring and reporting obligations under the Canada-U.S. Air Quality Agreement and the development of air quality management strategies, policies and regulations. It also provides data for air quality forecasting and informs Canadians about pollutants that affect their health and the environment.

The APEI is compiled from many different data sources. Emission data reported by individual facilities to Environment and Climate Change Canada's (ECCC) [National Pollutant Release Inventory \(NPRI\)](#)³ are supplemented with well-documented, science-based estimation tools and methodologies to quantify total emissions. Together, these data sources provide comprehensive coverage of air pollutant emissions across Canada. For more information on the APEI development, refer to [Chapter 3](#).

Overview of Canada's Air Pollution Emissions (1990 to 2023)

This edition of the Air Pollutant Emissions Inventory Report includes information on the most recent estimates of air pollutant emissions for 1990 to 2023.

The APEI indicates that 2023 emissions of 14 of the 17 reported air pollutants are decreasing compared to historical 1990 levels. A few air pollutant emission sources account for a significant portion of these trends as shown in [Table ES-1](#).⁴ Despite significant decreases in emissions of most pollutants, emissions of a few air pollutants have increased since 1990:

- Particulate matter emissions have risen gradually by 34% (TPM) and 25% (PM₁₀) since 1990. These increases are largely from dust emissions associated with transportation on unpaved roads as well as construction operations.
 - Transportation on unpaved roads has increased approximately 77% in terms of vehicle kilometres travelled between 1990 and 2023.
 - Capital expenditures on construction, which are used to calculate construction dust emissions and reflected in overall construction operations volume, have increased approximately 80% between 1990 and 2023.
- Emissions of NH₃ in 2023 were 25% higher than 1990 levels.
 - Ammonia emissions increased between 1990 and 2000 from 395 kt to 476 kt, then fluctuated between 449 kt and 498 kt.
 - This upward trend is primarily driven by increases in livestock populations in the first half of the time series in combination with continual increases in the use of inorganic nitrogen fertilizer throughout the monitoring period.

1 In this report, sulfur oxides (SO_x) are reported as SO₂ equivalent.

2 While the Gothenburg Protocol under the CLRTAP does include requirements to reduce NH₃ emissions, Canada and the United States are exempt from these requirements.

3 www.canada.ca/npri

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

Table ES-1 Canadian Air Pollutant Emission Trends (1990–2023)					
Air Pollutant	1990 Total Emissions	2023 Total Emissions	Change in total emissions (%)	Main contributor to the trend	Driver of the trend
TPM (Mt)	20	27	+34%	Dust	The increases in particulate matter emissions (TPM and PM ₁₀) are largely from dust emissions associated with transportation on unpaved roads as well as construction operations. Transportation on unpaved roads has increased in terms of vehicle kilometres travelled, and capital expenditures on construction, which are used to calculate construction dust emissions, have also increased.
PM ₁₀ (Mt)	6.5	8.2	+25%		
PM _{2.5} (Mt)	1.6	1.4	-15%	Agriculture	Changes in farming practices related to the production of annual agricultural crops contributed to emission decreases of PM _{2.5} , including reductions in areas under summer fallow and the adoption of conservation tillage practices. The increases in NH ₃ emissions are primarily driven by increases in livestock populations in the first half of the time series in combination with continual increases in the use of inorganic nitrogen fertilizer throughout the monitoring period.
NH ₃ (kt)	395	495	+25%		
SO _x (kt)	3 010	608	-80%	Ore and Mineral Industries	Non-Ferrous Refining and Smelting contributed to the decreases in emissions of SO _x , Pb, Cd and Hg, in part owing to the closure of outdated smelters and implementation of pollution prevention measures. The Aluminium Industry contributed to the decreases in emissions of PAHs, in part owing to process improvements and to the progressive phase-out of old Söderberg aluminium production technologies.
Pb (t)	1 023	93	-91%		
Cd (t)	81	4.3	-95%		
Hg (t)	34	3.1	-91%		
PAH (t)	243	20	-92%		
NO _x (Mt)	2.2	1.2	-45%	Transportation and Mobile Equipment	In the Transport and Mobile Equipment category, Heavy-Duty Diesel Vehicles contributed to the decreases in emissions of NO _x , and Light-Duty Gasoline Trucks and Vehicles, to the decreases in VOCs and CO emissions. Despite a 168% increase in total vehicle kilometres travelled from the Heavy-Duty Diesel Vehicles and a 28% increase in the total fuel consumption of Light-Duty Gasoline Trucks and Vehicles, emissions have decreased due to improved fuel economy and implemented regulations that have effectively lowered NO _x , CO and hydrocarbon emissions from engines.
VOC (Mt)	2.2	1.4	-38%		
CO (Mt)	13	4.5	-65%		
D/F (gTEQ)	233	77	-67%	Incineration and Waste	Waste Incineration contributed to the decrease in emissions of HCB and dioxins and furans, in part owing to improvements in incineration practices and technologies.
HCB (kg)	39	4.8	-88%		

When observing long-term emission trends, large-scale events can have a significant impact on a portion of the time series analyzed and should be considered. The years 2020 and 2021 were marked by the COVID-19 pandemic. This coincides with notable observed emission decreases between 2019 and 2020 for almost all pollutants. Impacts of the pandemic, more pronounced in 2020, are now harder to distinguish in recent years, as most air pollutants have resumed their gradual downward trend of recent decades.

Between 2022 and 2023, 9 of the 17 pollutants have shown increases. The most significant ones are HCB (15 %), followed by TPM (5.8%), Cd (4.8 %), PM₁₀ (4.5%) and Hg (4.2%). The PM increases are due to more kilometers travelled, while the other increases are due to variations in the facility-reported data or the activity data used to estimate emissions. Since most of these pollutants are now showing emission levels lower than the historical ones, and emissions totals are often driven mainly by only a few facilities, a small variation from one facility can be shown as a relatively large percentage variation. Additional information on air pollutant emission trends can be found in [Chapter 2](#).

Irrespective of the downward trends observed in Canadian emissions, air quality issues may still arise when emission sources are spatially concentrated. While the APEI provides valuable information on emissions within Canada, it does not distinguish localized sources of emissions within the provincial and territorial level aggregations. In this respect, work is ongoing to attribute emissions closer to where they occur. Indeed, gridded maps of latest year emissions are now published on the [Government of Canada Open Data Portal](#).⁵ For each of the main sources of air pollutant emissions, the most significant pollutants have been selected and mapped on a 1 km grid (by ecodistrict for Agriculture). This represents the first iteration and will undergo continuous improvements. More information on gridded maps can be found in [Chapter 3](#). Please contact ec.dirp.donnees-data.pird.ec@ec.gc.ca if additional details regarding the maps are needed.

5 <https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-air-pollutant-emissions-inventory/Gridded%20APEI%20maps?lang=en>

Improvements to Canada's Air Pollution Emission Estimates

Continuous improvement is considered good practice for air pollutants inventory preparation. ECCC consults and works with key federal, provincial and territorial partners, along with industry stakeholders, research centres and consultants, on an ongoing basis to improve the quality of the information used to compile the APEI. As new information and data become available and more accurate methods are developed, previous estimates are updated to provide a consistent and comparable trend in emissions.

This year's inventory includes numerous methodological improvements, the most significant one being in the Home Firewood Burning sector, resulting in overall downward recalculations in TPM, PM_{2.5}, SO_x, NO_x, VOCs, and PAHs emissions, and upward recalculations in CO, compared to the last APEI edition. For more information on recalculations, refer to [Annex 3](#).

Canada's Air Pollution Emissions Relative to International Commitments

Canada reports on atmospheric emissions of air pollutants to the UNECE through the European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP)⁶ pursuant to the 1979 CLRTAP and its associated protocols. This edition of the Canada's APEI indicates that all international commitments relative to air pollution emissions continue to be met. For more information on international commitments and a complete list of protocols under the CLRTAP, refer to [Annex 4](#).

Canada's Air Emissions Regulations and Non-Regulatory Measures

Downward trends in emissions of air pollutants reflect the ongoing implementation of a wide range of regulatory and non-regulatory instruments that aim to reduce or eliminate pollutants to improve and maintain air quality in Canada. Regulations related to the 17 APEI pollutants are under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

Several greenhouse gas regulations are also expected to achieve significant co-benefit reductions in air pollutants, for example the *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)*.

Non-regulatory instruments include guidelines, as well as codes of practice, performance agreements and pollution prevention planning notices for various sectors. More information on Canada's air emissions regulations and non-regulatory measures, including a list of regulations related to APEI pollutants, can be found in section [1.3](#).

6 www.ceip.at

INTRODUCTION

1.1. Background on the Air Pollutant Emissions Inventory

Canada's Air Pollutant Emissions Inventory (APEI) is a comprehensive inventory of air pollutant emissions at the national, and provincial and territorial levels. The APEI is prepared and published by Environment and Climate Change Canada (ECCC) and serves many purposes, mainly by:

- contributing to tracking and quantifying air pollutants in accordance with Canada's domestic and international reporting obligations;
- supporting the development of domestic air quality management strategies, policies and regulations;
- informing Canadians about pollutants that affect their health and the environment; and
- providing data to support air quality forecasting.

The first national inventory of air pollutant emissions in Canada was compiled in 1973, with national, provincial, and territorial estimates of emissions of carbon monoxide (CO), sulphur oxides (SO_x), nitrogen oxides (NO_x), hydrocarbons and particulate matter (PM) for the year 1970. Since then, air pollutant emissions estimates for Canada have continued to be published on a regular basis.

Today, the APEI includes emissions data for 17 air pollutants that contribute to smog, acid rain and diminished air quality, including:

- smog precursors: total particulate matter (TPM), PM less than or equal to 10 microns (PM₁₀), PM less than or equal to 2.5 microns (PM_{2.5}), SO_x, NO_x, volatile organic compounds (VOCs), CO and ammonia (NH₃)
- heavy metals: mercury (Hg), lead (Pb) and cadmium (Cd)
- persistent organic pollutants (POPs): dioxins and furans, four polycyclic aromatic hydrocarbon (PAHs) compounds (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene), and hexachlorobenzene (HCB)

The reporting format for the APEI organizes emissions into 11 source categories that are further broken down into 73 sectors and 75 associated subsectors (Table 1–1). The APEI is compiled and published on an annual basis. The time series of annual emissions contained in this report is updated from 1990 to the most recent inventory year, to ensure the trends in emissions are based on consistent and current methodological approaches and data.

Table 1–1 Air Pollutant Emissions Inventory Sector Descriptions	
Air Pollutant Emissions Inventory Source/Sector	Sector Descriptions
ORE AND MINERAL INDUSTRIES	
Aluminium Industry	Alumina production through bauxite refining, primary aluminium production through coke calcination, anode paste production, anode baking, potroom electrolysis and casting, and secondary aluminium production in which aluminium is recovered from aluminium-containing scrap.
Asphalt Paving Industry	Asphalt concrete (or hot-mix asphalt) manufacturing. Emissions are from permanent and portable hot-mix asphalt installations.
Cement and Concrete Industry	Entire process of cement production in rotary kilns, as well as the preparation of concrete and ready-mix concrete, lime manufacture, concrete batching and products, and gypsum product manufacture.
Foundries	Castings of various types of ferro-alloys as well as small iron and steel foundries not associated with integrated iron and steel facilities. The types of foundries include: open ferrous, electric arc and induction.
Iron and Steel Industry	Coke production, iron production, including blast furnaces, and direct reduced iron, and steel production, including basic oxygen furnaces, electric arc furnaces, sintering, direct reduction of iron, hot forming and semi-finishing.
Iron Ore Pelletizing	Iron ore induration of fired pellets.
Mineral Products Industry	Manufacture of brick, clay products such as pipes, liner and tiles and other mineral products such as glass products.
Mining and Rock Quarrying	Overburden removal, drilling in rock, blasting, crushing of rock, loading of materials, transporting raw materials by conveyors, scraping, bulldozing, grading, open storage pile losses and wind erosion from exposed areas.
Non-Ferrous Refining and Smelting Industry	Primary copper and nickel production using pyrometallurgical operations, lead ore crushing, concentrating and metallurgic processing and zinc metal production through electrolytic processes. Also includes other non-ferrous refining and smelting sources, such as those from magnesium and cobalt industry processes.
OIL AND GAS INDUSTRY	
Downstream Oil and Gas Industry	Refining and processing of crude oil to make fuels or other products such as solvents or asphalt. Storage and distribution of refined petroleum products, natural gas distribution and liquefied natural gas (LNG) processing.
Upstream Oil and Gas Industry	Drilling, testing and servicing of wells, conventional oil and gas production, in-situ bitumen extraction and open-pit mining, oil sands upgrading, natural gas processing, crude oil transmission, natural gas transmission and storage.

Table 1–1 **Air Pollutant Emissions Inventory Sector Descriptions (cont'd)**

APEI Source/Sector	Sector Descriptions
ELECTRIC POWER GENERATION (UTILITIES)	
Coal	Electric power generation from combustion of coal by utilities (both publicly and privately owned) for commercial sales and/or private use.
Diesel	Electric power generation from combustion of diesel by utilities (both publicly and privately owned) for commercial sales and/or private use.
Landfill Gas	Electric power generation from combustion of landfill gas by utilities (both publicly and privately) for commercial sales and/or private use.
Natural Gas	Electric power generation from combustion of natural gas by utilities (both publicly and privately owned) for commercial sales and/or private use.
Other (Electric Power Generation)	Electric power generation from other energy sources by utilities (both publicly and privately owned) for commercial sales and/or private use.
MANUFACTURING	
Abrasives Manufacturing	Manufacturing of abrasive grinding wheels, abrasive-coated materials and other abrasive products.
Bakeries	Manufacturing of bakery products, including frozen baked products.
Biofuel Production	Production of ethanol for fuel or oils for biodiesel.
Chemicals Industry	Large number of different product industries including fertilizer manufacturing, plastic resins, paints and varnishes, petrochemicals, inorganic chemicals, and pharmaceuticals. The raw materials, processes used and products produced are in many cases unique to individual plants.
Construction Fuel Combustion	Combustion of fossil fuels used for space heating and the heating of construction materials, such as concrete.
Electronics	Manufacturing of electronics, such as communications equipment, semiconductors and electronic components, navigational and guidance instruments, electric lamp bulbs and parts, transformers, switchgear, relay and industrial control, and electrical appliances.
Food Preparation	Activities related to food production for human or animal consumption, such as: manufacturing of dog and cat food; sugar and confectionery products; frozen food; dairy products; meat products; beverage products; seafood product preparation and packaging; fruit and vegetable canning; pickling and drying; and snacks, dressing, and tobacco products. This excludes grain-handling-related activities, such as malting and flour making.
Glass Manufacturing	Making of glass from sand and cullet as well as the remelting, pressing, blowing or otherwise shaping purchased glass.
Grain Industry	Primary, process, terminal and transfer elevators, as well as manufacturing or processing grain for use in other products.
Metal Fabrication	Activities related to metal fabrication, such as: production of iron and steel pipes and tubes, cold-rolling steel bars, sheets, strips and other steel shapes; steel wire drawing; copper rolling, drawing, extruding and alloying; forging; stamping and metal product manufacturing.
Plastics Manufacturing	Manufacturing of plastic products, including: plastic bags; plastic film and sheet; unlaminated plastic profile shapes; plastic pipes and pipe fittings; laminating plastic profile shapes (plates, sheets and rods); polystyrene foam products; urethane; other foam products; and plastic plumbing fixtures.
Pulp and Paper Industry	Chemical, mechanical, recycling and semi-chemical pulp mills, including the production of energy through the combustion of spent pulping liquor, biomass and fossil-fuel combustion. Also includes fugitive emissions from wood refining, screening and drying, and various steps in chemical recovery systems.
Textiles	Textile product-related activities, including: fibre, yarn, and thread manufacturing; textiles and fabric finishing; fabric coating; carpet and rug manufacturing; clothing knitting; as well as clothing accessories and other clothing manufacturing.
Vehicle Manufacturing (Engines, Parts, Assembly, Painting)	Activities related to: vehicle manufacturing (manufacturing of motor vehicles plastic parts, engine and power transmission equipment, automobile and light-duty motor vehicles, heavy-duty trucks, truck trailers, tractors and tractor parts, motor vehicle brake systems, seating and interior trim, and vehicle parts); urban transit systems; aircraft and aerospace vehicles and parts; and support activities for rail transportation.
Wood Products	Sawmills, panelboard mills (vener, plywood, waferboard, particle board and medium-density fiberboard mills), and other wood products manufacturing establishments (including furniture and cabinet makers, wood treating plants, wood pellet mills and Masonite manufacturers).
Other (Manufacturing)	Manufacturing and processing industries that are not included under a specific industrial sector, such as: asphalt shingle and coating activities; rubber manufacturing; and ship building and repair.
TRANSPORTATION AND MOBILE EQUIPMENT	
Air Transportation (LTO)	Landing and takeoff (LTO) cycles from piston and turbine aircraft used for commercial and private operations. LTO cycles and cruise modes cycles from piston and turbine aircraft used for military operations.
Domestic Air Transportation (Cruise)	Cruise modes from aircraft used for domestic commercial and private operations.
Domestic Marine Navigation, Fishing and Military	Marine vessels engaged in domestic navigation, fishing, or military operations within Canadian waters.
International Air Transportation (Cruise)	Cruise modes from aircraft used for international commercial and private operations.
International Marine Navigation	Marine vessels engaged in international navigation within Canadian waters.
Heavy-Duty Diesel Vehicles	Diesel vehicles with a Gross Vehicle Weight Rating (GVWR) greater than or equal to 3856 kilograms.
Heavy-Duty Gasoline Vehicles	Gasoline vehicles with a GVWR greater than or equal to 3856 kilograms.
Heavy-Duty LPG/NG Vehicles	Propane and natural gas vehicles with a GVWR greater than or equal to 3856 kilograms.
Light-Duty Diesel Trucks	Diesel trucks with a GVWR less than 3856 kilograms.
Light-Duty Diesel Vehicles	Diesel vehicles with a GVWR less than 3856 kilograms.
Light-Duty Gasoline Trucks	Gasoline trucks with a GVWR less than 3856 kilograms.
Light-Duty Gasoline Vehicles	Gasoline vehicles with a GVWR less than 3856 kilograms.
Light-Duty LPG/NG Trucks	Propane and natural gas trucks with a GVWR less than 3856 kilograms.
Light-Duty LPG/NG Vehicles	Propane and natural gas vehicles with a GVWR less than 3856 kilograms.
Motorcycles	Two- or three-wheeled vehicles that are registered for use on public roads.
Off-Road Diesel Vehicles and Equipment	Off-road vehicles and mobile equipment using diesel fuel in mining, construction, agriculture, commercial purposes, logging, railway maintenance, and airport ground support; lawn and garden equipment using diesel fuel; and recreational vehicles using diesel fuel.
Off-Road Gasoline/LPG/NG Vehicles and Equipment	Off-road vehicles and mobile equipment using gasoline, liquid petroleum gas, and compressed natural gas in mining, construction, agriculture, commercial purposes, logging, railway maintenance, airport ground support; lawn and garden equipment using gasoline, liquid petroleum gas, or compressed natural gas; and recreational vehicles using gasoline, liquid petroleum gas, and compressed natural gas.
Rail Transportation	Freight and passenger trains, including yard switching activities.
Tire Wear and Brake Lining	Tire and brake lining wear from all categories of road transportation.
AGRICULTURE	
Agricultural Fuel Combustion	Stationary combustion sources in agricultural facilities such as space and water heating and crop drying.
Animal Production	Decomposition of animal feed, animal digestion, and manure in housing, storage, applied to agricultural soils, or deposited during grazing.
Crop Production	Application of synthetic nitrogen fertilizers, biosolids, tillage, wind erosion and crop harvesting.

Table 1–1 Air Pollutant Emissions Inventory Sector Descriptions (cont'd)	
APEI Source/Sector	Sector Descriptions
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	
Commercial and Institutional Fuel Combustion	Combustion of fossil and biogenic fuels used for: space/water heating in commercial establishments; health and educational institutions; and government/public administration facilities.
Commercial Cooking	Cooking meat and french fries in commercial food service operations.
Home Firewood Burning	Burning of wood, pellets and manufactured logs as fuel for space heating and hot water. Includes emissions from fireplaces, wood stoves and wood-fired boilers.
Human	Human respiration, perspiration and dental amalgams.
Marine Cargo Handling	Handling, loading and unloading of materials, goods and merchandise between ships and docks.
Residential Fuel Combustion	Combustion of fossil fuels used for space/water heating in residences.
Service Stations	Fuel transfers and storage at service stations, as well as individuals refueling vehicles and off-road equipment.
Other (Miscellaneous)	Hg in products and facility-reported data from sectors that are not included elsewhere.
INCINERATION AND WASTE	
Crematoriums	Combustion of caskets and human bodies including dental amalgams, as well as companion animals.
Waste Incineration	Incinerators used to combust municipal, sewage sludge, and other waste types including hazardous and medical waste; as well as residential waste burning.
Waste Treatment and Disposal	Landfilling of waste, biological treatment of waste, specialized waste treatment and remediation, waste sorting and transfer as well as municipal wastewater treatment and discharge.
PAINTS AND SOLVENTS	
Dry Cleaning	Dry cleaning of fabric and leather items.
General Solvent Use	Broad range of applications occurring in residential, commercial, industrial and institutional locations. Industrial applications include uses such as: degreasing; adhesives and sealants; aerosols; blowing agents; and resin manufacturing. The use of consumer and commercial products, pesticides and personal care products are also included.
Printing	Manufacturing or use of printing inks, which includes: flexographic; gravure; letterpress; lithographic; and other printing.
Surface Coatings	Broad range of applications and industries, including individuals and companies engaged in use of paints and coatings.
DUST	
Coal Transportation	Transportation of coal by train or truck.
Construction Operations	Soil disturbance on construction sites (residential, industrial-commercial-institutional [ICI], engineering).
Mine Tailings	Wind erosion at mine tailings ponds located on active and inactive mine sites.
Paved Roads	Re-suspension of particulate matter by vehicles travelling on paved roads.
Unpaved Roads	Re-suspension of particulate matter by vehicles travelling on unpaved roads.
FIRES	
Prescribed Burning	Controlled fires used for land management treatments such as reducing logging residues, managing forest production, controlling insects, and minimizing the potential for destructive wildfires. Excludes the burning of agricultural residues.
Structural Fires	Vehicle fires (including trains and airplanes) and fires that burn buildings.

The APEI is compiled from many different data sources. Emissions data reported by individual facilities to ECCC's National Pollutant Release Inventory (NPRI) are supplemented with well-documented, science-based estimation tools and methodologies to quantify total emissions. Together, these data sources provide a comprehensive coverage of air pollutant emissions across Canada.

1.2. Reporting Requirement

The Convention on Long-range Transboundary Air Pollution (CLRTAP) endeavours to limit and, as far as possible, gradually reduce, and prevent air pollution. Since it was originally signed in 1979, the CLRTAP has been extended to a total of eight protocols, of which Canada has ratified seven. Six of these identify measures to be taken by Parties to achieve the Convention's objectives and the seventh concerns financing. Canada is a Party to the following six protocols that identify measures under the Convention:

- the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions (SO_x)
- the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions (SO_x for a designated "Sulphur Oxides Management Area" [SOMA])
- the 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides (NO_x)
- the 1998 Aarhus Protocol on Heavy Metals (Cd, Pb and Hg)
- the 1998 Aarhus Protocol on Persistent Organic Pollutants (including dioxins and furans, four species of PAHs, and HCB, among other POPs)
- the 1999 Gothenburg Protocol (Protocol to Abate Acidification, Eutrophication and Ground-level Ozone) and its 2012 amended version (which covers emissions of six¹ pollutants: SO₂, NO_x, VOCs, NH₃, PM and black carbon)

¹ The Gothenburg Protocol also contains an emission ceiling and a reduction commitment for NH₃, but these apply to Europe only.

These protocols set specific emissions reduction targets for sulphur, NO_x, Cd, Pb, Hg, dioxins and furans, PAHs, HCB, and VOCs. Parties are required to report emissions data to the United Nations Economic Commission for Europe (UNECE) each year by February 15 and submit the APEI Report by March 15. More information on the submission to the UNECE and emission reduction commitments can be found in [Annex 4](#).

In addition, Canada collects and publishes data on emissions of NH₃, CO and three categories of PM (TPM, PM₁₀ and PM_{2.5}) and voluntarily reports the emissions of these five substances, along with the 12 substances for which there are protocols, to the UNECE annually. Canada has ratified the 1984 Geneva Protocol on Long-Term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe.

Canada and the United States work jointly to address shared concerns regarding transboundary air pollution. Under the Canada-U.S. Air Quality Agreement, Canada monitors and reports emissions of SO₂, NO_x and VOCs other than methane.

In keeping with international reporting requirements, Canada's emissions of air pollutants from aircrafts at cruising altitudes, as well as emissions from international marine navigation are presented separately from other sources of emissions in this report and are excluded from Canada's national total emissions (see [Annex 4](#) for more information).

1.3. Canada's Air Emissions Regulations and Non-Regulatory Measures

Downward trends in emissions of air pollutants reflect the ongoing implementation of a wide range of regulatory and non-regulatory instruments that aim to reduce or eliminate pollutants in order to improve and maintain air quality in Canada. Regulations under the *Canadian Environmental Protection Act, 1999* (CEPA 1999) related to the 17 APEI pollutants include, but are not limited to, the following:

- *Benzene in Gasoline Regulations*
- *Contaminated Fuel Regulations*
- *Export of Substances on the Export Control List Regulations*
- *Gasoline and Gasoline Blend Dispensing Flow Rate Regulations*
- *Gasoline Regulations*
- *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations*
- *Multi-Sector Air Pollutants Regulations*
- *Off-Road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations*
- *Off-Road Small Spark-Ignition Engine Emission Regulations*
- *On-Road Vehicle and Engine Emission Regulations*
- *Products Containing Mercury Regulations*
- *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations*
- *Renewable Fuels Regulations*
- *Secondary Lead Smelter Release Regulations*
- *Sulphur in Diesel Fuel Regulations*
- *Sulphur in Gasoline Regulations*
- *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations*
- *Volatile Organic Compound (VOC) Concentration Limits for Automotive Refinishing Products Regulations*
- *Volatile Organic Compound Concentration Limits for Certain Products Regulations*

A number of greenhouse gas regulations are also expected to achieve significant co-benefit reductions in air pollutants, including Canada's *Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations* and *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)*.

Non-regulatory instruments include guidelines for new stationary combustion turbines, codes of practice, performance agreements, and/or pollution prevention planning notices for various sectors. These instruments address emissions from a number of sectors including aluminium, iron, steel and ilmenite, iron ore pellets, potash, base-metals smelting and refining, and pulp and paper.

Additionally, there is an International Maritime Organization (IMO) limit, known as “[IMO 2020](#),”² that came into force in 2020. This regulation restricts the amount of sulphur in the fuel oil used by ships travelling outside of specified Emission Control Areas (ECAs).³ This limit was implemented under an amendment to the Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL). A set of guidelines for the implementation of the MARPOL regulation was developed by the IMO. In 2024, [further amendments](#)⁴ were made to Annex VI to designate the Canadian Arctic Waters as an ECA. These amendments, which will take effect on March 1, 2026, place more stringent NO_x, SO_x, and PM emission limits on ships operating in this region.

All regulations and non-regulatory instruments administered under CEPA 1999 are available on the [environmental registry](#)⁵ and on the [Department of Justice’s online consolidation of federal acts and regulations](#).⁶

2 <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx>

3 ECAs are areas where special mandatory measures to regulate emissions from ships are required to prevent, reduce and control air pollution from NO_x, SO_x and PM, and their adverse impacts on human health and the environment.

4 <https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MEPC-82nd-session.aspx>

5 <https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry.html>

6 <https://laws-lois.justice.gc.ca/eng/regulations/>

CHAPTER 2

2023 EMISSIONS AND TRENDS

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This chapter describes the main sources and sectors contributing to the emissions of each pollutant and their historical trends. The descriptions of source categories and sectors are provided in Chapter 1, [Table 1–1](#).

The contribution of each source category and sector to total emissions of air pollutants for 2023 varies by pollutant ([Table 2–1](#)).¹

Air Pollutant	Category/Sector	Percentage of National Total
TPM	Dust: Unpaved Roads	58%
PM ₁₀		52%
PM _{2.5}		31%
SO _x	Oil and Gas Industry: Upstream Oil and Gas Industry	37%
NO _x		35%
VOC		38%
CO	Transportation and Mobile Equipment: Off-Road Gasoline/LPG/NG Vehicles and Equipment	37%
NH ₃	Agriculture: Animal Production	54%
Pb	Ore and Mineral Industries: Non-Ferrous Refining and Smelting Industry	70%
Cd		47%
Hg	Incineration and Waste: Crematoriums	22%
D/F	Incineration and Waste: Waste Incineration	22%
PAH ^a	Commercial/Residential/Institutional: Home Firewood Burning	84%
HCB	Ore and Mineral Industries: Cement and Concrete Industry	29%

Note:
a. PAH includes B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p.

¹ Throughout this report, data are presented as rounded figures. However, all calculations (including the ones to obtain percentages) were performed using unrounded data.

This edition of the Air Pollutant Emissions Inventory Report summarizes the most recent estimates of air pollutant emissions for 1990 to 2023, as of February 2025. The inventory indicates that emissions of 14 of the 17 reported air pollutants are decreasing compared to historical levels. Some key emission sources contributed to the downward trends since 1990, more specifically:

- In the Ore and Mineral Industries:
 - Non-Ferrous Refining and Smelting Industry contributed to the decreases in emissions of Hg, Cd, SO_x and Pb: emissions of these pollutants from this source have decreased by 99%, 97%, 95% and 93%, respectively, in part owing to the closure of outdated smelters and implementation of pollution prevention measures.
 - The Aluminium Industry contributed to the decreases in emissions of PAHs: emissions from this source have decreased by almost 100%, in part owing to process improvements and to the progressive phase-out of old Söderberg aluminium production technologies.
- In the Transport and Mobile Equipment category, Light-Duty Gasoline Trucks and Vehicles contributed to the decreases in VOC and CO emissions, and Heavy-Duty Diesel Vehicles, to decreases in emissions of NO_x: emissions of these pollutants from these sources have decreased by 91%, 79% and 65%, respectively.
 - Despite a 168% increase in total vehicle kilometres travelled (VKT) from Heavy-Duty Diesel Vehicles and a 28% increase in the total fuel consumption of Light-Duty Gasoline Trucks and Vehicles, emissions have decreased due to improved fuel economy and implemented regulations that have effectively lowered NO_x, CO and hydrocarbon emissions from engines.
- Changes in farming practices related to the production of annual agricultural crops contributed to emission decreases of PM_{2.5}; emissions from this source have decreased by 49%, in part owing to reductions in areas under summer fallow and the adoption of conservation tillage practices.
- Waste Incineration contributed to the decreases in emissions of HCB and dioxins and furans; emissions of these pollutants from this source have decreased by 93% and 83%, respectively, in part owing to improvements in incineration practices and technologies.

Despite significant decreases in emissions of most pollutants, emissions of 3 of the 17 reported air pollutants have increased since 1990. Some key emission sources contributed to these trends, in particular:

- Particulate matter emissions have risen gradually by 34% for total particulate matter (TPM) and 25% for particulate matter less than 10 microns (PM₁₀) since 1990. These increases are largely from dust emissions associated with transportation on unpaved roads as well as construction operations.
 - Transportation on unpaved roads has increased by approximately 77% in terms of VKT between 1990 and 2023.
 - Capital expenditures on construction, which are used to calculate construction dust emissions and reflect overall construction operations volume, have increased approximately 80% between 1990 and 2023.
- Emissions of NH₃ in 2023 were 25% higher than 1990 levels.
 - Ammonia emissions increased between 1990 and 2000 from 395 kt to 476 kt, then fluctuated between 449 kt and 498 kt.
 - This upward trend is primarily driven by increases in livestock populations in the first half of the time series in combination with continual increases in the use of inorganic nitrogen fertilizer throughout the monitoring period.

Between 2022 and 2023, 9 of the 17 pollutants have shown increases. The most significant ones are HCB (15 %), followed by TPM (5.8%), Cd (4.8 %), PM₁₀ (4.5%) and Hg (4.2%). The PM increases are due to more kilometers travelled, while the other increases are due to variations in the facility-reported data or the activity data used to estimate emissions (refer to [Chapter 3](#) for details on inventory development). Since most of these pollutants are now showing emission levels lower than the historical ones, and emissions totals are often driven mainly by only a few facilities; a small variation in data reported from one facility can be shown as a relatively large year-to-year emission variation in percentages.

When observing long-term emission trends, large-scale events can have a significant impact on a portion of the time series analyzed and should be considered. The years 2020 and 2021 were marked by the COVID-19 pandemic. This coincides with notable observed emission decreases between 2019 and 2020 for almost all pollutants. Impacts of the pandemic, more pronounced in 2020, are now harder to distinguish in recent years, as most air pollutants have resumed their gradual downward trend of recent decades.

Irrespective of the downward trends observed in Canadian emissions, air quality issues may still arise when emission sources are spatially concentrated.

Emissions for each pollutant by category and sector in 2023 are presented in Table 2–2. The subsequent sections 2.1 to 2.11 of this chapter identify major source contributions to total emissions over the 1990–2023 period. Emission trends analyses for 2005 to 2023 have also been included for PM_{2.5}, SO_x, NO_x and VOCs in relation to the emission reduction commitments as per the amended Gothenburg Protocol.²

The full-time series of national, provincial and territorial air pollutant emissions from 1990 to 2023, including emissions by subsector as well as other emissions estimated in the APEI³, are available online on the [Government of Canada Open Data Portal](#).⁴

Source	TPM (t)	PM ₁₀ (t)	PM _{2.5} (t)	SO _x (t)	NO _x (t)	VOC (t)	CO (t)	NH ₃ (t)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH* (kg)	HCb (g)
ORE AND MINERAL INDUSTRIES	210 000	91 000	31 000	170 000	85 000	8 100	520 000	1 600	74 000	2 600	1 100	18	400	3 700
Aluminium Industry	6 300	4 600	3 700	66 000	1 000	2 100	390 000	-	-	-	22	0.51	72	87
Asphalt Paving Industry	15 000	3 000	580	530	780	490	2 900	-	960	18	17	8.0	10	-
Cement and Concrete Industry	49 000	16 000	8 000	14 000	26 000	770	19 000	510	230	4.1	190	0.43	-	1 400
Foundries	5 000	4 500	3 900	1.8	69	1 100	43 000	-	1 300	260	-	0.00	-	99
Iron and Steel Industry	6 800	4 200	2 800	17 000	12 000	1 000	23 000	49	3 100	120	320	4.0	310	1 000
Iron Ore Pelletizing	7 100	2 200	520	9 000	9 300	510	15 000	0.94	1 600	45	67	4.1	-	640
Mineral Products Industry	450	400	290	620	210	79	460	170	41	-	-	-	-	-
Mining and Rock Quarrying	120 000	55 000	11 000	2 000	35 000	2 100	25 000	170	1 200	50	160	1.1	0.00	8.6
Non-Ferrous Refining and Smelting Industry	1 400	890	680	59 000	1 100	23	1 800	690	65 000	2 000	330	0.18	-	480
OIL AND GAS INDUSTRY	48 000	26 000	13 000	260 000	450 000	540 000	540 000	2 700	610	360	170	-	61	-
Downstream Oil and Gas Industry	3 600	2 400	1 500	38 000	20 000	24 000	33 000	54	380	74	130	-	30	-
Upstream Oil and Gas Industry	45 000	23 000	12 000	230 000	430 000	520 000	510 000	2 600	230	290	45	-	31	-
ELECTRIC POWER GENERATION (UTILITIES)	11 000	3 800	1 800	130 000	90 000	1 700	39 000	420	910	120	470	0.51	5.9	200
Coal	9 300	2 600	850	120 000	46 000	170	14 000	-	330	20	400	0.27	-	140
Diesel	230	220	200	59	11 000	110	2 800	-	-	-	-	-	-	-
Landfill Gas	8.7	7.1	7.1	6.5	130	-	500	-	-	-	-	-	-	-
Natural Gas	670	460	330	1 300	25 000	1 200	16 000	270	160	52	54	0.00	0.00	51
Other (Electric Power Generation)	890	530	450	9 000	7 200	200	5 700	150	410	46	17	0.24	-	9.9
MANUFACTURING	100 000	38 000	15 000	34 000	70 000	110 000	120 000	11 000	2 200	230	82	1.7	210	45
Abrasives Manufacturing	60	24	7.4	-	-	10	-	-	-	-	-	-	-	-
Bakeries	17	14	11	-	-	5 400	-	25	-	-	-	-	-	-
Biofuel Production	11	4.4	2.6	0.17	25	91	53	-	-	-	-	-	-	-
Chemicals Industry	3 000	2 200	1 200	17 000	23 000	9 100	14 000	9 000	39	8.1	18	0.10	89	0.00
Construction Fuel Combustion	170	160	160	33	3 200	58	550	52	5.7	10	2.4	0.00	0.16	-
Electronics	0.67	0.64	0.53	-	-	17	-	13	30	0.00	0.00	-	-	-
Food Preparation	2 100	1 300	590	200	1 600	17 000	1 100	180	0.28	0.62	-	-	-	-
Glass Manufacturing	160	150	130	510	670	150	240	-	-	-	-	-	-	-
Grain Industry	69 000	17 000	2 800	430	1 000	3 300	470	3.0	-	-	-	-	-	-
Metal Fabrication	350	240	200	6.9	190	3 800	530	25	310	6.6	3.2	0.00	-	-
Plastics Manufacturing	110	87	63	-	0.33	13 000	-	-	1.3	0.00	-	-	-	-
Pulp and Paper Industry	12 000	7 800	5 100	15 000	25 000	10 000	58 000	1 200	960	160	43	0.80	110	45
Textiles	-	-	-	-	-	500	-	-	-	-	-	-	-	-
Vehicle Manufacturing (Engines, Parts, Assembly, Painting)	390	270	230	0.050	560	7 300	1 100	6.6	59	0.54	-	-	0.00	-
Wood Products	14 000	7 800	4 200	780	14 000	37 000	48 000	880	780	45	16	0.73	8.3	0.078
Other (Manufacturing)	500	380	260	290	660	2 700	670	17	9.2	0.13	-	-	-	-
TRANSPORTATION AND MOBILE EQUIPMENT	32 000	32 000	23 000	2 900	470 000	190 000	2 700 000	6 900	14 000	47	65	25	2 200	-
Air Transportation (LTO)	240	240	240	480	7 100	2 300	26 000	4.2	14 000	-	-	-	4.7	-
Domestic Marine Navigation, Fishing and Military	890	860	780	1 500	70 000	2 900	3 200	-	96	8.9	0.17	3.2	19	-
Heavy-Duty Diesel Vehicles	3 700	3 700	3 400	120	120 000	7 400	53 000	910	-	-	0.31	0.43	390	-
Heavy-Duty Gasoline Vehicles	120	120	110	28	4 800	2 800	67 000	250	-	-	0.60	0.45	190	-
Heavy-Duty LPG/NG Vehicles	1.7	1.7	1.5	1.0	95	62	2 500	6.5	-	-	0.00	0.00	1.9	-
Light-Duty Diesel Trucks	10	10	9.7	3.2	650	420	7 500	21	-	-	0.00	0.00	0.68	-
Light-Duty Diesel Vehicles	3.3	3.3	3.0	1.1	180	150	4 000	7.3	-	-	0.00	0.00	0.39	-
Light-Duty Gasoline Trucks	910	910	810	370	22 000	25 000	480 000	3 200	-	-	17	13	1 000	-
Light-Duty Gasoline Vehicles	390	390	350	180	10 000	19 000	320 000	1 900	-	-	9.4	7.1	480	-
Light-Duty LPG/NG Trucks	0.00	0.00	0.00	0.00	3.7	1.3	21	0.091	-	-	0.00	0.00	0.063	-
Light-Duty LPG/NG Vehicles	0.00	0.00	0.00	0.00	0.23	0.094	1.7	0.00	-	-	0.00	0.00	0.00	-
Motorcycles	46	46	41	5.4	1 500	3 400	25 000	120	-	-	0.25	0.19	75	-
Off-Road Diesel Vehicles and Equipment	9 100	9 100	8 900	120	130 000	11 000	54 000	270	-	-	-	-	-	-
Off-Road Gasoline/LPG/NG Vehicles and Equipment	6 000	6 000	5 600	52	33 000	120 000	1 700 000	150	450	-	-	-	-	-
Rail Transportation	1 300	1 300	1 300	41	68 000	2 800	14 000	45	110	38	38	1.1	23	-
Tire Wear and Brake Lining	9 600	9 600	1 300	-	-	-	-	-	-	-	-	-	-	-
AGRICULTURE	3 500 000	1 500 000	350 000	170	2 800	110 000	1 100	460 000	21	76	6.7	0.27	0.20	0.51
Agricultural Fuel Combustion	430	280	240	170	2 800	160	1 100	19	21	76	6.7	0.27	0.20	0.51
Animal Production	35 000	9 800	2 000	-	-	110 000	-	270 000	-	-	-	-	-	-
Crop Production	3 500 000	1 500 000	350 000	-	-	-	-	190 000	-	-	-	-	-	-
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	77 000	73 000	72 000	2 000	58 000	120 000	560 000	1 800	1 400	930	360	3.1	17 000	0.20
Commercial and Institutional Fuel Combustion	2 600	2 500	2 500	610	27 000	1 400	20 000	190	170	470	61	0.15	2.2	-
Commercial Cooking	17 000	17 000	16 000	-	-	2 400	6 600	-	-	-	-	-	-	-
Home Firewood Burning	55 000	52 000	51 000	150	3 400	63 000	530 000	700	1 000	61	16	2.8	17 000	-
Human	-	-	-	-	-	-	-	670	-	-	-	-	-	-
Marine Cargo Handling	79	38	5.7	110	110	30	-	-	31	2.1	-	0.00	-	0.20
Residential Fuel Combustion	2 200	2 100	2 000	1 200	27 000	1 400	11 000	260	200	390	65	0.18	2.5	-
Service Stations	-	-	-	-	-	48 000	-	-	-	-	-	-	-	-
Other (Miscellaneous)	-	-	-	-	-	-	-	-	-	-	220	-	-	-

2 For more information on the reporting to the United Nations Economic Commission for Europe (UNECE), Canada's international commitments and related protocols under the Convention on Long-range Transboundary Air Pollution (CLRTAP), refer to Annex 4.

3 Other emissions estimated in the APEI include Domestic Air Transportation (Cruise), International Air Transportation (Cruise) and International Marine Navigation.

4 <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

Table 2–2 Total Air Pollutant Emissions in 2023 for Canada by Category and Sector (cont'd)

Source	TPM (t)	PM ₁₀ (t)	PM _{2.5} (t)	SO _x (t)	NO _x (t)	VOC (t)	CO (t)	NH ₃ (t)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH ^a (kg)	HCB (g)
INCINERATION AND WASTE	4 900	2 000	860	1 800	3 700	12 000	8 500	7 100	130	28	860	28	37	870
Crematoriums	17	15	15	31	360	5.7	61	-	13	2.2	680	7.4	0.00	65
Waste Incineration	240	210	190	570	2 000	360	1 000	12	61	9.6	100	17	37	800
Waste Treatment and Disposal	4 600	1 800	660	1 200	1 400	11 000	7 400	7 100	55	16	85	3.9	0.00	-
PAINTS AND SOLVENTS	57	57	49	-	140	270 000	130	-	-	0.15	-	-	-	-
Dry Cleaning	38	38	35	-	29	170	-	-	-	-	-	-	-	-
General Solvent Use	-	-	-	-	-	180 000	-	-	-	-	-	-	-	-
Printing	12	11	11	-	110	23 000	130	-	-	-	-	-	-	-
Surface Coatings	7.3	7.0	2.5	-	6.4	66 000	-	-	-	0.15	-	-	-	-
DUST	23 000 000	6 400 000	860 000	-	-	-	-	-	-	-	-	-	-	-
Coal Transportation	1 900	950	380	-	-	-	-	-	-	-	-	-	-	-
Construction Operations	6 800 000	2 000 000	410 000	-	-	-	-	-	-	-	-	-	-	-
Mine Tailings	83	66	17	-	-	-	-	-	-	-	-	-	-	-
Paved Roads	590 000	120 000	29 000	-	-	-	-	-	-	-	-	-	-	-
Unpaved Roads	15 000 000	4 300 000	430 000	-	-	-	-	-	-	-	-	-	-	-
FIRES	1 800	1 600	1 100	4.2	230	800	12 000	29	-	-	-	0.22	290	-
Prescribed Burning	1 600	1 300	950	4.2	200	590	11 000	17	-	-	-	0.22	290	-
Structural Fires	210	210	190	-	27	210	1 200	12	-	-	-	-	-	-
GRAND TOTAL	27 000 000	8 200 000	1 400 000	610 000	1 200 000	1 400 000	4 500 000	490 000	93 000	4 300	3 100	77	20 000	4 800

Notes:

Totals may not add up due to rounding.

a. PAH includes B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p.

0.00 Indicates emissions were truncated due to rounding.

- Indicates no emissions

Other Emissions Estimated in the APEI

Source	TPM (t)	PM ₁₀ (t)	PM _{2.5} (t)	SO _x (t)	NO _x (t)	VOC (t)	CO (t)	NH ₃ (t)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH ^a (kg)	HCB (g)
Domestic Air Transportation (Cruise)	330	330	320	1 800	35 000	1 700	31 000	15	15 000	-	-	-	3.0	-
International Air Transportation (Cruise)	620	620	600	3 900	67 000	940	8 400	25	580	-	-	-	2.0	-
International Marine Navigation	1 900	1 800	1 600	3 400	120 000	5 300	4 400	-	160	24	0.50	5.4	32	-

Note: Refer to Annex 4, section A4.4 for more information on international marine navigation and air transportation reporting emissions.

2.1. Particulate Matter Less than or Equal to 2.5 Microns in Diameter

In 2023, approximately 1.4 megatonnes (Mt) of particulate matter less or equal to 2.5 microns in diameters (PM_{2.5}) were emitted in Canada (Table 2–3).⁵ Dust sources accounted for 63% (864 kt) of total PM_{2.5} emissions, with the primary dust sources being Unpaved Roads at 31% (427 kt) and Construction Operations at 30% (407 kt) of total PM_{2.5} emissions. Agriculture was the second-largest contributor and accounted for 25% (348 kt) of PM_{2.5} emissions, almost all of which are attributed to Crop Production (25% or 346 kt). In these sectors, PM is largely emitted by non-combustion sources. Commercial/Residential/Institutional sources accounted for 5.2% (72 kt) of total PM_{2.5} emissions in 2023, with the primary contributor being Home Firewood Burning at 3.7% (51 kt) of total PM_{2.5} emissions.

Total emissions of PM_{2.5} decreased significantly from 1990 to 2009 and, fluctuated from 2010 to 2023, increasing overall during that period (Figure 2–1). Emissions in 2023 were 15% below 1990 levels. The downward trend between 1990 to 2009 was influenced predominantly by decreasing emissions from Crop Production. Emissions from Crop Production decreased for the period from 1990 to 2011 owing to a reduction in summer fallow and the adoption of conservation tillage practices; these were offset by an increase in wind erosion emissions resulting from increased production of pulse crops until 2016 when the proportion of pulse crops began to decrease relative to other less emission intensive crops.

For the 2010–2023 period, emissions from Dust influenced the overall trend. Road Dust PM_{2.5} emissions increased from 1990 to 2019, on average by 2.6% per year. Emissions decreased in 2020 (by 15% compared to 2019), coinciding with the COVID-19 pandemic, but have since returned to an increasing trend (on average 6.9% per year). Trends in Road Dust emissions are most strongly driven by the unpaved roads, which make up most emissions from this sector (49%). Generally, emission trends are linked with changes in VKT, though other factors such as climate (rain, snow and soil moisture) contribute to variations in the trend. Dust PM_{2.5} emissions from Construction Operations increased from 1990 to 2014, at an average rate of 4.4% per year over that period, then decreased in 2015 and 2016, remaining relatively consistent since.

Excluding sources from road dust, construction operations and crop production, PM_{2.5} emissions in 2023 were 41% lower compared with 2005 levels. For example, decreases in the Transportation and Mobile Equipment category occurred, primarily due to implemented regulations that have effectively lowered PM emission rates from diesel engines.

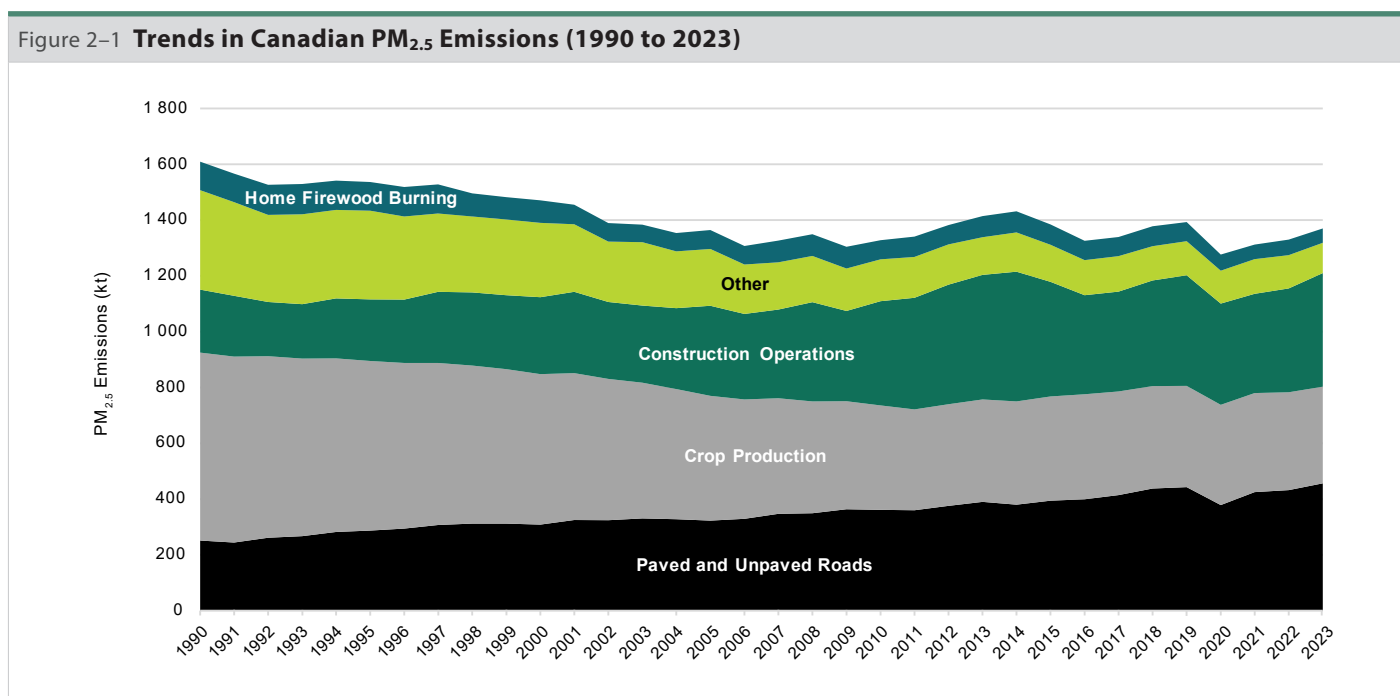
⁵ Only PM_{2.5} emission trends are described in this chapter, total particulate matter (TPM) and particulate matter less than or equal to 10 microns in diameter (PM₁₀) detailed emission data are available at <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>.

The most significant changes in PM_{2.5} emissions from 1990 to 2023 include:

- Dust: increase of 81% (387 kt), with:
 - Paved and Unpaved Roads: increase of 82% (205 kt)
 - Construction Operations: increase of 80% (181 kt)
- Agriculture: decrease of 48% (327 kt), with:
 - Crop Production: decrease of 49% (327 kt)
- Manufacturing: decrease of 87% (99 kt), with:
 - Pulp and Paper Industry: decrease of 92% (56 kt)
- Commercial/Residential/Institutional: decrease of 40% (48 kt), with:
 - Home Firewood Burning: decrease of 50% (50 kt)

The most significant changes in PM_{2.5} emissions from 2005 to 2023 include:

- Dust: increase of 34% (218 kt), with:
 - Paved and Unpaved Roads: increase of 41% (134 kt)
 - Construction Operations: increase of 26% (84 kt)
- Transportation and Mobile Equipment: decrease of 65% (42 kt), with:
 - Heavy-Duty Diesel Vehicles: decrease of 82% (16 kt)
 - Off-Road Diesel Vehicles and Equipment: decrease of 62% (15 kt)
- Manufacturing: decrease of 67% (30 kt), with:
 - Pulp and Paper Industry: decrease of 71% (12 kt)



Source	1990	2000	2005	2018	2019 (tonnes)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	54 000	51 000	41 000	33 000	34 000	35 000	36 000	35 000	31 000
OIL AND GAS INDUSTRY	12 000	13 000	12 000	12 000	12 000	12 000	14 000	14 000	13 000
ELECTRIC POWER GENERATION (UTILITIES)	49 000	23 000	9 100	3 200	2 800	2 400	2 000	2 100	1 800
MANUFACTURING	110 000	75 000	45 000	17 000	16 000	17 000	20 000	15 000	15 000
Pulp and Paper Industry	61 000	25 000	18 000	6 800	6 300	6 100	5 400	4 800	5 100
Wood Products	35 000	28 000	14 000	3 800	4 300	4 300	7 300	4 400	4 200
Other Manufacturing Sectors	18 000	22 000	13 000	6 800	5 800	6 100	7 200	5 900	5 600
TRANSPORTATION AND MOBILE EQUIPMENT	69 000	71 000	65 000	32 000	29 000	25 000	25 000	23 000	23 000
AGRICULTURE	680 000	540 000	450 000	370 000	370 000	360 000	360 000	350 000	350 000
Agricultural Fuel Combustion	120	140	130	260	260	230	230	240	240
Animal Production	1 700	2 100	2 300	2 100	2 100	2 100	2 100	2 000	2 000
Crop Production	670 000	540 000	450 000	370 000	360 000	360 000	360 000	350 000	350 000
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	120 000	100 000	90 000	92 000	89 000	79 000	72 000	76 000	72 000
Commercial and Institutional Fuel Combustion	2 000	2 600	2 600	2 900	3 000	2 700	2 500	2 700	2 500
Commercial Cooking	14 000	15 000	17 000	15 000	15 000	16 000	16 000	16 000	16 000
Home Firewood Burning	100 000	81 000	68 000	71 000	68 000	58 000	52 000	55 000	51 000
Residential Fuel Combustion	2 400	2 600	2 500	2 300	2 300	2 200	2 100	2 200	2 000
Other Commercial/Residential/Institutional Sectors	3.8	4.9	5.6	5.3	5.4	5.2	5.5	5.6	5.7
INCINERATION AND WASTE	2 100	2 200	1 800	820	840	840	860	850	860
PAINTS AND SOLVENTS	-	-	9.2	23	43	41	45	49	49
DUST	480 000	580 000	650 000	820 000	840 000	740 000	780 000	800 000	860 000
Coal Transportation	280	260	240	220	230	180	290	360	380
Construction Operations	230 000	280 000	320 000	380 000	400 000	360 000	360 000	370 000	410 000
Mine Tailings	5.5	7.1	6.9	15	14	16	18	16	17
Paved Roads	23 000	25 000	26 000	30 000	31 000	27 000	29 000	29 000	29 000
Unpaved Roads	230 000	280 000	300 000	410 000	410 000	350 000	400 000	400 000	430 000
FIRES	36 000	6 900	4 500	2 900	3 200	2 500	2 500	5 500	1 100
GRAND TOTAL	1 600 000	1 500 000	1 400 000	1 400 000	1 400 000	1 300 000	1 300 000	1 300 000	1 400 000

Notes:
 Totals may not add up due to rounding.
 0.00 Indicates emissions were truncated due to rounding.
 - Indicates no emissions

2.2. Sulphur Oxides

In 2023, 608 kt of sulphur oxides (SO_x) were emitted in Canada (Table 2-4). The Oil and Gas Industry was the largest contributor, accounting for 44% (264 kt) of national emissions. Approximately 86% (227 kt) of the emissions from this source were attributed to the Upstream Oil and Gas Industry sector. Ore and Mineral Industries was the second-largest source of SO_x, accounting for 28% (168 kt) of total SO_x emissions, mostly attributable to the Aluminium Industry sector at 11% (66 kt) and the Non-Ferrous Refining and Smelting Industry sector at 9.6% (59 kt) of the national total. Electric Power Generation (Utilities) also accounted for 22% (135 kt) of total SO_x emissions, mostly attributable to coal-electric power generation at 20% (124 kt) of the national total.

Overall, SO_x emissions decreased by 80% (2.4 Mt) between 1990 and 2023 (Figure 2-2). Reductions in emissions from the Ore and Mineral Industries, and in particular the Non-Ferrous Refining and Smelting Industry sector, were the largest driver of this downward trend, particularly in the early 1990s, and again from 2008 to 2023. The decrease since 2008 can be attributed to the preparation and implementation of pollution prevention plans by facilities, the installation of new technology or processes at facilities, the closure of four major smelters in Manitoba, Ontario, Quebec, and New Brunswick, and facilities achieving Base Level Industrial Emissions Requirements (BLIERs) through environmental performance agreements (ECCC, 2017, 2018a).

Emissions from Electric Power Generation (Utilities) decreased significantly from 2003 to 2023, primarily owing to the adoption of emissions control equipment on older coal units, and more recently, a decrease in coal consumption and closure of coal-fired power plants; resulting in a decrease of 77% (406 kt) of coal-electric power generation emissions during that period. Installation of pollution control equipment, switching to low sulphur heavy fuel oil and closure of generating stations burning heavy fuel oil also contributed 77% of the reduction in emissions in this sector between 2003 and 2023.

SO_x emissions from the Oil and Gas Industry exhibited an overall downward trend since the mid-1990s. Emissions from the Upstream Oil and Gas Industry have gradually declined throughout the time series due to the implementation of better emission control technologies, particularly in the Oil Sands Mining, Extraction and Upgrading and Natural Gas Production and Processing subsectors. Improvements to SO_x emissions mitigation technologies have similarly contributed to significant reductions in the Downstream Oil and Gas Industry, where Petroleum Refining emissions have decreased by 83 kt (69%) since 1990. Despite improved emissions controls SO_x emissions from the Upstream Oil and Gas Industry gradually increased between 2016 and 2023. This recent trend is driven by a 34% increase in crude bitumen production, as well as increased flaring at natural gas production and processing facilities as part of growing efforts to reduce methane (CH₄) emissions from venting. From 2020 to 2023, the Oil and Gas Industry experienced a 8.5% increase (21 kt) in SO_x emissions, including a 7.6 kt (14%) increase from Oil Sands Mining, Extraction, and Upgrading, a 6.4 kt (33%) increase from Oil Sands In-Situ Extraction, and a 6.6 kt (6.0%) increase from Natural Gas production and Processing.

Emissions of SO_x were 71% below 2005 levels. The main emission sources that contributed to these trends and the explanations for those decreases are similar to the ones between 1990 and 2023 that were previously explained.

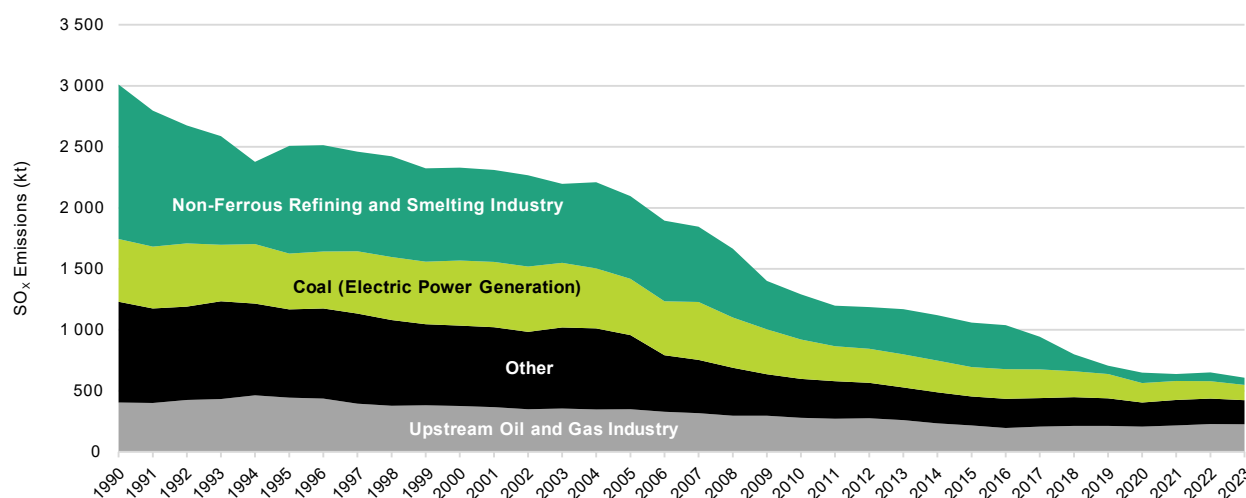
The most significant changes in SO_x emissions from 1990 to 2023 include:

- Ore and Mineral Industries: decrease of 89% (1.3 Mt), with:
 - Non-Ferrous Refining and Smelting Industry: decrease of 95% (1.2 Mt)
- Electric Power Generation (Utilities): decrease of 78% (484 kt), with:
 - Coal: decrease of 76% (390 kt)
- Oil and Gas Industry: decrease of 51% (271 kt), with:
 - Upstream Oil and Gas Industry: decrease of 44% (179 kt)
 - Downstream Oil and Gas Industry: decrease of 71% (92 kt)

The most significant changes in SO_x emissions from 2005 to 2023 include:

- Ore and Mineral Industries: decrease of 80% (691 kt), with:
 - Non-Ferrous Refining and Smelting Industry: decrease of 91% (618 kt)
- Electric Power Generation (Utilities): decrease of 74% (387 kt), with:
 - Coal: decrease of 73% (337 kt)
- Oil and Gas Industry: decrease of 43% (198 kt), with:
 - Upstream Oil and Gas Industry: decrease of 35% (122 kt)
 - Downstream Oil and Gas Industry: decrease of 67% (75 kt)

Figure 2–2 **Trends in Canadian SO_x Emissions (1990 to 2023)**



Source	1990	2000	2005	2018	2019 (tonnes)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	1 500 000	920 000	860 000	260 000	180 000	200 000	160 000	180 000	170 000
Aluminium Industry	31 000	48 000	63 000	61 000	57 000	62 000	59 000	53 000	66 000
Asphalt Paving Industry	740	650	720	640	570	530	580	520	530
Cement and Concrete Industry	48 000	45 000	54 000	25 000	23 000	20 000	19 000	20 000	14 000
Foundries	1 800	1 900	1 700	23	22	21	2.2	2.1	1.8
Iron and Steel Industry	37 000	30 000	31 000	20 000	20 000	15 000	14 000	16 000	17 000
Iron Ore Pelletizing	15 000	16 000	18 000	9 700	11 000	10 000	9 700	9 500	9 000
Mineral Products Industry	1 500	1 100	2 100	750	720	690	810	590	620
Mining and Rock Quarrying	83 000	15 000	12 000	1 600	1 500	1 700	1 700	1 900	2 000
Non-Ferrous Refining and Smelting Industry	1 300 000	760 000	680 000	140 000	70 000	85 000	57 000	73 000	59 000
OIL AND GAS INDUSTRY	540 000	510 000	460 000	270 000	270 000	240 000	260 000	280 000	260 000
Downstream Oil and Gas Industry	130 000	140 000	110 000	53 000	53 000	37 000	46 000	48 000	38 000
Upstream Oil and Gas Industry	410 000	380 000	350 000	210 000	210 000	210 000	220 000	230 000	230 000
ELECTRIC POWER GENERATION (UTILITIES)	620 000	620 000	520 000	220 000	210 000	170 000	170 000	150 000	130 000
Coal	510 000	530 000	460 000	210 000	200 000	160 000	160 000	140 000	120 000
Diesel	430	440	330	37	37	37	13	33	59
Landfill Gas	0.76	15	-	92	88	11	7.2	6.5	6.5
Natural Gas	29 000	21 000	19 000	1 400	1 100	770	3 600	2 100	1 300
Other (Electric Power Generation)	74 000	63 000	41 000	6 700	6 400	6 500	8 400	8 800	9 000
MANUFACTURING	230 000	150 000	140 000	44 000	41 000	35 000	39 000	38 000	34 000
Chemicals Industry	38 000	31 000	36 000	20 000	18 000	15 000	18 000	19 000	17 000
Pulp and Paper Industry	140 000	78 000	66 000	22 000	20 000	19 000	18 000	17 000	15 000
Other Manufacturing Sectors	49 000	44 000	43 000	2 500	2 600	2 200	2 700	2 800	2 300
TRANSPORTATION AND MOBILE EQUIPMENT	97 000	90 000	70 000	6 300	5 700	2 200	2 200	2 800	2 400
AGRICULTURE	2 200	1 500	2 900	240	220	190	160	170	170
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	47 000	33 000	33 000	2 900	3 000	2 600	2 400	2 500	2 000
INCINERATION AND WASTE	1 300	1 900	1 800	2 200	2 100	2 400	2 100	2 100	1 800
PAINTS AND SOLVENTS	-	-	0.00	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	180	28	18	12	15	11	10	24	4.2
GRAND TOTAL	3 000 000	2 300 000	2 100 000	800 000	710 000	650 000	640 000	650 000	610 000

Notes:
 Totals may not add up due to rounding.
 0.00 Indicates emissions were truncated due to rounding.
 - Indicates no emissions

2.3. Nitrogen Oxides

Approximately 1.2 Mt of nitrogen oxides (NO_x) were released in Canada in 2023 (Table 2–5). Transportation and Mobile Equipment was the largest contributor, accounting for 38% (467 kt) of total NO_x emissions. Within this source category, Off-Road Diesel Vehicles and Equipment, Heavy-Duty Diesel Vehicles, Domestic Marine Navigation, Fishing and Military and Rail Transportation sectors were the largest emitters, collectively contributing 32% (388 kt) of total NO_x emissions. The Oil and Gas Industry accounted for 37% (452 kt) of total NO_x emissions in 2023, with the Upstream Oil and Gas Industry sector accounting for nearly all of the Oil and Gas Industry total (96% or 432 kt). Electric Power Generation (Utilities) contributed 7.3% (90 kt) of total NO_x emissions, with coal-fired generation contributing 3.8% (46 kt) of the national total. The remaining 18% of NO_x emissions were distributed across multiple sources.

In 2023, national NO_x emissions were 45% (1.0 Mt) below 1990 levels and 46% (1.0 Mt) below 2005 levels (Figure 2–3). Significant drivers of this trend were the decrease in emissions from Heavy-Duty Diesel Vehicles as well as Light-Duty Gasoline Trucks and Vehicles. Despite a 168% increase in total VKT from Heavy-Duty Diesel Vehicles and a 28% increase in the total fuel consumption of Light-Duty Gasoline Trucks and Vehicles, improved fuel economy and implemented regulations have effectively lowered NO_x and hydrocarbon emissions from engines.⁶

Within Electric Power Generation (Utilities), coal-electric power generation contributed to the downward trend across the time series, with a gradual decrease in emissions from 1998 to 2023. This decrease can be attributed to coal-fired power plants that have closed down and been replaced by lower-emission sources such as natural gas power plants.

The Oil and Gas Industry experienced an increase of 31% (108 kt) in emissions since 1990. This increase is attributed to expansion and growth in the industry. Between 2019 and 2021, most major contributors to NO_x emissions experienced decreases. Notably, the Upstream Oil and Gas Industry saw a significant decrease between 2019 and 2020, a slight decrease between 2020 and 2021 and a minor increase between 2021 and 2023, resulting in an overall decrease of 17 kt (3.6%) over this five-year period. This can be attributed primarily to a 5.1% reduction in reported fuel gas consumption from 2019 to 2023.

⁶ See Chapter 1 for a list of regulations.

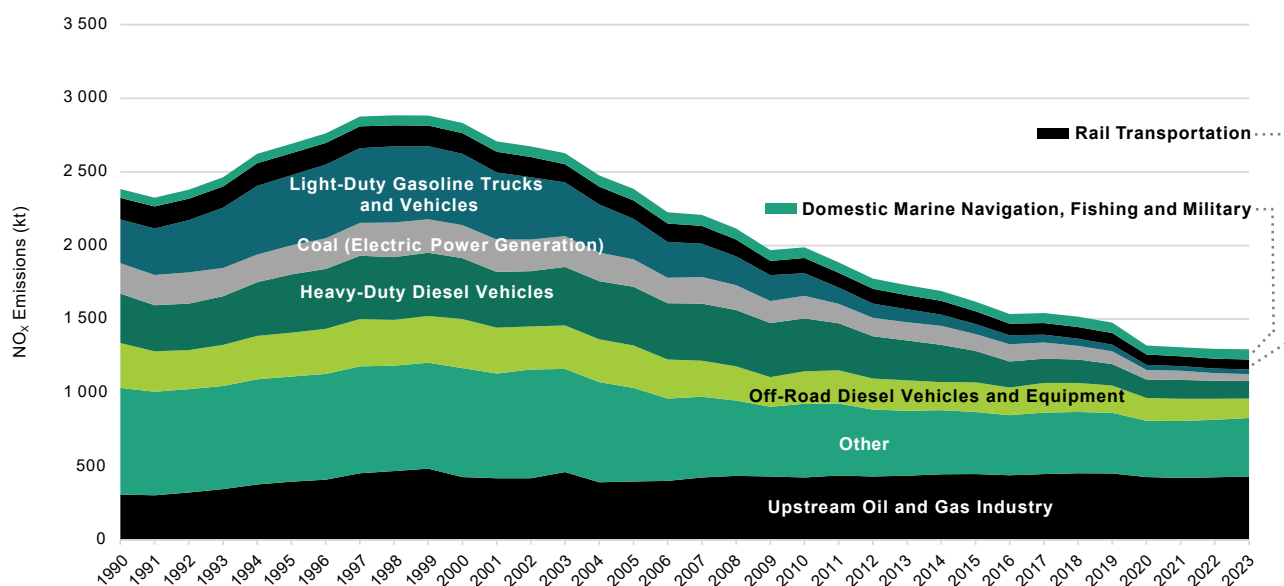
The most significant changes in NO_x emissions from 1990 to 2023 include:

- Transportation and Mobile Equipment: decrease of 63% (795 kt), with:
 - Light-Duty Gasoline Trucks and Vehicles: decrease of 89% (264 kt)
 - Heavy-Duty Diesel Vehicles: decrease of 65% (217 kt)
 - Off-Road Diesel Vehicles and Equipment: decrease of 57% (173 kt)
- Electric Power Generation (Utilities): decrease of 65% (167 kt), with:
 - Coal: decrease of 77% (160 kt)
- Oil and Gas Industry: increase of 31% (108 kt), with:
 - Upstream Oil and Gas Industry: increase of 40% (123 kt)

The most significant changes in NO_x emissions from 2005 to 2023 include:

- Transportation and Mobile Equipment: decrease of 63% (784 kt), with:
 - Heavy-Duty Diesel Vehicles: decrease of 70% (280 kt)
 - Light-Duty Gasoline Trucks and Vehicles: decrease of 88% (243 kt)
 - Off-Road Diesel Vehicles and Equipment: decrease of 54% (156 kt)
- Electric Power Generation (Utilities): decrease of 64% (164 kt), with:
 - Coal: decrease of 75% (140 kt)

Figure 2–3 Trends in Canadian NO_x Emissions (1990 to 2023)



Source	1990	2000	2005	2018	2019	2020	2021	2022	2023
	(tonnes)								
ORE AND MINERAL INDUSTRIES	100 000	99 000	110 000	82 000	80 000	77 000	82 000	79 000	85 000
OIL AND GAS INDUSTRY	340 000	460 000	430 000	470 000	470 000	440 000	440 000	440 000	450 000
Downstream Oil and Gas Industry	35 000	30 000	31 000	17 000	16 000	17 000	17 000	17 000	20 000
Upstream Oil and Gas Industry	310 000	430 000	400 000	450 000	450 000	430 000	420 000	430 000	430 000
ELECTRIC POWER GENERATION (UTILITIES)	260 000	330 000	250 000	130 000	120 000	100 000	100 000	94 000	90 000
Coal	210 000	230 000	190 000	92 000	88 000	66 000	62 000	52 000	46 000
Diesel	3 200	8 500	8 500	9 800	9 900	9 800	8 400	9 800	11 000
Landfill Gas	45	400	300	150	140	130	100	100	130
Natural Gas	20 000	65 000	38 000	18 000	18 000	18 000	23 000	25 000	25 000
Other (Electric Power Generation)	27 000	27 000	21 000	8 900	8 800	8 100	7 000	7 300	7 200
MANUFACTURING	190 000	180 000	140 000	72 000	70 000	66 000	70 000	70 000	70 000
TRANSPORTATION AND MOBILE EQUIPMENT	1 300 000	1 600 000	1 300 000	610 000	580 000	490 000	480 000	480 000	470 000
Air Transportation (LTO)	5 100	5 900	5 900	7 500	7 500	3 800	4 100	6 400	7 100
Domestic Marine Navigation, Fishing and Military	60 000	70 000	78 000	71 000	71 000	62 000	62 000	67 000	70 000
Heavy-Duty Diesel Vehicles	340 000	410 000	400 000	160 000	150 000	120 000	130 000	120 000	120 000
Heavy-Duty Gasoline Vehicles	37 000	35 000	25 000	9 200	7 700	5 700	5 200	4 600	4 800
Heavy-Duty LPG/NG Vehicles	6 700	340	140	86	97	87	90	100	95
Light-Duty Diesel Trucks	4 000	7 900	5 800	720	670	590	660	680	650
Light-Duty Diesel Vehicles	1 900	2 300	1 700	230	220	180	190	200	180
Light-Duty Gasoline Trucks	110 000	230 000	150 000	31 000	29 000	22 000	21 000	21 000	22 000
Light-Duty Gasoline Vehicles	190 000	250 000	120 000	17 000	16 000	11 000	11 000	11 000	10 000
Light-Duty LPG/NG Trucks	290	50	25	6.3	5.3	3.1	3.7	3.5	3.7
Light-Duty LPG/NG Vehicles	0.95	0.69	0.20	0.073	0.072	0.12	0.23	0.20	0.23
Motorcycles	660	970	980	1 700	1 700	1 400	1 500	1 400	1 500
Off-Road Diesel Vehicles and Equipment	310 000	330 000	290 000	200 000	190 000	160 000	150 000	140 000	130 000
Off-Road Gasoline/LPG/NG Vehicles and Equipment	62 000	62 000	46 000	36 000	36 000	33 000	33 000	32 000	33 000
Rail Transportation	150 000	140 000	130 000	79 000	79 000	71 000	67 000	66 000	68 000
Tire Wear and Brake Lining	-	-	-	-	-	-	-	-	-
AGRICULTURE	2 100	2 200	2 100	2 800	2 900	2 600	2 700	2 900	2 800
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	63 000	70 000	68 000	67 000	68 000	62 000	59 000	62 000	58 000
INCINERATION AND WASTE	6 700	6 700	7 900	4 300	4 400	5 200	4 600	4 600	3 700
PAINTS AND SOLVENTS	-	-	35	15	51	40	35	140	140
DUST	-	-	-	-	-	-	-	-	-
FIRES	7 500	1 400	890	600	670	530	520	1 200	230
GRAND TOTAL	2 200 000	2 700 000	2 300 000	1 400 000	1 400 000	1 300 000	1 200 000	1 200 000	1 200 000

Notes:
 Totals may not add up due to rounding.
 0.00 Indicates emissions were truncated due to rounding.
 - Indicates no emissions

2.4. Volatile Organic Compounds

In 2023, approximately 1.4 Mt of volatile organic compounds (VOCs) were released in Canada (Table 2–6). The Oil and Gas Industry was the largest contributor at 40% (541 kt) of total emissions with the Upstream Oil and Gas Industry sector emitting 38% (517 kt) of the national total. Paints and Solvents were the next-largest contributor, accounting for 20% (271 kt) of emissions, with General Solvent Use accounting for 13% (182 kt) of the national total. Transportation and Mobile Equipment sources accounted for 14% (194 kt) of emissions, with the Off-Road Gasoline / Liquefied Petroleum Gas (LPG) / Natural Gas (NG) Vehicles and Equipment sector contributing 8.5% (117 kt) of the national total. Commercial/Residential/ Institutional sources represented 8.5% (116 kt) of VOC emissions, attributed mainly to Home Firewood Burning (4.6% or 63 kt). The other significant contributing VOC sources were Agriculture and Manufacturing, with 8.3% (114 kt) and 8.0% (110 kt) of total VOC emissions, respectively.

Between 1990 and 2023, VOC emissions decreased by 38% (832 kt) (Figure 2–4). The most significant drivers of this trend are decreases in emissions from the Light-Duty Gasoline Vehicles and Trucks and Off-Road Gasoline/LPG/NG Vehicles and Equipment sector. These decreases are due to increasingly stringent regulations on these spark-ignition engines that have effectively lowered hydrocarbon emissions and VOC emission rates.⁷

Another driver of the downward VOC emissions trend between 1990 and 2023 is the Manufacturing category. The largest contributor to this decrease was from Wood Products, although almost all sectors observed a declining VOC emissions trend from 1990 to 2023. The decrease in emissions from Wood Products can be attributed in part to facilities closing and decreased production of lumber and panel boards, as well as the removal of incinerators at sawmill and panel board mill facilities that incinerated hog fuel.

The Oil and Gas Industry also experienced a decrease in emissions between 1990 and 2023. VOC emissions from the Downstream Oil and Gas Industry decreased by 81% (104 kt) over the time series as emission controls improved and five petroleum refineries closed or were converted to terminal facilities. Conversely, the Upstream Oil and Gas Industry (representing 96% of the Oil and Gas Industry VOC emissions) experienced increased emissions due to growth in the sector, which were most pronounced from 2011 to 2014. The Upstream Oil and Gas Industry experienced a significant decrease of 12% (73 kt) between 2019 and 2023, primarily due to the 14% (85 kt) difference between 2019 and 2020. This VOC decrease results from reductions in venting, storage losses, and equipment leaks at oil and natural gas production and processing facilities. The majority of this decrease is due to a combination of factors that coincided in 2020, including the COVID-19 pandemic. The economic impact of the pandemic resulted in a drastic drop in the price of oil and contraction of the industry as marginal wells were shut in. As a result, there was a 5% reduction in total crude oil production and a 2% reduction

⁷ See Chapter 1 for list of regulations.

in natural gas production in 2020. Additionally, federal and provincial regulations to reduce fugitive CH₄ and VOC emissions from oil and gas operations came into effect in 2020 (ECCC, 2018b; AB, 2018; BC, 2021; SK, 2020), and definitions for vent gas volumes were changed in updated reporting requirements in Alberta, Saskatchewan and British Columbia.⁸

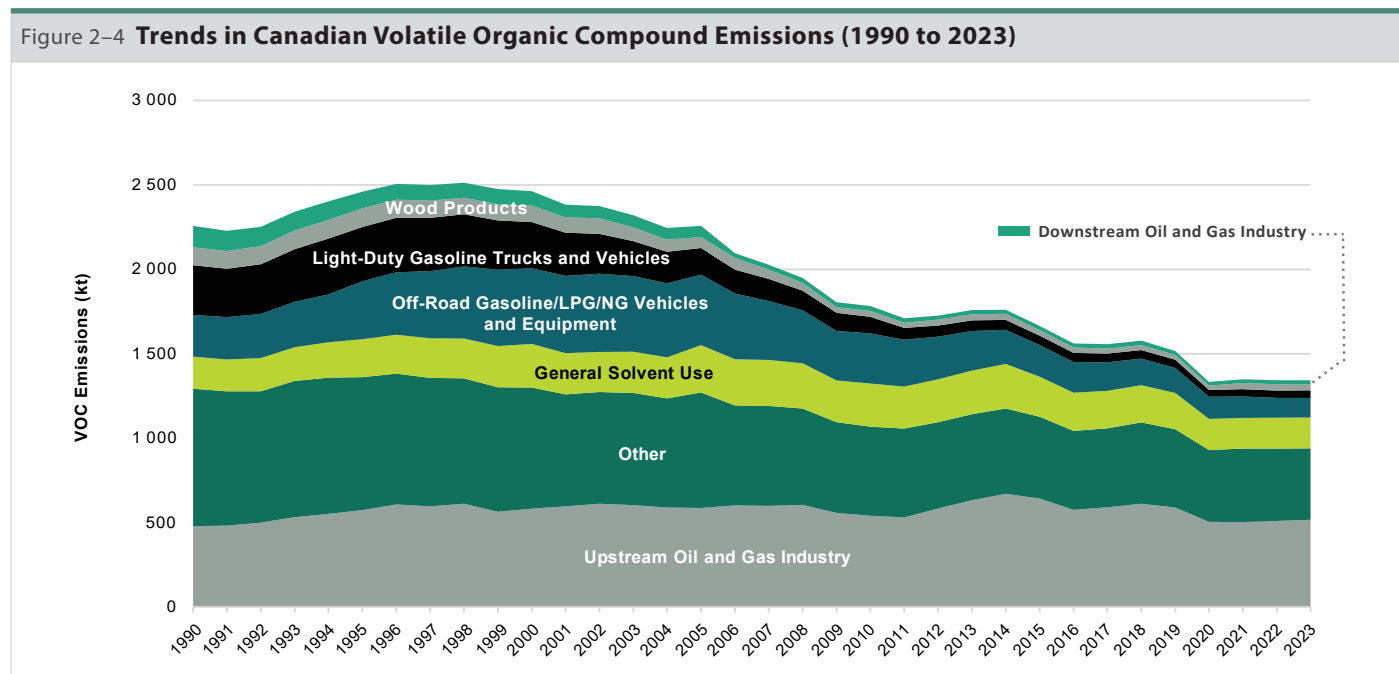
In 2023, emissions of VOCs were 39% (888 kt) below 2005 levels. The main drivers of this downward trend are similar to those between 1990 and 2023. Of note is a significant decrease in Paints and Solvents, with decreases in General Solvent Use between 2005 and 2023. The decrease in General Solvent Use can be associated with declining emissions from solvents in manufacturing as well as from private households.

The most significant changes in VOC emissions from 1990 to 2023 include:

- Transportation and Mobile Equipment: decrease of 69% (440 kt), with:
 - Light-Duty Gasoline Vehicles and Trucks: decrease of 85% (251 kt)
 - Off-Road Gasoline/LPG/NG Vehicles and Equipment: decrease of 53% (130 kt)
- Manufacturing: decrease of 57% (147 kt), with:
 - Wood Products: decrease of 65% (70 kt)
- Oil and Gas Industry: decrease of 11% (66 kt), with:
 - Downstream Oil and Gas Industry: decrease of 81% (104 kt)
 - Upstream Oil and Gas Industry: increase of 7.9% (38 kt)

The most significant changes in VOC emissions from 2005 to 2023 include:

- Transportation and Mobile Equipment: decrease of 71% (471 kt), with:
 - Off-Road Gasoline/LPG/NG Vehicles and Equipment: decrease of 72% (300 kt)
 - Light-Duty Gasoline Vehicles and Trucks: decrease of 72% (115 kt)
- Paints and Solvents: decrease of 38% (167 kt), with:
 - General Solvent Use: decrease of 35% (98 kt)
- Oil and Gas Industry: decrease of 17% (112 kt), with:
 - Upstream Oil and Gas Industry: decrease of 12% (70 kt)
 - Downstream Oil and Gas Industry: decrease of 64% (42 kt)



8 Effective January 1, 2020, updated requirements for the reporting of vent gas volumes in Alberta and Saskatchewan came into effect. Similar changes in British Columbia became effective July 1, 2020. New sources (e.g., venting from pneumatics, compressor seals, etc.), not previously required to be included in reported vent gas volumes, are now reported in the total vented volume. In order to avoid double counting, emissions from these sources are no longer estimated separately for each province, with the exception of pneumatics in Alberta. For Alberta, the availability of Alberta OneStop data delineated by source has allowed ECCC to partly address the changes in the updated requirements. In each case, the updated requirements result in a methodological inconsistency between 2019 and 2020. The methodological inconsistency introduced as a result of the changes to provincial reporting guidelines is a priority and is being actively investigated.

Source	1990	2000	2005	2018	2019 (tonnes)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	21 000	21 000	17 000	12 000	11 000	12 000	12 000	7 100	8 100
OIL AND GAS INDUSTRY	610 000	670 000	650 000	640 000	610 000	530 000	530 000	530 000	540 000
Downstream Oil and Gas Industry	130 000	85 000	66 000	26 000	24 000	22 000	23 000	23 000	24 000
Upstream Oil and Gas Industry	480 000	580 000	590 000	610 000	590 000	500 000	500 000	510 000	520 000
ELECTRIC POWER GENERATION (UTILITIES)	2 500	3 600	3 300	1 200	1 200	1 400	1 400	1 300	1 700
MANUFACTURING	260 000	250 000	190 000	110 000	100 000	98 000	110 000	110 000	110 000
Chemicals Industry	47 000	36 000	26 000	16 000	14 000	12 000	15 000	9 600	9 100
Food Preparation	10 000	13 000	15 000	17 000	17 000	18 000	18 000	18 000	17 000
Plastics Manufacturing	13 000	15 000	15 000	10 000	10 000	9 500	11 000	9 800	13 000
Pulp and Paper Industry	27 000	24 000	23 000	13 000	12 000	12 000	12 000	11 000	10 000
Vehicle Manufacturing (Engines, Parts, Assembly, Painting)	24 000	24 000	18 000	8 900	8 300	6 600	5 700	6 400	7 300
Wood Products	110 000	98 000	64 000	29 000	27 000	25 000	37 000	38 000	37 000
Other Manufacturing Sectors	29 000	45 000	26 000	14 000	15 000	14 000	14 000	14 000	16 000
TRANSPORTATION AND MOBILE EQUIPMENT	630 000	820 000	660 000	250 000	240 000	210 000	200 000	200 000	190 000
Heavy-Duty Diesel Vehicles	11 000	20 000	26 000	10 000	9 100	8 000	8 100	7 700	7 400
Heavy-Duty Gasoline Vehicles	17 000	17 000	12 000	4 200	3 800	3 300	3 100	2 800	2 800
Light-Duty Gasoline Trucks	96 000	120 000	74 000	27 000	27 000	23 000	23 000	24 000	25 000
Light-Duty Gasoline Vehicles	200 000	150 000	85 000	23 000	22 000	18 000	19 000	19 000	19 000
Off-Road Diesel Vehicles and Equipment	40 000	41 000	32 000	18 000	16 000	13 000	13 000	12 000	11 000
Off-Road Gasoline/LPG/NG Vehicles and Equipment	250 000	450 000	420 000	160 000	150 000	130 000	130 000	120 000	120 000
Other Transportation and Mobile Equipment Sectors	24 000	21 000	19 000	14 000	14 000	11 000	11 000	12 000	12 000
AGRICULTURE	100 000	120 000	130 000	120 000	120 000	120 000	120 000	110 000	110 000
Agricultural Fuel Combustion	81	91	82	160	160	150	150	160	160
Animal Production	100 000	120 000	130 000	120 000	120 000	120 000	120 000	110 000	110 000
Crop Production	-	-	-	-	-	-	-	-	-
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	180 000	170 000	150 000	150 000	140 000	120 000	120 000	120 000	120 000
Commercial and Institutional Fuel Combustion	1 000	1 400	1 400	1 600	1 600	1 500	1 400	1 500	1 400
Commercial Cooking	2 000	2 300	2 500	2 300	2 300	2 300	2 300	2 400	2 400
Home Firewood Burning	110 000	92 000	82 000	91 000	82 000	71 000	64 000	68 000	63 000
Human	-	-	-	-	-	-	-	-	-
Marine Cargo Handling	0.34	0.92	1.9	-	-	-	15	14	30
Residential Fuel Combustion	1 500	1 700	1 700	1 600	1 700	1 600	1 500	1 600	1 400
Service Stations	70 000	71 000	65 000	51 000	50 000	44 000	46 000	47 000	48 000
Other (Miscellaneous)	-	-	-	-	-	-	-	-	-
INCINERATION AND WASTE	9 500	12 000	11 000	11 000	11 000	11 000	12 000	12 000	12 000
PAINTS AND SOLVENTS	340 000	380 000	440 000	310 000	310 000	260 000	270 000	270 000	270 000
Dry Cleaning	700	700	220	200	190	180	170	170	170
General Solvent Use	190 000	260 000	280 000	220 000	210 000	180 000	180 000	180 000	180 000
Printing	23 000	33 000	55 000	23 000	24 000	17 000	22 000	23 000	23 000
Surface Coatings	130 000	89 000	100 000	68 000	66 000	60 000	68 000	66 000	66 000
DUST	-	-	-	-	-	-	-	-	-
FIRES	41 000	4 200	3 400	1 800	3 200	2 000	1 600	3 600	800
GRAND TOTAL	2 200 000	2 400 000	2 300 000	1 600 000	1 500 000	1 400 000	1 400 000	1 400 000	1 400 000
Notes: Totals may not add up due to rounding. 0.00 Indicates emissions were truncated due to rounding. - Indicates no emissions									

2.5. Carbon Monoxide

In 2023, approximately 4.5 Mt of carbon monoxide (CO) were released in Canada (Table 2–7). Transportation and Mobile Equipment accounted for 60% (2.7 Mt) of total emissions, with the Off-Road Gasoline/LPG/NG Vehicles and Equipment sector contributing 37% (1.7 Mt) and the Light-Duty Gasoline Trucks and Vehicles sectors contributing 18% (798 kt) of total CO emissions. The next-largest contributors are Commercial/Residential/Institutional sources, which in 2023 accounted for 13% (565 kt) of emissions, almost all owing to contributions from Home Firewood Burning at 12% (527 kt) of total CO emissions. The Upstream Oil and Gas Industry and Aluminium Industry sectors were the largest-emitting industrial contributors, accounting for 11% (506 kt) and 8.5% (386 kt) of CO emissions, respectively.

Between 1990 and 2023, CO emissions decreased by 65% (8.6 Mt) (Figure 2–5). Of the many contributors to the overall decrease in emissions, two in particular, Light-Duty Gasoline Trucks and Vehicles as well as Off-Road Gasoline/LPG/NG Vehicles and Equipment (spark-ignition engines), had the largest impact on emission reductions. The decreasing emission trend in these sectors is due to increasingly stringent engine and vehicle implemented regulations that have effectively lowered CO emission rates from spark-ignition engines.⁹

Emissions from Wood Products manufacturing declined from 1993 to 2016 due to the removal of incinerators at sawmill and panel board mill facilities that incinerated hog fuel and have remained relatively stable since 2016. Furthermore, emissions from Prescribed Burning, within the Fires category, have decreased considerably over the time series reaching their lowest level in 2023, which can be explained by the reduced use of this practice compared to 1990.

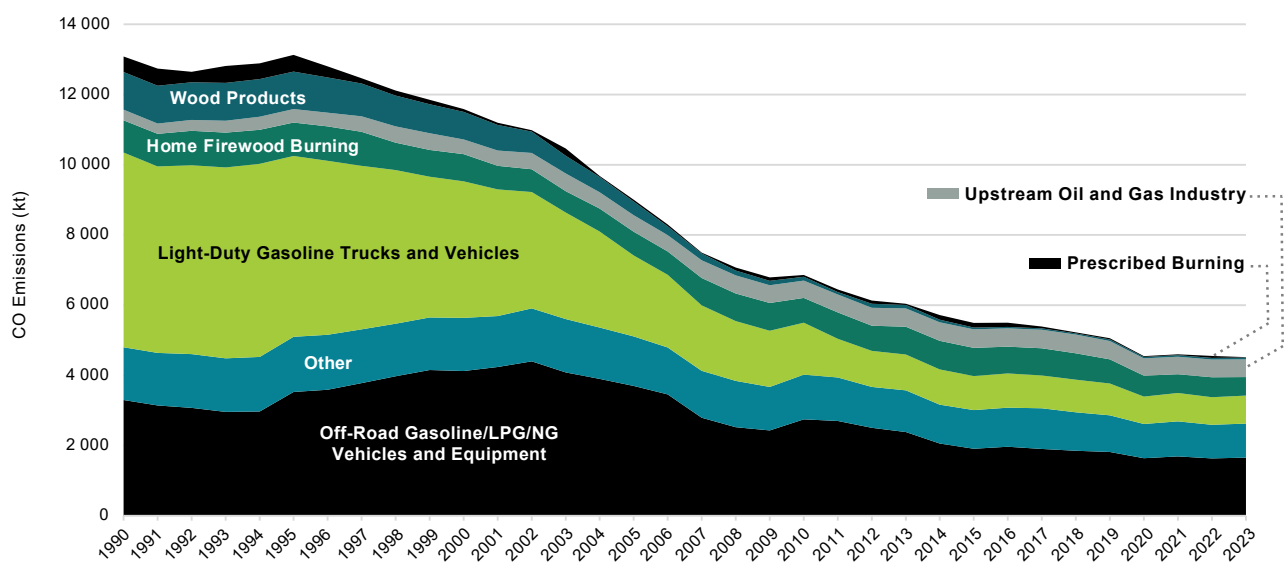
Finally, the Upstream Oil and Gas Industry sector experienced an increase in CO emissions across the time series, but more recently, experienced a decrease between 2019 and 2020 and remained stable between 2020 and 2023. The increase between 1990 and 2023 is attributed to expansion and growth in the oil and gas industry. The 18 kt (3.4%) decrease between the years 2019 and 2023 can be attributed to a 5.1% reduction in reported fuel gas consumption over this period.

9 See Chapter 1 for a list of regulations.

The most significant changes in CO emissions from 1990 to 2023 include:

- Transportation and Mobile Equipment: decrease of 72% (6.9 Mt), with:
 - Light-Duty Gasoline Trucks and Vehicles: decrease of 86% (4.8 Mt)
 - Off-Road Gasoline/LPG/NG Vehicles and Equipment: decrease of 50% (1.6 Mt)
- Manufacturing: decrease of 91% (1.2 Mt)
 - Wood Products: decrease of 96% (1.0 Mt)
- Fires: decrease of 97% (431 kt), with:
 - Prescribed Burning: decrease of 98% (430 kt)
- Oil and Gas Industry: increase of 61% (205 kt), with:
 - Upstream Oil and Gas Industry: increase of 66% (201 kt)

Figure 2–5 Trends in Canadian CO Emissions (1990 to 2023)



Source	1990	2000	2005	2018	2019 (tonnes)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	390 000	400 000	510 000	530 000	510 000	510 000	510 000	500 000	520 000
Aluminium Industry	240 000	250 000	310 000	380 000	360 000	390 000	380 000	370 000	390 000
Other Ore and Mineral Industries Sectors	150 000	150 000	200 000	150 000	150 000	130 000	130 000	130 000	130 000
OIL AND GAS INDUSTRY	330 000	440 000	490 000	560 000	540 000	510 000	540 000	520 000	540 000
Downstream Oil and Gas Industry	29 000	23 000	21 000	30 000	14 000	14 000	36 000	22 000	33 000
Upstream Oil and Gas Industry	300 000	420 000	470 000	530 000	520 000	500 000	500 000	500 000	510 000
ELECTRIC POWER GENERATION (UTILITIES)	50 000	43 000	52 000	36 000	30 000	30 000	38 000	41 000	39 000
MANUFACTURING	1 300 000	1 000 000	530 000	140 000	150 000	120 000	130 000	130 000	120 000
Pulp and Paper Industry	180 000	150 000	98 000	82 000	80 000	69 000	63 000	60 000	58 000
Wood Products	1 100 000	790 000	390 000	35 000	46 000	37 000	44 000	49 000	48 000
Other Manufacturing Sectors	75 000	110 000	42 000	19 000	21 000	17 000	19 000	22 000	18 000
TRANSPORTATION AND MOBILE EQUIPMENT	9 600 000	8 800 000	6 600 000	3 100 000	3 100 000	2 700 000	2 800 000	2 700 000	2 700 000
Air Transportation (LTO)	30 000	22 000	21 000	26 000	29 000	22 000	24 000	25 000	26 000
Domestic Marine Navigation, Fishing and Military	5 900	6 900	7 700	3 100	3 200	2 800	2 800	3 100	3 200
Heavy-Duty Diesel Vehicles	44 000	81 000	110 000	62 000	58 000	52 000	55 000	55 000	53 000
Heavy-Duty Gasoline Vehicles	290 000	320 000	260 000	100 000	99 000	87 000	81 000	65 000	67 000
Heavy-Duty LPG/NG Vehicles	61 000	2 600	990	1 500	1 900	2 000	2 300	2 700	2 500
Light-Duty Diesel Trucks	57 000	49 000	36 000	7 300	6 800	5 900	6 800	7 900	7 500
Light-Duty Diesel Vehicles	23 000	14 000	10 000	4 400	4 200	3 400	3 900	4 400	4 000
Light-Duty Gasoline Trucks	2 200 000	1 900 000	1 200 000	530 000	530 000	470 000	470 000	460 000	480 000
Light-Duty Gasoline Vehicles	3 300 000	2 000 000	1 100 000	400 000	380 000	320 000	330 000	320 000	320 000
Light-Duty LPG/NG Trucks	5 800	390	190	71	41	24	24	20	21
Light-Duty LPG/NG Vehicles	17	5.4	1.6	1.1	0.93	1.2	2.1	1.5	1.7
Motorcycles	30 000	38 000	33 000	31 000	32 000	26 000	28 000	24 000	25 000
Off-Road Diesel Vehicles and Equipment	180 000	190 000	150 000	92 000	83 000	69 000	65 000	59 000	54 000
Off-Road Gasoline/LPG/NG Vehicles and Equipment	3 300 000	4 100 000	3 700 000	1 900 000	1 800 000	1 600 000	1 700 000	1 600 000	1 700 000
Rail Transportation	15 000	14 000	15 000	16 000	16 000	15 000	14 000	14 000	14 000
Tire Wear and Brake Lining	-	-	-	-	-	-	-	-	-
AGRICULTURE	630	690	520	1 100	1 100	1 000	1 000	1 100	1 100
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	950 000	810 000	720 000	800 000	730 000	630 000	570 000	610 000	560 000
Home Firewood Burning	920 000	770 000	680 000	750 000	690 000	590 000	540 000	570 000	530 000
Other Commercial/Residential/Institutional Sectors	33 000	39 000	39 000	42 000	40 000	40 000	38 000	40 000	38 000
INCINERATION AND WASTE	8 500	10 000	9 900	8 900	8 200	8 800	8 600	9 200	8 500
PAINTS AND SOLVENTS	-	-	6.4	-	-	-	-	130	130
DUST	-	-	-	-	-	-	-	-	-
FIRES	440 000	78 000	52 000	30 000	36 000	26 000	26 000	57 000	12 000
Prescribed Burning	440 000	76 000	51 000	29 000	35 000	25 000	25 000	56 000	11 000
Structural Fires	2 100	1 700	1 500	1 200	1 000	1 100	1 200	1 200	1 200
GRAND TOTAL	13 000 000	12 000 000	9 000 000	5 200 000	5 100 000	4 500 000	4 600 000	4 600 000	4 500 000

Notes:
Totals may not add up due to rounding.
0.00 Indicates emissions were truncated due to rounding.
- Indicates no emissions

2.6. Ammonia

In 2023, approximately 495 kt of ammonia (NH₃) were released in Canada (Table 2–8). NH₃ emissions originated primarily from Agriculture, which accounted for 94% (463 kt) of total emissions with 54% (270 kt) from Animal Production sources and 39% (193 kt) from Crop Production sources. All other sources combined accounted for only 6% of emissions.

From 1990 to 2023, an exception to the general downward trends of air pollutant emissions in Canada is NH₃ emissions increase of 25% (99 kt) (Figure 2–6). NH₃ emissions increased steadily from 1990 to 2004 and have since fluctuated, reaching their highest level in 2021 and with a 2023 level similar to 2004 levels. This trend is primarily driven by the increasing use of inorganic nitrogen fertilizers in crop production and emissions from animal production. Animal Production, which accounts for most emissions throughout the time series, experienced a steady increase in emissions from 1990 to 2005, followed by a sharp decrease from 2006 to 2011, and has since stabilized. Emissions from Crop Production, however, have been steadily increasing.

The most significant changes in NH₃ emissions from 1990 to 2023 include:

- Agriculture: increase of 30% (106 kt), with:
 - Crop Production: increase of 136% (111 kt)
 - Animal Production: decrease of 1.9% (5.1 kt)

Figure 2–6 Trends in Canadian NH₃ Emissions (1990 to 2023)

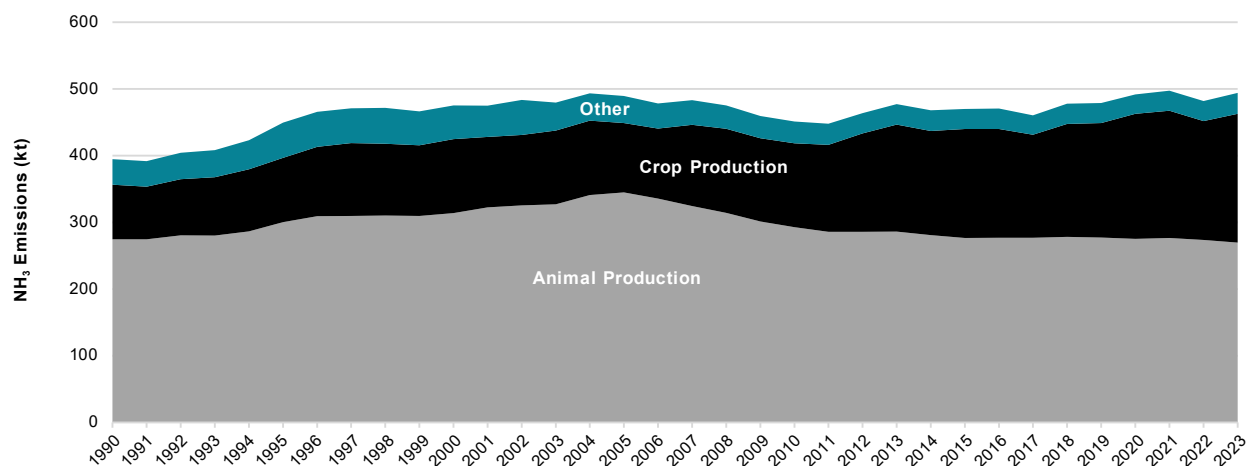


Table 2–8 National Summary of Annual NH₃ Emissions

Source	1990	2000	2005	2018	2019	2020	2021	2022	2023
	(tonnes)								
ORE AND MINERAL INDUSTRIES	1 800	2 200	1 100	1 400	1 500	1 400	1 500	1 500	1 600
OIL AND GAS INDUSTRY	560	1 600	2 200	1 800	2 200	1 700	2 200	2 600	2 700
ELECTRIC POWER GENERATION (UTILITIES)	710	1 400	990	220	220	220	260	240	420
MANUFACTURING	20 000	25 000	17 000	12 000	11 000	12 000	11 000	10 000	11 000
Chemicals Industry	9 900	15 000	11 000	9 400	8 700	9 900	8 900	7 900	9 000
Pulp and Paper Industry	4 400	3 600	2 600	1 600	1 500	1 400	1 300	1 300	1 200
Wood Products	4 800	4 800	2 600	700	630	570	890	920	880
Other Manufacturing Sectors	1 000	1 200	730	380	400	380	350	350	320
TRANSPORTATION AND MOBILE EQUIPMENT	5 900	12 000	11 000	7 300	7 400	6 200	6 600	6 800	6 900
AGRICULTURE	360 000	420 000	450 000	450 000	450 000	460 000	470 000	450 000	460 000
Agricultural Fuel Combustion	44	41	28	23	22	20	18	20	19
Animal Production	270 000	310 000	340 000	280 000	280 000	280 000	280 000	270 000	270 000
Crop Production	82 000	110 000	100 000	170 000	170 000	190 000	190 000	180 000	190 000
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	2 600	2 400	2 200	2 200	2 100	1 900	1 800	1 900	1 800
INCINERATION AND WASTE	6 000	6 200	6 100	5 900	6 000	6 100	6 800	7 000	7 100
PAINTS AND SOLVENTS	-	0.052	0.050	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	1 100	130	100	60	93	63	53	110	29
GRAND TOTAL	400 000	480 000	490 000	480 000	480 000	490 000	500 000	480 000	490 000

Notes:

Totals may not add up due to rounding.

0.00 Indicates emissions were truncated due to rounding.

- Indicates no emissions

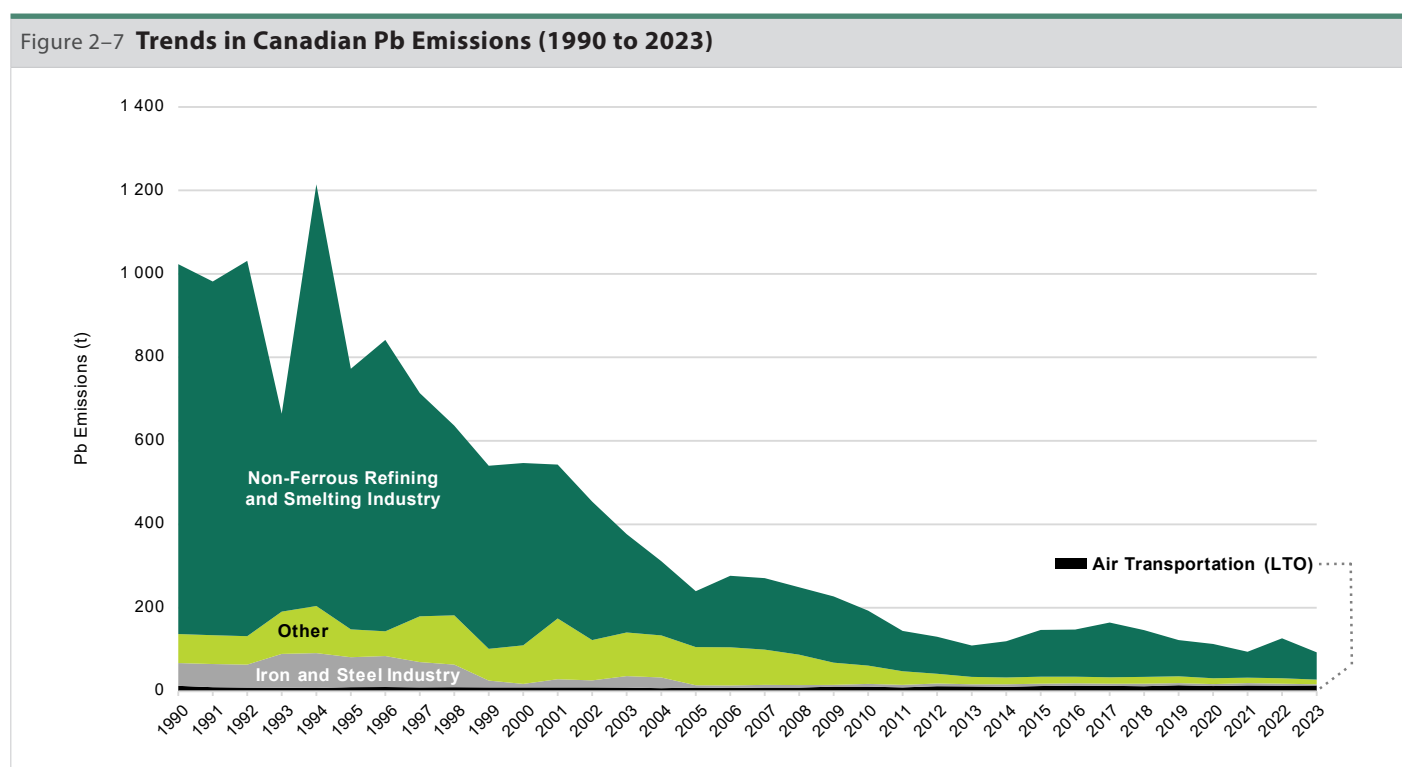
2.7. Lead

In 2023, approximately 93 tonnes (t) of lead (Pb) were emitted in Canada (Table 2–9). Ore and Mineral Industries were the largest contributor at 79% (74 t) of emissions, with the Non-Ferrous Refining and Smelting Industry sector accounting for the largest share at 70% (65 t) of total Pb emissions. Transportation and Mobile Equipment was the second-largest contributor at 15% (14 t) of total emissions, almost all of which came from the Air Transportation (Landing and Takeoff [LTO]) sector.

Overall, Pb emissions decreased by 91% (930 t) from 1990 to 2023 (Figure 2–7). This decreasing trend is attributable partly to the closure of outdated smelters and partly to the implementation, since 2005, of pollution prevention plans and facilities achieving BLIERs for particulate matters through environmental performance agreements (ECCC, 2017, 2018a). Although, since 2013, Pb emissions attributed to the Non-Ferrous Refining and Smelting Industry sector have fluctuated, in general the trend is decreasing. It should also be noted that even though BLIERs were written with focus on particulate matters, reduction of Pb emissions over the years has been an additional positive outcome. Since 2020, Pb emissions in Ore and Mineral industries have become sensitive to the inter-annual fluctuations in sampling results from operations at a single facility that accounts for 74 to 93% of emissions from the Non-Ferrous Refining and Smelting Industry. Other sectors aside from the Ore and Mineral Industries and the Manufacturing category also showed decreases since 1990 but to a lesser extent, having a minimized impact on the overall Pb emission trends compared to the Non-Ferrous Refining and Smelting Industry sector.

The most significant changes in Pb emissions from 1990 to 2023 include:

- Ore and Mineral Industries: decrease of 92% (876 t), with:
 - Non-Ferrous Refining and Smelting Industry: decrease of 93% (821 t)



Source	1990	2000	2005	2018	2019 (kg)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	950 000	500 000	220 000	130 000	100 000	94 000	74 000	110 000	74 000
Aluminium Industry	120	100	-	-	-	-	-	-	-
Asphalt Paving Industry	1 400	1 200	1 200	980	1 000	1 000	1 100	940	960
Cement and Concrete Industry	550	610	950	400	500	350	350	210	230
Foundries	4 800	14 000	8 900	1 300	1 900	1 900	1 300	1 500	1 300
Iron and Steel Industry	55 000	8 300	5 700	6 200	4 900	4 800	5 400	4 800	3 100
Iron Ore Pelletizing	-	-	-	2 900	3 100	2 400	2 300	2 200	1 600
Mineral Products Industry	1 500	440	0 090	-	-	2 7	5 4	5 7	41
Mining and Rock Quarrying	-	42 000	65 000	1 600	2 300	1 500	1 800	1 300	1 200
Non-Ferrous Refining and Smelting Industry	890 000	440 000	130 000	110 000	87 000	82 000	62 000	96 000	65 000
OIL AND GAS INDUSTRY	340	300	720	570	420	550	580	510	610
ELECTRIC POWER GENERATION (UTILITIES)	11 000	15 000	1 900	1 300	1 500	1 200	1 200	950	910
MANUFACTURING	43 000	14 000	7 400	4 000	3 000	2 500	2 600	2 600	2 200
Chemicals Industry	12 000	300	1 800	30	16	61	35	53	39
Metal Fabrication	16 000	5 200	760	480	440	430	270	230	310
Vehicle Manufacturing (Engines, Parts, Assembly, Painting)	7 200	3 800	790	67	88	52	69	64	59
Other Manufacturing Sectors	7 800	4 400	4 100	3 500	2 500	2 000	2 200	2 200	1 800
TRANSPORTATION AND MOBILE EQUIPMENT	14 000	11 000	11 000	13 000	15 000	13 000	14 000	14 000	14 000
Air Transportation (LTO)	13 000	9 400	8 800	12 000	15 000	12 000	14 000	13 000	14 000
Other Transportation and Mobile Equipment Sectors	1 600	1 800	1 800	1 100	540	740	520	1 000	660
AGRICULTURE	30	30	26	27	26	23	20	21	21
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	4 500	3 100	3 200	2 000	1 800	1 600	1 400	1 500	1 400
INCINERATION AND WASTE	380	370	390	180	160	120	160	180	130
PAINTS AND SOLVENTS	-	16	-	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	-	-	-	-	-	-	-	-	-
GRAND TOTAL	1 000 000	550 000	240 000	150 000	120 000	110 000	95 000	130 000	93 000

Notes:
Totals may not add up due to rounding.
0.00 Indicates emissions were truncated due to rounding.
- Indicates no emissions

2.8. Cadmium

Approximately 4.3 t of cadmium (Cd) were emitted in Canada in 2023 (Table 2-10). Ore and Mineral Industries accounted for 59% (2.6 t) of national emissions, with the Non-Ferrous Refining and Smelting Industry sector contributing 47% (2.0 t) of the national total. Commercial/Residential/Institutional fuel combustion sources contributed 21% (0.93 t) and the Oil and Gas Industry to 8.3% (0.36 t) of total Cd emissions.

From 1990 to 2023, national Cd emissions decreased by 95% (77 t) (Figure 2-8). This trend is almost entirely driven by the Non-Ferrous Refining and Smelting Industry sector. Emissions from this industry fluctuated greatly between 1990 and 2006 but decreased steadily from 2007 onward. As with Pb emissions, reductions in Cd emissions coincide with the closure of outdated smelters, the implementation of pollution prevention plans and facilities achieving BLIERs for particulate matter through Environmental Performance Agreements (ECCC, 2017, 2018a). Even though BLIERs were written with focus on particulate matters, reduction of Cd emissions over the years has been an additional positive outcome. Fluctuations in emissions prior to 2010 are almost entirely driven by emissions from a single smelter in Manitoba that is now closed.

The most significant changes in Cd emissions from 1990 to 2023 include:

- Ore and Mineral Industries: decrease of 97% (76 t), with:
 - Non-Ferrous Refining and Smelting Industry: decrease of 97% (76 t)

Figure 2–8 Trends in Canadian Cd Emissions (1990 to 2023)

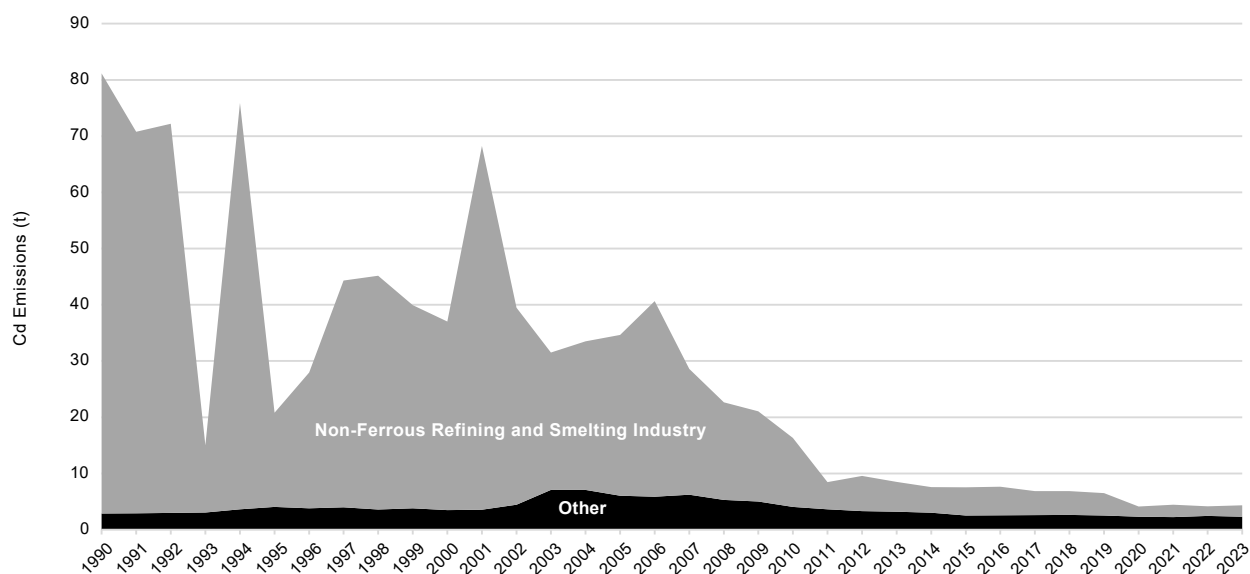


Table 2–10 National Summary of Annual Cd Emissions

Source	1990	2000	2005	2018	2019 (kg)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	79 000	34 000	32 000	5 000	4 600	2 400	2 800	2 300	2 600
Aluminium Industry	1.2	2.1	-	-	-	-	-	-	-
Asphalt Paving Industry	26	24	25	19	18	18	20	17	18
Cement and Concrete Industry	46	46	44	9.6	2.8	6.2	2.5	2.8	4.1
Foundries	50	57	310	320	370	310	260	280	260
Iron and Steel Industry	160	180	310	230	170	150	170	170	120
Iron Ore Pelletizing	-	-	-	48	52	48	46	48	45
Mineral Products Industry	25	24	-	-	-	-	-	-	-
Mining and Rock Quarrying	-	550	2 900	100	70	59	54	49	50
Non-Ferrous Refining and Smelting Industry	78 000	34 000	29 000	4 200	4 000	1 800	2 200	1 700	2 000
OIL AND GAS INDUSTRY	130	190	190	260	230	230	230	320	360
ELECTRIC POWER GENERATION (UTILITIES)	130	130	250	97	110	99	96	110	120
MANUFACTURING	1 000	870	610	290	240	230	240	260	230
TRANSPORTATION AND MOBILE EQUIPMENT	160	170	190	65	55	46	44	45	47
AGRICULTURE	51	54	64	80	84	75	76	80	76
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	990	1 100	1 100	1 100	1 100	1 000	970	1 000	930
Commercial and Institutional Fuel Combustion	340	510	480	530	550	500	480	510	470
Residential Fuel Combustion	540	500	500	450	460	430	420	440	390
Other Commercial/Residential/Institutional Sectors	98	84	120	92	82	71	65	68	63
INCINERATION AND WASTE	76	90	40	24	26	39	39	35	28
PAINTS AND SOLVENTS	-	-	0.00	0.14	0.14	0.14	0.15	0.15	0.15
DUST	-	-	-	-	-	-	-	-	-
FIRES	-	-	-	-	-	-	-	-	-
GRAND TOTAL	81 000	37 000	35 000	6 900	6 500	4 100	4 500	4 100	4 300

Notes:

Totals may not add up due to rounding.

0.00 Indicates emissions were truncated due to rounding.

- Indicates no emissions

2.9. Mercury

Approximately 3.1 t of mercury (Hg) were emitted in Canada in 2023 (Table 2–11). Ore and Mineral Industries accounted for 35% (1.1 t) of Hg emissions in 2023, with the Non-Ferrous Refining and Smelting Industry and Iron and Steel Industry sectors contributing 11% (0.33 t) and 10% (0.32 t) of the national total, respectively. Incineration and Waste sources accounted for 28% (0.86 t) of Hg emissions in 2023, with Crematoriums being the largest contributor at 22% (0.68 t). Electric Power Generation (Utilities) accounted for 15% (0.47 t) of 2023 emissions, most of which were emitted from coal-powered electric generation with 13% (0.40 t) of the annual national total.

Between 1990 and 2023, Hg emissions decreased by 91% (30 t) (Figure 2–9). This decrease in emissions is mainly due to a large decrease in emissions from the Non-Ferrous Refining and Smelting Industry sector. As with Pb and Cd emissions, reductions in Hg emissions coincide with the closure of outdated smelters, the implementation of pollution prevention plans, achieving BLIERs for particulate matter through Environmental Performance Agreements, increased emission control measures, such as changing feedstocks, improved particulate matter emission controls and fuel switching (ECCC, 2017, 2018a). Emission sources from the Electric Power Generation (Utilities) and Incineration and Waste categories also contributed to the overall decrease in Hg emissions, but to a lesser extent.

The most significant changes in Hg emissions from 1990 to 2023 include:

- Ore and Mineral Industry: decrease of 96% (25 t), with:
 - Non-Ferrous Refining and Smelting Industry: decrease of 99% (25 t)

Figure 2–9 Trends in Canadian Hg Emissions (1990 to 2023)

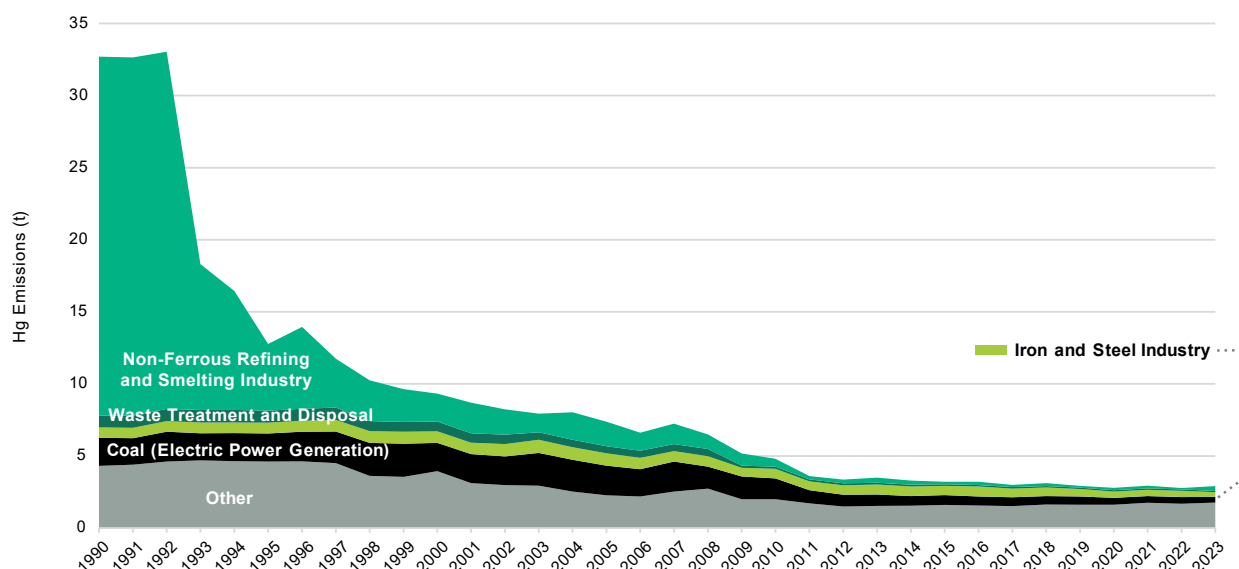


Table 2–11 National Summary of Annual Hg Emissions									
Source	1990	2000	2005	2018	2019 (kg)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	26 000	3 400	2 900	1 300	1 200	1 100	1 200	990	1 100
Iron and Steel Industry	710	800	860	600	520	440	440	440	320
Non-Ferrous Refining and Smelting Industry	25 000	1 900	1 700	200	120	160	190	95	330
Other Ore and Mineral Industries Sectors	790	630	360	530	530	510	580	460	450
OIL AND GAS INDUSTRY	120	61	83	74	70	68	76	92	170
ELECTRIC POWER GENERATION (UTILITIES)	2 200	2 000	2 200	610	600	500	500	500	470
Coal	1 900	2 000	2 000	590	580	480	470	470	400
Other Electric Power Generation (Utilities) Sectors	300	84	120	25	25	24	25	32	71
MANUFACTURING	1 100	1 400	500	110	79	78	89	84	82
TRANSPORTATION AND MOBILE EQUIPMENT	110	110	120	78	74	64	63	64	65
AGRICULTURE	2.8	3.4	3.2	6.7	6.7	6.1	6.2	6.5	6.7
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	980	780	740	450	440	410	390	390	360
INCINERATION AND WASTE	2 600	2 200	1 400	740	750	810	860	880	860
Crematoriums	190	260	330	560	570	630	640	700	680
Waste Incineration	1 600	1 300	600	81	91	91	130	92	100
Waste Treatment and Disposal	820	680	490	92	91	90	94	88	85
PAINTS AND SOLVENTS	-	-	-	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	-	-	-	-	-	-	-	-	-
GRAND TOTAL	34 000	9 900	7 900	3 400	3 200	3 000	3 200	3 000	3 100

Notes:
 Totals may not add up due to rounding.
 0.00 Indicates emissions were truncated due to rounding.
 - Indicates no emissions

2.10. Dioxins and Furans

In 2023, emissions of dioxins and furans (D/F) in Canada totaled 77 grams of toxicity equivalent (gTEQ) (Table 2–12). The Incineration and Waste source accounted for the largest share of these emissions at 37% (28 gTEQ), with Waste Incineration accounting for 22% (17 gTEQ) of the national total. Transportation and Mobile Equipment contributed 32% (25 gTEQ) of 2023 dioxins and furans emissions, 25% (20 gTEQ) of which are attributed to Light-Duty Gasoline Trucks and Vehicles. Ore and Mineral Industries accounted for 24% (18 gTEQ) of 2023 dioxins and furans emissions with the Asphalt Paving Industry being the largest sector contributing to this source with 10% (8.0 gTEQ) of total dioxins and furans emissions followed by the Iron Ore Pelletizing sector with 5.5% (4.1 gTEQ) of national emissions.

Between 1990 and 2023, dioxins and furans emissions decreased by 67% (156 gTEQ) (Figure 2–10). This decrease is due to large reductions in emissions from Waste Incineration between 2001 and 2012 resulting from improvements made in incineration technologies and closure of smaller batch incinerators. Ore and Mineral Industries also contributed to the overall dioxins and furans emissions decrease between 1997 and 2009, associated with effective emission controls on coke ovens and coke by-product plants in the Iron and Steel Industry (EC, 2001).

The most significant changes in dioxins and furans emissions from 1990 to 2023 include:

- Incineration and Waste: decrease of 73% (78 gTEQ), with:
 - Waste Incineration: decrease of 83% (86 gTEQ)
- Ore and Mineral Industries: decrease of 72% (46 gTEQ), with:
 - Iron and Steel Industry: decrease of 89% (31 gTEQ)

Figure 2–10 Trends in Canadian Dioxins and Furans Emissions (1990 to 2023)

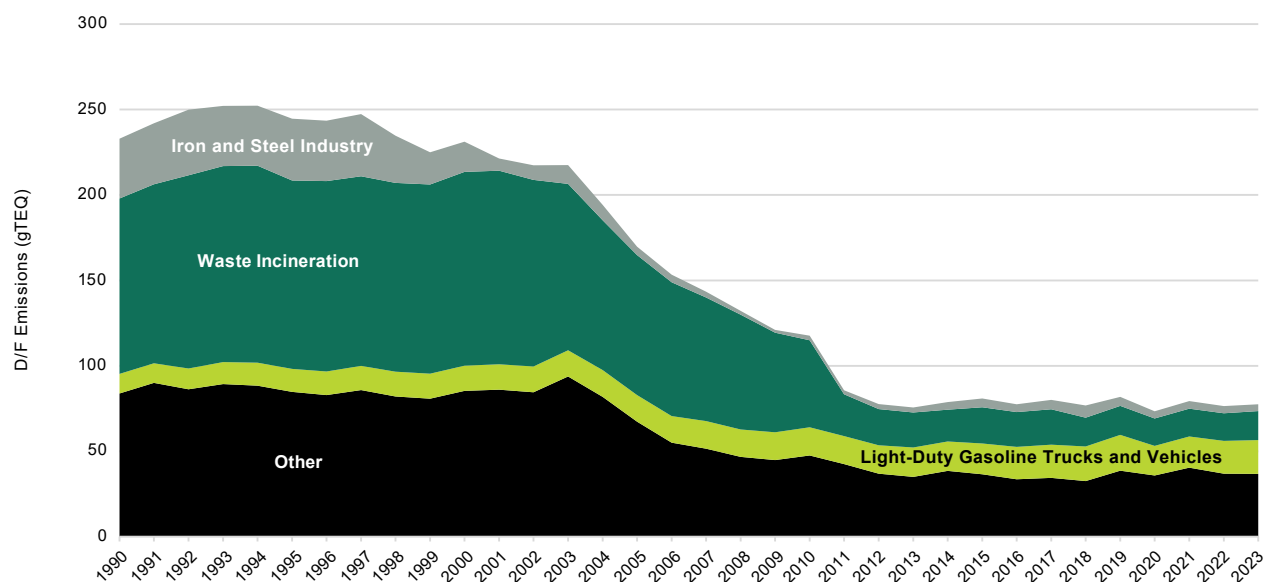


Table 2–12 National Summary of Annual Dioxins and Furans Emissions

Source	1990	2000	2005	2018	2019 (gTEQ)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	64	54	27	15	20	18	23	17	18
Asphalt Paving Industry	19	21	13	4.7	9.9	7.5	10	6.0	8.0
Iron and Steel Industry	35	18	5.0	7.1	5.3	4.2	4.4	4.2	4.0
Iron Ore Pelletizing	-	-	-	-	-	2.4	5.1	4.5	4.1
Other Ore and Mineral Industries Sectors	11	15	9.1	3.1	4.9	3.7	2.8	2.7	2.2
OIL AND GAS INDUSTRY	-	-	-	-	-	-	-	-	-
ELECTRIC POWER GENERATION (UTILITIES)	3.0	6.2	5.5	1.5	0.95	0.59	0.49	0.66	0.51
MANUFACTURING	19	13	8.1	2.0	1.7	1.5	1.8	1.4	1.7
TRANSPORTATION AND MOBILE EQUIPMENT	26	31	34	26	27	22	23	24	25
Domestic Marine Navigation, Fishing and Military	13	14	16	3.2	3.5	2.7	2.6	3.0	3.2
Light-Duty Gasoline Trucks	3.2	5.6	6.5	12	12	11	11	12	13
Light-Duty Gasoline Vehicles	8.3	9.1	9.0	8.5	8.5	6.7	7.0	7.2	7.1
Rail Transportation	1.1	1.1	1.2	1.2	1.2	1.1	1.1	1.1	1.1
Other Transportation and Mobile Equipment Sectors	1.1	1.5	1.8	1.3	1.3	1.1	1.2	1.1	1.1
AGRICULTURE	0.058	0.054	0.00	0.42	0.40	0.31	0.25	0.25	0.27
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	6.3	5.4	4.8	4.5	4.0	3.5	3.2	3.4	3.1
INCINERATION AND WASTE	110	120	89	27	27	27	27	27	28
Crematoriums	2.8	3.3	3.9	6.2	6.5	7.0	7.1	7.5	7.4
Waste Incineration	100	110	82	17	17	16	16	16	17
Waste Treatment and Disposal	1.1	2.8	3.6	3.8	3.7	3.9	3.9	3.9	3.9
PAINTS AND SOLVENTS	-	-	-	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	7.6	1.5	0.92	0.64	0.68	0.54	0.55	1.3	0.22
GRAND TOTAL	230	230	170	77	82	73	79	76	77

Notes:

Totals may not add up due to rounding.

0.00 Indicates emissions were truncated due to rounding.

- Indicates no emissions

2.11. Polycyclic Aromatic Hydrocarbons

The APEI reports emissions of four polycyclic aromatic hydrocarbons (PAHs): benzo(a)pyrene (B(a)p), benzo(b)fluoranthene (B(b)f), benzo(k)fluoranthene (B(k)f) and indeno(1,2,3-cd)pyrene (I(cd)p). The analysis presented here is based on the aggregate total of all four substances. In 2023, 20 t of PAHs were emitted in Canada (Table 2–13), with 84% (17 t) attributed to Commercial/Residential/Institutional sources. This is almost entirely due to Home Firewood Burning, this sector being the largest contributor to PAH emissions, with 84% (17 t) of 2023 total emissions. Transportation and Mobile Equipment was the next largest source, contributing 11% (2.2 t) of PAH emissions in 2023.

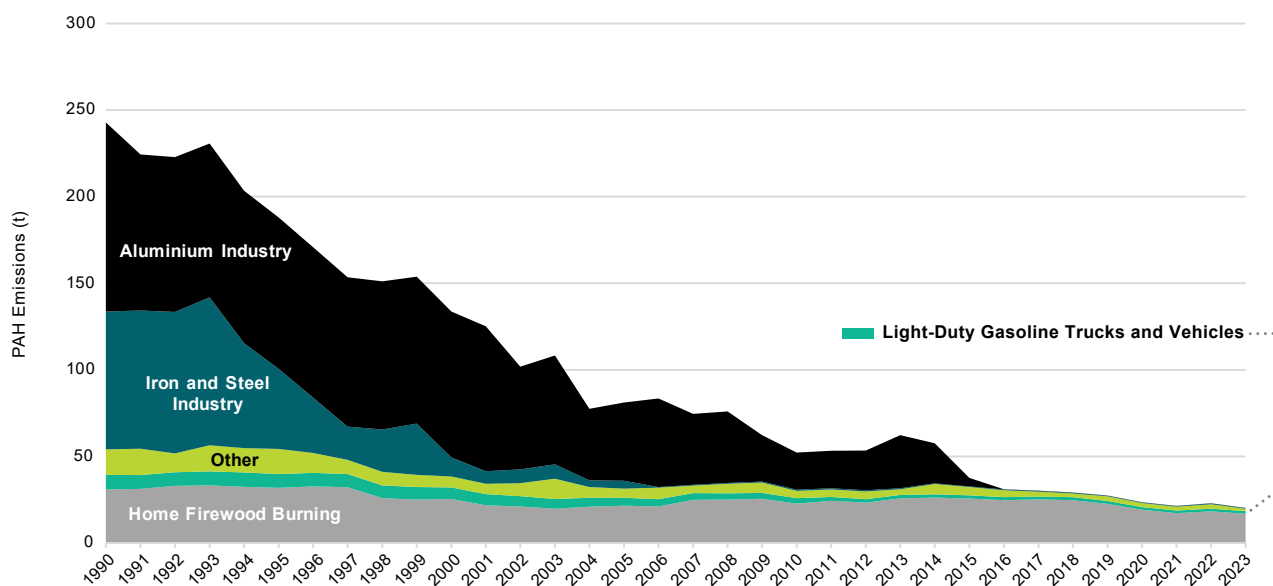
From 1990 to 2023, PAH emissions decreased by 92% (223 t) (Figure 2–11), primarily owing to emission reductions in the Aluminium Industry and Iron and Steel Industry sectors of almost 100% each (109 t and 79 t, respectively). Emissions from the Aluminium Industry experienced a large decrease in PAH emissions from 2008 to 2016 owing to process improvements and the progressive phase-out of old Söderberg aluminium production technologies (ECCC, 2014). Emissions of these four types of PAHs from the Iron and Steel Industry dropped significantly earlier in the time series, from 1993 to 2006, and emissions remained small through 2023. Reductions here are a result of effective emission controls on coke ovens and coke by-product plants (EC, 2001).

Within Commercial/Residential/Institutional sources, Home Firewood Burning contributed to the downward trend across the 1990 to 2023 time series. PAH emissions from Home Firewood Burning fluctuate from year to year, but have resulted in an overall decrease in emissions of 45% (14 t). This decrease is owed to a 32% reduction in wood consumption and the adoption of more efficient wood combustion equipment.

The most significant changes in PAH emissions from 1990 to 2023 include:

- Ore and Mineral Industries: decrease of almost 100% (188 t), with:
 - Aluminium Industry: decrease of almost 100% (109 t)
 - Iron and Steel Industry: decrease of almost 100% (79 t)
- Commercial/Residential/Institutional sources: decrease of 45% (14 t)
 - Home Firewood Burning: decrease of 45% (14 t)

Figure 2–11 Trends in Canadian Polycyclic Aromatic Hydrocarbons Emissions (1990 to 2023)



Source	1990	2000	2005	2018	2019 (kg)	2020	2021	2022	2023
ORE AND MINERAL INDUSTRIES	190 000	95 000	50 000	620	540	470	470	500	400
Aluminium Industry	110 000	84 000	45 000	190	140	83	89	89	72
Iron and Steel Industry	80 000	11 000	4 600	400	370	370	370	400	310
Other Ore and Mineral Industries Sectors	33	30	42	30	31	19	12	10	10
OIL AND GAS INDUSTRY	150	95	46	22	470	470	480	55	61
ELECTRIC POWER GENERATION (UTILITIES)	370	360	240	0.00	0.00	0.00	6.5	5.1	5.9
MANUFACTURING	320	310	290	140	150	160	120	120	210
TRANSPORTATION AND MOBILE EQUIPMENT	12 000	10 000	7 800	2 700	2 600	2 300	2 300	2 200	2 200
Heavy-Duty Diesel Vehicles	2 200	2 300	2 400	600	520	460	450	400	390
Heavy-Duty Gasoline Vehicles	1 300	880	660	260	260	230	210	180	190
Light-Duty Gasoline Trucks	2 700	3 000	2 200	1 100	1 100	970	990	970	1 000
Light-Duty Gasoline Vehicles	5 700	3 800	2 400	630	610	490	500	490	480
Other Transportation and Mobile Equipment Sectors	480	220	230	150	150	120	120	120	130
AGRICULTURE	0.32	0.31	0.21	0.23	0.23	0.21	0.20	0.21	0.20
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	31 000	25 000	22 000	25 000	23 000	19 000	17 000	18 000	17 000
Home Firewood Burning	31 000	25 000	22 000	25 000	23 000	19 000	17 000	18 000	17 000
Other Commercial/Residential/Institutional Sectors	110	120	130	120	120	120	120	120	120
INCINERATION AND WASTE	34	35	39	38	37	37	36	36	37
PAINTS AND SOLVENTS	-	-	-	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	9 800	2 000	1 200	820	870	700	700	1 600	290
GRAND TOTAL	240 000	130 000	81 000	29 000	27 000	23 000	21 000	23 000	20 000

Notes:
 Totals may not add up due to rounding.
 PAH includes B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p.
 0.00 Indicates emissions were truncated due to rounding.
 - Indicates no emissions

2.12. Hexachlorobenzene

In 2023, approximately 4.8 kg of hexachlorobenzene (HCB) were emitted in Canada (Table 2–14). Ore and Mineral Industries was the largest contributor, with 77% (3.7 kg) of total emissions. Within the same source category, the Cement and Concrete Industry accounted for 29% (1.4 kg) of the national total. The Iron and Steel Industry and Iron Ore Pelletizing sectors contributed to 21% (1.0 kg) and 13% (0.64 kg), respectively, of the total HCB emissions. Incineration and Waste was the second-largest contributor in 2023 with 18% (0.87 kg) of total HCB emissions.

Overall, HCB emissions decreased by 88% (34 kg) from 1990 to 2023. HCB emissions decreased significantly between 1990 and 2014 and have fluctuated since 2014 (Figure 2–12). Emission reductions were also observed in the Electric Power Generation (Utilities) category between 1990 and 2023 due to reduced HCB emissions reported at several coal plants, as well as plant closures. The overall national HCB decrease is also partly due to a drop in emissions from Waste Incineration since 1998, specifically because of a decline in the use of batch incinerators for municipal waste incineration. For example, the use of conical burners has declined steadily in Newfoundland and Labrador (Newfoundland Municipal Affairs and Environment, 2017). Between 2019 and 2020, Ore and Mineral Industries experienced a decrease in HCB emissions of 39% (1.9 kg), mostly due to a decrease in Non-Ferrous Refining and Smelting Industry of 73% (2.0 kg), in part owed to the permanent closure of a non-ferrous metal smelter in December 2019.

The most significant changes in HCB emissions from 1990 to 2023 include:

- Incineration and Waste: decrease of 93% (11 kg), with:
 - Waste Incineration: decrease of 93% (11 kg)
- Electric Power Generation (Utilities): decrease of 98% (11 kg), with:
 - Coal (Electric Power Generation): decrease of 99% (10 kg)

Figure 2–12 Trends in Canadian HCB Emissions (1990 to 2023)

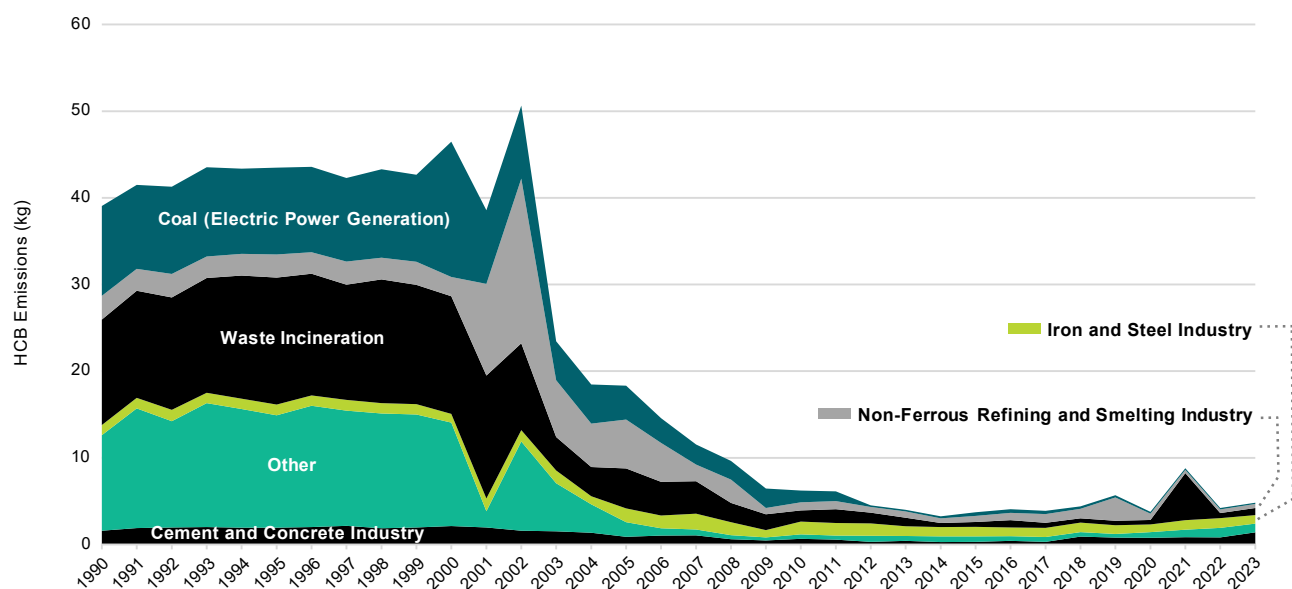


Table 2–14 National Summary of Annual HCB Emissions

Source	1990	2000	2005	2018	2019	2020	2021	2022	2023
					(g)				
ORE AND MINERAL INDUSTRIES	5 600	5 900	8 100	3 400	4 700	2 900	3 000	3 300	3 700
Cement and Concrete Industry	1 600	2 100	880	900	790	770	840	810	1 400
Iron and Steel Industry	1 200	1 000	1 600	1 100	1 000	890	1 100	1 100	1 000
Non-Ferrous Refining and Smelting Industry	2 700	2 200	5 600	1 100	2 700	720	370	420	480
Other Ore and Mineral Industries Sectors	72	510	44	270	240	490	690	930	830
OIL AND GAS INDUSTRY	1.3	1.6	-	-	-	-	-	-	-
ELECTRIC POWER GENERATION (UTILITIES)	11 000	17 000	4 100	400	310	240	240	220	200
Coal	10 000	16 000	3 900	300	260	200	190	160	140
Other Electric Power generation (Utilities) Sectors	640	1 500	170	98	53	39	51	61	61
MANUFACTURING	10 000	9 800	1 400	100	67	67	57	36	45
TRANSPORTATION AND MOBILE EQUIPMENT	-	-	-	-	-	-	-	-	-
AGRICULTURE	-	-	-	0.82	0.78	0.60	0.49	0.47	0.51
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL	1.6	4.4	1.3	-	-	-	-	-	0.20
INCINERATION AND WASTE	12 000	14 000	4 700	550	570	580	5 500	650	870
Crematoriums	25	29	35	55	57	62	62	66	65
Waste Incineration	12 000	14 000	4 600	490	520	520	5 400	590	800
Waste Treatment and Disposal	-	81	39	-	-	-	-	-	-
PAINTS AND SOLVENTS	-	-	-	-	-	-	-	-	-
DUST	-	-	-	-	-	-	-	-	-
FIRES	-	-	-	-	-	-	-	-	-
GRAND TOTAL	39 000	46 000	18 000	4 400	5 700	3 800	8 800	4 200	4 800

Notes:

Totals may not add up due to rounding.

0.00 Indicates emissions were truncated due to rounding.

- Indicates no emissions

AIR POLLUTANT EMISSIONS INVENTORY DEVELOPMENT

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The Air Pollutant Emissions Inventory (APEI) is a comprehensive and detailed inventory of air pollutant emissions in Canada, developed using two types of information:

- facility-reported data, consisting of emissions from relatively large industrial, commercial and institutional facilities
- in-house estimates, including diffuse sources and other sources that are too numerous to be accounted for individually, such as road and non-road vehicles, agricultural activities, construction, and solvent use

The APEI is developed using many sources of information, procedures and emission estimation models. Emissions data reported by individual facilities to Environment and Climate Change Canada's (ECCC) [National Pollutant Release Inventory \(NPRI\)](#)¹ are supplemented with documented, science-based estimation tools to quantify total emissions. Together, these data sources provide a comprehensive overview of pollutant emissions across Canada. A framework has been developed that makes use of the best available data, while ensuring no double counting or omissions. This chapter presents information about the inventory development process.

3.1. Overview of Inventory Development

The process of developing comprehensive emission estimates for the APEI is presented in [Figure 3–1](#). It consists of categorizing facility-reported data (section [3.2](#)), calculating in-house estimates (section [3.3](#)), and reconciling the facility-reported data and the in-house estimates in a database, where necessary (section [3.4](#)), followed by compiling and reporting the results (section [3.5](#)). Quality control (section [3.6](#)) is performed throughout the inventory development process. Every year, the whole time series (from 1990 to the latest year) is estimated and continuous improvement often results in revisions to previously published estimates, called recalculations (section [3.7](#)).

Facility-Reported Emissions

As a first step, 17 pollutants reported in the APEI are extracted from the NPRI verified database, which contains facility-reported data. New facilities are identified in the extracted data and classified within the APEI according to the nature of their activities. This step results in a compiled database containing most of the facility-reported emissions used in the air pollutant emissions inventory report.

More information on facility-reported emissions is presented in section [3.2](#).

¹ www.canada.ca/NPRI

In-House Emission Estimates

In-house estimates are based on documented estimation methodologies which are periodically reviewed and updated through literature searches, the collection and analysis of recent emission factors and activity data, and comparisons with alternative sources of information. Updated estimates are calculated using new or updated activity data. Where possible, inventory estimates calculated in-house use the most rigorous (highest-tier) methods. However, owing to practical limitations, the exhaustive development of all emissions categories is not possible. In these cases, estimates are generally calculated using activity data and emission factors following relatively basic (lower-tier) methodologies. Calculations are performed in spreadsheets (Excel), relational databases (MS Access and SQL server), using computational scripts (R and Python), and may include spatial data quantified using geographic information systems software (GIS-ArcGIS and QGIS).

More information on in-house estimates can be found in section [3.3](#).

Reconciliation

The next step in the compilation process is eliminating any double counting of emissions between the in-house estimates and the facility-reported data through a process of reconciliation. [Table 3–1](#) illustrates the origin of the emissions for each sector and subsector: facility-reported data, in-house calculated data or a combination of both, for the latest available year. The origin of the emissions can change depending on the year. Reconciliation of in-house estimates with facility-reported data is required for sectors or subsectors where both in-house and facility-reported estimates exist. For 2023, reconciliation was performed for 31 sectors.

More information on reconciliation is available in section [3.4](#).

Compilation and Reporting

The final steps in the development process involve compiling all reconciled data within a final database and generating the results. The final database houses all APEI data and is the source of data for all APEI-related products, including:

- [Canada's Air Pollutant Emissions Inventory Report](#)²
- open data emissions tables published on open.canada.ca³
- online [Search Tool](#)⁴
- emissions maps of certain air pollutants for selected categories
- input to other products, such as [Canada's greenhouse gas and air pollutant emissions projections](#),⁵ [air quality modeling](#), [Canadian Environmental Sustainability Indicators](#),⁶ and reports under the [Canada-U.S. Air Quality Agreement](#)⁷
- Canada's submission to the United Nations Economic Commission for Europe (UNECE) under the Convention on Long-range Transboundary Air Pollution ([Annex 4](#))

More information on compilation and reporting is available in section [3.5](#).

² www.canada.ca/apei

³ <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

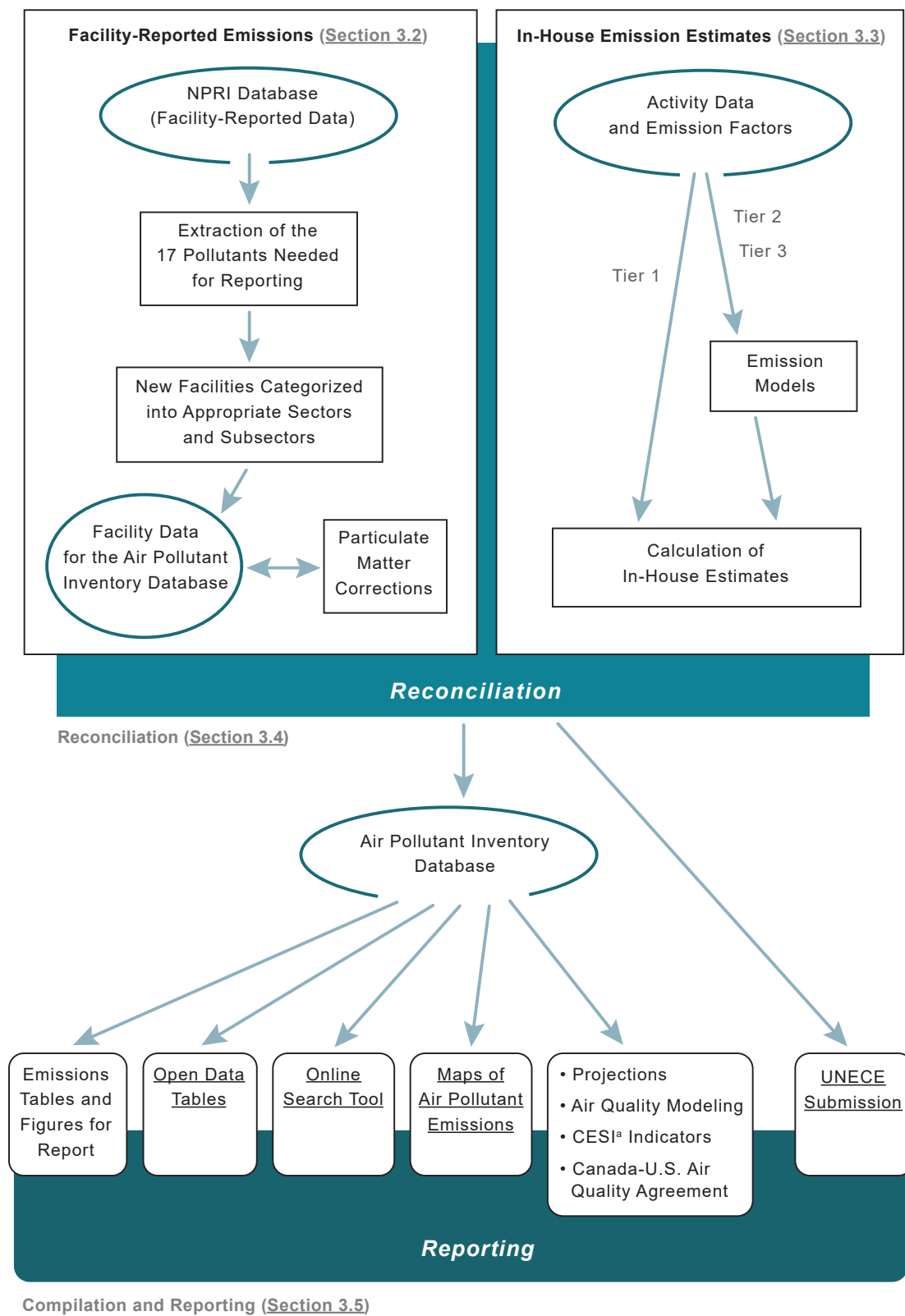
⁴ <https://pollution-waste.canada.ca/air-emission-inventory>

⁵ <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/projections.html>

⁶ <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/air-pollutant-emissions.html>

⁷ <https://www.canada.ca/en/environment-climate-change/corporate/international-affairs/partnerships-countries-regions/north-america/canada-united-states-air-quality.html>

Figure 3–1 **Overview of the Annual Air Pollutant Emissions Inventory Compilation Process**



Note:
a. CESI = Canadian Environmental Sustainability Indicators

Table 3–1 Origin of 2023 Air Pollutant Emission Estimates by Inventory Category

Air Pollutant Emissions Inventory Categories	Facility-Reported Data ^a	In-House Estimates ^b	Activity Data Used for In-House Estimates
ORE AND MINERAL INDUSTRIES			
Aluminium Industry			
Alumina (Bauxite Refining)	☑		
Primary Aluminium Smelting and Refining	☑		
Secondary Aluminium Production (Includes Recycling)	☑		
Asphalt Paving Industry	☑	☑	2023
Cement and Concrete Industry			
Cement Manufacturing	☑		
Concrete Batching and Products	☑	☑	2023
Gypsum Product Manufacturing	☑		
Lime Manufacturing	☑		
Foundries			
Die Casting	☑		
Ferrous Foundries	☑	☑	2023
Non-Ferrous Foundries	☑		
Iron and Steel Industry			
Primary (Blast Furnace and DRI)	☑		
Secondary (Electric Arc Furnaces)	☑	☑	2023 (Hg in Products)
Steel Recycling	☑	☑	2023 (Hg in Products)
Iron Ore Pelletizing	☑		
Mineral Products Industry			
Brick Products	☑		
Clay Products	☑		
Other (Mineral Products Industry)	☑		
Mining and Rock Quarrying			
Coal Mining Industry	☑		
Iron Ore Mining	☑		
Limestone	☑		
Metal Mining	☑		
Potash	☑		
Rock, Sand and Gravel	☑	☑	2023
Silica Production		☑	2023
Other (Mining and Rock Quarrying)	☑		
Non-Ferrous Refining and Smelting Industry			
Primary Ni, Cu, Zn, Pb	☑		
Secondary Pb, Cu	☑		
Other (Non-Ferrous Refining and Smelting Industry)	☑		
OIL AND GAS INDUSTRY			
Downstream Oil and Gas Industry			
Natural Gas Distribution	☑	☑	2023
Petroleum Refining	☑		
Refined Petroleum Products Bulk Storage and Distribution	☑	☑	2023
Refined Petroleum Product Pipelines	☑		
Other (Downstream Oil and Gas Industry)	☑		
Upstream Oil and Gas Industry			
Accidents and Equipment Failures		☑	2023
Disposal and Waste Treatment		☑	2023
Heavy Crude Oil Cold Production		☑	2023
Light/Medium Crude Oil Production ^c	☑	☑	2023
Natural Gas Production and Processing ^d	☑	☑	2023
Natural Gas Transmission and Storage	☑	☑	2023
Oil Sands In-Situ Extraction	☑		
Oil Sands Mining, Extraction and Upgrading	☑		
Petroleum Liquids Storage	☑		
Petroleum Liquids Transportation		☑	2023
Well Drilling/Service/Testing		☑	2023
ELECTRIC POWER GENERATION (UTILITIES)			
Coal	☑		
Diesel	☑		
Natural Gas	☑		
Landfill Gas	☑		
Other (Electric Power Generation)	☑		
MANUFACTURING			
Abrasives Manufacturing	☑		
Bakeries	☑	☑	2023
Biofuel Production	☑		
Chemicals Industry			
Chemical Manufacturing	☑		
Cleaning Compound Manufacturing	☑		
Fertilizer Production	☑		
Paint and Varnish Manufacturing	☑		
Petrochemical Industry	☑		
Plastics and Synthetic Resins Fabrication	☑		
Other (Chemical Industry)	☑		
Construction Fuel Combustion		☑	2023
Electronics	☑	☑	2023 (Hg in Products)
Food Preparation	☑		
Glass Manufacturing	☑		
Grain Industry			
Grain Processing	☑	☑	2023
Warehousing and Storage	☑		
Metal Fabrication	☑		
Plastics Manufacturing	☑		
Pulp and Paper Industry			
Converted Paper Product Manufacturing	☑		

Table 3–1 Origin of 2023 Air Pollutant Emission Estimates by Inventory Category (cont'd)

Air Pollutant Emissions Inventory Categories	Facility-Reported Data ^a	In-House Estimates ^b	Activity Data Used for In-House Estimates
MANUFACTURING (cont'd)			
Pulp and Paper Product Manufacturing	☑		
Textiles	☑		
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	☑		
Wood Products ^c			
Panel Board Mills	☑	☑	2023
Sawmills	☑	☑	2023
Other (Wood Products)	☑		
Other (Manufacturing)	☑		
TRANSPORTATION AND MOBILE EQUIPMENT			
Air Transportation (LTO)		☑	2023
Domestic Marine Navigation, Fishing and Military		☑	2023
Heavy-Duty Diesel Vehicles		☑	2023
Heavy-Duty Gasoline Vehicles		☑	2023
Heavy-Duty LPG/NG Vehicles		☑	2023
Light-Duty Diesel Trucks		☑	2023
Light-Duty Diesel Vehicles		☑	2023
Light-Duty Gasoline Trucks		☑	2023
Light-Duty Gasoline Vehicles		☑	2023
Light-Duty LPG/NG Trucks		☑	2023
Light-Duty LPG/NG Vehicles		☑	2023
Motorcycles		☑	2023
Off-Road Diesel Vehicles and Equipment		☑	2023
Off-Road Gasoline/LPG/NG Vehicles and Equipment		☑	2023
Rail Transportation		☑	2023
Tire Wear and Brake Lining		☑	2023
AGRICULTURE			
Agricultural Fuel Combustion	☑	☑	2023
Animal Production		☑	2023
Crop Production			
Harvesting		☑	2023
Inorganic Fertilizer Application		☑	2023
Sewage Sludge Application		☑	2023
Tillage Practices		☑	2023
Wind Erosion		☑	2023
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL			
Commercial and Institutional Fuel Combustion	☑	☑	2023
Commercial Cooking		☑	2022
Home Firewood Burning		☑	2021
Human		☑	2023
Marine Cargo Handling	☑	☑	2011
Residential Fuel Combustion		☑	2023
Service Stations		☑	2023
Other (Miscellaneous)^f		☑	2023
INCINERATION AND WASTE			
Crematoriums			
Human Crematoriums		☑	2023
Pet Crematoriums	☑	☑	2023
Waste Incineration			
Hazardous Waste Incineration	☑	☑	2023
Medical Waste Incineration	☑	☑	2023
Municipal Incineration	☑	☑	2023
Residential Waste Burning ^g		☑	2023
Sewage Sludge Incineration	☑	☑	2023
Other (Waste Incineration)	☑		
Waste Treatment and Disposal			
Biological Treatment of Waste	☑	☑	2018-2021 (based on availability)
Landfills	☑	☑	2023
Municipal Wastewater Treatment	☑	☑	2023
Specialized Waste Treatment and Remediation	☑		
Waste Sorting and Transfer	☑		
PAINTS AND SOLVENTS			
Dry Cleaning	☑	☑	2023
General Solvent Use		☑	2023
Printing	☑	☑	2022
Surface Coatings	☑	☑	2023
DUST			
Coal Transportation		☑	2023
Construction Operations		☑	2023
Mine Tailings		☑	2018
Paved Roads		☑	2023
Unpaved Roads	☑	☑	2023
FIRES			
Prescribed Burning		☑	2023
Structural Fires		☑	2023
Mercury in Products^h		☑	2023

Notes:

a. Based on the most recent facility-reported data from NPRI.

b. Estimated by ECCC

c. Facility-reported data consists of facilities located in Atlantic Canada. For other provinces, it consists of in-house estimates.

d. Facility-reported data consists of facilities located in Atlantic Canada and SO₂ emissions from Alberta's natural gas processing facilities.

e. In-house estimates for Wood Products were estimated by the Forestry Products group of the Environmental Stewardship Branch at ECCC. All other in-house estimates were estimated by PIRD.

f. Emissions reported under Other (Miscellaneous) are from breakage, transport and recycling of mercury-containing products using the Hg in Products methodology. Products include: automotive mercury switches, batteries, dental amalgams, fluorescent lamps, fungicides, measurement and control devices, non-fluorescent lamps, switches and relays, thermometers, thermostats and tire balancers.

g. Hg in Products estimates for Residential Waste Burning are not estimated after 2008 as a result of the updates for the Hg in Products models.

h. Emissions from Hg-containing products were calculated as a separate inventory. Emissions are reported under many sectors such as Iron and Steel Industry, Municipal Incineration, Human, Other (Miscellaneous) and Landfills. All in-house estimates for Hg in Products emissions continue to be estimated and reported under these sectors.

3.2. Facility-Reported Emissions Data

Facility-reported emissions data generally refer to any stationary sources that emit pollutants through stacks or other equipment at specific locations. The major source of facility-reported data is the NPRI, Canada's legislated, publicly accessible inventory of pollutant releases (to air, water and land), disposals and transfers for recycling. The NPRI has provided facility-reported data on all the 17 pollutants included in the APEI for industrial and commercial facilities since 2002. For some pollutants, the data collection began earlier. It started as early as 1993 for the three heavy metals (Pb, Cd and Hg), in 1995 for ammonia and in 2000 for polycyclic aromatic hydrocarbons (PAHs), dioxins and furans and hexachlorobenzene (HCB). Prior to 2002, facility-level emissions for the criteria air contaminants (CACs) were collected and compiled by provincial, territorial and regional environmental authorities across Canada and provided to ECCC for inclusion in the APEI.

Facility-reported data from the NPRI are used in the APEI without modification, except when 1) data quality issues are detected and not addressed during the quality control exercise, or 2) adjustments to particulate matter (PM) emissions are necessary to respect their size fraction. The NPRI reporting requirements and thresholds vary by pollutant and, in some cases, by industry. Details on these reporting requirements and thresholds are available on the NPRI ECCC's website in the [substance list by threshold section](#).⁸

A distinction has been made between reporting facilities and non-reporting facilities. Reporting facilities meet the threshold required to report to the NPRI, while non-reporting facilities do not meet the threshold owing to their size or emission levels. Some facilities may be required to report emissions of certain pollutants only. Therefore, emissions from the non-reporting facilities or of non-reported pollutants must be estimated in-house to ensure complete coverage.

Historically (e.g., for the years 1985, 1990, 1995 and 2000), facility-reported data were primarily provided by provinces and territories. In some cases, additional information was calculated to fill in intervening years or to update the original submissions. Trends for the intervening years were interpolated. The compilation of emissions for 2001 to 2005 occurred during a transition to the use of emissions data reported to the NPRI as the major source of industrial emissions. In general, facility-reported data from the NPRI and data provided by provinces and territories were used for years 2002, 2004 and 2005, and interpolation was used for 2001 and 2003.

Since 2005, information on facility-reported data has originated mainly from the NPRI, with limited data obtained from some provincial governments on selected sources that are not reported to the NPRI.

The NPRI groups substances into five parts, as listed below. Each part has its own reporting thresholds or triggers for mandatory reporting.

- Part 1A – Core substances, and Part 1B – Alternate threshold substances
- Part 2 – PAHs
- Part 3 – Dioxins, furans and HCB
- Part 4 – CACs
- Part 5 – Speciated volatile organic compounds (VOCs)

[Table 3–2](#) shows the 17 air pollutants reported in the APEI and their NPRI reporting thresholds. No VOC data collected under Part 5 are used in the APEI.

In 2023, 6682 facilities reported releases to air of one or more APEI pollutants to the NPRI. Since 1993, more than 21 000 facilities have reported at least one of the seventeen APEI pollutants. Over the years, many facilities have fallen below the emissions reporting threshold or have ended operations and no longer report to the NPRI program. There may also be times, for example, for oil and gas facilities, that facilities have changed ownership. The new owner would not necessarily reuse the same number used to identify the facility in the NPRI reporting system by the previous owner. The end result would look like the opening of a new facility and the closing of an old facility. Therefore, the total true number of facilities over time could be somewhat less than 20 000. Using the 2023 NPRI database, with data available as of October 10, 2024, facility information and air emissions data for pollutants listed in [Table 3–2](#) were extracted for each province and territory. The quality control process described in section [3.6](#) was applied to the NPRI data to identify outliers or missing substance reports.

For facilities reporting to the NPRI for the first time, the North American Industry Classification System (NAICS) codes (Statistics Canada, 2017), reported by the facilities, are used to assign preliminary APEI sector and subsector classifications. Additional research and verification on facilities' operations are then performed to confirm or correct the classification into the appropriate APEI sector or subsector. The assigned classification is used for subsequent reporting years, as long as the facility does not change operations.

⁸ <https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/substances-list/threshold.html>

Table 3–2 National Pollutant Release Inventory Air Pollutant Reporting Thresholds

Substance	National Pollutant Release Inventory Part # (Threshold Category)	Reporting Threshold
Ammonia	1A	10 tonnes MPO
Benzo(a)pyrene	2	50 kg total PAHs
Benzo(b)fluoranthene	2	50 kg total PAHs
Benzo(k)fluoranthene	2	50 kg total PAHs
Cadmium	1B	5 kg MPO
Carbon monoxide	4	20 tonnes air release
Dioxins and furans	3	Activity-based
Hexachlorobenzene	3	Activity-based
Indeno(1,2,3-c,d)pyrene	2	50 kg total PAHs
Lead	1B	50 kg MPO
Mercury	1B	5 kg MPO
Nitrogen oxides	4	20 tonnes air release
PM ₁₀ – particulate matter ≤ 10 microns	4	0.5 tonnes air release
PM _{2.5} – particulate matter ≤ 2.5 microns	4	0.3 tonnes air release
Sulphur dioxide	4	20 tonnes air release
Total particulate matter	4	20 tonnes air release
Volatile organic compounds	4	10 tonnes air release
Notes:		
MPO = Manufactured, processed or otherwise used		
NA = Not applicable		

NPRI reporting facilities may not report all three PM size fractions: TPM, PM₁₀ and PM_{2.5}. For cases where only one or two of the three PM size fractions are reported to the NPRI, a distribution procedure is applied to estimate a complete set of PM emissions for facilities. The procedure is based on sector-specific PM distribution profiles developed using 2006–2016 facility-reported PM emissions data for most sectors, 2002–2017 facility-reported emissions data or detailed studies for other sectors, or derived from NPRI toolbox guidance (e.g., unpaved roads). Where ratios were calculated using facility-reported data, the ratio for each facility is calculated and then averaged by sector. The resulting PM distribution ratios are available online on the [Government of Canada Open Data Portal](https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131).

The TPM, PM₁₀ and PM_{2.5} emissions calculated using the distribution procedure are added to the list of facility-reported data and flagged as an ECCC estimate within the compiled APEI final database.⁹

3.3. In-House Emission Estimates

The reporting of substances by facilities to the NPRI remains the primary source of industrial air pollution data in Canada. Sectors with significant sources of facility-reported data (e.g., petroleum refineries, smelters) are well represented by emissions data from the NPRI.

The completeness of the APEI is assessed by the level of inclusion of all known quantifiable sources of pollutant emissions in the provincial, territorial and national totals that are attributed to anthropogenic activities. Where NPRI facility-reported data do not provide for complete sector coverage, additional estimates are developed in-house by ECCC. An overall estimation of completeness in this case is related to the availability and reliability of the activity data and methodologies used for the in-house estimates.

The development of complementary in-house estimates is not required in sectors where NPRI facility data provide complete coverage of air pollutant emissions (e.g., pulp and paper). To produce a complete inventory of emissions, complementary in-house estimates are necessary for subsectors that have limited coverage in the NPRI because many facilities do not meet the reporting thresholds (e.g., Natural Gas Production and Processing, Light/Medium Crude Oil Production, Sawmills, Ferrous Foundries, etc.).

Other sources of air pollutants, such as Residential Fuel Combustion, Transportation and Mobile Equipment or Fires, are not subject to reporting to the NPRI, and coverage is assured solely through the calculation of in-house emission estimates for these sources.

⁹ <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

Although all major sources of air pollutant emissions are included in the APEI, several sources are not, such as the burning of agricultural wastes and demolition activities in the construction industry.

In-house estimates are calculated using information such as production data and activity data, using various estimation methodologies, emission models and emission factors.¹⁰ Depending on the source, there are three methodological tiers that represent varying levels of complexity: Tier 1 is the simplest; Tier 2, the intermediate; and Tier 3, the most demanding in terms of complexity and data requirements. Tier 2 and 3 methods are referred to as higher tier methods and are considered more accurate. Tier 1 methods typically apply a simple linear relation between activity data and emission factors. The default Tier 1 emission factors are chosen such that they represent typical process conditions, and they tend to be technology independent. UNECE provides Tier 1 methods for all sources and substances that countries that have ratified the protocols of the Convention on Long-range Transboundary Air Pollution are required to report. Tier 2 methods use the same or similar activity data as Tier 1 methods, but apply country-specific emission factors, which need to be developed using country-specific information. Tier 3 methods go beyond the previous two methods and may include using facility-level data, specific information on the types of technologies being used at facilities, pollution abatement equipment, and/or sophisticated models. It is a good practice to use higher tier methods for categories that are large contributors to total emissions.

Calculations of in-house estimates are based on the latest data available at the time of inventory development. When possible, the data are updated each year. These emission estimates are calculated at the provincial, territorial and national level. [Table 3–1](#) illustrates the complete list of sectors and subsectors of the APEI for which emissions are based on in-house estimates and provides the activity data year on which the 2023 in-house estimate is based.

A summary of in-house estimation methodologies is presented in [Annex 2](#). For more detailed information on methodologies, please refer to Canada's Air Pollutant Emissions Inventory Methodology Document on the [Government of Canada Open Data Portal](#).¹¹

3.4. Reconciliation

In several sectors, as noted in [Table 3–1](#), estimation of total emissions involves both estimates provided by facilities and estimates developed in-house by ECCC. To prevent double counting of emissions and to confirm that the APEI includes all emissions, a comparison and reconciliation of emission estimates from various sources is performed for each pollutant, industry sector and geographical region, as appropriate.

3.4.1. General Procedures

The approach for reconciling facility-reported data and in-house estimates for a specific pollutant is as follows:

- Case 1: If the total of the in-house estimates is greater than or equal to the total facility-reported data, the reconciled in-house estimate is equal to the total of the in-house estimates minus the total of the facility-report data, as outlined in [Equation 3–4](#).

Equation 3–4

$$\begin{aligned} &\text{If, } \mathbf{InHouseEstimate}_{Total} \geq \mathbf{FacilityReportedData}_{Total} \\ &\text{Then, } \mathbf{InHouseEstimate}_{REC} = \mathbf{InHouseEstimate}_{Total} - \mathbf{FacilityReportedData}_{Total} \end{aligned}$$

- Case 2: If the total in-house estimate quantity is less than or equal to the total of the facility-reported data for the source, the reconciled in-house estimate is equal to 0, as outlined in [Equation 3–5](#); i.e., facility-reported data are considered to reflect all the sector emitting sources.

Equation 3–5

$$\begin{aligned} &\text{If, } \mathbf{InHouseEstimate}_{Total} \leq \mathbf{FacilityReportedData}_{Total} \\ &\text{Then, } \mathbf{InHouseEstimate}_{REC} = 0 \end{aligned}$$

¹⁰ The United States Environmental Protection Agency (U.S. EPA) defines an emission factor as "...a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned)."

¹¹ <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

In addition, there are sectors where a variation of the general reconciliation approach is used. Sections [3.4.2](#), [3.4.3](#) and [3.4.4](#) provide information on reconciliation approaches that are unique in nature.

3.4.2. Wood Products

Particulate matter emissions (TPM, PM₁₀ and PM_{2.5}) from the Sawmills and Panel Board Mills subsectors (Wood Products sector) were not reconciled using the procedure described in section [3.4.1](#). Rather, NPRI facility-reported data from these subsectors were used to characterize the entire industry. The facility-reported data, together with several production indicators, were used to estimate the PM emissions from facilities that are not required to report to the NPRI. The sum of the resulting emission estimates represents the total emissions for these subsectors. All other pollutants were reconciled at the subsector and provincial and territorial levels, according to the standard procedure and equations outlined in section [3.4.1](#).

3.4.3. Dry Cleaning, General Solvent Use, Printing and Surface Coatings

The in-house estimates in the Dry Cleaning, General Solvent Use, Printing, and Surface Coatings sectors (Paints and Solvents source category) include a total of 92 different kinds of solvents and applications. The in-house emissions estimates for these categories are reconciled with facility-reported data, which include a variety of sources (solvent use as well as processes, fuel combustion, road dust, etc.) grouped under the same NAICS. Given the complexity of the solvent sectors, reconciliation of in-house estimates with facility-reported data from the NPRI requires that the following steps be performed (Cheminfo Services, 2020):

1. allocation of the solvent use in-house estimates to the 4-digit NAICS level from the NPRI
2. allocation of the NPRI VOC inventory totals at the 4-digit NAICS level to “Process” and “Solvent” type emissions
3. subtraction of the “Solvent” type NPRI emissions from the solvent in-house emission estimates

If subtraction of the facility-reported data from the in-house estimates for a certain solvent use yields a small negative value, the emission estimate for that in-house estimate is set to zero.

3.4.4. Mercury in Products

Mercury (Hg) can be released to air throughout the life-cycle of mercury-containing products, including during manufacture, distribution, use, disposal, transportation and final disposition, as well as through waste streams. Releases can also result from breakage and processing. Reconciliation of Hg air emissions from mercury in products with NPRI involves a review and characterization of the source of the Hg air emissions included in the facility-reported estimate. This is to ensure that the Hg emissions estimated through the life-cycle approach are not duplicated in the facility-reported data. In situations where overlap exists, either the in-house estimate emissions from mercury in products are removed from reporting in the APEI or a proportion method is applied. If there is no overlap, the facility-reported and in-house estimate emissions are simply added together. The proportion method changes the mercury in product emissions, while the point-source emissions remain unchanged ([Equation 3–6](#) and [Equation 3–7](#)):

Equation 3–6

$$\text{Proportion} = \frac{(\text{Sum Mercury in Product Emissions} - \text{Sum Point-Source Emissions})}{\text{Sum Mercury in Product Emissions}}$$

Equation 3–7

$$\text{Final Emissions for Mercury in Products} = \text{Sum of Mercury in Product Emissions} \times \text{Proportion}$$

This is done at the provincial and territorial level by year.

3.5. Compilation and Reporting

The time interval between the receipt of emissions data from industries and submission of the emissions and report to UNECE is relatively short. Tools used to compile emissions, populate the UNECE Nomenclature for Reporting (NFR) tables, perform quality control tests and generate the different tables and figures for this report are automated as much as possible to allow quick compilation, ensure efficient corrections and reduce the possibility of errors.

In addition, as each file prepared by an expert is submitted for compilation, it must first pass all the control tests of a verification tool before being integrated into the compiled database. More than 25 tests are carried out. This step enables errors to be detected as early as possible in the compilation process. More details on the tests performed are given in section 3.6.3.

3.5.1. Gridded Maps of Air Pollutant Emissions

While the APEI provides valuable information on emissions within Canada, it does not distinguish localized sources of emissions within the provincial and territorial level aggregations. In this respect, work is ongoing to attribute emissions closer to where they originate geographically. Models have been used to spatially distribute the air pollutant emissions. As the project moves forward, the models will be refined, and distribution of emissions will become more precise.

For this edition of the inventory, 14 static maps have been produced. For the following sources of air pollutant emissions, the most significant pollutants have been selected and mapped on a 1 km grid (by ecodistrict for Agriculture):

- Ore and Mineral Industries
- Oil and Gas Industry
- Transportation and Mobile Equipment
- Agriculture
- Commercial/Residential/Institutional

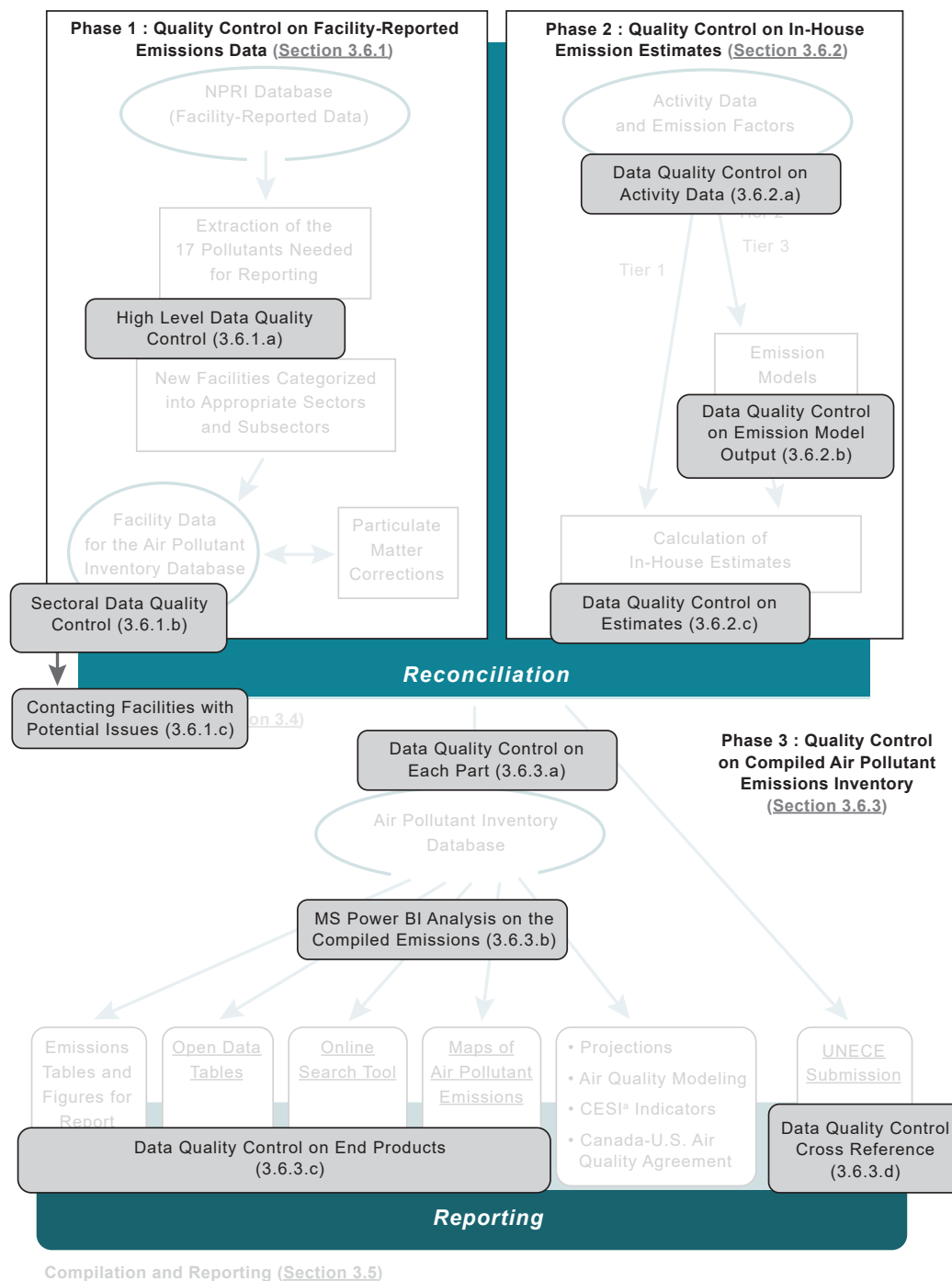
The maps produced represent the total emissions over the year as opposed to an atmospheric concentration at a certain point in time. The maps are published on the [Government of Canada Open Data Portal](https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-air-pollutant-emissions-inventory/Gridded%20APEI%20maps?lang=en).¹² Please contact ec.dirp.donnees-data.pird.ec@ec.gc.ca if additional details regarding the maps are needed.

3.6. Data Quality Control

Quality control for the inventory takes place at each step of the process, in three main phases. In phase 1, quality control is performed on the most recently submitted NPRI facility-reported data, prior to inclusion of the data in the estimates. Phase 2 of the quality control occurs on the in-house estimates at a subsector level, while phase 3 is performed on the final database of reconciled and compiled emissions, including NFR tables. See [Figure 3–2](#) for a visual representation of the different quality control check points.

¹² <https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-air-pollutant-emissions-inventory/Gridded%20APEI%20maps?lang=en>

Figure 3–2 **Quality Control Check Points**



3.6.1. Phase 1: Facility-Reported Emissions Data

The quality control process involves a system of documented activities and procedures performed to identify data outliers, inconsistencies, missing data, inaccuracies and errors. This phase is divided into two parts.

First, high-level completeness tests are completed on NPRI data before sharing facility data with sectoral experts. This step involves comparison with the previous year's dataset and identify any significant changes. High-level checks on the number of facilities reporting, number of records included in the database, number of new facilities and total emissions by pollutants by year are performed to ensure sufficient completeness before proceeding to more detailed analysis and quality control (refer to 3.6.1.a in [Figure 3–2](#)).

Once the initial checks are satisfied, the facility-reported dataset is prepared and shared with sectoral experts for more specific and in-depth quality control. The quality control process is adapted where necessary such that category-specific or sector-specific quality control procedures are applied, as appropriate (refer to 3.6.1.b in [Figure 3–2](#)). A key part of the quality control process is identifying missing NPRI facility reporters and assessing new reporters to ensure that the correct data are captured and allocated to the appropriate sectors and subsectors.

Identifying outliers (i.e., reports that significantly depart from comparable NPRI facility-reported data) is critically important to ensuring the usability of the NPRI facility-reported data.

Potential outliers are defined as any NPRI facility report that:

- has a large year-over-year change; and/or
- contributes an unrealistically high proportion of the total reported quantity of an air pollutant in the current or previous reporting year.

In addition to identifying missing NPRI facilities and outliers, the quality control review includes analysis of:

- the impact of first-year reporting;
- substances that are no longer reported, inconsistently reported, or that have never been reported by a facility that conducts activities that are expected to be emissive;
- substance reports with identical reported quantities of an air pollutant within a five-year period;
- substance reports with significant variation over a five-year period; and
- facilities assigned to incorrect subsectors.

Finally, quality control checks are also performed on facility information. These checks include facility identification numbers and geographical information (i.e., city, province and territory, address and latitude and longitude).

Once the review of the facility data is complete, facilities are contacted to resolve identified issues with significant impacts. Identification, facility follow-up and resolution of such issues are conducted at the earliest stage of the quality control review. Where unresolved issues persist, any updates to the data will be reflected in the next inventory edition (refer to 3.6.1.c in [Figure 3–2](#)).

3.6.2. Phase 2: In-House Emission Estimates

The objective of Phase 2 of the quality control process is to identify and verify inconsistencies in the APEI at the subsector level. A series of verifications and quality control checks are undertaken on the in-house emission estimates to ensure quality, accuracy and consistency. The following are verified:

- activity data
- emission factors
- unit conversions
- emission calculations

Activity data (refer to 3.6.2.a in [Figure 3–2](#)) and emission estimates are reviewed by multiple sector experts to identify outliers, similar to the review of facility reported data. Potential outliers are defined as sector-level activity data and emissions that:

- have large year-over-year changes;
- have changed significantly since the previous reporting year.

Emission estimates (refer to 3.6.2.b in [Figure 3–2](#)) are further compared against other metrics for the sectors, such as: heating degree days, electricity generation, population, or gross domestic product. These comparisons are used to confirm general trends identified. Additional information is gathered from industry associations or news releases related to temporary shutdowns, plant closures, and retooling of facilities which is used to confirm trends.

Best-available emission factors are chosen by sector experts to reflect Canadian conditions for the various sectors. For example, emission factors for residential firewood burning are currently taken from the U.S. EPA as their technology is also used in Canada.

Prior to implementation, in-house models are rigorously tested to ensure activity data and emission factors are correctly applied, unit conversions are consistent throughout and resulting emission estimates are in the appropriate sector (refer to 3.6.2.c in [Figure 3–2](#)).

3.6.3. Phase 3: Compiled Air Pollutant Emissions Inventory

Phase 3 includes all tests performed immediately prior to compiling the estimates as well as the analysis of the results and different products once they have been compiled in a final database. Before integrating the emission estimates from all sources, automated quality control tests are done on each individual part. The tests performed include checking for duplicates, ensuring that all sources are considered, and all mandatory fields are filled according to the standards, and verifying units. The purpose of the tests is to ensure the quality of the compiled data (refer to 3.6.3.a in [Figure 3–2](#)).

Once all estimates have been compiled, trend analysis and recalculation graphics are produced to analyze the consistency of the estimates. Data visualization tools, such as Microsoft Power BI, are also used to perform trend and recalculation analysis and to identify any abnormal gaps. Data are analyzed at different levels. They are analyzed by pollutant, by source, sector or subsector. Gaps can be identified either from their impact on the overall contribution to the national trend or from their impact on the category itself. Trends are also analyzed by province and territory. Any significant changes from year to year and any recalculated emissions are identified and explained (refer to 3.6.3.b in [Figure 3–2](#)).

Quality control is also performed on all other APEI products, including the data tables presented in this report as well as data published online (refer to 3.6.3.c in [Figure 3–2](#)). At this stage, the quality control tests mainly consist of verifying that totals (for different layers of disaggregation, different years and different pollutants) match the compiled estimates. The various end products are also compared against each other as an additional quality control step.

As a last step, quality control tests are made on the NFR tables (refer to 3.6.3.d in [Figure 3–2](#)). Some tests are automated and are run on the compiled tables that will be submitted to the UNECE. They include verifying totals for each pollutant and each year and comparing those values with what is reported in this report. A completeness test is also run to make sure every cell has a value, either a numerical value or a notation key. Other quality control checks are also made by sectoral experts and are, in some cases, cross-referenced with the sector-level estimates. For more information on the NFR tables, refer to [Annex 4](#).

3.7. Recalculations

Emissions recalculation is an essential practice in the maintenance of an up-to-date air pollutant emissions inventory. The APEI is continuously updated with improved estimation methodologies, statistics and more recent and appropriate emission factors. As new information and data become available, previous estimates are updated and recalculated from the base year (1990) to ensure a consistent and comparable trend in emissions. Recalculations of previously reported emission estimates are common for in-house estimates and can also occur with facility-reported emissions data. More information on recalculations is provided in [Annex 3](#).

DEFINITIONS OF THE AIR POLLUTANTS

This annex provides definitions for the 17 air pollutants inventoried by the Air Pollutant Emissions Inventory (APEI). These pollutants are identified in the *Canadian Environmental Protection Act, 1999* (CEPA 1999) and the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) and associated protocols ratified by Canada. The APEI also reports some emissions of additional air pollutants not covered by protocols including ammonia (NH₃), carbon monoxide (CO), particulate matter less than or equal to 10 microns in diameter (PM₁₀) and total particulate matter (TPM) that impact air quality as well. [Chapter 2](#) summarizes the air emissions of these air pollutants grouped into 12 families from various sectors.

A1.1. Criteria Air Contaminants

Particulate Matter (PM)

PM consists of microscopic airborne solid and liquid particles of various origins that remain suspended in air for any length of time. PM can be emitted directly into the atmosphere or formed secondarily from precursor gases as a result of physical and chemical transformations. PM includes a broad range of chemical species, such as elemental carbon and organic carbon compounds, oxides of silicon, aluminium and iron, trace metals, sulphates, nitrates and ammonia (NH₃). It is ubiquitous, being emitted from both natural and anthropogenic (human) sources. The size of PM particles influences the extent of environmental and health damage caused.

Total Particulate Matter (TPM)

TPM includes any airborne PM with a diameter less than 100 microns. It includes PM₁₀ and PM_{2.5}.

Particulate Matter Less Than or Equal to 10 Microns (PM₁₀)

PM₁₀ includes any airborne PM with a diameter less than or equal to 10 microns. It includes PM_{2.5}.

Particulate Matter Less Than or Equal to 2.5 Microns (PM_{2.5})

PM_{2.5} includes any airborne PM with a diameter less than or equal to 2.5 microns. Emissions of PM_{2.5} and its precursor gases originate typically from combustion processes, such as motor vehicles and vegetation burning, but can also come from industrial processes and crop production.

Sulphur Oxides (SO_x)

SO_x are a family of gases that consist mostly of sulphur dioxide (SO₂), a colourless gas. It can be chemically transformed into acidic pollutants, such as sulphuric acid and sulphates (sulphates are a major component of ambient PM). SO₂ is generally a by-product of industrial processes and the burning of fossil fuels, with the main contributors being ore smelting, coal-fired power generators and natural gas processing.

Both SO₂ in its untransformed state, and the acid and sulphate transformation products of SO₂, can have adverse effects on human health or the environment. SO₂ oxidation into sulphuric acid is the main ingredient of acid rain, which can damage crops, forests, buildings and materials, and contribute to acidification of ecosystems. When sulphate is combined with other compounds in the atmosphere, such as NH₃, it becomes an important contributor to PM_{2.5}. It is also one of the principal precursors to PM₁₀.

Nitrogen Oxides (NO_x)

NO_x include nitrogen dioxide (NO₂) and nitrogen oxide (NO). In this report, NO_x are reported as NO₂ equivalent. NO emitted during combustion quickly oxidizes to NO₂ in the atmosphere. NO₂ dissolves in water vapour in the air to form acids, and interacts with other gases and particles in the air to form particles known as nitrates and other products that may be harmful to respiratory systems of humans and their environment. Nitric acid (HNO₃) can cause damage to vegetation, buildings and materials, and contribute to acidification of ecosystems. NO_x reacts photochemically with volatile organic compounds (VOCs) in the presence of sunlight to form ground-level ozone. It can transform into ambient PM (nitrate particles) and is a component of acid rain. When nitrate is combined with other compounds in the atmosphere, such as NH₃, it also becomes an important contributor to the formation of PM_{2.5}. NO_x originate from both anthropogenic and natural sources. The main anthropogenic sources are from combustion in transportation, electric power generation as well as the upstream oil and gas industry. The main natural sources are forest fires, lightning and soil microbial activity.

Volatile Organic Compounds (VOCs)

VOCs are gases or vapors organic compounds containing one or more carbon atoms that evaporate readily to the atmosphere and react photochemically to form ground-level ozone, and PM_{2.5}, leading to smog. VOCs originate from anthropogenic and natural sources. Besides biogenic sources (e.g., vegetation), other major sources include combustion and evaporation processes related to the upstream oil and gas industry, general solvent use, mobile sources, and other miscellaneous sources.¹ VOCs may condense in the atmosphere, contributing to ambient PM formation and acid rain. A number of individual VOCs, such as benzene and dichloromethane, have been assessed to be toxic under CEPA 1999, while other VOCs (e.g., formaldehyde and benzene) are carcinogenic. The term Non-methane volatile organic compounds (NMVOCs) is equivalent to VOCs in this report.

Carbon Monoxide (CO)

CO is a colourless, odourless, and tasteless poisonous gas that, when inhaled, reduces the body's ability to use oxygen. It participates to a small degree in the formation of ground-level ozone. The principal human source of CO is incomplete combustion of hydrocarbon-based fuels, primarily from mobile sources. The wood industry, residential wood heating, and forest fires represent lesser but significant sources. Ambient CO concentrations are much higher in urban areas due to the larger number of human sources.

Ammonia (NH₃)

NH₃ is a colourless and corrosive gas that originates mostly from anthropogenic sources. Major sources of NH₃ emissions include agricultural livestock, waste management, agricultural fertilizer use and synthetic fertilizer manufacturing. NH₃ has been identified as one of the principal precursors to PM_{2.5}.

A1.2. Selected Heavy Metals

Lead (Pb)

Pb is a toxic metallic element, which occurs naturally in the Earth's crust. Pb is used in plumbing, gasoline, paint, and pewter manufacturing. It is used extensively in industry to manufacture products such as lead-acid batteries and radiation shields. Metals processing is the major source of Pb emissions to air, with the highest levels of Pb air emissions originating from the non-ferrous smelting and refining industry. Small amounts of lead can be hazardous to human health.

Cadmium (Cd)

Cd is present in the air as a result of anthropogenic activities and natural processes. The largest anthropogenic source is metal production (particularly base metal smelting and refining), stationary fuel combustion, transportation, solid waste disposal, and sewage sludge application. Major sources from natural processes include weathering and erosion of cadmium-bearing rocks, as well as forest fires and volcanic emissions.

Mercury (Hg)

Despite its toxic nature, Hg has unique properties utilized to produce various consumer products, such as fluorescent lights. When Hg is released to the atmosphere, it can be transported on wind currents, deposited onto land and re-emitted into the atmosphere several times. Emissions of Hg in the atmosphere come from various sectors such as iron and steel production, electric power generation from combustion of coal, waste incineration and various commercial, residential and institutional uses. Hg can exist in several forms depending on the surrounding conditions.

A1.3. Persistent Organic Pollutants

Dioxins and Furans

Dioxins and furans are a family of anthropogenic toxic compounds that are found in very small amounts in the environment, including air, water, and soil. Both dioxin and furan "congeners" are expressed in terms of toxic equivalents (TEQs) to the most toxic form of dioxin: 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The largest sources of dioxins and furans in Canada are the burning of municipal and residential waste. Other major sources include the production of cement and concrete industry, the production of iron and steel, electrical power generation and home firewood burning. Natural sources of dioxins and furans are forest fire and volcanic eruptions.

¹ Environment and Climate Change Canada's definition of VOCs can be found in the *Canada Gazette*, Part II. Statutory Instruments. Vol. 137, No. 14 <http://www.gazette.gc.ca/rp-pr/p2/2003/2003-07-02/pdf/g2-13714.pdf>.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of organic compounds emitted to the environment from natural and anthropogenic sources. Some PAHs are genotoxic and induce mutations that initiate cancer. The largest anthropogenic sources of PAHs released to the atmosphere are home firewood burning, aluminum smelters and transportation. Forest fires are the most important natural source of PAHs in Canada.

In this report, air emissions information is available for the following four PAHs: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene. The [National Pollutant Release Inventory](#) (NPRI) facility-reported data are available for additional information on PAHs.

Hexachlorobenzene (HCB)

HCB is carcinogenic. It has not been used commercially in Canada since 1972 (Environment and Climate Change Canada [ECCC], 2017), although it is released to the environment in trace amounts as a by-product from the manufacture and use of chlorinated solvents and pesticides, through long-range transport and deposition. HCB has been prohibited globally under the Stockholm Convention and the Protocol on Persistent Organic Pollutants under the CLRTAP. The largest sources of emissions are from residential waste burning, iron and steel production, and non-ferrous refining and smelting.

IN-HOUSE ESTIMATION METHODOLOGIES

The in-house emissions estimation methodologies and emission models used in Canada's Air Pollutant Emissions Inventory (APEI) are generally based on those developed by the United States Environmental Protection Agency (U.S. EPA) and adapted to use Canadian data, thereby accounting for differences in climate, fuels, technologies and practices. Therefore, methods used are generally consistent with those used in the United States, or otherwise, those recommended in the *EMEP/EEA Air Pollutant Emission Inventory Guidebook* (EEA, 2023).

Table A2–1 summarizes the in-house estimation methodologies for the entire time series, organised by the relevant sectors and subsectors. It also provides a general description of the inventory methodology approaches and the pollutants covered by each of those. Sectors and subsectors whose emissions are developed using only facility-reported data are not included in this table. More information on the origin of emissions (in-house estimates, facility-reported data or a combination of both) for each source is available in Chapter 3, Table 3–1.

For complete descriptions of the APEI methodologies, including the references to activity data and emission factors used, please refer to Canada's Air Pollutant Emissions Inventory Methodology Document on the [Government of Canada Open Data Portal](#).¹

Table A2–1 Estimation Methodologies for Ore and Mineral Industries																
Sectors	Subsectors	Description of Methodology	Pollutants													
			PM _{2.5}	SO _x	NO _x	VOCs	CO	NH ₃	Pb	Cd	Hg	D/F	PAHs	HCb	PM ₁₀	TPM
ORE AND MINERAL INDUSTRIES																
Asphalt Paving Industry	-	Total use of asphalt by province and territory is multiplied by pollutant-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Cement and Concrete Industry	Concrete Batching and Products	National domestic consumption of Portland cement is multiplied by the ratio of concrete produced to Portland cement used, distribution percentage by province/territory, and emission factors for each pollutant.	X	-	-	-	-	-	X	X	-	-	-	-	X	X
Foundries	Ferrous Foundries	Total production from grey iron or steel foundries by province and territory are multiplied by pollutant-specific emission factors, which are based on the type of foundry.	X	X	X	X	X	-	-	-	-	-	-	-	X	X
Mining and Rock Quarrying	Rock, Sand and Gravel	Total quantity of rock, sand and gravel produced by province and territory is multiplied by pollutant-specific emission factors to estimate PM emissions.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
	Silica Production	Total quantity of silica produced by province and territory is multiplied by pollutant-specific emission factors to estimate PM emissions.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
OIL AND GAS INDUSTRY																
Downstream Oil and Gas Industry	Refined Petroleum Products Bulk Storage and Distribution	Emissions are calculated using gross sales of gasoline for on-road motor vehicles multiplied by sector-specific emission factors.	-	-	-	X	-	-	-	-	-	-	-	-	-	-
	Natural Gas Distribution	Emission estimates are generated using data from comprehensive inventories and extrapolated from 2012 onwards based on gas distribution pipeline length.	X	X	X	X	X	X	-	-	-	-	-	-	X	X

¹ <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

Table A2–1 Estimation Methodologies for Ore and Mineral Industries (cont'd)

Sectors	Subsectors	Description of Methodology	Pollutants													
			PM _{2.5}	SO _x	NO _x	VOCs	CO	NH ₃	Pb	Cd	Hg	D/F	PAHs	HCB	PM ₁₀	TPM
OIL AND GAS INDUSTRY (cont'd)																
Upstream Oil and Gas Industry	Upstream Oil and Gas Industry subsectors, except natural Gas Transmission and Storage ^a	Emission estimates are generated using data from comprehensive inventories and extrapolated from 2012 onwards using various provincial-level activity data. Operator reported activity data and province-specific gas compositions are used to directly estimate emissions from reported venting and flaring in Alberta (2010-) and Saskatchewan, and from surface casing vent flows in Alberta and British Columbia.	X	X	X	X	X	X	-	-	-	-	-	-	X	X
	Natural Gas Transmission and Storage	Emission estimates are generated using data from comprehensive inventories and extrapolated from 2012 onwards. CO transmission emissions are extrapolated based on pipeline length, while natural gas storage emissions are extrapolated based on annual volumes of gas injected and withdrawn.	X	X	X	X	X	X	-	-	-	-	-	-	X	X
MANUFACTURING																
Bakeries	-	Wheat flour consumption per capita data are multiplied by population data, the fraction of flour use in yeast-leavened baked goods, the ratio of product to flour, and an emission factor.	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Construction Fuel Combustion	-	Sector-specific fuel consumption data taken from the Report on Energy Supply and Demand (RES-D) are multiplied by fuel and sector-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Grain Industry	Grain Industry	PM emissions by province and territory are estimated using grain production statistics from the Canadian Grains Commission and country-specific emission factors for primary, process, transfer and terminal elevator grain handling practices.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
Wood Products	Sawmills and Panel Board Mills	PM emissions by province and territory are calculated using a combination of NPRI facility-reported data and several production and capacity indicators. Emissions of all other pollutants are calculated using production rate estimates, hog fuel combustion data, and other fuel use data.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
TRANSPORTATION AND MOBILE EQUIPMENT																
Air Transportation	Air Transportation (landing and takeoffs [LTO])	Aircraft-specific activity (LTO) by province and territory is multiplied by pollutant-specific emission factors.	X	X	X	X	X	X	X	-	-	-	X	-	X	X
Domestic Marine Navigation, Fishing and Military	-	Vessel-specific activity (movements) is multiplied by pollutant-specific emission factors.	X	X	X	X	X	-	X	X	X	X	X	-	X	X
On-Road Transportation	-	Vehicle-specific activity is multiplied by pollutant-specific emission factors in the MOtor Vehicle Emission Simulator (MOVES) model.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Off-Road Vehicles and Equipment	-	Application-specific activity is multiplied by pollutant-specific emission factors. For Pb, emission factors are derived from data collected under the Gasoline Regulations (SOR/90-247). For all other pollutants, emission factors are sourced from the U.S. EPA.	X	X	X	X	X	X	X	-	-	-	-	-	X	X
Rail Transportation	-	Railway activity (fuel consumption) is multiplied by pollutant-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X

Table A2–1 **Estimation Methodologies for Ore and Mineral Industries (cont'd)**

Sectors	Subsectors	Description of Methodology	Pollutants													
			PM _{2.5}	SO _x	NO _x	VOCs	CO	NH ₃	Pb	Cd	Hg	D/F	PAHs	HCB	PM ₁₀	TPM
AGRICULTURE																
Agricultural Fuel Combustion	-	Sector-specific fuel consumption data taken from the RESD are multiplied by fuel and sector-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Animal Production	-	Animal population data are estimated using semi-annual surveys and corrected to the Census of Agriculture (COA), and country specific NH ₃ and PM emissions from livestock operations and manure management are used.	X	-	-	X	-	X	-	-	-	-	-	-	X	X
Crop Production	Inorganic Fertilizer Application	Fertilizer shipment data are used with country specific NH ₃ emission factors.	X	-	-	-	-	X	-	-	-	-	-	-	X	X
	Sewage Sludge Application	Biosolids production data from ChemInfo Services (2017) are multiplied by the default emission factor for inorganic N sources.	-	-	-	-	-	X	-	-	-	-	-	-	-	-
	Harvesting	Harvesting operation data are multiplied by the PM emission factors from the California Air Resources Board (CARB, 2003) and Pattey and Qiu (2012).	X	-	-	-	-	-	-	-	-	-	-	-	X	X
	Tillage Practices	Activity data for tillage operations in croplands from the COA are used with PM emission factors derived from the U.S. EPA (1985).	X	-	-	-	-	-	-	-	-	-	-	-	X	X
	Wind Erosion	Crop area cultivation data from the COA are used with country specific PM emission factors.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
COMMERCIAL/RESIDENTIAL/INSTITUTIONAL SOURCES																
Commercial and Institutional Fuel Combustion and Residential Fuel Combustion	-	Sector-specific fuel consumption data taken from the RESD are multiplied by fuel and sector-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Commercial Cooking	-	Pollutant-specific emission factors for each type of food and each type of commercial cooking equipment are multiplied by consumption rate and restaurant counts to estimate emissions.	X	-	-	X	X	-	-	-	-	-	X ^b	-	X	X
Home Firewood Burning	-	Emissions from home firewood burning are calculated using consumption information taken from the Households and the Environment Survey and equipment-specific emission factors.	X	X	X	X	X	X	X	X	X	X	X	-	X	X
Humans	-	Annual population data by province and territory are multiplied by an NH ₃ emission factor. A mass balance of Hg from dental amalgams is completed to estimate Hg emissions.	-	-	-	-	-	X	-	-	X	-	-	-	-	-
Marine Cargo Handling	-	Port-specific material handling quantities are multiplied by emission factors that account for wind speeds and the moisture contents of the materials.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
Service Stations	-	Activity data associated with the refuelling of underground fuel tanks, on-road vehicles, and off-road vehicles and equipment are multiplied by emission rates sourced by the U.S. EPA.	-	-	-	X	-	-	-	-	-	-	-	-	-	-
WASTE																
Crematoriums	Human Cremation Pet Cremation	Emissions are calculated using the annual number of cremations for humans and pets combined with pollutant-specific emission factors. For human cremation, mercury from dental amalgams is included which is covered by the Mercury in Products model.	X	X	X	X	X	-	X	X	X	X	X	X	X	X

Table A2–1 Estimation Methodologies for Ore and Mineral Industries (cont'd)

Sectors	Subsectors	Description of Methodology	Pollutants													
			PM _{2.5}	SO _x	NO _x	VOCs	CO	NH ₃	Pb	Cd	Hg	D/F	PAHs	HCB	PM ₁₀	TPM
WASTE (cont'd)																
Waste Incineration	Hazardous Waste Medical Waste Municipal Waste Sewage Sludge Other	Time-series gaps in facility-reported emissions (NPRI) are filled using interpolation or are estimated from reported quantities incinerated and technology-specific emission factors from the U.S. EPA AP-42 and EMEP/EAA.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Residential Waste Burning	The quantity of residential waste burned in outdoor barrels or open pits is combined with the pollutant-specific emission factors to estimate emissions.	X	X	X	X	X	X	-	-	X	X	X	X	X	X
Waste Treatment and Disposal	Landfills	Air pollutants are estimated using the AP-42 methods (U.S. EPA, 1998), based on the modelled landfill gas generated and reported landfill gas recovered (ECCC, 2025).	X	X	X	X	X	-	-	-	X	X	-	-	X	X
	Biological Treatment of Waste – Composting	Municipal and commercial facility-level activity data are compiled from industry surveys, annual reports or facility-based websites. Emission factors are derived from the CARB methodology.	X	X	X	X	X	X	-	-	-	-	-	-	X	X
PAINTS AND SOLVENTS																
Dry Cleaning, General Solvent Use, Printing and Surface Coatings	-	Emissions are estimated using statistical activity data on the production, distribution, end-use patterns and disposal of VOC-containing products. More detailed data on solvent quantities and practices are collected from a subset of solvent and formulated product users, producers and distributors in Canada. Emission factors are based on the portion of controlled release of the VOC in use.	-	-	-	X	-	-	-	-	-	-	-	-	-	-
DUST																
Coal Transportation	-	Dust raised from open rail cars, trucks and barges are estimated based on methods from Cope at Bhattacharyya 2001, which factor trip distance, precipitation and dust controls.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
Construction Operations	-	Dust emissions are estimated based on the surface area of soil disturbance and duration of construction projects. The geographic region, type of construction (residential, industrial-commercial-institutional, engineering) and soil characteristics are considered.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
Mine Tailings	-	Wind-born dust from exposed mine tailings, are estimated based on exposed surface area (Fuentes et al. 2020), regional wind speed, precipitation and snow cover.	X	-	-	-	-	-	-	-	-	-	-	-	X	X
Paved and Unpaved Roads	-	Dust emissions are estimated using AP-42 methods (U.S. EPA, 2011), paired with an in-house traffic distribution model. Note: Improvements to the in-house traffic distribution model are anticipated to result in significant downward revisions to unpaved road dust emission estimates by approximately 70% for the 2026 APEI. If you have any questions on this planned improvement, please contact us at apei-iepa@ec.gc.ca or 1-877-877-8375.	X	-	-	-	-	-	-	-	-	-	-	-	X	X

Table A2–1 **Estimation Methodologies for Ore and Mineral Industries (cont'd)**

Sectors	Subsectors	Description of Methodology	Pollutants													
			PM _{2.5}	SO _x	NO _x	VOCs	CO	NH ₃	Pb	Cd	Hg	D/F	PAHs	HCb	PM ₁₀	TPM
FIRES																
Prescribed Burning	-	The total number of hectares burned from controlled fires in each province/territory per year is multiplied by a conversion factor to convert the area burned into the mass of forest debris burned which determine the release of pollutants.	X	X	X	X	X	X	-	-	-	X	X	-	X	X
Structural Fires	-	The number of structure fires (including vehicle and building fires) in each province and territory is multiplied by a loading factor to convert the number of fires into tonnes of structure burned and pollutant-specific emission factors are used.	X	-	X	X	X	X	-	-	-	-	-	-	X	X
Mercury in Products	-	Emissions are estimated based on a model that includes partitioning factors for the various streams through the life cycle of mercury-containing products, from manufacture through final disposal.	-	-	-	-	-	-	-	-	X	-	-	-	-	-

Notes:

- = Not applicable

a. The Upstream Oil and Gas Industry subsectors included are Petroleum Liquids Transportation, Oil Sands In-Situ Extraction and Processing, Light Medium Crude Oil Production, Well Drilling, Well Servicing, Well Testing, Natural Gas Production, Natural Gas Processing, Heavy Crude Oil Cold Production, Disposal and Waste Treatment, Accidents and Equipment Failures.

b. B(a)p only

RECALCULATIONS

A3.1. Recalculations in this Air Pollutant Emissions Inventory Edition	54
A3.2. Considerations for Future Editions of this Inventory	58

Emission recalculation is an essential practice in the maintenance of up-to-date and consistent trends in air pollutant emissions. The Air Pollutant Emissions Inventory (APEI) is continuously updated with improved estimation methodologies, activity data and more recent and appropriate emission factors. As new information and data become available, previous estimates are updated and recalculated to ensure a consistent and comparable trend in emissions. Circumstances that warrant a change or refinement of data and/or methods include the:

- incorporation of updates to activity data including changes to data sources;
- refinements of methodologies and emission factors;
- reallocation of sources to different categories (which affects subtotals);
- inclusion of categories previously not estimated (which improves inventory completeness); and
- correction of errors detected by quality control procedures.

Resubmissions of facility-reported data previously reported to the National Pollutant Release Inventory (NPRI) can also result in revised historical estimates. Generally, these recalculations by facilities are completed for only a few years in their historical emissions.

In contrast, new activity data are incorporated into the in-house estimates as they become available, and these updates are reflected in the trends on an ongoing basis. [Table 3–1](#) in Chapter 3 shows which sources are estimated using facility reported data and/or in-house methods. Updated trends, based on updated facility-reported data and in-house estimates, are published on a yearly basis. For example, the calculation of emissions from commercial, residential, agricultural and construction fuel combustion sources rely on the latest fuel use quantities from the Statistics Canada annual publication *Report on Energy Supply and Demand in Canada* (RESO) (Statistics Canada, n.d.).

A3.1. Recalculations in this Air Pollutant Emissions Inventory Edition

The following pollutants were not significantly recalculated (net emissions change <2%) between the 2024 and 2025 editions of the APEI with negligible impacts on the time series trend lines:

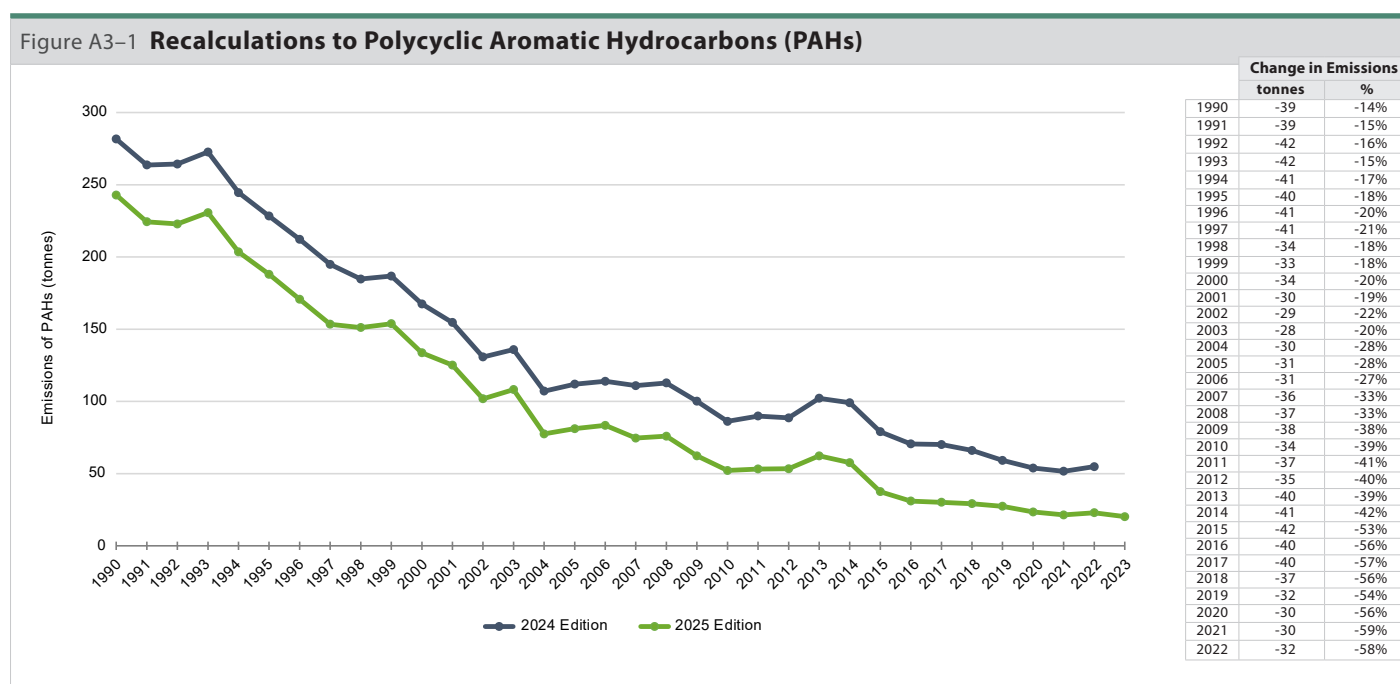
- particulate matter less than or equal to 2.5 microns in diameter (PM_{2.5})
- sulphur oxides (SO_x)
- carbon monoxide (CO)
- ammonia (NH₃)
- lead (Pb)
- cadmium (Cd)
- mercury (Hg)
- hexachlorobenzene (HCB)

The following pollutants had notable recalculations between the 2024 and 2025 editions of the APEI (in order of recalculation importance):

- polycyclic aromatic hydrocarbons (PAHs), comprised by the sum of the following pollutants:
 - benzo(a)pyrene (B(a)p)
 - benzo(b)fluoranthene (B(b)f)
 - benzo(k)fluoranthene (B(k)f)
 - indeno(1,2,3-cd)pyrene (I(-cd)p)
- nitrogen oxides (NO_x)
- dioxins and furans (D/F)
- particulate matter less than or equal to 10 microns in diameter (PM₁₀)
- total particulate matter (TPM)
- volatile organic compound (VOCs)

These recalculations are presented in [Figure A3–1](#) to [Figure A3–6](#), all at the national level.

Recalculations to PAHs emissions ([Figure A3–1](#)) are primarily attributed to incorporating a new emission factor from a Canadian residential wood combustion study. This study better reflects significant advancements made in stove designs and control strategies over the last several years, as well as Canadian practices in firewood burning. The new study is available online on the [Government of Canada Open Data Portal](#).¹



Recalculations to NO_x and dioxins and furans emissions ([Figure A3–2](#) and [Figure A3–3](#) respectively) are mainly attributed to new data received to determine emissions from the Domestic Marine Navigation, Fishing and Military sector. Dioxins and furans emissions recalculations are also attributed to changes in activity data used to calculate landfill emissions. Specifically, a reduction in the amount of landfill gas flared resulted in a decrease in dioxins and furans emissions from landfills.

¹ <https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-air-pollutant-emissions-inventory/>

Figure A3-2 Recalculations to Nitrogen Oxides (NO_x)

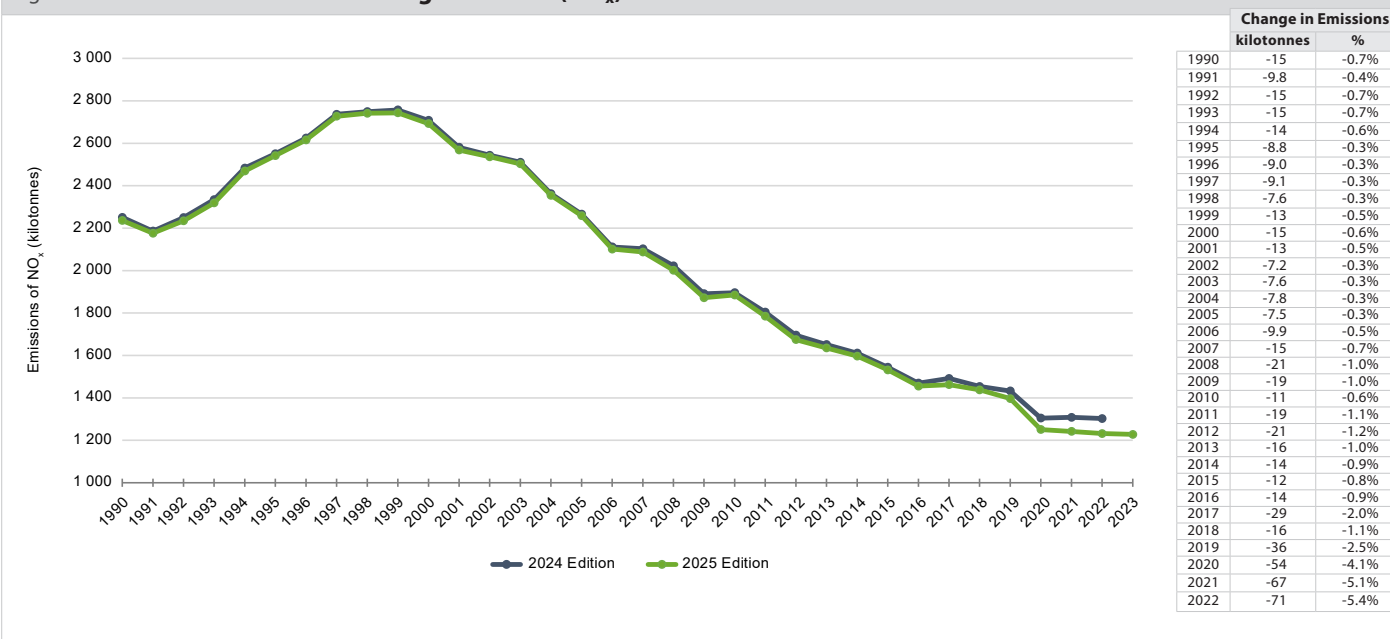
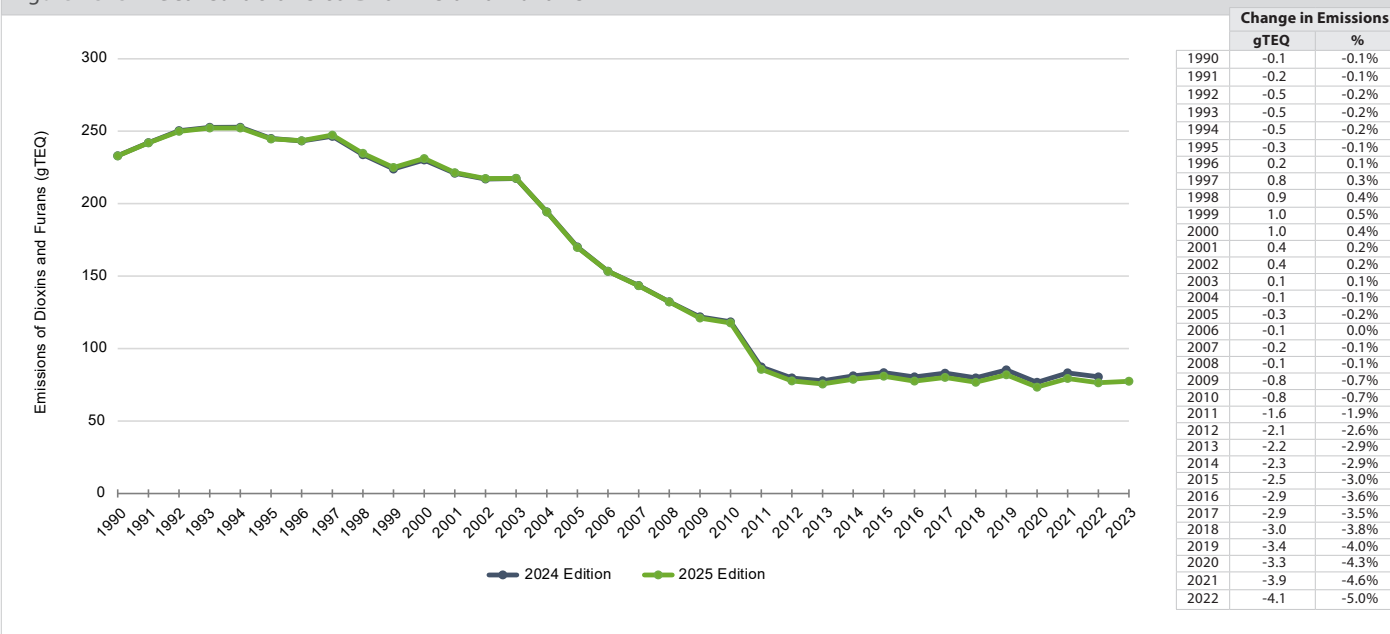


Figure A3-3 Recalculations to Dioxins and Furans



Recalculations to PM₁₀ and TPM emissions (Figure A3–4 and Figure A3–5 respectively) are largely attributed to changes in the Dust category. The main contributor for this category being the change in activity data (traffic counts) used as input to the road dust model. Another contributor is the incorporation of a new emission factor from a Canadian study to calculate emissions from the residential wood combustion sector (see PAHs recalculations section for more details).

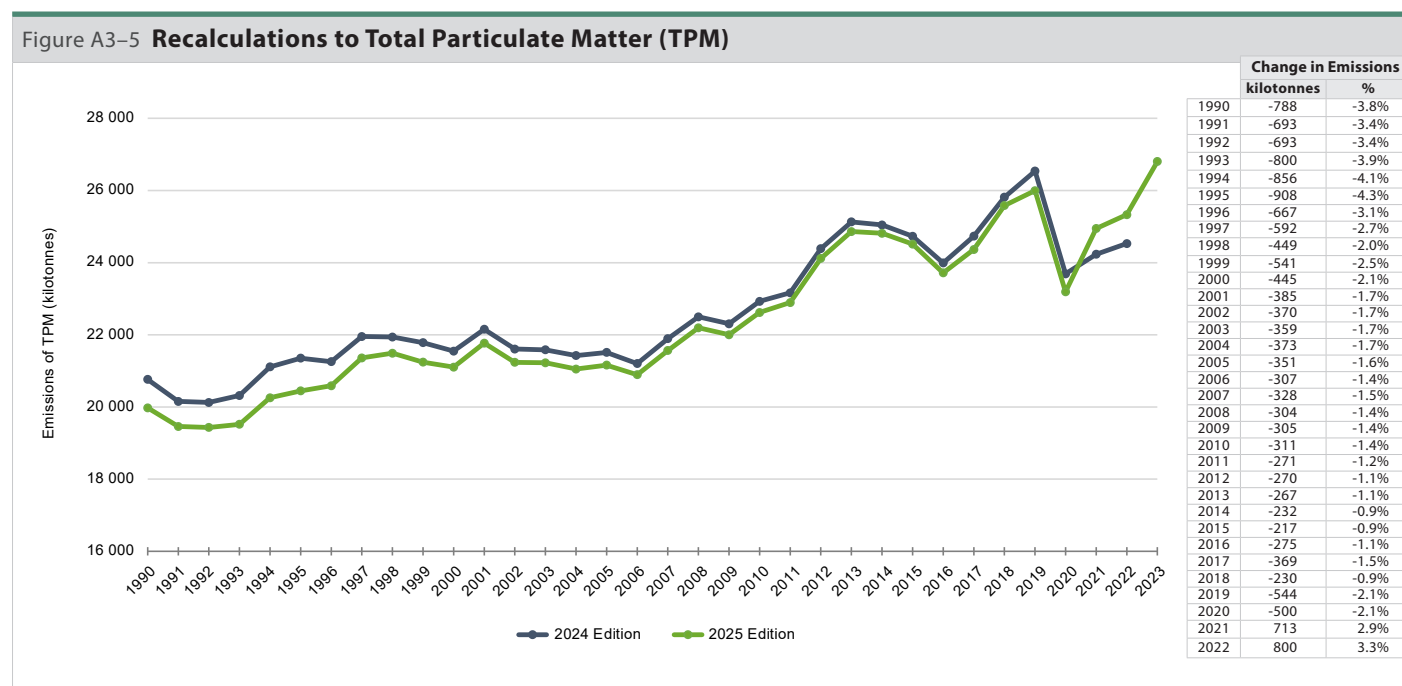
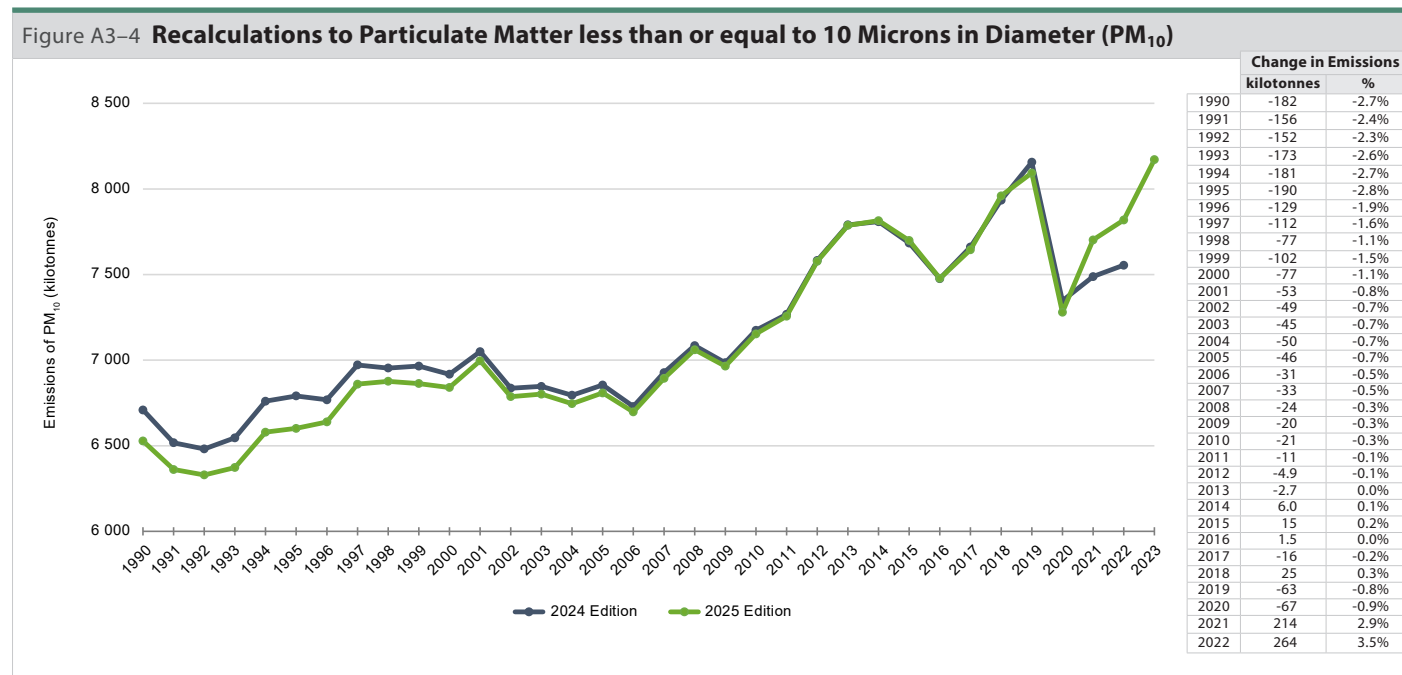
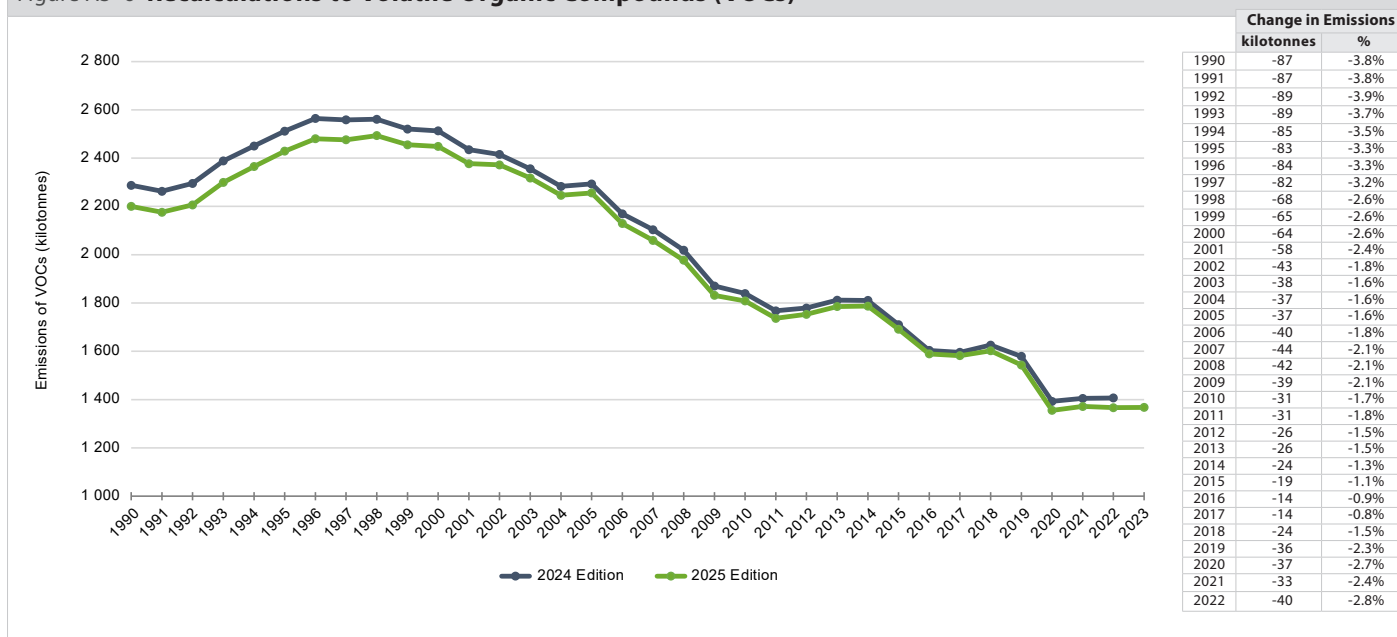


Figure A3–6 Recalculations to Volatile Organic Compounds (VOCs)



Recalculations to VOCs (Figure A3–6) are primarily attributed to incorporating a new emission factor from a Canadian study to calculate emissions from the residential wood combustion sector (see PAHs recalculations section for more details) as well as the refinement of the activity data used to determine the contribution of general solvent use.

Refer to Annex 2 and Canada’s Air Pollutant Emissions Inventory Methodology Document available on the [Government of Canada Open Data Portal](#)² for additional information on methodologies.

A3.2. Considerations for Future Editions of this Inventory

Further refinements and recalculations to the emission estimates are anticipated for subsequent editions of the APEI. An example of a suggested planned improvement is the refinement of the road Dust traffic-distribution model to include a variable (evolving) road network and, provincial and territorial specific total kilometers driven. This improvement is anticipated resulting in significant downward revisions to unpaved road dust particulate matter emission estimates by approximately 70% for the 2026 APEI.

Please contact apei-iepa@ec.gc.ca for more information on any methodological update or recalculations.

² <https://open.canada.ca/data/en/dataset/fa1c88a8-bf78-4fcb-9c1e-2a5534b92131>

SUBMISSION TO THE UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

A4.1.	Canada's Air Pollution Emissions Relative to International Commitments	59
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Canada reports on atmospheric emissions of air pollutants to the United Nations Economic Commission for Europe (UNECE) through the European Monitoring and Evaluation Programme (EMEP) [Centre on Emission Inventories and Projections \(CEIP\)](#)¹ pursuant to the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) of the UNECE and its associated protocols. Canada's annual official submission to the UNECE comprises an air pollutant dataset, the Nomenclature for Reporting (NFR) tables, submitted by February 15 and its accompanied report by March 15. The CLRTAP has been supplemented by a number of protocols, the most active being the Gothenburg, Heavy Metals, and Persistent Organic Pollutants (POPs) protocols. Canada has ratified all of the protocols except for the 1991 Protocol on Volatile Organic Compounds (VOCs). The requirements under that Protocol are obsolete given that Canada now has commitments on VOCs under the Gothenburg Protocol.

A4.1. Canada's Air Pollution Emissions Relative to International Commitments

This edition of the Canada's Air Pollutant Emissions Inventory (APEI) indicates that all international commitments relative to air pollution emissions continue to be met. [Table A4–1](#) lists the atmospheric pollutants and associated protocols under the CLRTAP along with the corresponding emission reduction targets or ceilings and the current situation in relation to those protocols (compared with the latest data year).

[Table A4–1](#) shows that all commitments were met between 1990 and 2018, and that they continue to be met, with the latest one to be met being for the emissions reduction of sulphur oxides (SO_x). Specifically, for the most recent protocol under the CLRTAP (1999 Gothenburg Protocol, as amended in 2012):

- Emissions of fine particulate matter (particulate matter less than or equal to 2.5 microns in diameter [PM_{2.5}]) decreased from most sources with the notable exceptions of dust sources (not from combustion) such as construction operations and roads; Canada's emission reduction commitment for PM_{2.5}² excludes these two sources along with crop production. Emissions of PM_{2.5} were 1.4 megatonnes (Mt) in 2023, but excluding these three sources, they were 21% lower than the 2020 reduction commitment of the amended Gothenburg Protocol of 2012.
- Emissions of sulphur oxides (SO_x) were 0.60 megatonnes (Mt) in 2023, which is 36% below the 0.9 Mt commitment as per the amended Gothenburg Protocol of 2012.
- Emissions of nitrogen oxides (NO_x) were 1.2 Mt in 2023, which is 16% below the 1.5 Mt commitment as per the amended Gothenburg Protocol of 2012.
- Emissions of non-methane VOCs (NMVOCs³) were 1.4 Mt in 2023, which is 24% below the 1.8 Mt commitment as per the amended Gothenburg Protocol of 2012.

¹ <https://www.ceip.at/>

² This commitment focuses on emission sources of PM_{2.5} from combustion, and therefore, that have a significant black carbon content. Canada's Black Carbon Inventory Report can be found at www.canada.ca/black-carbon.

³ Please see [Annex 1](#) within this report for more information on NMVOCs.

Table A4–1 Canada's Air Pollutant Emissions in Relation to Protocols under the Convention on Long-Range Transboundary Air Pollution

Pollutant		Protocols under the CLRTAP	Protocol obligation	Target met	Current situation (2023 emissions)
PM _{2.5}		1999 Gothenburg Protocol (as amended in 2012)	25% emission reduction from 2005 levels by 2020 and beyond ^a	Since 2016	21% under the emissions reduction commitment
SO ₂		1999 Gothenburg Protocol (as amended in 2012)	55% emission reduction from 2005 levels by 2020 and beyond	Since 2018	36% under the emissions reduction commitment
		1999 Gothenburg Protocol	2010 emissions ceiling of 1.45 megatonnes (Mt)	Since 2009	58% under the emissions ceiling
		1994 Oslo Protocol	Maintain emissions in the regional Sulphur Oxides Management Area (SOMA) ^b 46% below 1980 level	Since 1990	86% under the emissions ceiling of 1.8Mt
		1985 Helsinki Protocol	Reduction of emissions by at least 30% from 1980 levels by 1993	Since 1990	81% under the emissions ceiling of 3.3 Mt
NO _x		1999 Gothenburg Protocol (as amended in 2012)	35% emission reduction from 2005 levels by 2020 and beyond	Since 2016	16% under the emissions reduction commitment
		1999 Gothenburg Protocol	2010 emissions ceiling of 2.25 Mt	Since 2006	45% under the emissions ceiling
		1988 Sofia Protocol	Stabilize (not exceed) 1987 emission level by 1994	Since 1990	56% under the emissions ceiling of 2.8 Mt
VOCs		1999 Gothenburg Protocol (as amended in 2012)	20% emission reduction from 2005 levels by 2020 and beyond	Since 2011	24% under the emissions reduction commitment
		1999 Gothenburg Protocol	2010 emissions ceiling of 2.1 Mt	Since 2008	35% under the emissions ceiling
NH ₃		1999 Gothenburg Protocol	Emission reporting	Since established	Yearly reporting
Pb		1998 Aarhus Protocol on Heavy Metals	50% emission reduction of 1990 levels by 2011	Since 2002	82% under the emissions ceiling of 511 tonnes
Cd				Since 2007	89% under the emissions ceiling of 41 tonnes
Hg				Since 1995	81% under the emissions ceiling of 17 tonnes
Dioxins and furans		1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 emission levels	Since 1999	67% under the emissions ceiling of 233 gTEQ
PAHs	B(a)p			Since 1991	90% under the emissions level
	B(b)f				92% under the emissions level
	B(k)f				95% under the emissions level
	I(cd)p				89% under the emissions level
HCB			Since 2003	88% under the emissions ceiling of 39 kg	

Notes:

a. This commitment excludes road dust, construction operations and crop production emission sources.

b. The SOMA covers the provinces of Nova Scotia, Prince Edward Island, New Brunswick and parts of Quebec and Ontario.

A4.2. Overview of the United Nations Economic Commission for Europe Reporting Template

The UNECE NFR categories correspond to the sectors described in the *EMEP/EEA Air Pollutant Emission Inventory Guidebook* (EEA, 2023). In addition to providing technical guidance for developing inventory methodologies, the EMEP/EEA guidebook includes instructions for attributing sectoral emissions to NFR codes.

Whereas the APEI report groups emissions by sectors (e.g., pulp and paper industry), the emissions in the UNECE are grouped by process and combustion sources. For example, the pulp and paper industry within the APEI includes both combustion and process emissions. The combustion component is mapped to NFR sector 1A2d (Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print). The process component is mapped to NFR sector 2H1 (Pulp and paper industry).

Table A4–2 illustrates the structure of the UNECE reporting template. The template, last revised November 18, 2019, can be found in its entirety on the [CEIP website](https://www.ceip.at/).⁴ Canada's NFR tables annual submission can be found on the [CEIP website](https://www.ceip.at/) as well.⁵

Table A4–2 Excerpt from United Nations Economic Commission for Europe Nomenclature for Reporting Template for 2025												
Annex 1: National sector emissions: Main pollutants, particulate matter, heavy metals and persistent organic pollutants												
NFR aggregation for gridding and LPS (GNFR)	NFR sectors to be reported			Main pollutants (from 1990)				Particulate matter (from 2000)				Other (from 1990)
	NFR Code	Long name	Notes	NO _x (as NO ₂)	NM VOC	SO _x (as SO ₂)	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO
				kt	kt	kt	kt	kt	kt	kt	kt	kt
A_PublicPower	1 A 1 a	Public electricity and heat production										
B_Industry	1 A 1 b	Petroleum refining										
B_Industry	1 A 1 c	Manufacture of solid fuels and other energy industries										
B_Industry	1 A 2 a	Stationary combustion in manufacturing industries and construction: Iron and steel										
B_Industry	1 A 2 b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals										
B_Industry	1 A 2 c	Stationary combustion in manufacturing industries and construction: Chemicals										
B_Industry	1 A 2 d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print										
B_Industry	1 A 2 e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco										
B_Industry	1 A 2 f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals										
I_Offroad	1 A 2 g vii	Mobile combustion in manufacturing industries and construction: (please specify in your IIR)										
B_Industry	1 A 2 g viii	Stationary combustion in manufacturing industries and construction: Other (please specify in your IIR)										
Notes: BC = black carbon GNFR = Gridded nomenclature for reporting IIR = Informative Inventory Report, which is equivalent to Air Pollutant Emissions Inventory Report and Black Carbon Report in Canada LPS = Large point source NMVOC = Non-methane volatile organic compounds (refer to Annex 1 for more information) TSP = Total suspended particles (equivalent to TPM in this report)												

⁴ <https://www.ceip.at/reporting-instructions/annexes-to-the-2023-reporting-guidelines>

⁵ <https://www.ceip.at/status-of-reporting-and-review-results>

A4.3. Mapping of Air Pollutant Emission Inventory Emissions to the United Nations Economic Commission for Europe's Nomenclature for Reporting Categories

The mapping of APEI sector emissions to UNECE NFR categories involves dividing the sector emissions into their combustion and process components. Whereas certain sectors contribute solely a process component (in the case of road dust) or combustion component (in the case of the transport sector), the majority of sectoral emissions are distributed over both components. In most sectors, this is accomplished using a split ratio, which, apart from a small number of exceptions, is assigned to a particular subsector and pollutant. For example, in the oil sands mining, extraction and upgrading subsector, a portion of the emissions are attributed to combustion and are accounted in manufacture of solid fuels and other energy industries, while another portion is attributed to the process emissions and are compiled in the fugitive emissions oil as illustrated in Table A4–3. The only exception for that subsector is ammonia (NH₃), where all emissions are attributed to combustion activities. Finally, some in-house estimation methodologies produce detailed emissions by sources, and emissions are assigned directly to the appropriate combustion or process NFR code.

APEI subsector	UNECE NFR category		Pollutant	Split ratios (w/w) ^a	
	Combustion	Process		Combustion	Process
Oil Sands Mining, Extraction and Upgrading	1A1c: Manufacture of solid fuels and other energy industries	1B2ai: Fugitive emissions oil: Exploration, production, transport	B(a)p	0.998	0.002
			B(b)f	0.834	0.166
			B(k)f	0.998	0.002
			Cd	0.970	0.030
			CO	0.947	0.053
			Hg	0.969	0.031
			I(1,2,3-cd)p	0.999	0.001
			NH ₃	1.000	0.000
			NO _x	0.996	0.004
			Pb	0.990	0.010
			PM ₁₀	0.442	0.558
			PM _{2.5}	0.646	0.354
			SO _x	0.998	0.002
			TPM	0.293	0.707
			VOC	0.113	0.887

Notes:
w/w = weight by weight (mass fraction)
a. Data sources: ECCC (2017)

A4.4. Reporting International Marine Navigation and Air Transportation Emissions

The APEI reports marine and aviation differently than NFR tables. While the overall total of emissions for these sectors are the same, the allocation into different categories is different.

The NFR table has five categories for marine: 1A3dii – National navigation (shipping), 1A4cii – Agriculture/Forestry/Fishing: National fishing, 1A3di(i) – International maritime navigation, 1A3di(ii) – International inland waterways, and 1A5b – Other, Mobile (including military, land based and recreational boats). The APEI report includes all emissions occurring from domestic marine navigation (1A3dii), fishing vessels (1A4cii) and military vessels (1A5b) in one category as those emissions contribute to Canada's national total. International marine navigation (excluding fishing and military operations) is reported in a separate table in the APEI report and the NFR table, as those emissions do not contribute to Canada's national total. This is consistent with international reporting requirements. No values are reported under 1A3di(ii) – International inland waterways.

Similarly, the NFR table has five categories for aviation: 1A3ai(i) – International aviation landing/take-offs (LTO) (civil), 1A3ai(ii) – International aviation cruise (civil), 1A3aii(i) – Domestic aviation LTO (civil), 1A3aii(ii) – Domestic aviation cruise (civil), and 1A5b – Other, Mobile (including military, land based and recreational boats). The APEI report includes all emissions occurring from civil LTO cycles—1A3ai(i) and 1A3aii(i)—and military flights (1A5b) in one category as those emissions contribute to Canada's national total. The emissions attributed to the cruise phase for civil flights are reported separately in the APEI report and the NFR table, as those emissions do not contribute to Canada's national total. This is consistent with international reporting requirements.

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