

# *Inventory of* **GREENHOUSE GASES** *in Québec*

1990-2000



## HIGHLIGHTS

*This is a summary of a detailed report concerning an inventory of greenhouse gas (GHG)\* emissions produced by human activity in Québec from 1990 to 2000. Publication of this inventory marks a first in Québec. The inventory has been compiled annually since 1990 by the Ministère de l'Environnement du Québec, based on data-collected from businesses and institutions, as well as statistical data and calculations for some sectors.*

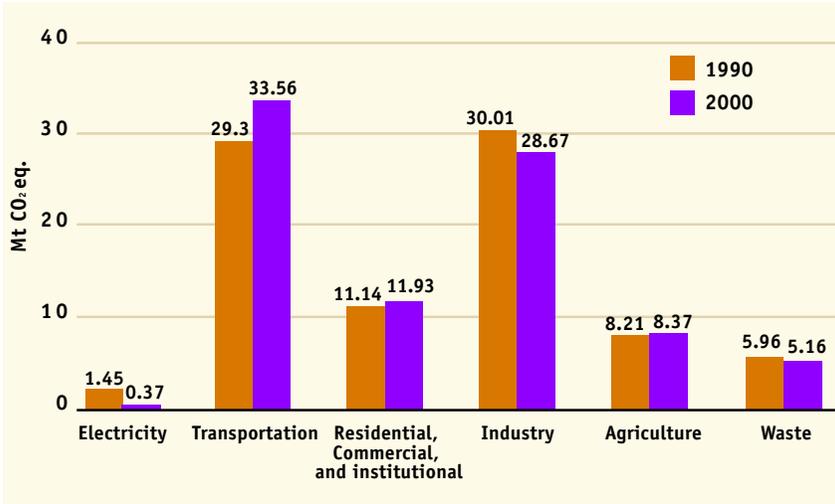
*The presentation of emissions by sector appearing in the detailed report has been modified in this summary in order to make the data more accessible.*

\* The GHGs covered by the report are those specified in the Kyoto Protocol. Emissions are expressed in millions of carbon dioxide (CO<sub>2</sub>) equivalent tons. This figure is calculated for each GHG based on its global warming potential (GWP) in comparison to carbon dioxide, which carries a GWP of 1.

### OVERVIEW

- GHGs in Québec totalled 88.3 million CO<sub>2</sub>-equivalent tons in 2000, or 12.5% of Canadian emissions and approximately 0.3% of global emissions.
- GHG emissions in Québec increased by 2.3% (or 2 million tons) from 1990 to 2000. During the same period, Québec's population grew by 6%, its gross domestic product (GDP) rose by 26%, and its fossil-fuel-based energy consumption increased by 7%.
- The main GHG discharged into the atmosphere by all Québec sectors in 2000 was carbon dioxide, which comprised 75.8% of the total, followed by methane at 11.2%, and nitrous oxide at 7.2%.
- The sectors that produced the most GHG emissions in 2000 in Québec were transportation, with 38%, and industry, with 32.5% of the total.
- The increase in GHG emissions in Québec from 1990 to 2000 is primarily attributed to the Transportation sector. Emissions in that sector rose by 14.5% (4.3 million CO<sub>2</sub>-equivalent tons) over 10 years, from 29.3 to 33.6 million CO<sub>2</sub>-equivalent tons. This is largely due to the greater number of light and heavy trucks on the road.
- The main sectors where emissions declined from 1990 to 2000 are industry (4.5% less) and waste (13.3% less).

FIGURE 1: Greenhouse Gas Emissions in Québec, 1990–2000.



## GHG EMISSIONS IN QUÉBEC IN 2000

In 2000, Québec discharged 88.3 million tons of GHGs into the atmosphere, which accounts for 12.5% of Canadian emissions and approximately 0.3% of global emissions. This represents 12.0 tons per Québécois, which is close to half the Canadian rate, estimated at 23.6 tons per capita for that same year. Québec's performance is close to the European Community's 10.7 tons per capita.

Québec GHG emissions are dominated by carbon dioxide (CO<sub>2</sub>), which makes up 75.8% of the 2000 total, followed by methane at 11.2%. Nitrous oxide accounts for 7.2%, and polyfluoro-carbons account for 4.2%. The remaining GHGs combined total just over 1% (Figure 2).

32.1 million tons, or close to half of the 66.9 million tons of CO<sub>2</sub> discharged into the atmosphere in 2000, came from the transportation sector, and was the result of burning fossil fuels. These emissions, combined with 1.5 million CO<sub>2</sub>-equivalent tons of methane and nitrous oxide, make the transportation sector the leading source of GHG emissions in Québec.

In all, transportation accounts for 38% of atmospheric emissions of GHGs, totalling 33.6 million CO<sub>2</sub>-equivalent tons. Industry is next, at 28.7 million tons (32.5%); then the residential, commercial, and institutional sector, at 11.9 million tons (13.5%); agriculture, at 8.4 million tons (9.5%); waste, at 5.2 million tons (5.8%); and electricity and steam generation, at 0.4 million tons (0.4%).

### Trends Since 1990

GHG emissions in Québec totalled 86.4 million tons in 1990. The next two years brought an economic slowdown in Québec, with an accompanying decline in GHG emissions. Emissions have been generally on the rise since 1993. In 1998, emission levels topped the 1990 figure for the first time, reaching 87.9 million tons, or 1.7% more than in 1990.

GHG emissions in Canada rose by 19.6% from 1990 to 2000. During that same period, they increased by 2.3% in Québec, which is a rate lower than the growth of Québec's population (up 6%), Québec's GDP (up 26%), and Québec's fossil-fuel-based energy consumption (up 7%) (Figure 4).

Per-capita GHG emissions in Québec declined by 3% from 1990 to 2000, whereas the Canadian average rose by 9% during the same period. During that decade, the ratio of GHG emissions to GDP decreased by 19% in Québec, from 0.5 to 0.4 CO<sub>2</sub>-equivalent kilotons per million dollars of GDP. This is below the Canadian average, which stood at 0.8 CO<sub>2</sub>-equivalent kilotons per million dollars of GDP in 1990, and dropped to 0.7 CO<sub>2</sub>-equivalent kilotons per million dollars of GDP by 2000 (a decrease of 10%).

There are a variety of factors that influence total GHG emissions from one year to the next. The increase recorded in Québec from 1990 to 2000 is due mainly to more fossil-fuel consumption in the transportation sector. In fact, this sector shows the largest increase (14.5%) in emissions since 1990. During the same period, emissions in the residential, commercial, and institutional sector and in agriculture rose by 7.1% and 1.9% respectively.

FIGURE 2: Breakdown of Québec GHG Emissions by Gas, 2000

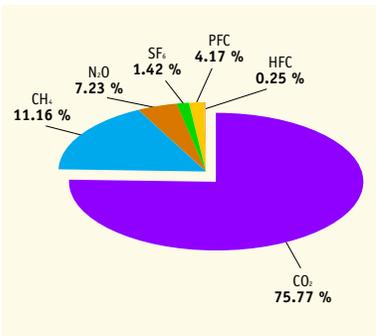
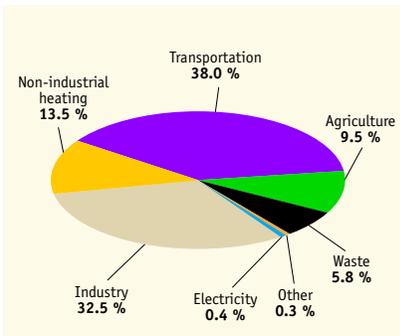


FIGURE 3: Breakdown of Québec Greenhouse Gas Emissions by Sector in 2000.



## GHG EMISSIONS BY SECTOR

### Transportation

*This sector includes emissions from any form of mobile transportation, with the exception of international transport. Road transport, off-road motor vehicles, civil aviation, rail and water transport are all included.*

The transportation sector is the main source of GHG emissions in Québec. At 33.6 million tons of emissions in 2000, it represents 38% of the Québec total. The GHGs in this sector come from burning fossil fuels (gasoline, diesel fuel, propane, natural gas, heavy oil, etc.).

Road transportation alone, which covers vehicles travelling on Québec roads (automobiles, motorcycles, light and heavy trucks, buses), produced 28.3 million CO<sub>2</sub>-equivalent tons in 2000, or 84% of total transport emissions.

Road transportation largely accounts for the 14.5% rise in emissions in the transport sector from 1990 to 2000. During that period, road transportation emissions climbed from 24.0 to 28.3 million CO<sub>2</sub>-equivalent tons. This 17.9% increase is due mainly to the sharp rise in the number of light and heavy trucks on the road. In fact, these vehicles have almost doubled fuel consumption in Québec since 1990. The number of automobiles changed only slightly.

GHG emissions from automobiles in Québec declined by 7% from 1990 to 2000, while those from light and heavy trucks climbed dramatically, by 75% and 43% respectively. This rise is directly related to the increase in the number of light and heavy trucks on the road. The number of light trucks<sup>1</sup> nearly doubled from 1990 to 2000, rising from 600,000 to almost 1,100,000, while heavy trucks in 2000 stood at 2.5 times their 1990 number, climbing from 100,000 to 250,000.

Domestic air and marine transport emissions remained stable, while those from rail transport climbed by 43%, from 0.6 million CO<sub>2</sub>-equivalent tons in 1990 to 0.8 million tons in 2000.

### Industry:

*This sector covers industrial emissions from burning fossil fuels, industrial processes, the construction sector, the use of solvents and other products, and emissions from oil refineries. It also includes fugitive emissions from natural gas transportation and distribution.*

In Québec, the industrial sector ranked second after transportation, with an estimated 28.7 million CO<sub>2</sub>-equivalent tons of emissions in 2000, or 32.5% of the Québec total, with 57% coming from fossil fuel combustion, 42% from industrial processes, and 1% from fugitive emissions and the use of solvents and other products.

1. Vehicles weighing 3,900 kg or less that are intended primarily to carry passengers are considered to be "automobiles"; those designed to transport light merchandise or those equipped with four-wheel drive are classified as "light trucks".

## GREENHOUSE GASES

The Earth absorbs some of the energy it receives from the sun, and releases heat in the form of infrared radiation. Without the greenhouse effect, this radiation would quickly dissipate into space, and the planet's average temperature would be -18°C instead of 15°C. If that were the case, life as we know it could not exist.

The greenhouse effect results from the presence of gases in the atmosphere that are capable of absorbing the radiation from Earth. These are known as "greenhouse gases" (GHGs). The most abundant are water vapour and carbon dioxide (CO<sub>2</sub>). Methane and nitrous oxide are also present, but at lower concentrations.

The average temperature on Earth reflects a balance between the energy received from the sun and the energy released into space. However, some human activities release GHGs that, when added to the gases naturally present in the atmosphere, tend to disrupt the balance. In fact, as GHG concentrations increase, the amount of radiation released into space declines, which results in an increase in the planet's average temperature.

Since the dawn of the pre-industrial era, the concentration of CO<sub>2</sub> in the atmosphere has risen by 31%, the concentration of methane has risen by 150%, and the concentration of nitrous oxide has risen by 16%. Furthermore, GHGs that are not found in nature, such as sulphur hexafluoride (SF<sub>6</sub>), are now detected in the atmosphere.

In light of this, many scientists believe that this substantial increase in GHG concentrations in the atmosphere is mainly responsible for the 0.6°C increase in average air temperature at the surface of the globe since the end of the 19th century.

TABLE 1:  
GHG Emissions by Activity Sector

Source	GHG Emissions		Change in GHG Emissions		Share of Emissions in Québec
	1990 Mt CO <sub>2</sub> -eq*	2000 Mt CO <sub>2</sub> -eq.	1990-2000 Mt CO <sub>2</sub> -eq.	%	
Electricity	1.45	0.37	-1.08	-74.5 %	0.4 %
Transportation	29.30	33.56	4.26	14.5 %	38.0 %
Residential, commercial and institutional	11.14	11.93	0.79	7.1 %	13.5 %
Industry	30.01	28.67	-1.34	-4.5 %	32.5 %
Agriculture	8.21	8.37	0.16	1.9 %	9.5 %
Waste	5.95	5.16	-0.79	-13.3 %	5.8 %
Other	0.30	0.27	-0.03	-9.0 %	0.3 %

\* Million CO<sub>2</sub>-equivalent tons

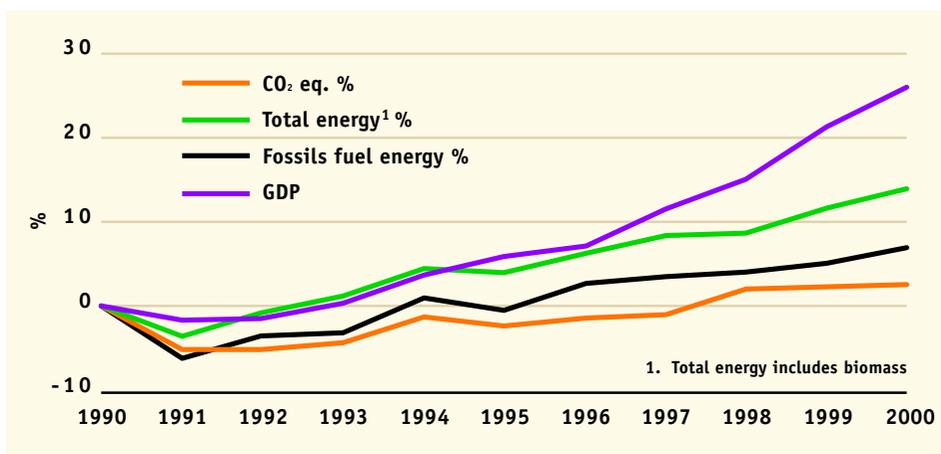


FIGURE 4:  
Percentage of Change in  
CO<sub>2</sub>-Equivalent Emissions,  
GDP, and Energy  
Consumption

GHG emissions for the entire industrial sector declined by 4.5% from 1990 to 2000. Those from industrial use of fossil fuels dropped by nearly 5%, and those from processes by 4% as a result of improvements in technology and energy efficiency in this sector. Fugitive emissions from burning residual gases in oil refinery flares and escapes during natural gas transportation and distribution remained stable in the last decade.

#### • Industrial Combustion

This subsector covers industrial emissions from burning fossil fuels used in the production of goods as well as those from thermal powerplants operated by industry.

In 2000, the industries producing the most emissions from fossil fuel combustion were pulp and paper (22.9%), oil refineries (21.9%), ferrous metal (15.1%), cement and lime factories (6.8%), and aluminum smelters and magnesium producers (2.4%). Emissions in this subsector have declined by 4.8%, from 17.2 million CO<sub>2</sub>-equivalent tons in 1990 to 16.4 million in 2000.

#### • Industrial Processes

The manufacture of some products results in GHG emissions either directly from industrial processes or as by-products.

In 2000, GHG emissions from industrial processes totalled 12.1 million CO<sub>2</sub>-equivalent tons. Aluminum production accounted for 58.1% of these emissions, with 7 million tons; followed by non-metallic mineral production, at 15.2% (1.8 million tons); magnesium production, at 10.9% (1.3 million tons); ferrous metal production, at 10.3% (1.2 million tons); and the production of other goods and undifferentiated products, at 5.5% (0.7 million tons).

GHG emissions from industrial processes declined by 4.1% from 1990 to 2000. Emissions in this subsector depend on production and the technology used.

For example, modernization of certain facilities and better control of anodic effects led to a reduction in the GHG emission rate for aluminum smelters. As a result, while aluminum production doubled from 1990 to 2000, smelter emissions only climbed by 2.3% during the same time period. Similarly, a decline in the use of sulphur hexafluoride (SF<sub>6</sub>) resulted in a 46.5% reduction in emissions from magnesium production since 1990. These emissions include CO<sub>2</sub> and SF<sub>6</sub>, a gas with a very high GWP (23,900).

GHG emissions from the production of non-metallic minerals are attributable to cement and lime factories. Production in this subsector increased from 1990 to 2000, resulting in a 7.6% rise in its GHG emissions. Ferrous metal production, which covers cast-iron and steel foundries, steel mills, and pelletization plants, rose sharply by 45%. This growth stems mainly from the steel mill subsector, whose emissions climbed by 57% over the same period.

### Residential, Commercial, Institutional, and Public Administration Sector

*This sector encompasses GHG emissions from the use of fossil fuels to heat buildings, and for various other purposes such as cooking in restaurants. It also includes methane and nitrous oxide emissions from the use of biomass as a combustible.*



This sector's emissions totalled 11.9 million CO<sub>2</sub>-equivalent tons in 2000, or 13.5% of all Québec emissions, with the residential subsector accounting for 52% and the commercial and institutional subsectors accounting for 48%. This represents a 7.1% increase since 1990.

Energy consumption in both subsectors rose in the last decade. However, the residential subsector saw a shift from heating oil to natural gas, an energy source that emits proportionally less GHGs. Consequently, residential GHG emissions in 2000 were 9.6%

lower than in 1990. During the same period, emissions in the commercial and institutional subsector increased by 33.9%, due to higher demand for energy.

### Agriculture

*This sector covers GHGs emitted by livestock during digestion (enteric fermentation), as well as those produced by manure management and agricultural soils.*

In 2000, agriculture accounted for 8.4 million CO<sub>2</sub>-equivalent tons, or 9.5% of Québec's total GHG emissions. Agricultural soils are the main source of these emissions, at 43%, followed by manure management at 31%, and livestock digestion at 27%.

Agricultural soils management and farming practices, such as the use of certain fertilizers, can release CO<sub>2</sub> and nitrous oxide into the atmosphere. Emissions due to this subsection increased by 9% from 1990 to 2000.

Handling manure from livestock causes methane and nitrous oxide emissions. The amount of gas depends on the characteristics of the manure, the animal species, and the method of managing the manure. Emissions due to manure management increased by 5.7% from 1990 to 2000.

Methane is a by-product of the normal digestion process of herbivores, especially ruminants like cattle. Methane emissions vary depending on the species, the size, the age, the feed quantities, and the climate. Livestock emissions declined by 11% from 1990 to 2000, due to improvements in feeding methods.

### Waste

*This sector covers GHG emissions from the treatment and disposal of liquid and solid waste.*

The waste sector produced 5.2 million tons, or 5.8% of Québec's total GHG emissions in 2000. These emissions are primarily methane, nitrous oxide, and CO<sub>2</sub>. Landfill sites are the main source, accounting for 92% of this sector's emissions. Wastewater treatment represented 6%, and garbage incineration accounted for 3%.

Waste sector emissions declined by 13.3% from 1990 to 2000. The decrease is due mainly to the introduction of biogas capture and burning practices at landfill sites. This resulted in an 18% reduction in methane emissions at these sites from 1990 to 2000, while the amount of buried waste rose by 38% over the same period.

Since 1990, GHG emissions from wastewater treatment have risen by 5%, while those from garbage incineration dropped by 34%. The shutdown of Montréal's Des Carrières incinerator in 1994 is the main reason for this decline.

## Electricity and Steam Generation

*This sector includes emissions from electricity and steam generation at thermal power stations that burn fossil fuels. It is important to note that 94% of Québec's electricity is generated through waterpower.*

In 2000, electricity generation accounted for 0.4 million CO<sub>2</sub>-equivalent tons, or 0.4% of total Québec emissions. The fluctuations that have occurred since 1990 are irregular, and are primarily related to use of the Tracy thermal powerplant. This was particularly the case in 1998, during the ice storm. That year, emissions from thermal powerplants reached 1.46 million CO<sub>2</sub>-equivalent tons, or four times the 2000 level.

## Changes in Land Use

*In keeping with Intergovernmental Panel on Climate Change (IPCC) guidelines, CO<sub>2</sub> emission and absorption stemming from changes in land use is not included in the national totals for the time being.*

The only factor presently included in total GHG emissions is controlled burning for blueberry cultivation. Emissions from this sector are negligible, and remained stable at approximately 0.01 million tonnes from 1990 to 2000.

## Inventory of Greenhouse Gas Emissions in Québec

The inventory of greenhouse gas (GHG) emissions in Québec is carried out with the cooperation of Québec companies who voluntarily provide their energy-consumption and production data, which is used to determine GHG emissions per entity.

This inventory, which is updated annually, adheres to the technical guidelines set forth by the Intergovernmental Panel on Climate Change, which is the international organization that oversees national GHG inventories, and a branch of the United Nations Organization. The GHGs covered are those specified in the Kyoto Protocol.

Some emissions are not included in the inventory total. For example, CO<sub>2</sub> from biomass is excluded, on the assumption that the CO<sub>2</sub> released during biomass decomposition or combustion is recycled by the growth of forests and all other photosynthesizing plants.

Emissions from fossil fuels used for international air and marine transport are also not covered in this report, nor are those from hydroelectric reservoirs. With respect to the "change of land and forest use" category, the data will be included in the inventory as soon as it becomes available.

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