Transportation: 1990-1999

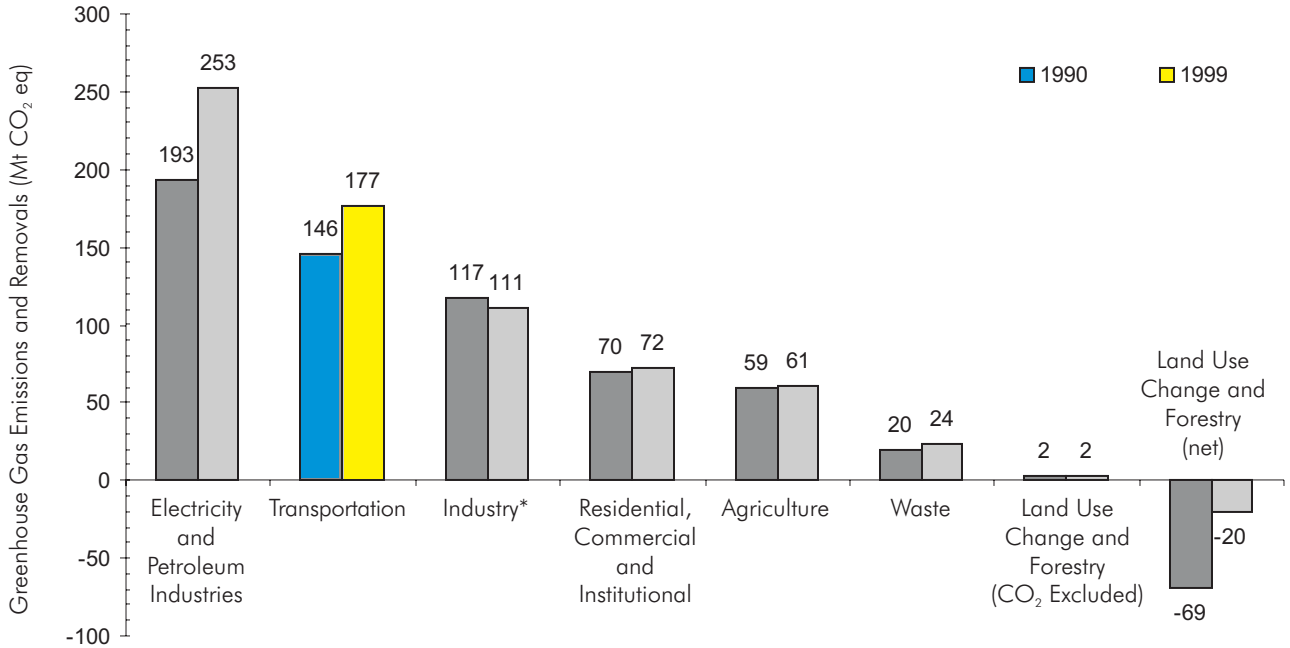
The Transportation sector includes estimates of all human induced greenhouse gases (GHG) resulting from the consumption of fossil fuels to move passengers, freight and bulk commodities throughout Canada. This category may be broken into five distinct sub-categories: on-road, air, marine, rail, and off-road. Emissions of carbon dioxide (CO_2) dominate this sector, although combustion processes also generate nitrous oxide (N_2O) and methane (CH_4) (Figure 2).

- *In 1999*, the Transportation sector accounted for 176.6 megatonnes of carbon dioxide equivalent* (Mt CO_2 eq) of greenhouse gases. This sector represents one of the largest sources of emissions, and was responsible for 25% of Canada's total emissions of 699 Mt.

- *Between 1990 and 1999*, this sector contributed 33% of Canada's emissions growth of 91.4 Mt from 1990 to 1999. In 1990, Transportation is estimated to have emitted 146.0 Mt; in 1999, this had risen 21%. Almost all of the growth in emissions since 1990 can be attributed to 3 sub-sectors. Light-Duty Gasoline Trucks (LDGT), the category including Sport Utility Vehicles (SUVs) and Minivans, contributed 42% or 13.0 Mt of this sector's growth, Heavy-duty Diesel Vehicles (HDDV) contributed 40% or 12.3 Mt and Off-Road Diesel Vehicles were responsible for 15% or 4.4 Mt of the overall sectoral growth.

**Unless otherwise indicated, all emissions are reported in Mt CO_2 eq. For brevity, this has been shortened to Mt. This concept provides a relative measure of the impacts of different greenhouse gases on global warming, with the effect of carbon dioxide being equal to one.*

Figure 1. Canadian Greenhouse Gas Emissions and Removals 1990 and 1999



* Value illustrated includes emissions due to *Solvent and Other Product Use*.

Table 1. Canadian Vehicular Transportation Emission Trends by Sector, 1990 and 1999

Vehicular Transportation Total	GHG Emissions (Mt)		Change 1990-1999		Contribution to 1999 Total	Contribution to 1990-1999 Growth	Functional Subcategories			
	1990	1999	(Mt)	(%)			On-Road	Off-Road	Passenger	Freight
Light-Duty Gas Vehicles (cars)	53.7	50.0	-3.7	-6.9%	28%	-12%	*		*	
Light-Duty Gas Trucks	21.7	34.7	13.0	59.6%	20%	42%	*		*	
Heavy-Duty Gas Vehicles	3.1	5.9	2.7	87.6%	3%	9%	*			*
Motorcycles	0.2	0.2	0.0	2.9%	0%	0%	*		*	
Off-Road Gas Vehicles	5.0	5.4	0.4	8.7%	3%	1%		*		*
Light-Duty Diesel Vehicles (cars)	0.7	0.6	-0.1	-14.3%	0%	0%	*		*	
Light-Duty Diesel Trucks	0.6	0.4	-0.2	-31.9%	0%	-1%	*			*
Heavy-Duty Diesel Trucks	24.6	36.9	12.3	50.2%	21%	40%	*			*
Off-Road Diesel Vehicles	11.3	15.7	4.4	39.4%	9%	15%		*		*
Propane and Natural Gas Vehicles	2.2	1.5	-0.7	-31.4%	1%	-2%	*		*	
Domestic Air	10.7	13.6	2.9	26.8%	8%	9%			81%	19%
Domestic Marine	5.0	5.2	0.1	2.2%	3%	0%			0%	100%
Rail	7.1	6.5	-0.6	-8.5%	4%	-2%			30%	70%
Vehicles SubTotal	146.0	176.6	30.6	21.0%	100%	100%				

Canada's Transportation Sector

In Canada, transportation activities involve over 17 million On-road vehicles alone. This sector also includes the largest of sea going vessels to the smallest gas powered lawn trimmer. It includes a variety of vehicle types, using various fuels with properties that constantly change depending on the season, geographic location or specific vehicle configuration. Furthermore, individual vehicles operating under different conditions greatly affect the rate at which they generate emissions. As a consequence, developing estimates of greenhouse gas emissions within this diverse sector is complicated at best. Methods rely on a combination of practices incorporating internationally accepted estimation protocols and measured emission data derived from emission testing undertaken in the United States and Canada. A complete description of the methods and principles used to generate the estimates are described elsewhere (Environment Canada, 2001).

Under the United Nations Framework Convention on Climate Change (UNFCCC) guidelines and the international reporting protocol, Pipeline emissions are reported within the Transportation sector (IPCC, 1997). These emissions are typically compressor emissions and fugitive leaks resulting from the bulk transport of fuels in oil and/or natural gas pipelines.

Pipeline emissions are the only non-vehicular transport mode and for the purposes of this Fact Sheet Series, these emissions and their trends are reported within the Oil and Gas industry (see *Fact Sheet #2 - Electricity and Petroleum Industries: 1990-1999*).

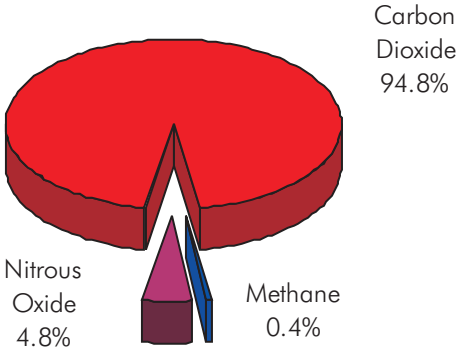
The Canadian Greenhouse Gas Inventory (CGHGI)

The Canadian Greenhouse Gas Inventory is developed, compiled, and reported annually by the Greenhouse Gas Division of Environment Canada, and utilizes methods and models developed in-house by engineering and scientific staff, as well as published data, data developed by industry, or methods developed by the Intergovernmental Panel on Climate Change (IPCC, 1997).

The greenhouse gases that have been estimated in the national inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydro fluorocarbons (HFCs).

The inventory uses an internationally agreed to reporting format that groups emissions and removals into the following six sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land-Use Change and Forestry, and Waste. The 1999 Trends Fact Sheet Series, while presenting the latest information on Canadian greenhouse gas emissions and removals derived from the latest national inventory, use a modified sector approach to facilitate the use of information by the public.

Figure 2. Contribution by Gas to Total Transportation Greenhouse Gas Emissions in 1999



General Trends

Vehicular Transportation emissions, henceforth referred to collectively as Transportation, increased 21.0% from 146.0 to 176.6 Mt over the period 1990-1999. Of the 30.6 Mt increase in emissions, 10.9 Mt can be attributed to passenger use, while 19.7 Mt may be attributed to freight purposes.

In order to distinguish trends in the use of vehicles as well as by type of vehicle, the following trend analysis has been undertaken and presented by both Form and Function. That is, what are the trends when observed according to the different types of transport vehicles - described by their Form, and what are the trends when we consider how we use these vehicles distinguished by their Function for either passenger or freight purposes. Furthermore, most transport modes include a component of passenger and freight but for the purposes of the trend evaluations, Marine and Off-Road are assumed to be predominantly non-passenger and, therefore, their emissions are allocated to Freight.

Trends in Transportation Emissions by Vehicle Type (Form)

In Canada, Transportation can be divided into 5 distinct sub-sectors:

- Domestic Air (80% Passenger);
- Rail (3% Passenger);
- Domestic Marine (0% Passenger);
- Off-Road (0% Passenger); and
- On-Road (67% Passenger).

Domestic Air

Air transport in Canada includes both domestic and international flights. For accounting purposes, only those fuels sold to Canadian registered carriers in Canada are reported within the inventory. This principle complies with the established international guidelines governing bunker fuels.

Emissions associated with Domestic Air increased 26.8% while through the same period their total activity, measured in total tonne-kilometres shipped, increased 47% and contributed to a 14% reduction in GHG intensity.

Marine Transport

Canada has 59,509 km of coastline (excluding island coastlines) plus the St. Lawrence Seaway, which is one of the world's largest inland waterways stretching 3,700 km from the Gulf of St. Lawrence to the western end of Lake Superior.

Rail

Rail transport boasts the lowest GHG intensity of all the freight modes. Total emissions actually declined 8.5% since 1990 while their annual shipping activity increased almost 20% over the same period, further reducing their GHG shipping intensity by 23.5%.

Domestic Marine

Marine Transport, like Air, has a substantial international component and similarly only the emissions resulting from fuel sold in Canada to Canadian registered vessels are considered here.

Although this sector's emissions have fluctuated over the period, overall emissions rose by only 2.2% from 1990 to 1999. Their activity, however, based on tonne-kilometres shipped, shows a reduction of almost 26%. While the GHG intensity associated with Domestic Marine is second only to that of Rail, these diverging factors illustrate an increase in GHG shipping intensity of 37%.

Off-Road

This sector, sometimes referred to as “Non-Road”, includes the use of heavy mobile equipment in the construction, mining, and logging sectors, recreational vehicles such as snowmobiles, and lawn and garden devices including lawnmowers and trimmers. The estimates are calculated using data on volumes of fuel sold that are reported as being exclusive of road tax.

In 1999, the Off-Road sector contributed an estimated 21.2 Mt or 3.0% of the national total, up from 16.3 Mt in 1990. Although this sector includes both gasoline powered equipment (snowmobiles, all-terrain vehicles, etc.) and diesel powered equipment (excavating, construction, generator sets, etc.), 91% of the period's growth resulted from the 39.4% increase in the diesel component (11.3 to 15.7 Mt). Emissions from Off-Road Gasoline sources rose 8.7% from 5.0 to 5.5 Mt.

Vehicle Populations

Canada has more automobiles per capita than any other country in the world except the USA, with at least one vehicle for every two Canadians.

On-Road

With greenhouse gas emissions of about 130 Mt in 1999, this category contributed 18.6% of Canada's total emissions and 73% of the total emissions from transportation.

For the purposes of calculating estimates, the entire On-Road component is divided into 8 categories:

- Light-Duty Gasoline Vehicles (LDGV);
- Light-Duty Diesel Vehicles (LDDV);
- Light-Duty Gasoline Trucks (LDGT);
- Light-Duty Diesel Trucks (LDDT);
- Heavy-duty Gasoline Vehicles (HDGV);
- Heavy-duty Diesel Vehicles (HDDV);
- Motorcycles (MC); and
- Alternative Fueled Vehicle (Alt Fuel).

Factors influencing the quantity of greenhouse gases produced and emitted are mainly dependent upon:

- vehicle population;
- vehicle kilometres traveled (Vkmt);
- fuel consumption ratio (FCR), and
- emission control technology.

Since 1990, each of the 8 sub-categories has experienced changes in the above factors; yet these factors, sometimes moving in opposite directions for different vehicle sub-categories, indicate shifts in preference and utility for the Canadian vehicle operator (Table 2).

From 1990-1999, Gross Domestic Product (GDP) and population grew 24% and 10%, respectively, while the total number of vehicles increased 12%. Most of the increase has occurred in the light-duty gasoline and the heavy-duty gasoline and diesel truck categories, which have shown individual growth rates over the period of 55%, 68%, and 114%, respectively. Evidence of a shift towards bigger, less efficient vehicles is indicated when one considers that the number of light-duty gasoline vehicles has declined 4.3% and the number of light-duty diesel vehicles has decreased 21%. One contributing factor is likely to be the almost steady decline in the price of fuel over the period 1990 to 1999 (Figure 3).

With the exception of LDDT and HDDV, which both show vehicle-kilometres-traveled declines of about 30% since 1990, vehicle kilometres traveled in all other categories show growth of about 8-12% from 1990 to 1999.

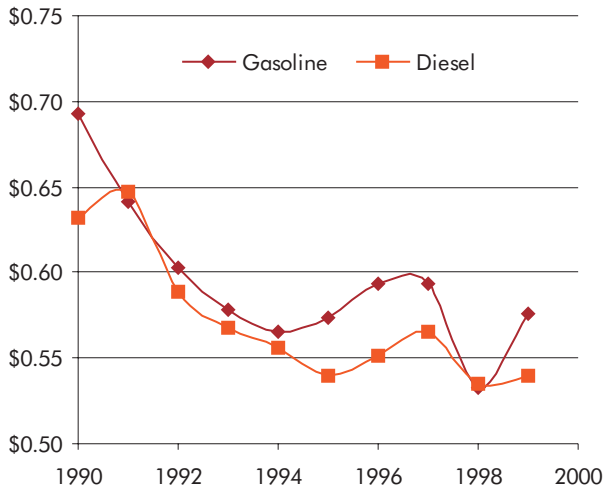
Over 90% of Canada's vehicles have benefited from improved efficiencies over the ten-year period. Since the 1990 model year, new LDGVs have become 11% more fuel-efficient while new LDGTs improved 8%.

Improvements in the emission control technology incorporated into new vehicles have been less progressive through the 1990's. The largest gains in emission reductions through technological improvements occurred in the 1980's when computer control, electronic fuel injection and new generation catalytic converters were introduced. As these technologies penetrate the market place, and as older vehicles are retired and replaced with vehicles incorporating more advanced emission and engine control devices, the benefits of these advances are realized.

Table 2. Factors Affecting Trends in Emissions, 1990 - 1999

	Vehicle Population	FCR	Vehicle km Travelled	Combined Effect	Change Since 1990 Mt	%
LDGV	-4%	-11%	9%	-8%	-3,710	-7%
LDGT	55%	-8%	10%	57%	12,952	60%
HDGV	68%	0%	12%	87%	2,747	88%
MC	-5%	0%	8%	2%	7	3%
LDDV	-21%	0%	9%	-15%	-96	-14%
LDDT	-2%	0%	-31%	-32%	-188	-32%
HDDV	114%	0%	-30%	50%	12,327	50%

Figure 3. Trends in Canadian Fuel Prices (1999$)



Trends in Transportation Emissions by Vehicle Use (Function)

Passenger Transportation

This functional category encompasses those greenhouse gas emissions from mobile sources primarily used for the movement of people. In 1999, 98.1 Mt or 56% of total vehicular emissions were allocated to this category, a rise of 87.2 Mt or 60% of the same total in 1990. On a national basis, over 14% of Canada's total emissions are allocated here with 97% coming from LDGV, LDGT and the passenger portion of Domestic Air travel (50.9%, 35.3% and 11.2%, respectively).

While emissions from the passenger portion of Domestic Air travel increased 29.1% and those from LDGV have actually decreased 6.9%, the overall trend has been heavily influenced by an almost 60% increase in emissions from LDGT, the class of vehicle that includes Sport Utility Vehicles (SUVs) and Mini-Vans.

Freight Transportation

In 1999, the collection of sub-categories representing freight and bulk transport contributed 78.4 Mt or 11% of Canada's total greenhouse gas emissions, an increase of 33.5% over the 1990 value of 58.7 Mt. Growth in these transport emissions is significantly higher than population growth over the same period and can be primarily attributed to increased use of three types of vehicles:

- Heavy-Duty Diesel Vehicles - responsible for 70% of the total increase;
- Heavy-Duty Gasoline Vehicle - responsible for 15% of the total increase; and
- Off-Road Vehicles - responsible for 14% of the total eight-year increase.

Other modes of freight transport include Domestic Marine, and the freight portions of Domestic Air and Rail emissions. These are distinguished from their total emissions by considering data indicating their different fuel allocations to passenger versus freight lines in the case of Rail, and passenger tonne-km versus freight tonne-km, as reported by Canada's main air carriers. In comparison, LDDTs accounted for only 1% of freight emissions in 1999.

Trucking: Heavy-duty Diesel and Gas Vehicles

Some of the growth in greenhouse gas emissions can be directly related to the growth of heavy-duty diesel and gasoline trucking primarily used for shipping freight. Difficulties arise, however, in obtaining accurate and complete data for this transport mode. Firstly, fuel consumption data, although primarily for freight, is mixed with several other uses (e.g. buses and emergency vehicles). Secondly, complete data are not available for freight shipments (often expressed in tonne-km) within the sector. Regardless, the trends in data from major for-hire truck haulers in Canada show conclusively that freight hauling by truck has increased substantially and that this activity is the primary activity attributed to Heavy-duty Gasoline and Diesel Vehicles.

The reported tonne-km of for-hire domestic and trans-border freight shipments by truck in Canada show significant growth from 1990 to 1999. Combined emissions from HDDVs and HDGVs increased steadily since 1992 in parallel with the reported domestic growth in trucking tonne-km. The rate of shipping growth has outpaced that of the emissions by almost 2:1, further reducing the industry GHG intensity by over 27%. Again, there is no indication of the value of the goods shipped and subsequently a trend in GHG/GDP intensity.

Railways

Railways are heavily dependent on delivering bulk shipments of coal, potash, wheat, and lumber. As a result, fluctuating supply or demand for these products in particular affects railway freight activity and emissions. Year-to-year total activity and therefore emissions depend on foreign markets and Canadian crop harvests, in particular. Statistics Canada's report entitled *Rail in Canada* indicates 3% of the total fuel consumption was for VIA Rail, a passenger only service. As such, it was therefore assumed that freight contributed the remaining 97% of total Rail emissions.

In 1999, Rail was responsible for just below 8% of Canada's freight transport greenhouse gas emissions. Between 1990 and 1999, railways shipped almost 20% more freight while using less fuel and producing 8.5% fewer emissions.

Table 3. Trends in Shipping/Freight-Related GHG Intensity

			Change Since 1990	
	1990	1999	Absolute	Relative
Rail				
GHG Emissions[1]	6.9	6.3	-0.6	-8.5%
Activity[2]	248.4	297.2	48.9	19.7%
GHG Intensity[3]	27.8	21.2	-6.5	-23.5%
Air				
GHG Emissions[1]	2.2	2.6	0.4	17.8%
Activity[2]	1.7	2.4	0.6	36.4%
GHG Intensity[3]	1274.9	1101.0	-174.0	-13.6%
Trucking				
GHG Emissions[1]	27.7	42.8	15.1	54.4%
Activity[2]	74.7	158.4	83.7	112.0%
GHG Intensity[3]	370.4	269.9	-100.6	-27.1%
Marine				
GHG Emissions[1]	5.0	5.2	0.1	2.2%
Activity[2]	53.4	39.6	-13.8	-25.8%
GHG Intensity[3]	94.6	130.3	35.7	37.7%

[1] Mt CO_2 eq

[2] Tonne Kilometre shipped (Billions)

[3] grams CO_2 eq per tonne-kilometre shipped

Air

Transport by air moves a significant and growing percentage of freight traffic. Canadian air carriers report a 50% and 36% increase in passenger and freight related tonne-kilometres, respectively, contributing to an overall 47% increase in shipments while only generating an estimated 27% more emissions. Although air shipping of freight is the least efficient way to go with respect to GHG intensity, the trend illustrated is positive.

Also, while the passenger and freight activity levels increased over the period by varying rates, they remained in similar proportions; that is, of the total annual tonne-km reported by major Canadian air carriers since 1990, 20%

is allocated to the transport of goods and 80% to that of passengers.

Marine

The emissions associated with domestic marine use of fuel in 1999 represented almost 7% of freight related greenhouse gas emissions. Since 1990, emissions have risen only 2.2% indicating low overall growth in marine shipments.

Data indicate that domestic shipping decreased 20% between 1990 and 1998 (measured in tonnes loaded and unloaded between Canadian ports), while international shipping increased 24%.

Glossary

Gross Vehicle Weight Rating (GVWR): The maximum allowable weight of a fully loaded vehicle, including liquids, passengers, cargo, and the tongue weight of any towed vehicle. This value is defined by the manufacturer and is based on vehicle design.

Heavy-Duty Vehicles: Any vehicle rated at more than 3900 kg GVWR or designed to carry more than 12 persons at a time. Typical icons in this category include tractor-trailers, city and highway buses and utility vehicles such as ambulances and fire trucks but also includes Light-Duty Trucks with GVRWs greater than 3900 kg (such as some heavier full size pick-up trucks and work vans).

Light-Duty Trucks: This category includes pick-up trucks, mini-vans and SUVs with a GVWR of 3900 kg or less which are designated primarily for transportation of light-weight cargo or that are equipped with special features such as four-wheel drive for off-road operation. It includes both LDGT and LDDT.

Light-Duty Vehicles: This category contains what we would commonly refer to as "cars" and includes LDGV, LDDV and alternatively fuelled vehicles used primarily for passenger transport.

Tonne-Kilometre: An expression of weight (mass) multiplied by distance from origin to destination for each freight shipment. This is the standard output metric for the shipping industry.

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Text Box Information:

http://www.communication.gc.ca/facts/trans_e.html

Road Transport

There are more than 900,000 km of roads and highways in Canada, and the national highway system is over 25,000 km in length. Canada also boasts the longest highway in the world - the Trans-Canada Highway - and one of the busiest sections of highway in the world - Highway 401 through the Greater Toronto Area - rivaled only by Interstate 5 in California.

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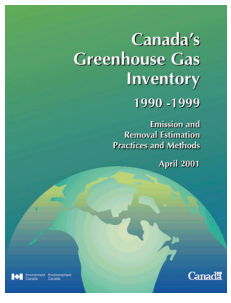

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