

Environmental Indicator: Greenhouse Gas Emissions in British Columbia

Primary Indicator:	<i>Per capita greenhouse gas emissions in British Columbia</i>
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Selection and use of the Indicator: The quantity of greenhouse gases emitted per person is a *pressure* indicator. It is an indicator of human activity that, in turn, has an impact on the global atmosphere. Greenhouse gases (GHGs) are atmospheric gases that trap solar energy, warming the atmosphere and the surface of the Earth. These gases include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and other trace compounds. They are released into the atmosphere by many naturally occurring processes as well as by human activity, such as fossil fuel combustion, deforestation, agriculture and industrial activity. Human created greenhouse gases include perfluorocarbon (PFC), which is a byproduct of aluminum production, sulfurhexafluoride (SF₆), which is used minimally in electrical switches and hydrofluorocarbon (HFC), which is now used to replace the ozone depleting chlorinated fluorocarbons (CFCs) in many applications.

In 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. These targets were set out in the Kyoto Protocol, which will become legally binding when ratified by at least 55 countries covering at least 55 percent of the emissions addressed in the protocol. Canada ratified the Kyoto Protocol in December 2002.

This indicator examines the trend in per capita GHG emissions in British Columbia from 1990 to 1999. The year 1990 is particularly important because it is the base year for calculating mandatory emission targets in the commitment period of 2008-2012 under the Kyoto Protocol.

Data and Sources:

Per capita emissions (Table 1) are calculated by dividing total GHG emissions by total population for that year (see Table 4 for total GHG emissions and population data for British Columbia).

Table 1. Per capita greenhouse gas emissions in British Columbia.

Year	CO ₂ equivalents ¹ (tonnes)
1990	16.8
1991	16.4
1992	14.8
1993	15.2
1994	15.4
1995	16.1
1996	16.0
1997	15.3

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

1998	15.4
1999	15.7
Percent change since 1990	-6.3%

¹ CO₂ equivalent is the amount of CO₂ that would cause the same effect as a given amount or mixture of other greenhouse gases.

Source: Environment Canada. 2001. *Canada's Greenhouse Gas Inventory 1990-1999*; BC Ministry of Water, Land and Air Protection. 2001.

Methodology and Reliability: Data for this indicator came from Environment Canada and Statistics Canada databases. The methodologies used by Environment Canada for collecting and reporting greenhouse gas emissions data follow the 1997 guidelines of the Intergovernmental Panel on Climate Change (IPCC/OECD/IEA, 1997), a scientific body established by the United Nations Environment Programme. Under these guidelines, emissions are grouped into six major sectors: energy (including transportation); industrial processes; solvents and other products; agriculture; land use change and forestry; and waste.

Two main methods were used to determine the emissions for a given process or combination of operations: the mass-balance approach and the emission-factors approach. Details are given in Neitzert, et al. (1999).

The mass-balance approach calculates the difference between the amount of a component, such as carbon, contained in feed materials or fuels, and the amount contained in end-products, process wastes and non-emitted residuals. Mass balances are mostly applied to fuel-carbon contributions and mineral-processing activities.

Emission factors are used to estimate the rate at which a pollutant is released to the atmosphere as a result of a process activity or unit throughput. In general, carbon dioxide emission factors are well-developed for many sources. Methane factors are less well defined, however, nitrous oxide, perfluorocarbon (PFC), sulfurhexafluoride (SF₆) and hydrofluorocarbon (HFC) emission factors are often limited and less certain.

Neitzert et al. (1999) caution that all emission data must be considered estimates, unless obtained from continuous emissions monitors. If the methodologies used to develop the estimates remain consistent, however, the trends can be considered a reasonably accurate measure of performance. The recently updated Environment Canada report (Environment Canada, 2002) includes revised and updated data for 1995-99, reflecting a better understanding of GHG emissions.

References:

Australia Institute. 1999. *Greenhouse Gas Emissions Per Capita of Annex B Parties to the Kyoto Protocol*. Submission to Senate References Committee on Environment Inquiry into Australia's Response to Global Warming.

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Environment Canada. 2002. *Canada's Greenhouse Gas Inventory 1990-2000*, Greenhouse Gas Division Environment Canada. Cat. No. En 49-5-5/5-9-2-2000E. Ottawa: Environment Canada

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Environment Canada, 1992. *Canada's Greenhouse Gas Emissions: Estimates for 1990*. Report EPS 5/AP/4. Ottawa: Environment Canada.

IPCC/OECD/IEA. 1997. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. IPCC, London, United Kingdom.

Natural Resources Canada. 2001. *Canada and the Kyoto Protocol*. http://www.nrcan.gc.ca/www3/cc/english/whats_new/overview_e.html

Neitzert, F., K. Olsen, and P. Collas. 1999. *Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends*. Ottawa: Environment Canada, Air Pollution Prevention Directorate, Pollution Data Branch. http://www.ec.gc.ca/pdb/ghg/1997_trends_e.pdf

Secondary Measure:	<i>Total greenhouse gas emissions in British Columbia.</i>
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Selection and Use of Indicator: The total amount of greenhouse gas emissions is a *pressure* indicator. Greenhouse gas emissions directly reflect consumption patterns that have negative environmental impacts, including global climate change. In 1997, Canada participated in the development of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, which commits Canada to reduce greenhouse gas emissions to 6% below 1990 levels by the period 2008-2012.

Data and Sources:

Table 2. Total greenhouse gas emissions in British Columbia.

Year	CO₂ equivalents (megatonnes)
1990	52.7
1991	52.7
1992	51.6
1993	54.4
1994	56.6
1995	60.6
1996	62.2
1997	60.8
1998	61.7
1999	63.5

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Percent change since 1990	+20.5%
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Source: Environment Canada, 2001. *Canada's Greenhouse Gas Inventory 1990-1999*

Data used in *Environmental Trends in British Columbia: 2002* are shown in Table 2. After this report was prepared, Environment Canada released new data showing that total greenhouse gas emissions in BC in 2000 were 65.9 megatonnes of CO₂ equivalents (Environment Canada, 2002). This is a change of +25% since 1990. The same report also published revised GHG emissions data for the period 1995-1999, which are available from: http://www.ec.gc.ca/pdb/ghg/1990_00_report/appel1_e.cfm. The revised data set was used to calculate the figures in Table 3.

Transportation accounts for the majority of British Columbia's emissions (41% in 1999), while industry contributes about 35%. The remainder of GHG emissions come from waste, residential, commercial and agriculture (Table 3).

Table 3. Comparison of Sources of Greenhouse Gas Emissions in British Columbia, 1999 and 2000 (kilotonnes).

Sector	1999 kt	1999 Percent	2000 kt	2000 Percent
Transportation (includes both vehicle and pipeline emissions)	26,100	41	26,300	40
Industry (includes industrial processes and all energy use except transportation)	22,710	35	24,300	37
Agriculture	2,600	4	2,500	4
Commercial	2,960	5	3,200	5
Residential	4,730	7	4,600	7
Waste	5,000	8	5,000	8
Total ¹	64,100	100	65,900	100

¹**Note:** Due to rounding, individual values may not add up to totals.

Emissions associated with the use of HFCs, PFCs, limestone and soda ash are reported in the national total.
 Source: Environment Canada, 2002. *Canada's Greenhouse Gas Inventory 1990-2000*.

Methodology and Reliability: See primary indicator.

References:

Environment Canada, 2001. *Canada's Greenhouse Gas Inventory 1990-1999. Emissions and Removal Estimation Practices and Methods*. Cat. No. 49-5/5-9-1-1999E.
 Ottawa: Environment Canada. http://www.ec.gc.ca/pdb/ghg/Provem_e.cfm

Environment Canada, 2002. *Canada's Greenhouse Gas Inventory 1990-2000, Greenhouse Gas Division Environment Canada*. Cat. No. En 49-5-5/5-9-2-2000E.
 Ottawa: Environment Canada
http://www.ec.gc.ca/pdb/ghg/1990_00_report/foreword_e.cfm

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Environment Canada. *Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020*. Report prepared for: Pollution Data Branch, Environment Canada by SENES Consultants Limited 925 West Georgia Street, Suite 910 Vancouver, BC V6C 3L2

Secondary Measure: *Across Canada comparison of greenhouse gas emissions.*

Selection and Use of Indicator: This indicator shows how British Columbia compares with other Canadian provinces and territories, and with the national average, in efforts to reduce greenhouse gas emissions. The data used in the table were those available at the time of writing from Environment Canada (Environment Canada, 2001). Revised data for 1995-99 have since been published and are available from:
http://www.ec.gc.ca/pdb/ghg/1990_00_report/appell_e.cfm

Across Canada, there has been a 15% increase in total GHG emissions since 1990. British Columbia's 20% increase in total GHG emissions in that period was the fourth-highest in the country. If current trends continue in British Columbia, total GHG emissions are expected to increase by 38% between 1990 and 2010. This represents one of the largest expected increases in Canada, exceeded only by Alberta and Saskatchewan. The influence of increasing population in British Columbia can be seen by the fact that, on a per capita basis, GHG emissions decreased by 6.3% in BC since 1990. This was the second-largest decrease across Canada and shows that BC has the third-lowest per capita GHG emission rate in the country.

Data and Sources:

Table 4. Total and Per Capita Greenhouse Gas Emissions 1990-1999 for Each Province (kilotonnes of CO₂ equivalent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BC										
Total emissions	52700	52700	51600	54400	56600	60600	62200	60800	61700	63500
Total population	3132500	3212100	3476900	3574600	3670800	3762900	3882000	3959700	3997500	4028100
Per capita emissions	0.0168	0.0164	0.0148	0.0152	0.0154	0.0161	0.0160	0.0153547	0.0154	0.0157
Alberta										
Total emissions	171000	173000	180000	185000	194000	199000	203000	204000	206000	214000
Total population	2473100	2521600	2646800	2686000	2715600	2752100	2780600	2837200	2907000	2959400
per capita emissions	0.069	0.0686	0.0680	0.0689	0.0714	0.0723	0.0730	0.0719	0.0709	0.0723
Saskatchewan										
Total emissions	46900	46100	50100	53000	56200	57600	60000	60800	61100	61200
Total population	997100	994200	1008000	1010800	1012200	1016600	1019500	1022000	1024900	1025700
Per capita emissions	0.0470	0.0464	0.0497	0.0524	0.0555	0.0567	0.0588	0.0595	0.0596	0.0597
Manitoba										

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Total emissions	20300	19900	20200	19700	20200	20100	21500	20600	21100	20900
Total population	1089000	1094400	1117600	1124100	1129500	1136800	1134300	1136600	1137900	1142600
Per capita emissions	0.0186	0.0182	0.0181	0.0175	0.0179	0.0177	0.0189	0.0181	0.0185	0.0183
Ontario										
Total emissions	181000	180000	184000	175000	178000	181000	188000	194000	194000	195000
Total population	9749600	9917300	10645400	10815400	10937100	11097500	11100900	11249500	11386100	11517300
Per capita emissions	0.0187	0.0181	0.0173	0.0162	0.0163	0.0163	0.0169	0.0172	0.0170	0.0169
Quebec										
Total emissions	86100	80500	80800	83500	87000	85700	85800	86100	88000	88300
Total population	6768200	6847400	7161200	7238600	7288800	7343200	7274000	7302600	7323500	7349100
Per capita emissions	0.0127	0.0118	0.0113	0.0115	0.0119	0.0117	0.0118	0.0118	0.0120	0.0120
Newfoundland										
Total emissions	9440	8240	8120	8250	7360	8290	8340	8850	10300	8960
Total population	572700	575700	583400	584200	581200	576600	560600	554100	545400	540800
Per capita emissions	0.0165	0.0143	0.0139	0.0141	0.0127	0.01434	0.0149	0.0160	0.0189	0.0166
New Brunswick										
Total emissions	15900	15300	16000	15200	16700	16900	16600	19000	19900	19000
Total population	722600	727600	753000	755500	757700	760200	753000	754200	753400	754300
Per capita emissions	0.0220	0.0210	0.0212483	0.0201	0.0220	0.0222	0.0220	0.0252	0.0264	0.0252
Nova Scotia										
Total emissions	19400	19300	19800	19800	19300	19000	19100	19700	19700	20300
Total population	895100	901000	924600	930400	933900	937800	931200	934500	936100	939200
Per capita emissions	0.0217	0.0214	0.0214	0.0213	0.0207	0.0203	0.0205	0.0211	0.0210	0.0216
PEI										
Total emissions	1940	1910	1950	1920	1930	1870	2010	2040	2000	2000
Total population	130700	131200	131600	133200	134600	135600	136200	136900	136900	137600
Per capita emissions	0.0148	0.0146	0.0148	0.0144	0.0143	0.0138	0.0148	0.0149	0.0146	0.0145
NWT & Yukon										
Total emissions	1780	1740	2030	2280	2470	3020	2890	2450	2540	2260
Total population	79900	81900	92900	94100	94300	96100	73700	74000	67600	68100
Per capita emissions	0.0223	0.0212	0.0218	0.0242	0.0262	0.0314	0.0392	0.0331	0.038	0.0332

Source: Environment Canada. 2001. *Canada's Greenhouse Gas Inventory 1990-1999*; BC Ministry of Water, Land and Air Protection. 2001.

Note: The 1999 data for NWT and Yukon includes Nunavut.

Methodology and Reliability: See primary indicator.

References:

Environment Canada. 2001. *Canada's Greenhouse Gas Inventory 1990-1999. Emissions and Removal Estimation Practices and Methods*. Cat. No. 49-5/5-9-1-1999E.

Ottawa: Environment Canada. http://www.ec.gc.ca/pdb/ghg/Provem_e.cfm

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

Secondary Measure:	<i>Trends in vehicle sales and use in British Columbia.</i>
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Selection and Use of Indicator: This indicator shows the trends in light-duty gasoline vehicle sales and use in British Columbia. It shows the impact of consumer transportation choices on greenhouse gas emissions. Revised Environment Canada emission data (Environment Canada, 2002) show that transportation (includes all modes) is the single largest source of GHG emissions in British Columbia, accounting for 26,100 kt or approximately 41% of the total GHG emissions (64,100 kt) in the province in 1999 (Environment Canada, 2002). Between 1990 and 1999, GHG emissions from the overall transportation sector increased by 32%. Population growth, which was 29% in that period, accounts for part, but not all, of that increase.

Most vehicles purchased by the average consumer are light-duty gasoline cars and trucks, (includes light trucks, sports utility vehicles (SUVs) and vans). Total sales of cars and light-duty trucks increased by over 7% between 1990 and 1999. Total emissions from light-duty trucks, however, increased 75% between 1990 and 1999 in BC (from 2,770 kt GHG in 1990 to 4,840 kt in 1999) (in the same period, emissions from cars decreased by 10%). This shows that in addition to an increase in the number of vehicles, the growth in transport sector emissions may be due to an increase in the number of less fuel-efficient vehicles being driven. Since 1990, there has been a shift in light-duty vehicle purchases from cars to other vehicles in the light-duty truck category (Table 5). The light-duty truck category emits, on average, 40% more GHGs per kilometre (Environment Canada, 2002) than light-duty cars (see: http://www.ec.gc.ca/pdb/ghg/1990_00_report/sec2_e.cfm#link5)

Increases in emissions may also be due to vehicles being driven longer distances. Using vehicle kilometres traveled (VKT) for passenger cars and growth factors using 1995 as a base year, BC passenger car growth data showed an increase from more than 22,161 million kilometers travelled in 1990 to in excess of 26,344 million kilometers traveled in 1999. This was an increase in passenger car VKT of 18%. The growth in kilometers travelled by the light truck category, which includes SUVs, was even more pronounced. It increased from approximately 7,590 million VKT in 1990 to in excess of 15,771 million VKT in 1999, which is an increase of over 100% (Environment Canada. nd)

Data and Sources:

Table 5. Sales of two classes (passenger cars and light-duty truck category) of vehicles in British Columbia 1981-2001.

	Passenger cars	Light-duty gasoline truck ¹	Total
1981	101,129	47,806	148,935
1982	66,529	27,524	94,053
1983	68,930	28,062	97,992
1984	75,706	32,458	108,164
1985	91,234	39,480	131,714
1986	100,304	44,408	145,712
1987	100,119	49,941	150,060

BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION - 2002

1988	100,034	55,133	155,167
1989	103,096	64,592	168,688
1990	96,204	65,079	161,83
1991	92,804	68,760	162,564
1992	85,066	66,259	151,325
1993	77,847	69,939	148,786
1994	79,734	76,232	156,966
1995	75,004	73,065	148,069
1996	70,122	73,574	144,696
1997	74,638	89,788	164,426
1998	65,929	81,568	147,497
1999	71,531	85,682	157,213
2000	78,671	89,099	168,770
2001	84,267	88,339	173,606

¹ Includes light trucks, SUVs, vans, commercial light-duty vehicles.

Source: Statistics Canada. 2002. CANSIM II. <http://www.statcan.ca/english/CANSIM/>

Methodology and Reliability: (see primary indicator)

References:

Environment Canada.nd.*Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020.* Unpublished report prepared for: Pollution Data Branch, Environment Canada by SENES Consultants Limited 925 West Georgia Street, Suite 910 Vancouver, BC V6C 3L2

Environment Canada. 2002. *Canada's Greenhouse Gas Inventory 1990-2000,* Greenhouse Gas Division Environment Canada. Cat. No. En 49-5-5/5-9-2-2000E. Ottawa: Environment Canada. http://www.ec.gc.ca/pdb/ghg/british_columbia_e.cfm