2003 Calgary Community Greenhouse Gas Emissions Inventory

2004-1623

THE CITY OF
CALGARY
ENVIRONMENTAL
MANAGEMENT

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Executive Summary

- The City of Calgary is one of 118 Canadian communities participating in the Partners for Climate Protection (PCP) Program. As part of its participation in the PCP Program, The City has committed to monitor and report on the Calgary community's greenhouse gas (GHG) emissions.
- For the purposes of this report, the Calgary community includes all residences and commercial, industrial and institutional facilities located within The City of Calgary's municipal boundaries.
- The most significant greenhouse gases emitted by human activities are carbon dioxide (CO_2), methane (CH_4) and nitrous oxides (N_20).
- In Calgary, as is the case in most other urban communities, the consumption of energy derived from fossil fuels is the dominant source of greenhouse gas emissions.
- Total Calgary community GHG emissions for 2003 were approximately 16,370 kilotonnes (kt).
- Electricity consumption was the largest source of local GHG emissions, responsible for 43.7% of the Calgary community total. This ranking can be directly attributed to Alberta's relatively heavy reliance on coal as an energy source for electricity generation. At 30.2%, vehicles were the second largest source of Calgary community GHG emissions. Methane from Calgary's landfills is a relatively small contributor to local emissions accounting for 2.7% of the total, but still are the source of over 442 kt of GHG emissions.
- Since 1990, Calgary community emissions have increased by 3,908 kt, or over 31% from 12,462 kt to 16,370 kt. This equates to an average annual rate of increase of approximately 2.3%. Between 1990 and 2003, significant increases in emissions occurred in all four source categories. The largest absolute increase occurred in the Electricity category, with emissions increasing by 1,718 kt (31.6%).
- The data suggests there is a direct correlation between community GHG emissions and population growth. Between 1990 and 2003, Calgary's population increased from 691,736 to 922,315—a growth rate of about 33%—which essentially mirrors the growth in GHG emissions (31%) over this timeframe. This relationship should not be surprising as more people inevitably translates into more vehicles traveling more miles and more homes and businesses requiring energy for heating, lighting and machinery operation.
- Green power is electricity produced from renewable sources, and whose consumption essentially does not result in the emission of greenhouse gases to the atmosphere. In 2003, total Calgary community green power consumption was 59,215,000 kWh—about 0.75% of total community electricity consumption.

Foreword

The City of Calgary is one of 118 Canadian communities participating in the Partners for Climate Protection (PCP) Program, which is jointly administered by the Federation of Canadian Municipalities (FCM) and ICLEI—Local Governments for Sustainability. The objective of the PCP program is to support municipal governments actively pursuing greenhouse gas (GHG) emission reductions. As part of its PCP membership commitment, The City of Calgary has agreed to monitor and report on the Calgary community's GHG emissions. This report fulfills this commitment; providing a full accounting of 2003 Calgary community GHG emissions.

The Calgary community includes all residences and commercial, industrial and institutional facilities located within the City of Calgary's boundaries. Commencing with this 2003 emission report, The City of Calgary will be reporting on community emissions on a biennial basis.

The City of Calgary Environmental Management business unit would like to thank the organizations listed below, who generously provided the data that forms the basis of this report. Without the cooperation of these organizations, this report would have been impossible:

- Alberta Energy and Utility Board (AEUB)
- ATCO Gas Ltd.
- ENMAX
- Government of Alberta (Department of Transportation)
- Parks Business Unit—The City of Calgary
- Pembina Institute for Sustainable Development
- Propane Gas Association of Canada
- Waste and Recycling Business Unit—The City of Calgary

Introduction to Climate Change

There is a strong consensus amongst scientists that climate change is occurring and that human activity is contributing to it. While uncertainties exist about the timing and rate of climate change, the United Nations International Panel on Climate Change (IPCC)—an international body comprised of over 2,000 of the world's leading climate scientists—estimate the average global surface temperature is likely to increase by between 1.4 and 5.8° Celsius by 2100. While these changes may appear modest, even small changes in global average temperatures can have a dramatic impact on our climate. For example, the last time the earth's average temperature was 5° colder Canada was covered by 3 kilometers of ice.

Scientists have concluded that changes consistent with global warming are already occurring in different parts of the world. Mountain glaciers are retreating and climate zones are shifting. The 20th century was the warmest century of the last millennium, and the 1990s were the warmest decade of the last century. Because scientists believe that northern countries will be more affected by climate change than those closer to the equator, Canada is particularly vulnerable.

What are Greenhouse Gases?

Greenhouse gases are collectively gases that absorb and essentially trap heat that is emitted as radiation by the earth's surface.

The most significant greenhouse gases emitted by human activities are:

Carbon dioxide (CO_2): Is the most abundant persistent greenhouse gas in the atmosphere. An increasing amount of CO_2 is being released by the burning of fossil fuels (coal, oil, natural gas). Over the last 200 years CO_2 levels in the atmosphere have increased dramatically from about 280 parts per million (ppm) to about 380 ppm.

Methane (CH_4): Is the second most abundant persistent greenhouse gas in the atmosphere. An increasing amount of CH_4 is being released from landfills, oil and gas development and transportation and the agricultural sector. Over the last 200 years CH_4 levels in the atmosphere have increased from about 0.7 ppm to about 1.7 ppm.

Nitrous oxide (N_2O): Is the third most abundant persistent greenhouse gas in the atmosphere. An increasing amount of N_2O is being emitted into the atmosphere through the use of chemical fertilizers and the burning of fossil fuels. Over the last 200 years N_2O levels in the atmosphere have increased from about 280 parts per billion (ppb) to about 310 ppb.

Sources of Calgary Community Greenhouse Gas Emissions

In Calgary, as is the case in most other urban communities, the consumption of energy derived from fossil fuels is the dominant source of greenhouse gas emissions. Generally, the energy we consume to light and heat our homes and businesses, and power our vehicles—that is our consumption of electricity, natural gas, gasoline, diesel and propane—is the primary source of community generated greenhouse gas emissions. The sources of Calgary community greenhouse gas emissions, and the uses and activities that generate these emissions, are summarized in **Table 1**.

Table 1: Sources of GHG Emissions

GHG Source	Uses/Activities
Electricity—in Alberta electricity is primarily produced from the burning of fossil fuels, with coal being the dominant fuel. Coal and natural gas account for about 90% of Alberta's installed generation capacity[1]	Lighting, Household Appliances, Indoor Space Heating, Machinery and Tools, Industrial Processes
Natural Gas	Heating of Indoor Space & Water, Household Appliances, Industrial Processes and Equipment
Gasoline	Vehicles, Outdoor Equipment, Generators
Diesel	Vehicles, Outdoor Equipment, Generators
Propane	Vehicles, BBQs
Methane—produced by anaerobic decay of organic materials, such as household garbage and sewage	Landfills (garbage dumps) and Wastewater Treatment Plants

The GHG inventory presented in this report includes GHG emissions associated with energy consumed and landfills located within The City of Calgary's municipal boundaries[2]. Additionally, due to data limitations, all vehicle fuel purchased within The City of Calgary is included in the inventory, despite the fact that not all of it is consumed in Calgary. Correspondingly, vehicle fuel consumed in Calgary, but purchased elsewhere is not included in the inventory.

2003 Calgary Community GHG Emissions

Calgary's 2003 community-wide GHG emissions were derived from energy consumption data collected from local utilities, the Government of Alberta and industry associations. Greenhouse gas **emission coefficients**[3] were used to convert energy consumption data into **carbon dioxide equivalents**[4] (CO_2e), which is the standard greenhouse gas measurement unit. The emission coefficients used in this report are provided in **Appendix 1**.

Total Calgary community GHG emissions for 2003 were approximately 16,370 kilotonnes (kt). **Table 2** provides a breakdown of 2003 emissions by source.

[1] Source: Clean Air Strategic Alliance, An Emissions Management Framework for the Alberta Electricity Sector Report to Stakeholders. November 2003.

[2] Note: Emissions associated with electricity consumed in Calgary is included in the total, even though most of this electricity is produced elsewhere in Alberta. This accounting procedure is in accordance with Partners for Climate Protection (PCP) protocol.

[3] Emission coefficient–mass of carbon dioxide equivalents emitted per unit of a particular fossil fuel unit consumed.

[4] Carbon dioxide equivalents (CO2e)–emissions of a gas, by mass, multiplied by its global warming potential. For example, the global warming potential of methane is 21—meaning the emission of one tonne of methane is equivalent to the emission of 21 tonnes of carbon dioxide, in terms of climate change impacts.

Table 2: 2003 Calgary Community GHG Emissions

Emission Source	GHG Emissions (kt of CO_2e)	% of Total
Electricity	7,153.0	43.7%
Natural Gas	3,846.1	23.5%
Vehicles	4,941.2	30.2%
Waste Disposal	442.7	2.7%
Urban Forest	(13.0)	n.a.
Total	**16,370.0**	

Electricity consumption was the largest source of local GHG emissions, responsible for 43.7% of the Calgary community total. This ranking can be directly attributed to Alberta's relatively heavy reliance on coal as an energy source for electricity generation. At 30.2%, vehicles were the second largest source of Calgary community GHG emissions. Natural gas consumption is the other major contributor to local GHG emissions, accounting for 23.5% of the Calgary total. Methane from Calgary's landfills is a relatively small contributor to local emissions accounting for 2.7% of the total, but still are the source of over 442 kt of GHG emissions. Finally, Calgary's urban forest acts as a *carbon sink*, that is it serves to remove CO_2 from the atmosphere through photosynthesis. It is estimated that Calgary's trees remove about 13 kt of GHGs from the atmosphere annually.

For more information on the specific amounts of energy consumed by the Calgary community during 2003, please see **Appendix 2** of this document.

Calgary Community Emissions 1990 to 2003

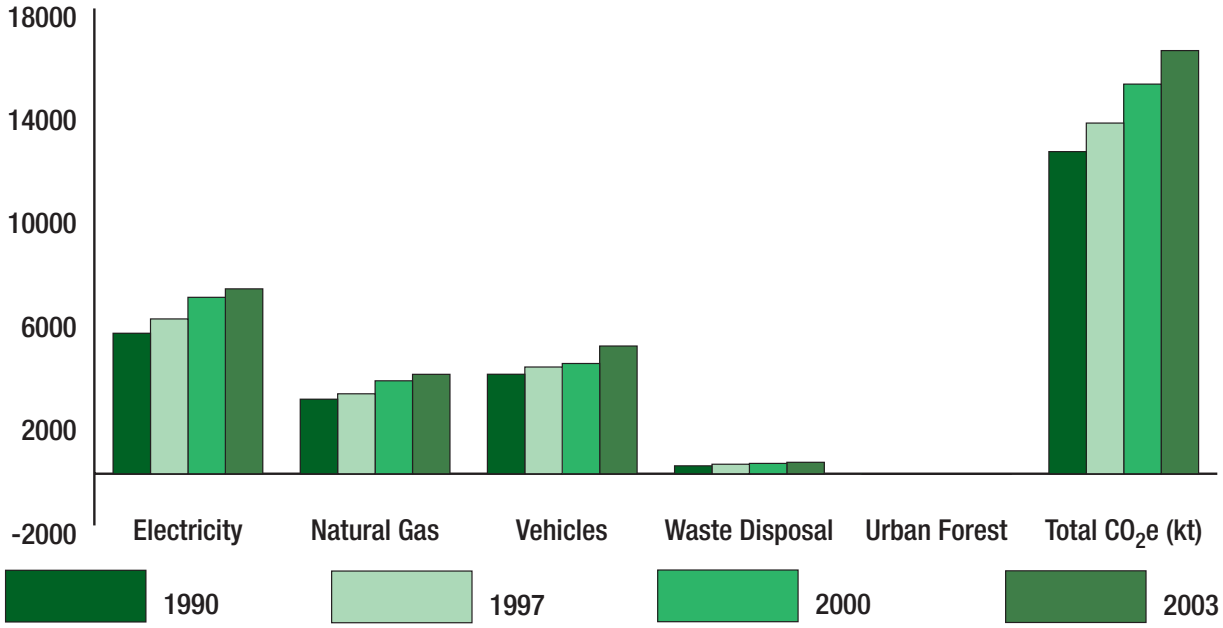
The base year for monitoring Calgary community emissions is 1990. Subsequent to 1990, community GHG emissions data was tabulated for 1997 and 2000. Since 1990, Calgary community emissions have increased by over 31%, from 12,462 kt to 16,370 kt (see **Table 3**). **Figure 1** provides a graphical presentation of emission increases between 1990 and 2003 by GHG source. The 1990 to 2003 GHG emission increase equates to an average annual rate of increase of approximately 2.3%.

Table 3: Calgary Community GHG Emissions 1990 to 2003

CO_2e Emissions (kt)						
	1990	1997	2000	2003	Absolute Increase 1990-2003	Percent Increase 1990-2003
Electricity	5,435	5,989	6,825	7,153	1,718	31.6%
Natural Gas	2,884	3,093	3,596	3,846	962	33.4%
Vehicles	3,849	4,129	4,265	4,941	1,092	28.4%
Waste Disposal**	307	368	400	443	136	44.3%
Urban Forest	-13	-13	-13	-13	0	0%
Total	**12,462***	**13,566***	**15,073***	**16,370**	**3,908**	**+31.4%**

*Source: The City of Calgary, Corporate Strategy & Economics. Data Collection & Analysis for the Calgary Community, December 2002.
**Source: CH2MHILL. The City of Calgary Landfill Gas Assessment Study, October 2002.

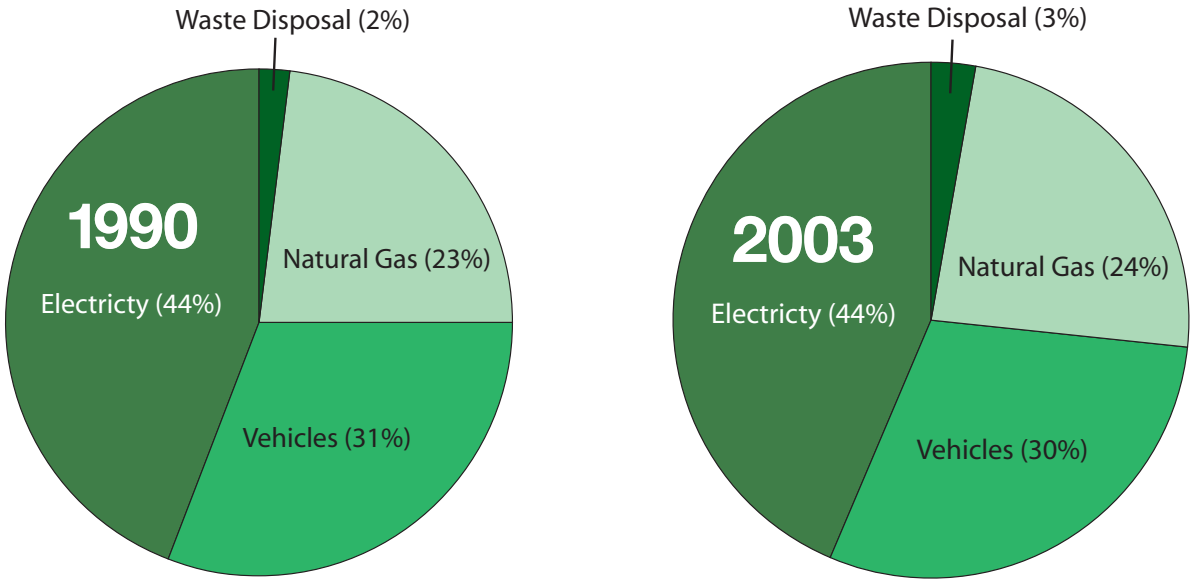
Figure 1: Calgary Community GHG Emissions by Source 1990–2003



As indicated by **Table 3** and **Figure 1**, between 1990 and 2003 significant increases in emissions occurred in all four source categories. The largest absolute increase occurred in the Electricity category, with emissions increasing by 1,718 kt (31.6%). However, the fastest growing source of GHG emission, on a percentage basis, was The City's waste disposal facilities (landfills) at 44.3%.

Over the 1990 to 2003 period, the proportional composition of community GHG emissions by source remained virtually static (see **Figure 2**).

Figure 2: Calgary Community Greenhouse Gas Emissions by Source 1990 and 2003

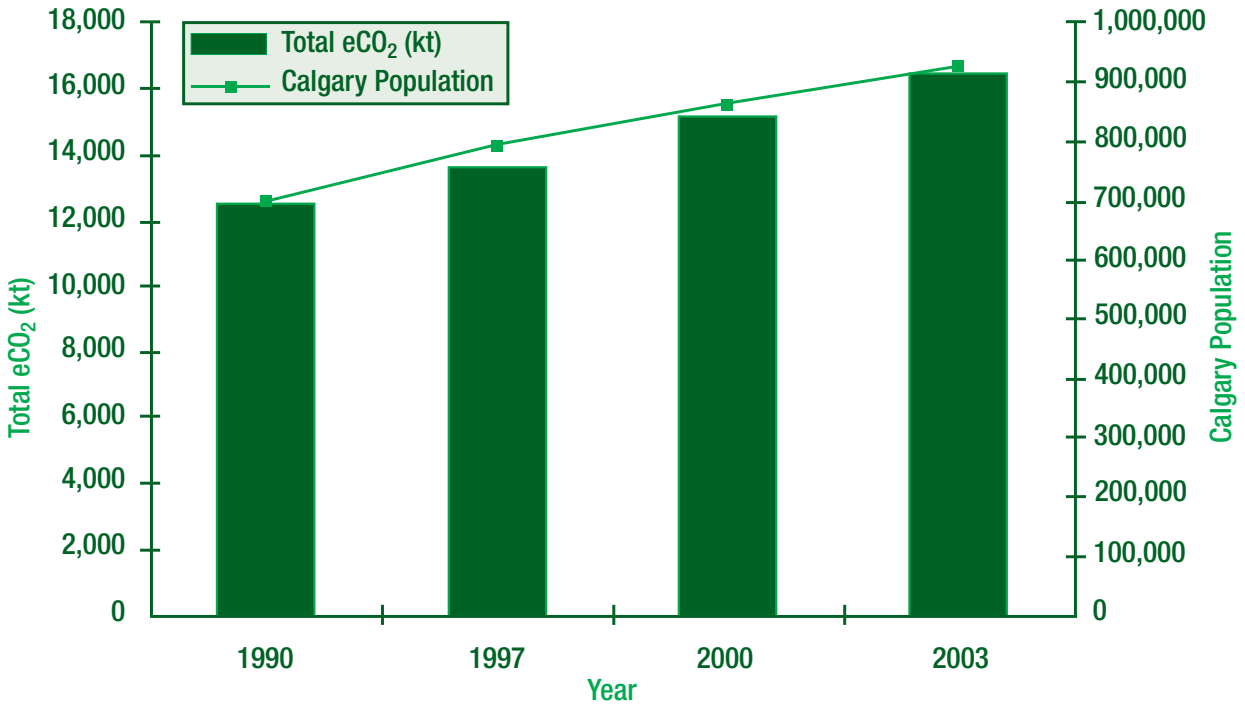


Link Between Population Growth and GHG Emissions

The Calgary community's rapid GHG emission growth over the 1990 to 2003 period cannot be viewed in isolation from the city's considerable population growth over this time frame, as more people inevitably means more vehicles traveling more miles and more homes and businesses requiring energy for heating, lighting and machinery operation. Between 1990 and 2003, Calgary's population increased from 691,736 to 922,315[5]—a growth rate of about 33%—which essentially mirrors the growth in GHG emissions (31%) over this timeframe. **Figure 3** graphically portrays the relationship between Calgary's population and community GHG emissions between 1990 and 2003.

[5] Source: The City of Calgary. The City of Calgary 2004 Civic Census.

Figure 3: Change in Calgary's Population and GHG Emissions in 1990, 1997, 2000 and 2003



Community Green Power Consumption

Commencing with this 2003 report, Calgary *green power* consumption will be reported. Green power is electricity produced from renewable sources, and whose consumption essentially does not result in the emission of greenhouse gases to the atmosphere. In the Alberta context, wind derived electricity is the dominant source of green power. In fact, Alberta is the leading producer of wind derived electricity in Canada, with an installed capacity of about 269 MW, accounting for about 61% of Canada's total wind power capacity[6].

In 2003, total Calgary community green power consumption was 59,215,000 kWh—about 0.75% of total community electricity consumption. The municipal government of The City of Calgary was the leading user of green power in Calgary, consuming about 29 million kWh, approximately 49% of the community total.

[6] Source: Canadian Wind Energy Association (CanWEA).

Appendix 1 – 2003 GHG Emission Coefficients	
Fuel Type	**Coefficient**
Gasoline	2.479 kg/litre[7]
Diesel	2.757 kg/litre[8]
Propane	1.52 kg/litre[9]
Natural Gas	49.95 kg/GJ[10]
Electricity	0.909 kg/kWh[11]
Green Electricity	nil

[7] Source: Government of Canada. Climate Change Technology Early Action measures (TEAM)–System of Measurement and Reporting to TEAM, December 2002.

[8] Source: Government of Canada. Climate Change Technology Early Action measures (TEAM)–System of Measurement and Reporting to TEAM, December 2002.

[9] Source: Government of Canada. Climate Change Technology Early Action measures (TEAM)–System of Measurement and Reporting to TEAM, December 2002.

[10] Source: Government of Canada. Climate Change Technology Early Action measures (TEAM)–System of Measurement and Reporting to TEAM, December 2002.

[11] Source: Torrie Smith Associates Inc. Cities for Climate Protection ICLEI–Local Governments for Sustainability Software.

Appendix 2 – Calgary Community 2003 Energy Consumption	
Electricity	7,869,085,000 kWh[12]
Green Electricity	59,215,000 kWh[13]
Total Electricity	7,928,300,000 kWh[14]
Natural Gas	77,000,000 GJ[15]
Gasoline	1,372,929,000 litres[16]
Diesel	415,132,000 litres[17]
Propane	196,272,503 litres[18]
Natural Gas (vehicles)	319,323 litres[19]

[12] Sources: Alberta Energy and Utility Board (AEUB).

[13] Sources: ENMAX and Pembina Institute for Sustainability.

[14] Source: Alberta Energy and Utility Board (AEUB).

[15] Source: ATCO Gas Ltd.

[16] Source: Government of Alberta, Department of Transportation.

[17] Source: Government of Alberta, Department of Transportation.

[18] Source: Propane Gas Association of Canadian.

[19] Source: ATCO Gas Ltd.