

A PRIMER ON URBAN TRANSPORTATION AND GLOBAL CLIMATE CHANGE

The threat of climate change, resulting from unrestricted emission of greenhouse gases (GHGs) from human activities, is an issue of growing awareness and concern. As one of the world's highest per capita emitters of greenhouse gases, Canada has a role to play in its resolution.

*The transportation sector, including urban transportation, is a major contributor to the problem. As the search for practical GHG reduction strategies intensifies, the role of urban transportation is coming under scrutiny. In that regard, the 1993 **New Vision for Urban Transportation** by TAC's Urban Transportation Council, provides useful directions for positive change. The vision has been cited by the Organization for Economic Cooperation and Development as an example of "best thinking on environmentally sustainable transportation in Canada". In a review of sustainable transportation for the National Round Table on the Environment and the Economy, it was called "perhaps the most influential vision statement currently in Canada".*

This briefing by the TAC Urban Transportation Council is presented as a service to all urban Canadians. It summarizes the climate change challenge, the role of urban transportation, and various GHG reduction strategies that are beginning to emerge. It does not contain a recommended strategy, but is intended as a useful introduction to an issue which will be the subject of much investigation and debate in the years ahead.

GREENHOUSE GASES (GHGs) FROM HUMAN ACTIVITIES MAY ALTER THE EARTH'S CLIMATE . . .

The Greenhouse Effect

When solar energy (mostly in the form of visible sunlight) reaches our planet, about 30% is scattered back into space by clouds, land and water. The remaining 70%: evaporates water; powers photo-synthesis in plants; and is absorbed in air, land and water, thus heating them.

That heat radiates upward in the form of infrared (thermal) radiation and would be lost directly into space if it were not for the presence of certain molecules in the atmosphere called "greenhouse gases" (GHGs), which retain some of that radiant energy.

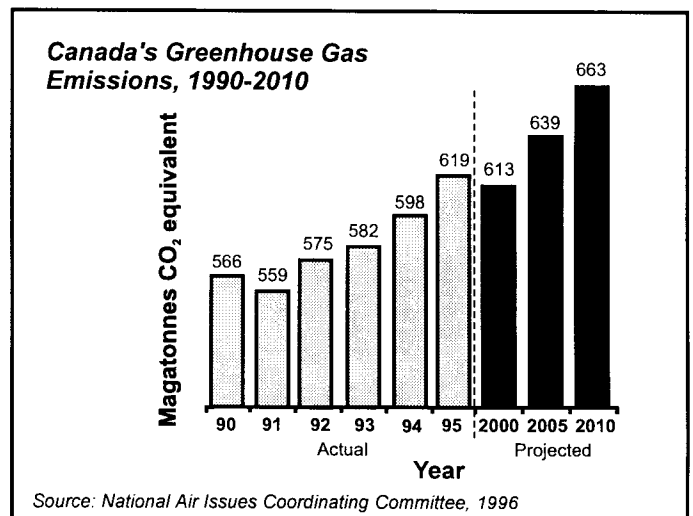
This process of retaining heat energy in the earth's lower atmosphere is called the "greenhouse effect". With it, the earth maintains a global average temperature of +15°C. Without it, the average temperature would be -18°C and life as we know it could not exist.

Greenhouse Gases

Naturally occurring GHGs are required only in trace amounts to be effective. About 99% of the (dry) atmosphere consists of nitrogen and oxygen, which have no greenhouse effect. Less than 1% of the (dry) atmosphere contains GHGs: carbon dioxide (CO₂ - the major GHG in dry air), methane (CH₄), nitrous oxide (N₂O) and ozone (O₃). Water vapour (H₂O) is the largest GHG by volume, accounting for up to 2% of all gases in the atmosphere.

Since the Industrial Revolution, atmospheric concentrations of dry GHGs have been rising as a result of emissions from human activities (called anthropogenic emissions). In this century, a new set of man-made gases, called halocarbons have been added; these powerful GHGs include chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)

Over the past 200 years, atmospheric concentrations of carbon dioxide have increased 30%, methane 145% and nitrous oxide 15%. Continued increases are predicted, both world wide and in Canada.



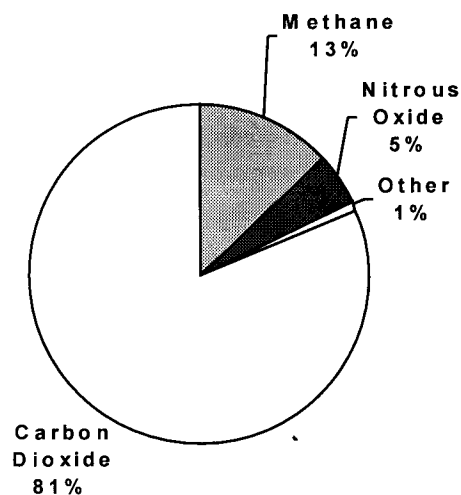
Some Sources of Natural and Anthropogenic GHGs

Greenhouse Gas	Natural Sources	Anthropogenic Sources
Water Vapour (H ₂ O)	Evaporation, respiration and transpiration.	(Negligible)
Carbon Dioxide (CO ₂)	Decaying plants, animal respiration, natural burning, volcanoes.	Burning fossil fuels (oil, coal, natural gas), deforestation, industrial processes.
Methane (CH ₄)	Decaying plants, animal digestion, volcanoes.	Landfill, oil and gas production, domestic livestock.
Nitrous Oxide (N ₂ O)	Released from soils and oceans.	Burning fossil fuels, chemical production, nitrogen fertilizers.
Halocarbons	NONE	Wide variety of industrial and consumer products.

Global Warming

Changes in the earth's average temperature have occurred naturally over geologic time as the atmosphere has evolved. However, the accelerating increase in GHG concentrations due to human activities in the recent past has led to a condition known as the "enhanced greenhouse effect" commonly called "global warming". The most significant GHG in this context is carbon dioxide, most of which comes from burning fossil fuels. For this reason, and because various GHGs have different heating effects, they are usually expressed as "CO₂ equivalents".

**Anthropogenic GHG Emissions
in Canada by Type of Gas
(in CO₂ equivalents)**



Total = 619 megatonnes

Source: from 1995 estimates by Environment Canada

The enhanced greenhouse effect has the potential to warm the planet at a rate unprecedented in human history. The science on this subject has been established by the UN **Intergovernmental Panel on Climate Change (IPCC)** representing the work of 2,500 scientists from over 80 countries. They have concluded that GHG emissions from human activities (notably CO₂) are indeed warming the planet, and may affect global climate patterns.

"Projections of future global mean temperature rise confirm the potential for human activities to alter the Earth's climate to an extent unprecedented in human history."

"The balance of evidence suggests a discernable human influence on global climate."

"Climate change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life."

- Intergovernmental Panel on Climate Change

The global average temperature has increased by 0.5°C over the past century, with most of that change occurring in the past 40 years. (The three warmest years on record were 1997, 1995 and 1990; the 10 warmest years in the past century have occurred since 1980.)

A further increase of 1.0°C to 3.5°C over the next century is predicted, if present trends continue. In comparison, the world was only 3.5°C cooler during the last ice age.

Climate Change

Many Canadians would probably welcome longer summers and milder winters. But global warming does not mean that every place will experience the same, average, temperature increase. Some places may heat up faster, and other places, such as the Canadian east coast, may cool down. Because of the complex nature of air and ocean currents and their impact on regional weather, scientists predict that the real danger will come from a phenomenon known as "climate change" characterized by increasing severity, or extremes, in weather patterns.

"The threat of climate change is real and present, and the cost in human discomfort and suffering is incalculable".

- Hon. Sergio Marchi, Fed. Environment Minister (1996)

Some of the potential global impacts of climate change, which could cause major social and economic disruptions, are:

- melting ice caps, rising sea levels and flooding in coastal areas.
- droughts, desertification and crop losses.
- spread of tropical diseases toward the poles; deaths, and other health problems from heat and smog.
- increasing frequency and intensity of hurricanes, tornadoes and other extreme weather events.

"The negative economic and social effects of climate change (in Ontario) would likely include: loss of shoreline amenities and recreational opportunities; less hydroelectricity production in the Great Lakes region; conflicts and trade-offs among water users, including demands for diversion of Great Lakes water to the United States and within Ontario; more frequent dredging of shipping channels and harbours; a higher rate of mortality due to heat stress; more frequent (poor) air quality incidents, with related fatalities and respiratory and cardiovascular illnesses; and increased forest losses from fires, insects and diseases."

From: "Climate Change Impacts," prepared for the Ontario Transportation and Climate Change Collaborative (1995).

Some people believe that the effects of climate change can already be seen, and point to: rising property insurance claims from hurricanes, tornadoes, snow storms, etc. and the recent Saguenay and Red River floods. The mild winter of 1997-98 on the Canadian prairies and the Ontario-Quebec ice storm may also provide evidence, although most observers have attributed those events to El Niño effects.

"Climate change is not a theory in the North. It is real. In the MacKenzie Valley, we are experiencing permafrost thaw, accelerated coastal erosion and this year (1997) unseasonably warm temperatures in November".

- Hon. Stephen Kakfwi, NTW Minister of Resources, Wildlife and Economic Development

The International Response

Ongoing work of the IPCC has helped focus attention on the potential threat of climate change. Worldwide GHG emissions from human activities may have to be reduced 50% from 1990 levels by the middle of the 21st century if serious consequences are to be averted - and the international community has started to respond.

One outcome of the 1992 Rio Earth Summit was the United Nations **Framework Convention on Climate Change (FCCC)**, signed by more than 140 nations. As a first step, Annex I signatories (the developed countries including Canada, which signed first) agreed to voluntarily stabilize GHG emissions at 1990 levels by the year 2000.

Almost no nation will reach this target, and the few who can will do so for reasons not related to any determined GHG reduction strategy. Great Britain switched from coal to natural gas for economic and supply reasons when its electric utility was privatized. The fall of the Berlin Wall and the reunification of Germany resulted in massive rebuilding of outdated, inefficient and polluting East German production facilities. The collapse of the former Soviet Union led to a major downturn in its manufacturing sector and a consequent reduction in emissions.

Canada has relied primarily on its Voluntary Challenge and Registry (VCR) Program, under which industries voluntarily pledge to reduce emissions (by filing a letter of intent to be followed by an action plan). However, a meeting of federal and provincial energy and environment ministers in December 1996 concluded that Canada will not meet its target.

In December 1997 a much stronger agreement was reached called the **Kyoto Protocol to the FCCC**. Under this agreement, developed nations (including Canada) would be legally bound to reduce GHG emissions by the 2008 to 2012 period. Reduction targets vary by nation; Canada agreed to a 6% reduction relative to 1990 levels, the United States agreed to a 7% reduction. Canada and other nations have until March 1999 to formally sign the Kyoto Protocol. Like the original FCCC, the absence of China and India from the new agreement is a matter of concern to many people.

Because Canadian GHG emissions have risen approximately 9% since 1990, the Kyoto Protocol really means a 15% reduction from today's levels over the next 10 to 14 years. This will be a major challenge.

Other Reactions

National governments are not alone in their concerns over climate change. Others are worried as well, and various groups are advocating action.

Property insurance and re-insurance companies worldwide are concerned about possible effects on their own businesses. Economic losses from natural disasters rose dramatically, from under US \$20 billion in 1981-85 to over US \$120 billion in 1991-95. The same trend, on a smaller scale, is occurring in Canada. Increased exposure combined with the difficulty of predicting future risks may threaten the financial viability of even the largest companies.

"The insurance business is first in line to be affected by climate change...it could bankrupt the industry."

- Franklin Nutter, President of the Reinsurance Association of America

Health professionals at the World Health Organization, the London School of Hygiene and Tropical Medicine, and the US Centers for Disease Control are concerned about the spread of malaria, dengue fever and other tropical diseases as colder areas warm up. In the months before Kyoto, Canadian health professionals urged the federal government to take leadership in the global effort to reduce GHG emissions.

"The College is on record as urging the Government of Canada to play an active role at the Kyoto Conference to exercise a leadership role ensuring our long-term well-being."

- Royal College of Physicians and Surgeons of Canada, (September, 1997)

Leading economists believe that action is necessary, and that net economic benefits can result.

"As economists, we believe that global climate change carries with it significant environmental, economic, social, and geopolitical risks, and that preventive steps are justified. Economic studies have found that there are many potential policies to reduce greenhouse gas emissions for which the total benefits outweigh the total costs. For the U.S. and Canada, sound economic analysis shows that there are policy options that would slow climate change without harming North American living standards, and these measures may, in fact, improve productivity in the longer run. The revenues generated from such policies can effectively be used to reduce the deficit or lower existing taxes."

- Statement signed by 2,800 leading American and Canadian economists, including 8 Nobel Laureates

People in Canada and around the world are adding their voices. In November 1997, Environics International Ltd. released a poll of 27,000 adults in 24 countries. Most of those surveyed believe that there is enough evidence to warrant action to reduce the impact of human activity on the earth's climate. In the Canadian sample, 61% said governments should act now to reduce human impact on the world's climate, even if there are major costs.

An Angus Reid poll in January 1998 found that 46% of Canadians thought the Kyoto Protocol was just about right, and a further 42% felt that it did not go far enough in addressing the issue. The same poll found that 22% of Canadians ranked global warming/climate change in the top two most important issues facing the world (up from 6% in 1996).

In Canada, the **Federation of Canadian Municipalities** has shown leadership through its FCM 20% Club. Municipalities who join the Club commit to reducing GHG emissions by 20% from 1990 levels within 10 years of joining, through action plans that stress continuous improvement. To date, 38 municipalities have signed on.

Greenhouse Gases and Smog Gases are Not the Same

The burning of fossil fuels (for motorized transport, space heating, electric power generation, industry, etc.) produces a wide variety of air emissions. Some, like carbon dioxide (CO₂) and nitrous oxide (N₂O), contribute to global warming. Others, like volatile organic compounds (VOC) and various oxides of nitrogen (NO_x) combine in sunlight to form smog. Carbon monoxide (CO) and particulate matter (PM), along with smog, contribute to poor air quality in urban areas. Therefore, although these air emissions derive from the same sources, their effects are quite different. There is often confusion on this point.

Effects of Air Emissions from Burning Fossil Fuels

Type of Emission	Contributes to	
	Global Warming	Smog and Poor Urban Air Quality
CO ₂	✓	
N ₂ O	✓	
VOC		✓
NO _x		✓
CO		✓
PM		✓

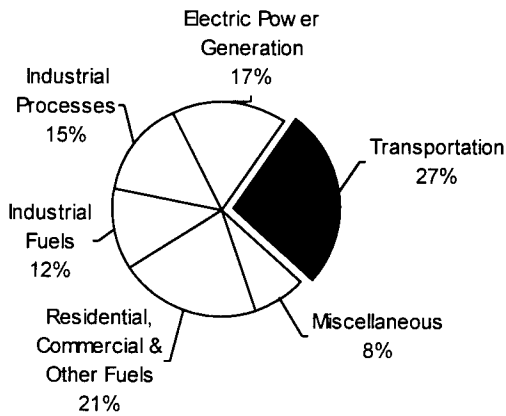
THE URBAN TRANSPORTATION SECTOR IS AN IMPORTANT CONTRIBUTOR TO GREENHOUSE GASES (GHGs).....

GHG Emissions from Transportation

The economies and societies of modern developed nations are heavily dependent on energy consumption, especially from fossil fuels which produce greenhouse gases. The transportation sector is almost totally dependent on fossil fuels and consumes some 30% of all energy used by Canadians.

Transportation is thus a major source of GHGs in Canada and its share is expected to increase. If no actions are taken, transportation GHGs are projected to exceed 1990 levels by 26% in 2010 and 42% in 2020 (compared to increases from all sources of 19% and 36% respectively).

GHG Emissions by Sector (in CO₂ equivalents)

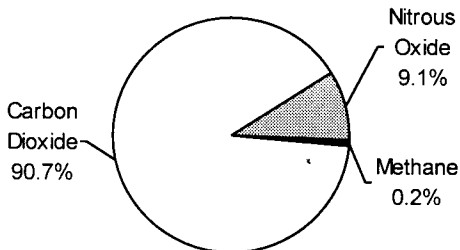


Total = 619 megatonnes

Source: from 1995 estimates by Environment Canada

The main GHG from transportation is carbon dioxide, responsible for 30% of all Canadian CO₂. On a per capita basis, Canada ranks number two in the world in transportation CO₂ emissions, after the US.

GHG Emissions from Transportation (in CO₂ equivalents)

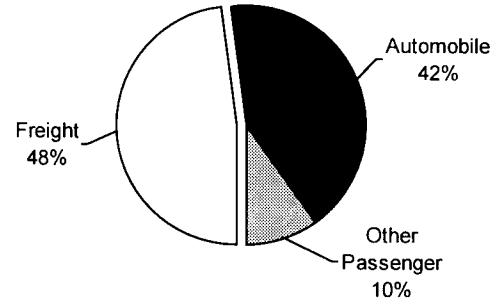


Total = 165 megatonnes

Source: from 1995 estimates by Environment Canada

Passenger travel accounts for the majority of CO₂ emissions from transportation, and most of that comes from automobiles.

CO₂ Emissions from Transportation



Total = 150 megatonnes

Source: from 1995 estimates by Environment Canada

GHG Emissions from Urban Transportation

Precise data on GHGs emitted by motorized transport in urban areas are not generally available. However, two studies by the IBI Group (1990 data) have produced CO₂ estimates. The first, for Natural Resources Canada, looked at ten cities and urban Canada in total. The second, for Environment Canada, looked at the Quebec-Windsor Corridor, including eleven CMAs. Baseline data (1990) has also been published by the Toronto Atmospheric Fund.

From this research, the following general indications can be seen:

- Approximately 1/2 of all CO₂ emissions from transportation in Canada originate in urban areas.
- More than 1/3 of urban transportation CO₂ emissions come from the three largest urban areas (Toronto, Montreal and Vancouver).
- In the (old) City of Toronto, 4/5 of transportation CO₂ emissions came from autos.

Therefore, any strategy to reduce GHG emissions from human activities in Canada must consider the transportation sector in general and urban transportation in particular.

STRATEGIES TO REDUCE GREENHOUSE GASES (GHGs) FROM URBAN TRANSPORTATION ARE STARTING TO EMERGE.....

Three Forces for Change

In spite of its important role, the transportation community has been largely absent from the climate change debate. Canada's response to the Rio Agreement (FCCC) has been led by the National Air Issues Coordinating Committee (NAICC), composed of federal and provincial ministries of environment and energy. The VCR Program, which is the main initiative of the NAICC, has been administered by Natural Resources Canada, and response from the transportation sector has been minimal.

But the picture is rapidly changing, and transportation is moving up on the agenda. In cities across Canada today, three forces are at work to change people's perceptions and stimulate the search for future urban transportation systems which are more environmentally, socially and economically sustainable.

1. ***The threat of climate change is being brought home to ordinary Canadians.*** Discussion has moved from the back rooms of science to the pages and screens of the popular media. The Kyoto Protocol has greatly increased public understanding and awareness of this long term problem, as demonstrated by recent opinion polls.
2. ***Urban air quality is becoming a public health issue*** especially in the lower mainland of British Columbia and in the Quebec-Windsor Corridor. In 1994, transportation was responsible for 59% of all nitrogen oxides and 25% of all volatile organic compounds (both precursors of smog) and 9% of particulates. The Canadian Council of Ministers of the Environment has estimated that Canada may face additional health care costs of \$11 billion to \$38 billion between 1997 and 2020, because of those three transportation related air emissions.
3. ***Shrinking municipal budgets are forcing people to re-think the ways we provide and pay for urban transportation.*** For the past several years, federal and provincial governments have reduced budgets to fight deficits and debt. This has resulted in reduced transfer payments to the municipal level. As part of the same trend, some provinces have "downloaded" responsibility for some health care, social programs and transportation services (roads and transit) to the cities. Now the search is on for new ways to provide affordable and equitable urban access without raising property taxes.

These three forces are mutually supportive. Many transportation related activities to improve urban air quality (cleaner and more efficient engines and vehicles, less need for motorized transport, etc.) can also reduce GHG emissions and vice-versa. Changes to urban structure/land use and changes to transportation infrastructure/services/pricing/regulations which provide real alternatives to single occupant auto dependency can improve air quality, reduce GHG emissions and lead to more economically efficient and socially equitable municipal services.

We are at a unique point in history where environmental, social and economic goals are beginning to converge in the urban transportation sector.

Four Elements in an Emerging Strategy

Over the past few years, a variety of research and policy initiatives have addressed the GHG issue in Canada. Most have come from federal departments and non-governmental organizations (E/NGOs). Some deal with transportation specifically; others include it within the larger context of energy use and air emission reductions. From this growing body of work, the beginnings of a strategy to reduce GHG emissions from urban transportation can be discerned.

No single action (or even a small number of actions) can adequately address the GHG challenge. A successful strategy will depend on a wide range of integrated, coordinated and mutually reinforcing actions (both voluntary and mandated). Such actions should:

- be based on cooperation between three levels of government, the private sector and citizens,
- start now and be applied incrementally over time, and
- demonstrate environmental, social and economic net benefits.

It appears that a successful strategy will include four elements.

1. Public Education and Awareness

Political will for change can only come from an informed public. All those who regulate, supply and use urban transportation infrastructure and services need to understand the costs and risks of current practices and the benefits which can flow from a more sustainable future.

2. Cooperation Among All Major Players

All three levels of government have some role to play in reducing GHG emissions from urban transportation. Their policies, legislation, regulations and programs need to be in harmony, in pursuit of common goals. The private sector and citizens should be active partners in developing those goals and working together toward their achievement.

3. Technological Change

A variety of new technologies (cleaner fuels, alternative fuels, more efficient engines, hybrid propulsion systems, intelligent transportation systems, etc.) can be useful tools to reduce fuel consumption and emissions per vehicle-kilometre. With limited exceptions (such as the Ballard fuel cell and Hydro Quebec's polymer-electrolyte battery) Canada will depend on technological innovation from other countries.

4. Institutional and Societal Change

Various measures to reduce the need for motorized transport or otherwise change urban travel behaviour will also be required. These may include changes to land use planning and urban development, realistic alternatives to auto dependency, regulatory change and various economic instruments. Many would require some degree of lifestyle change by urban Canadians. They are therefore harder to achieve than technological changes, but have the potential for greater long term benefits.

The Organization for Economic Cooperation and Development (OECD) has been researching the effects of technological and institutional change to meet GHG reduction targets in the transportation sector. Preliminary results indicate that the best blend may consist of approximately 1/3 technological change (beyond which the technology becomes too expensive) and 2/3 institutional change (beyond which social disruptions become unacceptable).

The next two sections summarize numerous technological and institutional changes which have been suggested by various groups.

Some Proposals for Technological Change

Proposals to reduce GHG emissions by reducing emissions per vehicle - kilometre (through new technology) come in two main areas.

1. Conventional Fuels and Engines

Improve the efficiency and use of gasoline/diesel powered internal combustion engines through:

- better maintenance practices and driving habits.
- stricter CAFC (Corporate Average Fuel Consumption) standards for new cars, equal to or better than US CAFE standards.
- programs similar to the US Partnership for a New Generation of Vehicles (PNGV) or the European Commission's Task Force on the Car of Tomorrow.
- application of ITS (Intelligent Transportation Systems) technology to vehicles and infrastructure.

2. Alternative Fuels and Engines

Stimulate research, development and early application of:

- alternative fuels for internal combustion engines.
- fuel cell, battery or solar powered electric vehicles.
- "hybrid" vehicles (ie: internal combustion or turbine engines producing electric power, on board, for direct drive).
- government and corporate "green fleet" programs using new and cleaner vehicles.

Current and Suggested Fuel Efficiencies	
Today's Fleet (average)	10.7ℓ / 100 km
New Cars (1995)	8.0ℓ / 100 km
CAFE (new standard)	5.0ℓ / 100 km
PNGV (target)	3.0ℓ / 100 km
Hybrid (potential)	1.6ℓ / 100 km

Some Proposals for Institutional and Societal Change

Proposals to reduce GHG emissions by reducing the need for motorized transport (fewer and shorter urban trips) and changing travel patterns (greater use of transit, high occupancy vehicles, cycling, walking and telecommuting) come in four main areas.

1. Urban Structure and Land Use

Work toward more environmentally, socially and economically sustainable cities through:

- increasingly compact, mixed land use and new developments concentrated at town centres and along transit corridors.
- integrated land use / transportation / environmental / financial planning and delivery across the entire urbanized area.
- transportation and urban development pricing signals that support the above strategies.

2. Alternatives to Single Occupant Auto Use

Provide realistic alternatives to single occupant auto use through:

- higher quality, more extensive and more attractive transit services.
- promotion of car pooling, car sharing, taxi buses, "walking school buses" and telecommuting.
- infrastructure for high occupancy vehicle lanes, park and ride facilities, etc.

3. Regulations

Encourage greater efficiency through:

- mandatory (annual) inspection of emission control equipment on all vehicles.
- stricter fuel economy (CAFE type) standards for all classes of new road vehicles.
- consumer information (labeling fuel efficiency of new vehicles)
- local trip reduction by-laws or ride share ordinances.

4. Economic Instruments

The wide range of proposals to change travel behaviour and consumption patterns includes:

- corporate tax incentives to stimulate new technology research and development.
- sales tax incentives or rebates to purchase more fuel efficient vehicles.
- fuel tax incentives for alternative fuels.
- fuel tax exemption for transit use.
- personal income tax exemptions for employer provided transit passes; income tax payable on employer provided parking spaces.
- restructured municipal taxes and development fees to encourage higher densities.
- location efficient mortgages.
- parking price increases to discourage single occupant auto commutes; incentives for high occupancy vehicles.
- distance based vehicle insurance fees.
- increased taxes on conventional motor vehicle fuels.
- roadway (congestion) pricing.
- increased licence fees or other restrictions on auto ownership.

THE NEXT STEPS.....

Achieving sustainability is probably the biggest challenge facing Canadian urban transportation today. Meeting the Kyoto target in the next 10 to 14 years will be a major part of that effort. Four steps are required to develop and implement a realistic, coordinated, consensus based strategy to reduce GHG emissions from the Canadian urban transportation sector.

1. **Gather Information.** More detailed data are required on GHG emissions from urban transportation, by mode, along with estimates of future trends.
2. **Evaluate Impacts.** Hard analysis of options or packages of options is needed, to estimate their environmental / social / economic impacts and overall practicality in the Canadian context, both during and after the Kyoto period. Government decision making will be very difficult without this.
3. **Build Consensus.** A cooperative mechanism is needed, which can bring together federal, provincial and municipal governments, along with private sector interests and citizen outreach, in an ongoing process to forge agreement on a preferred strategy and to work toward its achievement. Agreement on urban transportation's share of the Kyoto target may be part of this process.
4. **Implement and Monitor.** Responsibilities for action should remain with individual federal, provincial and municipal governments, private sector entities and citizens. But a monitoring process will be required to ensure coordination within an overall framework, track progress over time, and evaluate results.

This briefing was prepared by the TAC **Urban Transportation Council**. The principal author was **John Hartman**, Council Secretary. The Council wishes to express its thanks and appreciation to the following individuals who reviewed the briefing at the draft stage:

Richard Gilbert, *The Centre for Sustainable Transportation*

Neal Irwin, *IBI Group*

Wayne Kauk, *Transport Canada*

Ron Neville, *Management of Technology Services*

Nicole Richer, *Federation of Canadian Municipalities*

Russ Robinson, *Environment Canada*

Transportation Association of Canada
2323 St. Laurent Blvd., Ottawa, ON K1G 4J8
Tel.: (613) 736-1350 Fax: (613) 736-1395
E-Mail: secretariat@tac-atc.ca
www.tac-atc.ca

