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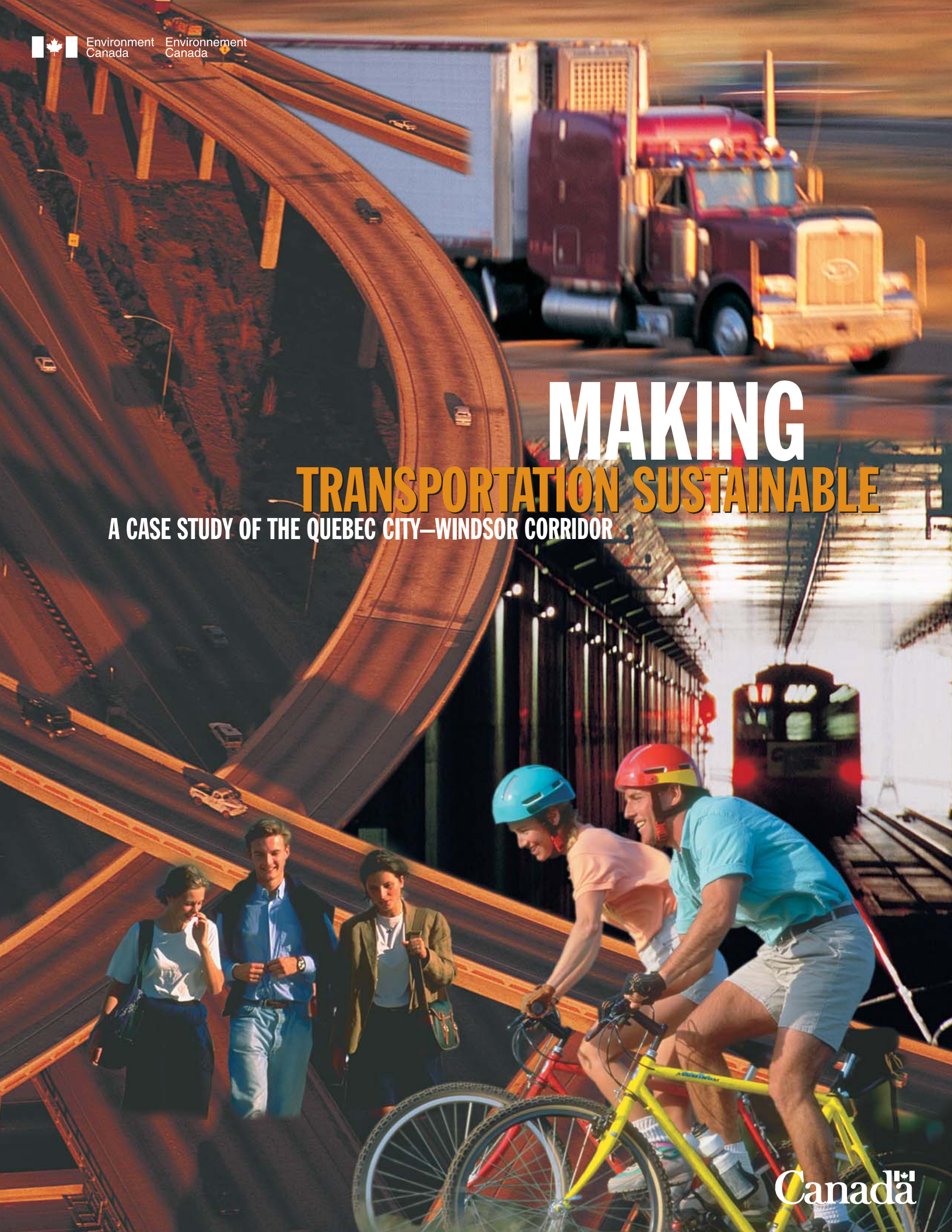

MAKING TRANSPORTATION SUSTAINABLE

A CASE STUDY OF THE QUEBEC CITY–WINDSOR CORRIDOR

Canada

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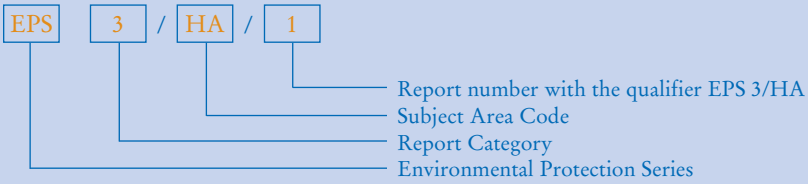

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Prepared by the IBI Group

For the Transportation Systems Division
Air Pollution Prevention Directorate
Environment Canada
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Disclaimer

The OECD Environmentally Sustainable Transportation (EST) Study was based on postulating a definition for EST, developing scenarios to realize that definition and, identifying potential criteria to assess the adequacy of proposed measures to achieve EST as defined for the purposes of this study. Teams from nine countries undertook six parallel case studies with Canada focussing its efforts on the Quebec City–Windsor Corridor. The Government of Canada has not endorsed this definition of EST nor the proposed scenarios or the criteria developed.

The views and opinions of the authors expressed herein do not necessarily state or reflect those of the Canadian government or agency thereof.

Readers' Comments

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This report has been reviewed by members of the Transportation Systems Branch, Environment Canada, and has approved it for publication. Approval does not necessarily signify that the contents reflect the views and policies of Environment Canada. Mention of trade names or commercial products does not constitute recommendation or endorsement for use.

Table of Contents

List of Tables and Figures

List of Tables

List of Figures

List of Acronyms

BAU	business-as-usual
CAFC	company average fuel consumption
CAFE	corporate average fuel economy
EST	environmentally sustainable transportation
GDP	gross domestic product
GHG	greenhouse gas
HOV	high-occupancy vehicle
ICE	internal combustion engine
IPA	Impact Path Approach
ITS	intelligent transportation system
NRTEE	National Round Table on the Environment and the Economy
OECD	Organisation for Economic Co-operation and Development
PKT	passenger-kilometres of travel
QWC	Quebec City–Windsor Corridor
SUV	sport utility vehicle
SVM	Surplus Value Model
TDM	travel demand management
VKT	vehicle-kilometres of travel
VOC	volatile organic compound
WHO	World Health Organization

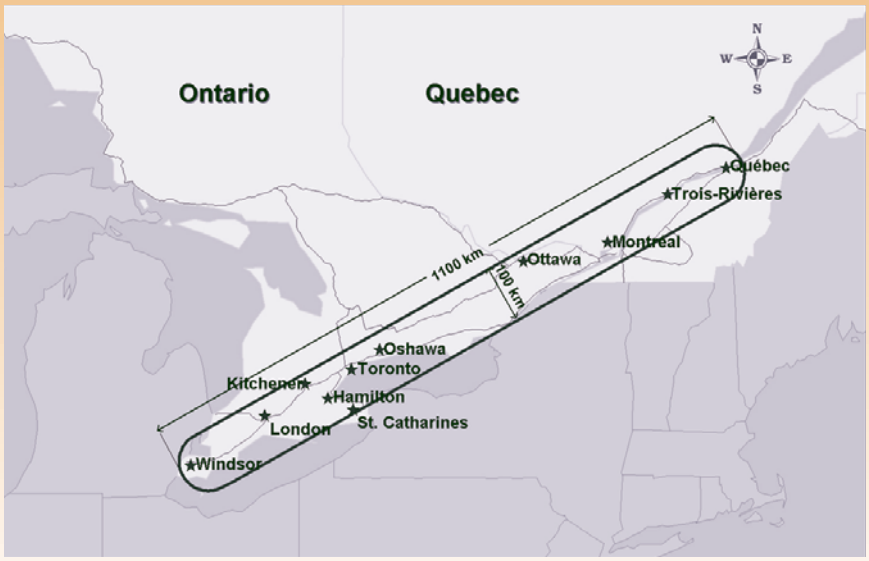
1 Introduction

Transportation has played a critical role in the development of Canada and has important economic and social benefits. However, there is growing concern that current transportation trends are not sustainable. Over the past 50 years, passenger travel in Canada has increased by more than five times, even though Canada's population only doubled during that period.[1] The overwhelming majority of passenger-kilometres (81%) are by private automobile, with the air mode making up a significant portion of the remainder (15%).[2] Trends in freight movement are similar, with the truck mode accounting for about 40% of tonne-kilometres. The environmental implications of growth in transportation, in particular road and air travel, are substantial. The effects of transportation are being encountered in the form of air pollution and related health problems, global warming, accidents, habitat disruption and depletion, loss of agricultural land, degraded water quality, and the depletion of non-renewable resources. Most experts agree that continuing on the current path of growth in transportation will compromise the local and global environment for future generations. In short, it is not sustainable.

A very large portion of transportation activity within Canada occurs within an area known as the Quebec City–Windsor Corridor (QWC). This corridor (Figure 1) contains roughly half of Canada's population and about 85% of the Quebec and Ontario populations, and nearly all of the major urban centres in these two provinces are located in the corridor. Consequently, any meaningful movement towards sustainable transportation will need to focus on this corridor.

This report summarizes the results of a project to look at ways to achieve environmentally sustainable transportation (EST) in the QWC.

Figure 1 The Quebec City–Windsor Corridor Study Area



The study area is a 100-kilometre-wide strip that hugs the U.S. border for about 1100 kilometres and stretches between Quebec City and Windsor, Ontario.

Regions Studied and Countries Participating in the OECD EST Project

Quebec City–Windsor Corridor, Canada

Greater Oslo Area, Norway

Sweden

Netherlands

Germany

Alpine region

– Austria, France, Italy, Switzerland

1.1 Summary of the EST Project — An International Effort

The Organisation for Economic Co-operation and Development (OECD) initiated the EST project in 1994, with two broad objectives in mind. The first was to give some precision to the concept of EST through the use of criteria that have environmental significance and can be quantified. The second was to develop guidelines for the attainment of EST that could be of use to governments in OECD countries and other decision-makers.

Teams from nine countries comprising six parallel case studies participated in the project. Case studies ranged in composition. In the case of Sweden, Netherlands, and Germany, whole countries were studied. Canada chose to study the QWC, while Austria, France, Italy, and Switzerland combined to look at the Alpine region shared by those countries. Norway studied transportation in the Greater Oslo Area.

The EST project began by defining EST and identifying potential EST criteria. The participating countries used the definition of EST and associated criteria to guide their own prospective research.

Timelines

1994: Study initiated by OECD

1996: Review of member countries and definition of EST and associated criteria

1996: OECD Vancouver Conference endorses Principles on Sustainable Transportation

1997–1998: Development of business-as-usual and EST scenarios

1999: Identification of instruments to achieve EST; social and economic implications

2000: Vienna Conference on EST

2000: EST Guidelines for Policy Development

2001: EST Guidelines adopted by OECD Ministers of Environment

Study teams were given the task of establishing a business-as-usual (BAU) scenario as a baseline and three other scenarios for 2030 that attempted to establish the extent to which changes in technology and transportation demand could lead to the achievement of EST. Three contrasting scenarios were initially explored, including a scenario that relied entirely on technological change to achieve the EST criteria; a scenario that relied entirely on managing and reducing demand to achieve the criteria; and a combination scenario that uses both technology and demand management to meet the EST targets.[3]

The scenario development demonstrated that achieving the EST targets would require a mix of both technology and activity reduction measures. The remainder of the project therefore focused on the combination scenario and the identification of packages of policy instruments aimed at achieving it, as well as assessing the social and economic implications of the BAU and EST scenarios.[4]

Based on the knowledge gained from the analysis of EST, study teams worked together to develop a set of draft guidelines that could be used by governments in OECD and other countries for moving their transport systems towards EST. The EST Guidelines received peer review by stakeholders at the Vienna Conference in October 2000. The revised EST Guidelines were adopted by OECD Ministers of the Environment in May 2001 and are listed in Chapter 6 of this report.[5]

1.2 Study Approach

Many studies guiding environmental policy development rely on a traditional forecasting technique, which involves the extrapolation of current interactions and trends into the future and subsequently determining what can be done to avoid an unwanted future. This approach tends to focus on what can be achieved under present circumstances and constraints. Invariably, traditional forecasting approaches will not lead to the attainment of meaningful long-term environmental objectives.

A distinctly different approach — referred to as "backcasting" — was used for the EST study. The backcasting approach initially defines a desirable future in terms of goals and objectives and then identifies the conditions for this future to materialize. The essential benefit of using a backcasting approach is that it highlights the discrepancy between the current situation and a desirable future and is capable of envisioning very large and even discontinuous changes.

The method adopted by the participating countries to carry out the backcasting approach and ultimately the identification of policy instruments was named "structured brainstorming." This method involves expert judgement and consists of multiple iterations to determine the most appropriate instruments to achieve the various features of EST. The determination of the most appropriate instruments is based on an assessment of the instruments in terms of their relative ability to change transportation activity and/or the unit impact of transportation and their impacts on various socio-economic indicators.

1.3 Defining Environmentally Sustainable Transportation (EST)

The concepts of sustainable development and EST have evolved over the last two decades, during which the world has begun to recognize the significance of the impacts of transportation activities on the environment.

At an early stage, participants in the OECD project defined an EST system as one where:

Transportation does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rate of development of renewable substitutes.

Table 1 EST Criteria

Criteria	Basis or Justification
Carbon Dioxide (CO_2) — Total emissions of carbon dioxide for transportation purposes in 2030 are to be no more than 20% of 1990 levels.	The carbon dioxide criterion is based on a recommendation from the Second Assessment Report of the Intergovernmental Panel on Climate Change, which states that in order to stabilize atmospheric carbon dioxide concentrations at near current levels, worldwide carbon dioxide emissions would need to be reduced by 50–70%, with further reductions thereafter.[6] In order to allow for increases in emissions in developing countries, it is felt that OECD countries should reduce their emissions by 80% or more so that a global reduction of 50% may be attained.[7]
Nitrogen Oxides (NOx) — Total emissions of NOx from the transportation system in 2030 are to be no more than 10% of 1990 levels.	Damage from ambient nitrogen dioxide and ozone levels and nitrogen deposition is greatly reduced by meeting WHO Air Quality Guidelines for human health and eco-toxicity. This criterion is set in line with the WHO guidelines.[8]
Volatile Organic Compounds (VOCs) — Total emissions of VOCs from the transportation system are to be no more than 10% of 1990 levels.	Damage from carcinogenic VOCs and ozone is greatly reduced by meeting WHO Air Quality Guidelines for human health and eco-toxicity. This criterion is set in line with the WHO guidelines.[9]

In order to operationalize this definition of EST, project participants established a set of goals or criteria. These criteria were based on internationally recognized goals, guidelines, and standards, including those of the World Health Organization (WHO) and the United Nations Framework Convention on Climate Change.

The criteria adopted by the country teams participating in the study are described in Table 1.

Three additional criteria were deemed to be optional for study, although still important in reaching EST, and were left to each country team to define within the scope of their study: particulate matter, land take, and noise. Canada chose to focus primarily on the first three criteria for the study of the QWC.

While the primary criteria identified at the start of the study and discussed above addressed primarily the environmental impacts of transportation, study teams also recognized the need to have a balanced view of sustainable transportation, which includes both economic and social considerations.

As agreed upon by the participating countries, the base year for the BAU scenario is 1990. The horizon year for developing EST scenarios is 2030. As noted in OECD's report on EST scenarios,[10] the year 2030 was selected as the horizon year primarily on the basis that current problems have been generated mostly during one or two generations and may require the same amount of time for a solution.

It is important to note that the criteria are not based on what is or is not reasonable to attain. Instead, the criteria are based on what is thought to be required to bring levels of emissions and impacts to below the respective critical loads. It is also important to note that the criteria for the EST project differ from those adopted as part of the Kyoto Protocol, which for Canada are to reduce greenhouse gas (GHG) emissions to 6% below 1990 levels by the period between 2008 and 2012. The EST targets are more aggressive than the Kyoto targets but also involve a much longer time frame for achievement: 2030 vs. 2008–2012.

According to a 1997 survey...

"Almost nine in ten Canadians think global climate change will have serious negative effects on the environment and the economy within the next ten years." (Ekos, Rethinking Government,1997)

Two other concerns were also noted by experts consulted for the Canadian QWC study:

- Using relative criteria (i.e., percentage reduction) was deemed to be unfair to those countries that had already achieved significant reductions prior to 1990. It was also felt that relative measures would result in different ambient concentrations at different locations and times. Future efforts may consider the development and inclusion of absolute sustainability criteria.
- Canadian experts were most uncomfortable with the carbon dioxide criterion, particularly in view of the large gap between the EST emissions reduction suggested for sustainability (-80% by the year 2030) and that committed by Canada in the Kyoto Protocol (-6% to be reached by 2012). Although there is an acknowledgement that the Kyoto targets may only be a step towards greater reduction, the EST criterion was felt to be extremely ambitious, particularly within the 2030 time frame. Furthermore, some experts were reluctant to look at sustainability of the transportation sector in isolation from other sectors. Some experts felt that it would be necessary to share the burden among sectors to meet an overall 80% reduction in carbon dioxide emissions in the most efficient manner.

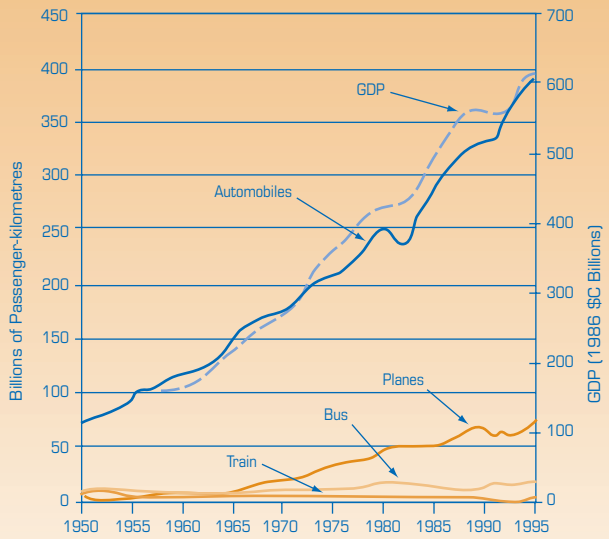
Notwithstanding these concerns, it was felt that the backcasting approach with its sustainability goal setting could shed light on the scope of societal changes required to move towards greater sustainability and on possible paths for achieving it. It was also felt that this exercise could provide a sound complementary long-term view to augment current analytical efforts undertaken under the Canadian implementation strategy on climate change carried out in the context of the Kyoto Protocol.

2 Current Transportation Trends and Impacts

2.1 The Problem

Virtually since the beginning of human existence, mobility and transportation have been part of our lives. Transportation is required for acquiring food, trade, and social interaction. It is a fundamental part of our economy. In recent years, in particular the last century, the movement of people and goods has been increasing at an astonishing rate. This is due in part to growth in population, but it is also a result of technological and economic development that has made us a more transport-intensive society. For example, total travel within and originating from Canada increased more than five times between 1950 and 1995, even though Canada's population only doubled during that period. The majority of passenger travel is by automobile, although, when expressed in terms of passenger-kilometres,[11] air travel is becoming a very significant mode (Figure 2). On the freight side, similar trends have occurred, with the truck mode growing at a rate even faster than that for automobiles. In the 10-year period between 1989 and 1999, truck tonne-kilometres more than doubled.[12]

Figure 2 **Passenger Transportation Trends**



SOURCE: Based on data from *Canadian Passenger Transportation, National Environmental Indicator Series*, Environment Canada.

Total travel within and originating from Canada increased more than five times between 1950 and 1995, even though Canada's population only doubled during that period.

Motorized transportation and related support activities have affected and will continue to affect the environment. Impacts occur throughout the entire life cycle of a vehicle, including manufacture, operations, and disposal. Some of the more prominent impacts of transportation include:

- **land use changes**, including land taken and changes in impervious surface area;
- **emissions to water, air, or land**, including criteria air pollutants, toxics, GHGs, and chlorofluorocarbons;
- **hazardous materials incidents** resulting from spills and leakages of fuel, oil, and other materials; and
- **production of waste** during the construction, operation, and disposal of vehicles.

These, in turn, have effects on human health and welfare, habitat, wildlife, and ecosystems. In addition to these direct effects, transportation has many upstream, downstream, and cumulative effects. One of the most significant impacts of transportation is the consumption of non-renewable resources, particularly its almost complete reliance on fossil fuels.

As highlighted by the previously mentioned criteria, the focus of the EST study is on the direct outputs from transportation activities, namely air emissions. These include the following:

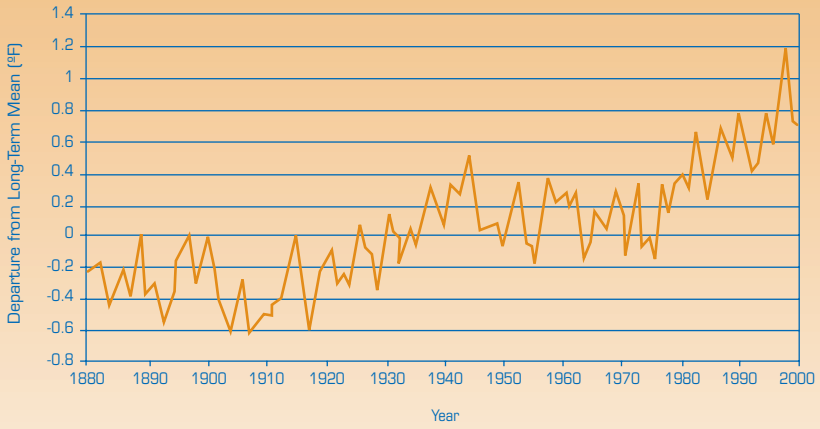
Carbon Dioxide (CO_2): There is convincing evidence that increasing concentrations of certain emissions such as carbon dioxide are contributing to global warming or climate change (Figure 3), although there continues to be a debate regarding the pace and nature of these changes. In 1997, transportation accounted for approximately 25% of all of Canada's GHG emissions.

Volatile Organic Compounds (VOCs): These are a chemically diverse group of compounds that have at least one carbon atom and are highly volatile. Many individual VOCs (e.g., benzene) are known to have or are suspected of having human health effects ranging from carcinogenicity to neurotoxicity. VOCs also contribute to the formation of ground-level ozone.

Nitrogen Oxides (NOx): These include nitric oxide (NO) and nitrogen dioxide (NO_2), which is formed from the oxidation of nitric oxide. Nitrogen dioxide is a lung irritant and may lead to depression of the immune system, particularly for children and the elderly. It also reacts with water to form nitrate (NO_3), which is a source of acid rain and contributes to the formation of ground-level ozone. Nitrogen dioxide is associated with suppressed vegetation growth and contributes to the corrosion of metals and degradation of other materials.

SOURCE: The above descriptions were adapted from Environment Canada Fact Sheets, SOE Fact Sheet No. 93-1.

Figure 3 Global Temperature Changes, 1880–2000



SOURCE: U.S. National Climatic Data Centre, 2001

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. Scientists expect that the average global surface temperature could rise 1–4.5°F (0.6–2.5°C) in the next 50 years, and 2.2–10°F (1.4–5.8°C) in the next century, with significant regional variation. (www.epa.gov/globalwarming/climate/)

2.2 Transportation's Role in the Production of Air Emissions

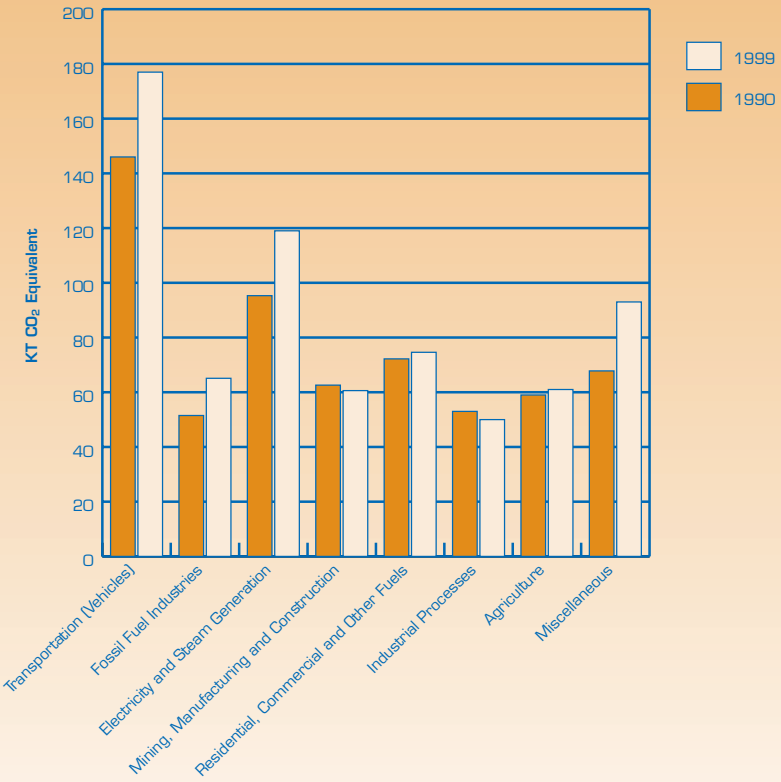
Transportation is a major contributor to air emissions. In Canada, transportation is responsible for about 25% of all GHG emissions. While regional breakdowns are not available for all sources of GHGs, it is expected that transportation's share of GHG production is similar in the QWC, if not higher. As shown in Figure 4, GHG emissions from transportation increased between 1990 and 1999 by about 21%. This highlights the challenge with which we are faced when considering options for moving towards EST.

As shown in Figure 5, within the transportation sector, passenger automobile transportation accounts for the largest share of GHG production by far (45%), followed by freight transportation by truck (28%). Freight transportation is experiencing the largest growth in the production of GHGs, increasing by more than 50% between 1990 and 1999.

Similar to GHG emissions trends, transportation accounted for some 52% of total Canadian NOx emissions in 1995, while stationary sources (e.g., power generation, industrial processing, commercial and residential combustion) accounted for the remainder.[13]

On a percentage basis, direct transportation accounts for a smaller portion of total Canadian VOC emissions, some 21%, although the upstream oil and gas industry accounts for a large share as well (19%).

Figure 4 Sources of Canada's Greenhouse Gas Emissions, 1990 and 1999



SOURCE: Environment Canada, Canada's Greenhouse Gas Inventory 1990–1999, April 2001.

2.3 Identifying the Gap

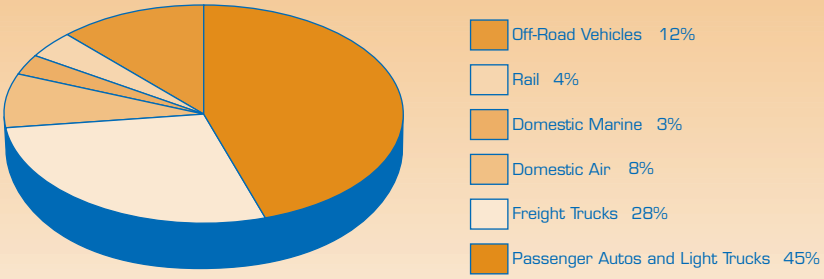
The study team looked at identifying the gap between continuing with current trends, referred to as a BAU scenario, and adopting an EST scenario in the QWC. The BAU scenario represents a case where trends in activity, technology, and policy adoption are continued and provides a base from which various EST scenarios can be developed and contrasted.

2.3.1 Transport Activity

The BAU scenario was developed using assumptions drawn from various government reports and other sources. Very generally, the baseline assumptions include:

- continued economic growth and related factors, such as automobile ownership and infrastructure construction;
- continued population growth, approximately 1% per year;
- unconstrained energy supply (i.e., the impacts of possible energy shortfalls were not considered) and relatively stable energy prices;

Figure 5 Model Breakdown of Canada's Greenhouse Gas Emissions Estimates, 1990–1999



SOURCE: Environment Canada, Canada's Greenhouse Gas Inventory 1990–1999, April 2001.

- no change in the general distribution of population within Canada and within the QWC; and
- for the BAU only, no change in the current modal share for road transport, with the exception of an increase in reliance on trucks for freight movement. Aviation travel is also expected to increase.

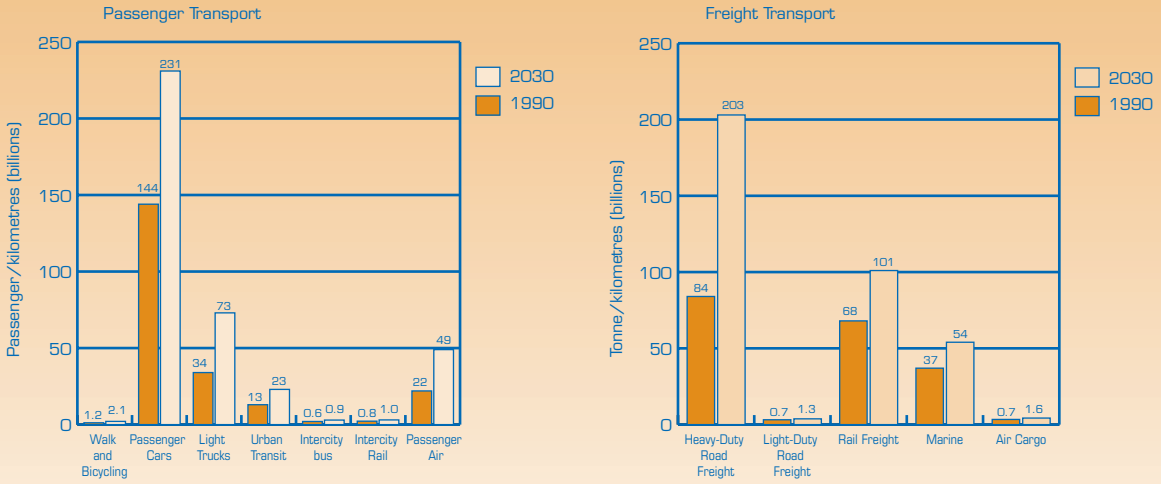
Based on these assumptions, passenger transport is expected to increase by 76% between 1990 and 2030, while freight transport will increase by 90%. As shown in Figure 6, the private automobile will continue to be the dominant mode of travel for personal travel, with cars and light trucks representing approximately 80% of all passenger activity in 2030. Similarly, heavy-duty trucks will continue to be the dominant mode for freight travel, accounting for almost 60% of all freight tonne-kilometres in 2030. The largest changes in transport activity that are projected are for the light truck mode (a result of the increasing popularity of sport utility vehicles [SUVs] in the 1990s) and the heavy-duty freight mode. Increases in the heavy-duty freight mode are expected as a result of increased North American trade combined with a shift towards the production/consumption of higher-order goods and continued just-in-time delivery.

2.3.2 Vehicle Technology and Load Factors

Besides activity, the other major factors influencing the production of emissions are vehicle technology and load factors. Significant improvements have taken place in the last two decades with respect to technology, particularly in the area of NOx and VOC emissions; additional improvements are expected.

Emissions factors for the BAU scenario were developed by extrapolating current trends. The impact of initiatives such as vehicle inspection and maintenance programs, which are now under way in Canada, were included in the baseline assumptions. The BAU emissions factors do not include the impacts of programs such as the Partnership for a New

Figure 6 **BAU Projected Transport Activity, 1990 and 2030**



NOTES: Activity projections are based on assumptions for the scenario development in the EST project. These assumptions may differ slightly from more recent projections.

Generation of Vehicles, a U.S.-based initiative aiming for fuel efficiency that may reach three times the present rate. Essentially, this program would involve the introduction of an entirely new type of technology and would require significant policy intervention, beyond what is considered "business as usual."

The basic source used for determining fuel consumption estimates for road vehicles was Environment Canada's report on trends in GHG emissions.[14] Results from the Canadian Mobile 5C model were also used extensively. The Mobile 5C model is a tool used by Environment Canada and other agencies to estimate existing and future emissions factors for various vehicle categories. The Mobile 5C model is capable of aging the existing vehicle stock over time and also allows for the introduction of new vehicles or technological improvements. The Mobile 5C model estimates NOx and VOC emissions, but not carbon dioxide emissions. Carbon dioxide emissions factors are derived directly from fuel efficiency estimates, which were largely adopted from Natural Resources Canada projections.[15]

Tables 2 and 3 summarize the emissions factors for the base and horizon years for passenger and freight transportation, respectively.

For passenger transportation, the most significant reductions in emission rates for carbon dioxide are expected to occur in the rail industry, as old locomotive stock is gradually replaced with newer, more fuel-efficient models. Improvements in fuel efficiency for automobiles and light trucks are expect to reduce carbon dioxide emissions rates by 23% by 2030, or about 0.6% per year.

Table 2 Business-as-Usual Emissions Factors — Passenger Transportation (grams per passenger-kilometre)

Mode	CO_2 1990	CO_2 2030	CO_2 Change	NOx 1990	NOx 2030	NOx Change	VOCs 1990	VOCs 2030	VOCs Change
Urban Auto	220	169	-23%	1.20	0.48	-60%	1.84	0.52	-72%
Urban Light Trucks	295	226	-23%	1.32	0.59	-55%	1.93	0.70	-64%
Urban Bus	81	69	-15%	0.63	0.14	-79%	0.07	0.04	-48%
Urban Rapid Transit	22	19	-14%	0.04	0.03	-15%	0.00	0.00	–
Urban Rail	47	31	-34%	0.93	0.56	-40%	0.04	0.02	-45%
Intercity Auto	147	113	-23%	0.80	0.32	-60%	1.23	0.35	-72%
Intercity Light Trucks	197	151	-23%	0.88	0.40	-55%	1.29	0.47	-64%
Intercity Bus	36	31	-15%	0.42	0.09	-79%	0.05	0.03	-48%
Intercity Rail	58	39	-33%	1.15	0.70	-39%	0.05	0.03	-44%
Air	179	108	-40%	1.10	0.66	-40%	0.10	0.06	-40%

NOTES: Assumes load factors of 1.2 persons per vehicle and 1.8 persons per vehicle for urban and intercity automobile, respectively. Emissions rates and projections are based on assumptions made during Phase 2 of the EST project carried out in 1998. These assumptions may differ slightly from current projections.

For freight transportation, significant improvements in NOx and VOC emissions rates are expected for heavy-duty vehicles, as advance emissions control systems make their way through the fleet. Less substantial improvements are forecast for fuel efficiency, and hence carbon dioxide factors, for heavy-duty vehicles.

A key conclusion from the development of BAU emissions factors is that fairly substantial reductions in emissions factors for NOx and VOCs are expected even without significant additional policy intervention. Most modes will move substantially closer to the EST criteria by 2030. On the other hand, only minor reductions are forecasted for carbon dioxide. As a result, it was generally accepted that if carbon dioxide targets are met, other emissions targets will also be met.

2.3.3 BAU Emissions Forecasts

The combined impact of changes in activity levels and emissions factors for the BAU scenario is shown in Figure 7.

In no case are emissions projected to meet the EST criteria. In fact, despite improvements in vehicle technology, carbon dioxide emissions are projected to increase by approximately 47%.

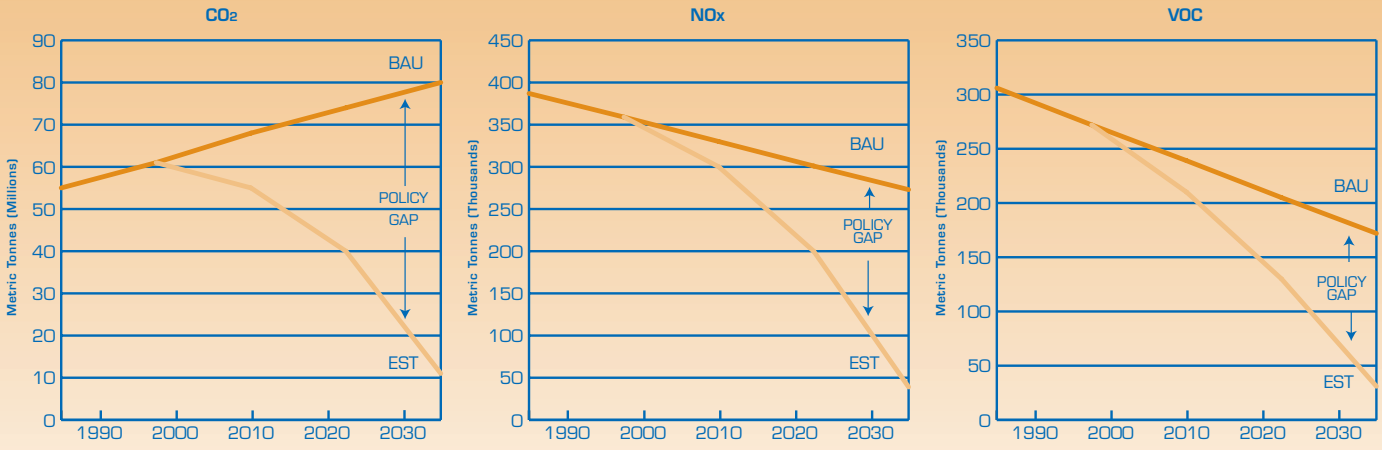
Some reductions are expected for overall NOx levels (-30%) and VOC (-44%) due to improvements in vehicle technologies, but these reductions are significantly less than what is required to meet the EST criteria.

Under the BAU scenario, total carbon dioxide emissions from transport activity are expected to **increase** by almost 50% between 1990 and 2030. For EST, an 80% **decrease** is the target.

Table 3 **Business-as-Usual Emissions Factors — Freight Transportation (grams per vehicle-kilometre, grams per tonne-kilometre)**

Mode	CO_2 1990	CO_2 2030	CO_2 Change	NOx 1990	NOx 2030	NOx Change	VOCs 1990	VOCs 2030	VOCs Change
	grams per vehicle-kilometre								
Heavy Duty Gas Vehicles	946	807	-15%	4.9	2.1	-57%	5.1	1.0	-80%
Heavy Duty Diesel Vehicles	1065	906	-15%	12.6	2.7	-79%	1.5	0.8	-48%
Light Duty Trucks	508	390	-23%	1.1	0.5	-56%	0.4	0.3	-32%
	grams per tonne-kilometre								
Rail Freight	22	14	-35%	0.4	0.3	-43%	0.02	0.01	-48%
Marine	9.4	6.8	-28%	0.2	0.1	-68%	0.02	0.01	-40%
Air Cargo	1375	831	-40%	8.4	5.1	-40%	0.7	0.4	-39%

Figure 7 **Business-as-Usual Emissions Forecasts, 1990–2030**



3 The Path Towards EST

3.1 Scenarios Considered

As discussed previously, three possible paths or scenarios to achieve EST were constructed for exploratory purposes. All countries participating in the project initially were given the task of looking at the following scenarios, in addition to the development of the BAU scenario:

- **Technology Scenario** — assumes that the amount of passenger and freight transport activity would be the same as in the BAU scenario and that EST targets would be achieved entirely through technological advances.
- **Activity Reorganization Scenario**[16] — assumes that the level of technology is the same as in the BAU scenario and that the EST targets would be achieved entirely through managing and reducing the demand for passenger and freight transport.
- **Combination Scenario**[17] — assumes that the EST targets are achieved through a combination of technological change and demand management.

The two extreme scenarios dealing with technology only and activity only were not looked at with the expectation that they would be feasible, but rather to challenge the study teams' thinking and to highlight the pitfalls of a one-sided approach.

The technology scenario assumed that a large portion of passenger vehicles would be powered by fuel cells, with the remainder powered by high-efficiency internal combustion engines (ICEs), batteries, and hybrid engines. Intercity passenger transportation featured high-speed electric rail and fuel cell buses. Most heavy-duty vehicles would need to be powered by fuel cells. The technology scenario would require a turnover rate of vehicles several times greater than the current rate, which would likely not be achievable without unmanageable economic costs. Most of the technology assumed is also 5–10 years off from being introduced to the mainstream population, particularly on the freight side, making the time period for vehicle turnover even shorter.

The activity reorganization scenario was similarly challenging. It relied on a reorganization of land use to reduce trip lengths, a significantly reduced emphasis on private automobiles compensated by a greater number of transit, walking, and cycling trips, reduced air travel, replacement of trips through the use of telecommunications, a greater reliance on locally produced goods, and several other infrastructure-related initiatives. In essence, achieving the EST targets through activity changes alone would probably require some form of rationing, which is not seen as feasible or desirable. Similar to the problem of vehicle turnover in the technology scenario, the activity

Study teams quickly reached the conclusion that both technology improvements and activity reduction would be required to achieve the stringent EST targets for CO_2.

Key Features of the EST Scenario...

- Virtually all electric power sources are zero emissions.
- More people live in denser, mixed-used urban environments that facilitate the use of efficient public transit modes and reduce the need for private automobiles.
- If required, people drive vehicles that are lightweight and powered by fuel cells or very-low-emissions ICEs.
- People travel between cities predominantly by high-speed rail on trains that are entirely electrified.
- People choose more efficient travel modes and purchase more efficient vehicles. They buy locally produced goods, due to the fact that the prices of goods and services reflect more closely the real cost of transportation and that they are more aware of the environmental consequences of their choices.

reorganization scenario would require a level of infrastructure construction (e.g., transit, bikeways, railways, etc.) that is unprecedented in Canada.

The combination scenario essentially takes the best of the technology and activity reorganization scenarios. The remainder of this report focuses on the development and assessment of the combination scenario, hereafter referred to as the "EST scenario."

3.2 Features of the EST Scenario

The development of the EST scenario was carried out using an iterative approach involving different degrees of implementation of technology features and activity reduction features. It involved looking at all possible technology and activity measures and deciding which ones would have the greatest potential to help achieve the EST criteria while having the least economic or social cost.

An initial step in the process was to define the key features of the EST scenario for the QWC, to help guide the development of policy instruments.

The features of the EST scenario were developed by the Canadian study team with the help of a number of experts and can be summarized as follows:

In order to help determine if and how EST could be achieved, the key features were defined in more detail and quantified in terms of their potential impact (Table 4). Essentially, "features" are used to describe what the future would look like in general terms (e.g., reduced dependence on private automobiles). This is not to be confused with policy instruments, described later in this report, which are the types of initiatives required to achieve each feature (e.g., road pricing).

3.3 Possible Policy Instruments to Achieve EST

Achieving EST would require the implementation of many instruments aimed at improving technology and reorganizing activity. Some of these instruments would require a significant shift in public policy. It is important to keep in mind, however, that the purpose of the EST study was to look at what would be required to achieve the given targets, which may differ significantly from what is possible given the current political environment.

A list of some of the more promising instruments is provided in Table 5. An assessment of the instruments is provided in Section 3.5 as well as Chapter 5.

Table 4 Features of the EST Scenario

Technology Features	Activity Reorganization Features
• use of zero-emission power sources • use of fuel cells for vehicles • use of other low-emission vehicles • reductions in vehicle weight • electrification of rail modes • introduction of high-speed rail	• more compact, mixed-use urban development • reduced dependence on private automobiles • market incentives to purchase more efficient vehicles • pricing regimes for more efficient travel behaviour • trip replacement through telecommuting • improved public transit • modal shifts to high-speed rail • reallocation of road lane kilometres through modal shift • reduced air travel • greater reliance on local products • improved logistics • innovation and public participation

Table 5 Instrument Identification and Characterization

Instruments	Mechanisms	Desired Effects	Issues
Economic and Fiscal Instruments			
Road pricing	• charges users of a specific road facility or a group of roads through tolling mechanisms (e.g., cordon tolls)	• encourages shifts to more sustainable modes • promotes ride-sharing • encourages more compact mixed-use urban forms	• current policy generally limits road tolls to new facilities only
Fuel pricing/taxation	• raises the cost of conventional fuels to account for external costs (i.e., environmental costs, accidents, land consumed for roads, etc.)	• reduces number and length of trips • encourages shifts to more sustainable modes • promotes use of more efficient vehicles	• suitable alternatives must be available to the user • revenues from fuel taxes should be used to fund infrastructure
Tradeable carbon dioxide permits	• individuals and/or corporations are given a specific budget of carbon dioxide credits per year to be used on travel by any mode; permits can be bought or sold by individuals	• allows governments to set targets for carbon dioxide emissions and then adjust carbon dioxide credits over time to meet this target	• a relatively unapplied concept in Canada, which would take some time to implement

Table 5 Instrument Identification and Characterization — continued

Instruments	Mechanisms	Desired Effects	Issues
Economic and Fiscal Instruments (cont.)			
Tax incentives for transit/passenger rail users	• employees would receive transit benefits (e.g., free transit passes) from employers without being taxed	• encourages use of transit	• at present, most commuters receiving free parking are not taxed
Differentiated registration/insurance fees	• involves the restructuring of insurance and/or vehicle registration pricing systems such that people pay according to use (i.e., kilometres driven per year)	• encourages people to use their car less	• would require a significant change in current industry policies
Parking pricing/management	• mandates minimum parking fees • parking bylaws are restructured to include maximum parking ratios, in addition to minimum parking ratios	• reduces commuter travel by private automobile • encourages ride-sharing • reduces amount of land devoted to parking	• most bylaws governing municipalities restrict the implementation of parking surcharges
Regulatory Measures			
Mandatory emissions inspection	• involves regular testing of vehicles at time of registration	• encourages vehicle maintenance • helps reduce "grossly" polluting vehicles	• programs are already in place
Reductions in speed limits	• speed limits are reduced to reflect "optimum" fuel efficiency speeds	• reduces fuel consumption • improves relative attractiveness of other modes (e.g., walking, cycling, and transit)	• traditionally has received public opposition
Urban Structure and Travel Demand Management (TDM)			
"Fuller cost" land taxation	• property taxes are revised to better reflect a development's full impacts in terms of required infrastructure, vehicle emissions, land consumption, etc.	• helps to achieve more efficient urban structures	• may penalize existing rural developments
Stricter land use controls	• municipalities have more power to keep development within designated urban boundaries	• encourages more compact mixed-use urban forms	• difficult to implement

Table 5 Instrument Identification and Characterization — continued

Instruments	Mechanisms	Desired Effects	Issues
Urban Structure and Travel Demand Management (TDM) (cont.)			
Employer-sponsored trip reduction programs	• includes initiatives such as ride-sharing programs, improved amenities for cyclists, free transit passes, flexible work hours, etc.	• reduces commuter travel by private automobile	• needs to be tied to incentives for employers (e.g., tax reductions, relaxed parking policies)
Programs to reduce school-related automobile trips	• includes initiatives such as the "walking school bus" whereby parents take turns walking groups of children to school along designated routes	• reduces unnecessary automobile trips (10% of morning peak)	• generally well received
Technological Development Initiatives			
Financial incentives for technology development	• this may include credits for stock turnovers, reduced registration fees for clean vehicles	• stimulates the development of new technologies	• requires government spending
New corporate average fuel economy (CAFE) standards	• the average fuel efficiency of all vehicles sold by a manufacturer must meet minimum fuel efficiency standards	• improves the efficiency of vehicles available to the public	• needs to be supported by other measures, as people may drive further if they have a more efficient vehicle
Feebates	• vehicles are subject to taxes or rebates in proportion to how much they exceed or fall below a specified reference fuel consumption rate	• discourages purchase of SUVs and other "gas guzzlers"	• North America has very little demonstrable experience with feebates
Promotion of alternative fuels	• alternative fuels such as ethanol, natural gas, and propane are promoted aggressively, possibly using financial incentives	• alternative fuels have lower GHG emissions per unit of fuel	• lack of existing supply and distribution systems is a barrier
Private/public technology development	• governments and private sector work together to develop new technologies such as fuel cells	• accelerates introduction of new technologies	• generally successful

Table 5 Instrument Identification and Characterization — continued

Instruments	Mechanisms	Desired Effects	Issues
Technological Development Initiatives (cont.)			
Develop memoranda of understanding with vehicle manufacturers	• manufacturers agree to a set increase in fuel efficiencies for new vehicles	• provides public with opportunity to purchase more efficient vehicles	• often market forces dictate manufacturers' decisions
Transportation Supply Management			
Transit service expansion and enhancement	• higher levels of transit services are provided where viable • coordinates transit services and fares within urban areas	• attracts new transit riders and reduces automobile use	• new transit requires significant public investment
Improved bicycle lanes/facilities	• urban roadways are re-engineered to provide dedicated facilities for cyclists	• encourages more shifts to bikes	• many municipalities struggle with the notion of reducing road capacity
Rail incentives	• includes options to make rail freight more competitive with trucks	• reduces road freight and related impacts	• rail is not viable for all freight markets
High-occupancy vehicle (HOV) lanes	• converts existing traffic lanes to HOV lanes	• promotes higher automobile occupancies	• more effective if existing lanes are used, rather than adding new lanes
Advanced technology applications	• includes the use of intelligent transportation systems (ITS)	• helps to make drivers and vehicles and transit systems more efficient	• some ITS measures can increase road capacity, thereby encouraging more vehicle trips
Traffic calming	• includes physical measures to slow traffic	• discourages automobile use and makes streets more friendly for pedestrians and cyclists	• can increase emissions, since vehicles are not travelling at a constant speed
Consumer Preference Mechanisms			
Improved education	• measures to make public aware of the need for EST	• encourages more sustainable transportation behaviour	• needs to target people at a young age
Advertising equity	• transit operators adopt more aggressive advertising campaigns	• promotes transit	• automobile industry needs to be more conscientious when advertising (e.g., ads showing SUVs "conquering Mother Nature")

Table 5 Instrument Identification and Characterization — continued

Instruments	Mechanisms	Desired Effects	Issues
Consumer Preference Mechanisms (cont.)			
Consumer/user awareness initiatives	• may include carbon dioxide labelling, information on housing choices, etc.	• allows public to consider the environment when making large purchases	• the cumulative effect of this policy could have large positive impacts
Support for community/political "champions"	• recognizes individuals/organizations that make significant progress towards EST	• helps stimulate ideas on EST	• few negative issues
Administrative Measures			
Improved data collection/dissemination	• data collection is given highest priority	• improves decision-making capabilities, allows progress on EST to be measured	• governments must work together
Coordinated decision-making	• all levels of government work towards EST goals	• accelerates implementation of instruments	• difficult with the current system of three levels of government

3.3.1 Comparing Canada's EST Strategy with Those of Other Study Teams

A useful aspect of the OECD study was that study teams could compare the different approaches in developing policies to achieve EST. Results varied significantly among study teams. As shown in Table 6, Canada and Austria in particular adopted an approach that involved a wide range of instruments, while teams such as the Netherlands focused on one primary measure: tradeable carbon dioxide permits.

3.4 EST Will Involve Both Activity and Technology Measures

Assessing the impact of each instrument on activity and technology is a difficult task, since very few of the measures have been tested or implemented to the extent that would be required for the EST scenario. For example, the EST scenario would likely involve fuel pricing increases of two or three times the current price. It is uncertain whether or not such changes could even be implemented, let alone what effect they would have. Another challenge is determining the net effect of a large number of instruments. For example, the impact of raising fuel prices would be quite different depending on the corresponding investment made in alternative modes such as transit.

For the purpose of the EST project, very broad estimates of the impacts of the possible instruments were made, drawing on a wide variety of research and policy documents. For example, research has shown that CAFE standards (i.e., implementation of a 2% per year North America-wide fuel efficiency target) could reduce emissions by 13% by 2020.[18] To achieve the EST target reductions for carbon dioxide, CAFE standards would need to be even more stringent.

Table 6	Key Features of Strategies of Participating Countries
Austria (Alpine region)	Deployment of a wide range of instruments, with some emphasis on regulatory instruments and on changing governmental arrangements.
France (Alpine region)	Deployment of a wide range of instruments, with some emphasis on fiscal instruments, non-motorized alternatives, and instruments already in use.
Italy (Alpine region)	Deployment of a wide range of instruments, with some focus on regulatory instruments, non-motorized alternatives, and national implementation.
Switzerland (Alpine region)	To facilitate acceptance, instruments are confined to those in use or under discussion, to be applied more rigorously with careful calibration according to effects.
Norway (urban region)	Focus on meeting the carbon dioxide criterion for the most part through pricing instruments, improvement of traditional technologies, and application of supporting instruments.
Germany (whole country)	Meeting the carbon dioxide and noise criteria through emission standards (passenger vehicles), road charging (freight vehicles), and fuel taxes in the context of eco-tax reform.
Netherlands (whole country)	Strong emphasis on the use of tradeable entitlements to emit carbon dioxide, with other instruments fashioned to ensure acceptance and effectiveness of the key measure.
Sweden (whole country)	The strongest possible emphasis placed on developing a package that will be or will become politically and publicly acceptable.
Canada (corridor)	Emphasis on deploying a wide range of instruments to reflect the wide diversity of Canada's geography and economy.

SOURCE: OECD, Project on Environmentally Sustainable Transportation (EST), Report on Phase 3: Policy Instruments for Achieving EST, 2002.

Again, it is important to stress that the EST study was not so much about looking at "what would be reasonable" but rather "what is necessary to achieve the EST criteria."

3.4.1 Activity Will Need to Be Reduced

Various policy instruments were identified that could change activity.[19] Figure 8 shows the activity levels required for each passenger mode to achieve EST, based on the proposed mix of policy instruments. As described previously, achieving the EST criteria requires not only changing current travel behaviour (e.g., getting people out of cars and onto more sustainable modes) but also addressing the anticipated 75% increase in overall passenger activity. As shown in Figure 8, significant reductions in urban automobile travel will need to occur. Urban automobile travel would be the focus of a number of policies, since there are generally other options for urban travellers (e.g., walk, cycle, and transit). Unlike some of the other participating countries, intercity automobile travel is harder to influence in the QWC since, in many cases, there are no other viable options. Even still, intercity transit will increase significantly in relative terms under EST, since its current mode share is very low.

Figure 8 Expected Changes in Passenger Movements for EST Scenario

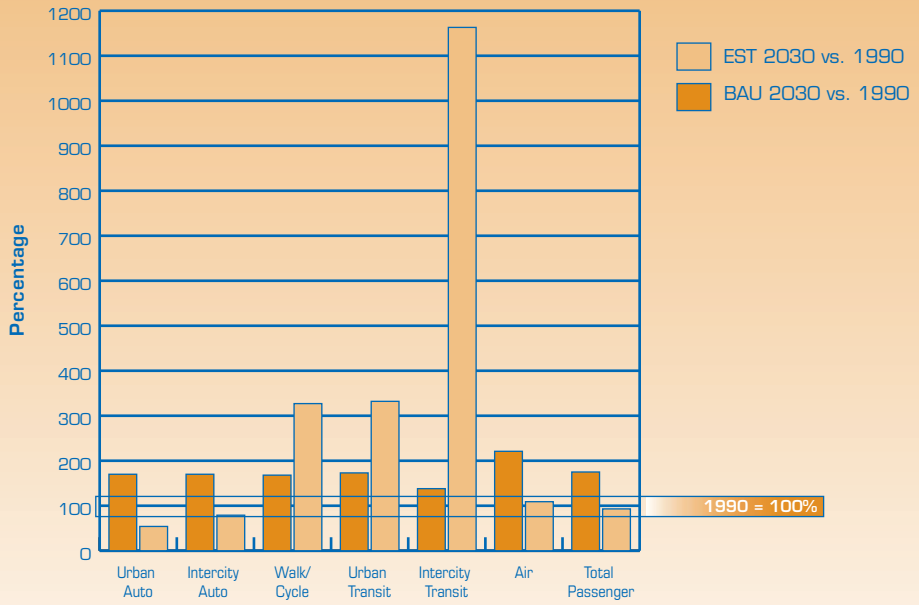
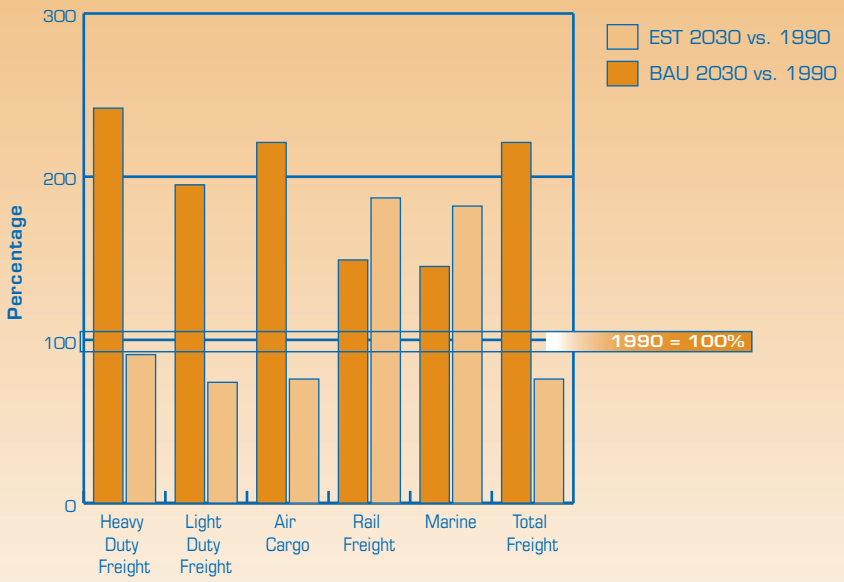


Figure 9 shows the expected changes in freight movement required to achieve EST. Under the BAU scenario, freight movement is expected to more than double. The EST scenario would involve reductions in the amount of freight moved combined with a shift from the use of road modes to the use of rail and marine. Significant reductions in air cargo activity would also need to occur, since this is one of the most energy-intensive modes of moving goods.

Compared with the other countries participating in the EST project, the relative changes in activity are fairly similar. The EST scenarios for all countries feature a heavy emphasis on public transport and rail freight. One difference on the passenger side is that the percentage increase in walking and cycling is much larger for Canada than for the European countries due to the fact that we are starting from a much lower base. Current walk/cycle mode shares for most European countries are in the order of 25–40%, compared with less than 10% (for work trips) in Canada. There are many reasons for the higher levels of walking and cycling in Europe. The more compact land use patterns in European cities explain at least

Overall, the EST scenario envisions a situation in which the level of passenger activity will be about the same as in 1990, although there will be significantly more people living in the corridor.

Figure 9 Expected Changes in Freight Movements for EST Scenario



some of the difference in travel behaviour. The average density of European cities is triple that of North American cities; conversely, average trip lengths in European cities are roughly half as long.[20]

3.4.2 Vehicles Will Need to Be More Efficient

For the EST scenario, policy instruments impacting activity will essentially hold passenger activity to 1990 levels in 2030, which is a significant achievement, given that the population will increase notably during this period. As a result, there is a heavy reliance on technology to achieve the remainder of the reductions. As shown in Figure 10 and described previously, some significant reductions in emissions factors for vehicles will occur regardless of the EST policy interventions. Substantially greater reductions will need to take place in order to meet the EST targets. It is envisioned that these changes will take place through the following:

- Light-duty passenger and freight vehicles will use ICEs (25%), fuel cell engines (25%), hybrid technologies (25%), and electric traction (25%). ICE and hybrid technologies would penetrate the market first, with fuel cell technology making its way into the mainstream vehicle population in the longer term. Advanced technology ICE light-duty road vehicles would feature high-efficiency gasoline use and an exhaust system that would eliminate 95% of NOx and VOC emissions. An ICE fuelled by biomass-generated ethanol could be used as well with favourable emission characteristics.

- Surface buses would use fuel cells with methanol, while rapid transit modes would be electrified in all urban areas. Guided passenger transportation would be either of Maglev or rail type. Compared with high-speed trains, the higher speeds offered by Maglev technology would enable a higher level of modal shifts from air and road modes. To be conservative, the emissions factors for high-speed rail (300 kilometres per hour) rather than Maglev technology have been used in all of the EST scenarios.

Public transit bus

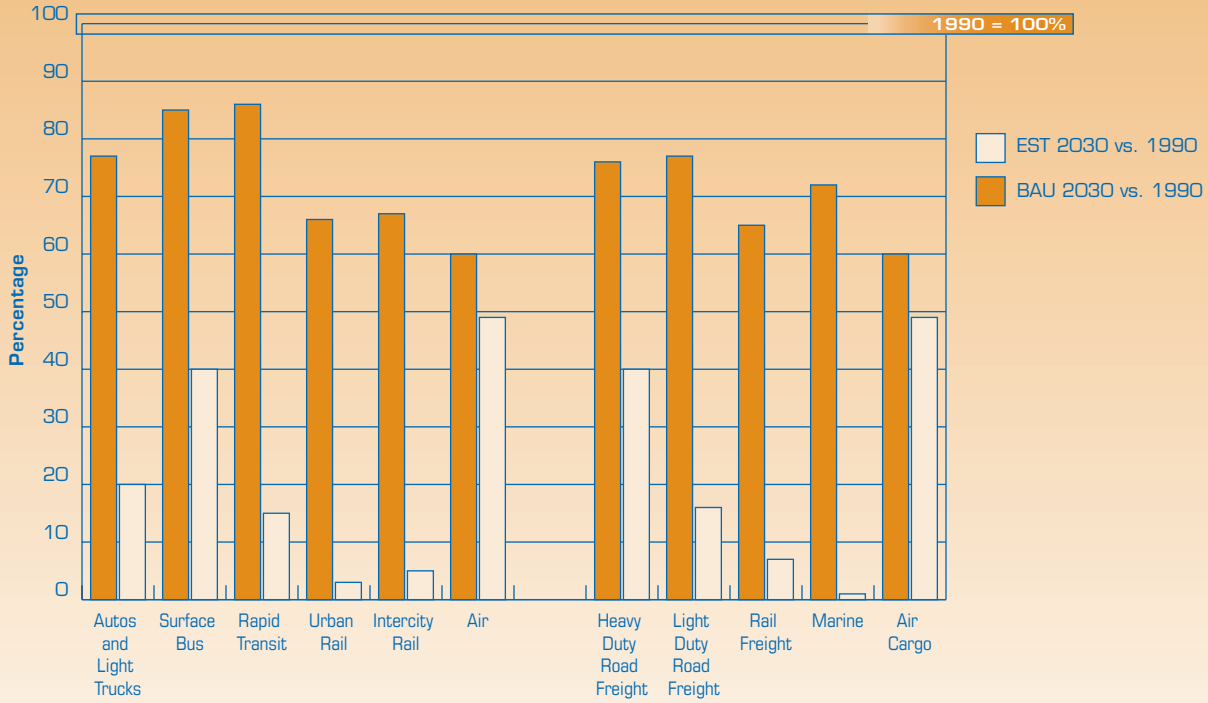
- In the EST scenario, it was assumed that air transportation would continue to use conventional aviation fuels. This is due to the uncertainty of the technical, economic, and safety aspects of the use of liquefied hydrogen by aircraft. However, compared with the BAU scenario, aircraft engine fuel efficiency would be 10% higher.
- Road freight vehicles and waterborne freight vessels are assumed to use fuel cell engines based on methanol, which will require a significant technological advancement. Freight railways would need to be electrified, both for reasons of energy efficiency and due to the higher service levels required. Air freight will be carried largely in the cargo holds of passenger aircraft.
- Load factors will rise due to logistics improvements and modal shifts. Through the use of ITS and supporting computer communications technologies, operational improvements will occur in transportation. In the case of passenger transportation, the energy and emissions factors reflect a 25% increase in load factors for urban automobiles and a 40% increase for intercity automobiles compared with the BAU scenario. For freight transportation, a 10% improvement is assumed due to higher utilization of the cargo-carrying capacity of these modes.

It is worthwhile noting that over the past two decades or so, improvements in freight technology have occurred at a much slower rate than improvements in passenger transportation, perhaps due to the small profit margins for this industry. If sustainable transportation is to be achieved, technological improvements to freight modes will need to play a key role.

3.4.3 Quantifying the Role of Activity and Technology Measures

Significant discussion occurred throughout the EST project among study teams about the virtues of activity reductions and changes versus technological solutions in achieving EST. OECD experts considered it relevant to define better the extent to which each approach (behavioural or technological) would contribute to achieving the EST criteria. The analysis

Figure 10 Relative Changes in CO_2 Emissions Factors for BAU and EST in 2030



became known as the balance-of-effort analysis and involved estimating the separate contribution of the following four main carbon dioxide emissions reduction strategies:

Technological approaches:

- Reduced carbon dioxide per unit of transport activity from technological change or from vehicle downsizing; e.g., smaller, more efficient vehicles.

Behavioural approaches:

- Reduced transport activity (passenger-kilometres or tonne-kilometres); e.g., avoiding travel through telecommunication, living at walking distance from shops, daycare, workplace, etc.
- Reduced carbon dioxide emissions per unit of transport activity through use of more efficient vehicle types; e.g., shifting mode from truck to rail, from single-occupancy vehicle to bus, from car to bike, etc.

- Reduced carbon dioxide emissions per unit of transport activity through better occupancy or loading of vehicles; e.g., better use of existing modes, shifting from a single-occupancy vehicle to car pooling, better loading of a given truck.

Figure 11 represents the results of the balance-of-effort analysis; it indicates the share of carbon dioxide production estimated for each of the above four strategies for the EST scenario and provides a comparison with findings by the study teams for four other countries/regions. For the QWC, the balance-of-effort analysis shows that under the EST scenario, almost half of the emissions reduction effort would be achieved through technological changes, including a heavy reliance on vehicles powered by fuel cells and highly efficient ICE vehicles.

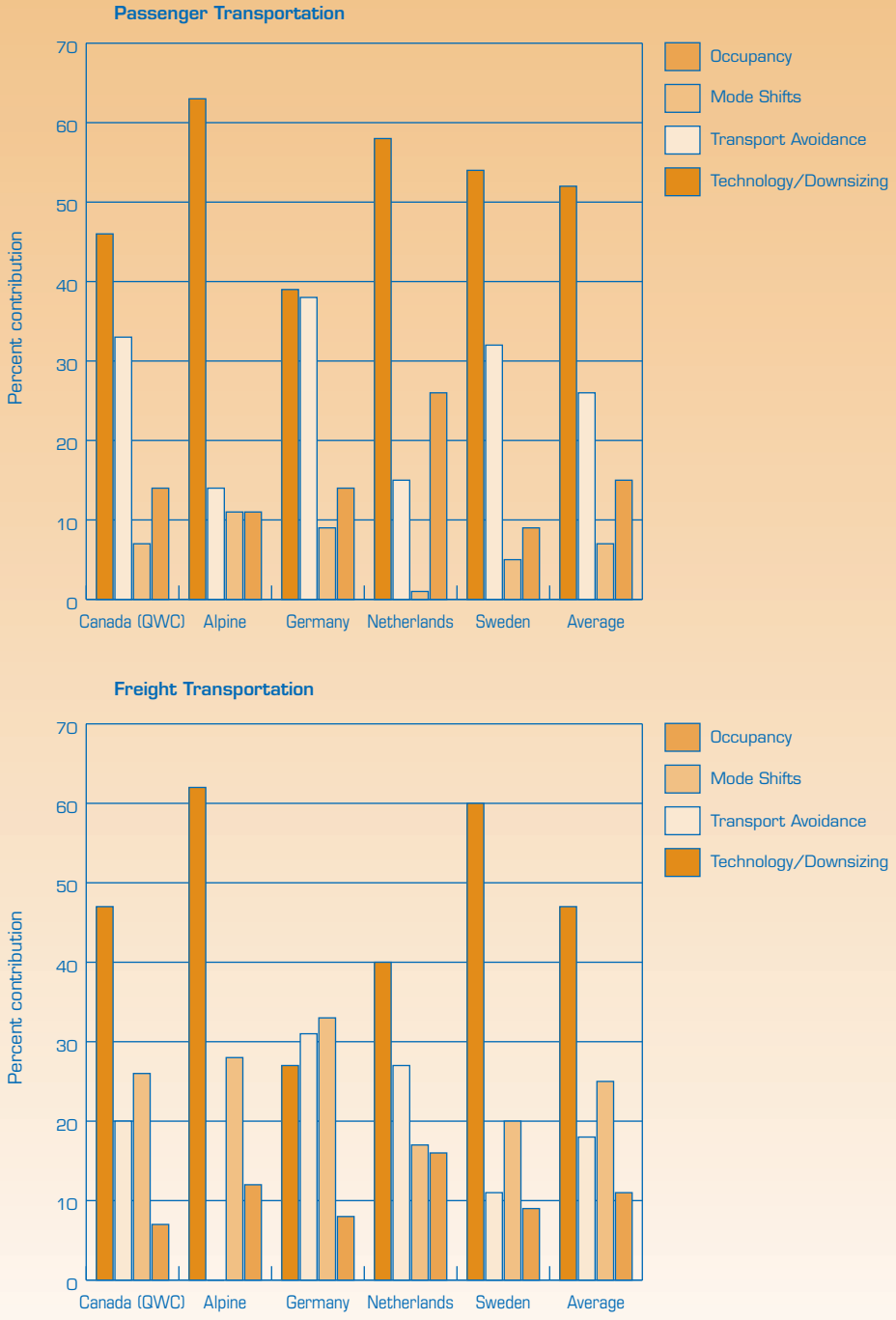
The other half of the emissions reduction effort would be achieved predominantly through less travel or more efficient travel, particularly for passenger transport. Less travel would be achieved by fewer and shorter trips; more efficient travel would be achieved through higher vehicle occupancies (e.g., car pooling, car sharing, etc.) and through shifting trips to more efficient modes such as bus and rail.

There was a considerable amount of variance in the relative use of technology and behaviour approaches among the study teams. The Alpine region, the Netherlands, and Sweden placed the largest emphasis on technology, while Germany focused more on activity reductions and mode shifts. Despite having very different political and geographic characteristics, Canada was closest to the average results of all study teams.

3.5 Assessing the Instruments

The methodology recommended by OECD for the assessment of instruments was described as a "structured brainstorming" approach. This approach involves expert judgement and consists of multiple iterations to determine the most appropriate instruments to achieve the various features of EST. For the Canadian study, the structured brainstorming approach was modified slightly. A preliminary list of instruments was generated by the core study team, similar to the list in Table 5, following which the list was subjected to a focused review during a brainstorming session of experts. Additional assessments using a number of different frameworks were undertaken throughout the study, including a framework developed by the Netherlands study team and adopted by all other study participants. The Netherlands Framework, however, did not provide a means for prioritizing the instruments. For the purpose of this report, only a summary of the assessment of instruments is provided.

Figure 11 **Percentage Contribution of Different Factors in the Attainment of the EST Carbon Dioxide Reduction Criteria**



At the outset of the Canadian study, some of the considerations and goals used in the selection of instruments included the following:

- the potential for carbon dioxide reduction, as determined by previous research;
- the ability to impact the most EST features;
- the ability to impact both activity and technology; and
- the potential to enhance the impacts of other instruments.

A more refined set of criteria, which also included social and economic features, was then applied to the initial list of instruments to help highlight the most promising instruments. The set of criteria included the following:

- **Reduces GHG and Air Pollution:** Ultimately this is the bottom line indicator for EST. As indicated previously, if the carbon dioxide target is met, it is basically a given that the other criteria for air pollutants (NOx and VOCs) will also be met. The assessment of each measure's impacts on carbon dioxide reduction was informed by previous work carried out in Canada.[21]
- **Reduces Vehicle-Kilometres of Travel (VKT) (Automobiles and Trucks):** A key feature of EST is a reduced dependence on roads for the movement of people and goods. A reduction of automobile and truck VKT has many advantages, in that it reduces traffic congestion and associated impacts, including accidents, noise, parking requirements, and land take. The VKT reduction criterion is a good way of distinguishing between instruments that just reduce the unit impact of vehicles but not the number of vehicles themselves (e.g., technology improvements) and those that address all impacts of vehicle use.
- **Minimizes Investment Cost:** The availability of financial resources will be a major limiting factor to the implementation of any instrument that requires significant capital investment or has high operating costs. Implicit within the cost minimization criterion is the recognition that some instruments may in fact generate a positive revenue stream, which can then be used to finance other EST initiatives. These instruments have been given a higher rating.
- **Improves the Economy:** Economic impact is probably the most contentious and debated issue related to the achievement of EST. Traditional economic analyses, such as input–output models, tend to underestimate the economic benefits of climate change mitigation while ignoring the possibly significant negative environmental ramifications and costs of the BAU scenario. Traditional economic analyses also often ignore the "efficiency improvements" that are spin-offs from environmental improvements.[22] For the purpose of short-listing instruments, this report takes a more general view of economic impacts and simply attempts to rate the instruments relative to each other. A more detailed economic assessment of EST in general is provided in Chapter 5.

- **Minimizes Administration:** The administrative and human resources requirements associated with an instrument could be so large that it would make the instrument infeasible. The rating attempts to reflect the administrative burden associated with each instrument.
- **Improves the Social Situation:** Instruments that were examined included those that would reduce social polarization, improve community relationships, promote cultural diversity, improve health and safety, reduce crime, and maintain the functioning of government. A more detailed assessment of the social implications of EST is provided in Chapter 5 of this report.

Based on the above criteria, Table 7 summarizes the results of the assessment of instruments. The assessment revealed that economic instruments would seem to provide the most potential in moving towards sustainable transportation. According to the assessment, fuel pricing, road pricing, and carbon dioxide emissions permits trading provide a great potential for large environmental benefits on both the activity side and the unit impact side. To the extent that these instruments are supported by alternatives to the single-occupant vehicle and an educational program to raise awareness, they would do much to reduce the environmental burden of our transportation activities.

Economic instruments such as those listed above would also be effective in reducing the environmental burden of road freight, which is the sector with the fastest increase in terms of activity. Care would need to be taken to ensure that pricing measures impacting road freight modes were put in place gradually, without undue burden, and that pricing of road freight did not translate directly into higher-priced goods. The movement of goods is critical to the Canadian economy. In addition to direct user pricing, there are several economic instruments that could promote rail transport — for example, changing the taxation regimes related to right-of-ways used for rail transport and changing the tax laws pertaining to railway capital cost depreciation allowances.

The Canadian instrument package was characterized as having a higher than average emphasis on fiscal and economic instruments. However, transportation prices are already much higher in Europe than in Canada.

In addition to pricing regimes, there would also be a need to enforce controls to limit urban sprawl and promote compact, mixed-use development. The difficulty with measures that pertain to restructuring land uses is that they have a long implementation period before their impacts are felt. Land use controls also require very coordinated decision-making in order to ensure that equity is maintained for all members of society. In the long term, measures that involve distance-based pricing can be expected to have an impact on people's live–work decisions and ultimately land use patterns.

Table 7 Assessment of Instruments to Achieve EST

INSTRUMENTS	CRITERIA						
	Reduces GHG and Air Pollution	Reduces VKT	Minimizes Investment Cost	Improves the Economy	Minimizes Adminis-tration	Improves the Social Situation	Overall Evaluation
Economic and Fiscal Instruments							
Road pricing	◑	◕	◕	◑	◑	◑	◕
Fuel pricing/taxation	●	◕	●	◑	●	◔	●
Tradable carbon dioxide permits	●	◑	◕	◕	◔	◑	●
Tax incentives for transit/passenger rail users	◔	◑	●	◕	◑	●	◔
Differentiated registration/ insurance fees	◑	◔	◕	●	◑	●	●
Parking pricing/ management	◕	◕	◕	◕	◑	◕	●
Regulatory Measures							
Mandatory emissions inspection	◔	◔	◑	●	◔	●	◑
Reductions in speed limits	◔	◔	◕	◔	◔	◕	◔
Urban Structure and TDM							
"Fuller cost" land taxation	◕	◑	◑	◑	◑	◑	◕
Stricter land use controls	◕	◕	◑	◑	◕	◑	◔
Employer-sponsored trip reduction programs	◔	◑	●	●	◑	●	◔
Programs to reduce school-related automobile trips	◔	◔	◔	◕	◑	●	◔
Technological Development Initiatives							
Financial incentives	◑	◔	◔	●	◔	◕	◑
New CAFE standards	●	◔	◕	◑	◑	◕	●
Promotion of alternative fuels	◕	◔	◑	◑	◑	◕	◕
Private/public technology development	◔	◔	●	◕	◕	◕	◕
Develop MoU with vehicle manufacturers	◔	◔	◕	◕	◕	◕	◑
Transportation Supply Management							
Transit service expansion and enhancement	◕	◕	◔	●	◕	●	●
Improved bicycle lanes/facilities	◑	◑	◑	◕	◕	●	◔
Rail incentives	◑	◑	◔	●	◑	●	◕
HOV lanes	◑	◑	◑	◕	◕	◕	◕
Advanced technology applications	◔	◔	◑	◑	◕	◑	◔
Traffic calming	◔	◑	◔	◔	◕	◑	◔
Consumer Preference Mechanisms							
Improved education	◔	◑	◑	◕	◑	◕	◑
Advertising equity	◔	◔	◕	◑	◕	◕	◑
Consumer/user awareness initiatives	◑	◑	◕	◕	◑	●	●
Support for community/ political "champions"	◔	◔	◕	◕	◔	●	◑
Administrative Measures							
Improved data collection/dissemination	◔	◔	◑	◕	◑	◕	◔
Coordinated decision-making	◑	◔	◕	◕	◑	◕	◕

LEGEND: ◔ Low Rating (Worst) ◕ Medium-Low Rating ◑ Low-Medium Rating ● High Rating (Best)

On the basis of the broad assessment of instruments carried out for this study, it was concluded that the most promising instruments to achieve EST are as follows:

- Fuel pricing/taxation
- Tradable carbon dioxide permits, in the longer term
- Parking pricing/management
- Designated funds for transit expansion
- New CAFE standards/feebates
- Differentiated registration/insurance fees
- Consumer/user awareness initiatives
- Tax incentives for transit/rail users
- Stricter land use controls
- Employer-sponsored trip reduction programs
- Improved bicycle lanes/facilities
- Transit service coordination and fare integration

It is important to note that all instruments examined in the study were felt to have some potential. The conclusion was reached that if the EST criteria were to be achieved, virtually all of the instruments identified for consideration in this study would need to be deployed, and even then it would be very difficult to meet the targets. The only other option would be to implement one overriding economic or regulatory instrument such as fuel rationing or tradeable carbon dioxide permits to the extent that the EST targets would be met. Most experts felt that this single-handed approach would have serious economic and social implications and would not be feasible in the time frame considered by the study (40 years).

4 Implementation Considerations

The time frame within which various instruments need to be implemented is largely determined by the fact that the desired effect of the instrument must be fully achieved by the 2030 horizon.

Under current conditions, a minimum of 15–20 years would be required for total fleet replacement of automobiles, buses, and on-road freight vehicles. Working backwards from 2030, it can be assumed that all vehicles sold after 2015 would need to be ultra-low or zero-emission vehicles. In the meantime, battery-powered electric vehicles and hybrid vehicles would need to become commercially viable almost immediately, fuel cell vehicles by 2004, and high-efficiency ICE vehicles by 2007.

Typically, full replacement of non-road vehicles such as trains, ships, and airplanes requires a significant amount of time, probably 20–30 years. As a result, the replacement of these types of vehicles would need to begin early in the present decade, suggesting that significant investment in research and development would be required in the very near term.

Although 2030 seems far away, the schedule for implementing the various instruments is very short and would require a fundamental shift in government objectives. Interprovincial harmonization and cooperation between levels of government would be necessary to reach EST. Furthermore, several of the instruments would require the cooperation and the endorsement of the United States due to the closely linked economies of the two countries.

Short-term Implementation of Instruments

Examples of instruments that could be implemented almost immediately while investigation of other instruments continues:

- Progressive fuel taxation/road pricing
- Improvement to bicycle/walking facilities
- Mandatory emission inspections
- Public education and awareness

4.1 Progress and Gaps

One of the most significant contributions of the EST project is to highlight the gap between the current path of transportation policy and the path that would result in EST. At the policy level, Canada has started to make some progress in the area of EST:

- Through government initiatives, Canadians are now aware of the link between transportation activities and the environment.
- The Transportation Table of the National Climate Change Process has outlined possible strategies to reduce GHG emissions.

The Urban Transportation Indicators Survey of the Transportation Association of Canada, which reviewed initiatives for 15 urban areas in Canada, reports that "the picture that emerges is one of good intentions…but as yet, little significant impact on the bottom line performance indicators has occurred" (e.g. fuel use per capita and transit rides per capita) (Transportation Association of Canada, December 1999).

- Many municipalities in Canada are implementing policies that attempt to promote more compact, mixed-use land use and other measures to manage growth in road transportation.
- In October 2000, the federal government announced that, through an initiative called Action Plan 2000 on Climate Change, it intends to invest up to $500 million on measures to reduce GHG emissions. Combined with the $625 million for climate change-related activities for the next five years that was announced in Budget 2000, this investment results in a commitment of $1.1 billion to reduce GHG emissions in Canada. The Action Plan includes initiatives such as the Urban Transportation Showcase and the Canadian Transportation Fuel Cell Alliance and, when fully implemented, is expected to take Canada one-third of the way to achieving its target established by the Kyoto Protocol.

However, most of the initiatives to date, while having good intentions, have thus far not served to impact the bottom-line EST indicator — namely, carbon dioxide emissions. Between 1990 and 1999, carbon dioxide emissions from transportation increased by 21%. At this point, Canada is not yet headed in a direction that would result in the achievement of EST by 2030.

One of the tasks given to the EST study teams was to identify the "gap" between the path followed using instruments that are currently in use or are planned for and the path that would need to be followed to achieve EST. This involved consideration of the following:

- **Degree of Implementation** — Are there examples of the instruments, or similar initiatives, already in place?
- **Implementation Time Frame** — Could the instrument be reasonably implemented to the extent necessary in the next few years?

Selected Examples of Progress towards EST Measures

Economic and Fiscal Instruments
- Road Pricing: *Highway 407 Electronic Toll Road*
- Fuel Pricing/Taxation: *Greater Vancouver Transportation Authority Dedicated Fuel Tax*
- CO_2 Permits: *Establishment of Tradeable Permits Working Group*

Regulatory Measures
- Mandatory Emissions Inspection: *BC Air Care, Ontario's Drive Clean*

Urban Structure and TDM
- Development Controls: *Ontario's Smart Growth Initiative*
- Trip Reduction Programs: *Walking School Bus, Various University Transit Pass Programs*

Technological Development Initiatives
- Financial Incentives: *Promotion of Change Technology and Innovation Program*
- Promotion of Alternative Fuels: *Future Fuels Program, Alternative Fuels Act, 1995*
- Private/Public Technology Development: *University of British Columbia/National Research Council National Fuel Cell Research Facility*
- Memorandum of Understanding with Manufacturers: *Automotive Manufacturing Pollution Prevention Project*

Transportation Supply Management
- Transit Service Coordination/Integration: *Greater Vancouver Transportation Authority, York Region*
- Transit Expansion: *Montréal Commuter Rail, Sheppard Subway in Toronto, Ottawa Light-Rail Transit*
- Traffic Calming: *City of Victoria*

Consumer Preference Mechanisms
- Improved Education: *Environment Canada's Greenlane*
- Consumer Awareness Initiatives: *Canada Mortgage and Housing Corporation — Neighbourhood Sustainability initiatives, Natural Resources Canada's Auto$mart, Public Education and Outreach Component of the Climate Change Action Fund*
- Support for Community Champions: *Transport Canada's Showcase Program and Moving on Sustainable Transportation Program*

Administrative Measures
- Improved Data Collection: *Canadian Vehicle Survey*
- Coordinated Decision-Making: *National Climate Change Process, Transport Canada's Sustainable Development Strategy*

For more information on some of Canada's recent initiatives, see the Government of Canada Climate Change website (www.climatechange.gc.ca).

- **Feasibility** — How difficult would it be to implement the instrument in terms of political acceptance, enabling technologies, regulatory framework, economic impacts, etc.?

The gaps analysis produced the following findings regarding the most promising instruments:

Road pricing has been implemented on a few selected facilities, but to date has been designed and used primarily to finance the construction of new roads as opposed to encouraging more efficient use of the transportation system and investment in a more sustainable system.

Fuel pricing/taxation exists in Canada in the form of gasoline taxes. Traditionally, these taxes have been directed into each government's general revenue accounts as opposed to being designated for roads or transit. Recently, some provinces have made available to their largest municipalities a portion of the existing fuel tax fund for urban transportation.

At the start of this decade, coinciding with an increase in fuel prices, the Canadian public and certain industry groups called for the federal and provincial governments to reduce fuel taxes in order to reduce the price of fuel. At present, there would appear to be little political or public support for an increase in fuel taxes in the near or long term. An unprecedented policy change would be required to change this position.

Tradeable carbon dioxide permits are still a relatively unknown concept in Canada. However, a Tradeable Permits Working Group has been created by Environment Canada to manage work relating to options that would involve mandatory permit requirements for at least some sources of GHGs. In December 1998, the Working Group released a Foundation Paper/Primer outlining the way a tradeable permits system might work. Furthermore, the National Round Table on the Environment and the Economy (NRTEE) recently completed a project examining possible designs for a GHG emissions trading program for Canada with the advice from a Multi-stakeholder Expert Group.[23] In terms of actually implementing a carbon dioxide permit system for individuals, it is unlikely that this would be considered in the near or long term without a significant change in government policy.

Parking pricing/management is covered by municipal zoning bylaws, which often stipulate minimum parking standards but not maximum parking standards. This is beginning to change, however, in some urban areas. Attempts by municipalities to impose parking price increases in urban areas, or mandated parking pricing, have not been met with success. In Ontario and other provinces, Municipal Acts do not allow a municipality to collect sales taxes or user fees on property not owned by the municipality. It seems likely that parking pricing and supply management policies will shift in focus to discourage rather than promote automobile use. Significant effort will be required, however, to solidify significant public support to achieve the changes that would be required for EST.

Ottawa's light rail transit pilot

Designated funds for transit expansion and enhancement are being considered in some urban areas in Canada, particularly those that have managed to obtain a portion of existing fuel taxes for transportation improvements, including transit expansion (e.g., Vancouver, Edmonton, Calgary, Montréal). For the most part, however, transit is not being expanded at a rate that is sufficient to cause a significant reduction in automobile use, particularly in suburban areas.

New CAFE standards/feebates are not anticipated to be implemented in the near future. Given that CAFE standards are set by the United States, it is unclear at the moment as to how Canada will proceed to tighten new vehicle fuel efficiency standards. There are a variety of options that could be pursued, such as implementing a voluntary fuel efficiency labelling program or tightening of the voluntary company average fuel consumption (CAFC) standards.

Differentiated registration/insurance fees, whereby registration fees and insurance fees are added to the price of fuel and therefore dependent on the amount of fuel consumed, as proposed for the EST scenario, have not been considered formally and are unlikely to occur under the BAU scenario.

Consumer awareness initiatives exist on a fairly widespread basis in Canada, but are largely up to the consumer to inquire about. For example, Natural Resources Canada has developed the Auto$mart Program to provide Canadian motorists with helpful tips on buying, driving, and maintaining their vehicles in ways that will reduce fuel consumption. Also, EnerGuide, which has helped consumers to consider energy consumption and cost when shopping for household appliances, is now available for vehicles.

Tax incentives for transit users have been considered in Canada but not accepted. The concept of tax-exempt employer-provided transit passes was one of the measures looked at by the Transportation Table of the National Climate Change Process and as a result has a status of "being considered." In fact, in April 1999, Motion #360 received resounding support in the House of Commons, as the vote carried 241 to 25. This motion encourages the federal government to consider making employer-provided transit passes an income tax-exempt benefit. As yet, there has been no action taken on this motion, but the gap between the BAU and EST scenarios with respect to this instrument would seem to be small in comparison with that for other instruments.

Stricter land use controls and the need for integrated transportation and land use planning have received much attention in most urban areas, but with little action taking place. A recent survey carried out for the Transportation Association of Canada found that most urban areas have adopted policies on limiting urban development boundaries and promoting mixed-use nodal development.[24] In practice, urban boundaries and urban sprawl appear to be proliferating in most areas. Significantly greater enforcement will be required to achieve the types of land use control required for EST.

Employer-sponsored trip reduction programs have existed for some time in various forms. Most have been developed out of a need to reduce employee trips (e.g., due to a lack of parking). Mixed results have been achieved, and significantly more effort is needed for this measure to affect demand significantly.

Improved bicycle lanes have been implemented in most urban areas within the QWC, but as yet are generally not constructed to operate separately from automobile traffic. In most cases, bicycle lanes are on-street facilities shared with other vehicles. Significantly more effort to develop safe and efficient bicycle facilities, while reducing the supply of automobile capacity, would be required for EST.

Transit service coordination/fare integration is seen as a cost-effective way to improve transit ridership and cost recovery levels. Several successes have been achieved in cities within the QWC and elsewhere, but significantly more work is required.

4.2 Roles and Responsibilities

It is not the purpose of a conceptual study such as this one to assign roles and responsibilities. It is worthwhile, however, to identify the current role of each level of government as it relates to the sustainable transportation agenda. Table 8 lists current federal, provincial, and municipal responsibilities pertaining to transportation in Canada.

It is anticipated that the federal government will need to initially take the lead role towards initiating any major changes related to sustainable transportation. It will need to present a clear message that Canada is willing to commit to sustainable transportation. The federal government will not be able to act alone, however, and will require the support of the provinces and the municipalities to put in place measures at the local level.

Table 8 Federal, Provincial, and Municipal Jurisdiction Pertaining to Transportation

Area of Jurisdiction	Federal	Provincial	Regional/ Municipal [25]
General	All interprovincial and international transportation, including almost all aviation and most marine and interprovincial surface transport	Most intraprovincial transportation	Varies according to the level of delegation provided by the provinces
Transportation Infrastructure	Providing and maintaining infrastructure for the above	Providing and maintaining infrastructure for the above, including all aspects of highway facilities except on federally owned lands and interprovincial and international bridges	Local roads, sidewalks, cycling paths, and infrastructure
Transportation Policy, Regulation, Standards, Programs, etc.	Regulating emissions, fuel efficiency, and safety standards for new vehicles Monitoring and evaluating performance against national air quality standards, including health effects and impacts on ecosystems Greening of federal fleets	Regulating in-use vehicles, such as licensing of vehicles and inspection and maintenance Public transit funding with delegation of operation to municipalities Greening of provincial fleets	Traffic demand management initiatives (HOV, parking policies, etc.) Public transit operation Greening of municipal fleets
Finance	Taxing fuels and vehicle purchases	Taxing fuel and vehicle purchases, road tolls	Road tolls, residential and commercial property taxes, local improvement taxes, etc.
Land	Federally owned land	Land use planning policies	Local land development and land use planning, zoning, construction permits
Education	National public education and awareness programs	Provincial public education and awareness programs	Local public education and awareness programs
Research and Development	Technology development programs	Technology development programs	Testing of new technologies for mass transit
International	International protocols, agreements		

5 Social and Economic Implications of EST

The concept of sustainable transportation implies that changes in transportation patterns to reduce environmental stresses also contribute to the general well-being of the individual and society at large. Although the OECD EST study focuses primarily on environmental sustainability, OECD experts felt that it was important to provide a preliminary qualitative assessment of potential social and economic impacts from both a BAU growth and an EST scenario. The social and economic implications assessments also helped to guide the development of instrument packages, in particular the balance between activity reduction measures and technology measures.

This chapter provides a summary of the assessment of social and economic implications.

5.1 Social Implications

In most societies, mobility is highly valued by individuals for both social and economic reasons. Increased mobility has generally been perceived as a "good thing." It has allowed individuals to experience greater freedom of movement, to enjoy products that come from distant locations, and to interact with people from around the globe.

Professor John Adams,[26] an expert from University College in London, was tasked to prepare a paper assessing the social implications of continuing on the current path (BAU scenario) compared with a more environmentally sustainable path (EST scenario). For the purpose of the OECD project, participating countries were asked to respond to a questionnaire prepared by Professor Adams. A summary of the Canadian assessment of potential social impacts is in this report.

Eight factors that provide indications of how the social fabric may be affected by changes in our mobility patterns were identified by Professor Adams. These eight factors are listed below, along with a brief discussion of how they might apply to the situation in the QWC.

- **Material wealth:** It is expected that under the BAU scenario, there will be a continuation of the close correlation between gross domestic product (GDP) and the movement of people and goods. Under the EST scenario, this close correlation may not exist. As this is uncharted territory, it is uncertain what the impacts on material wealth would be. However, many experts agree that it is likely that, under the EST scenario, there would be slower growth of the GDP. As GDP is not always perceived as a good indicator of well-being,[27] the social consequences of potentially slower growth in GDP is difficult to assess.
- **Social polarization:** Under current trends, people without access to cars can suffer from decreased access to social and economic opportunities. Changes in transportation system characteristics *may* contribute to or exacerbate poverty to the extent that they could 1) impede some people from looking for or holding jobs; 2) impede some people from acquiring the education or skills needed to earn enough income to support themselves or their families; 3) force people with limited incomes to spend more money to buy and maintain an automobile than they would spend to travel by transit, cycling, or walking, thereby leaving them less to spend for other necessities (e.g., housing, clothing, food) or discretionary goods; and 4) force people to pay more for goods in local stores than they would have to pay in more distant stores (e.g., supermarkets, discount warehouses) because they have no way to get to the latter. There is virtually no information on the trade-offs that poorer people make to survive in automobile-dominated societies, so there is no way of estimating what the long-term social costs and the related economic costs of BAU will actually be. Whereas it can be speculated that social polarization will increase as land use becomes more dispersed under BAU, these disparities would likely not be so pronounced under the EST scenario.
- **Land use:** The BAU trend towards urban sprawl is expected to continue, fuelling the need for the use of cars and trucks for mobility. There continue to be economic and political pressures on governments to maintain or strengthen policies that directly or indirectly promote sprawl. Examples include pressures to encourage new home building as a way to maintain a strong construction industry, especially during periods of economic slowdown, and pressures to support the automobile industry, which is an important part of the economy of the QWC. To the extent that land use patterns under an EST scenario make public transit more viable and walking and cycling more possible, more compact land uses with multipurpose housing should level the playing field for people with and without cars. For example, people without cars would have levels of access to employment opportunities similar to those for people with cars. Less sprawl also means the maintenance of more agricultural, forest, and wildlife areas.
- **Community relationships:** The general premise proposed by John Adams is that cars and the resulting dispersed land use patterns under the BAU diminish street life and make society more anonymous. The EST scenario provides more opportunities for face-to-face interaction. As such, it can promote street life and increase neighbourhood activity, such as local shops and cafés. However, increased use of electronic communications technology could have a negative impact on community life, although

this is open to debate. Electronic mobility may create new community structures that are widely dispersed, resulting in more travel for social and recreational purposes.

- **Cultural diversity:** Communications technology and global mobility tend to reduce cultural diversity. As cities become more like each other and more unpleasant to be in because of automobile pollution, congestion, noise, etc., fewer people may want to visit them (i.e., international tourist travel may decline). It is possible, then, that global homogenization will have a self-limiting effect on travel. Alternatively, tourists may tend to seek out the more remote, less urbanized places, where cultural differences are likely to survive longer and the environment remains relatively more pleasant. The EST scenario may preserve cultural diversity if there is less travel and interaction between people in different parts of the world. However, John Adams cautions that "EST is likely to be a weak restraint on this process [of culture homogenization] if the growth in electronic mobility continues."

- **Health and safety:** The health and safety impacts of road transportation are very significant, as road transportation contributes to collisions, lack of exercise, and pollution-related health problems. In Canada, approximately 3000 people are killed and 230 000 people injured in motor vehicle accidents annually.[28] Recent research has also shown that two-thirds of Canadians are not physically active enough to meet the guidelines in Canada's Physical Activity Guide. There is also increased evidence that transportation-related pollution is causing or aggravating respiratory diseases. There is a general consensus that health and safety would improve in all areas under the EST scenario.[29]

- **Crime and law enforcement:** In John Adams' study, which is based on data from the United Kingdom, it was found that the rise in car ownership was closely correlated with a rise in crime. It is suspected that the car culture is contributing to the disintegration of the social fabric, which, in turn, results in a society that is less self-policing. To our knowledge, no such studies have been conducted in Canada. Although long-term trends in Canada show a substantial increase in crime rates since the 1960s (from approximately 2700 per 100 000 to more than 8000 per 100 000 today), it is impossible to say whether this is due to the strengthening of the car culture or related to the disintegration of the social fabric.

  What can be said, though, is that crime related to motor vehicles[30] has increased in Canada, particularly in the province of Quebec, over the last decade. Between 1988 and 1992, the rate of vehicles stolen increased from 5.5 per 1000 registered motor vehicles to 8.4, an increase of over 50%.[31] Losses from motor vehicle thefts amount to $500 million annually in Canada. More research would need to be conducted to draw any conclusions on the link between criminal activity and transportation in the Canadian context.

- **The functioning of government:** John Adams contends that as travel becomes faster, cheaper, and easier under BAU, three phenomena could happen: 1) there could be more bureaucratic deterrents to travel to limit mass migration from poorer countries;

Traffic jam in Toronto

2) to avoid the increasing number of people crossing traditional political boundaries, political authority may become more remote from the citizen, and power may tend to concentrate at a higher level to avoid becoming impotent; and 3) as the scale of government increases and issues become more complex to manage, representative democracy may break down; either the number of representatives becomes unmanageable and the limits of the Athenian model are reached again — i.e., the forum for debate becomes overcrowded — or the number of voters per representative reaches a level that renders the individual voter insignificant.

However, in North America, countering the tendency to larger government, there is a tendency for people to form new political groups and find new means of political expression (e.g., "social movements") to make their views known to governments. Moreover, the widespread use of public opinion polls, and their apparent influence on government decision-making, may be making the cumulated voices of individuals more, rather than less, influential. The impact of EST on the functioning of government is difficult to determine. One clear realization is that elected officials will have to exercise considerably more leadership in the face of conflicting demands than they do today if major progress towards EST is to be made.

Example of a compact neighbourhood

In this preliminary assessment, it is possible to envision that a BAU scenario could place a significant burden on the social fabric and quality of life of Canadians. On the other hand, an EST scenario could bring more conviviality, closer community relationships, healthier lifestyles, and less social polarization and could maintain or enhance cultural diversity. While individual mobility may be construed as a symbol of freedom and liberty, unchecked growth in our current mobility patterns may very well result in a general loss of quality of life and a real inability to experience the freedom and liberty of movement we wish for. The image of a driver in a single-occupancy vehicle stuck in the middle of a traffic jam is illustrative of this potential contradiction. It may be that in the future, under an EST scenario, the freedom of movement is no longer embodied

in a car but rather in what we could call "transport freedom" (i.e., the ability to meet most of our needs without having to depend on a car to do so).

5.2 Economic Implications

As with the social impact assessment, this section aims at providing preliminary indications of the economic impact of both maintaining the current course and moving towards sustainable transportation. Assessing the economic impacts of EST is clearly one of the most difficult and uncertain aspects of the EST project. Even with the most sophisticated models and approaches, the assessment of the economic implications of the EST scenario and the BAU scenario is extremely complex. The EST scenario is an "uncharted territory." Part of the difficulty resides in the fact that the 2030 time horizon is far ahead and can hardly be predicted with accuracy. Another difficulty is the fact that EST would entail considerable changes; most conventional economic assessment methods usually deal with marginal changes.

5.2.1 Background and Previous Research

Several points are worth considering in regard to assessing the economic implications of the BAU and EST scenarios.

- There is a direct link between transportation and the economy. In Canada, transportation services and infrastructure account for 16% of the GDP.[32] There is a need to begin to de-couple transportation from economic growth. That is, economic growth must be able to take place without a corresponding growth in transport activity. The degree to which the Canadian economy continues to depend on the exploitation of primary resources, most of which are dependent on heavy transport, is an important consideration. While it is likely that knowledge-based industries will grow, it is reasonable to assume that primary resources will remain an important aspect of the Canadian economy.
- The automobile manufacturing industry fuels much of the economy in the QWC. In Canada, transport equipment, mainly automobiles and automobile parts, accounts for 22% of all manufactured goods.[33] Most of the automobile-related industries and jobs are located in the QWC. On the other hand, there are questions about the future employment prospects for the car industry that are unrelated to the sustainable transportation agenda. A recent study conducted in Germany showed that the robotization and the globalization of production, as well as the just-in-time assembly process, have resulted in a long-term trend of job losses in this industry.[34] To the extent that Canada follows this trend, it is important to assess production issues for their impact on the QWC economy.
- Recent trends towards a globalized economy have resulted in greater transportation and mobility needs. It is unlikely that a single country would be able to attain EST and remain economically competitive unless other industrialized nations also followed suit. This is particularly true with Canada and the United States, wherein trade and transportation sectors are highly linked.

In the literature to date, there have been many opinions expressed on the economic implications of climate change mitigation measures, but no consensus has been reached. In general, there is some agreement that economic benefits will be derived from energy efficiency gains if instruments to achieve sustainable transportation are put in place.[35]

With regard to economic competitiveness, a recent report commissioned by the Government of Canada concluded that "reducing CO_2 emissions will impose short to medium term transition costs on the Canadian economy." The study looked at a scenario of a GHG reduction of 6% and noted that after 10–15 years (post-2013), the Canadian economy is expected to produce about the same level of output, albeit at a reduced level of carbon dioxide emissions, as it would have under BAU conditions.[36] The study recognized, but did not address, the issue of benefits associated with climate change mitigation, which could be significant depending on the extent to which climate change mitigation measures could circumvent the occurrence of massive environmental disruptions. It must be noted that the EST study is concerned with a reduction of GHGs by 80% — a large difference in the scenario and quite possibly in economic impact.

5.2.2 Approaches to the Economic Assessment of EST

There are many possible methodologies that could be used to assess the economic impacts of EST in the QWC. Canada decided to conduct two independent economic impact assessments using separate approaches. The first assessment used an approach that followed the guidelines recommended to the OECD country teams and consisted of "simplified cybernetic modelling" or the "Impact Path Approach" (IPA). This work was carried out by Dr. Richard Laferrière of the Transport Research Centre at the University of Montreal and is documented in a separate report.[37] Recognizing the uncertainties in assessing the economic impacts of EST, a second assessment was conducted using a distinctly different approach, referred to as the "Surplus Value Model" (SVM). The second assessment was carried out by Professor David Nowlan of the University of Toronto and is also documented separately.[38]

The IPA and SVM are two distinctly different approaches. The IPA is based on a traditional input–output model that establishes the relationship between GDP and demand in passenger and freight sectors and then calculates GDP with BAU and EST demand. The SVM approach is based on the principles of cost–benefit analysis, as commonly used in evaluating the economic merits of a project or a policy proposal. In basic terms, the SVM approach essentially attempts to establish what the government would have to pay out to people (or take back, in the case of benefits incurred) to make them as well off under EST as under the BAU scenario. Alternatively, this can be stated as the amount that individuals would be willing to pay to keep from switching to EST. Each approach clearly has certain limitations, but both are valid attempts at trying to model the impacts of EST on the economy.

Table 9 provides a brief overview and comparison of the two approaches applied in the EST study. Perhaps the biggest attraction to the IPA is that it is based on an input–output model that has been around for some time and tested in different situations. On the other hand, input–output models are not typically used to examine changes as large as that required under EST. The most attractive feature of the SVM is that it is completely transparent and all assumptions are clearly discernible. The biggest gap in the SVM is the uncertainty regarding long-term elasticities for the various sectors. Another limitation is that it does not consider the impacts of EST on non-transport market sectors, which may be either positive or negative.

The range in the results is somewhat surprising. One model (IPA) suggests that the impacts of EST will be almost negligible (0.4% reduction in GDP in 2030), while the other model (SVM) suggests that the consequences will be similar to a significant recession (5% reduction in GDP in 2030). These results, however, must not be taken outside of the context of the models. For example, the IPA assumes that the changes in demand would occur in the QWC only. If an industry is not represented in the QWC economy, it would not be affected by EST. The IPA also assumes that any new investment is a benefit to the economy, whereas the cost–benefit analysis does not make the same assumption; in fact, new investment required is a cost or dis-benefit.

One of the most significant limitations of both approaches is that they do not attempt to estimate the economic benefits of reducing ground-level air pollution, which has significant health impacts,[39] or climate change, which may ultimately have catastrophic consequences.

A final point about the models is that the economic "indicators" used in both cases were GDP and industrial output. There was no attempt to use alternative measures of social and economic well-being that are currently under development.[40] GDP is based on the assumption that *more is better*, ignoring the fact that things such as increased road congestion, noise, and land consumption due to roads and parking have significant cost impacts. These changes in welfare are more difficult to measure but are nevertheless important tools to capture the new benefits from this scenario.

5.2.3 What Other Countries Had to Say

Each project team carried out an assessment of the economic implications of their EST scenarios. As reported in the OECD's synthesis report, "The general conclusion from this work was that on average the overall economic effects on the national economies from proceeding towards EST rather than BAU would be slight — in terms of changes in significant indictors such as Gross Domestic Product and employment rates — although there was some variation in the results obtained." [41]

The OECD also estimated the external costs of transport, which were not considered in the basic economic analysis. External costs include such factors as noise, accidents, climate change, air pollution, and upstream processes. Not surprisingly, external costs under the EST scenario are far lower than under the BAU scenario, about one-third.

Table 9 Comparison of IPA and SVM Approaches

	Impact Path Approach (IPA) (Input–Output Model)	Surplus Value Model (SVM)
Primary Use	Analyzing short-run market adjustments.	Cost–benefit assessments.
Basic Approach	Establishes relationship between GDP and demand in passenger and freight sectors and then calculates GDP with BAU and EST demand.	Uses demand curves (price elasticity) to describe how consumers will react to market changes.
Primary Advantages	Considers impacts on all sectors of the economy. Direct calculation of GDP impacts. Based on existing Statistics Canada model.	Makes it easy to identify winners and losers under EST. Highly transparent approach. Possible to optimize carbon dioxide reduction allocations by mode.
Limitations	Assumes constant relative prices and technical coefficients for input–output model (e.g., economies of scale are ignored). Assumes new investment is a benefit to the economy, regardless of employment supply. Typically used to examine small-scale projects. Does not examine non-market benefits and ancillary benefits such as improved health.	Long-run elasticities are difficult to estimate. Approach is untested at macroeconomic level. Does not look at impacts on non-transport markets. Does not examine non-market benefits and ancillary benefits such as improved health.
Projected Impacts of EST Scenario on GDP	**0.4% lower than BAU in 2030** [a]	**5% lower than BAU in 2030** [b]

[a] The economic impact estimates obtained with the IPA analysis should be interpreted as upper-bound estimates. In other words, it is very likely that a method that accounts for long-term reactions from consumers and producers would yield lesser negative impact. In addition, the preliminary macroeconomic assessment outlined in the Laferrière report suggests that the net impact of induced efficiency improvements could essentially cancel out the projected production growth rate losses of EST compared with the BAU scenario.

[b] It is estimated that this figure could be reduced if environmental taxes (e.g., tolls) are used to replace other taxes that have costly distortions.

6 Conclusions

6.1 Moving Towards EST

This report has highlighted the fact that current transportation trends are not sustainable. Continuing with a BAU approach has significant environmental risks and would likely involve an undesirable future.

Conversely, the pursuit of EST has tremendous potential to enhance quality of life for current and future generations by making transportation systems more efficient and urban environments more attractive, liveable, and vibrant.

Work must start now if the goals and targets of EST are to be achieved in the next 30 years.

This EST study identified a number of policy instruments that could help move towards EST. The most promising types of policy instruments are summarized in general terms below:

- **Increasing the variable costs of unsustainable modes:** Regardless of the instrument, increasing the cost of unsustainable modes to account for external costs is a fundamental prerequisite for change, both for the development and adoption of new technology and to influence travel behaviour. In the context of this study, both road pricing and increasing fuel prices are seen as essential elements, provided revenues are put back into providing new and improved infrastructure for alternative modes. Parking pricing and management are also key policy tools.
- **Carbon dioxide emissions trading:** This instrument has the potential to significantly reduce emissions and to dramatically alter the way people travel. Even though it is now difficult to conceptualize how it could be successfully implemented within the transportation sector, it would probably create one of the best incentives for the development of new technology and for shifting travel towards more efficient modes. More research should be conducted on this potential instrument.
- **Restructuring land use into more efficient forms:** Restructuring land use into more compact, mixed-use communities will be one of the most difficult features of EST to achieve. This is partially due to the fact that changes to land use require a long time to occur, and also because of society's current aspirations for more space. Several instruments have the potential to change land use, including restructured taxation (e.g., higher taxes in outer areas) and stricter development controls. A preferable approach would be to encourage more efficient urban structure land use by improving the attractiveness of urban areas (e.g., by providing high-quality affordable transit systems).
- **Refocus from roads to sustainable infrastructure:** If people are to reduce their use of cars and road freight, viable alternatives must be available. As a result, measures to replace some of the existing road capacity with exclusive transit and non-motorized facilities and improved transit service and coverage will be required to cause a

significant change in mode choice. Several instruments are available for changing the focus of infrastructure development. In the short term, increasing the person capacity of existing roads through the use of HOV lanes is a worthwhile initiative. In the longer term, replacement of roads with bicycle and pedestrian facilities would cause significant changes in travel choices. Through the transition period towards EST, transit expansion would be prominent.

- **Financial incentives:** Some use of financial incentives is likely necessary to achieve some of the features of the EST scenario, particularly those related to technology development. It is not expected that government will simply pay people to use other modes. However, some specific initiatives that deserve consideration are tax benefits for transit users, credits for stock turnover, funding for demonstration projects, and reduced registration/user fees for sustainable modes.
- **Other TDM measures:** There are a host of very attractive measures to encourage modal shifts and reduced travel demand. These include measures such as car sharing, replacement of work trips through telecommuting,[42] tax incentives for transit users, and traffic calming. All of these will be important in moving towards sustainable transportation. For the most part, many of the TDM measures could be implemented with minimal costs and significant economic and societal benefits. TDM may be the first realistic step that can contribute to changing travel behaviour.
- **Public education:** On its own, public education is likely to achieve very little. However, proper public education is required for nearly all of the other measures to succeed. Ultimately, changes will need to be brought forth by public demand, rather than being implemented from the top down.

6.2 Key Messages

The EST study was instrumental in challenging people involved in the study to reconsider how current policies would need to be changed if EST were to be achieved. Some of the key messages that emerged from this study are highlighted below:

- **Canada differs from other countries:** Canada is different from most other countries participating in this study in many ways. Physically, Canada is larger, less populated, and more dispersed than European countries and, as a result, is highly dependent on road and heavy truck transportation. Within the QWC urban areas, there is existing transit and pedestrian infrastructure, but the use of transit and non-motorized transportation is less and, in certain weather conditions, less practical in our society than in many European cities. Another difference between Canada and some other

countries is that there are three levels of government having jurisdiction over some aspect of both transportation and the environment. Many of the instruments would have to be implemented nationally, as the QWC extends through two provinces. EST implementation would also require federal, interprovincial, and municipal collaboration and negotiations.

- **Action must begin immediately:** The first step in moving towards EST will be to reverse current trends, which are moving away from rather than towards EST. Based on the initial timeline developed as part of this study, it is difficult to imagine how all instruments could be assessed, be implemented, and have the desired impacts within the required time frame (e.g., by 2030). Many of the changes required to move towards EST involve adoption of a sustainable development approach to land use practices. It would represent a commitment to changes that need to be in place over many years before results become significant. Given the importance of the changes required, critical decisions would need to be made now to have any significant impact by 2030.

- **A balanced approach is required:** The analogy to "sticks" and "carrots" has often been used to characterize the regulatory instruments and economic or other *incentives* that are used to change travel behaviour. There is no question that some use of "sticks" will be required, at least in the short term, to achieve EST. The current political climate is not favourable to regulatory approaches. Although voluntary approaches are important to a comprehensive action plan, voluntary approaches have not proven to be effective in reducing emissions substantially. It is unlikely that, used alone, voluntary measures would lead to EST.

- **Technological progress is as important as activity changes:** Among many experts, there is sound scepticism about the ability of technology to allow us to achieve sustainable transportation. Many view technology as the primary reason why we moved away from sustainability in the first place. However, one cannot discount the possibility that in the future, unanticipated technology development may play a critical role in helping us "leap frog" towards sustainability in the transportation sector. In such a case, the changes required in travel behaviour may be less significant or may become more acceptable than what is currently anticipated under the EST scenarios.

- **Non-transportation sectors must also become more sustainable:** It is unlikely that significant progress towards sustainable transportation could be achieved without significant changes in the society at large. Sustainability of the transportation sector implies that other sectors are moving towards sustainability as well and vice versa. Despite the dramatic changes required to implement EST, these changes are likely to be much less dramatic if other sectors, such as the energy, industry, or agriculture sector, are moving in the same direction.

- **Transportation demands are linked to general consumption patterns:** One could argue that there is a deeper link between why, when, and how people travel and general environmental degradation. For instance, it is not only the location of "megastores"

outside the urban core that may be cause for concern, but their very existence. EST may simply not be achievable unless current consumption patterns are challenged.

- **Innovation can occur without regulatory measures:** Experts involved in this study were generally of the belief that given the right incentives, individuals will find ways of achieving some of the features of EST, regardless of public policy. A conference on Moving the Economy (held in Toronto in 1998) brought together a number of individuals who have demonstrated that there are ways individuals can benefit economically from improved sustainability.
- **Changes would need to be radical:** In order to achieve the EST criteria developed for this study within the specified time frame (2030), changes could not simply be incremental. A whole new way of looking at transportation is required. One important barrier is the fact that billions of dollars have been invested to develop the current transportation infrastructure (roads and fuel). While EST would require important capital resources to succeed, there is currently pressure to reinvest in the existing infrastructure to maintain it and improve it due to social (safety, connectedness) and economic (competitiveness, trade) considerations.
- **International cooperation is essential:** It is highly unlikely that Canada, or the QWC for that matter, would be able to achieve EST without other nations following suit. Harmonization of EST policies between the United States and Canada would be particularly important, considering the strong integration of both economies and the automotive industry.
- **Equity must be maintained:** If EST is to be achieved, it should be done by not burdening any particular geographic area or sector or class of society. Despite this, it is reasonable to suggest that measures should be implemented initially in areas where they would have the greatest impact — namely, urban areas.
- **Improvements in efficiency may benefit the economy:** The economic impacts of EST are difficult to predict, although preliminary analysis suggests that there may be a reduction in the traditional measure of economic performance: gross industry output. What this does not take into account are the induced efficiency improvements that would likely occur along with EST, as well as the potential economic benefits from reduced pollution and global warming.

Perhaps what has been made most clear as a result of this exercise is that achieving EST would require an enormous and coordinated effort on behalf of all members of society, nationally and internationally. Moreover, the changes would have to start immediately in order to take effect by the horizon year 2030. To achieve any significant changes, the public would need to be made aware that there is significant cause for concern regarding environmental issues and global warming. Thus, public education and awareness initiatives would seem the obvious immediate step in the road towards EST.

6.3 Guidelines for EST

Based on the knowledge gained from the analysis of EST, study teams worked together to develop a set of draft guidelines as a basis for developing a feasible and viable strategy towards sustainable development and for future-oriented policy-making and practice in the transport sector. These guidelines, listed below, will assist Canada in its ongoing efforts to promote a more sustainable transportation system.

Guideline 1	**Develop a long-term vision of a desirable transport future** that is sustainable for the environment and for health and provides the benefits of mobility and access.
Guideline 2	**Assess long-term transport trends, considering all aspects of transport**, their health and environmental impacts, and the economic and social implications of continuing with "business as usual."
Guideline 3	**Define health and environmental quality objectives** based on health and environmental criteria, standards, and sustainability requirements.
Guideline 4	**Set quantified, sector-specific targets** derived from the environmental and health quality objectives, and set target dates and milestones.
Guideline 5	**Identify strategies to achieve EST** and combinations of measures to ensure technological enhancement and changes in transport activity.
Guideline 6	**Assess the social and economic implications of the vision,** and ensure that they are consistent with social and economic sustainability.
Guideline 7	**Construct packages of measures and instruments** for reaching the milestones and targets of EST. Highlight "win–win" strategies incorporating, in particular, technology policy, infrastructure investment, pricing, transport demand and traffic management, improvement of public transport, and encouragement of walking and cycling; capture synergies (e.g., those contributing to improved road safety) and avoid counteracting effects among instruments.
Guideline 8	**Develop an implementation plan** that involves the well-phased application of packages of instruments capable of achieving EST, taking into account local, regional, and national circumstances. Set a clear timetable and assign responsibilities for implementation. Assess whether proposed policies, plans, and programs contribute to or counteract EST in transport and associated sectors using tools such as strategic environmental assessment.
Guideline 9	**Set provisions for monitoring implementation and for public reporting on the EST strategy** using consistent, well-defined sustainable transport indicators to communicate the results; ensure follow-up action to adapt the strategy according to inputs received
Guideline 10	**Build broad support and cooperation for implementing EST**; involve concerned parties, ensure their active support and commitment, and enable broad public participation; raise public awareness and provide education programs. Ensure that all actions are consistent with global responsibility for sustainable development.

ENDNOTES

1 Environment Canada, *National Environmental Indicator Series, Canadian Passenger Transportation*, State of the Environment Bulletin No. 98-5.

2 Ibid. Includes all urban and intercity travel. Air travel includes international travel.

3 The complete results of the development of the BAU and EST scenarios for the QWC are documented in an Annex to the OECD report entitled *Report on Phase II of the OECD EST Project*, September 1998.

4 The complete results of the identification of policy instruments and assessment of social and economic implications are documented in a report to Environment Canada entitled *OECD Environmentally Sustainable Transportation (EST) Study — Quebec City–Windsor Corridor, Final Report on Phase 3*, prepared by IBI Group, June 2000. A summary for all countries can be found in the OECD's report on Phase 3 entitled *Project on Environmentally Sustainable Transportation (EST), Report on Phase 3: Policy Instruments for Achieving EST*, 2002.

5 Environmentally Sustainable Transport, *Guidelines for Environmentally Sustainable Transport (EST)*, presented to and endorsed at the International EST Conference held from 4 to 6 October 2000 in Vienna, Austria.

6 Intergovernmental Panel on Climate Change, *Second Assessment Report*, page xi, 1996.

7 OECD, *Environmental Criteria for Sustainable Transport*, Organisation for Economic Co-operation and Development, Paris, 1996.

8 World Health Organization, Air Quality Guidelines, 1998.

9 Ibid.

10 *Scenarios for Environmentally Sustainable Transport*, Report on Phase 2 of a Project on Environmentally Sustainable Transport, PPCG Task Force on Transport, OECD, Paris, September 1997.

11 Passenger-kilometres of travel (PKT) is a standard unit for measuring travel that takes into account both the number of people travelling and the distance travelled. For example, 200 passenger-kilometres of travel is equivalent to 10 people each travelling 20 kilometres or to 1 person travelling 200 kilometres.

12 Based on for-hire truck tonne-kilometre as reported on Transport Canada's T-Facts website.

13 Environment Canada, *National Environmental Indicator Series*, Acid Rain, State of the Environment Bulletin No. 99-3.

14 Environment Canada, *Trends in Canada's Greenhouse Gas Emissions, 1990–1995*, April 1997.

15 Natural Resources Canada, *Canada's Energy Outlook, 1996–2020*, 1997.

16 The terminology used by OECD to describe this scenario is "Capacity Constrain Scenario," which does not include the potential benefits derived from modifying or reorganizing the demand for transportation activities.

17 The exact term used by the OECD was the "Optimum Combination Scenario."

18 National Round Table on the Environment and the Economy, *Backgrounder: Greenhouse Gas Emissions from Urban Transportation*, prepared by IBI Group and Management of Technology Services, November 1998.

19 For a more detailed analysis of the impacts of individual policy instruments, refer to Environment Canada's report, *OECD Environmentally Sustainable Transportation (EST) Study — Quebec City–Windsor Corridor*, Final Report on Phase 2, prepared by IBI Group, March 1998.

20 John Pucher and Lewis Dijkstra, "Making Walking and Cycling Safer: Lessons from Europe," *Transportation Quarterly*, Vol. 54, No. 3, summer 2000.

21 Included the NRTEE's *Backgrounder: Greenhouse Gas Emissions from Urban Transportation* (see endnote 18). Preliminary reports prepared for the Transportation Table of the National Climate Change Process were also used.

22 A. Lovins, L. Hunter, and P. Hawken, *A Roadmap for Natural Capitalism*, Harvard Business Review, 1999.

23 NRTEE, *Canada's Options for a Domestic Greenhouse Gas Emissions Trading Program*, 1999.

24 Transportation Association of Canada, *Transportation Urban Indicators Survey #2*, prepared by IBI Group, 1999.

25 Municipalities' responsibilities vary depending on the degree of delegation by provincial governments. Larger municipalities generally have more scope for action than smaller municipalities.

26 John Adams, *The Social Implications of Hypermobility: Speculations about the Social Consequences of the OECD Scenarios for EST and BAU*.

27 In recent years, there has been abundant literature critiquing the use of the GDP indicators as a measure of progress and well-being. These have noted that, for example, car accidents, major environmental disasters such as oil spills, treatment of cancer patients, and divorces all generate economic activities that impact positively on the GDP.

28 Transport Canada, Canadian Motor Vehicle Traffic Collision Statistics, 2000 (T-Facts website)

29 A recent survey conducted on behalf of "Go for Green" and Health Canada, 1998 *National Survey on Active Transportation*, indicates that a majority of Canadians would like to increase their participation in walking (86%) and cycling (66%). A majority of respondents (53%) indicated that cycling is dangerous because of traffic. A large majority of respondents (82%) supported increased government spending on bike lanes, and 70% indicated that they would cycle 30 minutes to work if such lanes were available.

30 These include stolen motor vehicles and theft of property from motor vehicles.

31 Statistics Canada, *Canadian Social Trends*, Autumn 1994.

32 National Round Table on the Environment and the Economy, *State of the Debate on the Environment and Economy: The Road to Sustainable Transportation in Canada*, 1997.

33 Statistics Canada, *Canada's Yearbook*, 1997.

34 Frank Ebiner *et al*., *Chief Benefits for the Future, New Jobs Created with Environmentally-Compatible Traffic*, Institute for Applied Ecology, May 1998.

35 Intergovernmental Panel on Climate Change (IPCC), Climate Change 1995, *Economic and Social Dimensions of Climate Change*, Contribution of Working Group III to the Secondary Assessment Report of the IPCC, 1995.

36 Standard and Poor's DRI, *Impacts on Canadian Competitiveness of International Climate Change Mitigation: Phase II*, prepared for Environment Canada, Natural Resources Canada, Industry Canada, Department of Finance, and Department of Foreign Affairs and International Trade, November 1997.

37 Richard Laferrière, *Economic Assessment of the OECD Environmentally Sustainable Transportation Study in the Quebec City–Windsor Corridor*, January 2000.

38 David Nowlan, A Surplus Value Model for Estimating the Economic Impact of Achieving Environmentally Sustainable Transportation in the Quebec City–Windsor Corridor, May 2000.

39 A recent study by the City of Toronto Public Health Department entitled *Air Pollution Burden of Illness in Toronto* estimates the number of deaths due to smog in Toronto alone at 1000 per year.

40 For example, Genuine Progress Indicators accounts are a way of reporting to citizens on the condition, costs, and benefits associated with the total wealth or capital assets of a nation or community in order to achieve sustained well-being.

41 OECD, *Environmentally Sustainable Transport, Futures, Strategies and Best Practices, Synthesis Report*, presented on the occasion of the International EST Conference held from 4 to 6 October 2000 in Vienna, Austria.

42 One caveat needs to be made regarding tele-working or telecommuting. Many experts are enthusiastic about the possibility of information technology to reduce travel demand. However, others feel that this measure requires further investigation to ensure that its implementation does not result in a "rebound effect." This effect would occur, for instance, if by implementing telecommuting, people found it more appealing to reside further away from their work because they no longer have to drive daily on congested roads. This could ultimately result in more kilometres travelled rather than less.

NOTES

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