

# **OECD Proceedings**

## **TOWARDS SUSTAINABLE TRANSPORTATION**

### **The Vancouver Conference**

Conference organised by the OECD  
hosted by the Government of Canada

*Vancouver, British Columbia*

*24-27 March 1996*

**CONFERENCE HIGHLIGHTS  
AND OVERVIEW OF ISSUES**



## Foreword

The past fifty years have seen an exponential growth in the mobility of both people and goods. This growth, while having contributed to great social and economic advances, is now increasingly eroding some of the very benefits it has brought about. In particular, it is now clear that current trends in transport activity volume and growth pose severe challenges for societies aiming to move towards sustainable development.

In response to the problem of managing transport activity, on the one hand, and environmental, economic and social objectives, on the other, the Organisation for Economic Co-operation and Development (OECD), the International Energy Agency (IEA) and the European Conference of Ministers of Transport (ECMT) and a number of other agencies and governments have organised the following series of six meetings between 1990 and 1994:

- *“Low-consumption, Low-emission Automobile”* Meeting of an Expert Panel, Rome, Italy, February 14-15, 1990.
- *“Toward Clean and Fuel-efficient Automobiles”* International Conference, Berlin, Germany, March 25-27, 1991.
- *“Policy Instruments and Measures for the Promotion of the Fuel-efficient and Clean Vehicle”* Meeting of an Expert Panel, Rome, Italy, April 13-15, 1992.
- *“The Urban Electric Vehicle: Policy Options, Technology Trends, and Market Prospects”* International Conference, Stockholm, Sweden, May 25-27, 1992.
- *“Towards Clean Transport: Fuel-efficient and Clean Motor Vehicles”* International Conference, Mexico City, Mexico, March 28-30, 1994.
- *“Reconciling Transportation, Environmental, and Energy Issues: the Role of Public Transport”* International Conference, Budapest, Hungary, May 30-June 1, 1994.

These meetings underlined that technical solutions, alone, are unlikely to be sufficient to reduce the transport sector's environmental impact, especially in the light of current growth trends in vehicle numbers and travel volume which serve to offset gains in vehicle fuel efficiency and pollution reduction. The meetings also served to shape a growing consensus that a broader systemic examination of what constitutes sustainable transport -- including what such a system might look like, how it could be attained and what kind of policies might ensure its attainment - - was needed. The March 1996 “Towards Sustainable Transportation” Conference responded to that need.

The Conference, held in Vancouver, Canada, from 24-27 March 1996 brought together over 400 stakeholders in the transport sector (automobile and alternative vehicle manufacturers, fuel producers, government officials, regional and local planners, etc.) from 25 countries, in order to develop a vision of -- and chart a course towards -- sustainable transport. This document is the Conference Report.

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# 1. INTRODUCTION

The conference was organised in response to the concerns of governments that transportation poses severe challenges for sustainable development.

The conference entitled *Towards Sustainable Transportation* was held in Vancouver during the period March 24-27, 1996. It was organised in response to the concerns of governments that transportation<sup>†</sup> poses severe challenges for sustainable development.

The environmental and health effects of motorised transport are well known. They include global warming and depletion of the ozone layer; spread of toxic organic and inorganic substances, notably tropospheric ozone; depletion of oil and other natural resources; and damage to landscape and soil.

Improvements in pollution control and fuel efficiency during the past three decades have been directed towards reducing the impacts of transportation on environment and health. The improvements have mostly been more than offset by increases in the ownership, use, and power of motor vehicles. The number of motorised road vehicles, now over 800 million world-wide, is growing almost everywhere at higher rates than both human population and GDP; road traffic—freight and passengers—may be growing even more quickly.<sup>‡</sup> Air transport grows the most rapidly of all. Movement of people by rail and bus, which is generally more environmentally benign, is declining in many countries. In short, transportation is unsustainable and is becoming more unsustainable.

The conference in Vancouver built on six meetings organised between 1990 and 1994 by the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA), in collaboration with other agencies and national governments:<sup>2</sup>

- *Low-consumption, Low-emission Automobile*. Meeting of an Expert Panel, Rome, Italy, February 14-15, 1990.
- *Toward Clean and Fuel-efficient Automobiles*. International Conference, Berlin, Germany, March 25-27, 1991.
- *Policy Instruments and Measures for the Promotion of the Fuel-efficient and Clean Vehicle*. Meeting of an Expert Panel, Rome, Italy, April 13-15, 1992.
- *The Urban Electric Vehicle: Policy Options, Technology Trends, and Market Prospects*. International Conference, Stockholm, Sweden, May 25-27, 1992.
- *Towards Clean Transport: Fuel-efficient and Clean Motor Vehicles*. Inter-

## FOOTNOTES

<sup>†</sup> The words “transport” and “transportation” are mostly interchangeable. “Transport” is more often used to refer to the *means* of movement and is also preferred here for the adjectival form, as in “transport activity.” “Transportation” is more often used to refer to the conveyance of people and goods in general terms. In the UK “transport” is preferred for both senses, perhaps on account of the former use of “transportation” to refer to penal banishment.

<sup>‡</sup> Superscript numbers link the text to 164 reference and other notes that can be found on Pages 176-183.

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national Conference, Mexico City, Mexico, March 28-30, 1994.

- *Reconciling Transportation, Environmental, and Energy Issues: the Role of Public Transport*. International Conference, Budapest, Hungary, May 30-June 1, 1994.

Each of these meetings, particularly the last two, pointed to the need for a public examination of what a sustainable transportation system might be like, how it might be attained, and, in particular, what kinds of policies would have to be adopted by national governments in order to ensure attainment. The Vancouver conference responded to that need.

The Vancouver conference also built on a national conference on sustainable transport, organised by the British Columbia Ministry of Environment, Lands and Parks and Environment Canada. This conference, held in Vancouver from October 30 to November 1, 1995, focused on the policies and actions needed to achieve sustainable transportation in Canada, including the development of environmentally cleaner alternatives to the car.<sup>3</sup> A main objective of the national conference was to prepare for the OECD international conference reported on here.

As at the earlier OECD meetings, the Vancouver conference held in March 1996 brought together key stakeholders in the mobility service area: automobile manufacturers, fuel producers, producers of alternative vehicles and fuels, researchers, government officials, city planners, and others.

The stated objectives of the Vancouver conference were these:<sup>4</sup>

- To provide for dialogue among disciplines, among levels of government, and among economic sectors as to how to move towards environmentally sustainable transportation.
- To explore perspectives on environmentally sustainable transportation.
- To attempt to reconcile goals for transportation, environment, energy, and development.
- To contribute to the development of principles that will guide nations in implementing environmentally responsible transportation programs.
- To identify policies and measures that should be adapted to achieve sustainable transportation.

The conference was organised in plenary sessions. It moved from a consideration of what is unsustainable about present transportation systems and trends, to visions of how sustainability might be achieved, to consideration of barriers to attainment of sustainability, and finally to endorsement of principles for the achievement of sustainable transportation. Along the way, special attention was paid to the challenges posed by urban areas, air transport, and freight transport, and to North American actions related to sustainable transportation.



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The present review is both an overview of the highlights of the conference and an elaboration of some of the issues raised at the conference.

The present review is both an overview of the highlights of the conference and an elaboration of some of the issues raised at the conference. It builds on the presentations and discussions at the conference, on the papers presented in connection with the conference, on the reports made by the rapporteurs on the conference sessions, and on comments made on the conference material available on the World Wide Web.<sup>5</sup> In some parts of the review, additional data and analysis are provided to round out the conference presentations. (Conference and non-conference material are distinguished in the reference notes.)

The presentation here mostly follows the organisation of the conference in that it contains substantive sections on how present transportation systems are unsustainable, why transport activity is growing, what sustainable systems might look like, how they could be achieved, and the barriers to achievement. These five sections are preceded by a general discussion of sustainable transportation and followed by a section in which some conclusions are drawn.

The conference also included sessions on air transport, on urban and suburban transportation, and on the movement of freight. Material associated with these sessions is incorporated at appropriate places in the overview. Also incorporated is material associated with two informal evening sessions held at the conference: one on the sustainable automobile, the other on the Spanish Ciudades Accesibles (Accessible Cities) program.

Sustainable transportation is a subject about which reasonable and informed people can have quite disparate and strongly held opinions.

Some cautions are in order. The conference presentations and discussions and the continuing dialogues arising from the event embrace wide differences in opinion and approach. This review attempts to capture some of the controversies, especially in Section 6, but it falls short of illustrating the whole array of ideas. As a consequence, the review may convey the appearance of a more coherent approach to the attainment of sustainable transportation than actually exists. Moreover, readers of the review may well know that sustainable transportation is a subject about which reasonable and informed people, including writers of conference reports, can have quite disparate and strongly held opinions. Objectivity has been striven for here, but not necessarily always achieved.

## 2. SUSTAINABLE TRANSPORTATION

This section introduces the notions of sustainable development and sustainable transportation, and sets out some of the ways in which they have been defined and elaborated.

The term *sustainable development* was introduced in 1980, popularised in the 1987 report of the World Commission on Environment and Development (the Brundtland Commission), and given the status of a global mission by the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992.<sup>6</sup>

The Brundtland Commission defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The Commission noted that its definition contained two key concepts: *needs*, meaning “in particular the essential needs of the world’s poor,” and *limitations*, meaning “limitations imposed by the state of technology and social organisation on the environment’s ability to meet present and future needs.”<sup>7</sup>

Sustainable development for the Brundtland Commission had environmental, social, and economic aspects, but remediation of current social and economic ills came first.

The Brundtland Commission’s definition was thus not only about sustainability in the various senses of the term but also about equity, equity among present inhabitants of the planet and equity among generations. Sustainable development for the Brundtland Commission had environmental, social, and economic aspects, but remediation of current social and economic ills came first. The chief tools for the remediation were to be “more rapid economic growth in both industrial and developing countries, freer market access for the products of developing countries, lower interest rates, greater technology transfer, and significantly larger capital flows, both concessional and commercial.”<sup>8</sup> Such trends were said to be compatible with recognised environmental constraints, but the extent of the compatibility was not explored.<sup>9</sup>

The report of the Brundtland Commission nevertheless stimulated debate about the environmental impacts of industrialisation and about the legacy of present activities for coming generations. The report reactivated interest in what might be the physical or ecological limits to economic growth.<sup>10</sup> Further definitions were proposed that gave priority to such limits. One business writer (Paul Hawken) suggested the following:

“The word sustainability can be defined in terms of carrying capacity of the ecosystem, and described with input-output models of energy and resource consumption. Sustainability is an economic state where the demands placed on the environment by people and commerce can be met without reducing the capacity of the environment to provide for future generations. It can also be expressed in the simple terms of an economic golden rule for the restorative economy: Leave the world better than you found it, take no more than you need, try not to harm life or the environment, make amends if you do.”<sup>11</sup>

The author of the above paragraph and others have drawn on the work of Herman Daly, formerly of the World Bank, in considering how the environmental limits might be characterised. Daly suggested that the limits on society’s material and energy throughputs might be set as follows:<sup>12</sup>

- The rates of use of renewable resources should not exceed their rates of regeneration.
- The rates of use of non-renewable resources should not exceed the rates at which renewable substitutes are developed.
- The rates of pollution emissions do not exceed the assimilative capacity of the environment.

A group of Swedish scientists has provided another formulation of the conditions for sustainability:<sup>13</sup>

- Nature cannot sustain a systematic concentration of substances extracted from the earth’s crust, such as fossil fuels and mercury.
- Nature cannot sustain a systematic increase in unnatural persistent substances, such as polychlorinated biphenyls (PCBs) and chlorofluorocarbons (CFCs).
- The physical basis for the productivity and diversity of nature must not be systematically deteriorated beyond nature’s ability to replenish itself, for example, by overfishing, deforesting, and depleting and destroying arable lands.
- Given the above conditions, sustainability cannot be achieved without a just and efficient use of energy and resources.

At the UNCED in 1992, national governments endorsed *Agenda 21*, which states that the various sectors of human activity should develop in a sustainable manner. *Sustainable transportation* is the expression of sustainable development within the transportation sector. (*Sustainable mobility* is a synonym used by the European Commission.)

In contrast to the wealth of analysis of what might constitute sustainable development, there has been little work on defining and setting the conditions for sustainable transportation.

In contrast to the wealth of analysis of what might constitute sustainable development, there has been relatively little work on defining and setting the conditions for sustainable transportation. A brief review of such work appeared in an OECD paper distributed at the Vancouver conference and mentioned several times there.<sup>14</sup> This paper provided a preliminary qualitative definition of environmentally sustainable transport (EST), as follows:

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

The OECD paper set out six criteria for the attainment of EST in the target year of 2030:

- Transport-related emissions of nitrogen oxides (NO<sub>x</sub>) have been reduced to the extent that the objectives for ambient nitrogen dioxide and for ozone levels as well as for nitrogen deposition are achieved.
- Emissions of volatile organic compounds (VOCs) have been reduced to the extent that excessive ozone levels are avoided, and emissions of carcinogenic VOCs from all movement of all vehicles have been reduced to meet acceptable risk levels.
- Climate change is being prevented by achieving per-capita carbon dioxide emissions from fossil fuel use for transportation consistent with the global protection goals for the atmosphere.
- Emissions of particulates have been reduced to the extent that harmful ambient air levels are avoided.
- Land surface in urban areas is used for the movement, maintenance, and storage of motorised vehicles, including public transport vehicles such that the objectives for ecosystem protection are met.
- Noise caused by transportation should not result in outdoor noise levels that present a health concern or serious nuisance.

For the purposes of ongoing OECD work on the characterisation of EST scenarios and their attainment, the first three criteria have been quantified in a relatively stringent manner (e.g., carbon dioxide emissions consistent with EST have been set at 20 per cent of total emissions in 1990).

Work on transportation's role in sustainability is being conducted in the United States by the Transportation Research Board of the National Research Council (part of the National Academy of Sciences). The central matter being addressed by this work is, "whether transportation's long-term environmental impacts will result in future generations inheriting significantly fewer resources than those available to their predecessors."<sup>15</sup>

An *unsustainable* activity is one that cannot continue to be carried on the way it is now without serious difficulties. What would have to be added to the bicycle to make its widespread use unsustainable?

Yet another approach, perhaps more consistent with that of the Brundtland Commission, is that of the World Bank. Sustainability, whether applied to transportation or to other human activities, is seen as having three components. First is economic sustainability, which involves creating incentives for efficient response to needs. Second is environmental sustainability, which involves promoting more liveable settlements and reducing adverse external effects. Third is social sustainability, which focuses on the reduction of poverty.<sup>16</sup>

The question as to what might constitute sustainable transportation was central to the work of the Vancouver conference, which mostly focused on environmental sustainability. Some of the presentations and discussions on this matter are described here in Section 5. There seemed to be agreement at the conference that there is at present no motorised vehicle whose *widespread* use would meet any reasonable definition of sustainability, and that the only vehicle that might qualify is the bicycle.<sup>17</sup>

One speaker at the conference instead addressed *unsustainability*. He defined an *unsustainable* activity as one that cannot continue to be carried on the way it is now without serious difficulties. In this context, two kinds of unsustainability were defined: activities that are strongly unsustainable—“show-stoppers”—and activities that are weakly unsustainable—“nuisance problems.” Emissions and other impacts resulting in climate change and loss of soil and biodiversity were put into the former category. Most air pollution and other concerns were put into the second category.<sup>18</sup>

A focus on unsustainability allows a reversal of the usual preoccupation with how to make the automobile sustainable. Instead, one might ask what would have to be added to the bicycle to make its widespread use unsustainable: how large an engine and fuel supply, how many more wheels, fenders or windows? Consideration of the unsustainable bicycle might help clarify what is meant by sustainable transportation.<sup>19</sup>

A recurrent issue at the conference, and in other discussions of sustainability, has been the weight to be given to some of the factors described above as “weakly unsustainable.” Examples are noise and accidents, which may never have an evident inter-generational impact. Echoes of these discussion may be found in this review, particularly in Section 3. The scope of the discourse about sustainable transportation was delineated at the conference, and the risk remains that *sustainable* will become no more than another synonym for *good*.

### 3. HOW PRESENT TRANSPORTATION SYSTEMS ARE UNSUSTAINABLE

This section begins with a brief account of how transport activity is increasing that extends the discussion of this matter at the Vancouver conference. It then outlines conference presentations and discussions regarding the various ways in which transportation systems are causes of concern—concern about resource depletion, about global and local environmental impacts, and about accidents, congestion, and other impacts. In many cases the concern is increasing, on account of growth in transport activity that outweighs improvements in fuel efficiency and in control over emissions.

#### 3.1. Growth in transport activity

The number of people owning a car increased by as much as nine times between 1950 and 1990. In absolute terms, the growth in the number of people *without* a car was very much greater.

In most countries, the largest share of transport activity is by road. In OECD countries in 1990, road transport was responsible for 82 per cent of final energy consumption for transportation (87 per cent in Japan; 83 per cent in Europe; 81 per cent in North America).<sup>20</sup> In many other countries, the share taken by road transport is higher than the OECD average (e.g., Argentina, Brazil, Mexico, and Pakistan).<sup>21</sup> Air transport is responsible for the second largest share: some 13 per cent of transport energy use in OECD countries in 1990 and growing at a higher rate than for other modes.<sup>22</sup> The Vancouver conference was mainly concerned with road and air transport, which together likely account for more than 90 per cent of all transport activity world-wide, and just about all of the increase in transport activity.

##### Road transport

Between 1950 and 1990, the number of motorised road vehicles in the world grew by roughly ninefold, from about 75 million to about 675 million, with vehicles used primarily for personal transportation (cars and motorcycles) comprising close to 80 per cent of the total throughout the four decades.<sup>23</sup> During the same period the world's population doubled, from some 2.5 billion to near 5.0 billion. The point was made forcefully to the conference that this evidence of remarkable motorisation belies the fact that whereas some 450 million more people owned a car or motorcy-

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cle in 1990 than in 1950, the number of people in the world not owning a car increased by very much more, indeed by more than two billion.<sup>24</sup>

In 1990, freight and passenger activity levels per person in the United States were approximately twice those in western Europe.

Data on the *use* of road vehicles—as opposed to their number—are not so readily available. Table 1 shows data on passenger and freight movement by road in 1970 and 1990 for western Europe and the USA. The table indicates an approximate doubling of freight and passenger activity per capita in western Europe during this period, with smaller relative increases in the United States, especially for passenger travel. Nevertheless, in 1990 freight and passenger activity levels per person in the United States were approximately twice those in western Europe. Overall, transport activity during this period increased at roughly the same rate as the increases in the vehicle fleets.<sup>25</sup>

**Table 1. Intensity of movement of goods and people in western Europe and the United States, 1970 and 1990.**<sup>26</sup>

	Tonne-kilometres of freight by road per capita			Passenger-kilometres by private auto per capita		
	1970	1990	Δ%	1970	1990	Δ%
<b>USA</b>	3,250	4,880	+50	16,550	18,650	+13
<b>W. Europe</b>	1,250	2,550	+105	4,620	8,710	+90
<b>Ratio US/WE</b>	2.6	1.9		3.6	2.1	

**Table 2. Road transport indicators for OECD and other countries, 1990 and 2030.**<sup>27</sup>

	Light vehicles			Heavy vehicles		
	Totals		Δ%	Totals		Δ%
	1990	2030		1990	2030	
OECD countries:						
Number of vehicles (millions)	468	811	73	16	31	94
Kilometres travelled (billions)	7,057	12,448	76	687	1,377	100
Weight of fuel used (megatonnes)	563	520	-8	182	359	97
Non-OECD countries:						
Number of vehicles (millions)	179	725	305	14	56	300
Kilometres travelled (billions)	2,380	9,953	318	647	2,512	288
Weight of fuel used (megatonnes)	167	394	136	142	552	289
All countries:						
Number of vehicles (millions)	648	1,537	137	30	87	190
Kilometres travelled (billions)	9,437	22,400	137	1,334	3,889	192
Weight of fuel used (megatonnes)	730	914	25	324	911	181

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During the 40 years beyond 1990, the number of people owning a car is expected to increase by some 800 million, with the larger part of that increase occurring in countries that do not now belong to the OECD (see Table 2); but again there will be a much larger absolute increase in the number of people who do *not* own a car—an additional three billion people or more.<sup>28</sup> Thus for the foreseeable future, most of the trips that people make in their everyday business will be likely made by foot or bicycle and will, in consequence, presumably be sustainable.<sup>29</sup>

Among the less than 20 per cent of the world's population that lives in OECD countries, by far the predominant means of travel is the personal automobile, which accounts for about 80 per cent of person-km. in the U.S., 70 per cent in several countries in Europe, and 50 per cent in Japan.<sup>30</sup> The proportions of all trips made by personal automobile are lower but are nevertheless above 50 per cent in several European countries and well above 50 per cent in North America.<sup>31</sup>

Table 2 shows that, notwithstanding the already high levels of use of motorised road vehicles in OECD countries, both the number of vehicles and the amount of travel are set to increase substantially during the next few decades. Indeed, Table 2 suggests that *all* of the main indicators of road transport activity, except fuel use for light vehicles in OECD countries, will increase during the period 1990-2030. Overall, activity involving heavy vehicles is expected to increase more than activity involving light vehicles, a projection consistent with the assertion at the conference that emissions from heavy-duty vehicles constitute a growing share of health-threatening pollution.<sup>32</sup>

The increases in transport activity shown in Table 2 may well be underestimated. Work done for the German government indicates that, for that country since 1950, estimates of growth in the passenger car population have consistently been exceeded;<sup>33</sup> similar conclusions might be drawn for many other countries.

**Table 3. Energy use for motorised transport in different parts of the world (gigajoules/person in 1992).<sup>34</sup>**

	Moving people	Moving freight	Total
United States	57	24	81
Japan	16	13	29
Europe-4	19	9	28
Non-OECD countries	2	2	4

The differences in transport practices and trends among OECD countries are large. The most significant may be the amount of energy used for transport, which in 1992 was almost three times higher per capita in the United States and Canada than in other OECD countries (see Table 3),



although this index is falling in North America and increasing elsewhere. For movement of people, the difference in energy use may be related above all to the higher levels of automobile ownership and use in North America, rather than to other factors such as the fuel intensity of travel, the distance travelled per vehicle, and the distance travelled per trip.<sup>35</sup> The causes of transport activity are discussed further in Section 4.

### Other modes of transport

Air transport is the second largest user of transport fuels; it is also the fastest growing mode of transport. If present trends continue, aviation will be the major transport user of oil after 2023.

Air transport is the second largest user of transport fuels, accounting world-wide for 12.4 per cent of oil consumption for transportation in 1992. OECD countries account for some 70 per cent of aviation fuel consumed. Just under half of passenger traffic and about 80 per cent of freight traffic are international.<sup>36</sup>

Air transport is also the fastest growing mode of transport. World-wide, use of aviation fuel is expected to increase by more than a factor of three between 1990 and 2005 alone, i.e., an annual rate of increase in excess of eight per cent.<sup>37</sup> By contrast, use of fuel for road transport is expected to increase by an average of 1.4 per cent per year over the period 1990-2030 (Table 2). These projections suggest that by 2005, air transport will be responsible for 27 per cent of oil use for transport, compared with the 12.4 per cent noted for 1992. If the indicated trends continue, oil use for aviation will exceed oil use for road transport after about 2023.

Activity involving other modes of transport has generally remained static or declined, with two significant exceptions. Rail freight is experiencing a resurgence in North America, which has been attributed chiefly to the lowering of costs through deregulation. Passenger movement by train has increased in Europe where high-speed trains have been introduced.<sup>38</sup>

## 3.2. Dependence on finite fossil fuel sources

Oil accounted for more than 99 per cent per cent of transport energy use in 1990. Transportation comprised about half of all use of oil products

The world's transportation systems are almost entirely fuelled by oil, which accounted for more than 99 per cent of transport energy use in 1990. Transportation, conversely, comprises approximately 50 per cent of the use of oil products (60 per cent in OECD countries) and is everywhere the most rapidly growing type of use of oil. After falling in the early 1980s, world oil use is rising again, largely on account of industrialisation in non-OECD countries and transport uses everywhere. In OECD countries, non-transport use of oil is declining but use for transport is increasing at a rate of about two per cent a year, resulting in an overall increase in oil use of just under one per cent a year. In non-OECD countries, oil use is increasing overall at three to four times the rate of increase in OECD countries.<sup>39</sup>

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Oil is essentially a non-renewable resource that is being used more quickly than renewable substitutes are being developed and brought into use. Thus, according to the kind of characterisation of environmental sustainability discussed in Section 2, transportation is presently unsustainable in terms of resource use. Just *how* unsustainable it is in these terms was a matter for debate at the Vancouver conference. Some speakers gave more weight than others to resource depletion as a feature of sustainability.

Participants giving much weight to resource depletion argued that the end of recoverable oil is in sight, and that world oil production must inevitably enter a state of permanent decline during the early part of the 21st century.<sup>40</sup> The alternative view can be represented by the statement of one participant to the effect that any speculation that global oil supplies are nearing depletion is flawed.<sup>41</sup>

Should what are now regarded as recoverable reserves of oil become exhausted, other reserves will be made available, albeit at a higher cost of extraction.

Available data support both positions. Authoritative sources suggest that there are proved reserves of oil sufficient to last 35-50 years at present rates of extraction. This does not necessarily mean that available oil will be exhausted in 35-50 years. Since 1960 the identification of proved reserves has generally kept pace with extraction, meaning that the time horizon of available oil has been within the range of 35-50 years for several decades.<sup>43</sup> Moreover, should what are now regarded as recoverable reserves become exhausted, other reserves will be made available, albeit at a higher cost of extraction.

**Table 4. Actual and estimated production and consumption of oil (in millions of tonnes).<sup>42</sup>**

	1994 (actual)		2010 (estimated)		Increase 1994-2010
	Amount	% of total	Amount	% of total	
Production:					
OECD	740	30%	620	19%	-16%
Other	1690	70%	2650	81%	+57%
Consumption:					
OECD	1480	61%	1690	52%	+14%
Other	950	39%	1580	48%	+66%
TOTALS:	2430		3270		+35%

The use of energy for transportation varies greatly from one part of the world to another, as is evident from Table 3.

Since 1970, energy use per capita for moving people has remained approximately constant in the United States, while increasing elsewhere. Energy use per capita for moving freight has increased everywhere.<sup>44</sup>

## CONFERENCE REPORT

The poor match between where oil is extracted and where it is used is regarded by some as a source of unsustainability on account of the potential for conflict and resulting environmental devastation.

The poor match between where oil is extracted and where it is used is regarded by some as a source of unsustainability on account of the potential for conflict and resulting environmental devastation.<sup>45</sup> Table 4 shows the present imbalance (OECD countries use twice as much as they produce) and its potential for worsening (in 2010, OECD countries will use 2.7 times as much as they produce). A key feature of the imbalance is that approximately two thirds of proved reserves of oil lie in the politically volatile Persian Gulf area. The conference was told that 60 per cent of the oil used in the United States is imported—and the proportion is increasing.<sup>46</sup>

Table 4 also shows the anticipated increases in consumption of oil by the end of the next decade. Almost all of the increase in OECD countries and approximately 60 per cent of the increase elsewhere will be on account of transportation.<sup>47</sup>

**Table 5. Emissions from transport: Local, regional, and global effects.**<sup>48</sup>

Pollutant	Type of impact						Source of emission	Health effects of pollutant
	Local High concentrations	Regional		Global				
		Acidification	Photochemical oxidants	Indirect Greenhouse Effect	Direct Greenhouse Effect	Stratospheric Ozone Depletion		
Suspended particulate matter (SPM)	X		X				Products of incomplete combustion of fuels; also from wear of brakes and tires	Irritates mucous membranes, respiratory /pulmonary effects; carcinogenic
Lead (Pb)	X			X			Added to gasoline to enhance engine performance	Affects circulatory, reproductive, and nervous systems
Carbon monoxide (CO)	X		X	X			Incomplete combustion product of carbon-based fuels	Reduced oxygen-carrying capacity of red blood cells
Nitrogen oxides (NO <sub>x</sub> )	X	X	X	X		X	Formed during fuel combustion at high temperatures	Irritates lungs; increases susceptibility to viruses
Volatile organic compounds (VOCs)	X		X	X			Combustion of petroleum products; also evaporation of unburned fuel	Irritates eyes, causes intoxication; carcinogenic
Tropospheric ozone (O <sub>3</sub> )		X	X	X			Not an exhaust gas; product of photochemical reaction of NO <sub>x</sub> and VOCs in sunlight	Irritates mucous membranes of respiratory system; impairs immunities
Methane (CH <sub>4</sub> )					X		Leakage during production, transport, filling and use of natural gas	
Carbon dioxide (CO <sub>2</sub> )					X		Combustion product of carbon-based fuels	
Nitrous oxide (N <sub>2</sub> O)				X	X	X	Combustion product of fuel and biomass; also formed in catalytic converters	
Chlorofluorocarbons (CFCs)					X	X	Leakage of coolant from air conditioning systems	

### 3.3. Air pollution from transport

#### Overview

The burning of fossil fuels to provide energy for vehicles results in several kinds of emissions into the atmosphere. The emissions from transport of greatest concern are noted in Table 5, together with their main sources and, where appropriate, their direct impacts on human health.

#### Global impacts

The major global impact of transportation results from release of carbon dioxide into the atmosphere, an almost inevitable consequence of the combustion of fossil fuels. CO<sub>2</sub> traps the sun's heat causing an increase in the planet's surface temperature. Other radiatively active gases can be produced during combustion of fossil fuels, but the greatest potential impact is believed to arise from atmospheric accumulation of carbon dioxide.<sup>49</sup>

Carbon dioxide is an input or an output of the metabolism of plants and animals, and is regularly recycled through the biosphere, atmosphere, and oceans in a complex system that appears set to maintain the surface temperature of the Earth at about +15°C (instead of the average of -15°C that would prevail without the atmosphere). The burning of large amounts of carbon stored in fossilised plants can load the atmosphere beyond the system's assimilative capacity. Atmospheric levels of the gas have been increasing for more than a century, roughly in step with the increased fossil fuel use associated with industrialisation and with the motorisation of transport. The elevation in surface temperature over this period may now be attributable in part to the raised atmospheric CO<sub>2</sub> concentrations.<sup>50</sup> The effects of continued climate change could include more variable and extreme weather, raised sea levels, expansion of deserts, spread of vector-borne diseases, and widespread destruction of plants, animals, and ecosystems unable to adapt to changes in temperature and other aspects of climate. Developing countries are particularly at risk. (There may well be beneficial effects in some parts of the world, included expanded food production.<sup>51</sup>)

World-wide success in improving energy efficiency has served to reduce the rate of atmospheric accumulation of CO<sub>2</sub>; transportation is the conspicuous exception.

The close link between energy use and CO<sub>2</sub> emissions means that world-wide success in improving the energy efficiency of industrial and other operations during the last few decades should have served to reduce the rate of accumulation of CO<sub>2</sub>. Generally speaking this has happened, with the conspicuous exception of the transport sector, where increases in vehicle kilometres travelled have mostly offset what have sometimes been limited improvements in efficiency. Indeed, in many countries there have been no overall improvements in efficiency at all, in large part because new vehicles have become larger and more powerful.<sup>52</sup> Between 1973

and 1988, carbon dioxide emissions from transportation increased by 30 per cent world-wide to 773 million tonnes; CO<sub>2</sub> emissions from other human activities fell overall by about two per cent to 1,969 million tonnes.<sup>53</sup> (During the same 15 years, the world's human population increased by about 35 per cent.<sup>54</sup>) In OECD countries the differences are starker. In the U.K., for example, CO<sub>2</sub> emissions from transportation increased by 65 per cent between 1970 and 1990 while CO<sub>2</sub> emissions from all other human activity fell by 23 per cent.<sup>55</sup>

Because fossil fuel use is set to increase during the next few decades (see Table 4) so will CO<sub>2</sub> emissions. This is in spite of the various warnings of the Intergovernmental Panel on Climate Change, a large group of experts established by the United Nations, to the effect that in order to stabilise atmospheric CO<sub>2</sub> concentrations at near current levels, world-wide CO<sub>2</sub> would need to be reduced immediately by 50-70 per cent, with further reductions thereafter.<sup>56</sup> As noted in Section 3.2, most of the expected increase in fossil fuel use, and thus CO<sub>2</sub> emissions, will be the result of growth in transport activity.

For some conference participants, the potential contribution to climate change is the most important feature of transportation's unsustainability.

For some conference participants, the potential contribution to climate change is the most important feature of transportation's unsustainability. In this light, transportation could be made sustainable with some or all of the following: (i) a massive increase in the efficiency of use of fossil fuels; (ii) a massive switch to other fuels; and (iii) a massive reduction in transport activity.

Transportation makes other contributions to potential climate change, but perhaps three are significant. One is release of methane—more commonly known as natural gas—during its extraction, transmission, and use as a transport fuel. Methane is some 20 times more radiatively active than CO<sub>2</sub>; thus growth in its use without proper controls could be a cause for concern. Use of natural gas as a vehicle fuel might grow because it is cleaner burning, produces less CO<sub>2</sub> per unit of energy delivered, and may be more plentiful than oil.

A second potentially significant contribution of transportation to climate change arises from the formation of NO<sub>x</sub> during combustion of aviation fuel at high altitudes and the photochemical conversion of NO<sub>x</sub> into ozone. Ozone is at its most effective as a greenhouse gas at heights of about 8,000 metres at the poles and 17,000 metres at the equator (the layer of the atmosphere known as the tropopause), which includes the heights at which modern jet aircraft fly. The indirect greenhouse effect resulting from NO<sub>x</sub> formation at high altitudes is said to be as much as equal to the effect from aviation's CO<sub>2</sub> emissions.<sup>57</sup>

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A whole session was devoted to aviation at the Vancouver conference in recognition of both the growing concerns about its global impacts and the rate of growth of air transport—the highest among transport modes.<sup>58</sup> If

widespread use of supersonic aircraft for passenger transport were to occur, the environmental impacts per passenger-kilometre could be very much greater.

A third significant transport-related contributor to potential climate change arises from the use of chlorofluorocarbons (CFCs) in vehicle air-conditioning systems, and their almost inevitable release in the atmosphere during use and maintenance. CFCs are strongly radiatively active, although their net effect is reduced because they deplete the ozone layer and, as noted, ozone is also radiatively active.

About half the vehicles produced in the world are equipped with air conditioners (about 80 per cent in North America).<sup>59</sup> Vehicle air conditioning systems produced before 1993 continue to use substantial amounts of CFC-12. The cost of CFC-12 has increased by a factor of about ten during the last few years on account of taxes and shortages; by international agreement, CFCs are no longer produced in OECD countries. The cost increases, together with regulations concerning the handling of CFCs, have reduced the amounts of CFCs vented into the atmosphere. Non-OECD countries are exempt from the production ban until 2006. A black market in CFCs, based on illegal imports, has already emerged, weakening the impact of the ban in OECD countries and causing legislators in the United States to question its value.

Vehicle air conditioners brought into service in OECD countries since 1993 mostly make use of a hydrofluorocarbon (HFC) rather than a CFC. HFCs do not appear to deplete the ozone layer, but air conditioners that use an HFC are less efficient. Thus more vehicle fuel is required to operate them and combustion-related emissions are correspondingly greater.

CFCs are being phased out not because of their impact on potential climate change but because their depletion of the ozone layer allows life-damaging increases in the amount of ultraviolet radiation reaching the planet's surface.

**Regional and local impacts**

In the long-term, sustainability is more a global than a local matter. If an environmental impact is beyond the carrying capacity of the planet then life as we know it is threatened. If it is beyond the carrying capacity of one area then that area may become uninhabitable but life as we know it can most likely continue elsewhere. Nevertheless, it is the regional and local impacts noted in Table 5 that are usually of the greatest concern to the general public and their political representatives. Moreover, a sufficient accumulation of local and regional degradation can amount to a global problem.

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**Table 6. U.S. emissions standards for new vehicles, 1960 and current, and also European Union standards (all in g/km).<sup>60</sup>**

Emission	U.S. standards			Current EU
	1960	Current	Reduction	
Hydrocarbons	6.6	0.16	98%	1.13
Nitrogen oxides	2.6	0.25	90%	1.13
Carbon monoxide	52.5	2.12	96%	3.16

During the past three decades, government and industry have responded in what some regard as a remarkable manner to public concern about local and regional pollution from transportation.<sup>61</sup> The conference was told of the major enhancements in emissions standards for new automobiles, as shown in Table 6.

The conference was also told that total transport-related emissions of local and regional concern have decreased recently in the United States, despite increased mobility, as shown in Table 7.

**Table 7. U.S. emissions of selected transport-related pollutants in 1985 and 1994 (tonnes x 10<sup>3</sup>).<sup>62</sup>**

Pollutant	Emissions		Transport's share in 1994
	1985	1994	
Volatile organic compounds	8,508	5,712	27%
Nitrogen oxides	7,340	6,833	32%
Carbon monoxide	66,560	55,420	62%
Sulphur oxides	474	268	1%
Particulate matter (<10µm)	329	282	12%
Lead	14.5	1.3	29%

Over a similar period, total emissions from mobile sources in other countries have both increased and decreased, as illustrated in Table 8. The differences among countries, and from the United States, may be a

For emissions having local and regional impacts, it is not the overall amounts of emission that are of concern but the concentrations in the air, as recorded at monitoring stations. These were generally lower in the early 1990s than in the mid-1980s, notwithstanding increases in traffic.

function both of greater increases in transport activity and of different emission limits. To date, emission limits have usually been less strict in countries other than the U.S., as illustrated in Table 6, although the main tendency is towards progressively stricter, harmonised standards.

For emissions having local and regional impacts, it is not the overall amounts of emission that are of concern but the concentrations in the air, as recorded at monitoring stations. These were generally lower in the early 1990s than in the mid-1980s, notwithstanding increases in traffic.<sup>63</sup> Nevertheless, the concentrations continue to be of concern, as indicated in Table 9. The concentrations in the air reflect not only the impact of transport emissions but also the impacts of emissions from stationary sources such as industrial plants, electricity generating stations, and facilities for heating and cooking. The proportions attributable to transportation are indicated for the United States in Table 7; higher proportions have been estimated for other countries.<sup>64</sup>

The local and regional air pollution impacts of non-road modes of transport, while mostly small, should not be discounted. In particular, the emission of sulphur dioxide from coastal shipping can be significant, as can SO<sub>2</sub> emissions from electricity generating stations that supply electric rail systems and use coal or oil as a fuel. The contribution of aircraft emissions to local pollution is high near some airports.<sup>65</sup> Emissions from pleasure boats and off-road recreational vehicles deserve investigation, as do the environmental impacts of off-road vehicles used for construction and other commercial activities.

**Table 8. Direction of change in total amounts of indicated emissions from mobile sources in selected countries, 1985 to 1993 (or close year).<sup>66</sup>**

	VOCs	NO <sub>x</sub>	CO	SO <sub>2</sub>	PM
Austria	↘	↘	↘	↘	↗
Canada	↘	↘		=	
Denmark	↘	↗	↘	↘	
France		↗	↘	↗	↗
Germany (west)	↘	↗	↘	↘	↗
Iceland	↘	↗	↘	↗	
Netherlands	↘	↗	↘	↗	↘
Norway	↘	↗	↘	↘	=
Switzerland	↘	↘	↘	↘	=
U.K.	↗	↗	↗	↗	↗

↗ indicates an increase in total emissions. ↘ indicates a reduction in total emissions. = indicates no change in total emissions. A blank cell indicates that data are not available. VOCs refers to volatile organic compounds, NO<sub>x</sub> to nitrogen oxides, CO to carbon monoxide, SO<sub>2</sub> to sulphur dioxide, and PM to particulate matter.



The local and regional air pollution impacts of non-road modes of transport, while mostly small, should not be discounted. Also significant can be emissions from transport-related activities other than the operation of vehicles.

Also significant can be emissions from transport-related activities other than the operation of vehicles. Vehicle construction uses energy whose production and use can have air pollution impacts. The construction and maintenance of associated infrastructure, including roads and runways, can also have measurable impacts on air quality.

**Table 9. Extent of exceedances of air concentrations of transport-related pollutants.**<sup>67</sup>

Pollutant	Extent of exceedances
Suspended particulate matter (SPM)	WHO guidelines are exceeded by up to or more than a factor of two in 17 of 21 cities considered in one survey; in another, the guidelines were exceeded in 20 of 37 cities, with only 5 cities having concentrations within both annual and daily guidelines; the US EPA has designated 82 in 1994 areas as non-attainment areas.
Lead (Pb)	People in about one third of the world's cities are exposed to levels above WHO guidelines.
Carbon monoxide (CO)	Short-term WHO guideline values are often exceeded in many urban areas in Europe and in southern California; in the USA, the EPA designated 36 regions as non-attainment areas for CO in 1994, with Los Angeles being classified as serious.
Nitrogen oxides (NO <sub>x</sub> )	Major cities and metropolitan areas in Europe, the USA, and Japan continue to experience high episodic values exceeding applicable standards; concentrations exceeding WHO guidelines by a factor of 2-4 have been measured in some non-OECD megacities.
Volatile organic compounds (VOCs)	Emissions and exceedances vary according to the compound. Acceptable emission levels for carcinogens may be zero, as in the case of two of the most important VOCs, 1,3-butadiene and benzene, which respectively account for 32 and 5 per cent of US cancer cases related to air pollution and of which transport is responsible for 94 and 85 per cent of all emissions.
Tropospheric ozone (O <sub>3</sub> )	WHO guidelines for short- and long-term exposure are frequently exceeded in large areas of OECD Europe, North America, and Japan; the US EPA designated 77 areas as non-attainment areas in 1994.

### 3.4. Other environmental issues concerning transportation

The unsustainability of transportation is usually thought of in terms of its use of fossil fuels—both the depletion of a non-renewable resource and the pollution caused by combustion of fossil fuels—but there are other adverse impacts of transportation that can be unsustainable or at least contribute to unsustainability. Whether any particular adverse or undesirable impact is unsustainable is a matter of both the definition of sustainability (see Section 2) and the extent and permanence of the damage it causes. Both matters are usually controversial. The lack of data concerning impacts renders conclusions especially suspect.

**Resource use**

The passenger car is the consumer product associated with the most consumption of materials and energy and with the production of the greatest amount of waste and harmful emissions.

Fossil fuel consumption is the resource use of greatest concern associated with transportation, on account of both the depletion of non-renewable resources and the resulting air emissions. But transportation gives rise to other concerns about resource use and about resulting waste. A speaker at the conference noted that the passenger car is the consumer product associated with the most consumption of materials and energy and with the production of the greatest amount of waste and harmful emissions. Moreover, countries that are on target for reducing many emissions into the atmosphere may well not be on target for reducing the production of waste from transport activity.<sup>68</sup>

Considering the whole production chain from ore mining to the finished product, it takes 25-30 tonnes of material to manufacture a one-tonne vehicle. During the vehicle-manufacturing phase, some 800 kilograms of residual materials are left per vehicle produced, most of which can be recycled.<sup>69</sup>

The growing use of plastics and electronic components makes vehicles more difficult to recycle. In response, governments are imposing on manufacturers and importers greater responsibility for the final disposal of their products. Allocating responsibility to manufacturers helps ensure the development of vehicles that can be readily dismantled and recycled, as is happening, for example, in Sweden.<sup>70</sup>

**Water pollution**

Improper disposal of used lubricating oil is a major source of contamination of surface and underground water.

Land and air modes of transportation do not generate much water pollution directly, but there are several ways in which they can affect water quality. Oil and hazardous chemicals are ejected from road vehicles during normal operation, and especially during abnormal operation including accidents. Improper disposal of used lubricating oil is a major source of contamination of surface and underground water.<sup>71</sup> The common salt used to reduce ice formation on roads between -18°C and 0°C is another such source.

Land uses associated with a high level of motorisation of transport comprise large areas of impermeable surfaces created for roads, access routes, and parking spaces that interrupt the absorption and filtration of rainfall and thereby increase the risk of flooding and, consequently, the flushing of pollutants into water courses.

Shipping has more direct effects on water quality through spillage and through ballast operations. Indirect effects of shipping include disturbance of sediments during dredging.<sup>72</sup> Fuel and other oil from aviation also find their way into water courses, as does the glycol used to remove ice from aircraft wings.

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**Land use**

Transport is a major consumer of land. For example, five per cent of the total land area of the former West Germany is estimated to be used for transport routes; a further, unstated proportion is devoted to off-route transport purposes such as parking, manufacturing, and maintenance facilities.<sup>73</sup> Outside urban areas, transport infrastructure can disrupt or destroy natural habitats and adversely affect the ecological balance. Within urban areas, higher proportions of land area are devoted to transportation. Various imprecise estimates have been made as to the actual proportions. The range most often cited is that 25-35 per cent of the land is devoted to streets in modern cities, compared with less than 10 per cent in cities designed before the advent of motorised transport.<sup>74</sup> These proportions do not include land used for auxiliary transport purposes such as parking, which can raise the proportion of land paved for transportation purposes to very high levels. In Los Angeles and Indianapolis, more than 65 per cent of the land is said to be so paved; in Toronto it is more than 40 per cent.<sup>75</sup>

As well as causing the flushing of pollutants noted in the previous paragraph, extensive paving can absorb or reflect unusual amounts of solar radiation. The microclimates of urban and suburban areas are changed as a consequence, and the areas' liveability can be reduced.

Urban sprawl is made possible by motorised transportation and creates further demand for it, thereby magnifying its adverse effects. It often consumes good agricultural land; for example, in the Toronto region between 1966 and 1986, 33,000 hectares of rural land at the edge of the urban area, almost all prime agricultural land, were converted to urban use.<sup>77</sup> Such conversion increases demand for agricultural produce shipped

**Table 10. Travel and other characteristics of four concentric parts of the Toronto region.<sup>76</sup>**

	Core	Core ring	Inner sub-urbs	Outer Sub-urbs
Residential density (urbanised portion, persons/square km)	7,340	5,830	2,810	1,830
Percentage of households owning one or more cars	49%	75%	87%	96%
Income in 1991 (Can\$/person)	25,184	24,069	22,849	22,655
Income in 1991 (Can\$/household)	45,331	60,171	63,976	70,231
Travel by car (km/person/day)	7.5	10.2	15.0	25.6
Total travel by motorised transport (km/person/day)	11.1	14.2	18.7	27.0
Estimated CO <sub>2</sub> emissions resulting from travel (g/person/day)	1,710	2,280	3,222	5,200

from afar, and thus creates further demand for transportation.

Sprawl is mostly associated with low-density development of land that in turn is associated with high rates of automobile ownership and use. The conference was told that a 100-fold increase in residential density (from 100 to 10,000 persons per square kilometre) is associated with increases of only two to three times in total amount of travel and three to four times in total automobile use.<sup>78</sup> Data for the Toronto region, shown in Table 10, suggest a tighter relationship between density and travel. Similar data were presented at the conference for the New York and Paris regions.<sup>79</sup>

### Noise

Transport has been identified as the main cause of environmental noise. In OECD countries, 16 per cent of the population is exposed to noise levels from transport capable of severely disturbing sleep and communication, and thereby contributing to disease; an additional 50 per cent is exposed to “unsatisfactory” noise levels from transportation.<sup>80</sup> In Europe in particular, transport noise is often felt to be more of a concern than transport-related air pollution.

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## 3.5. Other costs of motorised transportation

The conference touched on some of the major non-environmental impacts of motorised transportation, including financial costs, accidents, congestion, and social disruption. They may or not be sustainable, in part according to one’s definition of sustainability. Some of them have indirect environmental impacts. For example, congestion usually results in traffic speeds that are below the optimum in terms of emissions.

### Financial costs

The most likely impact of the financial costs of transport on sustainability is lost opportunity: the amounts spent on transport might otherwise be spent on reducing other polluting activity. Thus a country that spends a relatively low proportion of its GDP on transportation (e.g., Japan, for which the proportion has been stated as 9 per cent) may have more resources available to spend on environmental protection than a country that spends more (e.g., the United States, for which the proportion of GDP spent on transportation has been stated to be 18 per cent).<sup>81</sup> Of course, the unused resources might be used for polluting activities. Moreover, a sharp distinction should be made between reducing resources allocated to transportation by keeping the costs of transportation low, on the one hand, and keeping transport activity at a low level, on the other hand. The former could result in *more* transport activity and a

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**Accidents**

Conference participants agreed that accident costs associated with transportation can be significant, and that many of these costs are not paid by transport users. There was no discussion as to how accidents might be unsustainable. Moreover, there was disagreement as to the relative importance of the unpaid costs of road accidents in relation to other unpaid costs. One participant argued that for all forms of road transport accidents comprise the most significant category of external (i.e., unpaid) costs, amounting in the case of cars to 65 per cent of all external costs.<sup>82</sup> Other participants recognised the significance of the unpaid costs of accidents but assigned much lower relative values.<sup>83</sup>

**Congestion**

As well as magnifying the adverse effects of transportation by causing vehicles to function at sub-optimal speeds and thus use more fuel and pollute more, congestion can have financial impacts in that it raises the cost of goods delivery by road and impedes productive human activity. Congestion eats into the time available for other activities. For many car commuters, congestion may not have an evident financial cost but it may be seen as having a social cost in that the time available for childrearing and other important social activity is reduced.

Congestion appears to be increasing. Certainly the number of vehicles per kilometre of road is increasing, as noted in Table 11. This table may overstate the potential for congestion because it does not take into account the increases in capacity through road widenings and improved traffic signalling that were implemented during the 1970s and 1980s.

**Table 11. Vehicles per kilometre of road, North America and Europe, 1970 and 1990.**<sup>84</sup>

	1970	1990	Δ%
North America	280	512	+83%
OECD Europe	364	674	+85%

Congestion may deter automobile use and may thus stimulate the use of more environmentally benign public transport, but less so if the public transport is also subject to the same congestion.

Simply expanding road networks to reduce congestion can have the counter-productive effect of increasing the volume of traffic with potentially offsetting or, in some cases, even more severe environmental consequences. Congestion may deter automobile use and may thus stimulate the use of more environmentally benign public transport, but less so if the public transport is also subject to the same congestion.

### **Social disruption**

The conference was warned of socially disruptive effects of motorised transportation that may be potentially stronger than those resulting from excessive expenditure on transport or from lost time due to congestion. Motorised personal transportation was described by one speaker as elitist, polarising, and undemocratic.<sup>85</sup> Another speaker said that the automobile has contributed to loss of community and solidarity.<sup>86</sup>

Social disruption due to motorised transportation, particularly the private automobile, was said at the conference to be more of an issue in Europe than in North America, although it should be noted that the two speakers mentioned in the previous paragraph came from different sides of the Atlantic. The main differences between North America in this respect may be merely temporal: motorisation in Europe, perhaps expressed most clearly in car ownership data, lags that in North America by some three decades.

One challenge in addressing the social impacts of transportation is the lack of pertinent data. Are the polarising effects of widespread automobile ownership matters of fact or opinion, likewise the effects on community coherence? A related challenge is the lack of cases where material affluence and other features of late-20th-century life in OECD countries have become evident in the absence of widespread motorisation. More work could be done on social factors in places such as Bermuda and Venice where private car ownership is restricted.

## 4. CAUSES OF THE GROWTH IN TRANSPORT ACTIVITY

This section notes the various factors in the growth in transport activity that were identified at the Vancouver conference. Factors in the growth in passenger traffic are noted first, and then factors in the growth in freight traffic. Each of the factors deserves a page of analysis—in some cases more; interactions among factors also deserve space. The brief noting here can be justified on the grounds that the conference's focus was on characterising sustainable transportation and planning for its attainment rather than on analysing the basis for current trends. Any program designed to secure sustainable transportation will likely be successful only to the extent that it addresses the multiplicity of factors that might be implicated in the movement of people and freight.

### 4.1. Passenger traffic

Several factors contributing to the growth in private automobile use were identified at the conference, including the following:<sup>87</sup>

1. **Automobile ownership:** This was characterised as the single most important step in boosting mobility.
2. **Affluence:** Automobile ownership and use vary positively with GDP per capita among countries and with personal or household incomes within countries.
3. **Residential density:** Automobile ownership and use vary inversely with residential density (see Section 3.4 above).
4. **Gender and age:** Men drive more than women; middle-aged people drive more than younger or older people.
5. **Number of trips:** High mobility is associated with making more trips rather than making longer trips.
6. **Purpose of trips:** The growth in trips almost entirely comprises trips for non-work purposes, including trips for educational, recreational, and social purposes, and for shopping and other family business, which now account for more than two thirds of motorised trips in most OECD countries.
7. **Mode of trips:** Most of the growth in trips comprises trips by personal automobile; the additional trips are mostly trips of kinds never made by public transport.

Automobile ownership was characterised as the single most important step in boosting mobility.

Little was said (or may be known) about why aviation has experienced the largest increases in activity of all modes. Important factors may include the greater significance of energy costs for aviation than any other mode, on the one hand, and the lack of taxes of any kind on fuel for aircraft, on the other.

8. **Cost of trips:** Automobile use is evidently related to its various costs, but the precise relationships are unclear. Most of the long-term price elasticity of fuel use arises from differences in the fuel intensity of cars, i.e., in the long term, raising fuel prices is more likely to cause the purchase of more fuel-efficient cars than to reduce the amount driven. Short-term price elasticities are much lower than long-term elasticities.
9. **Relative costs of ownership and use:** Countries with high ownership costs have lower per-capita car ownership but higher vehicle-kilometres-driven per vehicle. Countries with a native automobile industry tend to have lower taxes on ownership.
10. **Role of telecommunications:** Improved telecommunications was said to have the potential to *enhance* travel for these reasons: (i) the transaction costs of travel are reduced, meaning cheaper, more convenient travel; (ii) more workers can spend and are spending time on the road or in the air; (iii) constraints on where people live and work are relaxed; and (iv) telecommunications facilitates the acquisition of friends and acquaintances and the maintenance of relationships, stimulating more travel.
11. **The Jevons principle:** William Stanley Jevons, a 19th-century British economist, predicted that making coal burning more efficient would lead to more coal use rather than less as the more economic use of coal would lead to an expansion in its uses. The corresponding suggestion was made at the conference that improvements in fuel efficiency could result in more fuel use for transport not less.
12. **Power and weight of automobiles:** The power and weight of automobiles has increased (except in North America between 1975 and 1979, when there was a sharp decline), especially where company-car privileges are the rule. This is not evidently a factor contributing to automobile use, but it is a major component in the offsetting through use of improvements in energy efficiency.

Little was said (or may be known) about why aviation has experienced the largest increases in activity of all modes. Important factors may include the greater significance of energy costs for aviation than any other mode, on the one hand,<sup>88</sup> and the lack of taxes of any kind on fuel for aircraft, on the other.<sup>89</sup> The general globalisation of activity is a factor, although the extent to which it is a cause or a consequence of air transport activity remains to be determined.

Notwithstanding the kind of projections of increased travel represented in Table 2, one speaker at the conference proposed that (for the United States at least) automobile use will stabilise or decline.<sup>90</sup> Seven reasons were offered: (i) the costs of sprawl; (ii) inclusion of travel costs as a factor in the assessment of the debt-repaying ability of mortgagors; (iii) growth in demand for real estate co-located with employment and leisure opportunities; (iv) saturation of individual time and money budgets; (v) removal of tax exemption for municipal bonds, including those issued to pay for transport infrastructure; (vi) the introduction of road pricing and other user charges for transport infrastructure; and (vii) growth in the numbers of people who do not travel, mostly on account of age.



## 4.2. Freight traffic

The production of goods and services continues to become more “mobility intensive” on several counts, meaning that even without an increase in consumption there would be more freight movement.

There was relatively little discussion at the conference about factors contributing to the increase in freight traffic. Nevertheless, several factors were identified. One is increased consumption of goods and services—the result of growing affluence—which, other things being equal, results in more freight activity. Another is that the production of goods and services continues to become more “mobility intensive” on several counts, meaning that even without an increase in consumption there would be more freight movement.<sup>91</sup> A third factor, associated in part with the second factor, is the globalisation of business including the liberalisation of trade regulations. A fourth factor is the continued subsidisation and thus underpricing of transport. This last factor is common to the movement of both people and freight but may be of more significance for the latter because choices concerning freight may be more closely governed by market considerations.

Concerning consumption, it was noted at the conference that the use of materials for production expanded enormously until 1975 but has remained relatively constant since, notwithstanding growth in the economy. This plateauing reflects increased efficiencies in the use of materials, including those resulting from recycling processes.<sup>92</sup> Freight activity has increased nonetheless, because production has become more mobility intensive, in part to achieve the efficiencies in materials use.

Several factors contribute to the mobility intensive nature of the production and consumption of goods and services:<sup>93</sup>

1. **Just-in-time methods:** Use of these techniques allows manufacturers and wholesalers/retailers to dispense with warehouses; they rely on suppliers to deliver needed goods as required, resulting in more traffic.
2. **The dispersion and inter-linkage of production facilities:** An example is the automobile industry itself, which assembles vehicles from components produced at plants in several countries or even continents, resulting in more movement of goods (or at least more movement of manufactured goods).<sup>94</sup>
3. **Changes in consumer taste:** There are now demands, for example, for out-of-season fruits and for fruits from other places that were hitherto not available locally.
4. **The growth in tourism:** Tourism is not strictly a component of freight traffic, but its logistics and other attributes increasingly resemble freight rather than passenger transport.

There has been much location and relocation of retail activities to urban peripheries, driven in part by retailers' desires to shift responsibility for some freight movement to customers, thereby increasing the amounts of freight activity—albeit freight activity normally recorded as passenger activity.

1. **Spatial changes in shopping habits:** There has been much location and relocation of retail activities to urban peripheries, driven in part by retailers' desires to shift responsibility for some freight movement to customers, thereby increasing the amounts of freight activity—albeit freight activity normally recorded as passenger activity.
2. **Urban sprawl:** This is a component of the changes in shopping habits. It is also associated with dispersal of business activities and consequent increases in freight activity.

As well as contributing to increases in freight movement, globalisation of business was said to have the possibility of being a positive factor in the quest for sustainable transportation. A specific example that was proposed was globalisation's possible facilitation of the introduction of "supply-side innovations"—including high-speed rail,<sup>95</sup> which may presently have application only to passenger transport. The liberalisation of trade regulations was also endowed with the possibility of facilitating sustainable transportation, perhaps through opportunities to change practices that may arise as trade flows change.<sup>96</sup>

Important points concerning freight movement in urban areas were made at the conference. It was noted that even though freight is mostly considered to be an inter-regional or international activity, more than half of freight journeys take place wholly within urban areas, overwhelmingly by road.<sup>97</sup> In Japan, freight transport by road, particularly in urban areas, is seen to be the main transport problem.<sup>98</sup>

## 5. PRINCIPLES AND VISIONS OF SUSTAINABLE TRANSPORTATION

This section provides an account of the principles of sustainable transportation and strategic directions for achieving it that were developed for the Vancouver conference and discussed and modified there. The second part of this section provides an overview of a key discussion at the conference during which alternative visions of sustainable transportation were presented and contrasted. An important feature of the various discussions at Vancouver about the nature of sustainable transportation was general agreement that sustainability involves more than attainment of environmental criteria.

### 5.1. Canada's Sustainable Transportation Principles

To provide a shared vision to guide deliberations at the conference and the general movement towards sustainable transportation, Canada's Minister of the Environment asked Canada's National Round Table on the Environment and the Economy (NRTEE) to develop a set of principles designed to encourage thought and discussion about some of the key challenges facing the transportation sector.

There was general agreement at the Vancouver conference that sustainability involves more than attainment of environmental criteria.

The nine principles put forward by the NRTEE concern:

- entitlement to access
- intra- and inter-generational equity
- individual and community responsibility
- protection of health and safety
- education and public participation
- integrated planning
- conservation of land and other resources
- prevention of pollution, and
- economic well-being.

The principles were preceded by a problem statement and description of their context and followed by proposals concerning strategic directions and next steps.

In refining and supporting the nine Sustainable Transportation Principles as worthy of further consideration and development, participants noted the problem statement that framed the principles, the key sentence of which was this: “The challenge now is to find ways of meeting our transportation needs that are environmentally sound, socially equitable, and economically viable.”

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There was little systematic analysis of the instruments—financial, regulatory or promotional—that might be used to achieve sustainable transportation,<sup>99</sup> although there was some agreement at the conference as to the general approaches that should be employed. Participants discussed and amended 26 Strategic Directions presented in conjunction with the Sustainable Transportation Principles. They can be summarised as follows:

**Access:** Improve access to people, goods, and services, but reduce demand for the physical movement of people and things.

**Decision-making:** Make transportation decisions in an open and inclusive manner that considers all impacts and reasonable options.

**Urban planning:** Limit sprawl, ensure local mixes of land uses, fortify public transport, facilitate walking and bicycling, protect ecosystems, heritage, and recreational facilities, and rationalise goods movement.

**Environmental protection:** Minimise emissions and reduce waste from transport activity, reduce noise and use of non-renewable resources, particularly fossil fuels, and ensure adequate capacity to respond to spills and other accidents.

**Economic viability:** Internalise all external costs of transport including subsidies but respect equity concerns, promote appropriate research and development, consider the economic benefits including increased employment that might result from restructuring transportation, and form partnerships involving developed and developing countries for the purpose of creating and implementing new approaches to sustainable transportation.

The full text of the principle and strategic directions is appended to this review, in a manner that shows the changes made at the conference.

## 5.2. Visions of sustainable transportation

The conference explored three visions of sustainable transportation: a high-technology vision, a low-activity vision, and what might loosely be called the automobile industry vision.

Widespread use of the “hypercar” could mean we would run out of roads and patience rather than air and oil.

The **high-technology vision** centred around the notion of the “hypercar,” an ultralight and ultraslippery vehicle, moulded from advanced composites, with a hybrid-electric propulsion system, 5-20 times more fuel efficient than present cars, and yet “safer, sportier, probably cheaper, and more comfortable, durable, and beautiful.” Such an automobile, it was claimed, would meet public-policy goals of economy, environment, and security. It would also mean that “we would run out of roads and patience rather than air and oil.” Hypercars, it was proposed, would buy time for and increase the need for fundamental reforms in urban form and land use.<sup>100</sup>

The changes required to secure the low-activity vision are social rather than technological and are predicated on the notion that building cities with an assumption of automobile use and growth is no longer sustainable.

The high-technology vision was taken further by another participant who invited the imagination of “cars powered by pollution-free perpetual-motion engines, and built with materials that are cheap, and recyclable without imposing any burden on the environment; wide-bodied supersonic passenger aircraft with science fiction engines that make no noise and consume negligible amounts of energy; high-speed maglev trains powered by pollution-free electricity; and a super-Internet that connects everyone, without charge, to everyone else and every library and database in the world via portable computerphones.” The consequences of such a state of affairs, it was said, would be a socially polarised world that would be one continuous suburb peopled by aspatial communities of interest, with no opportunity to travel to unusual places, no fragile ecosystems, no street life, Orwellian law enforcement, remote political authority, and little in the way of democracy.<sup>101</sup>

Although the conference to a degree reflected the prevailing preoccupation with technological solutions to transportation problems, there was sympathy with the view that technical fixes can result in more problems than they resolve. Mention was made of the Jevons principle: named for a British economist who argued correctly in the 1860s that making coal burning more efficient would increase rather than reduce the use of coal, because there would be more economic uses of coal.<sup>102</sup>

Presentation of the **low-activity vision** began with the proposition that the central issue is “automobile dependence,” which can be interpreted to refer on the one hand to an innate disposition of humans to engage in motorised travel and on the other hand to a condition of reliance on automobile use for essential activities such as may be found in a rural area or a low-density suburb. Attainment of sustainable transportation, the argument continues, will require reductions in the use of motorised transport to be achieved by making it less desirable or less necessary than non-motorised transport, or both, or at least substitution of more benign forms of motorised transport such as buses and trains for less benign forms such as personal automobiles and aeroplanes.

The changes will involve giving non-auto infrastructure higher priority than auto infrastructure, developing land-use patterns that minimise the

It was said that road traffic is becoming environmentally less cumbersome, and concern over the financial stability of public transport will replace public concern over road traffic's environmental sustainability.

need for travel, and placing greater emphasis on community rather than individual values and on urban rather than suburban and exurban living conditions.

The **automobile industry vision** extolled the central place of private transportation in modern industrialised society, and noted the accomplishments of automobile manufacturers in absorbing new technologies and adapting them to the needs of their customers. The improvements in pollution control and cost effectiveness will continue, and the private automobile will be preferred even by people with the lowest incomes, and even though public transport will be “kept afloat” with large subsidies. Information technologies will make vehicles more efficient and replace some travel. Working hours will fall, resulting in increases in leisure time that people will choose not to spend in trains and buses. Road traffic, according to the automobile industry, has an important contribution to make towards achieving the increases in productivity necessary for environmental and social sustainability.<sup>103</sup>

## 6. ACHIEVING SUSTAINABLE TRANSPORTATION

This section opens with a note on the challenges and opportunities posed by urban areas. It continues with discussion of two potential requirements for sustainable transportation that were given strong emphasis at the conference: intensification of land use and the need to set targets. It then presents six of the controversies about attainment of sustainable transportation engaged in by participants. The section concludes with discussion of the need for consensus-building with respect to the attainment of sustainable transportation and with consideration of how it might be done.

### 6.1. Addressing the special challenges of urban regions

Most movement of people and much movement of freight occur in urban areas, although the exact proportions are mostly unknown on account of the ways in which data about movement are gathered. Urban areas are the focus of even more concern about transportation than might be expected from the amounts of movement there, because of the concentrations of vehicles and the proximity of people to them. Thus, when sustainable transportation is discussed it is usually urban problems that are analysed and urban solutions that are proposed.

Transportation, especially in urban areas, requires a comprehensive approach; it must not be considered in isolation from issues of governance, land-use planning, economics, and equity.

Speakers at the conference session on urban and suburban transportation stressed the point that transportation, especially in urban areas, requires a comprehensive approach; it must not be considered in isolation from issues of governance, land-use planning, economics, and equity.<sup>104</sup> What is needed, speakers said, is the development of strategies for cities that set “virtuous cycles” in motion rather than present vicious and often irreversible cycles of sprawl, automobile mobility, and reduced accessibility. A core issue is the city’s role as the genesis and embodiment of civilisation and the need to sustain that role in the absence of an obvious alternative.

The point was made that moves towards sustainable transportation may well require less investment than continuing with present means of transport activity. Such reduced investment is compatible with current atti-

tudes of fiscal restraint and diminishing budgets, particularly the budgets of city governments.

Local pollution from transport activity is overwhelmingly a phenomenon of urban areas, but the global impacts of transportation are less so. To the extent that concern about transportation becomes focused on its global impacts, interest in transport activity will move away from transportation in urban areas. Indeed, strong pleas were made at the conference for more work on inter-city travel and on aviation. However, as we move into what will be the first urban century,<sup>105</sup> most of the problems associated with transportation will continue to be seen as problems of urban areas, and most of the solutions to transport issues will be found in urban areas.

## 6.2. The importance of increasing urban and suburban densities

The powerful relationship between intensity of land use and movement of people is illustrated in Section 3.4 above: other things being equal, people who live in the denser inner parts of large urban areas travel much less, particularly by automobile, than people who live in the less dense outer parts.<sup>106</sup> Every urban area is experiencing more development at its periphery than elsewhere, and typically this development continues a pattern of low intensity of land use and associated high levels of transport activity.

Every urban area is experiencing more development at its periphery than elsewhere, and typically this development continues a pattern of low intensity of land use and associated high levels of transport activity.

Conference participants heard several appeals for intensification of land uses. These took several forms: (i) intensification of land already developed at low densities; (ii) intensive development of undeveloped land; and (iii) creation of high-density nodes or sub-centres within urban regions. Associated with the appeals for intensification were appeals for focuses on the provision of infrastructure for non-motorised travel and on the need to ensure mixes of land uses.

A challenge facing policy-makers concerns the applicability to other circumstances of the declining density and increasing travel found as one moves out from the core of large urban region. Do people who live in a high-density development at the edge of an urban region travel as little as people who live at a similar density in the core of the region? The answer to this important question is not known. If intensification at the edge of urban regions is found not to reduce travel, a better strategy might be to focus on expanding the high-density core of the region. One reason why high-density development at the edge of an urban region might not reduce travel is because it lacks the critical mass of activity compatible with living without the automobile.



Another challenge concerns the importance of mixed development. Mixing residential, commercial, and other land uses at the edge of an urban region may on analysis be found not to reduce travel because the residents of such areas may still be as likely to own—and therefore use—automobiles as those who live in suburban developments without a mix of uses. These residents may well seek employment and shopping opportunities outside the immediate mixed developments in which they live.<sup>107</sup> However, the mixing of different types of development may have socially beneficial results that do not include reductions in travel.

To be in the flow of things, and to ensure vital face-to-face contacts—nurturing and mentoring, both deliberate and accidental—home-workers may have to live in or near business centres.

The point was made that the common practice of taxing buildings and their uses more than land can be a major contribution to sprawl. Higher taxes on land would result in more efficient use of land.<sup>108</sup>

The growing and more sophisticated use of information technologies was said at the conference to have the potential for enhancing sprawl by relaxing the constraints on where people live and work (see Section 4.1). However, working at home, made increasingly possible by improved telecommunications, may be found to be an activity that for many people can be carried out more productively and with more satisfaction in an urban rather than a suburban environment. To be in the flow of things, and to ensure vital face-to-face contacts—nurturing and mentoring, both deliberate and accidental—home-workers may choose to live in or near business centres. Central business districts (downtowns) may offer the best opportunities for flexible home-work, work-home arrangements.<sup>109</sup>

Several barriers and stimulants to intensive urban development are noted in Section 7.1 (Table 13).

### 6.3. The importance of setting and enforcing targets

Several speakers at the conference emphasised the need for quantifiable goals or targets. Participants were advised, for example, that a key feature of the Austrian approach to sustainable transport has been the setting of “ambitious targets for reducing air pollution and noise.” They heard too that the starting point for the German Plan of Action on Environment and Transportation is “the derivation of traffic-related targets for the areas of climate protection, carcinogenic air pollutants, summer smog, damage to forests, acidification of soil and waters, noise, waste and waste management, land and nature conservation, and improvement of the quality of residential and urban life.”<sup>110</sup>

The main item of U.S. legislation concerning transportation, the *Intermodal Surface Transport Efficiency Act* (ISTEA), is less effective than the *Clean Air Act* because it does not provide quantified targets for the wide range of matters it is concerned with.

Participants were told that the application of specific targets to just one part of the transportation nexus could be detrimental to sustainability. The point was made that the clear targets for air quality set by the U.S. *Clean Air Act* are driving transportation decision-making, and “societal and sustainability goals unrelated to air quality are not incorporated into project evaluation.” It was noted that the main item of U.S. legislation concerning transportation, the *Intermodal Surface Transport Efficiency Act* (ISTEA), is less effective than the *Clean Air Act* because it does not provide quantified targets for the wide range of matters it is concerned with, including land use, congestion relief, freight movement, transit enhancements, the overall social, economic, energy, and environmental effects of transportation decisions.<sup>111</sup>

Participants were also told that specific targets should be set for the transportation sector. “If we do not have environmental targets for traffic, it will be extremely difficult to prevent polluters from passing the buck (cut CO<sub>2</sub> emissions from home heating but not from cars) or to establish a clear need for action in the transport field.”<sup>112</sup>

#### 6.4. Can information technologies reduce the need for mobility?

One speaker made a video-conferenced presentation, obviating his travel between Brussels and Vancouver.

The conference heard, and to a degree experienced, both sides of the argument that information technologies can substitute for mobility and thereby reduce travel. One speaker made a video-conferenced presentation, thereby obviating his travel between Brussels and Vancouver. (The question as to whether the environmental gains from the conference would at least offset the travel it had precipitated was raised in several sessions.<sup>113</sup>) Energy use for travel was avoided and conference participants experienced a presentation that might otherwise not have been available. They were also able to note the inadequacies of video-conferencing, particularly as a vehicle for dialogue in a conference situation.

Several arguments were made that enhanced information technologies might *increase* travel. These have been noted in Sections 4.1 and 6.1. Relevant data are few. They mostly concern what is known as telecommuting or teleworking; i.e., working some days at home instead of at the office. Here the effect of information technology seems clearly in the direction of reducing travel both for work purposes and overall.<sup>114</sup> Other aspects of information technology, such as those listed in Section 4.1, require investigation.

## 6.5. Are technological improvements counter-productive?

There were several controversies at the conference concerning the role and value of technological improvements to vehicles, fuels, and infrastructure. Many participants believed that technological approaches were given too much play at the conference. More attention, it was suggested, should have been given to means of reducing the amounts of movement, as opposed to making movement more environmentally benign.

This conference represented a new focus by the OECD on better management of the demand for movement of people and goods.

Associated with the concern about too strong a focus on technology were the two concerns noted in Section 5.2 above: that reliance on technology would lead to cultural and physical uniformity and political oppression, and that technical fixes can result in worse manifestations of what is being fixed (road-building can result in more rather than less congestion; fuel efficiency can result in more rather than less fuel use).

There was also a current of opinion at the conference that things may have to get worse before they get better, and that technological improvements, by softening the impact of a high level of mobility, may be removing the impetus to secure necessary changes.

Partly in response, the point was made that until now OECD's focus had been on the technological improvement of vehicles, fuels, and infrastructure, but this conference represented a new focus on better management of the demand for movement of people and goods.<sup>115</sup>

## 6.6. Should automobile ownership or use be restrained more?

An intriguing and unresolved controversy at the conference concerned the emphasis that should be placed on restraining automobile use as opposed to automobile ownership. As noted in Section 4.1, the conference was advised that automobile ownership is the single most important step in boosting mobility. The same speaker has noted too, however, that "owning a car *per se* leads to few environmental problems: A gas guzzler sitting in a garage pollutes and congests less than an efficient car driven several hours per day."<sup>116</sup> The conclusion from these observations was that taxes should be shifted away from the fixed costs of ownership to the variable costs of use—"to reflect the fact that most externalities arise from use of transportation."

Another speaker suggested that attempts to reduce ownership, as opposed to use, would be unpopular and perhaps impracticable in a democratic society. It was observed that recent position papers of both of the main political parties in the U.K. argue for an expansion of car ownership.<sup>117</sup> A

1994 report by a U.K. Royal Commission concluded, “the increased cost of mobility should be imposed on the use rather than on the ownership of cars, in part because we do not consider it equitable to erect high barriers against car ownership.”<sup>118</sup> The Commission went on to note that higher taxes on use would not be “significantly regressive” because fewer low-income households own cars.

The scant evidence suggests that loading costs on to ownership rather than use may be a little more effective in reducing travel by car and a little more equitable. Nevertheless, conference participants reflected the prevailing ethos, which is to favour taxing use rather than ownership.

It is instructive to examine how actual expenditures on ownership and use vary with income. U.K. data suggest, perhaps surprisingly, that low- and middle-income households spend more on the *use* of motor vehicles (variable costs) than they do on their ownership (fixed costs); high-income households tend to spend more on ownership.<sup>119</sup> Accordingly, increased taxes on ownership could be more progressive than increased taxes on use. This may not apply in other countries, where fixed costs often comprise a higher proportion of total automobile costs than in the U.K.<sup>120</sup>

Comparisons between countries are complex on account of differences in density and population and differences in the overall cost of automobile ownership and use. Available data nevertheless suggest that high ownership costs may be more strongly associated with low levels of use than high use costs. For example, automobile use in Denmark, which has high ownership costs and relatively low use costs, is considerably lower than use in Italy, which has relatively low ownership costs and high use costs.

The relationship between ownership and use *within* countries has been well established in cross-sectional and longitudinal studies. As might be expected, the largest differences in household travel patterns are found between households without a car and households that have one or more cars. However, such is the prevalence of automobile ownership in the United States, with the large majority of households owning two or more cars, the importance of ownership as a factor in trip generation in that country appears to have diminished.<sup>121</sup> Indeed, conference participants were advised that encouragement of ownership of several vehicles might be an environmentally sound strategy in the U.S.—although perhaps not in other countries—to allow for more appropriate matching of vehicles to the task at hand: small cars for urban travel, larger vehicles for inter-city travel, and so on.<sup>122</sup>

Conference participants were advised that “No one knows how to reduce travel other than by raising its cost.” To the extent this is true, the question of how the costs are applied is important. The scant evidence suggests that loading costs on to ownership rather than use may be a little more effective and a little more equitable. Nevertheless, conference participants reflected the prevailing ethos, which is to favour taxing use rather than ownership.

The ethos favouring putting constraints on use rather than ownership is not confined to OECD countries. Regarding Southeast Asia it has been argued, “If car restraint policies are to avoid penalising rural people and denying mobility to those who aspire to it, they will have to be carefully targeted against the use (not ownership) of cars in these urban areas.”<sup>123</sup> In Hong Kong, the (aborted) road pricing scheme of the mid-1980s was claimed to be fairer than other methods of traffic control because it did not make car ownership exclusive to the rich.<sup>124</sup>

The conference was warned that motorised personal transportation is elitist, polarising, and undemocratic. The paradox that widespread ownership of the means of such transportation is promoted in the name of democracy requires further examination.

Southeast Asia is the location of the one market economy where there is a systematic attempt to restrain ownership: Singapore. There, in response to evidence that constraints on use had been inadequate in terms of reducing noise and air pollution, a vehicle quota scheme was introduced that limits purchases of new vehicles to those successful in monthly auctions of entitlements to purchase. A feature of this scheme is the availability of “weekend cars,” which cost less and may not be used during normal business hours. Even the cost of a weekend car is much higher than the cost of a car in any OECD country.<sup>125</sup>

Consideration of what happens in Singapore inevitably raises the question again as to whether constraints on ownership are politically possible in a truly democratic society. As noted in Section 3.5 above, the conference was warned that motorised personal transportation is elitist, polarising, and undemocratic. The paradox that widespread ownership of the means of such transportation is promoted in the name of democracy requires further examination.<sup>126</sup>

Whatever the prevailing ethos and practice concerning automobile ownership, there will be many in society who do not own a car, because they are too poor, too old, too young, too infirm, too handicapped or too principled. Conference participants were asked to consider including among the principles or strategic directions to be adopted a statement that urban areas should be planned so as to increase opportunities for households to live without owning a car.

Ownership is not an either-or proposition; there are grades of ownership that differ in degree of attachment to a particular automobile and in availability of a vehicle. The most common alternative is leasing, which in terms of practical matters is hardly different from conventional ownership. More removed from conventional ownership is shared ownership, which appears to be a growing practice in parts of Europe and Canada. In a shared ownership arrangement, members commit to a monthly or yearly amount of automobile use, which is made available from a commonly owned pool of vehicles. Hardly different in practical reality from some forms of shared ownership may be regular car rental, which can usefully supplement an otherwise car-free existence.

Further examination of the importance of ownership for automobile use is required, and perhaps even more examination of the effectiveness of restraints on ownership in comparison with direct restraints on use. The paradox of the car-owning democracy also warrants further consideration.

## 6.7. Would full-cost pricing result in sustainable transport?

Several participants in the conference emphasised the need for a full-cost, life-cycle approach to issues of sustainability, including consideration of indirect energy costs. Not only should vehicles be sustainable (however defined) when in use, their production and disposal—and the production, maintenance, and disposal of essential infrastructure—should also be sustainable.<sup>127</sup>

Some participants argued that sustainability exists when the full social costs of an activity are paid, including intergenerational costs.<sup>128</sup> One difficulty with this kind of definition is the matter of estimating the costs of transportation. Taking into account human illness and death, ecosystem damage, and reductions in biodiversity, estimates have been made of the cost of the following impacts of transport activity: climate change, stratospheric ozone depletion, ground-level ozone formation, emissions of particulates, noise and vibration, land use changes, resource use, waste disposal, and water pollution and hydrologic impacts, among others. The costing is rarely satisfactory even when only present generations are considered.<sup>129</sup> More mundane consequences of mobility such as congestion may be more readily costed, but such estimates can also be controversial.<sup>130</sup>

Every conceivable cost of driving a car might have been identified and applied but cars might still be driven, with unsustainable effects on the environment and on availability of resources.

Another difficulty with defining sustainable transportation based on payment of full social costs is that payment of full social costs may nevertheless result in mobility that is environmentally unsustainable. Every conceivable cost of driving a car might have been identified and applied but cars might still be driven, with unsustainable effects on the environment and on availability of resources. A case could be made that such driving would be irrational; but several conference participants likened automobile use to the equally irrational behaviour involved in drug dependency.<sup>131</sup> (An argument could also be made that the continuation of unsustainable mobility would be evidence that not all costs had been identified and applied; but such an argument would be circular.)

There was widespread agreement at the conference that the users of motorised transportation of all kinds pay less than the full social costs of their use. Several externalities (i.e., unpaid costs) were identified, including the costs of waste disposal, water pollution, land use impacts, barrier effects, resource consumption, noise, air pollution, municipal

services, road facilities and land value, congestion, and accidents. One thorough analysis of the paid and unpaid costs of owning and operating the average automobile in the United States concluded that on average the paid costs amounted to \$1.09 per kilometre and the unpaid costs—covering all the items just listed—amounted to \$0.34 per kilometre.<sup>132</sup>

This same analysis of the paid and unpaid costs of automobile use found that the paid costs of ownership and use were in an approximate 60:40 ratio, not counting the paid costs of parking and accidents. Thus if the unpaid costs were to be internalised and added to ownership costs, they would raise ownership costs by 52 per cent, from \$0.65 to \$0.99 per kilometre. If they were added to use costs they would raise use costs by 78 per cent. (However added, they would raise total costs by 31 per cent.)

These increases seem large, but they would do no more than bring U.S. costs of owning and operating within the range of costs in Europe,<sup>133</sup> where the level of automobile use, although lower than in the United States, is nevertheless believed by many to be unsustainable. The elasticities of vehicle-kilometres-travelled with respect to fuel prices and overall costs for the 1- to 15-year period appear to be in the order of -0.4 and -1.0, respectively.<sup>134</sup> This means that a 78 per-cent-increase in fuel prices or a 31-per-cent increase in overall costs would over 15 years reduce distances travelled by in the U.S. by about 31 per cent; the resulting amounts of travel would still be above the range for European countries.<sup>135</sup>

Congestion pricing was proposed as being more equitable and also as providing the greatest benefits to travellers of all incomes. Charging by distance, through fuel prices or in some other way, was said to be more effective in reducing pollution.

There was some discussion at the conference of the most effective way of charging for use. Present charging systems for transportation, it was alleged, benefit the rich. Congestion pricing was proposed as being more equitable and also as providing the greatest benefits to travellers of all incomes. Charging by distance, through fuel prices or in some other way, was said to be more effective in reducing pollution.<sup>136</sup>

The conclusion that can be drawn from this analysis is that internalisation of the full social costs of automobile use may well *not* be sufficient to ensure sustainability. Moreover, definitions of sustainability in terms of avoidance of unpaid costs may well be inadequate. Achieving sustainable transport may well depend on additional actions, including the imposition of additional costs. Full-cost pricing is nevertheless a useful principle because the strong political argument can be made for it that the people responsible for polluting activity should pay the costs of that activity.

### 6.8. Should public transport be encouraged?

In the U.K. at least, high-income households are the major users of public transport and therefore of subsidies for it.

Questioning the value of public transport may seem heretical in a forum on sustainable transportation; but it was done at the Vancouver conference during the presentation of the automobile industry’s vision of sustainability, as noted in Section 5.2.<sup>137</sup> The argument made at the conference was that people do not want public transport and given that “road traffic is becoming environmentally less cumbersome” there may be less reason to support it financially.

Another reason not to provide public support for public transport flows from the analysis of household expenditures noted in the previous section. In the U.K. at least, high-income households are the major users of public transport and therefore of subsidies for it. In 1992, households with a gross income of more than £800 per week spent almost three times as much on public transport as the average household and, indeed, spent a higher proportion of their income on public transport than any lower income group.<sup>138</sup> Accordingly, it can be assumed, they were the greatest direct beneficiaries of subsidies for public transport. As they were also the biggest spenders on automobile ownership and use (although varying not quite so much from the average as in the case of public transport) it might be assumed that they also received the greatest *indirect* benefit of spending on public transport.

**Table 12. Primary energy use of different modes of transportation at different occupancies, in megajoules per passenger kilometre.<sup>139</sup>**

	Occupancy	
	25%	100%
Automobile:		
Diesel under 1.4 litres	2.26	0.57
Gasoline over 2.0 litres	4.65	1.16
Railway:		
German Inter-city	1.14	0.29
Brussels-Paris TGV	2.86	0.72
Bus:		
Double-decker	0.70	0.17
Minibus	1.42	0.35
Aircraft:		
Boeing 727	5.78	1.45
Airbus A320	4.02	1.15

The automobile industry’s claim that public transport may no longer have evident superiority over its products has merit, at least when extreme cases are considered. Table 12 suggests that a small diesel car is inherently less energy intensive than the most energy-intensive train; indeed, when full, a small car can be even less energy intensive than a double-decker bus—when the bus is only one quarter full. The reality is that the occupancy of private cars is generally less than the occupancy of public transport, at least during peak periods.<sup>140</sup> However, it is worth bearing in mind that the environmental superiority of public transport depends to a considerable extent on its being used; any bus with one passenger is likely to be less environmentally sound than an automobile carrying only the driver. It is also worth noting that high-quality inter-city public transport (i.e., planes and high-speed trains) may be more energy intensive than private cars.



If subsidies are removed from public transport then it becomes less affordable by the poor and less able to compete financially with the private automobile. The former problem may have no resolution other than the eradication of poverty, or a restructuring of society that reduces the need for travel. The latter problem can be resolved both by making automobile ownership and use more expensive or more unpalatable in other ways and by making public transport more appealing and convenient.

The environmental superiority of public transport is chiefly a matter of ensuring efficient operation—i.e., relatively high occupancies—although if the high occupancies are achieved by inducing trips that might not otherwise be made there may be no environmental gain.

The matter of the environmental superiority of public transport is chiefly a matter of ensuring efficient operation—i.e., relatively high occupancies—although if the high occupancies are achieved by inducing trips that might not otherwise be made there may be no environmental gain. There is also the issue of the performance of public transport vehicles, particularly buses. They are often among the noisiest and visibly most polluting vehicles on the road.

The continued growth in the ownership and use of private automobiles may well be unsustainable, but the simple substitution of trips for public transport for trips by automobile may not necessarily provide an environmental advantage. It could, however, provide other kinds of advantage, including the avoidance of the social problems associated with motorised personal transportation (see Section 3.5). Although support for public transport must play a role in the quest for sustainability, it may be of less significance than support for measures that reduce motorised travel of any kind.

## 6.9. Do the benefits of the automobile outweigh its costs?

Conference participants heard mostly about the various costs of use of motorised transport, and only a little about the benefits. They also heard a strong statement to the effect that the benefits of the automobile are substantially greater than the costs. The statement was buttressed by the results of several studies demonstrating the high level of preference for automobiles over other forms of travel.<sup>141</sup> The question as to whether preference is a valid indicator of benefit was not raised.

The issue for sustainability is not so much whether the benefits outweigh the costs but rather whether the costs are unsustainable.

The issue for sustainability is not so much whether the benefits outweigh the costs but rather whether the costs are unsustainable. If the costs are unsustainable, they presumably outweigh the benefits, although perhaps only for future generations.

## 6.10. Building a consensus about sustainable transportation

Most participants in the conference recognised the need for radical changes in technology or transport activity, or both, in order to secure transportation systems that might be considered sustainable. But, as one speaker noted, there is little experience of policies capable of bringing about the kinds of changes that are required.<sup>142</sup>

The view was often expressed that the most successful strategies for change may well be those that are based on a community-wide consensus concerning the need to act and the kinds of actions that should be undertaken. Differences between Portland and Vancouver, on the one hand, and Seattle, on the other hand, were provided as an example in this respect. Trends and the policy climate for sustainable transportation were reported as improving in the former two cities while degenerating in the latter city. In Portland's case, the difference was accounted for in terms of "a long history of civic engagement shared between business leaders, elected officials, and residents organised in dozens of neighbourhood associations that shape planning and policy reactively and proactively."<sup>143</sup> Vancouver's advantage was attributed in part to the establishment of its Alternative Transportation Centre, a venture of four levels of government, business, and non-profit organisations.<sup>144</sup>

In a similar vein, the value of Calgary's intensive series of Round Table meetings involving community leaders and urban design experts was said to be a positive force in the move to plan for new environmentally sustainable suburban communities in that city.<sup>145</sup>

The importance of the media in consensus-building was emphasised,<sup>146</sup> as was the potential role of communication through the World Wide Web.<sup>147</sup> A strong plea for community revitalisation and involvement through transportation was made that noted the "central and unifying role of walking ... in community life."<sup>148</sup> Walking, the oldest of transportation modes, should be seen not as a fringe activity but as "the heart of life itself," the central mode of movement around which other modes should be organised and subordinated.

Walking has a central and unifying role in communities and should be seen as the central mode of movement around which other modes should be organised and subordinated.

## 7. BARRIERS TO ACHIEVING SUSTAINABLE TRANSPORTATION

This section provides highlights of the conference discussions on barriers to the attainment of sustainable transportation, including barriers resulting from individual and societal attitudes, barriers concerning methods and approaches, barriers concerning governments, and barriers concerning the major role of particular kinds of transport in the economies of OECD countries.

### 7.1. Barriers involving individual and societal attitudes and trends

There is strong public support for steps that could be taken towards securing sustainable transportation

The conference was told that surveys in Canada and elsewhere have shown that there is strong public support for steps that could be taken towards securing sustainable transportation, including lower fleet emission standards, cleaner gasoline blends, and more use of alternative fuels. Increases in the costs of driving would be supported if the resulting revenue were applied to reducing air pollution from transportation. The surveys have shown that there is a willingness for people to change their behaviour to reduce the impacts of air pollution, including driving less, substituting walking for short trips and ride-sharing for longer ones, and taking public transport, if it were made more convenient.<sup>149</sup> The question arises as to why, with all this evident willingness to change, more is not done towards reducing transportation's impacts, both individually and collectively?

Individual transport behaviour can change quite radically—it does not reflect deeply held values. Changes are most likely to occur through experiencing alternatives.

A clue concerning the behaviour of individuals may be the phenomenon of *cognitive dissonance* whereby people reduce discrepancies between their behaviour and the problems it causes by underrating the problems. The conference was advised of experiments in the Netherlands that illustrated this phenomenon: the more thoroughly subjects were induced to think about the problems resulting from motorised traffic, the lower became their problem awareness. The subjects' initial judgement was that the collective situation is a problem but that their personal transport behaviour was hardly problematic. On further discussion, when the role of personal contributions became clearer, the response was to minimise the problem. The authors of this work concluded that the way to overcome

cognitive dissonance would be to couch needed changes positively, for

**Table 13. Barriers to and stimulants of intensive urban development.**<sup>152</sup>

<b>Barriers</b>	<b>Stimulants</b>
Global manufacturing and international economic interdependency that emphasises the need for good transportation and communications and disengages production from local markets.	The prospect of increased energy costs and uncertain energy supply.
Facilitation by telecommunications of (i) high-quality medical and educational services and entertainment at locations remote from the centres of large urban regions; (ii) the liberation of manufacturing and other production from locational constraints; and (iii) dispersal (and partial obsolescence) of office work.	The continuing need for face-to-face interaction. Emergence of anti-technology attitudes. Recognition of the cost and complexity of telecommunications.
The movement of influential personnel to high-amenity areas at the urban fringe in pursuit of low-density, quasi-rural environments, with jobs following these managerial groups.	Growing awareness of the need to preserve the countryside and to engage in ecologically sustainable development.
Encouragement of greater personal mobility through societal acceptance of the 'car-is-here-to-stay' mentality, with the assumption that there will be continuing public investment in transportation infrastructure.	Emerging information about the high costs of provision of infrastructure and other services in low-density areas, and of the lower costs of repairing inner-city decay and making use of available infrastructure.
Reinforcement of the preference for personal mobility through collective disfavour of public transport on account of its high subsidies, high marginal cost, perceived risks to personal safety, lack of privacy, and relative inconvenience and discomfort.	Increasing concern about the pollution, noise, and serious health risks associated with automobile dependency and commuting. Recognition of the existence of a large minority in urban areas that do not have use of a car.
Changes in shopping habits—including increased teleshopping and the location of huge 'category-killer' and other shopping facilities at suburban fringes—that draw people away from traditional urban cores.	A growth in understanding of the advantages of urban living, its excitements and conveniences, and cultural, social, and business opportunities—much of which depends on urban areas continuing to be marketing centres.

example, in terms of liberating space, money, and people-power.<sup>150</sup> Further points made at the conference were that individual transport behaviour can change quite radically—it does not reflect deeply held values—and that changes are most likely to occur through experiencing alternatives.<sup>151</sup>

At the societal level, several barriers to maintaining or creating a compact urban form were noted. Some of these are listed in Table 13 together with countervailing factors that might be exploited to overcome the barriers.

## **7.2. Barriers concerning methods and approaches**

A frequently-mentioned, already-noted barrier to progress towards sustainable transportation is the lack of targets and performance indicators (see Section 6.3). Also mentioned was the use of inappropriate and even perverse indicators of well-being, notably Gross National Product, which

gives more weight to a car journey than to a bicycle ride to the corner store.<sup>153</sup>

Barriers to the development of appropriate technology were noted, including (for fuel cells) high capital costs resulting from small-scale production, and lack of appropriate refuelling facilities.<sup>154</sup>

A strong case was made that the lack of integrated transport planning (ITP), of the kind developed and refined in the electric-power generation sector, is a barrier to the achievement of sustainable transportation. The hallmark of ITP is full-cost accounting of *all* available options to secure the access (as opposed to mobility) that people need in their daily lives, giving equal treatment of both demand-side as well as supply-side alternatives.<sup>155</sup>

It was argued that increased prices for transportation can happen in a democratic society only if users experiencing higher costs also experience improved system performance.

Other barriers were said to include the subsidisation of automobile use and the relatively low incremental costs of use. Associated barriers to change are potential equity impacts and political/institutional structures that favour continuation of present pricing systems. It was argued that increased prices for transportation can happen in a democratic society only if users experiencing higher costs also experience improved system performance.<sup>156</sup>

One speaker suggested that present legislation concerning safety requirements is a barrier to the introduction of relatively non-polluting, slow-moving neighbourhood vehicles, including small electrically powered vehicles. Presently all cars on the road must meet safety standards and speed requirements designed for freeway-capable vehicles.<sup>157</sup>

### 7.3. Economic barriers

A major barrier to reducing mobility is the implication (and perhaps the certainty) that it would be associated with a decline in the vehicle and fuel production industries and their associated activities, which together comprise between 10 and 20 per cent of economic activity in OECD countries.

Work is required to demonstrate how a transition could be made to a condition of sustainable transportation—one that depended on much-reduced mobility—without increasing unemployment and other kinds of hardship.

The question has already been raised—in Section 0—as to whether internal transport activity is a cost or a benefit: if one country spends more than another on transportation is it ahead or behind? One speaker made several specific points concerning possible financial and employment benefits of moves towards sustainable transport, including these:<sup>158</sup>

- Compact development requires less costly infrastructure.
- Bicycle facilities require less costly infrastructure.
- Highway construction involves less jobs per unit of investment than other forms of infrastructure.
- Much more of the money spent on public transport stays in the community than money spent on automobiles.
- Restricting automobile traffic in city centres usually stimulates retail sales.

Set against these benefits must be the prospect of substantial unemployment and community dislocation if there were to be a reduction in mobility. Clearly work is required to demonstrate how a transition could be made to a condition of sustainable transportation—one that depended on much-reduced mobility—without increasing unemployment and other kinds of hardship.

#### 7.4. Barriers concerning government

There were several references at the conference to barriers to progress towards sustainable transportation posed by the structures or practices, or both, of governments. For Canada, there was a plea for a strong leadership role by the federal government, notwithstanding its limited and declining jurisdiction in matters concerning transportation and the environment.<sup>159</sup> For Europe, the tendency towards decentralisation and subsidiarity was presented as a barrier to the implementation of technologies that could contribute to the reduction of environmental impacts.<sup>160</sup> It was also argued that the move to common EU standards has in some instances impeded the introduction of technological improvements: the EU's opposition to Danish implementation concerning catalytic converters was noted.

Responsibilities of transportation planners should be broadened to include helping people gain access to their basic requirements in ways not limited to transportation including, for example, reorganising the distribution of goods and facilitating electronic communication.

Also for Europe, what were described as “interaction failures” were presented as a barrier to the development of a process leading to efficient, safe, and sustainable transport systems.<sup>161</sup> Interaction failures were said to concern the interactions between the relevant actors interested in transport systems and consumers/voters. This barrier could be removed, it was said, through the medium of “intensified controversies about sustainable mobility,” perhaps mediated by networks of actors that are to become “social carriers of sustainable mobility objectives” with the European Commission taking the initiative in building the network. The Spanish Ciudades Accesibles program was offered as a model for overcoming interaction failures.

At a more local level there was a plea at the conference for a redrawing of the job classification of transportation planners, whose present mission is chiefly to keep traffic moving. Planners might be required to focus on making provision for non-motorised, sustainable transport rather than motorised transport.<sup>162</sup>

There was also a plea for co-operation and consensus building within the “transportation community” in Canada. This community was described as comprising federal, provincial, and municipal governments; carriers and shippers; manufacturers and suppliers; energy producers; labour; researchers; and citizens. Co-operation and consensus building are necessary because no one member of the transportation community is strong enough to impose its will on the others. A new entity is being created—the Centre for Sustainable Transportation—whose mission is “to provide leadership in achieving sustainable transportation in Canada by facilitating co-operative actions, and thus contributing to Canadian and global sustainability.”<sup>163</sup>

## 8. CONCLUSIONS

The Vancouver conference can be considered as having several outputs. One is the set of principles and strategic directions appended to this review. Another comprises conclusions derived from the presentations and discussions at the meeting. A preliminary set of such conclusions was presented at the meeting and accepted by the participants. It has been elaborated into the conclusions that follow:

1. Sustainable transportation is achieved when needs for access to people, services, and goods are met without producing permanent harm to the global environment, damage to local environments, and social inequity. This implies rates of use of non-renewable resources that do not exceed the rates at which renewable substitutes are developed, and rates of emission and of concentration of substances that do not exceed the assimilative capacity of the environment.
2. Systems of transportation used in OECD and some other countries are unsustainable. Substantial improvements in technology have been made, but their impact has been more than offset by growth in individual mobility and in the movement of freight. In most countries, current trends point away from sustainability.
3. Achievement of sustainable transportation will likely involve improvements in vehicles, fuels, and infrastructure, on the one hand, and reductions in personal mobility and in the movement of goods, on the other hand. It is possible that some improvements may be counterproductive, and even that things may have to get worse before they get better; environmental catastrophe may be the only sufficiently strong motivator for change in transport practices.
4. Present thinking focuses on measures concerning the use of vehicles—as opposed to ownership—designed to secure progress towards sustainable transportation. However, a focus on ownership may also be required, notwithstanding the political difficulties inherent in limiting ownership. Successful restrictions on use or ownership will require the development of satisfactory alternatives.
5. Moves towards life-cycle analysis, full-cost accounting, and full-cost pricing are desirable components of strategies for achieving sustainable transportation. However, full-cost pricing may not be enough to



secure sustainability; even higher prices may have to be imposed, or other measures.

6. Other key components of strategies for moving towards sustainable transportation are measures to increase urban and suburban densities of land use and the setting and enforcing of targets that represent required changes in environmental and other indicators concerning transportation.
7. More work needs to be done on the identification and removal of barriers to securing progress towards sustainable transportation, including societal attitudes and trends, government and corporate practices, and the prospect of economic adversity. Work is required also on how the economic benefits associated with moves towards sustainable transportation might be enhanced.
8. Two other areas requiring further work with respect to the attainment of sustainable transportation are aviation generally and the inter-city movement of people and freight and aviation generally. Both areas been somewhat neglected in the series of OECD meetings, in part because there are relatively few relevant data.

The Vancouver conference provided several additional outputs of potential use to the OECD and to the Government of Canada. In particular, the networks of experts and officials interested in sustainable transportation were much expanded. Continuing work on sustainability—on sustainable transportation in particular—was greatly enriched by the material presented at the conference and by the discussions there.

Discussions about transportation are usually caught up in details of vehicles, fuels, infrastructure, and traffic management. This conference provided a rare opportunity to focus on visions, principles, and directions. Its proceedings have been criticised for not conveying a sufficiently strong sense of urgency about the challenges concerning transportation that face governments, communities, and business.<sup>164</sup> That being acknowledged, what happened in Vancouver may well influence work on transportation for several years ahead.



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**SUSTAINABLE TRANSPORTATION**  
**PRINCIPLES**

## Draft Sustainable Transportation Principles

*Note: The following set of draft principles were developed by Canada's National Round Table on the Environment and the Economy through a consultative process with a number of Canadian transportation stakeholders. They were developed at the request of Canada's Minister of the Environment, and were tabled for discussion at the March 1996 OECD Conference on "Towards Sustainable Transportation" held in Vancouver, B.C. They were revised and amended at that meeting, and further developed by OECD's Task Force on Transport.*

### Problem Statement

Our current transportation system is not on a sustainable path. Our admirable achievements in terms of mobility have come at some considerable environmental as well as social and economic cost. The challenge now is to find ways of meeting our transportation needs that are environmentally sound, socially equitable and economically viable. Accessibility, not mobility, is the issue.

### Context

Humans are inherently mobile, and in most societies, mobility is both highly valued personally and essential for social and economic reasons. Over time, however, as population has increased, cities have grown, and globalisation and free trade have increased the regional and international movement of people and goods, our transportation infrastructure and systems have expanded dramatically. The cars, trucks, buses, subways, trains, aeroplanes, ships and ferries that we use to move ourselves and our goods today have significant environmental implications in terms of energy and material resource uses, environmental pollution, noise and land use at local, regional and global level.

In many countries, transportation infrastructure is increasingly devoted to motor vehicles - chiefly automobiles. The increased use of the private automobile is a major contributor to air quality problems and global climate change. While emission rates on a per kilometre driven basis have been substantially reduced in the last two decades, the enormous increase in the number of vehicles and their use has offset these gains.

In addition, while the emphasis on roadways for cars has increased mobility and independence for many, it has had a negative impact on the quality of life of others. Those far less able to access automobiles (the poor, the disabled, women, the elderly etc.) have fewer transportation options. Road infrastructure has tended to make more sustainable options such as walking and bicycling more difficult to use, and it often detracts from the aesthetic appeal of our urban and rural environments, and consumes land that is extremely valuable for other uses (for example

agriculture). In many urban areas, however, public transport infrastructure has not had the capital funding necessary to provide commuters with a suitable alternative to the use of the automobile.

The health and safety of people have also been threatened by air quality and noise problems and traffic accidents associated with increased car and truck use. In larger urban centres, traffic congestion causes losses in productivity, quality of life and health (increased stress, in particular by high noise levels).

While the transportation sector is an important economic sector, contributing both directly and indirectly to jobs and export earnings, social costs from transport and the costs of maintaining and updating transportation infrastructure and services continue to rise, and many governments can no longer afford to support this kind and pace of infrastructure development.

## **Guiding Principles**

The aim is to develop transportation systems that maintain or improve human and ecosystem well-being together - not one at the expense of the other. Due to varying environmental, social and economic conditions between and within countries, there is no single best way to achieve sustainable transportation systems. A set of guiding principles can be described, however, upon which transition strategies should be built.

## **Access**

Access to people, places, goods and services is important to the social and economic well being of communities. Transportation is a key means, but not the only means, through which access can be achieved.

### **Principle #1: Access**

People are entitled to reasonable access to other people, places, goods and services, as well as responsible information that empowers them towards sustainable transportation.

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## **People and Communities**

Transportation systems are a critical element of a strong economy, but can also contribute directly to building community and enhancing quality of life.

### **Principle #2: Equity**

Nation states and the transportation community must strive to ensure social, interregional and inter-generational equity, meeting the basic transportation-related needs of all people including women, the poor, the rural, and the disabled. Developed economies must work in partnership with developing economies in fostering practices of sustainable transportation.

### **Principle #3: Individual and Community Responsibility**

All individuals and communities have a responsibility to act as stewards of the natural environment, undertaking to make sustainable choices with regard to personal movement and consumption

### **Principle #4: Health and Safety**

Transportation systems should be designed and operated in a way that protects the health (physical, mental and social well-being) and safety of all people, and enhances the quality of life in communities.

### **Principle #5: Education and Public Participation**

People and communities need to be fully engaged in the decision-making process about sustainable transportation, and empowered to participate. In order to do this, it is important that they be given adequate and appropriate resources and support, including information, about the issues involved, as well as the benefits and costs of the array of potential alternatives .

  
**Principle #6: Integrated Planning**

Transportation decision makers have a responsibility to pursue more integrated approaches to planning.

**Principle #7: Land and Resource Use**

Communities should be designed to encourage sustainable transportation and enhance access, as a contribution to providing comfortable and congenial environments for living. Transportation systems must make efficient use of land and other natural resources while ensuring the preservation of vital habitats and other requirements for maintaining biodiversity.

**Environmental Quality**

Human activities can overload the environment's finite capacity to absorb waste, physically modify or destroy habitats, and use resources more rapidly than they can be regenerated or replaced. Efforts must be made to develop transportation systems that minimise physical and biological stress, staying within the assimilative and regenerative capacities of ecosystems, and respecting the habitat requirements of other species.

**Principle #8: Pollution Prevention**

Transportation needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes.

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## **Economic Viability**

Sustainable transportation systems must be cost effective. If adjustment costs are incurred in the transition to more sustainable transportation systems they should be equitably shared, just as current costs should be more equitably shared.

### **Principle #9: Economic Well-Being**

Taxation and economic policies should work for, and not against, sustainable transportation, which should be seen as contributing to improvements in economic and community well-being. Market mechanisms should support fuller cost accounting, reflecting the true social, economic and environmental costs, both present and future, in order to ensure users pay an equitable share of costs.



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## **Strategic Directions**

A number of strategic directions are proposed for moving toward sustainability in transportation. Many of these strategic actions respond to more than one of the guiding principles outlined above.

### **Access:**

#### **Complementarity of Options**

- Improve access by providing environmentally sound transportation options best adapted to the specific circumstances, giving people attractive choices as to how they meet their access needs.

#### **Demand Management**

- Reduce the need for travel while protecting social and economic needs for access by changing urban form, promoting new communications technologies, and developing more efficient packaging and delivery of goods etc.

### **People and Communities:**

#### **Decision Making Processes**

- Make transportation-related decisions in an open and inclusive process. Inform the public about transportation options and impacts, and encourage them to participate in decision making so that the needs of different communities (i.e. rural versus. urban; cyclists versus. drivers, etc.) can be understood and accounted for.
- Ensure public and private sector stakeholders co-ordinate their transportation planning, development and delivery activities for the different transport modes to achieve integrated solutions. These transportation decisions should also be integrated with environment, health, energy, financial, and urban land-use decisions.
- Anticipate environmental or social impacts of transportation-related decisions by improving impact assessment and using life-cycle analysis rather than trying to react to them after the effects have occurred. This will result in considerable cost savings since transportation decisions often involve costly, long-term infrastructure investments.
- Consider both the global and local social, economic and environmental effects of decisions, and minimise negative effects.

## **Education of the Public**

- Ensure adequate education, disclosure of information and raising awareness to allow the public to recognise the full costs and benefits of alternative transportation choices. Public participation will be critical at all stages in the transition to sustainable transportation.

## **Urban Planning and Transportation Planning**

- Limit urban sprawl and provide for more mixed land use through urban structure, economic and land use policies. This would reduce demand (especially for automobile trips) by moving origins and destinations closer together and also help reduce habitat destruction and loss of agricultural and recreational lands.
- Give priority to less polluting, lower impact modes of transportation in the design of transportation systems and urban areas. Pedestrian and cycling paths should be provided as attractive and safe alternatives to cars.
- Maintain and enhance the performance and viability of urban public transit systems.
- Reconsider the organisation of transport modes, whether for passengers or goods, in order to provide more environmentally efficient goods movement, and to increase the availability and attractiveness of lower impact transportation options such as public transit.
- Protect historical sites and archaeological resources, and consider both safety and attractiveness in the planning, design and construction of transportation systems.

## **Environmental Quality:**

### **Environmental Protection and Waste Reduction**

- Minimise transportation-related emissions of air pollutants and discharges of contaminants to surface (fresh and salt water), ground water and soils.
- Minimise the generation of waste through each phase of the life-cycle of transportation vehicles, vessels and infrastructure. Reduce, reuse and recycle.
- Recognise that traffic noise is a significant nuisance for people and animal life, and set decibel level standards accordingly.
- Ensure that the rate of use of renewable resources does not exceed rates of regeneration, and non-renewable resource use is minimised.
- Ensure emergency management systems are in place in order to respond to spills, hazardous substances releases and other transportation-related accidents.

## Land Use

- Emphasise compact urban form in order to reduce habitat destruction and division of ecosystems, and loss of agricultural and recreational lands around urban areas.
- Reorganise cities primarily around transport services that minimise land use.
- Minimise division of land, its use as well as the impact on natural habitat and the wildlife and people it supports in the design, construction and operation of inter-city transportation systems and infrastructure, including, for example, highways, pipelines, and railways.

## Energy Use

- Improve quality of fuels to reduce their impacts on health and the environment.
- Reduce fossil fuel consumption and other transportation energy uses through improving efficiencies and demand management.
- Promote the use of alternative fuels and renewable energy.

## **Economic Viability:**

### Fuller-Cost Accounting

- Identify and recognise public supports and subsidies (hidden or otherwise) to all modes of transport and make transportation decisions accordingly.
- Reflect the full social, economic and environmental costs (including long term costs) of each mode of transport or transport related practice as accurately as possible in market prices.
- Ensure users and others benefiting from transport systems pay a fuller share of all costs, while respecting equity concerns.

### Research and Technological Innovation

- Promote research and development of innovative alternative technologies and types of organisations that improve access and help protect the environment. The emphasis should be on providing a wide range of transportation options with a view to achieving the best environmental solution for a particular circumstance.
- Promote research and development on better adapting economic instruments to environmental challenges, in particular addressing long-term concerns, irreversibility of changes and threshold effects (“switching”) of the global ecosystem.



## Job Creation

- Consider the potential economic, social and employment benefits that could be derived from the restructuring of present transportation systems, in particular for those sectors involved in construction of infrastructure that need to adapt to new markets.

## Partnerships with Developing Countries

- Developed and developing economies should form strategic partnerships in order to create and implement new approaches to sustainable transportation. Specific initiatives with respect to access to information, impact assessment and evaluation, clean and resource efficient technology, and financial resources should be strongly supported.

## **Next Steps**

- Every effort should be made to encourage and invite further work on the development and wider dissemination of this set of principles.
- Identify and remove the various barriers to sustainable transport, and provide actors and stakeholders with the necessary competence and resources to facilitate the inevitable transition.
- A process needs to be established whereby indicators of sustainable transportation, as well as short, medium, and long-term benchmarks, targets and goals are established. In particular, the relationship between moving towards sustainable transportation and meeting the targets set by the FCCC (as already adopted by the OECD countries) should be directly addressed.
- An environment that facilitates and encourages experimentation around transportation alternatives should be promoted. Those experiments aimed at diversifying options or demonstrating potential economic and social benefits should be given priority. Best practices and already working alternatives from around the world should be examined, highlighted, and shared.
- A substantial effort should be made to articulate and emphasise the potential benefits of moving towards sustainable transportation systems.



**CONFERENCE PROGRAM**

**INTERNATIONAL CONFERENCE  
TOWARDS SUSTAINABLE TRANSPORTATION**

**Final Program**

**March 24 - 27 1996**

Vancouver, British Columbia  
Waterfront Centre Hotel  
900 Canada Place Way

**Presented by:**

Organisation for Economic Co-operation and Development (OECD) and collaborating international organisations

**Hosted by:**

Government of Canada

**Sponsored by:**

B.C. Ministry of Environment, Lands and Parks  
Canada Mortgage and Housing Corporation  
Environment Canada  
Foreign Affairs and International Trade Canada  
Health Canada  
Industry Canada  
Natural Resources Canada  
Superior Propane  
The E7  
Transport Canada  
Turbodyne Technologies Inc.  
Westcoast Energy

## The Program

### Sunday, March 24

18:00-20:00 Registration and Reception  
(Foyer and Ballroom A/B)

### Monday, March 25

08:00-09:00 **Registration**

09:00-10:00 **Session 1a - Opening Ceremony**

Speakers:

**Bill Long**, Environment Directorate, OECD

**The Honourable David Anderson**, Minister of Transport, Canada

**The Honourable Moe Sihota**, Minister of the Environment, Lands and Parks,  
British Columbia

Master of Ceremonies:

**G. Victor Buxton**, Transboundary Air Issues, Environment Canada

10:00-12:00 **Refreshments**

10:30-12:00 **Session 1b - The End of the Road**

This session will set out how and to what extent current transport practices and trends are unsustainable, and what will happen if they continue. Subjects to be covered include trends in transportation throughout the world and their environmental, economic, and social impacts.

Co-Chairs:

**Jae Hyun Lee**, Ministry of Environment, Korea

**Doug Russell**, Air Pollution Prevention Directorate, Environment Canada

Speakers:

**James MacKenzie**, World Resources Institute, U.S.A.

**Laurie Michaelis**, Environment Directorate, OECD

**Lee Schipper**, International Energy Agency

**Wolfgang Zuckermann**, Author of End of the Road: From World Car Crisis to Sustainable Transportation, France.

Rapporteurs:

**Marie Schingh**, Natural Resources Canada

**John Whitelegg**, Eco-Logica Ltd., U.K.

Discussion from the floor

## APPENDIX B: CONFERENCE PROGRAM

12:00-13:00

### Lunch

#### **Sustainable Transportation and Information Technology**

Peter Johnston, European Commission

13:00-15:00

### **Session 1c - Drivers for Change**

This session will continue the analysis of present practices and trends, focusing on particular issues including consumer factors, climate change, aircraft emissions, and the health impacts of transportation.

Co-Chairs:

**Roy Hickman**, Environmental Health Directorate, Health Canada

**Robert Larson**, Environmental Protection Agency, U.S.A.

Speakers:

**Daniel Sperling**, University of California, U.S.A.

**James Bruce**, Canadian Climate Change Program Board

**Peter Wiederkehr**, Environment Directorate, OECD

**Jane Warren**, Health Effects Institute, U.S.A.

Rapporteurs:

**Sandra Bos**, University of Groningen, Netherlands

**Morgan MacRae**, Canadian Energy Research Institute, Canada

Discussion form the floor

15:00-15:30

### **Refreshments**

15:30-17:30

### **Session 1d - Looking down the Road**

This session will explore three visions of sustainable transportation: the incremental technology vision of the automobile industry, a vision based on the introduction of major technological advances in vehicles and fuels, and a vision that focuses on achieving sustainable transportation through reducing the amount of movement of people and goods.

Co-Chairs:

**Al Cormier**, Canadian Urban Transit Association

**Don Fast**, B.C. Ministry of Environment, Lands and Parks

Speakers:

**Amory Lovins**, Rocky Mountain Institute, U.S.A.

**Peter Newman**, Murdoch University, Australia

**Achim Diekmann**, Verband der Deutschen Automobilindustrie, Germany

Panel Discussion:

**Deborah Bleviss**, Department of Energy, U.S.A.

**Gunther Ellwanger**, International Union of Railways, Paris

**Martin Kroon**, Ministry of Housing, Planning, and the Environment, Netherlands

*(Session 1d, continued)*



## APPENDIX B: CONFERENCE PROGRAM

**Ricardo Neves**, Institute of Technology for the Citizen, Brazil  
**Roberta Nichols**, Formerly with the Ford Motor Company, U.S.A.

Rapporteurs:

**Jay Barclay**, Global Air Issues Branch, Environment Canada  
**Marie Thynell**, Institute for Interdisciplinary Studies, Sweden

Discussion from the floor

19:30-21:00                      **Session 1e - Air Transportation** (Informal)  
(No simultaneous translation provided)

The movement of people and freight by air is of concern because it is the fastest growing mode of transport, although presently it accounts for only a small part of transportation contribution to local and global pollution. This session will comprise a relatively informal examination of the environmental impacts of air transport and of other matters concerning the sustainability of air transportation.

Moderator:

**Jeremy Cornish**, Centre for International Aviation and the Environment,  
Canada

Speakers:

**John Crayston**, International Civil Aviation Organisation  
**Henk Brouwer**, Ministry of Housing, Spatial Planning and the Environment,  
Netherlands

Rapporteurs:

**Hélène Tanguay**, University of Toronto, Canada  
**Henrik G. Erlingsson**, National Environmental Research Institute, Denmark

### **Tuesday, March 26**

08:00-09:00                      **Registration**

08:00-09:00                      **Keynote Address:**

**The Honourable Sergio Marchi**, Minister of the Environment, Canada

09:00-10:00                      **Session 2a - Guiding Principles for the  
Achievement of Sustainable Transportation**

Canada's National Round Table on the environment and Economy (NRTEE) has undertaken to develop a set of guiding principles for consideration by the conference. These will be presented by the chair of the NRTEE and then discussed by an expert panel and the conference as a whole. A drafting committee will consider what is said at this session and (*Session 2a, continued*)

## APPENDIX B: CONFERENCE PROGRAM

present a revised set of principles for possible approval during Session 3b.

Co-Chairs:

**José Capel Ferrer**, United Nations Economic Commission for Europe  
**David MacDonald**, United Nations Association, Canada

Speaker:

**Stuart Smith**, Chair, NRTEE, Canada

Panel Discussion:

**Per Kågeson**, European Federation for Transportation and Environment, Belgium  
**David Martin**, Energy Technology Support Unit, U.K.  
**André Schrade**, Office fédéral de l'environnement, Switzerland  
**Zmarak Shalizi**, World Bank  
**Sue Zielinski**, City of Toronto, Canada

Rapporteurs:

**Maureen Allalat**, Department of Trade and Industry U.K.  
**Peter Timmerman**, University of Toronto, Canada

10:00-10:30	<b>Refreshments</b>
10:30-12:00	<b>Discussion from the floor</b>
12:00-13:00	<b>Lunch</b>

**The Role of the Media in Achieving Sustainable Transportation**  
**Luis Manuel Guerra**, INAINE, Mexico

13:00-15:00                      **Session 2b - Barriers and Roadblocks**

This session will identify the ways in which policy decisions about transportation and the environment are taken and identify the economic, technological, and political barriers to the pursuit of sustainable transportation visions.

Co-Chairs:

**G. Victor Buxton**, Transboundary Air Issues, Environment Canada  
**Francisco Fernandez Lafuente**, Secretary of State for Territorial Policy and Public Works, Spain

Speaker:

**John Adams**, University College London, U.K.  
**Eric Britton**, EcoPlan International, France  
**Lars Hansson**, University of Lund, Sweden  
**Michael Replegle**, Environmental Defense Fund, U.S.A.

*(Session 2b, continued)*

Rapporteurs:

## APPENDIX B: CONFERENCE PROGRAM

**Grant McVicar**, Manitoba Energy and Mines, Canada

**David Miles**, European Commission

Discussion from the floor

15:00-15:30

### **Refreshments**

15:00-17:30

### **Session 2c - Urban and Suburban Transportation**

Cities are the locus of most transportation activity and must be an important focus of efforts to achieve sustainable transportation. As in other developed countries, over three quarters of Canadians live in urban areas, where most economic activity and environmental impacts occur. This session will provide the conference's focus on the critical challenges posed by the movement of people and goods in urban areas and by related land-use planning issues.

Chair:

**Douglas A. Stewart**, Canada Mortgage and Housing Corporation

Speaker:

**Jean-Pierre Orfeuill**, National Institute for Research on Transport and its Safety, France

**Michael Bach**, Department of Environment, U.K.

**Neal Irwin**, IBI Group, Canada

Panel discussion:

**Michel Labrecque**, Vélo Québec, Canada

**Clive Rock**, Greater Vancouver Regional District, Canada

**Charles Vlek**, University of Groningen, Netherlands

**Paul Zykofsky**, Local Government commission, U.S.A.

Rapporteurs:

**Mikel Murga**, Leber, Spain

**Peter Spurr**, Canada Mortgage and Housing corporation

Discussion from the floor

### **Wednesday, March 27**

08:00-09:00

### **Registration**

08:30-10:00

### **Session 3a - Industry and the Global Economy--Trade-Related Challenges**

The globalisation of markets presents special challenges and opportunities for the achievement of sustainable transportation. Some aspects of globalisation are consistent with sustainability; others suggest the opposite. This session will explore the possibly  
(*Session 3a, continued*)

conflicting interpretations and trends and evaluate the potential implications of globalisation for sustainable transportation.

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Co-Chairs:

**Peter Fawcett**, Foreign Affairs and International Trade, Canada

**Michael Lawrence**, Jack Faucett & Associates, U.S.A.

Speakers:

**Ken Eriksen**, Washington State University, U.S.A.

**Dereck Scrafton**, Transport Ministry, Government of South Australia

**Anthony Perl**, University of Calgary, Canada

Panel discussion:

**Dale Andrew**, Trade Directorate, OECD

**Steve Bernow**, Tellus Institute, U.S.A.

**Tom Hart**, University of Glasgow, U.K.

**Yuishi Moriguchi**, National Institute of Environmental Studies, Japan

Rapporteurs:

**Philippe Crist**, EcoPlan International, France

**Kurban Ali Keshvani**, B.C. Ministry of Environment, Lands and Parks

10:00-10:30

**Refreshments**

10:30-12:00

**Session 3b - New and Emerging Policy Initiatives**

This session will review national programs and plans concerning transportation and the environment and their relevance to sustainable transportation, with a focus on Canada and the United States.

Co-Chairs:

**H.A. Clarke**, Environmental Protection Services, Environment Canada

**Setsuo Hirai**, Air Quality Bureau, Environment Agency, Japan

Speaker:

**Bill Long**, Environmental Directorate, OECD

**David Bell**, Environmental Stewardship, Transport Canada

**Mary Nichols**, Environmental Protection Agency, U.S.A.

Panel Discussion:

**Benjamin Dessus**, CNRS, France

**Axel Friedrich**, Federal Environmental Agency, Germany

**John Hartman**, Transportation Association of Canada

**Robert Thaler**, Federal Ministry for Environment, Austria

*(Session 3b, continued)*

Rapporteurs:

**Philip Fleming**, Environmental Affairs Branch, Industry Canada

**Ronald Neville**, Apogee Research International Ltd., Canada

## APPENDIX B: CONFERENCE PROGRAM

12:00-13:00

### Lunch

#### **The E7 and Sustainable Transportation**

**Diane Wittenberg**, Southern California Edison, U.S.A.

13:00-14:30

### **Session 3c - Towards Sustainable Transportation**

This session will review, discuss, and possibly adopt the principles for sustainable transportation put forward by the drafting committee, based on the discussions during Session 3a. It will also consider and possibly adopt the report on the conference prepared by the rapporteurs and associated recommendations based on the work of the conference.

Chair:

**Mark Nantais**, Motor Vehicle Manufacturers Association, Canada

Presentation of Revised Draft Principles

**David MacDonald**, Chair of Drafting Committee

Conference Overview and Recommendations

**Richard Gilbert**, Chief Rapporteur

Discussion from the floor

14:30-15:00

### **Refreshments**

15:00-16:00

### **Session 3d - Closing Ceremony**

Speakers:

**G.Victor Buxton**, Transboundary Air Issues, Environment Canada

**Bill Long**, Environmental Directorate, OECD



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**CONFERENCE ABSTRACTS**

## **Making the Path to Sustainable Transportation**

**James J. MacKenzie**  
Senior Associate  
Climate, Energy, and Pollution Program  
World Resources Institute

Speaker  
Session 1b

Continued near-exclusive reliance on oil-powered motor vehicles as the backbone of ground transportation is not sustainable and will lead to: increased risks from reliance on insecure and finite oil resources; an aggravation of global warming; an exacerbation of urban air pollution; and condemnation of the world's metropolitan areas to deepening congestion. The carbon-based "alternative" fuels -- ethanol, methanol, and compressed natural gas (CNG) -- are unable to solve the underlying problems of non-sustainability inherent in the present burning of petroleum. The vehicles of the 21st century are almost certain to have electric drive-trains, with the electricity supplied by batteries, hydrogen fuel cells, flywheels, and ultra capacitors. In the long term, electricity and hydrogen for transportation will be derived from renewable, domestic, pollution-free sources.

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## **Greenhouse Gas Abatement in the Transport Sector**

**Laurie Michaelis**  
Environment Directorate  
OECD

Speaker  
Session 1b

If historical trends continue, greenhouse gas emissions from the transport sector are likely to grow substantially in the next 20 to 30 years. This growth could be checked by the implementation of policies to encourage the development and use of energy-efficient vehicles, manage the growth in vehicle use, and shift to alternative patterns of land-use, transport, and energy supply.

Many greenhouse gas mitigation policies for the transport sector have been tried or analysed. While increases in fuel taxation are likely to be the most cost-effective means of reducing greenhouse gas emissions, transport fuel taxes in most countries are already higher than those on other fuels, and increases can be difficult to justify politically. Other measures, such as vehicle fuel economy tax/rebate schemes, can be designed to be revenue-neutral within the transport sector, making them more politically acceptable, and still achieve substantial greenhouse gas emission reductions.

Measures reviewed in this paper that focus on greenhouse gas mitigation - such as a 10 US¢/litre increase in fuel taxes, or implementation of a \$200 per litre/100 km fuel economy tax - have the potential to achieve substantial emission reductions relative to the trend, in the region of 10-15% by 2010. More stringent measures could achieve greater reductions: the technical potential for emission reductions through vehicle energy efficiency improvements is nearer 30-50% by 2025, without reducing vehicle performance. To achieve this through fuel taxes; fuel prices would need to be quadrupled. Converting existing vehicle taxes to fuel economy-related taxes might be a more politically acceptable way of achieving the same result.



## APPENDIX C: CONFERENCE ABSTRACTS

Greater reductions in fossil fuel use are almost certainly needed to stabilise concentrations of greenhouse gases in the atmosphere. This is only likely to be achieved through radical changes, both in vehicle technology and in the way we use vehicles. Such changes might include a move to ultra-efficient alternative-fuel cars, a shift away from motorised transport, and a complete reorganisation of patterns of goods transport. There is, so far, no experience of policies that would bring about such changes.

In the near term, the most feasible opportunities for greenhouse gas mitigation in the transport sector are likely to lie in efforts to achieve other policy objectives—including reducing traffic congestion, accidents and air pollution, as well as reducing net subsidies to road users. These objectives may best be addressed through combinations of measures, including regulations and charges to internalise social and environmental costs, and changes in access to public funding and infrastructure to shift priorities away from cars and trucks, towards buses, rail and non-motorised transport. Such measures can achieve greenhouse gas emission reductions relative to trends in the region of 10-15% by 2010. They can also contribute to longer term emission reductions, by beginning the task of shifting transport system trends towards a more sustainable path.

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### **Sustainable Transport: What It is, and Whether It Is**

**Lee Schipper, Ph.D.**  
IEA

Speaker  
Session 1b

This talk reviews the underlying trends that have boosted energy use for transportation and travel in ten OECD countries. We also show how these trends have affected emissions of CO<sub>2</sub>. We draw on a unique analysis that tracks each fuel for each mode (cars, bus, rail, domestic air travel). We focus on the automobile, but provide important information on factors affecting energy use of complementary modes. We touch briefly on factors that affect travel, modal splits, and car characteristics and use: fuel prices, incomes (and company-car tax policies), demographics, urban structure and density, and other factors. We discuss some of the policy instruments that have affected mobility and energy use. We speculate briefly how changes in some policies might affect these variables in the future, concluding that only a broad framework that integrates concerns for CO<sub>2</sub> with strategies to solve other problems related to transportation can be successful.

We advance a definition of “sustainable transport” that suggests that transportation where the beneficiaries pay their full social costs, including those paid by future generations, is sustainable. We note how the observed changes in travel are related to a number of prominent “externalities” arising from travel, including accidents, air pollution, congestion, noise, damage to species habitat, CO<sub>2</sub>, and importing of oil. It is these externalities, and not transportation or travel per se that threaten the sustainability of the system. We suggest that strategies to reduce the costs of these externalities should recognise that each has both a behavioral and a technical component. We assert that any policies or strategies to reduce the problems of transport without strong pricing components will only produce weak results.

**W. J. Zuckermann**  
Shakespeare Books

Speaker  
Session 1b

I propose to base my text on a selection of the awkward (but vital) questions posed by my colleague Eric Britton on the "electronic environment" component of the conference. In my talk, I shall try to answer them as best as I can, hoping to stimulate the participants to do likewise.

(Questions and answers are very much abridged here):

1. Is "Sustainable Transportation" a contradiction in terms?

Do we even know what it means?

*Answer: Definitions of those terms.*

2. Do we know enough to do something concrete today, or do we need more conferences?

*Answer: Reasons why we can start today.*

3. Can we leave the answer to the free market and technology?

*Answer: Free markets are superb at setting prices, but incapable of recognising true costs. Technology is a double-edge sword.*

4. Do you think the answer to these issues is to be found in transport policy?

*Answer: No. that is only one tiny part of a whole organic web which we must put in place.*

5. Are carbon taxes a good idea?

*Answer: Yes, of course, if our Fortune 500 companies will let carbon taxes (only one part of a needed tax shift) happen.*

6. Can the Information Society and Telework make inroads on these problems?

*Answer: Yes, if they can be proved actually to REDUCE physical transport; go into pros and cons here.*

7. Can a transition to sustainable transport be made quickly?

*Answer: yes, in some cases; no in others.*

8. Are these issues only government can deal with?

*Answer: Decidedly no, it needs a co-ordinated effort from ALL the actors.*

9. What is the role of organisations like OECD and conferences like this?

*Answer: To bring awareness to decision-makers.*

10. What exactly is it that YOU intend to do about this?

*Answer: Be even more careful about ever using unsustainable transport.*

## Transportation and Climate Change

**J. P. Bruce**  
Chair, Canadian Climate Program Board  
Co-Chair, Working Group 3, IPCC

Speaker  
Session 1c

The rapid increase in atmospheric concentrations of greenhouse gases due to human activities, particularly the burning of fossil fuels, gives rise to projections of significant climate change in the

## APPENDIX C: CONFERENCE ABSTRACTS

coming decades. The Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (1995) indicates that the imprint of human actions on climate is evident in recent records, and that the next century will probably see a rate of warming greater than any in the last 10,000 years unless remedial action is taken. The most severe potential impacts will be unmanaged ecosystems (coral reefs, boreal forests), human health, effects of sea level rise and the potential for more severe natural disasters. Impacts are estimated to be proportionately much greater for developing regions than for presently industrialised countries. This seriously threatens sustainable development in many countries.

In 1990, the transportation sector contributed about 22% of global carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel use, and is the most rapidly increasing sector. While CO<sub>2</sub> is the most important of the greenhouse gases, other emissions from the transportation sector also contribute. Unless there is major policy intervention, transportation energy use could increase 40 to 100% by 2025 and as much as 400% by 2100. At present, the industrialised countries dominate global emissions, and transportation accounts for as much as 1/3 of their emissions. By 2025, presently developing countries may become equal or greater contributors.

Achieving the initial objectives for 36 industrialised countries in the Framework Convention on Climate Change, i.e. stabilisation of national emissions at 1990 levels by 2000, may require early intervention in the transport sector for a number of countries. However, the longer term objective of the Convention - the stabilisation of atmospheric concentrations at levels that will not result in "dangerous anthropogenic interference" in the climate system will require major changes in transportation systems in the decades to come.

The IPCC Assessment suggests that technical options exist, or are under development, which, if implemented, could achieve the major reductions needed in transportation sector greenhouse gas emissions. These changes could be driven by movement towards full-cost accounting of transportation externalities, other economic instruments, improved transportation planning, and/or by regulatory measures.

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### Desirability/Sustainability

**Daniel Sperling**  
Professor and Director  
Institute of Transport Studies  
University of California

Speaker  
Session 1c

The proliferation of motor vehicles in the world is creating exceptional stresses on physical environments, energy resource supply, and the financial resources of cities. Some argue that the mobility offered by cars also weakens the social fabric of urban societies by reducing the sense of community, but that debate is not resolved; the role of the auto in social deterioration is unclear. What is widely accepted is that auto use is under-priced in most urban (but not rural) areas of the world, resulting in "excess" driving.

It would certainly be desirable, economically and environmentally, to reduce car use in most urban areas. But is growing car use unsustainable!? The answer is yes, if we were to straightforwardly extrapolate all these adverse car-related trends into the future. But that's an alarmist and mistaken

## APPENDIX C: CONFERENCE ABSTRACTS

Malthusian scenario. As pressures on energy supply and the environment increase, government and the marketplace will respond. They already are.

The revolution in materials, electronic, and energy storage technologies is making much more environmentally benign vehicles possible. For instance, the cost of producing and operating a vehicle powered by a fuel cell supplied with hydrogen made with solar energy may cost less than 10% more than today's gasoline cars. Such a vehicle would have vastly reduced impact on the environment and use no fossil energy. Oil consumption, greenhouse gases, and pollution from motor vehicles would be essentially eliminated. The transportation system would be sustainable in an environmental and energy sense. Whether the proliferation of such vehicles would be desirable is a different (but important) question. In any case it is important to keep in mind that what is sustainable and desirable in one region (i.e. affluent OECD countries) may be sustainable and/or undesirable in other regions.

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### Motor Vehicle Pollution: Impacts and Long-Term Reduction Strategies

Peter Wiederkehr  
Environment Directorate  
OECD

Speaker  
Session 1c

Growing motor vehicle traffic is a major contributor to nearly every air pollution problem facing developed and developing countries today. In the OECD area, road transport is the dominant source of CO, NO<sub>x</sub>, VOC; a major source of other toxic trace pollutants, including a number of carcinogens related to particulate matter; and a substantial, growing contributor of greenhouse gases such as CO<sub>2</sub>. In urban areas, levels of motor-vehicle related pollutants frequently exceed international air quality guidelines, and are directly responsible for a large number of adverse health effects.

In many countries, there are impacts over wide areas and across national boundaries from large-scale formation of photochemical smog and long-range transport of air pollution originating in cities. Materials are damaged, and rural areas, forests and other ecosystems are affected.

This paper views the problem of motor vehicle pollution within the context of sustainable development in which the protection of health and of the environment are priority concerns. It presents a comprehensive review of the health and environmental impacts caused by motor vehicle pollution with reference to traditional major air pollutants and toxic trace pollutants, stressing the need for substantial, further emission reductions.

As the vehicle fleet continues to grow, the effectiveness of current emissions control policies in OECD countries is being undermined, while the increase in toxic pollutants and carbon dioxide remains largely unaddressed. The paper presents a synopsis of the impact that stricter, comprehensive control programmes could have on motor vehicle emissions over the next thirty to forty years. It shows the substantial potential for reducing emissions offered by state-of-the-art control technology, but also underlines the crucial importance of preventive and integrated approaches for any long-term strategy capable of realising durable reductions in motor vehicle emissions.

## Looking Down the Road

**Deborah Lynn Bleviss**  
Consultant  
U.S. Department of Energy  
Office of Energy Efficiency

Panelist  
Session 1d

In looking down the road towards sustainable transportation, several issues need to be kept in mind. In order to be acceptable to consumers, governments, and the private sector, sustainable transportation will first need to meet several goals simultaneously: minimise costs; promote economic development; minimise environmental degradation and the resultant impacts on human health; minimise imports of oil; maximise safety; and maximise accessibility by all to the services provided by transportation. In short, the goals of sustainable transportation overlap substantially with the goals of achieving liveable communities. Second, it is important to recall that most of the future growth in transportation will be in the developing world, where vehicular demand is expected to explode in the next decades while transport-related problems today are already quite massive: poor air quality, growing levels of import dependence, intolerable congestion, etc.

These facts point to the need for highly integrated solutions to achieve sustainable transportation. It is not simply a matter of just pursuing major technological advances in vehicles and fuels, or modal shifting, or transportation demand management, or land-use restructuring. It is a combination of all of these, because a single path is much less likely to achieve these goals simultaneously. Pursuing technological advances in vehicles and fuels, for example, will not address the problems of growing congestion as more vehicles pour onto the roads. Similarly, an approach that just embraces modal changes and land-use restructuring is not likely to achieve acceptable air quality or reduce dependence on imported oil if the vehicles continue to be highly polluting and consume petroleum. And, in fact, cities that are seen as models of sustainable transportation such as Curitiba, Brazil, already embrace this vision of the need for an integrated approach.

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## Difficult Times Ahead for Public Transport

**Professor Achim Diekmann**

Speaker  
Session 1d

In the past, there has been a tendency to underestimate the pace of growth of motorisation. In many countries the number of vehicles in use has grown far more rapidly than expected. There is some evidence that with we now may be underestimating the qualitative changes road traffic is undergoing.

## APPENDIX C: CONFERENCE ABSTRACTS

Though remaining essentially a tool on four wheels, destined to carry people and goods individually rather than collectively, the motor vehicle has developed an astounding capability to absorb new technologies adapting them to the needs of its users. This is likely to be even more so in the future.

Being reluctant for some time, the motor industry has embarked on a course of product innovation which will make private transportation even more attractive, adding to the competitive advantage it has over other modes of transportation being much more closely integrated into our everyday life than any of these (with the possible exception of the bicycle).

In spite of transport policy showing an undeniable bias towards public transport in most countries, providing infrastructure to public transport operators free of charge and paying sizeable subsidies to cover their operational losses, public transport has been fighting a battle of retreat for many years. This process is likely to be exacerbated. Unless public transport operators succeed in individualising their services, only a few niches will be left to them. One of them will probably be high-speed links between major centres of activities. But these are rather in competition with air traffic rather than with the road.

There are a number of reasons for viewing the prospects of public transport with some scepticism. One is, that at a time when many governments will be forced to dismantle extensive welfare provisions subsidies to public transport spent so lavishly during more prosperous periods are unlikely to survive. With road traffic becoming environmentally less cumbersome, we are quickly moving to a point where concern over the financial sustainability of public transport will replace public concern over road traffic's environmental sustainability.

At the same time, demand for commuting will lessen as new information and communication technologies progress. This will widely affect the pattern of land use to the benefit of overcrowded cities reducing their environmental burden but hardly to the benefit of public transport.

Priorities in our society are about to change. There will be growing recognition that the environmental and societal problems we are facing can only be solved in a climate of growth, not by self-imposed restriction. Road traffic by its very nature has an important role to play to set the stage for the gains in productivity required to achieve both environmental and social sustainability. This is why governments would be well-advised to check their priorities when assigning their scarce financial resources to the transport sector in the future.

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### External Effects of Transport

**Gunther Ellwanger**  
Director for Economics and Environment  
International Union of Railways (UIC)

Panelist  
Session 1d

External effects of transport do not form part of economic calculations in that they are not contained in the market price. As a result, external effects are not taken into proper account in individual production and consumer decisions. This leads, at the national economic level, to distortions in the allocation of resources. External effects can essentially be either positive in representing external benefits, or negative in causing external costs.

## APPENDIX C: CONFERENCE ABSTRACTS

Environmental damage is quantifiable in certain sectors, but the figure put on these external costs is different depending on the evaluation methods used. Today, internalization could be practised in several sectors: in other words the "polluter = payer" principle could be applicable.

A study by IWW (Prof Rothengatter) - INFRAS (Dr. Mauch), on the "External Effects of Transport," quantifies the total external costs in 17 European countries to 272 billion ECU per year. On the whole, 92% of the external costs are caused by road transport while rail transport induces 1.7 %. The share of external costs on GDP is 4.6% on the average

The authors of the study also investigated the "external benefits" of road transport with the conclusion that it is extremely difficult to find examples of real extended benefits of transport, and that transport generates no external benefits of any significance. The average costs for passenger transport can be estimated with 50 ECU per 1,000 km on the road, 10 on rail and 18 in the air, while the costs for freight transport are estimated with 58 ECU/1,000 km for trucks, 7 for trains and 93 for planes.

On the one hand a full internalization of transport-related external costs would avoid certain traffic flows. On the other hand, the position of the rail mode on the transport market would be enhanced and induce transfer of some business from road to rail.

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### **Downsizing Power and Speed: the Safe Road to Fuel Economy and Sustainability**

**Mr. Martin C. Kroon**  
Netherlands Ministry of Housing, Spatial Planning  
and the Environment

Panelist  
Session 1d

Environmentally Sustainable Transport brings about the need to reduce total transport-related fossil fuel consumption and CO<sub>2</sub> emissions by over 50%. If global car use will be allowed to grow as predicted, (and if solar or other sustainable energy sources are not available to feed the world vehicle fleet of over one billion by 2015) then future cars need to be at least 300% more fuel efficient than current new car fleet averages.

All R&D activities of North American and European automakers, focused upon either the New Generation of Vehicles or the so-called "3 litre car," are directed towards putting more and better technology into vehicles to reduce fuel consumption/emissions. Apart from some construction materials-oriented efforts to reduce weight, R&D seems to neglect that putting "less of the same" into cars could be a more cost-effective and sustainable way of making cars environmentally compatible.

Vehicle characteristics most relevant to fuel consumption are body weight, power and performance. These characteristics have been upgraded ("more of the same") dramatically in almost every aspect - (US cars exempted thanks to CAFE ) at the expense of improving fuel efficiency. Compared to the car fleets of the 60s and 70s, current European and Japanese cars have been upgraded with respect to body weight and dimensions, engine capacity, power output, top speed and acceleration capacity, comfort and safety. As a consequence market segments have been upgraded as well.

Available power and performance levels lead to "upgraded" driving speeds and a more powerful driving behaviour, thus reducing the potential fuel efficiency benefits of such modern (engine) technology as TDI, multivalve variable valve timing and drag reduction. Moreover the growing

## APPENDIX C: CONFERENCE ABSTRACTS

popularity of weight-adding accessories such as airfoils's, and of "fun" -oriented vehicle classes such as 4WD, pick-ups and MPV, is trading off overall efficiency improvements.

Recent research in the Netherlands into the effectiveness of reducing vehicle speeds and improving driving behaviour by speed limit enforcement, in-car feed back and speed control instruments, has shown a huge potential in energy savings and GHG emission reduction, as well as considerable road safety improvements. These effects may range between 10% and 40%, relative to the quality of the measures, accounting for a total cost reduction of 1% to 2% GNP. Surprisingly though, these measures seem a taboo - or least neglected - both in Europe and North America when addressing sustainability of transport and traffic.

The paper presents this new evidence and the arguments which point towards the great life - and earth- saving potential of "putting less" into cars instead of the costly search for more of the same.

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### **Hypercars And Negatrips: The Next Transport Revolution**

**Amory B. Lovins**  
VP, Director of Research  
Rocky Mountain Institute

Speaker  
Session 1d

*A thousand policeman directing the traffic  
Cannot tell you why you come or where you go.  
-T.S. Eliot*

The auto industry--one-seventh of North America's gross product, and the highest expression of the Iron Age--is about to trigger the biggest transformation in global industrial structure since the microchip. Ultralight cars moulded from advanced composites can be severalfold lighter and more slippery than present steel cars, yet safer, sportier, probably cheaper, and more comfortable, durable, and beautiful. Modern hybrid-electric propulsion can boost efficiency ~1.3-1.5x in ordinary cars, but ~5-20x in such ultralight, very-low-friction platforms. By synergistically combining these elements, family cars can achieve ~0.4-1.6l/100 km with state-of-the-art technologies, yet also be superior in all other respects. This permits hypercars to meet public-policy goals of economy, environment, and fuel security without compromise, in a robust, radically free-market fashion driven by consumers' desire for better cars and manufacturers' quest for competitive advantage rather than by governmental mandate or subsidy. This process is already well underway.

Hypercars offer potentially decisive competitive advantages to early-adopting manufacturers--notably an order-of-magnitude reduction in product cycle time, tooling cost, assembly effort and space, and body parts count. These advantages have permitted Rocky Mountain Institute's Hypercar Center to commercialise hypercars not by patenting and auctioning the intellectual property, but rather by putting most of it prominently into the public domain and getting everyone fighting over it. Two years later, ~25 current and intending automakers have already committed roughly US\$1 billion of private capital to hypercars' rapid introduction. There are persistent cultural barriers to overcome in the auto industry, yet RMI is exploiting powerful motives to overcome those obstacles by maximising competition among an increasingly vibrant group of both traditional and new market entrants.



Hypercars, however, cannot solve the problem of too many people driving too many km in too many cars, and could make it worse by making driving even cheaper and more attractive. Making driving nearly a pure capital cost, crashing the world oil price (by discovering hypercars' "nega-OPEC"), and making cars seem environmentally benign (hence less of a spur to substituting negakilometres and negatrips for driving) means only that we'll run out of roads and patience rather than air and oil. Hypercars therefore buy time for and increase the need for fundamental reforms in urban form and land-use.

### Reducing Automobile Dependence

**Peter Newman**

Associate Professor in City Policy  
Murdoch University

Speaker  
Session 1d

Visions for sustainable transportation usually incorporate elements of technological change, economic change or social change. It is obvious that all three elements must play a part, but our contribution has always been to emphasise the social for the following reasons:

1. Technological solutions invariably forget the Jevons principle.

This principal was first enunciated by the economist Jevons in 1865 who predicted that making coal burning more efficient would lead to more coal use as the efficiencies would lead to more economic uses of coal. In transportation, it is not sustainable if new super efficient motor vehicles are merely used to travel more. In the U.S., 40 years of population growth has been outstripped three times by the number of vehicles and the distance they are driven. Despite doubling vehicle fuel efficiency between 1973 and 1988, transportation oil consumption increased nearly 20%. The problem is automobile dependence.

2. Economic solutions invariably are politically unacceptable.

Increasing the price of travel so that it at least covers its full costs is hard to dispute. However the process of implementation is fraught with political difficulty. First the inelasticity of demand for automobile usage is created by the physical layout of our cities. Thus to reduce demand is to cause considerable pain as alternatives are just not there. Second, those who suffer most are those who can least afford it. Social justice is not enhanced by making automobile user pay their full costs. Politicians cannot afford such negativity in automobile dependent cities.

3. Social solutions can penetrate to the ultimate problem of automobile dependence.

Building cities with an assumption of automobile usage and growth is no longer sustainable. To change this requires a) changed priority in physical planning to ensure that non-auto infrastructure is more of a priority than auto infrastructure, b) changed land use patterns to minimise the need for travel, and c) changed lifestyle values so that greater emphasis is on the community rather than private/isolated values and on the urban rather than suburban and exurban. "The New Urbanism"

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encapsulates all of these principles. With cities moving towards a series of nodal/information subcentres it is possible to restructure towards sustainable transportation far quicker than if engineering and economic solutions alone are envisaged.

Data will be presented from 50 cities around the world on trends in automobile dependence to highlight the signs of hope as well as the extent of the problem. Some of the best examples of rebuilding cities with a more sustainable vision will be outlined, particularly in Canada and Australia.

### **Sustainable Transportation in the Twenty-First Century**

**Roberta Nichols**  
Ford Motor Company (retired)

Panelist  
Session 1d

Transportation involves movement from place to place; movement requires energy. Throughout the world, transportation has been/is heavily dependent on oil for this energy. Petroleum-based fuels have provided good performance for many years, and will continue to do so for many more to come. Petroleum supplies are finite, however, so it is not too soon to begin the difficult transition to new sources of energy.

For many countries, such as the United States, domestic oil supplies have not met demand. The need to purchase foreign oil has been the single biggest factor in the imbalance of trade payments for the U.S. In 1972, the U.S. had to abandon the limit of twelve percent (12%) imported oil in order to meet needs. Today, more than 60% of the oil used in the U.S. is imported.

Development of vehicles to operate on non-petroleum fuels began in earnest in some countries in response to the energy shocks of the 1970's. For example, in Brazil, which was 95 % dependent on imported oil, the government decided to shift to the use of ethanol produced by their sugar industry. Brazil has a huge land-mass, with only two percent devoted to growth of sugar cane, so an increase in sugar production was not a threat to their human food supply.

Improvement in air quality has become the near-term driver for alternative fuels. Composition of the fuel used is now recognised as a major factor in the control of emissions, a factor in introduction of reformulated gasoline in the U.S. Further improvements in air quality can be realised, however, by using vehicles that operate on natural gas, propane or LPG (liquefied petroleum gas), methanol, or ethanol. Moreover, the battery-powered vehicle, and beyond that, the hydrogen-oxygen fuel cell-powered vehicle, have no tailpipe emissions at all. It is not likely that the solution to transportation pollution will come about by expecting or asking people to give up their automobile, so we must continue to make it as clean as possible. At present, there does not appear to be any one best choice for replacement of petroleum based transportation fuels. Diversity of fuel use is likely, depending on resource availability and economics, which can vary around the world. Most alternative

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fuels can be more energy efficient than gasoline, which is important when considering carbon dioxide emissions, as well as the rate of energy consumption.

The introduction of alternative fuels seems to require revolutionary actions to achieve significant change but these must be carefully planned to avoid chaos and economic hardships. Since the need for new sources of energy is long-term, with no immediate need to give up petroleum-based fuels in most cases, making the transition to alternative transportation fuels and technologies will be a slow and difficult process.

### **Sustainable Air Transportation**

**Henk C.G.M. Brouwer**

**Jochem H.A.M. Peeters**

Netherlands Ministry of Housing, Spatial Planning  
and the Environment

Speaker  
Session 1e

The main objective of environmental management is to preserve the carrying capacity of the environment in order to achieve sustainable development. The international civil aviation industry contributes to global, transboundary and local air pollution. From a policy point of view, carbon dioxide (CO<sub>2</sub>) and oxides of nitrogen (NO<sub>x</sub>) are currently believed to be the most important emissions from aircraft. For both substances, emissions of air transport account for a share of between 2 and 3% of world emissions from the combustion of fossil fuels.

Since international civil aviation will continue to grow at higher rates than the world economy, its relative share in world emissions will rise in the future. Model calculations suggest that, on the basis of present policy, world-wide aviation emissions in 2015 will be three times those in 1990, and will then account for 3 to 4% of all emissions due to the combustion of fossil fuels.

With firm and clear policy action, such as implementation of technical, operational and economic measures, considerable reductions in aviation emissions can be achieved.

The international nature of air transport leaves little room for individual countries to pursue an autonomous policy. Therefore, a successful policy that allows the international civil aviation industry to contribute to sustainable development must be predicated on an international approach.

Although the International Civil Aviation Organisation (ICAO) obviously should have an important role in reducing the environmental impact of international civil aviation, its actual role highly depends on the positions of individual countries within this organisation. Recent developments in ICAO's Committee on Aviation and Environmental Protection (CAEP) confirm this. The Netherlands has deep concern over these developments and would like to discuss with the participants of the conference possible ways to strengthen a global approach towards sustainable air transportation.

## **Civil Aviation And the Environment**

### **John Crayston**

Co-ordinator, Air Transport  
and Environmental Programmes  
International Civil Aviation Organisation

Speaker  
Session 1e

The environmental problems associated with civil aviation fall into three categories: aircraft noise, the impact of aircraft engine emissions, and other local problems at airports. The third category includes such problems as water and soil pollution, problems arising from construction and expansion of airports and associated infrastructure, and management of wastes at airports. Since the significance and implications of these problems are likely to differ from one airport to another, this paper focuses on noise and emissions.

Noise levels have been declining at many airports in recent years as the proportion of total movements performed by new, quieter aircraft has increased. However, aircraft noise has continued to be a major problem, particularly at busy airports in developed countries. Following the unanimous adoption in 1990 of an ICAO resolution on a world-wide policy towards operating restrictions, many countries have therefore recently introduced operating restrictions on noisier aircraft. Policy-makers are now focusing on what will happen once operations by the noisier aircraft have been eliminated. This includes considering whether aircraft engine manufacturers can make much more progress in making engines quieter, and whether other measures can reduce noise, such as increased use of noise abatement flight procedures and better land-use planning near airports.

Many consider that aircraft engine emissions are fast overtaking noise as the most important environmental problem associated with civil aviation. Here it is necessary to distinguish between two types of emission problems: namely the impact on local air quality near airports and the global impact that engine emissions may be having on long-range air pollution, climate change and depletion of stratospheric ozone. Policy-making in this area is made difficult because of the scientific uncertainties involved, and because actions taken to address one problem could adversely affect another.

The paper will describe what has been done so far to address both noise and emissions problems and what is expected over the new few years.

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## **The Concept of Sustainable Transport**

**Per Kågeson**  
Nature Associates

Panelist  
Session 2a

For something to be sustainable it has to be able to maintain its normal qualities over a very long period of time: essentially "forever." According to Agenda 21 it is necessary to meet the basic needs of all citizens of the earth while at the same time protecting and maintaining our natural resources and ecosystems.

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A strict interpretation of sustainable transport means that we should concentrate on measures aimed at avoiding long-term damage. From a practical point of view, however, there are good reasons to adopt a definition which also includes major short-term disturbances to nature as well as negative effects on human health.

Economic theory says that we should try to achieve any goal at the least possible cost. From this point of view it is clearly wrong to enforce the same physical restrictions on the use of fossil fuels in all sectors of society or to demand a flat rate reduction in all sectors of any given pollutant. This implies that we should refrain mandatory restrictions on the use of different modes of transport, and that we should use economic policy levers rather than different types of regulation.

There is, however, also a great deal that argues in favour of introducing performance targets for the transport sector. There are two particular reasons for this. One is that transport is the source of 30 to 40 per cent of some pollutants, and there is no way that the aggregate emissions can be reduced below critical loads and limits without a major contribution from transport. The second reason is that taxing fuels and emissions is not alone going to achieve these objectives. Market imperfections make it necessary to use additional policy measures such as more stringent emission limit values, fuel efficiency standards and mandatory check-ups for old vehicles.

A policy aimed at achieving sustainable mobility should: 1) define parameters to be included in the definition of sustainable transport; 2) be based on a long-term objective which guarantees ecosystems maintain their normal qualities; 3) include intermediate targets and a clear medium and long-term timetable in cases where it is obvious that an objective based on sustainable development cannot be achieved in the foreseeable future; 4) make sure such intermediate goals bring us considerably closer to our final objective; 5) include decisions on measures and policy levers that are likely to fulfil objectives and make short-term commitments trustworthy.

If sustainable transport is to have a meaning, governments need to develop an operational definition of this concept and to commit themselves to a firm implementation of short and long-term objectives. Without clear objectives and a strict timetable there can never be a policy of sustainable mobility!

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### **Sustainable Transportation Principles**

**Stuart L. Smith, M.D.**

Chair National Roundtable on the Environment  
and the Economy,

Speaker  
Session 2a

By means of multi-stakeholder consultation, Canada's National Roundtable on the Environment and the Economy (NRTEE) will have developed by March 1996 a set of strategic principles with respect to sustainable transportation.

Among other matters, consensus appears to be building upon issues related to environmental protection, waste management and lifecycle analysis, energy use, demand management, land use and urban design, as well as methods of accounting, decision making and achieving public accountability.

The strategic principles agreed upon will be presented at the conference so they can be discussed by an expert panel and the conference as a whole.

**Innovation, Job Creation, and Economic Opportunities in the Sustainable Transportation Sector**

**Susan Zielinski**

City of Toronto Planning and Development  
Department,  
and Transportation Options

Panelist  
Session 2a

Remaining competitive in the global market requires innovation. But in a world where the world transportation has become virtually synonymous with the private automobile, our innovative scope is often constrained to solving transportation problems, and even broader problems, by attempting to improve upon cars.

Hence we look to the development of alternative fuel technologies, IVHS, and in-car safety devices as key solutions. This ultimately results in increased car use and road use. A growing body of evidence suggests that the ecological and economic sustainability of this approach to innovation is questionable.

This paper explores the benefits of an economic transition to sustainable transportation, and recommends the preparation and implementation of a Strategic Action Plan for Economic Growth in the Sustainable Transportation Sector. The proposed Action Plan is based on discussions and plans being carried out by participants in the Toronto-based Sustainable Transportation Economic Development Initiative. The initiative is a wide ranging effort dedicated to creating and supporting a sustainable transportation economy, facilitated by Transportation Options.

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**Dr. John Adams**

Department of Geography  
University College

Speaker  
Session 2b

The reader is invited to assume incredible technological “progress” in endeavours to solve problems of energy scarcity, pollution and congestion. Imagine a Super Car powered by a pollution-free perpetual motion engine. Imagine a super Internet to which everyone in the world is connected, which permits anyone anywhere to contact anyone else free by cordless videophone, and which also provides free and efficient access to all the databases and libraries in the world. The result would be a social and environmental disaster - *unless at the same time humankind manages to curb the appetites which are driving the steeply rising growth curves of material consumption and physical and electronic mobility.*

The technological enterprises that are currently consuming the lion's share of resources directed to the solution of transport problems are relaxing important constraints on these appetites. The most worrying transport problems are not congestion, pollution and shortage of energy. They are the consumption of space for the means of travel, the despoliation of rural landscapes and historic towns, the growing disparities in access to opportunities between those who can drive and those who cannot, the danger that denies children their traditional freedoms, and the paranoia, anomie and social

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disintegration that result from a level of mobility that is creating a world of strangers. The principal barrier to a morally and politically sustainable transport policy is the belief that there are technical fixes for these problems.

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### Sustainable Transportation: A Possible Dead End One Barrier Less

**Eric Britton**  
EcoPlan International  
Centre for Technology & System Studies

Speaker  
Session 2b

*"I am pessimistic about the human race because it is too ingenious for its own good. Our approach to nature is to beat it into submission. We would stand a better chance of survival if we accommodated ourselves to this planet and viewed it appreciatively, instead of skeptically and dictatorially."*

- E.B. White

1. Sustainable Transport - The experts keep pointing and arguing but...

- If it's such a great idea, why isn't it happening?
- Why we don't need to know everything for sure, now!
- The Sustainable Transport nexus (assemble, improve a bit, adjust, begin again)

2. People, inertia and the need for *breakthrough strategies*

- Electronics as a substitute/complement to physical movement
- When resistance is high enough, current doesn't flow (historic perspectives)
- Transport/telecommunications trade-offs and the "box diagram"
- Recent experience as a guide

3. Where might it go<sup>3/4</sup> and what might we do to make it go there better and faster

- Looking out to the (near) future
- Brains on the knee
- New ways of 'accreting knowledge'
- Convivial transitions to a sustainable society

*"The processes that occur in our [societies] are not arcane, capable of being understood only by experts. They can be understood by almost anybody. Many ordinary people already understand this; they simply have not considered that by understanding these ordinary arrangements of cause and effect, we can also direct them, if we want to."*

- Jane Jacobs, in *Death and Life of Great American Cities*

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### Towards Sustainable Transportation - Going from Mere Words to Practice

**Lars Hansson**  
Senior Researcher  
International Institute for Industrial Environmental  
Economics  
University of Lund,

Speaker  
Session 2b

In the last few years, there have been many documents and frameworks for a transport policy based on sustainable transportation. Although there is extensive knowledge pertaining to fiscal and economic incentives, and political will exists, there is inertia in the implementation of measures adequate for coping with the external effects of transportation. One explanation for the delay used to be that it is not possible to accurately determine how much should be charged. However, there is enough knowledge on the costs and evaluations of external effects to introduce a formal transport policy based on the polluter pays principle. The explicit evaluations of social and external costs for traffic accidents, air pollution and noise officially recommended by the Swedish Institute for Transport Analysis (under the Department of Transportation) show the total social costs for road traffic amounts to 4.3% of GNP. The external costs amount to 2.4% of GNP. In relation to passenger kilometres and tonne-Kilometres, the external effects of road traffic are 10-15 times that of rail traffic.

Even if sufficient knowledge exists about the costs and evaluations of external effects in transportation, there is still another major reason for the policy-making inertia. For example, it is difficult to gain acceptance from the public about increasing petrol taxes. It is necessary to consider the following:

- The externality charges must be explicit. The current petrol tax must be substituted for a more differentiated system including a traffic accident charge, an air pollution charge, etc.
- The externality charges must be distinguished from taxes. When the external effects are reduced, the charges must be reduced accordingly.
- These charges must be generally adopted, not only implemented for transportation.
- The revenues should not be treated as general tax revenues to allow for more tax neutrality (based on the “club theory” approach) and a stronger correlation between the political objectives of the externality charges and the subsequent use of the revenues (direct and indirect compensations for the external costs, ecology funds, R&D, etc.).

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### **Overcoming Barriers to Market-Based Transportation Reform**

**Michael Replogle**  
Environmental Defense Fund

Speaker  
Session 2b

One of the most significant barriers to the development of more sustainable transportation systems in many countries is the manner in which motorists pay (or are subsidised) for their motor vehicle use. High fixed costs of motor vehicle acquisition combined with low incremental motor vehicle user costs (e.g. free parking, free roads, and in some countries like the U.S., very low motor fuel taxes) encourage rapid growth of motor vehicle use. Major institutional and political factors impede public awareness of large hidden subsidies and external costs related to transportation. These are an obstacle



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to introduction of market-based pricing mechanisms that might better internalise both marginal costs and social and environmental cost factors, thus shaping decision-making by consumers and policy-makers. This paper explores these economic and perceptual barriers and discuss strategies that might contribute to progress in both cost internalization and regulatory reform, with particular attention on the American situation, where highway user subsidies significantly exceed those of many other OECD countries.

The most promising strategy for incrementally overcoming these barriers is through introduction of a customer-orientation to transportation innovation, bundling technological, pricing, and institutional reforms with major new transportation investments. Contributions can come from: improved information; analysis and decision support systems for transportation management and planning; appropriate applications of Intelligent Transportation Systems technologies such as electronic road and parking pricing; development of performance and incentive based regulatory systems; privatisation of infrastructure management; and by influencing advertising that shapes public attitudes towards motor vehicles.

Key issues that must be addressed include equity impacts and political/institutional structures that favour continued pricing systems and subsidies that promote greater motor vehicle use. In democratic societies, public and market acceptance of a shift to fuller marginal cost pricing of transportation will follow only if users who experience higher user costs gain improved system performance, if the array of attractive alternatives and choices is expanded particularly for the most price-sensitive users, and if information and marketing emphasises positive attributes and a customer service orientation. Meeting these conditions will require reform of public institutions involved in transportation to force greater accountability for the effects of transportation system management and investments on system performance, including externality effects.

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### OECD/EMCEE Project: Urban Travel And Sustainable Development

**Michael Bach**  
United Kingdom Department of the Environment

Speaker  
Session 2c

Making the car cleaner, quieter and more energy-efficient is a necessary but not sufficient condition for reconciling the car with sustainable urban development. To achieve this, a package of measures is needed: economic instruments, transport policies and land-use planning policies applied consistently over a long period of time, with the aim of bringing about a reduction in car use for urban travel. Further, we need to organise our cities to reduce the need to travel and reduce the demand for travel, especially by car.

This paper presents a report prepared under the guidance of an OECD/EMCEE project group set up in May 1991. The three-year inquiry analysed the transport, planning and environmental policies in 20 countries and 132 cities. The final report was published by OECD/EMCEE in April 1995 and examines:

- the trends and the problems;
- the policy levers available, in particular the roles of economic incentives and disincentives: the role of land-use planning; the potential of traffic calming and other new approaches to traffic

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management; and the use of marketing, telematics and other innovations to improve public transport; and

- their performance/achievements.

### **Acknowledging that present policies are unsustainable, the report proposes:**

- a new approach for the 1990s and beyond which combines land-use and transport policies; and
- a three-stage process for moving toward sustainable urban development.

### **This three-stage approach advocates moving upwards to:**

- best practice: adoption of best practice in land-use and transport planning;
- policy innovation: using innovative policies in land-use and transport planning, and traffic management, to influence the pattern of development, the location of travel-generating uses and the choice of means of travel; and
- sustainable development: progressively increased fuel tax to significantly reduce vehicle kilometres and the amount of fuel used.

Whilst stages 1 and 2 will reduce the rate of growth of vehicle kilometres, only when stage 3 is reached will there be a significant reduction in car-kilometres and fuel use in road transport.

This report underlines the importance of combining, in coherent, reinforcing packages, land-use planning, economic, incentives and traffic management policies.

## **Canadian Work on Sustainable Urban Transport**

**Neal Irwin**  
Managing Director  
IBI Group

Speaker  
Session 2c

Following a brief commentary on urban transportation sustainability objectives and shortfalls in Canada, the paper presents highlights of Canadian approaches to date in working towards more sustainable urban transport, including the five following types of initiatives:

1. Planning and delivery of more compact, mixed-use and pedestrian-friendly urban areas;
2. Planning and delivery of efficient and effective transportation networks and systems;
3. Transportation demand and supply management, including pricing and other incentives for more sustainable behaviour by transportation users;
4. Technology improvements, including more energy-efficient, less polluting vehicles; and
5. Outreach, public information and voluntary programs supporting initiatives towards more sustainable transportation.

Estimates of existing transportation energy consumption and airborne emissions levels in Canadian cities are presented along with short term projections under alternative growth rate and policy

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scenarios. Longer term considerations are discussed briefly, noting that while land use, transportation system, technological and outreach initiatives will all be important, transportation demand/supply management strategies, including pricing incentives, are expected to be critically important in moving towards sustainable urban transportation.

It is anticipated that the other two papers to be presented at the Urban and Suburban Transportation session will focus on problems concerning urban and suburban transportation sustainability and on possible solutions in the urban context, both drawing primarily on European experience. Complementing those presentations, the focus in this paper will be on suburban initiatives in the North American context, drawing on recent Canadian experience.

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### **Cycling: An Efficient Mode of Transportation**

**Michel Labrecque**  
President, Groupe Vélo  
La Maison des cyclistes

Panelist  
Session 2c

For three years now, Vélo Québec has been expanding its approach and message on the role of the bicycle in transportation plans with the objective of integrating it into the concept of "transport mix".

Its objectives are now directed towards the organisation of mass transit, car-pooling, taxis, go-trains, intercity buses and walking. The combination of these different modes of transportation is the only way, in Vélo Québec's view, of offering Canadians an efficient, rapid, safe, economical and, first and foremost, less polluting transportation concept. It is the only concept that makes it possible to maintain the current level of personal mobility while at the same time sparing households the need to purchase a second, and nowadays often third, car.

Vélo Québec has observed, however, that since the early 1960s, personal car ownership has steadily increased in the West, while the mobility of people without cars has steadily declined. Moreover, the technological gains in fuel consumption have been offset by the increase in the size of the vehicle fleet and by increased mileage. Unfortunately, this has been to the detriment of the environment, and we currently foresee no change in the trend in the near future.

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### **Personal Mobility in High-Density Cities in the Context of Sustainable Development**

**Jean-Pierre Orfeuil**  
INRETS

Speaker  
Session 2c

The issue of sustainable development and the required changes in public transit systems play out very differently in sprawling conurbations and in large European cities, which continue to be characterised by high-density, centre-driven development. However, even in the latter, car use is increasing, shaping the forms and spatial patterns of land use and creating problems concerning the principle of sustainable development.

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The key characteristics of these changes, particularly in terms of global mobility, the use of modes and territories concerned will be described; an attempt will be made to provide an understanding of the institutional, economic, regulatory and cultural mechanisms; and the consequences in terms of the sustainability of the mode of development at both the urban and more global scale will be evaluated.

On the basis of the diagnosis presented, it is possible to identify the key policy directions and, more importantly, given that the system is very interactive, to determine the main associations to be developed.

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### **Social Dilemmas and Policy Strategies for Behaviour Change in Reducing the Use of Motor Vehicles: A Behavioral-Science Perspective and Some Empirical Data**

**Charles Vlek and Linda Steg**

Department of Psychology, University of Groningen

Panelist  
Session 2c

Our aim is to offer a socio-behavioural view of motorised mobility and to consider possible ways to get onto the track of a 'sustainable transport development'. We begin with a social-dilemma analysis of mobility and transport, its individual attractiveness, and its collective problems with respect to accessibility, quality of life and environmental quality. This leads to the conclusion that the collective problems of massive car use can only be controlled via significant changes in the transport behaviour of individual car users. To stimulate this, we discuss important conditions and six different policy strategies for social behaviour change.

In the second part of the paper we discuss major results from a four-year project including two field studies in which two general hypotheses were tested, via personal interviews and small-group discussions with a total of 875 participants. First, it was expected that the more people are confronted with the problems of car use (in densely populated areas, in city centres, or via advance information), the higher would be their problem awareness, the greater their feelings of co-responsibility and perceived control, the stronger their willingness to reduce car use, and the more positive their evaluation of policy measures. Secondly, we expected that thorough discussion and opinion formation in a group setting would lead to a different, more thorough judgement about the problems of car use and to a greater willingness to contribute to their possible resolution, in comparison to an individual interview.

As hypothesised, we found significant positive relationships among problem awareness, co-responsibility and perceived controllability, willingness to reduce car use, and the evaluation of policy measures. Moreover, respondents having a higher problem awareness actually used their car less, perceived more opportunities to reduce their car use, and were more strongly of the opinion that the government should take active measures to reduce car use, in comparison to respondents having a low problem awareness. In the second study, on average, respondents evaluated car use as 'a (societal) problem', but thought *their own* car use was 'hardly a problem' for society. Indeed, therefore, the problems involved in the massive use of cars can be characterised as a true social dilemma. In contrast to our expectation, after thorough group discussion many respondents had a *lower* score on problem awareness than before the discussion and in comparison to the first study. Apparently, people are confronted with a discrepancy: they perceive car use as a problem, but they are using a car themselves and they are not willing to give up the enormous advantages of car use. This evokes cognitive dissonance, which people tend to reduce by changing their beliefs about problem seriousness.

### **The Ahwahnee Principles for More Liveable Communities**

**Paul Zykofsky**  
Manager  
Local Government Commission's Center for  
Communities

Panelist  
Session 2c

Existing patterns of urban and suburban development seriously impair our quality of life. The symptoms are more congestion and air pollution resulting from our increased dependence on automobiles, the loss of precious open space, the need for costly improvements to roads and public services, the inequitable distribution of economic resources, and the loss of a sense of community. By drawing upon the best from the past and the present we can first, retrofit existing communities and, second, plan new communities that will more successfully serve the needs of those who live and work within them. Such planning should adhere to the following principles which were developed by several leading architects at a 1991 conference at the historic Ahwahnee Hotel in Yosemite National Park in California.

#### Community principles:

1. All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.
2. Community size should be designed so that housing, jobs, daily needs and other activities are within easy walking distance of each other.
3. As many activities as possible should be located within easy walking distance of transit stops.
4. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.
5. Businesses within the community should provide a range of job types for the community's residents.

#### Regional principles:

1. The regional land use planning structure should be integrated within a larger transportation network built around transit rather than freeways.
2. Regions should be bounded by and provide a continuous system of green-belt/wildlife corridors to be determined by natural conditions.
3. Regional institutions and services (government, stadiums, museums, etc.) should be located in the urban core.

#### Implementation strategy:

1. The general plan should be updated to incorporate the above principles.
2. Rather than allowing developer-initiated, piecemeal development, local governments should take charge of the planning process.
3. Prior to any development, a specific plan should be prepared based on these planning principles.
4. Plans should be developed through an open process and participants in the process should be provided visual models of all planning proposals.

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### **The North American Free Trade Agreement and Sustainable Transportation**

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**Ken A. Eriksen** (Contact Person)

-and-

**Dr. Kenneth L. Casavant**

Professor of Agricultural Economics

Department of Agricultural Economics

Washington State University

Speaker

Session 3a

The U.S. and Canada share the world's longest political border, a boundary that continues to become more transparent. The ratification of NAFTA seeks to enhance the border's transparency and the flow of trade between the two countries. Conceptually, free trade and NAFTA portray a sustainable "seamless" environment where producers, processors and transportation firms move goods safely from a packing house or processing plant to the buyer in a timely cost effective manner without complication or delays. Washington State provides critical border crossings and a highly competitive transportation network that not only serves the citizens of Washington State but also producers, processors and consumers of near-by states, Canadian Provinces and international markets.

However, problems exist when transportation corridors are inadequate to support increased trade volumes, which then impedes the movement of trade and decreases the economic returns to production. The degree of value, volume and timing of trade impact on those corridors is not well documented. This presentation evaluates free trade and sustainable transportation, projecting and evaluating Western Canada-U.S. trade flows between Canada and Washington State under an emerging NAFTA. Direct analysis of the impacts on the transportation infrastructure and the need for industry capacity to achieve the requirements of sustainable transportation is the focal point of the paper. Potential policies and implementation measures conclude the presentation.

### **Longer-Distance Movement : A Global View**

**Tom Hart**

Department of Economic and Social History

University of Glasgow

Panelist

Session 3a

A 'trade' perspective needs to be replaced by a perspective looking at the implications of sustainability for the longer-distance movement of both goods and passengers - passenger movement has experienced particularly high growth.

Taking reductions in the use of non-renewable resources as the principal criterion for sustainability, how is this likely to affect longer-distance movement? The paper suggests that the tension between a pro-mobility liberalising approach and planning to reduce movement can be resolved through the international application of appropriate fiscal and pricing frameworks to transport. These can allow extra movement while also cutting the use within transport of non-renewable resources.

Speculations on the outcome of such a framework confirm the possibility of continuing, though re-structured, growth in movement. Revised estimates of Regional Products point to some slackening of economic growth rates within sustainable criteria. However, savings of non-renewable resources within localised transport (below 100 miles) and in other sectors of the economy suggest that considerable expansion of longer-distance passenger movement by air and related rail services will be

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possible within likely sustainable scenarios. The low resource costs and improving quality of water transport will facilitate the further expansion of general merchandise world shipping though decline in bulk shipping is to be expected.

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### **Life Cycle Assessment of Transportation Systems - Its Concept and a Case Study on GHG Emissions from Motor Vehicles**

**Yuichi Moriguchi**

**Yoshinori Kondo**

**Hiroshi Shimizu**

National Institute for Environmental Studies

Environment Agency of Japan

Panelist

Session 3a

In order to identify the features of sustainable transportation systems, measures for comprehensively quantifying their environmental burdens are required. The Life Cycle Assessment (LCA) is one of the most promising tools for such purpose in general. Though the LCA is usually applied to industrial products, it may also be applied to technology systems like transportation systems. The paper describes a general framework of the LCA on transportation systems, and reviews major environmental burdens to be assessed. Special attention has to be paid in the LCA on transportation systems, as the system boundary of the assessment should be expanded to include infrastructures. This is followed by substantiated results from the life cycle analysis of Greenhouse Gas (GHG) emissions related to motor vehicles. Input-output analysis, as well as ordinary summing-up approaches are applied for the calculation. Life cycle emissions of Carbon dioxide (LCCO<sub>2</sub>) by an average-sized Japanese motor vehicle amounts to 8.9 tons as carbon, assuming lifetime travelling distance as 100,000km. This accounts for 1.5 times as much as direct emissions from fuel consumption. Comparison of LCCO<sub>2</sub> between a gasoline vehicle and an electric vehicle is also made, with sensitivity analysis of the fuel mix of electricity generation. Contributions of greenhouse gases other than CO<sub>2</sub> emitted as exhaust gas are relatively small, whereas the release of CFCs or HFCs used for air conditioners, unless recovered, may have significant contribution to the life cycle greenhouse gas emissions from motor vehicles.

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### **U.S. Initiatives on Sustainable Transportation Policy**

**Mary Nichols**

Assistant Administrator for Air and Radiation

U.S. Environmental Protection Agency

Speaker

Session 3a

In the United States, transportation policy plays a critical role in promoting economic growth. But, we are now much more cognizant of the considerable burden placed upon us to develop, manage and use our transportation resources in a ways which provide for protection of public health and the preservation of our environment and natural resources. Historically, the U.S. Environmental Protection Agency has viewed its role in transportation policy as reducing auto emissions and has focused primarily on technology and tailpipe controls. Our successes are well known auto exhaust emissions on a per mile basis decreased 40% during the last 20 years, while fuel economy of

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passenger auto mobiles doubled. But, while new U.S. vehicles are designed and built to meet stringent emission standards, auto air pollution continues to rise. Because of dramatic increases in the number of miles being travelled by car, the demand for personal travel continues to grow faster than technological improvements can reduce auto emissions. Here, as throughout the industrialised world, the distance travelled by motor vehicles continues to increase, contributing both to pollution and to a growth in global warming emissions from the transportation sector. The result is that gains in emission control made possible through technological innovation are being offset by in-use maintenance and operating trends.

It is therefore no longer prudent to focus just on the design stage of vehicles. In striving to develop a truly sustainable transportation system, we must broaden our efforts to improve in-use vehicle maintenance and decrease the pressure for continual growth in personal vehicle transit. Similarly, we must recognise that while regulations have proven effective in forcing vehicle design improvements, these must be supplemented with other non-regulatory tools. Efforts and consumer education and market based approaches must be undertaken in order to achieve an environmentally sustainable transportation system capable of meeting the transportation and mobility needs of a modern society.

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### **The Secret of Policy Success - European HSR's Triumph as a Transportation Alternative**

**Anthony Perl**

Director, Research Unit for Public Policy Studies  
University of Calgary

Speaker  
Session 3a

High Speed Rail (HSR) achievements can be measured on three different scales. At the macro level of the transport sector, European HSR represents the first, and to date the only technology that has persuaded people to forego travel by aeroplane and the automobile. Unlike the Japanese "Shinkansen," European HSR has developed a clientele of passengers who had previously driven or flown. At the meso scale of the railway industry, HSR represents an administrative and fiscal rupture with 19<sup>th</sup> century roots, stimulating a re-invention of business practices extremely rare in declining industries. From marketing to operational practices, European railways appear "modern" in HSR, and often only in this subset of their business activity. At the micro level of individual and firm behaviour, HSR has created incentives to support more sustainable mobility. Passengers choose HSR because it is more convenient, and usually faster, than alternate modes. Both private and public companies pursue HSR development because it provides financial rewards.

The secrets of this success can be found in a willingness to regard transportation policy as a causal variable, and not simply the result of public and private pressures on government. Public officials were open to the possibility that "progress" in transportation was neither linear nor homogenous, and that alternatives to air and automobile travel were not only possible, but desirable. This experimentation was nurtured by public enterprise managers who blended the entrepreneurial behaviour of market actors with the long term perspective of public servants. Instead of looking on government-led experimentation as a threat, Europe's private industry became partners in innovation. Similar links have fostered today's achievements in aerospace and automobiles in North American transportation. There is no reason to believe these policy "secrets" definitely exclude HSR options in North America.



**The Economic and Environmental Challenges of Freight Movements, Particularly in Cities**

**Derek Scrafton**  
Director General of Transport Australia

Speaker  
Session 3a

Any strategy for sustainable transport must take account of, and reflect, the changing significance of urban transport journeys: the fact that freight trips, non-home based trips, and linked trips for a variety of purposes are now at least as important as CBD-bound journeys to work.

The demands that lead to freight movements are increasing in all geographic spheres - in urban areas, rural regions, across national transport networks, and on international land, sea and air links. However, whereas non-urban freight traffic is shared amongst all modes of transport, urban goods are carried mainly by road-based modes: from ancient times by people (on their heads, shoulders and backs), by horse and cart, on modified tricycles, and in more recent times by trucks, buses, courier vans, bicycles, motorcycles, and in the boots (trunks) and on the back seats of cars and taxis.

This paper considers the economic significance of goods transport, particularly in urban areas, identifies the challenges of accommodating a freight task that will be much greater in volume and number of movements than today's cities experience, and outlines the transport technology and land-use planning required to facilitate urban freight movement.

The paper is based on research commissioned for three major Australian inquiries undertaken in the 1990s: the Industry Commission Inquiry on Urban Transport; National Transport Planning Taskforce; and the Economic Planning Advisory Commission Taskforce on Private investment in Infrastructure.

**A Proposal for Sustainable Transportation - A National Framework**

**David Bell**  
**Robin Lewis**  
**Rick Delaney**  
Environmental Stewardship Team  
Transport Canada

Speaker  
Session 3b

The ability of technological and institutional advances to satisfy a growing demand for people and goods transportation, has not been paralleled by advances to reduce the environmental consequences of such growth in mobility. In the longer term, integration of environmental considerations into transportation decision makings from the outset will result in the evolution of more sustainable transportation systems. At issue is the immediate action needed to address environmental impacts and, at the same time, put in place a policy framework to guide development of and achieve continuous improvements to the sustainability of transportation services.

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A new balance must be struck between economic and social drivers for transportation action and national and international requirements for environmental protection, to prevent pollution and to conserve resources.

The evolution of sustainable transportation systems will be guided by a mix of voluntary, economic and regulatory policies and mechanisms designed to enable passengers, shippers and carriers to make more sustainable decisions about their transportation preferences. Sustainable transportation actions require collective commitments and partnerships for action within and between all levels of government, by shippers and carriers and by the public at large.

With these considerations in mind the paper will propose a national framework for sustainable transportation. The elements of this framework are:

- a) The Canadian government's Sustainable Development policy whose application in all sectors of the economy will guide and be supported by the evolution of sustainable transportation systems.
- b) The goal of and principles which must be addressed in a sustainable transportation strategy.
- c) Indicators, performance measures, national and international transportation and environmental legal regimes, and objectives for sustainable transportation.
- d) Mechanisms for building sustainable transportation and their application to a Canadian sustainable transportation strategy.

The paper will also review current major challenges to the evolution of transportation systems, nationally and internationally; and will discuss how the framework is being applied in the context of Transport Canada's Environmental Action plans and the Federal Action Plan for Climate Change.

### **Plan of Action on Environment and Transportation - A Holistic Approach**

**Dr. Axel Friedrich**

German Federal Environmental Agency  
Head of Division, Environment and Transport

Panelist  
Session 3b

The aim of the Plan of Action on Environment and Transportation is to compile the measures for reducing traffic-related environmental impacts that have been proposed and discussed over the past few years, combine them into sets and evaluate them with respect to: effectiveness in reducing environmental impacts; associated time periods and; acceptance and social and economic impacts. Using this as a basis, a Program of Action is to be developed containing steps that are to lead to environmentally sustainable transport patterns.

The starting point for the Plan of Action is the derivation of traffic-related targets for the areas of climate protection, carcinogenic air pollutants, summer smog, damage to forests, acidification of soil

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and waters, noise, waste and waste management, land and nature conservation, and improvement of the quality of residential and urban life.

Required reductions in CO<sub>2</sub> and air pollutants emissions can be derived from the targets set. Different scenarios are used to demonstrate possible ways to influence emissions of CO<sub>2</sub>, air pollutants and noise. Based on this work and the results of the evaluation, measures necessary to reduce traffic-related environmental impacts are derived and combined into sets. With respect to the set of measures aimed at climate protection, for example, the following measures were found to be of greatest importance:

- fuel consumption limits for passenger cars and other motor vehicles;
- gradual increase in the mineral oil tax.

An assessment as to whether such sets of measures not only provide effective protection of human health and the environment but also ensure environmentally sustainable development in the transport sector, in an all-encompassing sense, can not be made until a concrete definition of such conditions has been established with the aid of indicators.

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### Canadian Initiatives in Sustainable Transportation

#### **John Hartman**

Director of Transportation Forums  
Transportation Association of Canada

Panelist  
Session 3b

For many years, Canada has played a leading role in the international sustainable development movement. Today, sustainable strategies are beginning to emerge in individual sectors. As they do, the critical importance of transportation to the economy, to society and to the environment is causing this sector to rise toward the top of the sustainability agenda. Here too, Canada is playing an important role. This paper reviews some of the many initiatives now underway.

The Government of Canada has created a Commissioner of the Environment and Sustainable Development charged with monitoring the progress of federal departments in achieving their own sustainable development strategies. Transport Canada is preparing a National Framework for Sustainable Transportation. Environment Canada's State of the Environment Reports include a review of the transport sector, and media campaigns educate the public regarding the impacts of current auto use. Research by Natural Resources Canada improves understanding of transport's fuel consumption and atmospheric emission patterns.

Canada's National Round Table on the Environment and the Economy has prepared draft principles for sustainable transportation and is launching a one year National Sustainable Transportation Forum. The Ontario Round Table on the Environment and the Economy has released a comprehensive Sustainable Transportation Strategy for Ontario, which has possible application beyond the province.

Environment Policy and Code of Ethics from Transportation Association of Canada (TAC) will soon be supplemented with a model Code of Practices to assist agencies and corporations in their own transport related environmental stewardship programs. TAC's New Vision for Urban Transportation, which has been strongly endorsed by Canadian municipalities, points the way to more sustainable

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urban transportation systems in the future. The TAC vision complements and supports a variety of local initiatives.

Reasons for success with the TAC vision approach are reviewed, as are some remaining barriers to be overcome. The paper closes with a strong call for co-operative action by all members of the transportation community, as the best means to achieve sustainable transportation goals.

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### **Approach to Sustainable Transport in Japan**

**Kagu Onogawa**  
**Setsuo Hirai**  
Traffic Pollution Management Division  
Air Quality Bureau  
Environment Agency

Co-Chair  
Session 3b

This paper introduces the latest state of the approach to sustainable transport in Japan, where sustainable transport has been discussed in relation to the protection of urban air quality, noise pollution and global climate change. Among these, the most urgent ones are air and noise pollution problems in big cities. While well established mass transit systems have played an important role for passenger transportation and contributed successfully to the sustainable transport in Japan, freight transport still depends greatly on the vehicles and has been the major reason of the problems outlined.

As an additional counter measure for these problems, Japan has enacted a law for total nitrogen oxides emission control of vehicles in specified areas in big cities, in addition to the conventional emission control standards for all types of vehicles throughout Japan. Another example of additional counter measures is the 1980 law for the improvement of road-side condition for traffic noise control.

On the issue of global warming, the Cabinet approved the “Action Plan to Arrest Global Warming” in 1990, which recommends formation of ecological transport systems with fewer emissions of carbon dioxide, to be achieved through the improvement of vehicle fuel consumption, introduction of electric vehicles, further use of mass transit systems, etc.

### **Sustainable Transport - Austrian Strategies and Experiences**

**Robert Thaler**  
Austrian Ministry for the Environment  
Department Transport Affairs and Noise Protection

Panelist  
Session 3b

### **Current problems**

Air pollution, noise, urban sprawl, congestion: urban areas and agglomerations are burdened by a lot of negative effects on human health and the environment caused by the enormous increase of traffic. There is a triple challenge of local and regional home-made transport problems and, because of the specific geographical situation of Austria in the heart of Europe, added burdens by long-distance transit traffic in the main transit corridors.

As national guidelines for the transport policy, the Austrian National Environmental Plan, based on the principles of sustainability (1994), and the Austrian Transportation Concept (1991), have been established. The federal states and several cities have also worked out their transport plans on the regional and local level, based on concrete targets.

#### **Measures for sustainable transport**

- Reduce the needs for motorised transport by an adapting land-use planning to shorten transport distances;
- Shift to environmentally sound transport modes, and promote and prioritise rail and public transport, cycling and walking;
- Optimise transport technologies (electric vehicles, fuels, logistics) based on the "best available technology" with ambitious standards for reducing air pollutants and noise;
- Cleaner fuels and raising the fuel efficiency of the vehicle fleet significantly;
- Making transport pay its full costs, including internalization of external costs;
- Improve infrastructure for environmental friendly transport
- Organise transport in an environmentally sound way (e.g. traffic calming and parking regulations) and raise the load factor of vehicles;
- Making infrastructure, town planning and land use environmentally acceptable;
- Improvement of infrastructure and logistics for rail and combined transport in goods transport (e.g. city logistics);
- Raising public awareness for environmental friendly mobility behaviour and transportation demand management;
- Promote research and development programs focusing on sustainable transport and realising of pilot projects.

Implementation examples in Austria

Ban of leaded petrol, parking regulations and charges, integrated public systems transport, ultra low floor streetcars, traffic calming and promoting walking and cycling, city speed limits 30 km/h, pilot projects for car-free housing and car-free tourism.

#### **The Diesel Fuel Engine - Practical Experience and Future Trends**

**J. Beck, P. Beck, Clean Air Partners**  
E. Mirosh, Alternative Fuel Systems Inc.

Participants

Diesel Dual Fuel (DDF) engines are fuelled by a mixture of diesel fuel and gaseous fuel, which often is natural gas. Multipoint port injection of natural gas allows precise control of gas apportioning as well as responsiveness and controllability.

DDF engines can be shown to outperform equivalent - sized dedicated natural gas engines in areas of better fuel efficiency, lower greenhouse gas emissions and better operating economics.

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Practical experience gained from operating DDF engines has shown that these expectations can be met and that driveability is equal to the preconverted diesel engine.

As a side issue, the superior fuel economy of DDF engines compared to dedicated natural gas engines, allows less natural gas fuel to be required on board, less storage cylinder weight, and lower capacity filling stations for fleets. As well, DDF engines can operate on dedicated diesel so that conversions can be made while CNG filling station infrastructure is being established, resulting in minimum operations disturbance and maximum vehicle utilisation.

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### **Evaluation Framework And Processes: Towards Sustainable Transportation**

**Peter Bein, Ph. D., P.Eng.**

Participant

Transportation Planning Economist  
British Columbia, Ministry of Transportation and  
Highways

In response to new requirements for transportation project, program and policy appraisals, the British Columbia Ministry of Transportation and Highways (MoTH) selected the social cost benefit analysis as the recommended framework based on agency and road user costs. In order to incorporate environmental and social costs as well, MoTH launched a study in 1992 to examine evaluation frameworks as to their suitability to incorporate the additional criteria, assemble existing environmental cost information and estimates, and develop methods for monetising impacts for which estimates are lacking.

Based on the study, this paper proposes an evaluation approach that is socially and environmentally more sensitive compared to more traditional appraisals. It can be applied across the strategic and tactical levels of transportation planning. The fresh approach considers the values that have been notoriously omitted or ignored in many cost benefit analyses and other evaluations of transportation. The methods include emerging work in ecological economics. The different evaluation approaches are reviewed to identify comparative advantages. An approach is presented, which is based on social cost benefit analysis of monetised values, supplemented with the consideration of non-monetisable and intangible factors in a multi-criteria evaluation framework guided by the precautionary principle of sustainable development.

### **Sustainable Transportation: A Situational Analysis**

**Peter Bein, Ph. D., P.Eng.**

Participant

Transportation Planning Economist  
British Columbia Ministry of Transportation and  
Highways

The unprecedented rate and character of change in current human activities, including transportation as a major factor, has negative impacts on the natural world and provides a warning that continuing along the same paths of development may create even greater problems. Methods and assumptions that were appropriate in the past provide little help to guide society in determining solutions for today's environmental problems. Transportation activities contribute to the problems to a large

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degree, and create social problems as well. They would be avoidable if transportation was planned to be more sustainable environmentally and more socially equitable, without necessarily impairing the economy. The symbolic appeal, convenience and attractiveness of the personal automobile is the fundamental factor that must be addressed when visioning sustainable transportation.

A research and development project of the British Columbia Ministry of Transportation and Highways embarked in 1992 on a study of the environmental and social impacts of transportation. Considerable work has been assembled in the course of the research and some of it is completed. This paper conveys the findings from that study regarding the paradigm underlying sustainable transportation, present situation in various jurisdictions, and the direction to steer the change into the desired tracks in the near future.

This paper supports a socially and environmentally more sensitive approach to sustainable transportation planning. The elements of sustainable transportation are examined based on international examples. The necessary changes in politics, leadership, regulation, institutions and consumer behaviour towards sustainable transportation are then discussed using situational analysis at different government levels in Canada and internationally.

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### Monetisation of Environmental Impacts of Transportation

**Peter Bein, Transportation Economist**  
**Chris J. Johnson, Research Contractor**  
**Todd Litman, Research Contractor**

Participants

British Columbia Ministry of Transportation and  
Highways

The British Columbia Ministry of Transportation and Highways has developed monetary estimates (shadow prices) of environmental impacts based on environmental economics, sustainability principles and prevailing scientific opinion. While other papers from the Ministry to this conference address situational analyses, description of the evaluation framework, and detailed derivation of some of the difficult-to-quantify environmental impact costs, this paper summarises the estimates and the underlying methodologies and assumptions. Shadow prices have been developed for the following impact categories:

- global atmospheric changes (global warming, ozone depletion)
- biodiversity
- loss of space
- traffic noise
- barrier effects (community, farms, wildlife)
- local air quality (fine particulates, ground-level ozone)
- water pollution and hydrologic impacts
- energy and resource consumption
- waste disposal

The shadow prices account for direct impacts of traffic operations and infrastructure construction, and for indirect impacts embedded in the full system cycles from vehicle manufacture to fuel distribution and urban sprawl encouraged by transportation.

**Towards Sustainable Freight Transport: Considering Both Direct and Indirect Energy Requirements**

**A.J. M. Bos, MSc.**

Participant

Center for Energy and Environmental Studies,  
Faculty of mathematics and natural sciences  
University of Groningen

Within the framework of the programme “transition towards sustainability and quality”, freight transport (i.e. road, rail and inland water transport) is studied with regard to energy use and other environmental impacts, such as emissions and noise. The study takes into account the energy and environmental impacts of the whole life cycle of the vehicles and infrastructure: the construction phase, the use phase and the disposal phase.

This paper concentrates on the part of the project which deals with the calculation of energy and material requirements of the construction and maintenance of infrastructure and vehicles. Two analysis methods are used for the calculations:

- input-output energy analysis (IOEA), which relates investments to primary energy use; and,
- process energy analysis, which combines material use balances and the embodied energy of materials.

Results show that the embodied energy of freight transport is not negligible. Depending on the transport mode considered, the indirect energy requirements can reach to 50 % of the direct energy requirements, such as fuel or electricity use.

The case study presented here illustrates the value of taking into account indirect energy requirements. For a developing economy like Poland, a growing GDP means an increase of the transport of goods, and therefore, an expanding freight transport system. The increase of the energy demand, covering both direct and indirect energy, should concern the policy makers because sustainable transport will be difficult to achieve.

For the transport modes considered, IOEA and process energy analysis can also be used to calculate the indirect emissions and their contribution to the total emissions of freight transport.

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**Walking, Walkability and Community: Green Transportation Hierarchy**

**Chris Bradshaw**

Participant

Founder, Ottawalk

The only way to approach sustainable transportation is to accept the "green transportation hierarchy," which places walking first, then cycling, then transit and other multi-passenger modes, then the private automobile. This places a great deal of importance on understanding what measure will increase the use of walking.



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The author, North America's leading pedestrian advocate, contends that walking not only increases the efficiency of other modes, but should be the only mode necessary for many trips now taken by car. In this elaboration of his 1993 paper presented to the International Pedestrian Conference in Boulder, Colorado, a ten-point "neighbourhood walkability index" has been developed, designed to produce a single rating value.

Such an index can be used to: 1) moderate property taxes for properties in highly rated neighbourhood, 2) assist people in the market for housing (and businesses) to better judge their transportation costs and options for comparable areas of town, and 3) provide guidance to community organisations as to what they can do to make their neighbourhoods more liveable.

After an "interlude" that deals with the "pyramid" of the scales of life and the importance of the viability of street-level and neighbourhood-level functions to re-establish the stability of the pyramid, seven community "inventions" are proposed that will build the self-sufficiency of local communities' economy, social life, and environment which play such an important role to all people, not just AAAs (active, affluent adults). These include: co-transportation clubs, PESTs (public environment stewards), community-vision and walkability-assessment processes, neighbourhood-focussed TRD (travel-reducing development), "neigh-net" (a local computer network), DcPoTs (Delivery and Point of Transfer: the new corner store), and developing a walk-oriented neighbourhood business strategy.

A plea is made for the revitalisation of local life, where average people can make sense of things, where problems are still small, and where people can feel connected and valuable.

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### **The Alternative Transportation Centre: An Innovative Initiative to Reduce Reliance Upon The Single Occupancy Vehicle**

**Gavin Davidson**

Participant

Better Environmentally Sound Transportation  
Association

The Greater Vancouver Regional District (GVRD) and the Province of B.C. have each pledged a commitment to develop comprehensive transportation demand management programs, including increasing costs for individual drivers (through tolls and taxes), as well as improved infrastructure and services for transit users and cyclists. Yet, to date, there have been very few concrete steps taken. Meanwhile, growth in the use of transit, bicycle and pedestrian modes has not kept pace with automobile usage. Individuals are using cars more often and are travelling further. Moreover, certain private and public interest groups have indicated opposition to any increased costs for automobile drivers. Clearly there is a need for a grass roots initiative which will support efforts to decrease automobile dependence. From this need grew the concept for the Alternative Transportation Centre (ATC).

The ATC is a project of Better Environmentally Sound Transportation (BEST), a non-profit organisation, whose mission is to encourage use of socially, economically and environmentally responsible alternatives to the private automobile within the GVRD. The project will encourage responsible transportation by:

- undertaking trip reduction plans for employers in order to enhance facilities, policies and programs which promote "greener" trips;

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- developing a public resource library on urban transportation issues;
- undertaking yearly promotional campaigns to encourage use of alternative modes;
- providing personalised support to individual commuters who wish to break the auto addiction;
- raising public awareness of the convenience, health, and economic benefits of cycling;
- creating communication networks for cyclists and organisation;
- advising City Councils and other legislative bodies on transportation issues;
- ensuring that alternatives to the private automobile are emphasised in municipal and provincial transport systems;

This unique project marks one of the first occasions that all four levels of government, the private and nonprofit sectors have joined together in an effort to improve the environmental well-being of our region. This paper fully describes the project, the innovative partnerships and the funding arrangements which will ensure its long term viability and positive impact on transportation habits within Greater Vancouver.

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### Tools for Applying Sustainable Development Ideas

**Quentin Farmar-Bowers**  
ARRB Transport Research Ltd.

Participant

AUSTROADS<sup>1</sup> is tackling the objectives of the NS-ESD<sup>2</sup> in the next two years by implementing two key elements of the AUSTROADS ESD Strategy<sup>3</sup>.

1. *Development ESD Analysis.*

ESD Analysis<sup>4</sup> comprises *Development Analysis, Payment Analysis, Resource Use Analysis*. Road authorities and ARRB Transport Research will work together on a small number of projects to refine analytical tools over the next two years.

2. *The development through workshops of a National Protocol System for the maintenance of Biodiversity on roadsides and in adjacent ecosystems, including waterways.*

The National Protocol System comprises (i) a Core that sets out the national objectives, (ii) Chapters that commit all stakeholders to a program of their own devising to achieve the objectives and (iii) Management Arrangements to allow the work to proceed in the field. The management arrangements will be reported during the next two years and include: *Information Systems (GIS based), Jurisdiction certainty, Decision Framework, Roadside Management Practices and Finance*.

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<sup>1</sup> Austroads is the national association of road transport and traffic authorities in Australia and includes Transit New Zealand.

<sup>2</sup> NSESC is the National Strategy for Ecologically Sustainable Development which was accepted by all Australian term for Sustainable Development.

<sup>3</sup> AUSTROADS, (1995) Ecologically Sustainable Development strategy, Publication No. AP-40/95 Austroads, Sydney (available from ARRB Transport Research)

<sup>4</sup> ESD Analysis was developed by ARRB Transportation Research and published in 1994 (ARR 157).

**Mobility Management - A New Integral Approach to Achieve Sustainable Transportation Concept and Experiences From Austria**

**Susanne Ferril**

Forschungsgesellschaft Mobilität FGM  
Austrian Mobility Research AMOR

Participant

In spite of many efforts to tame traffic problems, no striking success has emerged until now. One reason may be the neglect of social factors and the lack of co-ordination of different strategies. This is the aim of mobility management: not a particular transport system, but each individual as the centre of consideration.

**The three basic aims of mobility management are:**

- to guarantee the possibility of mobility for all social groups
- to promote a modal choice in favour of the green modes
- to promote responsibility and consideration in transport behaviour

**Preconditions for these aims are:**

- making transport systems available
- sufficient information, public awareness
- a mixture of stick and carrot measures
- convincing political marketing

It is evident that such a complex task demands a new orientation (new field of activity) in institutions, and good co-ordination of the different responsibilities. The paper will give a survey about the tasks of mobility consultants, co-ordinators etc. within authorities, public transport companies, “traffic producers“ (such as companies, schools, hospitals etc.) and on the political level. A mobility centre represents the key element of mobility management as it provides “mobility.” This signifies an almost endless range of services: disposition of collective taxis, call-a-bus, car-sharing; information about public transport (time-tables and fares); bike-rental & repair, delivery service.

Mobility management as an integral approach does not only require reconciled measures on different levels but also an interdisciplinary training for all actors of mobility management. It is clear that the professional requirements comprise a lot more than merely technical know-how. Some important skills are project management, understanding of contexts and effects, public relations work, communication and social competence. In Austria, the Austrian Mobility Research offers practice-orientated nine-month training, which imparts the above mentioned skills.

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**Transportation and International Sustainable Development: A Preliminary Conceptualisation and Application**

**Andrew R. Goetz**

**Joseph S. Szyliowicz**

**Paul Stephen Dempsey**

Center for Transportation Studies  
University of Denver

Participant

As a major stimulus for economic development and a significant contributor to local and global environmental problems, transportation systems must be viewed in a new way which encompasses a wider range of concerns than the traditional market-oriented approach. We must develop and operationalise a new paradigm for transportation, educate all stakeholders to the nature of the problems and potential solutions, and implement the kinds of policies that will optimise transportation's role in promoting sustainable development.

In order to do so, it is essential to develop explicit criteria that can be utilised to assess transportation systems. In this paper, we present a preliminary effort at constructing an analytical framework that permits evaluation of transportation modes in terms of their sustainability, and apply it to aviation to demonstrate its utility.

It posits that a transportation system which promotes sustainable development must possess three key characteristics. It must be: (1) environmentally sound, (2) efficient and flexible, and (3) safe and secure. Each of these contains the following three elements --technology, planning and policy, and ethics. Any attempt to enhance the energy efficiency of any mode, for example, necessarily utilises technology, involves planning and policy, and raises ethical issues.

When analysed within this framework, the aviation industry is shown to have some attributes that are consonant with sustainability but many that are not. Yet no other mode can match its ability to transport people and goods swiftly over long distances. Accordingly, we conclude that a systemic approach which analyses modes on the basis of sustainability is required. In this way it is possible to identify the strengths and weaknesses of each mode, devise means to minimise negative impacts, and develop an efficient, integrated transportation system that is consonant with the goal of sustainable development.

### **Urban Transport Planning : Focusing on Co-operation and Responsibilities**

**Harry Gow**

**Normand Parisien**

Transport 2000 Canada/Québec

Participant

While trade barriers are opening world-wide, particularly within North America under NAFTA (North American Free Trade Agreement), not to mention the level of public sector's debt, recent trends towards deregulation and decentralisation of state activities encompassed even the transportation sector.

However, agreements from the United Nations Conference on Environment and Development, to which both Canada and United States adhered, set up a comprehensive approach to address energy and transportation systems planning as well as urban settlements. Meanwhile, market forces, by themselves, and blind reliance to the user-pay principle, all led to undesirable and unsustainable side-effects.

### **Urban transportation diagnosis for Canada**

In the context of a high-level of urbanisation, there are three major metropolitan areas in Canada: Montréal, Toronto and Vancouver. Despite an apparent extensive land-use process, the first two are located in the urban Windsor-Québec corridor (almost two-thirds of the Canadian population) and the latter in the lower Fraser Valley, British Columbia.

While urban smog appears to be the most important urban environmental problem as far as transportation is concerned, there are related economic and/or social issues: business cycles, mobility and motorization, etc. Unlike the United States, strategic or stabilising forces (such as macroeconomic) assured by the Canadian government, remain rather low domestically. Regional gaps characterise Quebec, Ontario and British Columbia.

### **Policy planning and implementation**

Although provided with limited jurisdictions with respect to urban transport, the federal government should play a strong leadership role. If it is to run a serious sustainable development agenda, it must empower both intergovernmental bodies and effective participation of the civil society, given the crucial influence of what is called “enabling environment” as a determinant for success or failure of adequate measures.

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### **City Space - A Scarce Resource**

**S. Olof Gunnarsson**

Professor

Chalmers University of Technology

Participant

City activities demand a great deal of space: for housing and living, for industrial production, commerce and services, for recreation and for transportation. As ground space is limited, high ground costs are set for building rights, especially in central areas. When a city expands, residential areas, industrial plants and commercial interests will be located in the outskirts of the city where land costs are much lower. Distances and transport demand will increase tremendously, and the predominant means of transport are automobiles and trucks. Extensive road construction follows, coincident with the expansion and exploitation of land. The phenomenon is known as "urban sprawl".

A comparison of land use and transportation characteristics in cities shows that the lower the rate of automobile dependency, the higher the degree of land utilisation, the higher the rate of public transport and walking/cycling, the lower energy consumption, and the lower the environmental impact. Urban density - or space consumption - is therefore a good indicator of how a city will function from an environmental point of view.

The ideal city development seems to be one that can control consumption of land, strive for a variety and integration of urban functions on a human scale, restrict the use of automobiles and give high priority to safe and comfortable walking and biking together with an effective public transport system. It is shown that walking and biking are the most efficient modes of transport and that they consume up to 100 times lower volumes for movement in a city centre than motor vehicles.

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A shift to a new paradigm for urban and traffic planning is necessary. Recommendations are given for both industrial and developing countries.

Conserving space - thinking spatially - will be an important way to achieve Sustainable City Development and Transportation.

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### Urban Transport Policy in Vietnam on the Way Towards Sustainable Transportation

**Dr. Luu Duc Hai**

Deputy Head of Planning Division  
National Institute for Urban and Rural Planning  
Ministry of Construction

Participant

There is a definition of sustainability. It can be referred to "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Everybody in the world is trying to find out a general approach: a global approach to sustainable transportation.

Urban transportation policy in principle nearly everywhere proposes an environmentally-friendly package. The package usually consists of:

- containment or reduction of the total volume of traffic;
- improved and expanded public transport system;
- better provision for pedestrians and cyclists;
- traffic calming to reduce the dominance of vehicle traffic;
- traffic restraint and traffic management, aimed at reduced flows and increased reliability rather than maximising the thoroughfares for vehicles;
- the control of land-use changes and new development, in such a way as to reduce journey length and car use wherever possible; etc.

However, the application of above mentioned issues is different, depending on the specific situation in each country.

Vietnam is a poor and developing country, and has an urban transport policy towards sustainable transportation on its way.

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### The Motorcycle as an Alternative Mode of Transport

**Craig W. Heale**

British Columbia Coalition of Motorcyclists

Participant

#### **The traditional role of the motorcycle in North American transportation:**

- Motorcycles historically visualised here as recreational vehicles not commuter vehicles
- Under-utilised as commuter vehicles in North America compared to the rest of the world
- Cheap gasoline and low density urban centres encouraged auto dependence
- Poor "Hollywood" image regarding MIC has handicapped public relations efforts in the past

**Some of the numerous advantages motorcycles can offer:**

- Motorcycles occupy less space to park and operate compared with automobiles
- Motorcycles are more environmentally friendly, requiring less natural materials to produce and maintain (for example, they use two tires instead of four)
- All motorcycles here in British Columbia are exempt from "Air Care" emissions testing
- Motorcycles generally use less fuel and thus produce fewer CO<sub>2</sub> emissions

**Barriers to increased motorcycle usage:**

- High insurance premiums throughout most of North America (often higher than autos )
- Motorcyclists are forced to "queue up" with autos in spite of their smaller size
- Most parking garages ban motorcycles and/or charge automobile prices
- Perceived noise pollution problems ( most MIC are actually quieter than buses)
- Very few jurisdictions offer designated on-street parking, thus forcing motorcyclists to compete with automobiles and pay automobile parking rates in spite of their small size

**Future Contributions to Sustainable Transportation:**

- All jurisdictions should recognise the many advantages increased MIC use will offer
- Motorcycle use should be encouraged similarly to non-motorised cycle usage
- Graduated licensing and compulsory rider training will reduce accidents and insurance
- Transferable insurance and license plates = affordable second vehicle for commuting

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**Dual-Mode Technology - The Third Alternative?**

**Palle R. Jensen**  
RUF International

Participant

Until now, policy makers have been focusing on the two old sectors within transportation: Automobiles and Public Transportation. It is very difficult within this framework to create sustainable development and maintain mobility.

Fortunately, a new sector is currently being developed: Dual-Mode transportation systems. Combining car mobility with train sustainability is possible with this new and very attractive development.

The paper will present the principles of Dual-Mode transportation, exemplified with the Danish RUF system.

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**Public Perceptions of Transportation Demand Management Measures in Kwangju City, Korea**

**Bonghyun Jeong, Phd.**  
Department of Regional Development

Participant

Kwangju City is the hub of the Honam area, the southwest part of the Korean Peninsula. In 1993, it was one of the five largest cities in Korea and had a population of 130 million in 500.9km<sup>2</sup>. Rapidly

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increasing traffic volumes and insufficient transport facilities have aggravated a number of transport problems, including traffic congestion, parking difficulties and traffic accidents. The most common approach to the improvement of transport problems in Kwangju has been expansion of the transportation system. This simplified approach had some problems, such as massive capital investment and a consequent increase in travel demand. This approach was partly ascribed to the absence of any transportation demand management (TDM) policy. TDM is now finding a growing constituency among local officials pressed to find solutions to worsening traffic congestion in Kwangju City.

This paper provides findings from the public's perception of TDM measures for reducing traffic congestion in Kwangju City. It deals with the study results covering transport problems, comprehension acceptance and implementation of TDM measures. The purpose of this paper is to obtain comprehensive insights into the public understanding of legislative restraint measures in Kwangju City. This paper could best be introduced by a review of selected literature and the analysis of Perception Survey data.

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### **Sustaining Urban Transport In Canada: A Function Of Rising Social Costs**

**Mebs S. Kanji**

Ph.D. Student

Department of Political Science

University of Calgary

Participant

Most recent evidence suggests that urban transit ridership in many advanced industrial countries has declined (Pucher, 1995; Pucher and Kurth, 1995). Yet in Canada, despite rising automobile sales, growing sub-urbanisation, and increasing transit fares, the crosstime evidence indicates that public transit rider ship over the last two decades has been remarkably consistent. The key question then becomes: Why do Canadians continue to support urban transit systems - especially since most now own cars, and urban transit systems have become more inconvenient and expensive to use? The answer, at least in part, has to do with rising public concern for the environment (Nevitte and Kanji, 1995; Kanji and Nevitte, 1995). Simply put, those Canadians who are actively willing to pursue the environmental cause are also more likely to support the urban transit system. Furthermore, the evidence suggests that public concern for environmental issues is not likely to be a temporary "fad"; the trend appears to be driven by generational change (Inglehart, 1977, 1990a; Dalton, 1984, 1988) and as such, will probably increase over time.

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### **Transportation Subsidies, Public Goods, Economic Efficiency, and Equity**

**Michael F. Lawrence**

**Thomas Kornfield**

Jack Faucett Associates

Participants

According to many environmentalists, the U.S. transportation sector is being subsidised by federal, state, and local governments. Whether or not road users are actually paying the cost of using roads is



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a critical issue in supporting sustainable transportation. The impact of subsidies is to increase road consumption above levels that would otherwise be dictated by the market. This paper compares different estimates of transportation subsidies, noting their strengths and weaknesses. Following this discussion, the issue of transportation as a public good is covered. How economic efficiency and equity are considered, depends in large part on the role of transportation in society. If transportation is deemed a public good, then alternative evaluation criteria must be applied. If not, then economic efficiency would need to be considered. Both efficiency and equity could be enhanced by a pollution tax. Such a measure would improve equity by charging users for the pollution they generate. In addition, economic efficiency could be enhanced by internalising the environmental externalities associated with transportation. This paper, then, compares different estimates of transportation subsidies as a prelude to discussing economic efficiency and equity issues. The paper does not develop a definitive answer to the problem of transportation subsidies but rather highlights the important public policy issues that exist within this arena.

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### Transportation Cost Analysis for Sustainability

**Todd Litman**

Victoria Transport Policy Institute

Participant

Sustainable transport planning requires a knowledge of the full costs of specific transportation decisions, including indirect environmental and social impacts. In recent years researchers have made considerable progress quantifying transportation costs. This paper:

- Describes a framework for evaluating the full cost per passenger kilometre of different travel modes.
- Summarises current research on transportation costs, provides cost estimates for eleven modes under three travel conditions, and identifies which portion of costs are internal or external, fixed or variable, market or non-market.
- Explores the implications of current transportation costs on economic efficiency, equity, environmental impacts, and land use.
- Demonstrates how this framework can be used for specific transportation decisions, such as the evaluation of congestion reduction options and transportation demand management programs.

The results indicate that a significant portion of automobile costs are either fixed or external. As a result, automobile use is significantly underpriced, resulting in overconsumption and inefficient use of resources. Other travel modes are also underpriced, but at a smaller amount per passenger mile. The implications on sustainability criteria (economic efficiency, equity, environmental impacts, and land use patterns) are discussed. Recommendations are provided for incorporating full cost analysis in transport planning and policy analysis for better decision making.

This paper summarises the report *Transportation Cost Analysis: Techniques, Estimates and Implications* published by the Victoria Transport Policy Institute.

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### ISTEA, the Clean Air Act, and Sustainability

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**Daniel R. Luscher**  
Acurex Environmental Corporation

Participant

Two entirely separate regulatory frameworks have been established in the United States for air quality planning and transportation planning. Air quality planning is based on the federal Clean Air Act, which directs states to attain, within a defined timeframe, clearly defined health-based ambient air quality standards for six pollutants. Measures to reduce emissions of air pollutants are evaluated strictly on their contribution toward meeting the standards.

Surface transportation planning, on the other hand, has a multitude of goals, none of which is clearly defined. These goals include providing basic mobility and accessibility to economic opportunity, and encouraging economic growth with a comprehensive and efficient transportation system. The Intermodal Surface Transportation Efficiency Act requires that transportation plans and projects be evaluated on 15 factors, including overall social, economic, energy, and environmental impacts.

The differences in these regulatory frameworks lead to a key imbalance that affects projects and measures that impact both transportation and air quality. Projects and investments designed to meet transportation needs often consider air quality, but transportation projects designed for air quality purposes essentially never consider anything other than air quality. As a result, project evaluation is constrained, potentially to the detriment of sustainability and other societal goals.

In order for sustainability issues to be more effectively incorporated into the evaluation of transportation projects, clear sustainable transportation goals need to be set. In addition, the Clean Air Act should be made more flexible so that benefits other than air quality can be considered in evaluating air quality measures.

### **Shipping, Ports And Pollution Control**

**Scott MacKnight, Ph.D.**  
Land & Sea Environmental Consultants Ltd.

Participant

The oceans form a key component of the biosphere. At the same time, the oceans provide us with a everything from important sources of food to recreational areas, from convenient waste disposal sites to key transportation routes. Growing recognition of the limits of assimilative capacity of the oceans, particularly in the coastal zone, has led to implementation of several international agreements to restrict and manage the discharged of wastes into the marine environment. While focus has often been placed on marine shipping of oil along select sea routes, the increase in all forms of shipping,

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particularly through the Indian and Pacific Oceans has led to increased demands for control of pollution arising from shipping and the associated pollution from port activities.

With funding from the Global Environmental Facilities Fund, projects have been or are proposed in several Pacific Rim nations to address the issue of reduction of ocean pollution from shipping and port. The evaluation and design of appropriate waste reception and treatment facilities has been relatively straight-forward. It is the implementation of such programs, both at the shipping and port levels which has proven to be difficult.

This paper will review projects in China, Indonesia and Philippines. Discussion will include issues of cost recovery for facilities, shipping requirements for waste management, regulatory problems and evaluation of "environmental benefits." The development of a "port environmental management strategy" provides one component of the evolution of an environmentally sustainable or "green" port.

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### **Some Contrasts in Planning for Urban Cyclists in Britain and Continental Europe**

**Hugh McClintock**

Lecturer

Department of Urban Planning

Nottingham University

Participant

The paper assesses the experience in providing for the urban cyclist in Britain, in comparison with provision in Continental European countries such as the Netherlands, Denmark, Germany and Switzerland. It compares levels of cycle use, official and social attitudes to the use of the bicycle in urban areas. It then analyses British experience both in terms of the provision of special facilities for the cyclist, consideration for cyclists' needs in traffic-calming and mainstream traffic management, transport planning and town planning. Comparing British with Continental experience and best practice it concludes by emphasising the need for cycling to be given a central place in urban transport policy, and to be promoted for health and environmental reasons, by close co-operation between a number of agencies in different sectors, including employers, health authorities and cycling groups as well as central and local government.

### **Public Support for Sustainable Transport**

**Doug Miller, President**

Derek Leebosh, Sr. Research Associate

International Environmental Monitor Ltd.

Participant

The authors draw from their own extensive public opinion research on Canadian attitudes and behaviours associated with air pollution, climate change, the automobile and personal transportation options to demonstrate the extent to which public support is already in place for sustainable transportation initiatives.

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Findings from over 30 Environmental Monitor™ surveys (conducted quarterly since 1987) exploring the environmental and sustainable development views of the Canadian public are used to demonstrate that:

Automobile exhaust is being increasingly targeted by the public, not only due to the human health effects of smog, but because of the auto's contribution to global atmospheric problems including climate change.

There is strong public support for public policy changes, including lower fleet emission standards, cleaner gasoline blends and alternative fuels.

The public would support increases in the costs of driving if funds were applied to reduce air pollution impacts. (Fully two thirds of Canadians do not believe current costs of driving, including all taxes and fees, come close to covering their environmental impacts.)

There is a significant and growing readiness on the part of drivers to change their behaviours to reduce their air pollution impacts, including driving less, substituting walking for short trips and ride-sharing for longer ones, and taking public transit (if it is made more convenient.)

Finally, the authors draw from a 20-nation public opinion survey conducted by the University of Chicago in 1993 that suggests the findings and conclusions stemming from Canadian public opinion likely apply to varying extents in other OECD countries.

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### **Changing Material Use in Passenger Cars: a Road To a Sustainable Use of Material and Energy?**

**Dr. H. C. Moll**

Center for Energy and Environmental Studies  
Faculty of Mathematics and Natural Sciences  
University of Groningen

Participant

The current pattern of personal mobility in the OECD countries can not be characterised as sustainable because of the exhaustion of resources for car production, the consumption of energy and exhaust emissions during the useful lifetime of a car, and the generation of waste in car disposal. The introduction of new materials in car production, the application of clean and efficient engines and the application of better design practice may improve the performance of an individual passenger car, but the continuous increase of demand may deteriorate further the environmental conditions on national and global levels. In this study, a set of options to improve the performance of the passenger car is evaluated with regard to material consumption, energy consumption and atmospheric emissions from a dynamic lifecycle perspective. The options considered in detail are material substitution of steel by light weight materials (plastics and aluminium), the introduction of clean engines or three-way catalysts in cars and the introduction of better dismantling practices. The potential results of the introduction of these options in The Netherlands are calculated for the period 1990-2020.

The Netherlands may be considered as a representative example for the North-West European countries. It is concluded that an increase of the aluminium use in cars will decrease substantially the

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lifecycle energy requirement of cars (in the case of a high recycling level of aluminium), that the car waste amount may be reduced by the introduction of a design-to-dismantle practice, and that the emissions of harmful substances by cars will be reduced more substantially -- at least in the short term -- by the application of three-way exhaust catalysts than by the further development of current clean engines. The results of these options are related to the environmental policy objectives on national and international levels.

It is concluded that these objectives will not be fully met by the application of the options considered here. Options possibly available in the long term (e.g. electric and fuel cell powered vehicles) are evaluated qualitatively in the perspective of long term environmental objectives. The realisation of these options may result in a compliance with the long-term environmental objectives.

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### **Sustainable Transportation Through an Integrated Planning Process**

**Dick Nelson and Don Shadow**  
Institute for Washington's Future

Participant

A new planning tool allows urban planners and decision makers to select the most sustainable transportation strategies and alternatives. This methodology, integrated transport planning (ITP), was developed and refined in the energy sector, and recently has been applied to transportation investment decisions in the Seattle, (USA), metropolitan area.

ITP provides a thorough examination of strategies that potentially would lessen the impact motor vehicles have on the earth's environment, resources, and people. It does this by fully accounting for the costs of transportation, including direct and indirect environmental costs. ITP searches for alternatives that reduce the total costs of transportation while providing the access people need in their daily lives. These alternatives include those which seek to manage the demand for travel and to use motor vehicles more efficiently, as well as traditional and innovative public transport systems.

ITP assumes that people desire accessibility, not simply mobility. Accessibility can be provided through urban forms that reduce the need for motor vehicle trips and that shorten trip lengths. Accessibility will increasingly be provided through telecommunications systems that allow for high quality interaction and the exchange of information. ITP recognises alternative future scenarios that involve more compact and mixed-use urban development, greater substitution of telecommunication system connectivity for transportation system connectivity, and the governmental policies that can promote these alternatives.

The Institute for Washington's Future, headquartered in Seattle, is a nonprofit research and educational centre working in partnership with environmental, labour, and community groups to address important policy issues in the state of Washington and its communities.

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### **Policy Instruments for Reducing Greenhouse Gas Missions From Transportation In Ontario "A Multi-Stakeholder Strategy"**

**Ron Neville**

Participants

Apogee Research International, Ltd.  
-and-  
**Ken Ogilvie**  
Pollution Probe

On November 22, 1995, the Ontario Round Table on Environment and Economy (ORTEE) submitted a report to the Premier of Ontario: "Towards a Sustainable Transportation Strategy for Ontario." The report was the result of a year of research and consultations sponsored by a multi-stakeholder Transportation and Climate Change Collaborative. The latter was a partnership effort by ORTEE and the National Round Table on the Environment and the Economy (NRTEE). The Collaborative process engaged senior decision makers from a wide range of transportation stakeholders in policy-level discussions focussed on means of reducing greenhouse gases from Ontario's transportation sector.

The paper reports on a study, commissioned by ORTEE on behalf of the Collaborative, of policy instruments for reducing greenhouse gas (GHG) emissions (especially CO<sub>2</sub>) from all modes of transportation in the Province of Ontario. The study included preliminary evaluation of a comprehensive list of possible technology, economic and regulatory policy instruments. Based on this evaluation, the Collaborative selected those instruments for detailed study which were considered to have the most promise as practical measures for achieving substantial GHG emissions reductions. Instruments studied in detail included alternative fuels, automotive fuel efficiency standards, gasoline tax increases, feebates, parking policies, urban land use, transit improvements, freight fuel taxes, and intermodal freight movement.

Quantitative projections were made of GHG emissions impacts of the selected instruments to the year 2015. The relative effectiveness of the policy instruments was assessed against selected environmental, cost effectiveness, economic and social criteria. One key conclusion is that technology alone is unlikely to provide the level of reductions needed for the transportation sector to meet the goals of the UN Framework Convention on Climate Change, to which Canada is a signatory. The most important conclusion of the study was that impressive GHG reductions can be achieved by adopting integrated strategies that recognise the interactions, both reinforcing and conflicting, among combinations of policy instruments. This conclusion strongly influenced the recommendation made by the Collaborative that a comprehensive, integrated strategy is needed for Ontario to make significant progress on reducing GHG emissions from transportation.

### **Comparing the Emissions Impact of Airport Operations**

**Judith Patterson**  
**Anthony Perl**  
**Alain Bonnafous**  
**Yves Crozet**  
**Benedicte Molin**

Participants

**Jean-Pierre Nicolas**

Department of Geology  
Concordia University

Moving towards sustainable transportation requires the ability to assess the environmental impact of airport operations. Increased passenger travel and air freight shipments prompt development projects which can range from new runway construction to intermodal to rail transport networks. A first step in formulating a sustainable airport infrastructure policy requires assessing the magnitude of existing environmental impacts.

We will compare the emissions impact of three airports (Toronto YYZ, Charles De Gaulle Paris CDG, and Lyon Satolas LYS), both relative to one another and to the total level of atmospheric loading into the surrounding airsheds. The inter-airport comparison can point out operational and physical attributes that make some facilities "cleaner" than others. Comparison with total emissions in the region/airshed of each airport will highlight the airport's relative impact on regional air quality. Both indicators can assist policymakers in deciding which infrastructure development options pose acceptable environmental costs.

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**Forces Shaping Urban Form: The Next Millennium**

**Norman Pressman**

University of Waterloo  
School of Urban & Regional Planning

Participant

This paper explores the forces at work which will transform urban lifestyles in the next millennium, and to which spatial patterns must respond as cities experience growth and decline. It adopts a deductive approach predicated on urban interventions and policies generally established in European cities, and questions the power of information technology to act as a determining variable in the evolution of built form. This is based on the supposition that we do not fully understand the degree to which technological substitution can successfully replace human proximity and face-to-face interaction.

Any existing trends will be scrutinised in terms of the kinds of land use schemata they propagate, in an attempt to speculate on the future shape of the town and metropolis beyond the year 2000. This is a critical issue that planners and designers will confront as they try to reverse many existing socio-economic forces and to establish directions for sustainable living.

A broad range of factors determining and modifying built form shall be critically analysed. These include newly emerging and current technologies, the "new" urbanism, sustainable transportation, reduced automobile dependency, energy conservation, peripheral retail developments and new shopping patterns, changing demographics, and climatic elements. What emerges is that discontinuous, scattered, low-density development is neither feasible nor acceptable. An urban region composed of fragmented elements that are weakly interrelated and poorly integrated cannot be part of a holistic vision for an energy efficient or a socially cohesive urban entity.

### **Pricing Atmospheric Change Due to Transportation**

**Donald Rintoul**

Research Officer  
British Columbia Ministry of Transportation and  
Highways

Participant

This paper describes a process employed at the Province of British Columbia Ministry of Transportation and Highways for estimating the shadow price (surrogate price of a commodity not traded on the open market) of the production of green house gas (GHG) and ozone depleting substances (ODS), effects to which motor transportation greatly contribute.

A model of GHG production and global warming damage is reconstructed from works by William R. Cline of the Institute for International Economics. The purpose of the reconstruction is to allow the province to estimate the shadow price consistent with the assumption of "business-as-usual" and employing precautionary principles. The model's sensitivity to various parameters is demonstrated using 3-dimensional projections of the price surfaces. Principle variables tested are benchmark damages a 2 x pre-industrial CO<sub>2</sub> concentrations, climate sensitivity, damage function and social rate of time preference (discount rate).

Techniques learned in reconstructing the GHG model are applied to a similar phenomenon: that of stratospheric ozone depletion. Using a linear, time-dependent model for ODS decay, atmospheric levels of ODS are predicted for the next 150 years for various ODS production scenarios. These levels are used as an indicator for the stream of economic damages from which the ODS shadow price is estimated. Principle variables tested are social rate of time preference, and ODS production trajectory.

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### **Fuel Cells for Transportation: Learning by Doing**

**Hans-Holger Rogner**

**John D. Wells**

Institute for Integrated Energy Systems  
University of Victoria

Participants

The successful market introduction of novel technologies is closely related to at least one of the following opportunities: (1) the emergence of new markets or previously non-existing applications, (2) the provision by the new technology of better and cheaper services, or (3) the existence of market niches where the new technology lifts fundamental-technical constraints without imposing stringent new ones. However, a market opportunity is not, by itself, sufficient to ensure success. It is also essential to have: (4) good prospects for appropriately scaled mass production processes, (5) early adopters who will choose a new technology for reasons beyond strict bottom-line economic performance, and (6) a plan for market expansion which allows effective use of the technology "learning curve".



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These issues can be readily applied to the introduction of fuel cells into the transportation sector. While fuel cells have clear market opportunities in their potential to satisfy mandates for zero or near-zero emission light-duty vehicles, their market development faces significant barriers. Foremost among these are (1) high capital costs due in large part to small-scale production and, (2) lack of appropriate refuelling infrastructures.

This paper discusses these and other issues affecting the market development of transportation fuel cells, and identifies initial market niches having the greatest potential for successful commercialisation.

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### Tax Reform Fights Sprawl

**Rick Rybeck**

Legislative Assistant  
c/o Honorable Hilda Mason  
Council of the District of Columbia

Participant

Low-density, discontinuous land use development, known as "sprawl," contributes to many of the ills that plague our society. Property tax reform can create economic incentives to reverse this trend, thereby conserving energy and open space while encouraging the use of transit.

Sprawl inhibits the use of transit, necessitates auto travel, pollutes the air and creates political and economic dependence on petrochemical suppliers. Per capita infrastructure costs are high because roads, sewers, etc. must be extended through sparsely occupied areas. Undeveloped areas are too small and too scattered to support meaningful agricultural or conservation uses.

To counteract sprawl, the property tax can be reformed by reducing the tax rate applied to building values while increasing the tax rate applied to land values. This reform recognises that the property tax is really two different taxes, each with very different economic consequences.

Buildings must be produced and maintained in order to have value. Thus, a tax on building values is a cost of production. Taxes on production result in lower production and higher prices. Inflated residential and business rents exacerbate housing and unemployment problems.

Land is not produced. Because a tax on land cannot be avoided by producing less land, or by moving land from one jurisdiction to another, a tax on land values is not a cost of production, but a cost of ownership. By making land ownership more costly (less desirable), a tax on land values results in lower land prices. Taxing them helps make many infrastructure investments (like roads and subways) self-financing.

The higher land tax cannot be avoided or passed on to space users. Land owners are motivated to generate income from which to pay the tax. The greatest economic imperative to develop land will exist where land values are highest, adjacent to existing infrastructure and amenities. At the same time, a reduction in the tax rate applied to building values makes that development more profitable. Away from infrastructure, where land values are low, taxes will be low and there will be less economic motivation for development.

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The result is more compact development that can be served by existing infrastructure, at lower costs to taxpayers and the environment. Compact development also enhances opportunities to walk, cycle, car-pool or use transit in lieu of the single-occupant vehicle.

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### **Prospects for Sustainable Transportation in the Pacific Northwest: Issues and Trends in Vancouver (BC), Seattle (WE) and Portland (OR)**

**Preston L. Schiller, Ph.D.**

Alt-Trans, the Washington Coalition for  
Transportation Alternatives  
-and-

**Jeffrey R. Kenworthy, Ph.D.**

Institute for Science & Technology Policy  
Murdoch University

Participants

Today there is a burgeoning discussion of the Pacific Northwest region as "Cascadia," a region whose sub-units, the U.S. states of Washington and Oregon and the Canadian province of British Columbia, are assumed to share many commonalities. The major cities of the Pacific Northwest do, indeed, share many physical, social, and historical characteristics. Significant differences arise, however, when one begins to compare transportation and land use policies and practices.

This paper will compare issues and trends in three cities on either side of the Canadian-American border in the context of movement towards or away from sustainable transportation. Among the issues to be explored are:

1. The policy and political climate in each city in regards to transportation.
2. The meeting inter-city travel demand through commercial aviation and airport expansion or transportation demand management and diversion of passengers to inter-city rail.
3. A comparison of trends such as vehicle trips and miles travelled, parking supply, provision and performance of public transportation, use of public transportation, and provision and use of non-motorised facilities.
4. An examination of issues and trends related to transportation energy consumption, e.g. fuel consumption, electrification of public transportation, etc.

The paper will conclude with a discussion of the differences found between the three cities as well as their implication for the development of a sustainable Cascadia. In general, it is seen that trends and policy climate for sustainable transportation are improving in Vancouver and Portland while degenerating in Seattle.

**The Impact of Gasoline Price on CO<sub>2</sub> Emissions From Automobiles: Lessons from the United States and Canada**

**Paul Schimek**

U.S. Dept. of Transportation

Volpe National Transportation Systems Centre

Participant

This paper considers the prospects for the United States reducing CO<sub>2</sub> emissions from personal motor vehicles, given recent trends in fuel prices and automobile efficiency regulations. The paper compares recent U.S. fuel use trends to those in Canada, which has similar conditions but higher gasoline prices. Between 1980 and 1992, fuel use increased 12% in the U.S., but declined 12% in Canada, due to more rapid growth in vehicle fuel efficiency and less rapid growth in vehicle use. This difference is attributed chiefly to higher gasoline prices in Canada. U.S. fuel consumption would have been far higher if not for the Corporate Average Fuel Economy (CAFE) program. However, U.S. fuel efficiency stopped improving in 1992, and total emissions have resumed their upward trend. By contrast, Canada is likely to have emissions below its historic high until 2000. The US is not likely to stabilise, let alone reduce, CO<sub>2</sub> emissions from personal motor vehicles if current policies continue. Growing passenger motor vehicle emissions will make it difficult for the US to convince rapidly growing countries such as China to take measures to reduce emissions.

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**Technology has the Power! A Plea for a Stratified Approach to Reach a Sustainable Development**

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Reduction of the environmental impacts caused by transportation has become a leading item in national and international transport policies. In practice, we see that implementing effective environmental sound policies is difficult. The authors indicate that the present trend towards decentralisation and subsidiarity is a big threat for the implementation of technologies which could contribute to the reduction of environmental impacts.

In the paper the authors identify two clusters of "complexities." Firstly, an analysis of the different types of technology is made. In this context they plea for the implementation of so called source related technologies. Second, the authors identify what is the appropriate level for implementation of the identified technologies in the transport systems.

The authors conclude that a nuanced and stratified approach is needed for a successful implementation of technologies. One of the specific conclusions drawn, is that the implementation of effective technologies which could contribute to a more sustainability oriented transport policy is not in line with the present trend towards decentralisation and subsidiarity.

### **Fiscal Practices Inflate Auto Use and Impede Transit Development**

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In a free economy, use of any good or service, once acquired or contracted for, is directly proportional to its fixed cost and inversely proportional to its perceived variable cost. In the case of the automobile, both are exaggerated in directions that incite inflated use. The fixed cost is inordinately high, as a result of both high purchase cost of the machine and policies dictating collection of certain auto costs on calendar - rather than usage - basis. The variable cost is inordinately low, due to absorption as public costs of bulk of the cost of auto/road infrastructure. As a result, normal pricing is unable to provide the level playing field essential for equitable competition between the auto and public transit. Efforts to mitigate resulting loss of public transit have been limited to granting of subsidies to keep fares and patronage at levels deemed attractive.

There is reason to believe that the reverse approach -reduction of auto/road subsidies -- would be more effective.

It is the purpose of this paper to draw attention to the magnitude of auto cost aberrations and to suggest that their mitigation would present advantages not obtainable with current approaches to the problem.

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### **Sustainable Mobility In Europe and the Role of the Automobile**

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The aim of the paper is to discuss the current responses in Europe to the problems of road transport, particularly the problems of increasing car use. The basic point of departure is the new Common Transport Policy (CTP) of the EU as of December 1992. The catch-word of this document, "sustainable mobility", has inspired also the title of the paper.

Actors (political, industrial, NGOs etc.) relevant for the transport policy in Europe are identified. After a description of the present interaction among those in the field of road transport, and consequences of the current situation on the roads of the European Community (high level of injuries, congestion in many areas, heavy impact on ecosystems and air quality and an energy provision which is highly vulnerable to future turbulence on the oil market), the perceptions of the actors are analysed on the problems of road transport, the goals of transport policy and the measures to be used to implement the policy. This analysis is based upon written documents containing strategies for the

## APPENDIX C: CONFERENCE ABSTRACTS

transformation of existing transport systems. The analysis has its focus on the future role of the automobile in the transport systems.

A diagnosis is then presented: The present situation of road transport in Europe is seen as the result of interaction failures rather than of market failures or government failures. The reason for this interaction failure is lack of agreement on the problems, goals, measures and implementation. A solution is indicated: intensified controversies about the perceptions could possibly create opportunities for new forms of interaction.

Special attention is then given to the future role of the automobile in European transport systems. It is argued that efficient, safe and sustainable transport systems in Europe necessitate a redefinition of the role of the automobile in transport systems. Such a redefinition will give rise to hard conflicts as the car is associated with lifestyle, prestige and power.

Special attention is also given to the global context of the European transport problem. The current globalisation of automobility will probably lead to intensified global conflicts about energy resources as well as to serious climate effects, if a continued use of fossil fuels will be the main energy source of an expanding global fleet of automobiles.

The paper ends with a discussion of the possible creation of social carriers of sustainable transport systems in Europe. A number of requirements which must be fulfilled if success is to be guaranteed is presented.

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### **Environmental-Cleaner Goods Transport in Theory and Practice**

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In the study "A New Course in Freight Transport" three ways of reducing emissions and energy-use were evaluated: the use of new vehicle technologies (cleaner engines, other fuels, etc.), optimising the logistic chains (from an environmental point of view) and the use of combined road-rail and road-inland waterway transport. In the study it is made clear that these three elements are of comparable importance.

Two case studies are completed where the theory is put into practice. In the case studies the environmental effects of using combined road-rail transport and combined road-inland waterway transport for the transport of polluted soil were evaluated.

In this paper some of the ins and outs of the computation models are discussed and the results of the theory and the case-studies will be presented. The studies prove that in theory as well as in practice it is possible to decrease energy-consumption and emission-production drastically.

**Designing More Sustainable Urban Communities: Calgary's Approach**

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Redesigning cities to reduce car dependency and encouraging cycling, walking and the use of public transport is a widely held goal of senior levels of government, international agencies and other organisations concerned about public health, energy consumption and environmental impacts. What is less clear is how to achieve that goal at the municipal level where good intentions must face the reality of declining budgets, local politics and a public that is reluctant to give up the convenience and comfort of private cars.

This paper describes how Calgary, a vibrant and prosperous city of 750,000 that enjoys an excellent road system and faces no immediate crisis from traffic congestion or air quality, has taken up the challenge and is starting to design its new suburban communities so that they are fiscally, socially and environmentally more sustainable. Following an intensive series of Round Table meetings involving community leaders and urban design experts from the municipality, development industry and university, a package of policies, performance standards and design guidelines has been agreed upon and adopted by Calgary City Council. While this package, the Sustainable Suburbs Study, deals with community design in a comprehensive way, it has a major focus on reducing the need for private vehicle trips, making transit more accessible and streets more friendly to pedestrians and cyclists.

Moreover, a potentially adversarial planning process has been replaced by a collaborative approach where government officials and landowners, in consultation with community representatives, work together in designing more sustainable communities.



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## REFERENCE AND OTHER NOTES

The references to “conference papers” in this list are to papers presented at the Vancouver conference or in connection with the conference. In most cases, the full text of the paper is available on the conference CD-ROM available from Environment Canada at the address given in Note 3 below. Abstracts of the papers appear in the OECD report on the conference, which is available from the address given in Note 2. For conference papers with multiple authorship, only first-listed author’s name is given in these notes except when the use of other authors’ names must be given to avoid ambiguity.

1. The estimate of the number of vehicles on the road in 1996 is based on data presented in Table 2 of the present report. The statement about the higher rate of growth in road traffic is based on the increasing trend in distance travelled per vehicle noted in the conference paper by Lee Schipper.
2. The proceedings of most of these six meetings are available from the OECD Publications Service, 2, rue André-Pascal, 75775 Paris Cedex 16, France. Fax +33 1 49 10 42 76.
3. The proceedings of the October 1995 conference have been published in *National Conference on Sustainable Transportation: Conference Summary*, British Columbia Ministry of Environment, Lands and Parks, and Environment Canada, 1996. (Available from EPS Publications, Environment Canada, 351 St. Joseph Boulevard, 18th Floor, Hull, Quebec, Canada K1A 0H3. Fax +1 819 953 7253.)
4. The conference objectives set out here were adapted from the conference program, as were some other parts of this section.
5. For information about the use of the World Wide Web in conjunction with the Vancouver conference contact Eric Britton of Ecoplan International (Paris) at 100336.2154@compuserve.com.
6. Per Kågeson, *The Concept of Sustainable Transport*, European Federation for Transport and the Environment, Brussels, Belgium, March 1994.
7. World Commission on Environment and Development, *Our Common Future*, Oxford University Press, U.K., 1987 (p. 43).
8. See p. 89 of the Brundtland Commission’s report (Note 7).
9. William Mees, “Understanding sustainability,” in Bernd Hamm et al. (eds.) *Sustainable Development and the Future of Cities*, Centre for European Studies, Universität Trier, Germany, 1992.
10. See p. 32 of the article by William Mees (Note 9).
11. Paul Hawken, *The Ecology of Commerce*. HarperCollins, New York, 1993 (p. 139).
12. Herman Daly, “Towards some operational principles of sustainable development,” *Ecological Economics*, 2, pp. 1-6, 1990.
13. The group of Swedish scientists is led by Karl-Henrik Robert. See, for example, Karl-Henrik Robert, John Holmberg, and Goran Broman, *Simplicity without Reduction: Thinking Upstream Towards the Sustainable Society*, Natural Step Environmental Institute (Stockholm, Sweden), May 1996.
14. OECD, *Environmental criteria for sustainable transport*, Document OECD/GD(96)136, 1996. This document was produced by the OECD Environment Directorate’s Task Force on Transport.
15. Communication from Stephen Godwin, Director, Studies and Information Services, U.S. National Research Council, July 1996.
16. World Bank, *Sustainable Transport: Priorities for Policy Reform*, World Bank, Washington, D.C., 1996.
17. Several pleas were made at the conference that travel by motorcycle may approach sustainability more closely than travel by automobile. See the conference paper by Craig Heale.



18. See the conference paper by James MacKenzie.
19. Identification of the decade or period of transition of a country's transportation systems from sustainability to unsustainability might be similarly provocative.
20. OECD, "Indicators for the integration of environmental concerns into transport policies," *Environment Monographs* No. 80, 1993 (p. 19). Data on energy use for transport are more widely available than data on transport activity, and thus the former is often used in this overview as an indicator of the latter.
21. IEA, *World Energy Outlook*, International Energy Agency, 1995 (Fig. 7-6, p. 255).
22. See p. 19 of the OECD document detailed in Note 20.
23. OECD, *Motor Vehicle Pollution: Reduction Strategies beyond 2010*, Organization for Economic Cooperation and Development, Paris, 1995 (pp. 121-126); also, Michael Walsh, "Global trends in motor pollution control: 1996 state of the art and remaining problems," issued with *Car Lines*, May 1996; also *World Motor Vehicle Data*, American Automobile Manufacturers Association, 1996 (p. 15). Using these sources, estimates of the world totals of passenger cars, motorcycles, and other vehicles were made as follows: for 1950, respectively 53, 5, and 17 million; for 1990, respectively 445, 90, and 140 million. The overall total of road vehicles in 1995 was close to 775 million, and at the end of 1996 it is likely to exceed 800 million. The urge to use motorized transport seems strong, and not restricted to the automobile. The huge increase in car ownership and use during the post-war years in relation to population was less than what happened in respect of public transport in London, England, during the period 1875-1920, when the region's population doubled and public transport use increased twenty-fold. (See p. 134 of Winfried Wolf, *Car Mania: A Critical History of Transport*, Pluto Press, London, 1996.)
24. See the conference paper by John Adams.
25. While this generalization is true overall for the U.S. and western Europe, it may well not apply for particular groups of vehicles; these relationships deserve further analysis.
26. The data in Table 1 for freight and passenger movement in Europe are taken from Achim Diekmann, *Towards More Rational Transport Policies in Europe*, International Association of Motor Vehicle Manufacturers, 1995. The data for freight movement in the U.S. come from Lee Schipper et al., "Trends in transportation energy use, 1970-1988: An international perspective," in David Green and Danilo Santini, *Transportation and Global Change*, American Council for an Energy-Efficient Economy, Washington D.C., 1993 (p. 80). The data for passenger movement in the U.S. come from Stacy C. Davis, *Transportation Energy Data Book: Edition 14*, Oak Ridge National Laboratory, 1994 (p. 1-16).
27. Table 2 is based on data and projections that appear on pp. 121-126 of the OECD publication *Motor Vehicle Pollution: Reduction Strategies beyond 2010* (Note 23). "Light vehicles" here includes passenger cars, light trucks, and motorcycles.
28. This estimate of the number of people who will not own a car presumes that roughly three quarters of all vehicles represented in Table 2 will continue to be private cars, and that the world's population in 2030 will be in the order of nine billion.
29. The recently published *Second Assessment Report* of the Intergovernmental Panel on Climate Change (Cambridge University Press, 1996) reports on surveys of how people travel in Asian and African cities, including Tianjin and Nairobi where, respectively, 91 and 15 per cent of journeys are by non-motorized means, and 9 and 50 per cent are by public transport or taxi. (This information was taken from Table 1 of the final draft of the section on transportation.)
30. How these percentages were estimated is explained in Section 3.4 of the OECD publication *Environmental Criteria for Sustainable Transportation* (Note 14).
31. See Table 2 of the source detailed in Note 29.
32. See the conference paper by Michael Replogle.
33. *Mobility and Climate: Developing Environmentally Sound Transportation Concepts*, Report of the Enquete Commission "Protecting the Earth's Atmosphere" to the German Bun-

- destag, Economica Verlag, Bonn, 1995, (p. 364).
34. Data for the United States, Japan, and Europe in Table 3 come from the conference paper by Lee Schipper. (Europe-4 is Britain, western Germany, France, and Italy only.) The rough estimates of energy use for transport in non-OECD countries are based on the OECD publication *Motor Vehicle Pollution: Reduction Strategies beyond 2010* (Note 23), with the further assumption that road travel comprises 80 per cent of all motorized travel in non-OECD countries and the travel/freight split for other motorized travel is the same as for road travel.
  35. Lee Schipper, "Determinants of automobile use and energy consumption in OECD countries," *Annual Review of Energy and Environment*, 1995 (pp. 325-386).
  36. Data on air transport are from pp. 260-263 of IEA's *World Energy Outlook* (Note 21) and from pp. 57-58 of the German Enquete Commission report (Note 33).
  37. See the conference paper by Henk Brouwer. The author notes that implementation of various measures including new technology, retrofitting, load-factor improvement, and higher fares could reduce the worldwide increase in use of aviation fuel in 2005 from 3.5 times to 2.1 times 1990 levels. The same measures would reduce the NO<sub>x</sub> emissions from 380 per cent to 74 per cent of 1990 levels.
  38. According to *High Speed Rail in Europe Gains New Momentum* (International Union of Railways, 1994), full implementation of current proposals for 2010 will result in rail's modal share of passenger journeys being 23 per cent of all trips over 80 kilometres rather than the 14 per cent that would be the case without high-speed rail. Such trips by car would be 60 per cent rather than 66 per cent of the total; trips by air would be 17 per cent rather than 21 per cent of the total.
  39. See the conference paper by James Bruce and also IEA, *Cars and Climate Change*, International Energy Agency, Paris, France, 1993 (pp. 27-33).
  40. See the conference paper by James MacKenzie.
  41. See the conference paper by Hans-Holger Rogner.
  42. From Table 1.4 of the IEA's *World Energy Outlook* (Note 21), with the data expressed in tonnes/year. The estimates for 2010 are for the *capacity-constraints case*, for which trends in past behaviour are assumed to continue to dominate future energy consumption patterns.
  43. WEC, *Global Energy Perspectives to 2050 and Beyond*. World Energy Council, 1995.
  44. See the conference paper by Lee Schipper.
  45. See, for example, the conference paper by James MacKenzie and Joseph J. Romm and Charles B. Curtis, "Mideast Oil Forever?" *The Atlantic Monthly*, April 1996.
  46. See the conference paper by Roberta Nichols.
  47. See Figure 7.1 of the IEA's *World Energy Outlook* (Note 21).
  48. The classification of types of impact in Table 5 is taken from p. 181 of the IEA's *Cars and Climate Change* (Note 39). The health effects are taken from pp. 182-183 of the same source and from the conference paper by Jane Warren.
  49. See p. 30 of the IEA's *Cars and Climate Change* (Note 39).
  50. The relationship between increased atmospheric CO<sub>2</sub> emissions and increased global temperatures continues to be controversial. See, for example, Robert C. Balling, Jr., "Global warming: Messy models, decent data, and pointless policy," in Ronald Bailey (ed.), *The True State of the Planet*, New York: Free Press, 1995 (pp. 83-107).
  51. WHO, *Health Effects of Climate Change*, World Health Organization, United Nations, New York, 1992.
  52. See the conference paper by Martin Kroon. In North America, the use of heavier, more powerful, and more fuel-intensive vehicles has mostly constituted the gain in popularity of minivans, pickups, and sport-utility vehicles. In 1981, such vehicles amounted to 18 per cent of all new vehicles sold; in 1995, they were 41 per cent (reported in *Maclean's*, September 16, 1996, p. 36).
  53. See, for example, Table 2 in Peter Nijkamp, "Road towards environmentally sustainable transport," *Transportation Research*, 28A(4), 261-271, 1994 (p. 262).

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54. See Table 4.1 on p. 100 of the Brundtland Commission's report (Note 7).
55. See Tom Hart, "Transport choices and sustainability: A review of changing trends and policies," *Urban Studies*, 31, 705-727, 1994 (p. 711).
56. See the 1996 IPCC report (Note 29).
57. See *Government Policy of the Netherlands on Air Pollution and Aviation*, Ministry of Housing, Spatial Planning and the Environment, 1995 (pp. 28-30). See also the conference paper by Henk Brouwer.
58. See the conference papers by Henk Brouwer and John Crayston.
59. See p. 32 of the Netherlands Government's report (Note 57) and also p. 6 of David Martin and Laurie Michaelis, *Research and Technology Strategy to help overcome Environmental Problems in relation to Transport*. United Kingdom Atomic Energy Authority, March 1992.
60. See the conference paper by Jane Warren. The EU emissions limits are taken from Table 8.1 of Royal Commission on Environmental Pollution, *18th Report: Transport and Environment*, Her Majesty's Stationery Office, London, U.K., 1994. Tighter standards for the EU have been proposed recently (see Michael Walsh, *Car Lines*, July 1996, and also David White, "On the road to zero emissions," *The Chemical Engineer*, July 25, 1996, pp. 34-41).
61. The main but not the only contributors to the reductions in emissions have been reductions in the weights of vehicles and the introduction of three-way catalytic converters. The latter can also increase certain kinds of emissions: for example, emissions of nitrous oxide average 6 grams per kilometre in cars without converters and 72 g/km in comparable cars fitted with converters. See J.M. Dasch (General Motors Research Laboratories), *Nitrous oxide emissions from vehicles*, paper presented at the annual meeting of the Air and Waste Management Association, Vancouver, June 1991.
62. See the conference paper by Jane Warren.
63. See Tables 2.5A to 2.5C of *OECD Environmental Data Compendium 1995*, OECD, Paris, 1996.
64. See pp. 25-28 of the OECD publication *Motor Vehicle Pollution: Reduction Strategies beyond 2010* (Note 23) and also the conference paper by Peter Wiederkehr.
65. See the conference paper by Henk Brouwer.
66. See Tables 2.2A to 2.2E of *OECD Environmental Data Compendium* (Note 63).
67. The information in Table 9 is taken from pp. 25-28 of the OECD publication *Motor Vehicle Pollution: Reduction Strategies beyond 2010* (Note 23) and from the conference paper by Peter Wiederkehr. Evidence from Denmark suggests that there can be health problems even when World Health Organization threshold values are not exceeded. See O. Raaschou-Nielsen et al, "Traffic-related air pollution: Exposure and health effects in Copenhagen street cleaners and cemetery workers," *Archives of Environmental Health*, vol. 50(3), 1995, pp. 207-213.
68. See the conference paper by H.C. Moll.
69. See pp. 79-81 of German Enquete Commission report (Note 33).
70. Erik Rydén and Thomas Lindhqvist, "Strategies for the management of end-of-life cars: Introducing an incentive for clean car development" in OECD, *Towards Clean Transport: Fuel-efficient and Clean Motor Vehicles* (proceedings of an International Conference, Mexico City, March 1994), Organization for Economic Cooperation and Development, Paris, 1996.
71. Environment Canada has estimated that 300 million litres of used oil is dumped in Canada each year, each litre being enough to contaminate two million litres of water. (Information taken from Environment Canada's description of its program concerning re-refined motor oil, May 1992.) Thus the total amount of oil dumped in a year could contaminate an amount of water similar in volume to that of all the Great Lakes (60,000 cubic kilometres).
72. See p. 9 of OECD, *The Environmental Effects of Freight*. Trade and Environment Directorates, Organization for Economic Development and Cooperation (COM/TD/ENV (96)72), June 1996.
73. See p. 81 of German Enquete Commission report (Note 33).
74. See p. 3.7-1 of Todd Litman, *Transportation Cost Analysis: Techniques, Estimates and Implications*, Victoria Transport Policy Institute,

- Victoria, B.C., Canada, 1995. See also pp. 148-149 of Gerald Hodge, *Planning Canadian Communities*, Nelson Canada, Toronto, 1989.
75. See pp. 42-44 of Edmund Fowler, *Building Cities that Work*, McGill-Queen's University Press, Montreal, Canada, 1992.
  76. See Richard Gilbert, "Transports et urbanisation dans la région de Toronto," in proceedings of a colloquium entitled *Les régions urbaines: des réalités, des projets*, Centre Jacques Cartier, Lyon, France, December 1995.
  77. See pp. 29-30 of *State of the Environment Report: Metropolitan Toronto*. Metropolitan Toronto Planning Department, 1995.
  78. See the conference paper by Lee Schipper.
  79. For New York data see the conference paper by Peter Newman; for Paris data see the conference paper by Alain Morcheoine.
  80. See pp. 3-4 of Jean-Philippe Barde and Kenneth Button, *Transport Policy and the Environment*, OECD, Paris, 1990.
  81. The estimates of proportion spent on GDP are taken from Walter Hook, *Increasing public transit ridership through improved bicycle access*. Institute for Transportation and Development Policy, New York, U.S.A., 1994. The analysis of the financial costs and benefits of transportation needs to be taken much further than is possible in this review (also see Sections 3.5, 6.9, and 7.3). There is no doubt that, to use the words of one conference presenter, Mary Nichols, "transport ... plays a critical role in promoting economic growth." The fundamental questions here are whether there would be more growth with less transportation, and whether that growth would be sustainable.
  82. See the conference paper by Gunther Ellwanger.
  83. See the conference papers by Lars Hansson and Todd Litman.
  84. See Tables 4.1 and 4.2 of the OECD publication detailed in Note 20.
  85. See the conference paper by John Adams.
  86. See the conference paper by Michael Replogle.
  87. Many of the listed factors were addressed in the conference paper by Lee Schipper, or in that speaker's paper referenced in Note 35. For Factors 7 and 11 see the conference paper by John Adams. For Factor 12 see the conference paper by Peter Newman.
  88. See p. 377 of Lee Schipper's paper detailed in Note 35.
  89. See the conference paper by Henk Brouwer. A strong plea was made by this participant—reflecting the position of the Netherlands government—that use of aviation fuel should be restrained by levies or taxes. This would require international action through the International Civil Aviation Organization; such action should also be applied to reducing NO<sub>x</sub> emissions from aircraft.
  90. The proposal and reasons were offered by Amory Lovins during the conference's informal evening session on the sustainable automobile.
  91. See the conference paper by Anthony Perl.
  92. See the conference paper by Tom Hart.
  93. Most of the following points come from the conference paper by Anthony Perl.
  94. Within North America there is a huge amount of automobile industry movement of components. An illustration of this was provided by the Toyota Motor Corporation in an advertisement placed in the *New York Times* (December 11, 1994) that illustrated 22 U.S. suppliers of components for its Camry model, assembled in Georgetown, Kentucky. The average distance of the suppliers from Georgetown was 1,060 kilometres, ranging from 114 to 3,402 kilometres. No account was given of non-U.S. suppliers. In Europe, perhaps the best known example is a food product, reported in Stefanie Böge, "The well-travelled yogurt pot: lessons for new freight transport policies and regional production," *World Transport Policy & Practice*, vol. 1(1), 1995, pp. 7-11. An analysis of the movements involved in the production of 150-gram glass pots of strawberry yogurt revealed that each truckload of product moved through an equivalent of 1,005 kilometres during production and distribution, or 9.2 truck-metres per pot, with commensurate vehicle emissions. The author suggested that "9.2 metres of lorry movement" should be listed as an ingredient.
  95. See the conference paper by Anthony Perl.

96. See the conference paper by Ken Eriksen.
97. See the conference paper by Derek Scrafton.
98. This point was made by Yuichi Moriguchi during the panelists' discussion in the conference session on freight and in the conference paper by Kazunobo Onogawa.
99. An exception was the conference paper by Ronald Neville, which reported on an evaluation of 85 policy instruments conducted for the Ontario Round Table on Environment and Economy, based on the approach set out in Deborah Gordon, "Sustainable transportation: What do we mean and how do we get there?" in Daniel Sperling and Susan A. Shaheen (eds.) *Transportation and Energy: Strategies for a Sustainable Transportation System*, Washington D.C., American Council for an Energy-Efficient Economy, 1995. The evaluation concluded that "impressive greenhouse-gas reductions can be achieved by adopting *integrated* strategies that recognize the interactions, both reinforcing and conflicting, among combinations of policy instruments."
100. See the conference paper by Amory Lovins.
101. See the conference paper by John Adams.
102. See the conference paper by Peter Newman for the observation concerning the Jevons principle and the account of the low-activity vision in the following paragraphs. For comments on automobile dependence see also the conference paper by Anthony Perl in which it was asserted, "if mobility were a tangible substance, it would be apparent that late 20th century civilization is addicted to it." Anthony Perl writes of "allowing people to consider an alternative to their mobility addiction without going into immediate withdrawal, much the same way that addicts use methadone to kick a heroin habit." and also of "shifting from addictive to responsible travel behaviour." German psychologist and sociologist Alexander Mitscherlich has argued that the car is not just a means of transport but also "a status symbol, a shelter for lovers, and a drug for those with a strong addiction to movement." (Quoted on p. 151 of the book by Winfried Wolf detailed in Note 23.)
103. See the conference paper by Achim Diekmann. The magazine *Tomorrow* provided a useful perspective on the automobile industry vision in its January-February 1996 issue, which featured the following:
- Volvo's prototype hybrid truck, with gas turbine, high-speed generator, batteries, and electric motor, and its praise for California's ZEV legislation
  - General Motors' support for incremental change that "protects its investments in steel and gasoline," and its espousal of a broad definition of the mobility business it is in that includes electronic communications.
  - Mercedes-Benz' view of battery cars as an intermediate step to hydrogen-based fuel-cell cars, and its support for California's ZEV legislation.
  - Peugeot-Citroën's production of the Tulipmobile, a small rentable electric car made from fewer parts and materials than conventional automobiles and 95-per-cent recyclable.
  - Suzuki's production of the Geo Metro, which has topped the U.S. fuel-efficiency race for six of the last seven years and now achieves an average of just over five litres per 100 kilometres of gasoline (46 miles per U.S. gallon).
104. See the conference presentations by Michael Bach, Neal Irwin, Alain Morcheoine, and Paul Zykofsky.
105. The 21st century is so named because it will be the first century in human experience throughout which the majority of the world's human population will likely live in cities. See Richard Gilbert, Don Stevenson, Herbert Girardet, and Richard Stren, *Making Cities Work: The Role of Local Authorities in the Urban Environment*, Earthscan Publications Ltd. (London, U.K.), 1996.
106. Some authors (e.g., Reid Ewing, "Beyond density, mode choice, and single-purpose trips," *Transportation Quarterly*, v49(4), 1995, pp. 15-24) have argued from U.S. data that people who live in dense areas use cars less and travel less because they are poor. The data for the Toronto region in Table 10 indicate that residents of Toronto's dense inner city have *higher* average incomes than those of other parts of the region and nevertheless own fewer cars and travel less; however, they have lower *household* incomes. Thus the relationship between automobile ownership and income may hinge in part on whether automobiles are household or individual possessions.

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107. A review of several studies suggested that mixing land uses may have less potential for reducing travel than increasing densities. See Robert A. Johnston and Raju Ceerla, "Land use and transportation alternatives," in the compendium detailed in Note 99.
108. See the conference paper by Rick Rybeck.
109. See Richard Gilbert, *The Future of the North American Downtown*, presentation to the Annual Conventions of the Canadian Institute of Planners and the American Planning Association, Toronto, April 1995.
110. See the conference paper by Robert Thaler for the Austrian approach and the conference paper by Axel Friedrich for the German approach.
111. See the conference paper by Daniel Luscher.
112. See the conference paper by Axel Friedrich, and also the conference paper by Per Kågeson.
113. See, for example, the conference papers by Eric Britton and Wolfgang Zuckerman.
114. See, for example, Jack M. Nilles, "What does telework really do to us?" *Journal of World Transport Policy and Practice*, vol. 2(1), 1996, pp. 20-34. However, many studies of the impact of information technology on travel raise serious methodological issues. See, for example, P.L. Mokhtarian et al., "Methodological issues in the estimation of the travel, energy, and air quality impacts of telecommuting," *Transportation Research*, vol. 29A(4), 1995, pp. 283-302.
115. See the conference paper by Bill Long.
116. See p. 376 of the paper by Lee Schipper detailed in Note 35.
117. See the conference paper by John Adams.
118. See p. 254 of *Transport and the Environment* (Note 60).
119. See Table 6.4 of David Banister, "Equity and acceptability questions in internalizing the social costs of transport," in *Internalising the Social Costs of Transport*, ECMT and OECD, 1994.
120. See Figure 16 of the paper by Lee Schipper detailed in Note 35.
121. See, for example, Lidia Kostyniuk and Ryuichi Kitamura, "The changing effects of automobile ownership on household travel," *Transportation Research Record*, n1085, 1986, pp. 27-33. See also Ryuichi Kitamura, "Maturing motorization and household travel: the case of nuclear-family households," *Transportation Research*, v20A(3), 1986, pp. 245-260.
122. See the conference paper by Michael Replogle.
123. A. Spencer and S. Madhavan, "The car in Southeast Asia," *Transportation Research*, v23A(6), pp. 425-437.
124. D. Boothroyd, "Toll scheme gets on the road," *Electronics Times*, n300, 1985, pp. 24-25.
125. A.T.H. Chin, "Containing air pollution and traffic congestion: Transport policy and the environment in Singapore," *Atmosphere and Environment*, v30(5), 1996, pp. 787-801.
126. Over the years, car ownership has been promoted in Germany by political regimes as disparate as that of the National Socialist Party in the 1930s, and that of the post-war Communist Party of the former East Germany. In the former Soviet Union, car rental rather than car ownership was espoused. ("Who needs a car of their own?" said Nikita Khrushchev.) These and other points about the politics of the automobile are discussed in Winfried Wolf's recent book (Note 23).
127. See, for example, the conference papers by Sandra Bos, Gunther Ellwanger, Michael Lawrence, Todd Litman, Yuichi Moriguchi, and Lee Schipper.
128. See, for example, the conference paper by Lee Schipper.
129. See, for example, the conference paper by Peter Bein, Chris Johnson, and Todd Litman, and also the compendium by Todd Litman (Note 74). Estimates of costs can vary considerably; for example, the conference papers by Gunther Ellwanger and Lars Hansson respectively estimate accident costs as comprising 65 per cent and 29 per cent of road transport's external costs.
130. Kenneth Button, "Overview of internalizing the social costs of transport," in *Internalizing the Social Costs of Transport*, European Conference of Ministers of Transport, Paris, 1992 (pp. 7-30).

## APPENDIX D: REFERENCE AND OTHER NOTES

131. See, for example, the conference papers by John Adams and Anthony Perl.
132. See p. ES-3 of the compendium by Todd Litman (Note 74) and also the conference paper by Todd Litman.
133. See Figures 14 and 16 of Lee Schipper's paper (Note 35).
134. See p. 5-7 of Todd Litman's compendium (Note 74).
135. See Figure 14 of Lee Schipper's paper (Note 35).
136. See the conference paper by Michael Replogle.
137. See the conference paper by Achim Diekmann.
138. See David Banister's paper (Note 119).
139. See pp. 77-78 of the German Enquete Commission report (Note 33). The data are the best and worse cases listed in Table 3.3-1 of the report, for 50-per-cent occupancy in each case.
140. Data from the 1992 *Annual Report* of the Toronto Transit Commission and the *Transport Tomorrow Survey* conducted by the University of Toronto's Joint Program in Transportation suggest that the average loading of public transport vehicles in Metropolitan Toronto is 16.6 passengers; the average trip length is 7.3 kilometres. Using the estimates in the source used to compile Table 12, it can be further estimated that the average energy use per passenger-kilometre for public transport in Toronto is in the order of 0.64 megajoules, which is higher than but close to that of a small, fully loaded, energy-efficient automobile.
141. See the conference paper by Daniel Sperling.
142. See the conference paper by Laurie Michaelis.
143. See the conference paper by Preston Schiller.
144. See the conference paper by Gavin Davidson.
145. See the conference paper by Robin White.
146. See the conference paper by Luis Manuel Guerra.
147. See the conference paper by Eric Britton.
148. See the conference paper by Chris Bradshaw.
149. See the conference paper by Doug Miller.
150. See the conference paper by Charles Vlek.
151. See the conference paper by Laurie Michaelis.
152. The barriers and stimulants to intensive development are taken mostly from the conference paper by Norman Pressman.
153. See the conference paper by Laurie Michaelis.
154. See the conference paper by Hans-Holger Rogner.
155. See the conference paper by Dick Nelson.
156. See the conference papers by Lars Hansson and Michael Replogle.
157. See the conference paper by Michael Replogle.
158. See the conference paper by Sue Zielinski.
159. The conference paper by David Bell was presented as the "first step [by the Government of Canada] to develop a sustainable transportation policy for Canada."
160. For the Canadian reference see the conference paper by Harry Gow; for the European reference see the conference paper by Theo Schoemaker.
161. See the conference paper by Emin Tengström.
162. See the conference paper by Sue Zielinski.
163. See the conference paper by John Hartman.
164. See the post-conference discussions on the World Wide Web (Note 5).