Policy Instruments for Achieving Environmentally Sustainable Transport



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Foreword

Conventional approaches to mitigating transport's environmental impacts have used observed and projected transport trends and sought to assess the environmental impacts of these developments. This approach has led to important efficiency gains and has helped to reduce many of the environmental and health risks stemming from the transport sector. It has not—and likely will not—lead towards meeting long-term environmental objectives.

A new policy approach is needed that places environmental criteria in the forefront with other policy goals. Recognising this need, the OECD Environmental Policy Committee's Task Force on Transport initiated the project on Environmentally Sustainable Transport (EST) late in 1994 to give some precision to the concept of EST through the use of criteria that have environmental significance and can be quantified. The overall objectives of the EST project have been to provide an understanding of EST, its implications and requirements, and to develop methods and policy guidelines towards its realisation. The core of the EST approach is to develop long-term scenarios and to identify instruments and strategies capable of making the scenarios a reality. **Unlike conventional approaches to transport system development, the EST project is a backcasting exercise**. One or more desirable futures are defined and policy development is guided by an assessment of what is required to achieve them.

The EST project comprised four phases:

- Phase 1 involved a review of relevant activities of Member countries as well as the development of the definition and criteria for EST. An account of Phase 1 appears in *Environmental Criteria for Sustainable Transport*, published in 1996[1†] with a separate annex volume containing relevant expert papers.[2]

- Phase 2 focused on the identification of the gap between current and projected trends and the EST criteria through scenario-development for 2030. During this phase participants constructed a 'business-as-usual' (BAU) trend forecast scenario and scenarios consistent with the EST criteria. An account of Phase 2 appeared in *Scenarios for Environmentally Sustainable Transport*, published in 1998 with an updated version in 1999,[3] with a separate annex volume containing the individual Member country case studies on scenario development.[4]

- Phase 3—reported here—has been the 'backcasting' exercise. It comprised the identification of packages of policy instruments whose implementation would result in achieving the EST scenarios. Phase 3 has also involved some assessment of the social and economic implications of moving towards and attaining the BAU and EST scenarios. Some of this work was reported in *Economic and Social Implications of EST*, proceedings of a workshop held in Ottawa, Canada in October 1998.[5] The present report has a

† Superscript numbers refer to end notes that begin on Page 165.

separate annex volume containing the individual Member country reports on policy instruments for achieving EST.[6]

- Phase 4, which has overlapped with Phase 3, refined the criteria for achieving EST and developed policy guidelines for governments towards environmentally sustainable transport. The guidelines are touched on briefly here in Chapter 5 and are reported on more fully in two other documents. One is *Synthesis Report*, prepared for the OECD International Conference held in Vienna, Austria, 4-6 October, 2000 entitled *est! Futures, Strategies, and Best Practices*.[7] The other is the report on that conference.[8] The guidelines were endorsed by OECD Environment Ministers at their Ministerial meeting in May 2001.

The core work for the EST project was carried out by six teams of experts from nine countries, each with a separate geographical focus. The six case studies concern Sweden, The Netherlands, Germany, the Quebec-Windsor corridor in Canada, the Greater Oslo region of Norway, and the Alpine region comprising parts or all of France, Switzerland, Austria and Italy.

Related national studies have been undertaken by Austria, France, and Japan. As well, a related study concerned Central and Eastern European economies in transition, conducted jointly by UNEP, the OECD, and Austria under the Central European Initiative (CEI).

This report presents the results of Phase 3 of the project concerning policy instruments for attainment of EST, and briefly presents the guidelines developed during Phase 4. It comes in two volumes: (i) this synthesis report, whose main purpose is to describe and synthesise the project teams' identification of policy instruments and implementation strategies, and (ii) an annex volume comprising the case studies prepared by the participating countries.[9] These and other materials on the EST project are available at <www.oecd.org/env/ccst/est>.

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Executive Summary

This is the overview report on Phase 3 of the OECD's Environmentally Sustainable Transport (EST) project, which focused on policy instruments and strategies for achieving EST. In the course of Phase 3, there was also preliminary assessment of the economic and social implications of moving towards and attaining EST. Phases 1 and 2 of the EST project had been primarily concerned with defining EST and establishing criteria for its attainment (Phase 1) and with developing visions or scenarios of EST consistent with the EST criteria (Phase 2).

Experts from nine OECD member countries worked in six project teams concerned respectively with these geographic areas: the whole of Germany, The Netherlands, and Sweden; the Quebec-Windsor corridor of Canada and the Greater Oslo region of Norway; and the Alpine region, comprising parts or all of Austria, France, Italy, and Switzerland. Related studies have been undertaken by Austria, France, and Japan, and jointly by UNEP, the OECD, and Austria under the Central European Initiative (CEI) for the Central and Eastern European economies in transition.

The basic framework involved **backcasting**, i.e., setting longer-term targets or other objectives and determining which instruments could be deployed in order to reach them. The teams had developed and characterised EST scenarios in Phase 2 of the EST project. The backcasting exercise in Phase 3 was based on those scenarios, specifically what were known as the EST3 scenarios, which involved changes to both transport technology and transport activity. The teams concluded that the EST3 scenarios were sufficiently distant in time and different from present activity to require that the identification of implementation strategies be mostly exercises in informed judgement rather than application of sophisticated modelling techniques.

The basic technique chosen by the project teams was named **structured brainstorming**. It involved iterative identification and assessment by experts of potential instruments and packages of instruments by groups of experts using a consistent methodology for the backcasting exercise. A large number of policy instruments was considered. The proposed packages of instruments included regulations (e.g., concerning emissions of CO_2 and local pollutants), fiscal instruments (e.g., fuel taxes and road pricing, other disincentives and also incentives), and hybrid regulatory-fiscal instruments such as tradeable entitlements to emit CO_2 from vehicles. They included policies concerning infrastructure investment and land use planning. Most importantly, they included instruments to raise public awareness about the problems, need for action, and possible solutions.

For the most part the teams concluded that **if the CO_2 target were met the other emissions targets would also be met**. Thus, there was a strong focus on CO_2 reduction in the selection of instruments. **Noise and land-use targets were not necessarily met when the CO_2 target was met**—indeed, noise could be worsened—and so separate focuses were needed on these concerns.

In some cases, instruments applied in isolation were anticipated to have **perverse effects**. For example, requirements for vehicle fuel efficiency can cause increases in transport

activity and even increases in fuel use because of the resulting excessive use due to reduced costs of transport. Complementary measures—in this case, higher fuel taxes—were applied where appropriate.

Each package of instruments included each type of instrument—regulatory, economic (fiscal investment), and informational—but there were considerable differences among the teams as to how much emphasis was placed on each type of instrument.

The most important aspect of the instrument packages was their **phasing**. The general strategy adopted by the teams involved late introduction of the more stringent instruments. There was much emphasis early in the implementation periods on deployment of instruments that made later use of more stringent instruments acceptable, chiefly through education but also through judicious use of less stringent instruments.

In general, although with many specific exceptions, the **instruments** included in the proposed packages were:

- directed at the movement of people rather than freight,
- regulatory rather than fiscal in nature,
- directed towards achieving mode shifts and favouring non-motorised alternatives rather than towards numerous other objectives, and
- designated as being the responsibility of national or sub-national governments and agencies rather than the responsibility of international agencies, on the one hand, or local or regional governments or agencies, on the other hand.

It was recognised that some key instruments nevertheless require coordinated international action. Overall, more than two thirds of the instruments proposed are already in use or being discussed. However, to meet the EST goals, the intensity of their application may be increased and the extent of their integration with other instruments improved.

Participants in the EST project also considered **barriers to the implementation of EST and gaps in knowledge** that need to be bridged. They noted that present transport practices have a formidable momentum that has deep psychological, social, and technological characteristics. Lack of relevant knowledge is itself a major barrier to attainment of EST. Technical knowledge is lacking in ways that could prevent needed improvements in vehicles, fuels, and infrastructure. Even more, there is lack of knowledge about human behaviour and societal organisation, knowledge that could help policy-makers secure needed changes.

The case studies concluded that **three things are required**. One is a better understanding of how to make potential future distress relevant to present circumstances. Another is a more appealing vision of sustainable transportation. The third, following from the first two, is greater interest among the public generally, and transport industries in particular, in moving towards sustainable transportation.

During Phase 3 of the project, consideration was also given to **social and economic factors** to provide a preliminary assessment of the broader implications of EST and, more specifically, to help with the identification of instruments. In respect of the latter point, instruments were chosen where possible to be consistent with broader societal objectives such as maintenance of employment levels and enhancement of equity.

Preliminary assessments of the economic and social implications of attainment of EST were conducted. The reference point in each case was the BAU scenario for 2030, rather than the actual circumstances of 1990. These assessments were extremely preliminary in nature, in part because of available resources but chiefly because of the inherent hesitation of experts to project about such matters so far into the future.

The teams assessed the **economic implications** of their EST3 scenarios and of the application of their instrument packages using a variety of approaches (e.g., impact path analysis, system dynamics, general equilibrium models, and qualitative assessments). The general conclusion from this work was that the overall economic effects on the national economies from proceeding towards EST rather than BAU would be slight—in terms of changes in significant indicators such as Gross Domestic Product and employment rates—although there was some variation in the results obtained. However, it was recognised economies will have to adapt to significant structural changes. To mitigate short-term negative effects would require targeted policies stimulating developments and activities towards EST.

As well, the OECD Secretariat estimated the **external (i.e., unpaid) costs** of transport for the study areas: for 1990, for BAU in 2015, and for EST3 in 2015. These costs were estimated to be much increased with BAU (by 30 per cent), compared with 1990, and much reduced with EST3 (by 40 per cent).

Social implications were assessed for each study area through evaluation of the appropriateness of several statements about BAU and EST based on perceived social trends. The project teams concluded that social conditions could be more benign with EST3 compared with BAU, and perhaps more than now. Continuation of BAU could result in loss of independent mobility among the elderly and particularly children, who could be the major losers. With movement towards EST3, on the other hand, life could become more healthful, safe, convivial, and child-friendly, at least in comparison with BAU. Some individuals, however, could experience negative effects from reduced opportunity for motorised mobility.

This preliminary work on the economic and social implications of EST compared with BAU suggests that the overall effect will be positive. Some people, businesses, and institutions will be negatively affected in the short term as societies change the nature of such a fundamental matter as their transport systems, and care must always be taken to mitigate adverse economic and social impacts. Nevertheless, the overall impact of moving towards EST appears positive: economies will remain robust, energy security will be increased, society's costs will be lower, and there could be significant social advantages.

As an outcome of the project, the *EST Guidelines* were developed to assist governments in their efforts to move towards EST. They provide a set of key points that governments could use when developing EST strategies and designing implementation processes.

Moving towards environmentally sustainable transport is one of the principal policy challenges facing OECD and other countries at the outset of the 21st century. International co-operation within the OECD framework will assist Member countries in the development of innovative methods and policy approaches towards sustainable transport that will be environmentally responsible, socially acceptable, and economically viable.

1. Introduction

1.1. Background to the EST project

The Environment Directorate of the Organisation for Economic Co-operation and Development (OECD) initiated the project on Environmentally Sustainable Transport (EST) at the end of 1994 in response to several considerations:

Reasons for carrying out the EST project

- Growing concerns about the environmental unsustainability of trends in human activity.
- Particular concerns about transport's adverse environmental impacts, present and future, and about the contribution of trends in transport activity to the overall unsustainability of human development.
- Concern too that transport activity may in many places have increased to a level at which the various costs of further increases in transport activity would outweigh the economic and social advantages of the increased activity.
- Awareness that conventional approaches to reducing transport's environmental impacts, mostly reliant on improved technology, were in many important respects doing little more than offsetting the growth in transport activity.
- Awareness too that an alternative to conventional approaches was available, involving the setting of ambitious but appropriate and achievable long-term goals, on the one hand, and the application of packages of instruments designed to secure attainment of the goals, on the other hand.

Overall purposes of the project

These considerations led to the development of a plan for what became known as the EST project. **The overall purposes of the project are to characterize EST and establish guidelines for policies whose implementation could lead to attainment of EST.**

The reasons for doing the EST project were elaborated in the reports on Phases 1 and 2 of the project.[10†] These phases were concerned mostly with developing criteria for EST and devising scenarios or scenes consistent with the criteria. They are reviewed briefly in Section 1.3 below. Phase 3 of the EST project is the

† Superscript numbers refer to end notes that begin on Page 165.

topic of the present report. It had been concerned primarily with identifying and assessing instruments and packages of instruments required to ensure attainment of EST. Subsequent reports will draw on the results of the three phases and propose policy guidelines for the attainment of EST, provide an update of worldwide data and projections relevant to EST, reassess the definition and characteristics of EST, and draw further conclusions as to how EST might be achieved.

1.2. Backcasting: the key feature of the EST project

At the core of the design of the EST project is a method for policy development known as *backcasting*, a term to make a distinction from the *forecasting* methods that are more frequently used.

Avoiding an unwanted future vs. achieving a desirable future

Policy development can be shaped in the light of present circumstances or future goals. In the former case, *forecasting* based on current trends provides the basis for determining what may be required to accommodate or counteract those trends. In the latter case, goals are set and there is a working backwards— *backcasting*—from the goals to determine what must be done to reach them. **Policy development based on forecasting results in attempting to change projected trends to avoid an undesirable future. Policy development based on backcasting results in doing what is necessary to achieve a desired future.**

Box 1
Two approaches to decision-making about transport.

The EST project is thus a testament to the idea that it is possible to decide what future you want, plan for it, secure it, and hold on to it. This is different from the prevailing idea, which can be summed up by the phrase "predict and provide, and protect where

Conventional approach (key process is forecasting)	**Management by EST objectives** (key process is backcasting)
1. Assess problems arising from current transport activity and expected from a continuation of current trends.	1. Define what is meant by EST both quantitatively and in terms of a long-term vision of the future (EST scenario).
2. Address problems almost always by improving infrastructure and by improving technology, and sometimes by displacing traffic from trouble spots to other routes.	2. Determine what must be done to secure the vision in relation to what would happen if no extraordinary steps were taken (BAU scenario).
3. Repeat Step 1 when problems return because growth in transport activity has offset the infrastructure expansions and technology improvements.	3. Identify and apply instruments capable of moving from the present to the EST scenario rather than the BAU scenario, adjusting the implementation strategy according to results.
4. Repeat Step 2 (and continue the predict and provide spiral).	4. Do what is required to maintain conformity to the quantitative features of the EST scenario.

possible". The two approaches are outlined in Box 1

Several reasons have favoured the conventional approach, with its focus on 'end-of-pipe' controls when severe health or environmental problems arise. The most important has been that it provided for an expansion in motorised mobility. The extent of the expansion is illustrated in Box 2.[11]

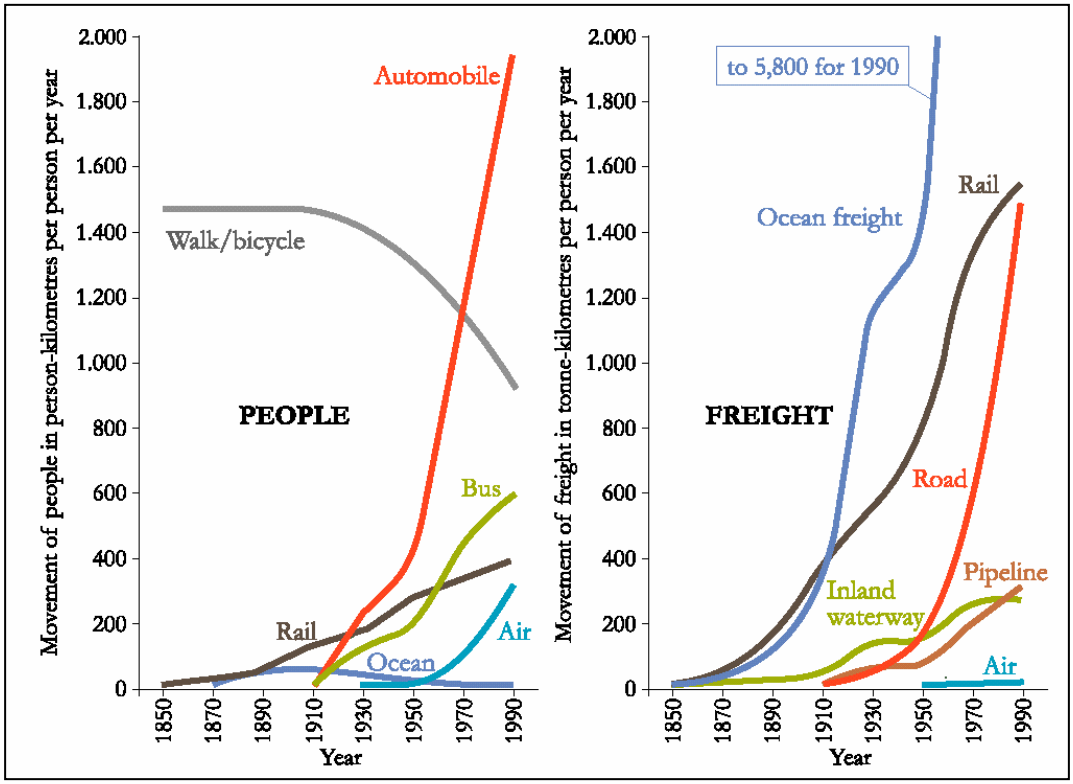
This expansion has mostly been perceived positively. Motorised transport has facilitated and even stimulated just about everything regarded as progress. It has helped expand intellectual horizons and deter starvation. Comfort in travel is now commonplace in OECD countries, at a level hardly dreamed of in former years even by the wealthiest and most powerful of citizens, as is access to the products of distant places.

Motorised transport has facilitated and even stimulated just about everything regarded as progress

Also important has been the close association of widespread motorised mobility with two of the major phenomena of this century: democratisation and material prosperity. Ownership of an automobile has become associated with freedom of action, and has even acquired something of the status of a democratic right. As a token of passage into adulthood, it can be more important than the ability to vote.

The evident benefits of mass motorisation have begun to pall, and a strong case can be made that the disadvantages it brings are beginning to outweigh the numerous advantages. The case has been put eloquently by David Greene and Michael Wegener,

Box 2
Worldwide trends in the movement of people (left panel) and freight (right panel), 1850-1990.



The benefits of mass motorisation have begun to pall

> Near the end of the 20th century, the belief in the desirability of perpetual growth in mobility and transport has started to fade. In many countries, highway accessibility is so ubiquitous that transport cost has almost disappeared as a location factor for industry. In metropolitan areas, the myth that rising travel demand will ever be satisfied by more motorways has been shattered by reappearing congestion. People have realised that the car has not only brought freedom of movement but also air pollution, traffic noise and accidents. It has become obvious that in the face of finite fossil fuel resources and the need to reduce greenhouse gas emissions the use of petroleum cannot grow forever. There is now broad agreement that present trends in transport are not sustainable, and many conclude that fundamental changes in the technology, design, operation, and financing of transport systems are needed.[12]

In this context, the problem with the conventional approach to transport challenges, as depicted in the left-hand column of Box 1, is that it almost inevitably results in further growth in transport activity. There may be even long-term attenuation of some local problems, but others return as the growth in transport activity outweighs recent relief provided by technology and infrastructure enhancement. Global problems are rarely considered in this kind of approach, and they tend to become worse.

The alternative approach of target-oriented backcasting is set out in the right-hand column of Box 1. It is not a new approach. Indeed, it is standard in business and increasingly within government where it is known as "management by objectives" or a similar name (hence the column heading in Box 1).[13] The approach is as simple as what was outlined in the first sentence of this chapter: you decide what future you want, you plan for it, you secure it, and then you hold on to it.

Predicting the future remains fashionable, but more to satisfy curiosities and to wring small advantages than as a basis for changing what is otherwise in store

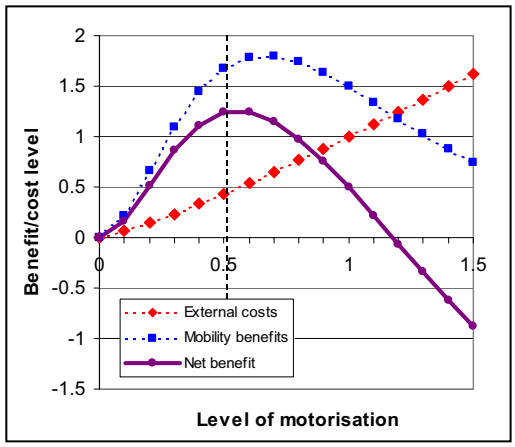
Although managing by objectives is the practice *within* government (so that government is run in a business-like way), it is increasingly less a function *of* government. Planning for the future as a function of government has lost favour since the collapse of most of the world's major command economies in and near 1990. Policy-makers and others who would prepare for avoidance of climate change, species extinction, and other outcomes of current trends have the added challenge of being unfashionable. *Predicting* the future remains fashionable, but more to satisfy curiosities and to wring small advantages than as a basis for changing what is otherwise in store.

Such an attitude has characterised thinking about transport for more than 50 years, which places it decidedly in the vanguard of contemporary thought. "Going with the flow" has been the modus operandi of most transport planning. "Predict and provide" has been another way of putting it. The forces of transport growth, like those of the Market, are considered irresistible.

Concerns about impacts of the growth have for the most part been addressed with often-beneficial technological fixes—e.g., the three-way catalytic converter—or by actions that by design or circumstance have no more than a slight impact on traffic growth. The result has been impressive technology and uninterrupted growth in transport activity.

Box 3
Schematic "net mobility benefits/costs" curve, showing how benefits may increase at first with growing mobility and may then decline

To the extent that Green and Wegener—quoted at length above—are right, we seem to be passing the peak of a mobility benefits curve and moving into a situation where the costs exceed the benefits (see Box 3).[14] Also, perhaps by coincidence, we seem to be approaching the peak of production of inexpensive, conventional oil.[15] It may therefore be especially propitious to explore application of an approach that may promise more success in reducing transport's impacts than the conventional approach.



At the heart of the 'management by EST objectives' approach is the already-mentioned process known as **backcasting**. This term was introduced by John Robinson as an analogue of forecasting, which involves working forward from present circumstances.[16] Backcasting, by analogy, involves working backwards from future circumstances, usually desired rather than projected future circumstances. Backcasting corresponds to Steps 2 and 3 in Box 1, i.e., the 'how to get there' part of the process, to be invoked when objectives have been set.

The approach of backcasting from a desired future rather than forecasting from an undesired present has had considerable success in many enterprises, notably the electricity generating industry, and in policy areas such as air quality management. Many parts of the electricity generating industry have successfully passed beyond a 'predict and provide' mode to one in which financial, environmental, and other objectives are set and business is conducted accordingly. Rather surprising results have ensued. For example, in some cases it has been found more advantageous to pay people to conserve than to provide for their apparent need for electrical energy.[17] Such a result could not have been the outcome of a predict-and-provide approach.

The nature of backcasting

Several of the seminal papers supporting the approach based on backcasting used here were compiled during the course of the EST project.[18]

Policy development often involves elements of both of the approaches described in Box 1, although usually with more emphasis on present circumstances than on goals for the future. Engag-

ing in forecasting rather than backcasting is especially appealing when setting goals may be controversial or when desired goals are not known or are considered unattainable, and also when the impacts of politically acceptable policy measures have to be evaluated. Moreover, an approach based on forecasting is likely to be incrementalist and to be seen as responsibly cognisant of current realities. By contrast, an approach based on backcasting may prescribe large and even disruptive changes, and may appear, at least at first, to be quixotically idealistic.

When backcasting can be appropriate

A backcasting approach may nevertheless be preferable if it is necessary to develop policies capable of achieving major departures from current trends. Transport is a sector for which such an approach could be especially valuable. Current policies and measures—mostly based on forecasting—have not significantly reduced the overall environmental impacts of transport, even though such reductions have been the objective of the policies. Much reliance has been placed on technology, and the environmental benefits of technological improvement have in many respects been offset by the environmental costs of increased activity. More to the point, achieving and maintaining EST, as defined and characterised in Phases 1 and 2 of this project, would involve dramatic overall reductions in several atmospheric emissions from transport of a scale not previously contemplated, dramatic reductions in the amount of noise from transport, and dramatic changes in how land is used.

1.3. Overview of Phases 1 and 2

The initial challenge in a backcasting exercise is determination of the goals to be used. In the EST project, this challenge was met during Phases 1 and 2 of the four-phase project.

Phase 1 activities

Phase 1 primarily concerned establishment of a definition of EST and the selection of criteria for its attainment; it also included a review of activities of Member country governments relevant to EST. The following definition of EST was developed during Phase 1:

Definition of EST

An environmentally sustainable transport system is one that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes.

Six criteria for EST were developed during Phase 1 as being the minimum number required to address the wide range of health and environmental impacts from transport. These criteria were selected to address local, regional and global concerns, notably, local noise and urban air quality, regional acidification, eutrophication, tropospheric ozone, global climate change, and land use. Internationally agreed goals, guidelines, and standards for these impacts—such as the critical levels and loads defined by the World Health Organization, adopted as part of the UN ECE

Box 4
Summary of criteria for Environmentally Sustainable Transport
▼

CO_2 Climate change is prevented by reducing carbon dioxide emissions so that atmospheric concentrations of CO_2 from transport are stabilised at or below their 1990 levels. Accordingly, total emissions of CO_2 from transport should not exceed 20-50% of such emissions in 1990, depending on specific national conditions.[a]	***NO_x*** Damage from ambient NO_2 and ozone levels and nitrogen deposition is greatly reduced by meeting WHO Air Quality Guidelines for human health and eco-toxicity. This implies that total emissions of NO_x from transport should not exceed 10% of such emissions in 1990.[b]
VOCs Damage from carcinogenic VOCs and ozone is greatly reduced by meeting WHO Air Quality Guidelines for human health and ecosystem protection. Total emissions of transport-related VOCs should not exceed 10% of such emissions in 1990 (less for extremely toxic VOCs).[b]	***Particulates*** Harmful ambient air levels are avoided by reducing emissions of fine particulates (especially those less than 10 microns in diameter). Depending on local and regional conditions, this may entail a reduction of 55% to 99% of fine particulate (PM_{10}) emissions from transport, compared with 1990 levels.[c]
Noise Noise from transport no longer results in outdoor noise levels that present a health concern or serious nuisance. Depending on local and regional conditions, this may entail a reduction of transport noise to no more than a maximum of 55 dB(A) during the day and 45 dB(A) at night and outdoors.[d]	***Land use/Land take*** Land-use and infrastructure for the movement, maintenance, and storage of transport vehicles is developed in such a way that local and regional objectives for air, water, biodiversity, and ecosystem protection are met. Compared to 1990 levels, transport activity will likely entail the restoration and expansion of green spaces in built-up areas.[e]

[a] The Second Assessment Report of the Intergovernmental Panel on Climate Change (1996) maintains that, in order to stabilise atmospheric CO_2 concentrations at near current levels, world-wide CO_2 emissions would need to be reduced by 50% to 70% with further reductions thereafter (IPCC, *Second Assessment Report*, page xi, Intergovernmental Panel on Climate Change, 1996). However, in order to allow for increases in emissions in developing countries, OECD countries should reduce their emissions by 80% or more so that a global reduction of 50% may be attained (OECD, *Environmental Criteria for Sustainable Transport*, OECD Environment Directorate, Paris, France, 1996). A reduction target of 50% might be more appropriate for certain countries that benefit from a favourable (e.g., a more environmentally friendly) modal split, as was suggested by the EST pilot study for the countries of the Central and Eastern European region.

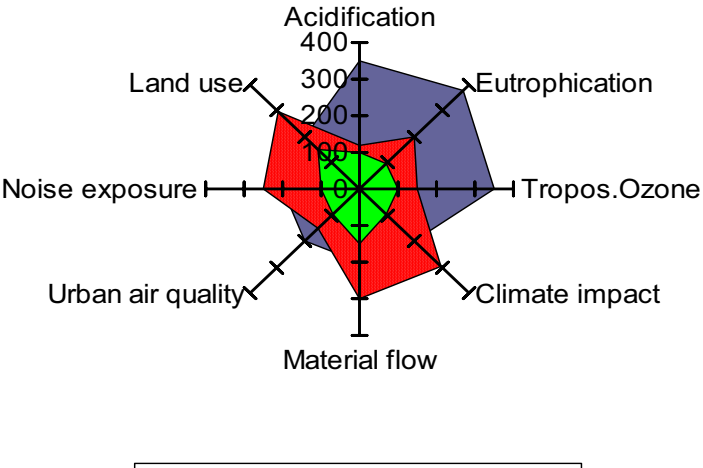
[b] These criteria are set in line with the WHO guidelines for human health regarding NO_x, VOCs, and ozone (WHO, 1996) and the UNECE protocols under the Convention on Long-Range Transboundary Air Pollution for ecosystem protection regarding critical loads for nitrogen deposition and critical levels of ozone (UNECE, LRTAP Convention, 1999)

[c] WHO advises that there is no ambient level of fine particulate matter (smaller than PM_{10}) and ultrafine particles (smaller than $PM_{2.5}$) below which health effects (including cancer) do not occur. Countries should set targets based on dose-effect considerations. The targets set here are preliminary due to the ongoing research on the health effects from ultrafine particulate matter (WHO, Air Quality Guidelines, World Health Organization Regional Office for Europe, Copenhagen, Denmark, 1998).

[d] This criterion is based on the former WHO recommendation on noise that has been recently updated in the WHO Guidelines for Community Noise (WHO, Guidelines for Community Noise, World Health Organization, Geneva, 1999).

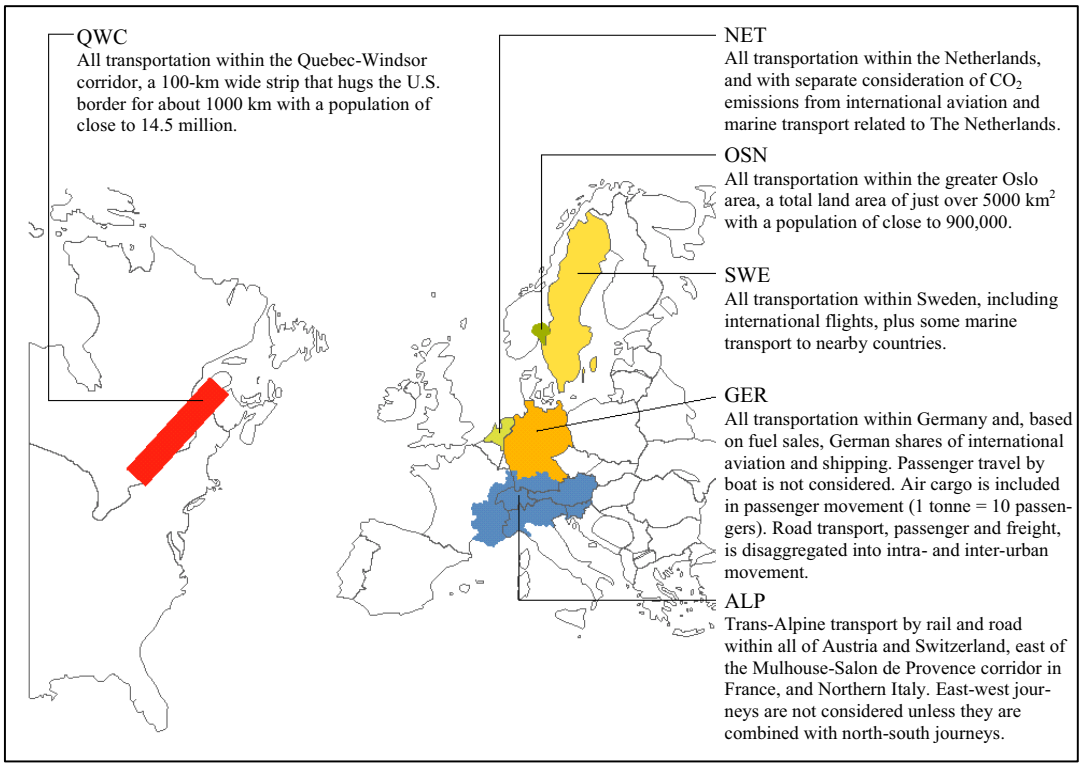
[e] The quantification of the land-use criterion will require further research.

Box 5
Criteria for environmental sustainability (European data). The scales show extent of exceedance in relation to standards, guidelines or critical loads/levels (index=100), except for land use, for which a standard is being developed



Convention on Long-range Transboundary Air Pollution, and proposed within the UN Framework Convention on Climate Change—were used to derive operational criteria and targets. For three of the criteria—concerning carbon dioxide, nitrogen oxides, and volatile organic compounds—both the topics and the criteria values were common to the six project teams. For the other three—concerning particulate matter, noise and land use—only the topics were in common; each team was free to specify the actual criteria.

Box 6
Study areas and transport modes considered in Phases 2 and 3



	EST1	EST2	EST3
Technological progress	*much greater than BAU*	*equal to BAU*	*greater than BAU*
Transport activity	*equal to BAU*	*much less than BAU*	*less than BAU*

Box 7
How the three EST scenarios differed from the BAU scenario

The rationale for the criteria and the criteria themselves were set out in the reports on Phase 1 and 2 of the EST project. They are summarised in Box 4. The earlier reports also contain justification for using *relative* rather than absolute criteria, and set out the basis for using the chosen scenario date of 2030. The criteria are characterised in Box 5, in relation to 1995 impact values and in relation to 'business-as-usual' projections.

For Phase 2 (and also Phase 3) the nine participating Member countries worked in six project teams, each concerned with the respective study area shown in Box 6.

Phase 2 involved the construction of three visions or scenarios of EST (known as EST1, EST2, and EST3) and a vision or scenario of what might be the case if current trends in activity, technology, and policy adoption were continued (the business-as-usual or BAU scenario).[19] In each of the four cases, 2030 was used as the target year and 1990 was used as the reference or baseline year.

BAU scenarios

The first task was development of the business-as-usual (BAU) scenarios or visions for transport in 2030. The working principle in their development was that current trends will continue throughout the period 1990-2030, including trends in transport activity, technological change, and the implementation of relevant policies. The BAU scenarios were characterised in terms of transport activities, the environmental performance of the transport activities, and the resulting extent of conformity with the six EST criteria. The scenarios and their development are described in the report on Phase 2 of the EST project.

The three EST scenarios comprised different ways of meeting the EST criteria. They were defined in relation to the respective BAU scenarios, as shown in Box 7.

EST scenarios

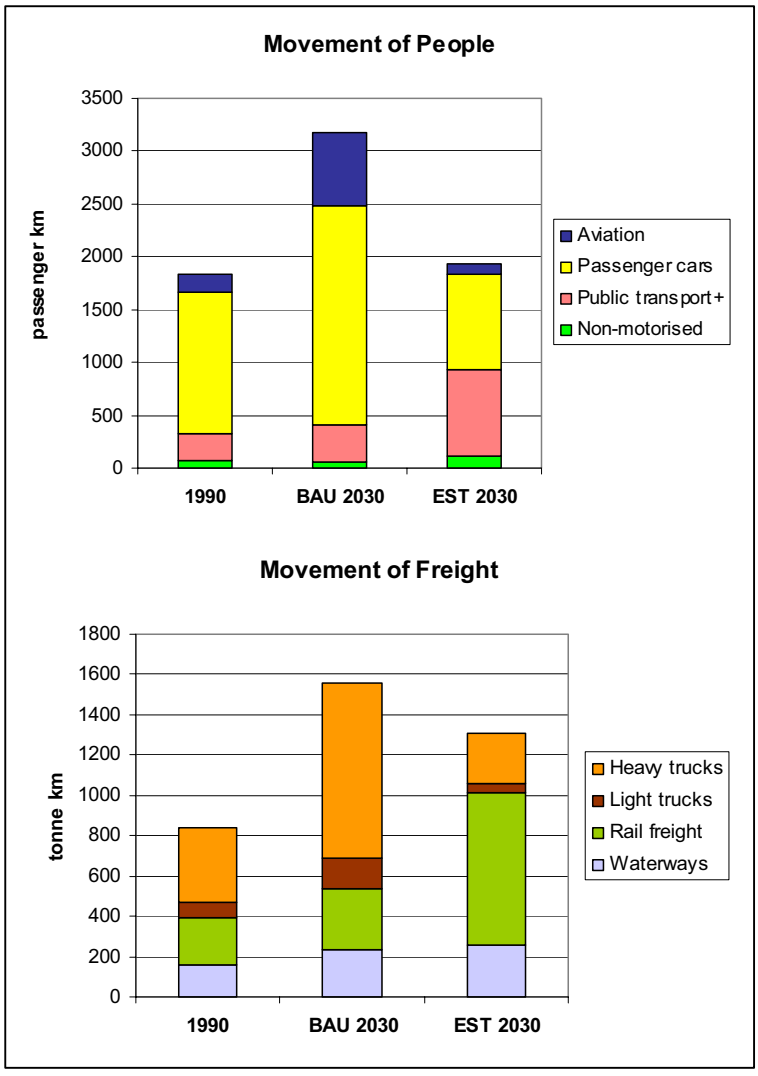
EST1 and EST2 were extreme scenarios. In EST1, the EST criteria were met entirely through improvements in the technology of vehicles, fuels, and infrastructure. In EST2, the criteria were met entirely through changes in transport activity (reductions in overall activity, use of less harmful transport modes and use of vehicles more efficiently). Extreme scenarios were used because they are sometimes advocated, and, more important, because they challenge thinking and help frame more moderate positions

Rationale for the EST3 scenarios

The EST3 scenario for each study reflected the respective project

team's assessment of the best balance of technology improvement and activity change for the study area.

The scenarios and their construction were described fully in the report on Phase 2 of the EST project. In brief, the project teams were able to construct EST1, EST2, and EST3 scenarios for 2030 that met the EST criteria. They were also able to develop BAU scenarios. The EST1 and EST2 scenarios appeared to be too extreme, even though versions of them have been espoused at one time or another by various interests. The EST1 scenarios seemed as though they could involve unacceptable economic costs. The EST2 scenarios gave the impression of incurring unacceptable social costs, e.g., the need for an uncomfortably authoritarian government. Accordingly, the project teams decided that further work should be confined to assessment of how the EST3 scenarios might be attained, and comparison of the EST3 and the BAU scenarios. Hereafter in this report, the EST3 scenario is referred to as the 'EST scenario'.



Box 8
Summary of Phase 2 results showing differences between the BAU and EST3 scenarios. 'Public transport +' in the upper chart includes smart mobility concepts and integrated mobility services involving public-private transport arrangements such as carsharing/ publicars, on-demand services, etc.

Box 8 provides a schematic representation of the overall results of the construction of the EST and BAU scenarios. It shows transport activity in relation to 1990 levels, both people and freight. The EST scenarios allowed on average a 21-per-cent increase in transport activity over 1990 levels (almost 40 per cent in the case of freight), but less of an increase than would occur with business as usual. However, the distribution of transport activities in EST and BAU was quite different, notably with higher shares of less harmful modes, smart transport management, and new mobility services.

Results of the scenario construction

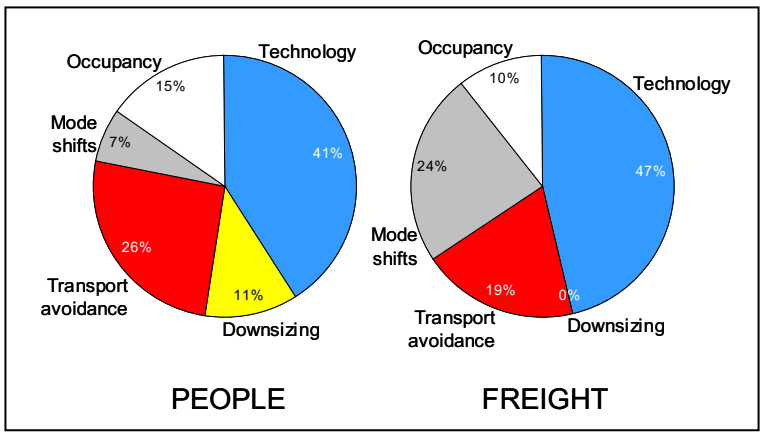
Details of the features of the BAU scenarios are given in the report on Phase 2 of the EST project. For full details, reference should be made to the reports of the individual Member country project teams on their work during Phase 2.[20]

Box 9 shows the results of a more in-depth analysis of how the six project teams constructed the EST scenarios.[21] This analysis focused on reductions in carbon dioxide emissions only, the EST criterion that had by far the strongest effect on strategy development (noise abatement in some countries was the only exception). Box 9 shows that on average **less than half of the contribution towards meeting the CO_2 criteria came from technological change** including downsizing of vehicles, slightly more for the movement of people and slightly less for the movement of freight.

Technology comprised less than half of the contribution towards meeting the CO_2 reduction criterion.

Because, for the most part, strategy development was driven by the need to meet the CO_2 reduction criterion, it may be reasonable to conclude that **the contribution of 'pure' technological improvements—such as improvements in engine design—to the construction of the EST scenarios was under half of the total effort.** More than half of the effort came from demand-side and mobility management measures.

Box 9 also shows that in constructing the EST scenarios for the



Box 9
Percentage contribution of different factors to attainment of the CO_2-reduction criterion in the construction of the EST scenarios.

movement of people, there was more emphasis on reduction in or avoidance of transport activity than on mode shifts. For the movement of freight, mode shifts—towards less polluting rail freight—were given more emphasis. As well, improvements in occupancy were the least important factor for the movement of freight, although contributing 10 per cent of the total; for the movement of people the least important factor was mode shifts.

There was considerable variation among project teams in the 'balances of effort' employed in the construction of the EST scenarios. The balance employed by the Canadian team, the only North American participant, was the closest to the average for the movement of both people and freight. This may be surprising to the extent that North America and Europe are believed to exhibit different transport characteristics.

It should be stressed that Box 9 concerns how the project teams constructed their EST scenarios in relation to meeting the CO_2 criterion. It does not represent actual transport phenomena.

1.4. Phase 3 and the present report

Setting goals is one of the two essential components of a back-casting exercise. The other is the identification of ways of meeting the goals. Identifying packages of instruments for the attainment of the EST scenarios was the prime activity of the project teams during Phase 3 of the EST project.

Chapter 2, the core of this report, summarises and analyses the results of Phase 3

Chapter 2, the core chapter of the present report, summarises and analyses the results of this activity. Much more extensive accounts of the assessment and selection of instruments appear in the reports of the individual project teams, published as a companion document.[22]

Chapter 3 summarises the work on economic and social implications

A subsidiary part of the work done by the project teams during Phase 3 of the EST project concerned preliminary assessment of the economic and social implications of moving towards and maintaining EST. A summary of this preliminary work appears here in **Chapter 3**. During the course of the Phase 3 of the EST project, a workshop on the economic and social implications of EST was held in Ottawa, Canada. More substantial reports on the work on economic and social implications appear in connection with the separately published report on that workshop[23] and in Appendix B to this report. Chapter 3 also contains an assessment of the external costs of the BAU and EST scenarios, i.e., the unpaid costs expressed in monetary terms of accidents, pollution, climate change, and noise, as well as from the production of vehicles, fuels, and infrastructure.

Chapter 4 sets out the barriers to attainment of EST and gaps in relevant knowledge about transport's roles and trends that have become evident during the Phase 3 work. It discusses how trends can be changed and the implications of change. This chapter builds on the discussions in the reports of the Member country teams.

Chapter 4 concerns barriers and gaps

Chapter 5 discusses how the concepts and strategies developed during the EST can be translated into action, in particular how some of the barriers identified during Chapter 4 can be overcome.

Chapter 5 points to the way ahead

Chapter 6 pulls together all of the foregoing and provides conclusions that point towards the next and last phase of the EST project. Phase 4 is to be concerned with two matters. One will be the provision of advice and guidelines for policy-makers concerned to encourage attainment of EST. The other will be presentation of the EST project in a way that will increase general understanding of the nature of EST and the reasons for attaining EST, as well as how EST might be achieved.

Chapter 6 provides conclusions

2. Instruments for achieving EST

2.1. Assessment and selection of instruments by the Member country project teams

In identifying and assessing instruments, most of the Member country teams used a method developed during the course of the EST project and known as *structured brainstorming.* This is a method based on collective expert judgement provided in multiple iterations organised around a prescribed form.[24] The general process for this method is set out in Box 10 on the next page. An illustrative, hypothetical example of the application of the form is provided in Box 11 on the subsequent page. Norway did not make use of structured brainstorming in identifying instruments for the Greater Oslo area. France and Italy relied heavily on work already done towards respective national plans.[25] Sweden, as part of her already initiated EST project involving use of a scenario method, went through a more elaborate process involving attempts to secure consensus among representatives of major transport interests.

Some of the specifics of the strategies and methods used by the project teams are set in the balance of this section. For full details, reference should be made to the reports of the individual project teams in Volume II of this report.

2.2. The instrument packages proposed by the project teams

The actual instrument packages proposed by the project teams are set out in Appendix A of this report, in Table 1 to Table 9. The instruments are listed there in the orders provided by the project teams (after slight editing). These tables also provide assessments of each instrument conducted by the OECD Secretariat. The key to these assessments is in Table 10. The assessments are further discussed in Section 2.3 below, where they are summarised in Box 14.

Instrument packages set out in Appendix A

/text continues three pages ahead

Box 10
General process of *structured brainstorming* employed by the Member country teams for identification of instruments and packages of instruments.

STAGE 1
1. Review the country's EST3 scenario, identifying **features to be attained** (e.g., level of technology, modal split, demand-side management, infrastructure, etc.), preserving the link in the identification between each feature and the EST criteria it is associated with.
2. For each feature, identify which are the most promising instruments that if implemented in a timely manner would result in occurrence of the feature by 2030.
3. Conduct a structured brainstorming exercise, using the framework set out in Box 11, to assess the individual instruments and develop a package or packages of instruments for the attainment of EST3.
STAGE 2
4. Identify the **potential interactions among the instruments** selected during Step 3 and develop options for accommodating them.
5. Conduct a second structured brainstorming exercise to revise the preliminary package of instruments to take into account the work done in the meantime on the interactions among packages and on their implications.
STAGE 3
6. Develop a schedule of implementation of the instruments together with appropriate milestones.
7. Incorporate further results of the assessments of economic and social implications.
8. Conduct a third structured brainstorming exercise to incorporate into the formulation of instrument packages the work on schedules and milestones. As well, determine whether implementation of the resulting package or packages of instruments would be feasible, or whether the EST criteria and the basic features of EST3 might need adjustment.
STAGE 4 (IF NECESSARY)
9. If adjustments to the criteria or to the EST3 features are required, conduct a fourth structured brainstorming exercise to incorporate the adjustments and finalise the package or packages of instruments.

Box 11
Illustrative, hypothetical example of the framework used by Member country teams to identify instruments and packages of instruments.

Assessment of instruments [example]

Which *type* of feature is being attained?	Which instrument is being assessed?	Effect of the instrument on:[a]		Cost-effectiveness[a]	Impacts inside the transport system on:[b]			Impacts outside the transport system on:[b]			Macro-economic impacts[b]		Links to other features and/or instruments[c]	What are the advantages and disadvantages of implementing the instrument?	What are the social, economic, and political contexts within which this instrument can be implemented?
		Activity	Unit impact		Vehicles	Fuels	Infrastructure	Land use	Social activity	Psychological factors	Employment	Other impacts			
Reduction in transport distances (passenger transport)	*Spatial planning*	+		0/+	-	-	++	++	0	0	0	0	A	*Adv: reduction at source* *Dis: only long-term effects*	*A strong government; favouring of regional development; acceptance of mobility confined to short distances.*
	Regulation of CO_2 emissions per capita	++		++	+	0	0	0/+	++	++	0	0	A/I	*Adv: short-term effects*	*Social acceptability; international agreements*
	Pricing policy; (fuel prices)	+		++	+	0	0	0/+	++	++	0	0	A/I	*Adv: short-term effect; raises revenues* *Dis: large increases required for an effect*	*Social/political acceptability; international agreements*
Electric cars in urban areas	*Emissions regulation (CO_2/km) (tradeable permits)*		++	++	++	0	0	0	0	+	0	0	I	*Adv: also effective outside urban areas* *Dis: possible increase in 2nd car ownership*	*Social/political acceptability*
	Limiting use of conventional cars inside urban areas	+	+	+	++	0	0/+	0/+	0	+	0	0	A/I	*Adv: also reduces car use and noise, and need for space* *Dis:*	*Social/political acceptability; accessibility to shops etc.*
	Pricing policy (differential car taxes; road pricing for conventional cars)	0/+	+	++	+	0	0	0	0	+	0	0	A/I	*Adv: simple to implement* *Dis: major differentiation in taxes needed for effect*	*Social/political acceptability*

[a] Assess on a five-point scale as follows: -- = very negative, - = negative, 0 = neutral, + = positive, ++ = very positive

[b] Assess on a three-point scale as follows: 0 = no impact, + = some impact, ++ = strong impact

[c] Indicate links in this way: A—instrument is linked to features/instruments involving activity reductions; I—instrument is linked to features/instruments involving reductions in impacts per pk/tk; A/I—instrument is linked to features/instruments involving both activity and impact reductions.

A further point to be made about the project teams' work on instruments is that within the Alpine group (Austria, France, Italy, and Switzerland) there was much analysis of the instruments proposed by the individual Member country teams with a view to achieving convergence of the separate strategies. For the most part, this analysis is not presented in what follows; the four Alpine project teams are treated separately.[26]

Austria's instrument package

Austria: In following the method of structured brainstorming, four workshops of experts were convened. One informed participants about the EST project. During the other three, participants progressively refined instruments to be used for attainment of EST. Social and economic implications were also considered by the workshops. Instruments were considered initially in relation to an overall hierarchy of three strategies:

- reducing the demand for motorised transport
- shifting as much as possible of remaining motorised transport activity towards more sustainable modes
- using the best available technology—in terms of attainment of EST criteria—for all remaining transport activity.

Austria's strategies, emphasising mode shifts and changes in activity patterns

The three strategies were then elaborated into four strategies for the movement of freight and six strategies for the movement of people. For freight, the strategies were the above three plus "regionalisation of the economy, reduction of outsourcing". For people, the reduction in demand strategy became two: "reduction of passenger-kilometres in motorised traffic" and "reduction of daily and weekly distances travelled per person". Two further strategies were added for people: "zoning and planning" and "change of lifestyle/cultural background".

For the movement of freight, the most effective instruments were considered to be those that resulted in mode shifts towards rail or water and in reductions in tonne-kilometres. For the movement of people, the most effective instruments were considered to be those that resulted in mode shifts and in changes in lifestyle and cultural background.

Feasibility and awareness raising

Two supplementary factors were considered by the Austrian team: technological feasibility and awareness raising and education. The time frame of the exercise—until 2030—was considered sufficient to allow solution of technical problems of implementation. The Austrian team placed emphasis on the importance of cultural change towards favouring sustainably produced goods. Education from kindergarten to university and beyond would be an essential tool in securing cultural change.

The instrument package selected by the Austrian team is set out in Table 1 in Appendix A. The keys to the letters used in the

OECD secretariat's assessments to the right of each instrument are in Table 10 in Appendix A.

Austria's key long-term instrument is a system of tradeable entitlements to emit CO_2

Austria proposed rather more than the average number of instruments (85 vs. 44 for the nine countries summarised in Box 14). More than half of the instruments were directed at the movement of both people and freight. Three quarters of the instruments were for early introduction or for gradual application over the whole of the implementation period (2000-2030). The types of instruments used were similar to those for the other project teams except for a stronger emphasis on changing institutional arrangements. The key long-term instrument in the Austrian team's strategy—as with the strategies of the Netherlands and Swedish teams discussed below—is a system of tradeable entitlements or permits to emit carbon dioxide, in this case internationally harmonised and separately managed for the movement of freight and for the movement of people. Austria extended its EST-Alpine work to include the whole territory of Austria; the results of this case study are published elsewhere.

Canada's instrument package

Canada: The Canadian team used a modified version of the structured brainstorming method, using the brainstorming exercise for Stage 1 only of the process illustrated in Box 10.

The instruments proposed by the Canadian team are listed in Table 2. Included in the eventually proposed package were instruments that, according to the Canadian team:

- have the greatest potential for CO_2 reduction, as determined by previous research;
- impact the largest number of EST features;
- have impacts both on activity and technology; enhance the impacts of other instruments.

Canada's strategy was to choose a broad combination of instruments

In packaging the instruments, the Canadian strategy was to choose a broad combination of fiscal, regulatory, voluntary, and educational instruments that best mirrored the nation's geographic, economic, and social diversity. This broad combination would serve "to capitalise on synergies and reduce the risk of failure of a single instrument, and also to spread the burdens and benefits across modes and across individuals." The EST criteria would be met through a judicious mix of technological enhancement and changes in transport activity.

Canada placed more than average emphasis on fiscal and educational instruments

The Canadian instrument package was characterised by having a higher-than-average emphasis on fiscal instruments and on educational instruments. In terms of effect sought, there was more focus on reducing local and regional impacts, and on reducing overall levels of motorised transport activity by raising its cost. Although the emphasis of the Canadian team was on

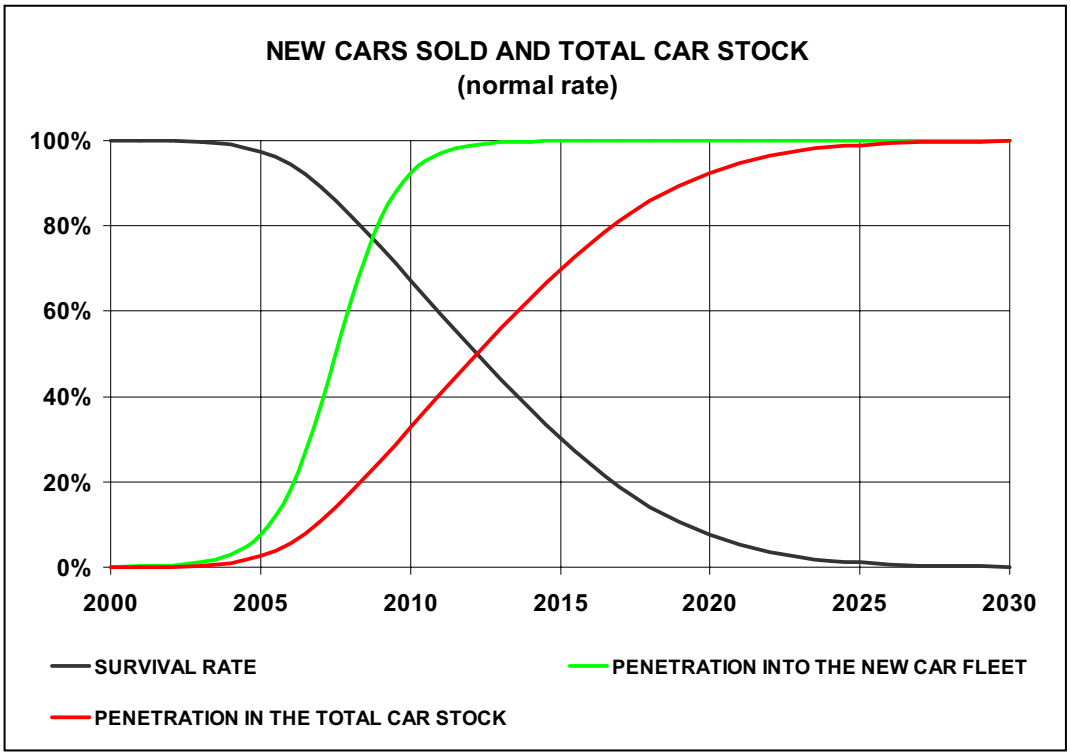
national initiatives, the study's conclusion that "international co-operation is essential" should be noted. The six most promising instruments according to the Canadian team were, in order, fuel pricing/taxation, tradable CO_2 permits, parking pricing/management, designated funds for public transport expansion, new CAFE standards/feebates, and differentiated registration/insurance fees.

A general conclusion of the Canadian team in the presentation of its instrument package was that "achieving EST would require an enormous and coordinated effort on behalf of all members of society. Moreover, the changes would have to start immediately in order to take effect by the horizon year 2030. To achieve any significant changes, the public would need to be made aware that there is significant cause for concern regarding the environmental issues and global warming."

France's instrument package

France: As noted, in developing their instrument package, the French team constructed their instrument package with reference to the national plan concerning climate change. Thus, the resulting package, set out in Table 3, has the highest proportion of instruments that are already in use or are under consideration (see Box 14). In just about every other respect, the French approach was close to the average of the nine Member country teams, with a stronger-than-average focus on instruments designed to minimise motor transport activity.

Box 12
Illustration of rates of penetration of new technology into the new car fleet and total car stock, and the resulting vehicle survival rate



In their work, the French team also stressed the distinction between penetration of new technology into new vehicles and into the total vehicle stock. Penetration into new vehicles is a matter of 5-10 years, but penetration into the total stock is a matter of 20-25 years, due to low vehicle turnover rates (see Box 12).

Germany's instrument package

Germany: The German team made use of the structured brainstorming process but with a modified version of the assessment form rather than the one illustrated in Box 11. This team put a strong focus on reducing CO_2 emissions. This was done on the assumption that the other criteria would for the most part be met if the CO_2 criterion were met. The main exception was noise, which was considered to require additional instruments. Aviation was also given special consideration.

Germany's key instruments are standards for all vehicles, particularly CO_2 emissions standards, fuel taxes for the movement of people and road pricing for the movement of freight.

For the German team, the key instruments were standards for all motorised vehicles (cars, trucks, buses, trains, aeroplanes, etc.) and fiscal measures for road vehicles in the form of a fuel tax for the movement of people and road pricing for the movement of freight. CO_2 emissions standards would be tightened sufficiently over the period until 2030 to reduce emissions by more than 70 per cent below 1990 levels, other things being equal and assuming effective implementation and maintenance of the standards.

Additional taxes were proposed in part to offset increases in transport activity that might arise through the imposition of tighter CO_2 emissions standards (i.e., from the resulting increased fuel efficiency), and in part to secure additional reductions in transport activity and thus support transport demand management (including transport avoidance). For freight, the key measure proposed by the German team was road charging. Higher fuel taxes were rejected "to avoid tankering (using cheaper fuel from neighbouring countries)".

As listed in Table 4 in Appendix A, numerous other measures were proposed by the German team to address particular features or modes and to deal with corollary matters including land use and public transport. Two features of the German instrument package—in relation to those of the other Member country teams whose instruments are summarised in Box 14—were focuses on achieving mode shifts (towards public transport and rail freight) and on making land use and regional economic arrangements more conducive to sustainable transport. Other emphases concerned a focus on the need for international action and on making use of instruments that are already being deployed.

The proposed measures may be inadequate. Tradeable permits for emissions of greenhouse gases from aircraft may be required; the attainment period may have to be extended beyond 2030

The German team concluded that enormous efforts will be required to attain the EST criteria, "and the time left is very

short". The team expressed concern that the measures it had proposed may not be adequate in several respects, notably noise, air travel, and the local movement of freight. For noise, improved abatement technology will be required. For local freight movement, there will be need for innovation in freight distribution. For air travel, the German team suggested that tradeable permits for aviation-related emissions of greenhouse gases might have to be introduced.

The German team expressed scepticism as to whether the pace of technological change will be enough to make the required contribution towards reduction in CO_2 emissions. It may be necessary to extend the attainment period beyond 2030, or perhaps even make the CO_2 target less stringent.

Italy's instrument package

Italy: Italy's instrument package, listed in Table 5 in Appendix A, was derived mostly from its National Transport Plan and from the National Strategy for meeting Italy's obligations with respect to the 1997 Kyoto Protocol. Particular challenges faced by the Italian team in identifying instruments included large projected reliance on road-based transport modes and on the generation of electricity from fossil fuels.

Nevertheless, Italy's instrument package was exceptional among the packages only in the way in which responsibility for implementation was assigned to the national government rather than to international agencies or to local and regional governments (which may reflect no more than a limited initial evaluation). There were also a stronger than average emphases on regulatory as opposed to fiscal instruments, on reducing local and regional environmental impacts, and on changing attitudes, culture, and lifestyles.

The Netherlands' instrument package

The Netherlands: This team was the first to work through the structured brainstorming approach, which had been developed by the Netherlands team.[27] The Netherlands team placed a strong focus on reducing CO_2 emissions by means of one particular instrument to be implemented in the longer-term: tradeable permits to emit CO_2. Numerous other instruments were proposed as part of the Netherlands' package; they were positioned as short- or middle-term instruments, implemented to support the effectiveness of the tradeable permits system and enhance its social, political, and economic feasibility. The instrument package proposed by The Netherlands team is listed in Table 6 in Appendix A.

Strong emphasis was placed on tradeable permits schemes for the movement of both people and freight, with other instruments in a supporting role

As detailed in the Netherlands report, the tradeable permits scheme would apply to the movement of both people and freight. Individuals would each receive a no-cost permit allocation. Businesses would be able to purchase permits from a

permit bank. Both would be able to trade permits, probably through the permit bank.

The permits that would be available to individuals and from the permit bank would reflect the stage of progress towards attainment of the target for reducing emissions of CO_2. Assuming effective implementation, the tradeable permits scheme would restrain emissions within the set CO_2 'budget'.

The permit scheme would be implemented gradually and relatively late in the process. Numerous other measures, notably fuel taxes and road pricing, would encourage "anticipatory behaviour".

The Netherlands justified its tradeable permits scheme as a sophisticated form of emissions regulation. The team concluded that "CO_2 emissions regulations form a necessary instrument in meeting the EST criteria; pricing instruments, infrastructure policy, and education/information are not enough".

Netherlands' stronger emphasis on freight transport

Compared with the packages of the other project teams summarised in Box 14, the instrument package of The Netherlands' team was notable for having a larger-than-average number of instruments specifically directed towards freight transport alone and, as already suggested, towards reducing global impacts. The Netherlands' package had more instruments directed towards the short term and the very long term and more instruments that would require implementation by national governments.

Netherlands' conclusions

The Netherlands team presented several conclusions from its instrument assessment process, including the following:

- EST cannot be attained without changes in other sectors (e.g., agriculture and industry), or without international co-operation;
- impacts outside transport—e.g., on land use and on the organisation of social activities—are expected to be greater than impacts within the system;
- impacts of the adjustment processes leading to EST are likely to be greater than the impacts of sustainable transport as such;
- large differences among countries can be expected in most aspects of the attainment of EST as a result of geography, culture, and transport practice.

Norway's instrument package

Norway: This team's work was the most narrowly focused, on the Greater Oslo area. For this reason, and because there was a focus on instruments aiming at reductions in CO_2 emissions, the

Norwegian team proposed the fewest instruments, 15 in total, as listed with their assessments in Table 7 in Appendix A.

Norway's approach relied heavily on two models of transport activity

The Norwegian team's report on its Phase 3 work indicates that the identification and assessment of instruments relied heavily on the use of two models of transport activity, one for movement of freight throughout Norway and one for the movement of people in Greater Oslo. The structured brainstorming method was not used by the Norwegian team. The estimates of effects of the instruments was in some cases made outside the models on the basis of the models' results.

Attainment of an intermediate target for 2020 can be achieved with improvements to traditional engines (plus other instruments); further reduction will require replacement of traditional technologies.

Norway's modelling work used 2020 as the target year; the corresponding required reduction in CO_2 emissions was taken to be 60 per cent, i.e., three quarters of the project target of 80 per cent because 2020 is three quarters of the way from 1990 to 2030. The conclusion of the Norwegian team based on the modelling work is as follows: "By 2020 it will be possible to reduce the CO_2 emissions in the Greater Oslo area by more than 60 per cent compared with 1990. This can be achieved by technological improvement of traditional engines to reduce fuel consumption, by a national charge on CO_2 emissions, and by local instruments like land use regulation, encouraging public transport, developing cycle paths, and encouraging telecommuting." There was also discussion of the period 2020-2030, with the following conclusion: "To achieve the goal of an 80-per-cent reduction in CO_2 emissions by 2030, replacing traditional technologies with electrical vehicles will be necessary. If further increases in transport is constrained by an increasing oil price and—if necessary—increased charges, the reduction in CO_2 emissions compared with 1990 will be 84 per cent by 2030."

Sweden's instrument package; a focus on political feasibility

Sweden: As noted, the Swedish EST work had been launched separately from and before the OECD work, as the MATS (EST) project. Its procedures, more than those used in the OECD work, emphasised the political and societal aspects of attaining EST. This emphasis pervaded the Swedish work on the identification and assessment of instruments. (The instruments proposed by the Swedish team are listed in Table 8 in Appendix A.) All the Swedish work was imbued more with a sense of what was or could become *politically* possible in Sweden than with what made the best sense technically or economically. Nevertheless, economic and social implications have also been assessed within Sweden's work on Phase 3 of the EST project.

More than much of the other work on the EST project, the Swedish approach emphasised the need for phasing of the implementation of instruments for attainment of EST. The three main implementation phases were the *acceptance phase*, during which the environment would be accepted as a constraint on the design of transport policy, and environmental objectives and

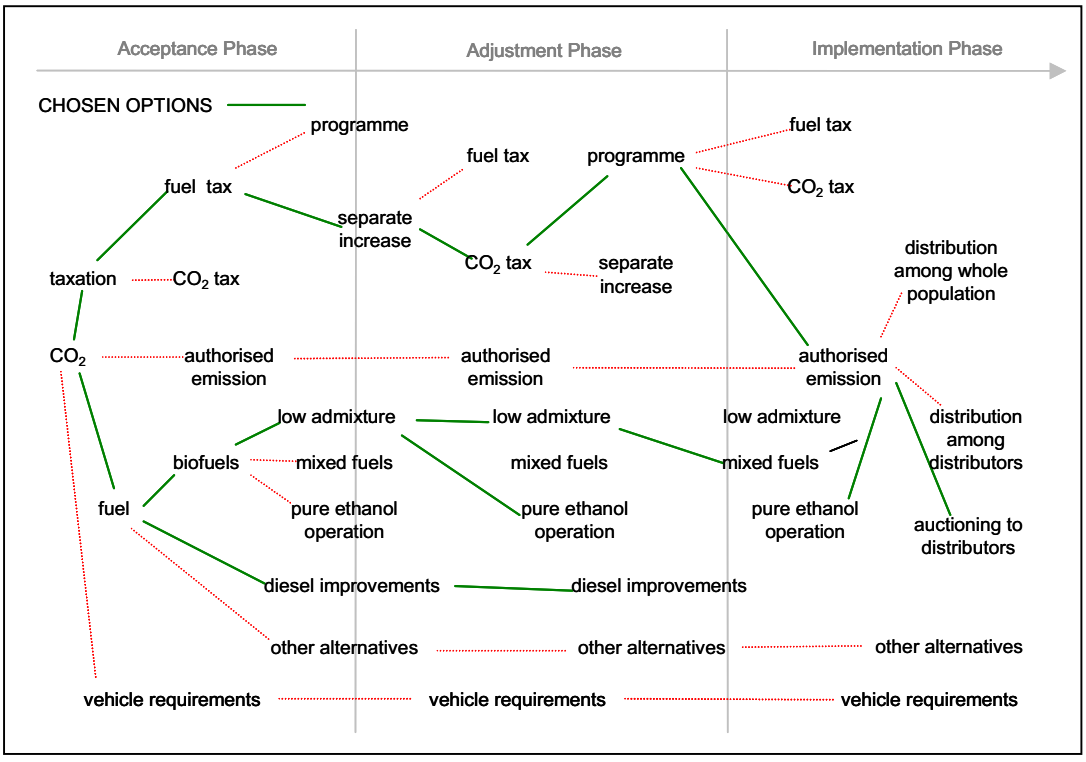
targets would be agreed to; the *adjustment phase*, during which existing objectives would be replaced at least in part by environmental objectives; and the *implementation phase*, during which environmental objectives would emerge as dominant.

The work on the Swedish equivalent to the EST scenario showed that the environmental objectives that would provide the strongest challenges would be those for CO_2 and noise. Consequently, a great number of instruments would be directed to attain those goals. For CO_2, a successively increased fuel tax was proposed as the major instrument in the initial phases of the transition. In the implementation phase, a system of emission rights, auctioned out to the distributors of fuel, was introduced as a replacement for the fuel tax. This was illustrated in the diagram that appears here as Box 13. Another main policy thread is also evident in Box 13: a strong focus on the introduction of biofuels.

Important supplementary instruments for attainment of the Swedish EST scenario would be more stringent exhaust requirements—here, Sweden is expected to be a strong force within the European Union—environmentally determined shipping and landing charges, auctioning of landing rights to reduce noise, and road-pricing schemes based on the environmental performance of the vehicles.

Box 13
Aspects of the Swedish instruments strategy
▼

The construction of the Swedish EST scenario and development of an instrument package for attaining it resulted in several



insights, including the following:

Insights from the Swedish work

- A national consensus is needed to transform society through political means. Achieving EST will require many political decisions made over a long period of time.
- A national environmental policy has severe limitations. Equivalent actions with respect to the environment are required in other countries, in the European Union and across the world.

Switzerland's instrument package

Switzerland. The list of instruments proposed by Switzerland is in Table 9 in Appendix A. It was developed through use of an attenuated version of the structured brainstorming process described in Section 2.1.

The Swiss list of instruments mostly includes only instruments that have already been introduced or are presently under discussion in Switzerland. This was done in the belief that these instruments would be sufficient, if applied in a rigorous way with intensity adjusted according to changes in transport volumes and their effects. It is worth noting that Switzerland is the only country that has a law and financing plan in place to ensure a significant mode shift towards rail freight. (This concerns traffic through the Alps, with infrastructure financing raised to a large extent from distance-based charges on heavy duty vehicles, to be gradually increased until 2010.)

The Swiss team relied on instruments in use or already proposed, but applying them with higher intensity.

The logic for including the limitation to current deployed or discussed instruments is as follows. Instruments need much public and political discussion before they are introduced. Accordingly, it is better to propose instruments that are already accepted or on the way to acceptance than to propose completely novel instruments.

Each of the instruments proposed by the Swiss team is presented with a statement as to its current status and, where possible, its expected effect.

Although most of the Swiss team's instruments concerned the movement of people, instruments concerning the movement of freight or both people and freight generally had higher priority. Compared with the instruments proposed by the other Member country teams, the Swiss team put more emphasis on regulatory instruments and on instruments designed to improve environmental performance by securing mode shifts (shifts from automobiles to public transport and non-motorised modes and from road freight to rail freight).

Complementary work. Coincident with and related to the EST project were two projects, one involving countries in central Europe and one conducted in Japan.

The CEI project: towards EST in central Europe

The former study, entitled "Environmentally Sustainable Transport in the CEI countries", was initiated by the United Nations Environment Programme (UNEP), the OECD, and the Republic of Austria (Federal Ministry for the Environment, Youth and Family Affairs). The "Environment and Transport" subgroup of the Central-European Initiative (CEI)—a intergovernmental collaborative involving Austria, Italy, and 14 countries in transition—acted as the steering committee for what became known as the CEI project.

This pilot project followed the same general strategy as the presently reported EST project in that it used the application to several countries of three scenarios similar to EST1, EST2, and EST to help identify and assess strategies and measures for achieving EST. The CEI project focused on the particular challenges of countries in transition. Lack of data, institutional capacity, methodological problems, and limited resources meant that the CEI project had to be conducted at a higher level of generality than the EST project. The findings of the CEI project—notably the need to preserve investment levels for maintenance and to renew public transport and rail freight—nevertheless point the way toward environmentally sustainable transportation in the Central European region and, where comparable, complement the results of the EST project.

Japan's EST project

The project in Japan was conducted under the auspices of the EST Committee of Japan, which involves academic, government, and private-sector interests. The project was entitled, "A Meso-Scale Estimation of Future CO_2 Emissions from Transport in Japan". It estimated future emissions and involved application of a backcasting approach and assessment of instruments that would achieve designated levels of emissions reduction. Policy implications were drawn from this analysis for Japan as a whole and for urban areas in particular. The study found that even a return to 1990 levels of GHG emissions would be difficult to achieve with mode shifts alone, and the potential for application of additional measures was explored.

2.3. Comparisons of instrument packages

Six types of instrument feature

The instrument packages proposed by the Member country teams were compared by assessing each instrument according to six features, and then analysing the ratings. The detailed assessments are provided in Table 1 to Table 9 in Appendix A, one table for each Member country team. They are summarised in Box 14.[28] **The six features were these** (the letters after each aspect of a feature refer to the codes used in Table 1 to Table 9, also summarised in Table 10):

People or freight

- whether the instrument is directed to the movement of people (P) or freight (F), or both (B);

Phasing

- the *phasing* of the instrument, whether it is to be applied gradually throughout the whole implementation period of 2000-2030 (G) or brought into play mostly in the short term, to 2005 (S), the medium term, to 2010 (M), the long term, to 2015 (L) or the very long term (V);

Type of instrument

- the *mechanism of operation* of the instrument, according to whether it is regulatory (R) or fiscal (F) in nature, or a combination of both (B), or whether it requires investment, usually by government (I), relies on education or persuasion (E), or designed to change governmental or institutional arrangements (G);

Type of effect; local regional, and global impacts and others

- the *type of effect sought*, whether the instrument is designed to reduce the global impacts of motorised transport activity (A), reduce local or regional impacts (B), improve environmental performance by mode shifts (C), reduce overall activity by better occupancy or logistics (D) or by imposing costs or penalties (E) or by favouring non-motorised alternatives (F), reduce transport activity in specific locations (G), make land use or the organisation of regional economic activity more conducive to sustainable transport (H), reduce noise (I), alter attitudes, culture or ways of living (J), or take more general actions or other actions not included above (K);

Responsibility

- who would have primary *responsibility for implementation* of the instrument, international (I), national, including states and provinces in federations (N) or more local or governments and agencies (L);

Readiness

- the *readiness* of the instrument, whether it is in use (A), under consideration (B), or not yet under consideration (C).

To achieve some consistency, much of the analysis on which Box 14 is based was carried out initially by the OECD secretariat rather than by the project teams, but with subsequent confirmation or revision by the project teams. For the purposes of the analysis, each proposed instrument has been assumed to be of equal weight within a team's set of instruments. This is a simplified assumption in light of the already mentioned priorities afforded some instruments by some of the project teams. However, alternatives to this simple formulation were found to provide too little in the way of new insights to justify the additional complexity.

Box 14
Summary of the features of the Member country teams' instruments.

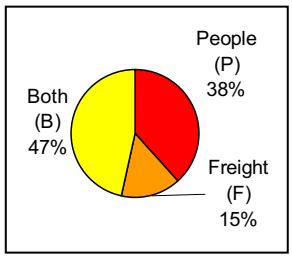
	Percent of each category*									
	Au	Ca	Fr	Ge	It	Ne	No	Se	Sw	Aver-age
Number of instruments	85	36	60	39	55	34	15	24	32	44
Movement of people or freight										
People (P)	31	42	40	41	35	24	73	29	31	38
Freight (F)	13	6	18	13	11	35	20	8	13	15
Both (B)	56	53	42	46	55	41	7	63	56	47
Phasing										
Gradually, over the period 2000-2030 (G)	38	11	33	26	33	0	47	0	22	23
Short term (<2005) (S)	36	53	30	36	45	56	7	38	41	38
Medium term (2005-2009) (M)	18	19	25	36	20	29	40	25	31	27
Long term (2010-2014) (L)	8	17	10	0	2	3	7	38	6	10
Very long term (>2014) (V)	0	0	2	3	0	12	0	0	0	2
Type of instrument										
Fiscal (fee or subsidy) (F)	22	36	35	26	20	29	20	33	16	26
Regulatory (R)	33	28	33	36	42	35	13	50	41	35
Both fiscal and regulatory (B)	0	3	3	3	0	3	13	8	0	4
Investment, usually by government (I)	18	8	13	31	18	26	47	0	34	22
Educational or hortatory (E)	13	19	10	0	9	3	7	4	6	8
Change governance arrangements (G)	14	6	5	5	11	3	0	4	3	6
Type of effect										
Reduce impacts on global environment (A)	14	11	20	21	11	26	7	17	16	16
Reduce impacts on local and regional environment (B)	20	22	18	0	24	6	0	38	0	14
Improve environmental performance by mode shifts (C)	14	14	17	21	18	15	20	4	31	17
Minimise transport activity by improving loading/logistics (D)	5	3	0	5	4	6	33	0	3	7
Minimise motor transport activity by cost or other penalties (E)	5	11	13	5	7	6	13	8	6	8
Favour non-motorised alternatives (F)	4	6	3	8	5	6	13	0	9	6
Reduce motor transport activity in specific locations (G)	4	8	5	3	2	6	7	8	16	6
Improve land use or economic arrangements (H)	9	11	12	28	5	15	7	13	9	12
Reduces noise (I)	11	0	8	10	9	3	0	13	9	7
Change attitudes, culture, lifestyle (J)	14	8	3	0	15	6	0	0	0	5
Other effects (K)	1	6	0	0	0	6	0	0	0	1
Responsibility										
International (I)	13	6	13	28	9	15	7	8	19	13
National/state/provincial (N)	66	61	62	36	78	71	7	67	34	53
Local/regional (L)	21	33	25	36	13	15	87	25	47	33
Readiness of Instrument										
In use (A)	38	25	50	62	29	35	53	33	59	43
Under consideration (B)	36	47	33	21	33	6	27	33	6	27
Not yet under consideration (C)	26	28	17	18	38	59	20	33	34	30
Number of times highest	1	4	1	3	2	6	9	5	2	

* Except for the first row, which shows the absolute number of instruments deployed, each number is the percentage of the particular type of instrument within its category deployed by the indicated expert team. Thus, within each category (e.g., 'Phasing') the percentages for a country sum to 100. The highest percentages for each type of instrument among countries are shaded. The bottom row shows the number of times each country recorded the highest percentage. The right-hand column shows the averages of the numbers in each row,

		Mode			Phase					Instrument						Effect											Responsibility		
		People	Freight	Both	G	S	M	L	V	F	R	B	I	E	G	A	B	C	D	E	F	G	H	I	J	K	I	N	L
Phase	Gradually, over the period 2000-2030 (G)																												
	Short term (<2005) (S)																												
	Medium term (2005-2009) (M)																												
	Long term (2010-2014) (L)	–																											
	Very long term (>2014) (V)																												
Instrument	Fiscal (fee or subsidy) (F)							+																					
	Regulatory (R)		–	+																									
	Both fiscal and regulatory (B)																												
	Investment, usually by government (I)	+		–			+																						
	Educational or hortatory (E)					+																							
	Changing governance arrangements (G)			+																									
Effect	Reduce impacts on global environment (A)		–	+			–				+																		
	Reduce impacts on local environment (B)				–						+		–																
	Improve environmental performance by mode shifts (C)		+	–						–	–		+																
	Minimise transport activity by improving loading/logistics (D)			–		–					–																		
	Minimise motor transport activity by cost or other penalties (E)					–					–																		
	Favour non-motorised alternatives (F)	+		–																									
	Reduce motor transport activity in specific locations (G)																												
	Improve land use or economic arrangements (H)										+		–																
	Reduce noise (I)	–		+		–					+																		
	Change attitudes, culture, lifestyle (J)			+																									
	Other effects (K)																												
Responsibility	International (I)	–			+	–				–	+		–																
	National/state/provincial (N)							+		+						+			–		–	–			+				
	Local/regional (L)	+		–			+			–			+			–	–							+	–				
Readiness	Instrument in use (A)					+		–						+							+			–				
	Instrument under consideration (B)		–					+												+									
	Instrument not yet under consideration (C)		+			–		+						–				–					+						

Box 15
Interrelationships among assessments of instruments. (The '+' signs indicate higher than expected probabilities of concurrence between particular characteristics; The '-' signs indicate pairs of characteristics that were unlikely to occur together.)

The following discussion is based primarily on the information in Box 14, as highlighted for each category of instrument in several pie charts below. There are two additional analysis items. The chart in Box 15 shows **interrelationships among the features of the instruments**. The squares containing a '+' or '-' in Box 15 indicate pairs of assessments that occurred respectively more or less frequently than expected.[29] For example, an instrument assessed as being specifically to do with the movement of people was less likely than expected to be also an instrument assessed as having its main application in the long term (see the uppermost square containing a '-' in Box 15).



▲
Box 16
Overall distribution of proposed instruments as they concerned people or freight

The second additional analysis item is Table 11 in Appendix A. This long table provides a presentation of *all* of the instruments proposed by the project teams. In Table 11, the instruments are grouped first by type of effect sought and then by type of instrument.

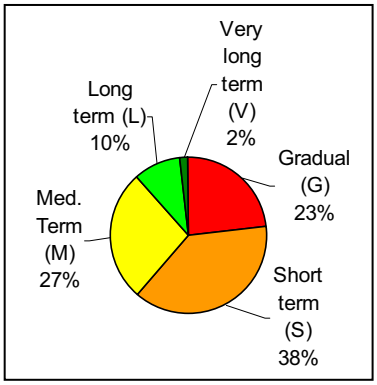
Analysis in terms of the objects of the instruments: movement of people or freight

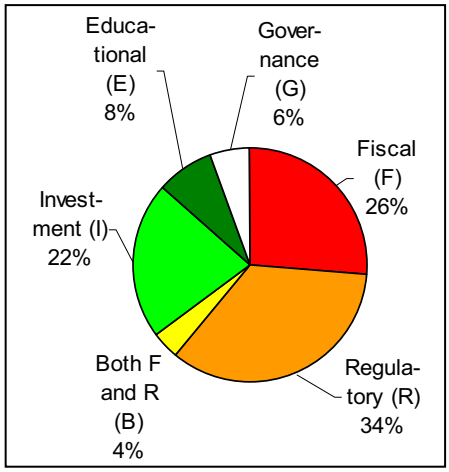
Box 14 and the summary pie chart in Box 16 show that **overall most instruments concerned the movement of people or the movement of people and freight, rather than the movement of freight alone**. The Netherlands' package gave more weight than the others to restraining freight transport. This reflects the greater proportion of freight transport in the Netherlands compared with the other Member countries.

Box 15 indicates that instruments concerning the movement of people were more likely than might be expected to achieve their result through investment, to favour non-motorised transport, and to be the responsibility of municipalities, regional governments, and other local agencies (see the squares in the 'People' column of Box 15 containing a '+'). Instruments concerning the movement of freight were more likely to involve mode shifts and to be not yet under consideration. Instruments concerning both people and freight were more likely to be regulatory in nature, to involve a change in governance arrangements, and to be such as to reduce global impacts, to reduce noise, and to change attitudes, culture or lifestyle.

Box 17
Overall distribution of proposed instruments as they concerned phasing
▼

In respect of **phasing**, Box 14 and the summary pie chart in Box 17 indicate that **early rather than late introduction was preferred overall**, more so in the case of The Netherlands and Canada, and less by Norway and Sweden. The Netherlands, however, also had the most incidences of instruments for the very long term; and Norway favoured gradual implementation more than the other teams. Austria—and to a lesser extent the other Alpine countries—also favoured gradual implementation, reflecting an explicit policy that would involve extensive monitoring and public review of progress to ensure continued acceptance.





As well as the one noted above, there were several other interrelationships concerning phasing. Box 15 shows that instruments for introduction in the short term were, as might be expected, more likely to be instruments in use, while those for the long term were more likely not to be presently in use. Educational instruments were more likely to be considered for the short term, investments for the medium term, and fiscal instruments for the long term. International responsibility was associated with gradual introduction of instruments throughout the attainment period, whereas local and national responsibility was associated more with medium- and long-term actions, respectively.

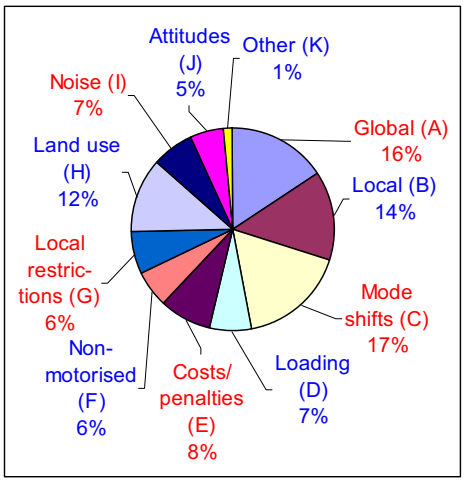
Box 18
Overall distribution of proposed instruments as they concerned type of instrument

The phasing of instruments is among the most important aspects of the development of instrument packages for attainment of sustainable transport. Phasing is discussed further in Section 2.4 below.

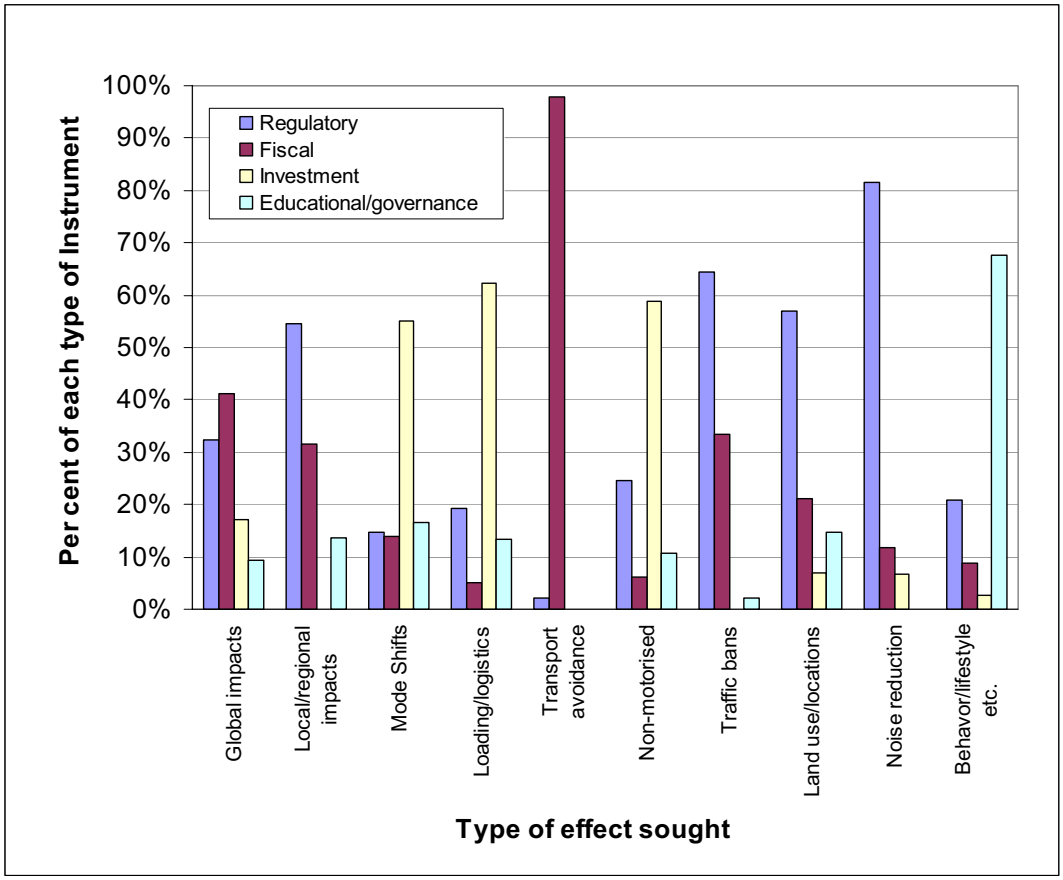
Analysis in terms of type of instrument

In respect of **type of instrument**, Box 14 and the summary pie chart in Box 18 indicate that **almost two thirds of the instruments proposed were fiscal or regulatory or both**. Except for Canada, Norway, and France, the project teams more often proposed regulatory than fiscal instruments. The Canadian team put more weight on education and related processes than the other teams. Norway focused on instruments involving investment. Austria proposed a relatively higher proportion of instruments designed to secure attainment of the EST criteria through changes in governmental arrangements.

Box 19
Overall distribution of proposed instruments as they concerned type of effect sought (colouring of labels is for clarity only)



Some of the **interrelationships** involving assessments of the types of instrument have already been noted above. Box 15 shows the interrelationships with assessments of type of effect sought. (These can also be seen in Table 11 in Appendix A.) Fiscal instruments were associated—more than expected—with reducing impacts on the global environment and with national or sub-national responsibility. Regulatory instruments were especially associated with reducing impacts on the local environment, with moving towards EST through improved land use or regional economic arrangements, and with reducing noise. Regulatory instruments were also associated, more than expected, with international responsibility for action (to harmonise regulatory frameworks). Instruments involving investment, usually by government, were, more than expected, associated with achieving mode shifts and with local responsibility for implementation. Educational or hortatory instruments were more likely to be in use.



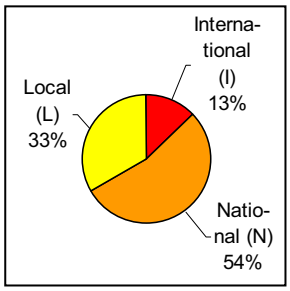
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Box 20
How the proposed use of each type of instrument varied with the type of effect sought

In terms of the **type of effect** sought, Box 14 and the summary pie chart in Box 19 show a range of focuses, with stronger emphases on specific measures to reduce global and regional or local impacts, reducing impacts by shifting modes (e.g., people to public transport or freight to rail), and making land use or economic arrangements conducive to sustainable transport.

Some teams focused on global impacts; others on local impacts

The Member country teams exhibit several differences in emphasis. Box 14 shows that The Netherlands' team focused on reducing global impacts, whereas the Swedish team put more of its emphasis on reducing regional and local impacts. The Canadian team also had some focus on regional and local impacts, but had a more evenly balanced distribution of types of effect sought than the other project teams, although with a stronger than average emphasis on changing attitudes. The Swiss team put a strong emphasis on improving environmental performance through mode shifts.

The German team emphasised making land use or economic arrangements more conducive to sustainable transport. This emphasis was distinctive and went along with relatively high concerns to reduce noise from transport.



Box 21
Overall distribution of proposed instruments as they concerned responsibility for action

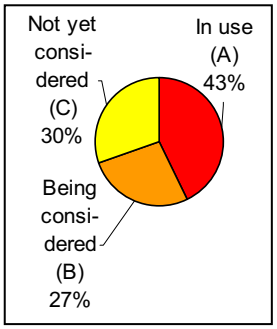
Other categories could have been used to construct the table in Box 14. They would have shown, for example, a major difference between The Netherlands' team, on the one hand, which proposed some focus on improving the performance of the transport system, and Germany, which proposed a corresponding focus on changing transport behaviour. The emphasis of the Swedish team on instruments directed towards reducing local and regional emissions can also be seen as a focus on transport system performance. (Four of the seven of these instruments concerned boats large and small.) Overall, there seemed to be just about the same amount of weight among the project teams on changing transport behaviour as on improving performance.

Box 20 indicates how the proposed use of each type of instrument varied with the type of effect sought. It shows, for example, how regulatory instruments would dominate in the reduction of local/regional impacts and noise, whereas investment would be the main focus in achieving mode shifts and more use of non-motorised transport.

Other interrelationships among the assessments of instruments involving type of effect sought, as shown in Box 15, have already been discussed. Those concerning responsibility for implementation and readiness are discussed below. The understanding of the interrelationships, particularly between type of instrument and type of effect sought, can be supplemented by reference to Table 11 in Appendix A.

Table 11, which lists all the instruments proposed by the nine project teams, shows that across the teams no one type of effect sought was dependent on one type of instrument. Moreover, no type of effect sought relied on fewer than five individual instruments. **Clearly, there are many possible paths towards attainment of EST**.

Box 22
Overall distribution of proposed instruments as they concerned readiness for implementation



Box 14 and the summary pie chart in Box 21 show that primary responsibility for implementing a clear majority of the proposed instruments would lie with national governments (or in some cases state or provincial governments), with Italy being the most extreme in this respect. The Norwegian team's instrument package provided the obvious exception; its study area was an urban region. Germany and Switzerland also saw relatively strong roles for local governments and agencies. The matter of primary responsibilities is complex because for the implementation of one instrument several levels of government may play essential and complementary roles.

The **interrelationships** involving responsibility for action and type of effect sought, illustrated in Box 15, are not quite as might be predicted. Local government responsibility was more strongly associated with improving land-use arrangements, but

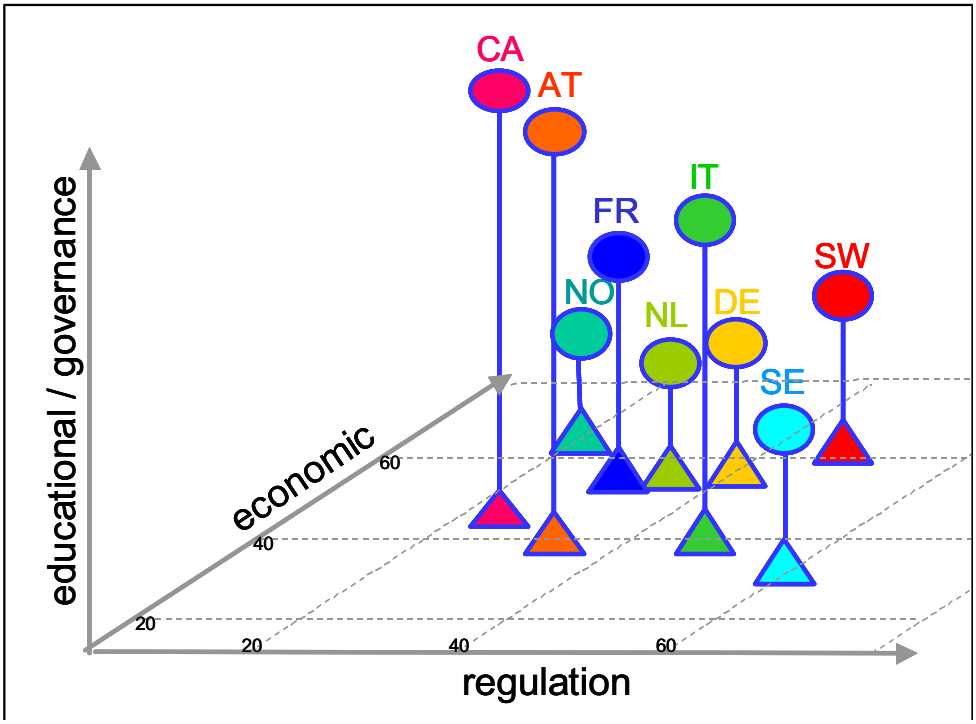
not with reducing noise. International responsibility was not strongly associated with any type of effect. National and sub-national responsibilities were especially associated with reducing global impacts, and with changing attitudes, culture or lifestyle.

Regarding **readiness for use**, Box 14 and the summary pie chart in Box 22 show that the proposed instruments were assessed as being roughly evenly divided between being in use, under consideration, and not yet under consideration. Germany relied the most on instruments in use, Canada on instruments under consideration, and The Netherlands on wholly new instruments. Within the Alpine group there were mixed levels of readiness according to political and other circumstances: e.g., Switzerland is bound by a referendum result require that 70 per cent of Alpine transit freight is to be rail-borne by 2015; Austria, France, and Italy have similar challenges but no agreed long-term goals; Italy, in particular, has little rail-based freight and thus a major task in achieving transfer to rail.

Analysis in terms of readiness

Regarding associations of readiness and type of effect sought, instruments for favouring non-motorised alternatives were more likely to be in use, instruments for minimising mot transport activity were more likely to be under consideration, and instruments for improving land use or economic arrangements were more likely to be not yet under consideration.

Box 23
Typology of principal policy instruments.
(See text for explanation of the triangles, circles, and joining lines.)



The overall strategies of the project teams are represented in Box 23, which is based on the table in Box 14. The chart in Box 23 provides a schematic representation of these strategies according to degree of reliance on economic (fiscal) instruments, on regulation, and on provision of information. The first two of these factors are shown by the positions of the triangles; the third is shown by the corresponding circle. The chart suggests that the project teams struck similar although not identical balances between economic and regulatory instruments, but perhaps differed more in their use of educational and governance instruments.

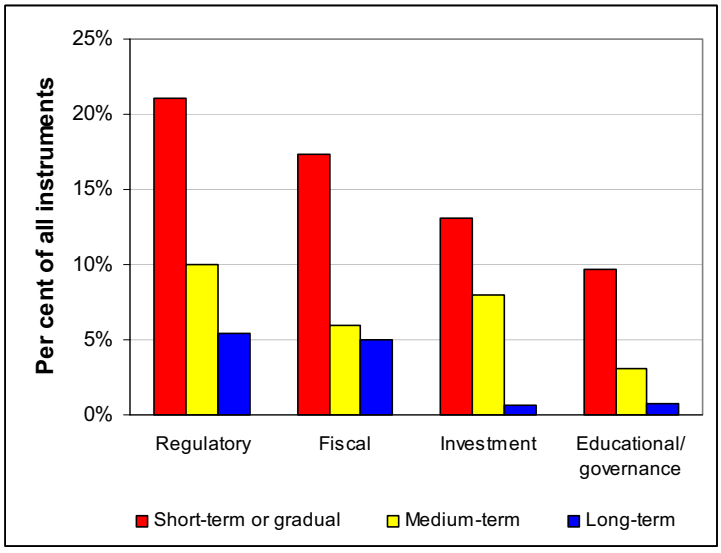
2.4. Phasing of implementation

Phasing of the instrument packages would be a key feature of the attainment of the EST scenarios. Instruments effective enough to ensure conformity with the EST criteria may be initially unpalatable. Other instruments may have to be deployed to ensure early progress and to prepare the way for stronger measures. The proposed phasing arrangements have already been summarised in Box 14. As well, the three phases of the Swedish EST program are evident at the top of Box 13.

A summary of the phasing arrangements by type of instrument appears in Box 24. As already noted in respect of Box 17, most instruments were proposed for the short-term or for gradual implementation. Box 24 shows that this applied to all types of instruments; for each, there were more short-term or gradually applied instruments, and there were also more instruments proposed for the medium than for the long term.

Box 25 allows a comparison of the phasing arrangements of the six of the Member country teams that articulated a phasing

Box 24
Phasing arrangements by type of instrument



	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40
Austria	Accep-tance	Adjust-ment	Further gradual implementation, evaluation, monitoring, and adaptation					
Canada	Investigation and testing		Application		Maintenance/preservation			
Germany	Accep-tance	Action		Evaluation and adjustment				
Netherlands	Recogni-tion	Adjust-ment	Implementation				Control	
Sweden	Accep-tance	Adjust-ment	Implementation					
Switzerland	Short term	Medium term	Long term and very long term					

▲
Box 25
The project teams' implementation phases

strategy. The period covered in Box 25 goes beyond the EST 'target' date of 2030 to show the 'control' phase envisioned by the Netherlands team. This would extend even beyond 2040. Once EST is attained, it will have to be maintained.

The importance of appropriate phasing was stressed by most of the project teams. Attainment of EST will be as much a political as a technical matter. Meeting the EST criteria will depend as much on radical changes in transport behaviour as on appropriate technological improvement in transport systems. Ready access to convenient, efficient, and affordable transportation has become almost the defining feature of progress during the past century. Sustainable transportation may involve changes and limitations that would presently be considered unacceptable, if not outrageous. The strong reasons that make attainment of EST imperative are not yet widely evident.

It is clear from the Member country teams' work that phasing involves several elements, including the following:

- Direct and indirect education as to the need for EST and for the strong measures needed to secure it.
- Gradual and progressive deployment of instruments so that adjustment to them occurs with the minimum of social and economic hardship.
- Establishment of milestones that provide targets for the application of instruments in the shorter term.
- Exploitation of technological change so as to reduce the impacts of severe instruments, in part by offering alternatives to transport of people and goods.
- Avoidance of perverse effects (such as fuel-efficiency induced increases in transport activity) that would serve to counter attainment of EST.
- Monitoring of performance and application of instruments designed to maintain transport activity consistent with EST.

2.5. Discussion of the Member country teams' strategies

The diversity and complexity of the Member country teams' strategies for attainment of EST, taken together, is impressive. As already noted, there are numerous potential paths towards attainment. In an attempt to provide some clarity as to what the project teams have proposed, Box 26 provides 20-30 words for each team that describe one or more of the salient features of the team's strategy (and also those of the CEI and Japanese projects). These capsule summaries should *not* be taken as full descriptions of the teams' strategies or even as properly representative of them.

Main differences in strategy

Of the several strategies and sub-strategies evident from the account in Sections 2.1-2.4, the major apparent difference is between the Austrian and Canadian teams and the others. These project teams—and perhaps also the other Alpine teams—did not emphasise any one or a few instruments but instead proposed using a wide range of tools for moving towards environmentally sustainable transportation. At the other extreme is the Netherlands, which put a strong although not exclusive focus on tradeable entitlement to emit carbon dioxide.

In support of a broad approach, it should be said that almost none of the instruments in current use has been well evaluated.

Box 26
Key features of the project teams' strategies and projects.

Austria (Alpine region)	Deployment of a wide range of instruments, with emphasis on regulatory and fiscal instruments, modal shift, and changes in activity patterns.
France (Alpine region)	Deployment of a wide range of instruments, with some emphasis on fiscal instruments and on minimising motor transport activity by cost or other penalties.
Italy (Alpine region)	Deployment of a wide range of instruments, with some focus on regulatory instruments, on changing attitudes, and on national implementation.
Switzerland (Alpine region)	To facilitate acceptance, instruments are confined to those in use or under discussion, to be applied more rigorously with careful calibration according to effects.
Canada (corridor)	Emphasis on deploying a wide range of instruments to reflect the wide diversity of Canada's geography and economy.
Norway (urban region)	Focus on meeting the CO_2 criterion for the most part through pricing instruments, improvement of traditional technologies, and application of supporting instruments.
Germany (whole country)	Meeting the CO_2 and noise criteria through road charging (freight vehicles), fuel taxes (passenger vehicles), and emission standards, in the context of eco-tax reform.
Netherlands (whole country)	Strong emphasis on the use of tradeable entitlements to emit CO_2, with other instruments fashioned to ensure acceptance and effectiveness of the key measure.
Sweden (whole country)	The strongest possible emphasis placed on developing a package that will be or become politically and publicly acceptable.
CEI-Region (parallel study)	Stressed the importance of maintaining modal split by targeted investment in public transport and rail-based freight transport.
Japan (parallel study)	Application of a backcasting approach and assessment of instruments that would achieve designated levels of emissions reduction.

Where there has been evaluation, it has often revealed inconsistent and sometimes perverse effects. Regulations concerning emissions and fuel economy appear to have been the most promising, but even this conclusion has been challenged.[30] The behaviour to be modified is complex and varied, and the required technological improvements present daunting challenges. Proponents of a broad approach argue that reliance on a single instrument or a few instruments could be risky.

Uncertainty may favour a broad approach

In this atmosphere of uncertainty about the effectiveness of any particular instrument, it may well be reasonable to propose using as many as possible. An emphasis on a broad range of instruments could result in more certain success than an emphasis on one or two instruments, especially unproven instruments, that may not work.

However, the problem with an emphasis on a broad range of instruments is that this is essentially what has been done over the years, without success. Many of the 374 instruments proposed by the Member country teams—brought together in Table 11 in Appendix A—have been and continue to be used. To the dismay of many policy-makers, transport activity and, in many respects, transport's impacts continue to grow. A case can be made that the instruments have not been applied with sufficient vigour, but this case must be set up against the numerous appeals from transport interests that there has been too much taxation, too much regulation, and too much protection of financially 'unproductive' modes such as rail.

The broad approach has growing appeal

Whatever the merits of the broad approach, it must be noted that it has growing appeal. One recent paper, which arises out of the Swedish work on EST, argued as follows: "… if instruments are introduced in isolation, their effect will be limited and indeed, even though an instrument can be beneficial to achieving some objectives, it may well be detrimental to attaining others. Consequently, there is a need for instruments to be introduced as part of a **package of complementary measures** that aim to meet a set of predefined objectives. The implementation needs to be undertaken as part of a broader strategy, so that instruments are implemented together in a strategic framework rather than in a piecemeal fashion."[31]

The strategies of the other teams reported on here are certainly not piecemeal. Nevertheless, their emphases on one or a few measures—albeit with adequate preparation and much ancillary 'covering off' of neglected or potentially perverse effects—must be considered contrary to prevailing views of the kind indicated above.

Extreme ends may require drastic measures

In defence of the more focused approach, it can be argued that the teams' mission has been quite extraordinary in comparison

with the usual run of transport-related objectives. Reducing CO_2 emissions by 80 per cent or more is an extreme goal—however essential it may be for EST—for which drastic measures may be necessary. Thus, the emphases on instruments that specifically address securing dramatic reductions in CO_2 emissions may well be especially appropriate. These include tradeable entitlements to emit CO_2 permits in the case of The Netherlands and, with less emphasis, most of the other Member country teams. They also include the focus of Germany and, to a lesser extent, Switzerland on CO_2 emissions standards for passenger vehicles.

Versions of these instruments are not entirely untried. Tradeable emissions entitlements (permits) are being used with apparent success for stationary sources.[32] The tradeable CO_2 permits system would in essence be a form of fuel rationing, which in less sophisticated guises has been effective in several countries during wars and in other times of shortage. CO_2 emissions standards for new vehicles are similar in effect to the CAFE standards of the U.S.. These standards may not have improved fuel efficiency as much as their proponents claim but they may have prevented declines in efficiency during the 1990s in the face of falling fuel prices.[33]

The tradeable permits scheme is adventurous and potentially effective

Of the two proposed instruments directed specifically to a targetted CO_2 reduction, the most adventurous and potentially the most effective is the tradeable permits scheme. If it works, CO_2 emissions *must* decline to the criterion level. The main challenge may be to prevent the use of forged permits. To be effective, such a system must operate within a well-defined framework with clear rules and sanctions

Seven teams included tradeable entitlements schemes

Seven of the nine Member country teams—Norway and Switzerland were the exceptions—included some kind of tradeable entitlements arrangement as part of its instruments package. Only the Netherlands team—and to a lesser extent the Swedish team—made such an arrangement the centrepiece of its strategy for attainment of EST.

By contrast, CO_2 standards for new vehicles could be implemented with perfect conformity and the CO_2 criterion could still not be met. This could happen because of growth in use, which may be insufficiently restrained by fuel taxes. It could also happen because of declines in performance with vehicle age that remain unchecked and unremedied.

No proposals were made regarding restraints on vehicle ownership.

Between them, the Member country project teams have proposed just about every known instrument for restraining transport's impacts, except one. The instrument that has not been proposed—direct restrictions on vehicle *ownership* (as opposed to use)—would hardly be worth mentioning if it were not po-

tentially the most effective instrument of all. Use appears to be more closely correlated with ownership than with any other variable. Strong evidence of this is the near constancy within countries across decades of the average distance driven annually per automobile. Other evidence—from Singapore and Tokyo, for example—suggests that restrictions on ownership may be particularly effective in restraining use.[34]

The main objection to restrictions on ownership is that they are seen to be inequitable (although logically they may be no more inequitable than restrictions on use). Restrictions on ownership are believed to be even more controversial than other instruments, which—with widely held perceptions of ownership as a right—may be an important reason why such restrictions do not appear in the teams' lists.

Ownership rates can be reduced without coercion

Directly addressing ownership need not be a matter of coercion or even controversy. One positive approach is to adopt the following as a land-use planning principle: an urban region should be developed so that in each part it is as advantageous to live without owning a car as with a car.[35] For this kind of approach, the features of places where people *chose* to live without cars could be noted and attempts could be made to reproduce these features in places where rates of car ownership are to be lowered.

Some of the instruments proposed by the Member country teams could also have the effect of reducing ownership. Several 'smart mobility' schemes including public-private transport arrangements (e.g., car-sharing, publicars), can reduce ownership while ensuring a high level of mobility.

Regionalisation of production and consumption

Other instruments were mentioned by the teams but with what may have been insufficient emphasis. An example is the regionalisation of production and consumption. At present, trade between quite distant places is advocated as healthy for economic development, but often as though the transport involved were without cost of any kind.[36] Scattered production systems involve extraordinary amounts of transport, again apparently justified in terms of transport's low cost. As the costs of transport become more apparent and rise, consumption of locally produced goods will become more popular. Early moves to regional production and consumption will reduce transport's impacts.

Interactions among instruments

A key feature in the consideration of packages and sequences of instruments is the extent to which they interact, both positively and negatively. Positive interactions have been emphasised by the Member country teams in several ways, chiefly in the sequencing of implementation. Box 13, for example, illustrates how a fuel tax could evolve into a carbon dioxide tax, which in

turn could evolve into a scheme for tradeable permits. This is a progression from the familiar to the unfamiliar, from some effectiveness to greater effectiveness. The positive interaction lies in the way in which implementation or strengthening of one instrument prepares the way for implementation of another, more effective instrument.

The German case illustrates another kind of positive interaction, simultaneous in effect rather than sequential. Fuel taxes are proposed to complement tight CO_2 emission standards; they would reduce the possibility that vehicles would be used more if they consumed less fuel.

Negative interactions among instruments need to be considered

There is less evidence in the work of the Member country teams of concern about potential negative interactions. Some of these have been detailed in a previous OECD publication.[37] Others are considered here in Chapter 1. The most obvious negative interactions concern approaches to reducing emissions through reducing congestion and thereby allowing optimum road speeds. Such approaches are considered in the cited OECD publication to be incompatible with several measures designed to reduce transport demand. These include parking control measures, improvements in public transport, installation of high-occupancy-vehicle lanes, and certain land-use planning measures. As it happened, no team has proposed measures to reduce congestion, which may mean that such negative interactions were taken into account but not discussed.

Key questions: Will the strategies be accepted and will they work?

The most important questions to be asked with regard to the project teams' strategies are, in order of importance: (1) will they be accepted? and (2) if they are accepted and implemented will they result in attainment of EST?

It is beyond the scope of this synthesis report to comment on whether the project teams' strategies will be acceptable, initially or as they unfold. The factors involved in the political and public acceptance of proposals are extraordinarily difficult to understand, even for specialists with profound knowledge of particular national circumstances and cultures. It is clear from the above accounts that almost all of the project teams give high priority to facilitating acceptance, and many give this matter the highest priority of all.

Events and trends that may encourage acceptance of otherwise unacceptable strategies

One thing should be said, nevertheless. It is that unfolding events and trends may well be such as to encourage acceptance of strategies for moving towards EST and their component instruments. Here are some of the indications:

- To the extent that international agreements help make it possible for politicians to address global environmental issues, we have the strong example of the Montreal Protocol

concerning use of substances that deplete the stratospheric ozone layer, and the less clear example of the Kyoto Protocol concerning greenhouse gases of the United Nations Framework Convention on Climate Change.

- Production of conventional oil is set to peak during the EST attainment period, i.e., the period until 2030.[38] The resulting discrepancies between demand for and supply of oil, and consequent large fuel price increases, may cause reductions in transport activity—the area of human endeavour most dependent on oil—including reductions that might otherwise be difficult to secure. As well, transport needs will likely strongly influence the energy industry, hastening development of renewable sources, for example.

- In many countries, including OECD Member countries, the overall costs of transport activity appear to be beginning to exceed the benefits, after many years in which benefits may have exceeded costs. This has been noted in Chapter 1, particularly in relation to Box 3. Costs may include the consequences of congestion, local and global pollution, and resource depletion and some of the potential social costs discussed in Chapter 1. As present transport systems become less advantageous, the kind of radical changes proposed here may well become more acceptable.

The enormous challenges in changing lifestyles

Notwithstanding these potentially auspicious events and trends, there is likely to be substantial and continuing resistance to changes towards sustainable transportation. A large majority of residents of OECD countries live in ways that depend fundamentally on present modes of movement of people and freight. They like how they live, and countless people in other countries aspire to live in the same manner. The enormous challenges to be faced in changing these ways of living—these lifestyles—should never be underestimated.

Will application of the proposed instruments result in attainment of EST?

The project teams differed in their representations of how application of the instruments would contribute to attainment of the EST criteria. Where a rationing mechanism such as a system of tradeable permits is to be deployed, attainment is a matter of setting the parameters of the system appropriately—e.g., ensuring that total available entitlements do not exceed the EST criterion—and then ensuring enforcement of the system's rules.

Quantification of potential effects of instruments

Where there is no rationing system, attainment is a matter of ensuring that the instruments are applied with sufficient intensity to achieve the required total effect. Where numerous instruments are to be applied, as in the case of the Swiss strategy, estimating the intensity may be a matter of summing the expected effects of the individual instruments, while making allowances for possible interactions.

In the Swiss case, estimated reductions in CO_2 emissions, fuel intensity or transport activity (which may amount to the same thing), were provided for five of the 32 proposed instruments. These five instruments were estimated to contribute a total reduction of 38-45 per cent (which assumed some equivalency among the transport aspects that are reduced and no perverse interactions). The remaining 27 instruments are not evaluated in terms of specific reductions. The Japanese work also involved quantification of the reductions in CO_2 emissions to be expected from application of five instruments, including changing land uses and raising the purchase price of cars. Other project teams provided a more qualitative approach. For example, the Canadian team rated each of its 36 instruments according to three- or five-point scales.[39]

Confidence in the ability of the proposed instruments to achieve the targetted reductions may be greater if each instrument is associated with a quantified reduction. On the other hand, the complexity of the potential interactions, the uncertainties about anything to do with human behaviour, and the impenetrability of even the near future all undermine any confidence that might be held in respect of precise judgements about effectiveness.

The need for careful monitoring and adjustment of instruments in the light of results

These considerations favour careful titration of the vigour with which measures are applied against their measured effectiveness. This in turn implies careful monitoring of progress towards EST. Most of the project teams' strategies provide for these necessary features. General strategies are outlined in terms of instruments to be used, and the sequence of their application, with details to be decided as the strategies unfold.

2.6. Conclusions from the work on instruments

This section sets out some of the important points that arise from consideration of the reported work of the project teams during the part of Phase 3 of the EST project concerned with the development of packages of instruments for achieving EST. These 14 summary points are followed by a preliminary general conclusion.

The challenge has been met

1. All nine Member country teams have met the challenge of devising instrument packages that can secure attainment of EST. None of the reporting teams has claimed that attainment of EST is impossible or impracticable. However, the teams noted several important requirements for success, including: (i) the pace of technological progress must increase (see Box 12 on the penetration of technology into the vehicle stock); (ii) mobility patterns must change radically (see

Box 8); (iii) international economic structures must change; and (iv) there must be changes in other sectors, notably energy, agriculture, and international trade.

Eclectic approach

2. The strongest note of scepticism came from the German team, which has questioned whether the pace of technological change will be fast enough for a sufficient contribution to be made by technology (again, see Box 12). The team suggested that the proposed attainment date, 2030, may as a consequence have to be moved back. The Swedish team also spoke to a later attainment date for stringent reductions in CO_2 emissions. The Norwegian team cautioned that replacement of traditional automotive technologies with electric vehicles will be required if the CO_2 criterion is to be met fully, as did the Austrian team.

Scepticism about the pace of technological change

3. The Member country teams have developed instrument packages of considerable diversity. Their common feature is that the scope and stringency of the proposed instruments is far beyond what is currently deployed. This is to be expected if the dramatic changes required for conformity with the EST criteria are to be achieved.

Considerable diversity of approach

4. Several project teams rely ultimately on sophisticated systems of rationing involving tradeable entitlements to emit carbon dioxide from motorised vehicles. If appropriately applied and properly enforced, such systems will by their nature result in attainment of the most intractable criterion, that for CO_2. These teams have devised complex systems of phasing of other instruments designed to make it possible to ensure acceptance of the radical rationing arrangements.

Sophisticated rationing schemes (tradeable entitlements)

5. The Canadian team has also proposed use of a tradeable permit scheme, but as one of an array of measures that could be employed in moving towards an environmentally sustainable scenario. The Canadian team's approach is in this respect perhaps more eclectic than most of the other Member country teams. The Austrian team's instrument package was also notable for its breadth.

6. The Norwegian and Swiss teams have developed packages that do not involve rationing schemes, and the strategy of the German team invokes rationing only in respect to aviation. Their strategies thus beg the question as to whether the various measures involved could ever be adequate in securing conformity with the EST criteria.

Effectiveness of non-rationing schemes

7. Two major questions raised by this assessment of the teams' packages are thus whether or not to invoke rationing and whether or not to lay out a detailed implementation strategy in advance, including intermediate targets.

Needed detail of implementation strategy

8. An overriding concern in the implementation of the instru-

Acceptability of instrument packages

ment strategies is their political and public acceptability. This is closely linked to how the most stringent and potentially most unpopular instruments are phased in. Almost all of the teams have proposed complex phasing arrangements to facilitate acceptance. The strategy of the Swedish team appears to place the most emphasis on this aspect of implementation.

More focus on the movement of people than on freight

9. The largest number of proposed instruments concern the movement of people. This reflects the greater contributions to unsustainability of this type of transport when compared with the movement of freight. (However, it should be noted that freight transport activity grows at a higher rate, and thus provides the prospect of growing impacts.)

Most instruments are for early implementation

10. The largest number of instruments are for implementation in the short term, i.e., before 2005, rather than in the medium, long or very long terms, or gradually over the whole of the implementation period until 2030. Early action towards attainment of sustainable transportation appears to be imperative.

More focus on regulatory than fiscal instruments

11. The largest number of proposed instruments are regulatory in nature, with the greater dependence of the Canadian and Norwegian teams on fiscal instruments being the clear exceptions. Overall, regulatory instruments were more associated with reducing local and regional impacts. Fiscal instruments comprise the second largest group (often associated with addressing global impacts), followed by instruments involving capital investment, usually by governments.

Emphasis on achieving mode shifts and use of non-motorised modes

12. Types of effect receiving the most emphasis across the project teams were those that would achieve mode shifts (e.g., from car to public transport and from road to rail freight), and those that would favour use of non-motorised alternatives. There was some emphasis too on addressing global and local environmental impacts directly, and on instruments designed to improve environmental performance by achieving changes in land use or local economic arrangements.

More focus on national or subnational rather than local or international responsibility

13. Overall, national or sub-national responsibility for implementation was emphasised, rather than local or international responsibility. However, local responsibility was especially associated with instruments concerning the movement of people.

No instrument directed towards reducing car ownership

14. Also of interest was what was *not* included in the instrument packages. The most conspicuous omission may concern instruments for fdrectly reducing car ownership, which none of the project teams proposed.

The most **general conclusion** that can be made at this time is the following:

EST could be attainable, although only with a concerted commitment involving many sectors of society. Member country teams of experts working on how this can be done have developed a wide range of strategies for moving towards EST, involving promotion of relevant technology and innovative means of mobility management, as well as information, communication, and awareness raising. The most important challenges lie in the acceptability of the strategies and their component instruments rather than in the effectiveness of the instruments themselves. Issues of acceptability are best addressed by careful phasing of the application of instruments across the whole implementation period until 2030. Issues of effectiveness are best addressed by careful monitoring of the effects of instruments and appropriate adjustment of the vigour of their implementation.

3. Economic and social implications of EST

This chapter summarises the results of the analyses of economic and social impacts conducted in the course of Phase 3 of the EST project and draws conclusions from the analyses.

The assessments of economic and social implications were preliminary and cursory

At the outset, it should be stressed that the assessments of economic and social implications conducted during the EST project were preliminary and cursory. They were conducted because it was unthinkable that there should be no consideration of these matters. More substantial analyses were not conducted at this time for several reasons, including the following:

- Within the EST project, they would have distracted from the focus on *environmentally* sustainable transport by competing for limited resources. It is useful to consider sustainability as having environmental, economic, and social components. Ultimately, however, the environmental component must prevail, for environmental factors provide the limiting conditions for other activity.[40]

There are no accepted methods of assessment of distant scenarios

- There are no accepted methods for social and economic assessment of distant scenarios. Indeed, there is some reluctance among economists and social scientists to engage in this kind of work because of the methodological perils. Commitment to full-scale assessments of EST's economic and social implications would have been premature and potentially costly.

With these cautions in mind, it was nevertheless considered important to have some assessment at this time for several reasons. The most important one was that such assessment would address questions such as those raised frequently during Phase 2, when the scenarios were being constructed. The EST1 scenarios were not proceeded with because the Member country teams felt they would be too expensive (although this was not examined in detail); the EST2 scenarios were not proceeded with because it was felt they would involve too much coercion. The EST3 scenarios were seen as less expensive and less coercive, but how much less? And what of the BAU scenarios? Were they expensive and coercive?

Expected outcome of the assessments

Two important outcomes were expected of the assessments of

economic and social implications. One was that they would inform the identification of instrument packages in constructive ways. The other was that they would help with the presentation of the results of the EST project by rounding out the characterisations of EST and the strategies required to reach it.

As well, it was expected that the assessments would provide useful preliminary results of independent value. More important, they would help with the design of more substantial assessments of the economic and social implications of changing historic transport trends and moving towards EST.

Consultants were engaged to help with developing methods for the preliminary assessments of economic and social implications. Their methods and results were discussed and generally endorsed at workshop on "Economic and Social Implications of Sustainable Transport" held in Ottawa, Canada, in October 1998. The consultants' reports appear as appendices to the workshop proceedings.[41]

3.1. Assessment of economic implications

A consultant (Professor Werner Rothengatter) was engaged to provide assistance with comparing the implications of the BAU and EST scenarios and their attainment, and more specifically with answering expanded versions of the following questions:

Questions concerning economic implications

1. In what ways would the economy be different if the EST scenario were attained rather than the BAU scenario?
2. What would be the relative economic costs and benefits of the two scenarios for individuals and households, for businesses of all sizes, and for local, regional, and national governments?
3. How would macroeconomic indicators, notably employment levels, differ between the BAU and EST scenarios?
4. In economic terms, who would be the winners and who would be losers if the EST rather than the BAU scenario were attained, particularly in terms of age groups, income groups, and geographic regions?

The consultant advised that the questions were mostly unanswerable in quantitative terms within the time available. Moreover, the complexity and uncertainty inherent in a prospective study such as the EST project point to the use of qualitative methods.

Three potential approaches

There are basically three methods of providing qualitative analysis of the scenarios, the consultant continued. They are: (i)

classical methods including private rate of return, cost-benefit analysis, cost-efficiency analysis, and multi-criteria analysis; (ii) system dynamics modelling (SDM); and (iii) simple cybernetic modelling (SCM)—also referred to as the "paper computer" method (it involved spreadsheet calculations).

Use of a simple cybernetic model (SCM) recommended for the assessment

The consultant rejected the classical methods on the grounds that they require detailed information about a specific point in time, information that cannot be provided about the BAU and EST scenarios over the entire period up to 2030. SDM could provide a sophisticated response to the matters posed, but SCM may be more appropriate for the present task in view of the time and resources available. Of the three types of method, he thus recommended the SCM approach. He added that a more refined analysis could be provided using the SDM, which would require use of an appropriate software package.

The Impact Path Analysis (IPA) approach

Some Member country teams (Canada, Norway, The Netherlands, Sweden) opted for the SCM approach. The consultant provided a framework for using this approach, which he named Impact Path Analysis (IPA). IPA has two stages.

In Stage 1, six evaluation sheets are used to assess respectively the application of each of several types of instrument at the micro-economic level (transport technology, transport behaviour, transport supply, transport demand, and affected markets), and at the macroeconomic level (aggregate economic indicators).

Stage 2 concerned identification and assessment of the interactions among the effects of the instruments by means of a matrix prepared for this exercise. It was agreed that quantification based on this method should extend only until 2015 or 2020, and that qualitative methods should apply to the remaining years until 2030.

Austria and Norway used their own macroeconomic models. France provided a qualitative assessment translating macroeconomic conditions into household and business situations. The German project team opted to use the SDM approach—as well as the IPA approach—in a way that would produce results comparable with those of the other project teams.

What follows is an extremely brief account of the results of these analyses. For more details, reference should be made to the summary in Appendix B and also to the individual case studies in Volume II of this report.

Austrian team's results

The **Austrian team** used what it described as the Computable General Equilibrium analysis—an analysis in the spirit of OECD's GREEN model—to develop the following results for

2015: The annual rate of growth of real GDP would be about 0.1 per cent lower if the EST scenario rather than the BAU scenario were to prevail. However, the unemployment rate would also be lower, at 5.8 to 5.9 per cent, according to the assumptions used, rather than an anticipated 6.4 per cent under the BAU scenario. The lower GDP is attributed at least in part to the inadequacy of this indicator with respect to external effects, particularly environmental costs. EST would be associated with more local production and with more vertical integration of business activities. There will be economic winners and losers, especially during the transition period. The Austrian team cautions that it will be of crucial importance to enable people to see what is advantageous for them individually.

Canadian team's results

The **Canadian** team used two quite different approaches to assess economic impacts. The first involved a variant of the IPA approach. The results gained from this approach demonstrated that gross industry output in the two provinces spanned by the Quebec-Windsor Corridor would be lower under the EST scenario than the BAU scenario, a decrease of 0.4 per cent for the year 2030. The analysis identified many winners and losers among the transportation industries.

Recognising the uncertainties of assessing the economic impact of EST, the project team used a second approach involving the Surplus Value Model (SVM). This approach is based on the principles of cost-benefit analysis and involves estimating how demand and supply curves of various sectors would shift under EST. The results of the SVM approach suggested a net impact of EST compared with BAU of between -3.9 and -5.3 per cent of GDP for the two provinces in 2030, a much larger impact than was estimated using the variant of the IPA approach. This approach did not take into account the environmental benefits of achieving EST, which could have reduced the net cost.

An important caveat is that both approaches had significant limitations and made use of debatable assumptions. Nevertheless, the IPA and SVM approaches were considered to be worthy preliminary attempts at exploring the economic impacts of BAU and EST.

German team's results

The **German team** assessed economic implications using both the SDM and IPA methods. The SDM method indicated small changes in all indicators. Changes by 2030 in consumption, investment, and final demand were estimated to be +1.1, +1.3, and -0.8 per cent, respectively, with a loss by 2030 of 335,000 jobs, all compared with the BAU estimate. A second SDM analysis was conducted, loosening the timeframe to meet the CO_2 reduction target. This analysis assumed that by 2030 CO_2 emissions from transport are to be reduced by 50 per cent compared to 1990. The results for all indicators (except export)

were positive in this case. Changes by 2030 in consumption, investment, and final demand were estimated to be +2.8, +0.5 and +0.6 per cent, with a gain of 335,000 jobs, all compared with the BAU estimate.

For reference, the results of the second SDM analysis *for 2015* were compared with those of an analysis for the same year using the IPA method. The differences between the EST and BAU scenarios were found to be smaller using the more sophisticated SDM approach. In the IPA analysis, structural changes and dynamic developments are not considered, and more weight is given to the negative influences of higher prices and restrictions in the demand side. The SDM analysis takes account of positive stimulation of market forces by environmental policy, leading to an increase in productivity. In the long run, the productivity gain and the associated stimulation of production may more than offset the initial reduction of demand.

The following conclusions were drawn from the German results: Sectoral restructuring of the economy will be necessary. There will be winner sectors (services sectors above all) and loser sectors (car manufacturers). There will be sectoral and regional unemployment at the beginning of the process, but within levels usually experienced as a result of restructuring. Governments can reduce adverse effects and support restructuring. EST policy could result in positive effects on employment and economic growth if restrictions on transport activity are well balanced with stimulation of technological progress. This is more likely to occur if the process of change is slightly slower than that implied by the EST scenario, specifically the requirement for an 80-per-cent reduction in CO_2 emissions by 2030.

Netherlands team's results

The **Netherlands team** conducted an IPA analysis involving two EST variants: in one, there were no changes in the structure of the economy; in the other, more realistic variant, the economy adjusted dynamically to take advantage of such matters as productive investment of revenue from ecology taxes. With both variants, there were estimated to be reductions in GDP and employment: the average yearly GDP growth in the EST scenario will be a few tenths of one percentage point lower than that in the BAU scenario; the employment level will be a few percentage points lower. For each indicator, the decline was less for the variant in which changes in the structure of the economy were taken into account. The Netherlands' team concluded that the total loss of material welfare for 2030 can be largely—but probably not fully—compensated for by gains in non-material welfare (i.e., reductions in external costs).

Norwegian team's results

The **Norwegian team** conducted its own economic analysis as an integral part of the application of the models of transport

activity in the Oslo region. The results appear to be mixed, according to the extent of replacement of traditional automotive technologies. As already noted, the Norwegian team considered complete replacement by electric vehicles essential for full attainment of EST within the Oslo region. If this happens, there could be an increase in GDP under EST compared with BAU.

Swedish team's results

The **Swedish team** used the IPA approach and concluded that for the year 2026 there would be a very slight increase in GDP for EST as opposed to BAU, and a very slight decrease in employment. Notable in the analysis is an *increase* in the value-added for the road passenger vehicle industry. This arises on account of an estimated shortening in average vehicle longevity from 16 to 9 years, the result of incentives to retire older vehicles.

Alpentree family

The **Austrian, French, Italian, and Swiss teams** collaborated in development of "The Story of the Alpentree family", a characterisation of the "economic and social world in EST". This device is used to illustrate numerous aspects of the household economics of life under EST with details as to prices, economic choices, and related matters.

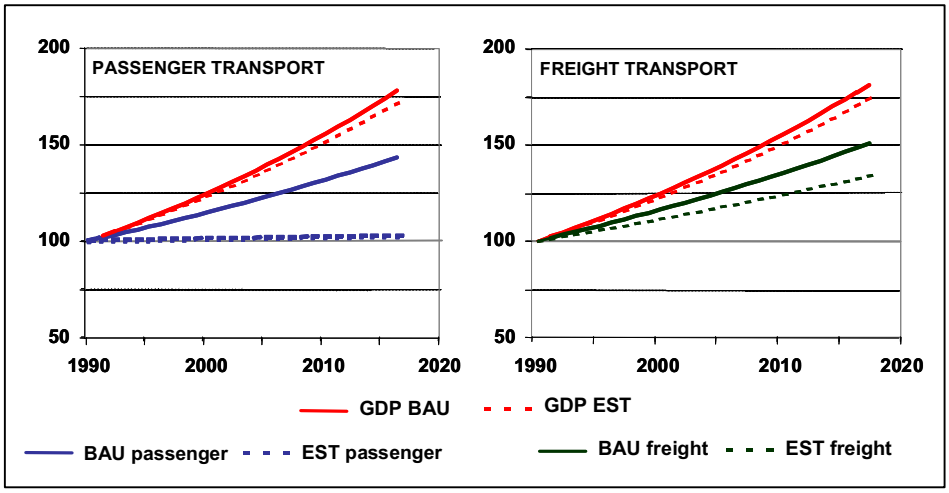
The economic and social world of the Alpentree family included massive reorganization of the motor-vehicle industry to accommodate widespread use of hybrid electric propulsion systems, integrated mobility services and public transport, a new rail network for freight, and new rules for car drivers designed to improve road safety. These factors increased economic activity in the transport sector as a whole, but with a major shift to rail, public transport, cycling, and walking.

Conclusion from the analyses of economic impacts

The conclusion to be drawn from this cursory overview of what in many cases are still very preliminary results is that the overall economic effects on the Member country's economies as a result of proceeding towards EST rather than BAU would be slight. On average across the countries, annual GDP would hardly change (although with some variability among the results). Employment rates may either increase or decrease depending on the country's situation and policies.

A more thorough overview of the project teams' work on economic impacts appears in Part 1 of Appendix B (beginning on Page 129). It is summarised in Figure 1 of Part I this Appendix, which for convenience is reproduced here as Box 27.

Box 27 shows that the overall change in GDP under the EST scenarios would be slight compared with BAU in terms of both total growth and annual growth rates. On average across the various analyses, the annual rate of growth in GDP under EST is only one tenth of a percentage point than under BAU. Overall



between 1990 and 2020, GDP would increase by 95 per cent under BAU and by 86 per cent under EST. Note too that Box 27 speaks to substantial *decoupling* of GDP from transport activity, more in the case of passenger than freight transport.

▲ Box 27 Economic and transport activity trends under the EST and BAU scenarios

To the extent that these conclusions are sustained through further work on the economic implications, it would seem necessary in moving towards EST to take corrective action with respect to employment. How this might be done is beyond the scope of the present analysis. What is already clear, nevertheless, is that new mobility services could require more people than conventional systems.

Because the anticipated reductions in employment are slight, effective corrective action would seem a feasible proposition. One suggestion—in the Austrian work—is for the economic arrangements for EST to include some redistribution of transport tax revenues to households (e.g., an 'eco-bonus'). The results from Germany's SDM work also point to the need to redistribute tax revenue, in order to foster development of alternative transport systems and modes.

3.2. Estimation of external costs

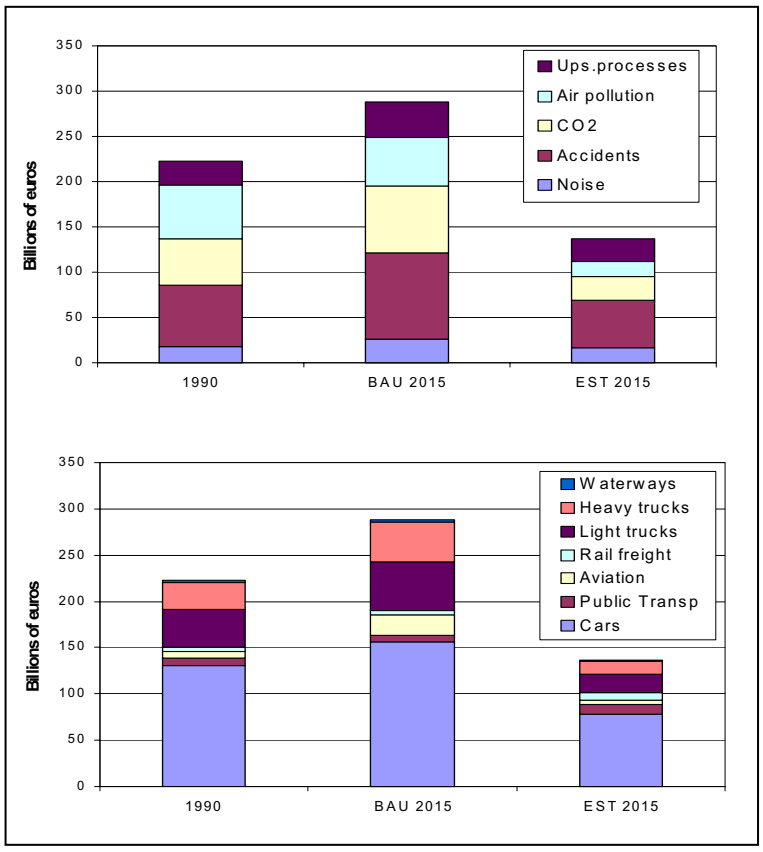
To supplement the work done by the project teams on the economic implications of the EST and BAU scenarios, an estimation of the external costs of these scenarios was conducted by the OECD Secretariat. It made use of the methods employed in a recent major assessment of the external costs of transport in Europe.[42] The estimates were based on transport activity data and projections aggregated from the work of the project teams, as detailed in Appendix B. The results are summarised in Figure 4 in Part III of Appendix B, reproduced for convenience here as Box 28.

External costs are paid by society rather than by the source of the costs

The *external costs* of an economic activity are costs paid by society or by other individuals rather than by the actor. They are thus presumed not to be a factor contributing to the activity. For the estimates represented in Box 28, monetary values were assigned to the societal impacts of noise, air pollution, climate change, and accidents arising from transport activity. Monetary values were also assigned to transport's 'upstream processes', chiefly the production and distribution of vehicles, fuels, and infrastructure.

The upper and lower panels of Box 28 show the estimates of the external costs in 1990 of transport activity in the geographic areas studied by participants in the EST project. They also show estimates for the BAU and EST scenarios for 2015. In the upper panel, the costs are broken down by type of impact. In the lower panel, they are broken down by transport mode.

Considering the estimated increases in external costs between 1990 and the BAU scenario, climate change was estimated to make the largest contribution among the types of impact, both absolutely and relatively, to the increases in external costs in respect of the BAU scenario. Cars were estimated to contribute the largest absolute increase in costs among transport modes, but the costs of aviation (particularly) and light and heavy trucks increased proportionately more.



Box 28
Estimates of the external costs in billions of euros incurred by transport in the EST study areas for 1990 and for two 2015 scenarios, broken down by type of impact (upper panel) and by mode (lower panel).

Total external costs, excluding congestion costs, were 223 billion euros in 1990, increasing to 288 billion euros under the BAU 2015 scenario and decreasing to 137 billion euros under the EST 2015 scenario. Total external costs for the six study areas represented approximately six per cent of total GDP, in 1990 and would represent 4 per cent of total GDP in BAU 2015. However, they would represent 2 per cent of GDP in EST 2015. This assumes an expected more-than-80-per-cent growth in GDP for the period 1990 to 2015. The external costs of accidents are important in all three scenarios, because overall transport activity increases in both BAU and EST scenarios. In all three cases, road transport accounts for the highest portion of external costs.

In the base year 1990, accidents are the most important cost category, particularly accidents involving cars, contributing 30 per cent of total costs. The next most important cost categories are air pollution (27 per cent) and climate change (23 per cent). Under the BAU scenario, accidents are also the most important costs category, representing 33 per cent of the total costs, followed by climate change (26 per cent) and air pollution (18 per cent).

Under the EST scenario, accidents are the most important cost category, representing 38 per cent of the total costs, followed by upstream processes (18 per cent), climate change (20 per cent), and air pollution (12 per cent). The sharp reductions in the latter two categories of cost reflect the stringent EST criteria.

Overall conclusion from the analysis of external costs

The overall conclusion from the estimation is that for the BAU scenario, the external costs of transport activity in 2015 will be 30 per cent higher than in 1990. For the EST scenario, these costs will be 39 per cent lower in 2015 than in 1990.

The results of the assessment of the external costs of transport in 1990 and for the BAU and EST in 2015 scenarios supplement the analyses of economic implications **The results reinforce conclusions that EST would constitute a net benefit for the environment and for quality of life in general.** More important, it follows from the estimated reduction in costs associated with the EST scenario that some public costs could be significantly lower with the implementation of EST. The net benefit could be transferred to key areas of the economy including consumption, saving, and investment. Overall, this reduction in externalities could lead to a significant improvement in social well-being.

3.3. Assessment of social implications

A consultant (Professor John Adams) was engaged to provide

assistance with comparing the implications of the BAU and EST scenarios and their attainment, and more specifically with answering expanded versions of the following questions:

Questions concerning social implications

1. In what ways would the social fabric be different if the EST scenario were attained rather than the BAU scenario, both from an individual and from a societal perspective?
2. What would be the relative social costs and benefits of the two scenarios for individuals and households, for businesses of all sizes, and for local, regional, and national governments? Among social factors to be considered are family cohesion, democratic activity, social polarisation, alienation, criminal activity, and lifestyle.

Social factors considered

3. In general, would people experience more freedom (or have more freedom) under the BAU scenario or the EST scenario?

The consultant developed a set of 16 pairs of propositions, one of each pair applying to the BAU scenario and the other to the EST scenario. Supporting data, drawn mostly from U.K. experience, were provided for each proposition. Member country teams used expert advice to provide indications of agreement or disagreement with the propositions from their national perspectives. The pairs of propositions (in abbreviated form) and the responses to them are provided in the table in Box 29.

Results of the work on social implications.

The shaded propositions in Box 29 are the 15 for which there was substantial agreement among participating Member country teams.[43] In the case of four topics, there was agreement with both the BAU and the EST propositions. For these four, the topic is shaded in Box 29. For seven of the remaining 12 pairs, there was agreement with one proposition and not with the other.

The four instances of agreement with both propositions of a pair can be summarised as agreement with the following:

- Land use: With BAU, sprawl will continue, increasing society's dependence on the car, and increasing the disadvantage of those without cars. With EST, land-use patterns will be more 'disciplined', and transport policies will promote equity of access for those with and without cars.
- Street life: The greater amount of traffic associated with BAU will undermine street life, whereas the lesser amount associated with EST will promote street life.
- Communities: Society will become more anonymous with BAU; fewer people will know their neighbours. With EST, more time will be spent in neighbourhoods, thereby promoting conviviality.

- Children: The main losers with BAU will be children; their independent mobility will be much constrained. They will be the principal winners with EST, the safer environment permitting greater independence.

Conclusions from the work on social implications

It could thus be concluded from this assessment of social implications that continuation of BAU will result in growing social disparity and alienation, less street life, more anonymity, and more car dependence, resulting in loss of independent mobility for many, especially children. With movement towards EST, on the other hand, life would become more egalitarian, convivial, and child-friendly, at least in comparison with BAU.

It would be inappropriate to attach much weight to this conclusion, except to note that in general terms the project teams collectively considered that social conditions will worsen with BAU and that they will be more benign with EST, certainly more benign than with BAU and perhaps more than now.

This first attempt at exploring the social implications of EST indicates topics for further consideration and suggests methods for addressing the potential social implications of future scenarios with more rigour.

Box 29
Summary of responses of the questionnaire concerning social implications of BAU and EST.

TOPIC	BAU PROPOSITION	A/R†	EST PROPOSITION	A/R†
Social polarisation	Disparities between the rich and poor in terms of access to social and economic opportunities will grow larger.	7/7	Disparities between the rich and poor in terms of access to social and economic opportunities will diminish.	4/4
Car dependence	The rate of increase of car dependence will be greatest in the poorest countries.	4/4	If OECD leads by example the prospect of dissuading poor countries from following OECD's unsustainable example is much improved.	6/6
Land use	Land-use sprawl will continue, increasing society's dependence on the car, and increasing the disadvantage of those without cars.	6/6	Land-use patterns will be more "disciplined", and transport policies will promote equity of access for those with and without cars.	7/7
Street life	More traffic undermines street life.	8/8	Less traffic promotes street life.	8/8
Communities	Society becomes more anonymous, fewer people know their neighbours	8/8	More time spent in neighbourhood promotes conviviality.	8/8
Children	Children are the principal losers under BAU, their independent mobility being much constrained	8/8	Children are the principal winners under EST, the safer environment permitting greater independence.	6/8
Telecommu-nications	Increasing electronic mobility will promote further dispersal and encour-age more travel.	4/4	Increasing electronic mobility a two-edged sword; it has the potential to promote or destroy community life.	5/5
Uniformity	The world becomes everywhere more the same culturally—the Hilton-McCulture effect.	7/7	Cultural diversity is preserved by restraints on cross-cultural contact.	1/5
Safety	Life becomes more dangerous for pedestrians and cyclists, especially children and the elderly.	2/6	Life becomes safer for pedestrians and cyclists, especially children and the elderly.	7/7
Health	Health deteriorates from lack of exercise.	4/6	Life becomes healthier as exercise is incorporated into daily regime.	7/7
Nutrition	Those without cars find access to healthy food increasingly difficult.	5/6	The poor gain better access to healthy food.	1/5
Crime	The threat of crime increases.	3/4	The threat of crime decreases.	2/3
Law enforcement	Numbers of strangers increase, society becomes more paranoid, and law enforcement become Orwellian.	1/4	Societies in which people know their neighbours are mostly self-policing.	5/6
Equality	Access will be rationed by fiat and price, increasingly discriminating against the poor.	4/5	Equitable demand management is assumed, detail of how it will be achieved remains unclear.	2/3
Participation	The scale of government will increase, diminishing the significance of the individual voter.	4/4	Community politics will be revived.	2/2
Democracy	Democracy under threat.	0/3	Democracy under threat.	0/1

† A/R indicates Agreement Ratio (number of Member country responses in agreement with the proposition/total number of definite responses to the proposition). A proposition is shaded if three quarters of the responses were definite and three quarters of definite responses were in agreement or three quarters of definite responses were in disagreement. All instances here are of agreement; no dis-agreements with a proposition met the criterion. Where there is agreement with both of a pair of corresponding propositions for BAU and EST3, the cell in the "topic" column is also shaded.

4. Barriers to attainment and gaps in knowledge

This chapter first sets out some of the barriers to attainment of EST identified by Member country teams during the course of the project. It also draws on presentations and discussions in connection with the associated OECD conference on Sustainable Transportation, held in Vancouver in March 1996.[44] The barriers are described here in terms of individual barriers, societal barriers, and technological barriers. The distinctions among the three types of barrier, particularly between the first two, can be somewhat arbitrary.

A subsequent section of the chapter concerns gaps in knowledge. This section to a degree recapitulates material in the three sections on barriers in that lack of knowledge about individual, societal, and technological factors is itself a major barrier to attainment of EST.

A final section provides some conclusions about barriers to attainment of EST and relevant gaps in knowledge.

4.1. Individual barriers to attainment of EST

This section is concerned with how human nature and people's perceptions can impede changes towards sustainable practices in transport activity. Nine general types of barrier have been identified:

Nine types of individual barrier

- Lack of awareness of the need for change
- Cognitive dissonance
- Lack of concern for future generations
- Fear of change, and thus resistance to change
- Attractiveness of present transport modes
- Absence of transport alternatives
- Resistance to collective alternatives
- Car ownership

- Lack of adequate professional advice

These types of barrier are discussed in turn in the next several paragraphs, together with initial consideration of what might be required to overcome the barriers.

Lack of awareness of the need for change as a barrier

For individual behaviour to change without outside direction, or for individuals to accept and even support political and other action that could result in change, **there has to be individual awareness of the need for change**. Across OECD Member countries, there is a relatively high level of awareness of the local and regional impacts of transport. There is a lower level of awareness of transport's global impacts because the links between individual actions and decisions, on the one hand, and global effects, on the other hand, are not so evident; but awareness of transport's global impacts is growing. The main local and regional concerns are noise and air pollution, with concern about noise being possibly stronger in Europe and concern about air pollution being possibly stronger in North America.

A finding of the present project is that criteria for local and regional impacts on air quality—concerning NO_x, VOCs, and particulates—are met when the criterion concerning a global impact, i.e., CO_2 is met. The reverse is not always true. 'End-of-pipe' reduction of local and regional emissions—using catalytic converters and particulate traps—can increase CO_2 emissions, and also emissions of nitrous oxide (N_2O), another greenhouse gas.[45] However, reducing local and regional emissions in ways that reduce fuel consumption—by reducing transport activity or fuel intensity—will at the same time reduce globally acting emissions, possibly enough to meet the CO_2 criterion.

Thus, the higher level of concern about local and regional air pollution can be used to help meet the global criterion, provided the response to the concern is to reduce fuel use. However, the strategy implied in this approach is a weak substitute for the important task of raising general awareness of global environmental concerns and their relation to transport. Much public education is required, including both formal processes in educational institutions and less well structured processes involving campaigns through television, newspapers, and other media.

Cognitive dissonance as a barrier

Education is rarely easy. It may well fail in its intent and even produce an opposite effect on account of the phenomenon of **cognitive dissonance**. When people learn about the adverse consequences of using their cars, they may be as likely to minimise the consequences as they are to use their cars less.[46] Both outcomes are adaptive in that they reduce the dissonance between behaviour and result, but the former outcome is perverse in that it is the opposite to what was intended as the result of the educational programme.

Lack of concern for future generations as a barrier

Awareness of the need for change is only a first step; actual change is far from being an inevitable sequel to awareness. A barrier to action—even though there may be awareness of the need for change—can be the timescale of global effects and a **disposition to disregard the welfare of future generations**. The severe consequences of increased atmospheric CO_2 concentrations may not be felt for decades, and thus they may not appear relevant to the more immediate concerns that characterise everyday existence. Contemporary 'Western' culture may elevate immediate preoccupations over concern for the welfare of descendants.[47]

Changing a culture of immediacy would be a major undertaking, but it may be possible to bridge the present and the future by emphasising the shorter-term effects of climate change. The apparent growing instability of climate may be one such feature. Another way of bridging present and future would be to put emphasis on bringing forward the costs of change into present investments. For example, building codes that accommodate potential climate change could result in present signals about global impacts in the form of more expensive homes and other structures. Businesses that depend on certainty, such as insurance companies, could play a major role in public education about the need for greater concern about the future.[48]

Fear of change as a barrier

Another individual barrier to take account of is understandable **fear of change**, and the resulting resistance to change. 'Change' has become something of a watchword of contemporary politicians, but they can be frustrated by a citizenry intent on the maintaining familiar things and familiar ways in the face of convulsions in telecommunications, global trade, and other contemporary transformations.[49] Some people thrive on diversity of experience or on the unexpected, but a more common response is to seek what is familiar and resist other than small doses of novelty. Sustainable transportation will involve much that is new. It will likely be attained successfully only if progress towards it is gradual enough for most people to remain comfortable, and if the strategies are attractive enough to facilitate change.

Attractiveness of present modes as a barrier

Another barrier is the **attractiveness of present transport modes**. The car-based life can be extraordinarily rewarding. Those who live it travel with comfort, convenience, and privacy unknown in times past even to royalty. Provision of society-wide personal transportation has been an remarkable accomplishment that is for the most part highly appreciated. The evident problems of mass motorisation—notably road congestion, land take, and habitat destruction—can appear trivial in comparison with the apparent benefits. Modern aviation is similarly appreciated; it enables large numbers of people to traverse great

distances with ease and comfort that could hardly be imagined even a century ago.

Relinquishing what are now regarded as the commonplace benefits of aviation and personal vehicle ownership, however extraordinary they may have once seemed, could be considered to be as unthinkable as dispensing with the written word or other such products of human ingenuity.

The special attractiveness of the private car as a barrier

The only painless way of breaching this barrier may be to provide even better—and sustainable—alternatives. A special challenge in this respect lies in **the many functions of the private car**, which may be owned as much for its ability to carry shopping, luggage, infants' requirements, sports equipment, and other items as to move people from place to place. Well-managed local freight and delivery services could ensure that these things are transported. But however excellent such services may be, and however well integrated with good public transport, the combination is unlikely to surpass the private car in overall convenience and general utility.

Absence of transport alternatives as a barrier

Even where there is willingness or where it would be expedient to change transport behaviour, the **absence of transport alternatives** can be a barrier to change. Notable instances of this barrier occur in suburban developments where essential journeys are too long for a walk or bicycle ride and there is no public transport, in part because suburban densities are too low to allow adequate public transport to be financially viable in the face of competition from the private automobile. Moreover, inter-modal links are often missing, meaning that cars are used for complete journeys when they could be used for only parts of the journeys. The convenience and low cost of air travel has led to the demise of travel by sea and, in many places, rail, leaving travellers who prefer not to be airborne without alternatives.

The solution is to restore or otherwise provide more sustainable alternatives. This can be a costly business if it necessitates major investment and insufficient revenue. Such solutions require restrictions on or disincentives for the use of present modes (car or aircraft) to ensure use of the alternatives and provide sufficient revenue for their operation. Regulatory restrictions on present modes may be preferred; fiscal restrictions may result in dependence on the resulting revenue and a consequent disposition to ensure more continuing use of the revenue-producing modes than may be desirable in terms of sustainability objectives.

Resistance to collective alternatives as a barrier

Yet another barrier, related to the foregoing two, is **resistance to collective alternatives**. Comfort and privacy are rarely available in public transport systems, and there can be fears of harassment. Moreover, some cultures may foster individual over

collective solutions to societal challenges and thereby creating dispositions to favour personal transport even when it could otherwise be less attractive than public transport. In some places, there is outright prejudice against collective alternatives, as may be exemplified in the North American characterisation of buses as 'loser-cruisers'.

Widespread car ownership as a barrier

A final substantive barrier in the present list is **car ownership** itself. As noted in Section 2.5, car ownership and use are highly correlated. This arises in part because a car is seen as essential for some purposes—for example, the weekly visit to the supermarket or the monthly visit to relatives—and, once owned, is used for trips that might readily be undertaken by other means, on account of its convenience and lower marginal cost.

Promising solution

A solution here can be to ensure ready availability of rental cars or car-sharing services that allow the essential journeys to be made without car purchase. As in the case of public transport, steps may have to be taken to ensure use of the alternatives, here involving penalties or structured inconvenience for ownership. An example of 'structured inconvenience' would be the separation of buildings from associated parking places.[50]

Several other individual barriers could be mentioned, such as the symbolic value of cars in helping display status or idiosyncrasy. These can generally be subsumed under one of the above barriers—in this case 'attractiveness' or 'resistance to collective solutions'—or under one of the barriers outlined in the next section.

Lack of adequate professional advice as a barrier

The many individual barriers to sustainable transport present a complex set of challenges for policy-makers. For the most part the **policy-makers must act without expert advice as to how individual transport behaviour can be changed** because few psychologists—experts in changing human behaviour—show an interest in how to make transport behaviour more sustainable.[51]

Even without professional advice, policy-makers would do well to acknowledge the many individual barriers just noted. Policy-makers need also to ensure a stronger focus on what people actually do and the circumstances under which they do it. For example, a rapidly increasing number of journeys—with corresponding growth in globally acting emissions—are made for leisure purposes, a topic given relatively little attention by the economists and engineers whose explanations of transport behaviour constitute most received opinion. The usual focus is on commuting to and from work, which provides many challenges for engineers but is a declining proportion of all travel in most OECD Member countries, and is consequently resulting in a declining proportion of globally acting emissions.

4.2. Societal barriers to attainment of EST

The barriers set out in this section are also concerned with human behaviour but more from perspective of societal organisation than from the view of an individual in a physical and social world. Six types or sources of barrier have been identified:

Six types of societal barrier

- Political factors
- Institutional barriers
- Ongoing societal trends
- Urban form
- Methodological barriers
- Professional barriers

As for the individual barriers discussed in the previous section, the societal barriers are set out in turn in the next several paragraphs, together with initial discussions of what might be required to overcome these barriers.

Political factors as a barrier

Perhaps the most important of the societal barriers are those that arise from **political factors**. They include the weight of commercial interests in present transport arrangements. These interests include vehicle manufacturers and providers of transport fuel, transport services, and transport infrastructure, as well as developers of land at the edges of urban regions.

Much of the impediment these interests pose to progress toward sustainable transportation arises from the ordinary activities of large commercial sectors within the economy and within society. They are major employers and major providers of government revenue, directly and indirectly, whose fate is understandably a cause for political concern. Instances of overt opposition to progress towards sustainable transport seem rare. An example has been the strong questioning of the need for action with respect to climate change that has come from some producers of fossil fuels. Other fuel producers appear to be embracing the need for change, although such commitments can also be perceived as a barrier. A company that produces both oil and renewable energy can be seen—often uncharitably—as co-opting the latter in the service of continued fossil fuel use.[52]

Different sectors apply their influence at different levels of government. The fate of vehicle producers is usually a national or international concern, although also a local concern where factories are located. Providers of road infrastructure are more likely to exert their greatest influence on local governments, as are land developers.

Politicians are more often concerned about potential losers than potential winners. A political action providing widespread benefit—for example, reduced air pollution—can be stalled because a relatively few persons would experience loss of employment or profit as a result of the action.

Concern for losers as a barrier

Overcoming these kinds of political barrier requires careful interventions to ensure alternative economic activity and, where necessary, compensation to losers.

There is another kind of political barrier that is more difficult to overcome. As discussed in Section 3.3, present trends—perhaps reinforced by current transport practices—seem to be towards greater societal polarisation. The people who benefit most when polarisation is occurring are generally whose who are already in a good position in society with political power or access to it. They may have a strong disposition to reinforce that power. This could mean favouring actions consistent with further polarisation including maintenance of current transport practices.

Related to what might be called the barrier of class factors is the matter of the **world outlook of decision-makers**. More than others, decision-makers are likely to be people with strong commitments to individual transport—or chauffeured separate transport—and to convenient air travel. Their frequent use and even dependence on unsustainable modes can colour the decisions they make. A politician whose most frequent view of the outside world is through a car or aircraft window may be limited by this experience to consideration of car-based transport solutions.

World outlook of decision-makers as a barrier

There are no specific remedies to class biases and the perspectives of decision-makers. The existence of these factors should be considered during development of strategies for moving towards sustainable transportation.

Linked to the political factors are several **institutional factors** that help perpetuate the transport status quo. Within government, there are the longstanding trends towards decentralisation and subsidiarity. These trends could act as a barrier to the implementation of technologies and common practices that could contribute to the reduction of environmental impacts (offset to a degree by the innovation that could result from more local decision-making).

Institutional factors as a barrier

The trends are offset to a degree by the strengthening of supranational organisations and the associated moves towards common standards for matters such as air quality and noise. However, it has been argued that common standards can stifle innovation. Policy-makers need to tread a fine path between the

barriers posed by localisation, on the one hand, and globalisation, on the other hand.

Counter-productivity of government is also cited as an institutional barrier, arising from the uncoordinated actions of different departments and agencies.

Subsidies and pricing systems as a barrier

Perverse **subsidies and pricing systems** can be seen as institutional barriers to progress towards sustainable transportation. These range from North American subsidies for oil exploration and trade to pricing mechanisms that favour use of the car over public transport.[53]

The automobile is favoured in part because almost everywhere the *marginal* cost of use of public transport is higher than the marginal cost of car use, especially where there is no charge for parking. This could be remedied by 'variabilising' fixed costs,[54] notably insurance, and raising the cost of fuel. However, fixed costs may have to be kept high to deter ownership, which appears to be a major cause of use, whether variable costs are high or low. The final package should thus embody fixed costs of car ownership and use that are high enough to moderate ownership and variable costs that are high enough to favour public transport.

Perverse pricing systems also apply to other modes. Road freight may be subsidised in that the taxes do not cover its share of the costs of providing highways. By contrast, rail freight may not only have to pay for the cost of its track but may be contributing to road freight subsidies through taxes paid on track maintenance materials and services.

Barriers to maintaining or creating a compact urban form

The barriers posed by **incompatible urban form** are not obviously a matter of societal organisation, but they fit more comfortably into this section than in the sections on individual and technological barriers. Box 30 reproduces a list of barriers related to urban form that was presented at the 1996 Vancouver conference, together with countervailing factors—"stimulants"—that could be exploited to overcome the barriers.

The main issue in urban form is the transport-inducing effects of low-density development at the periphery of urban areas, and the cycle whereby the ready availability of personal motorised transport both stimulates low-density development and is stimulated by it. What is known as **urban sprawl** is a matter of the geographic size of urban regions increasing at a much higher rate than population growth.[55] The urbanized area of the Los Angeles region, for example, increased by about 300 per cent between 1970 and 1990, while the population of the region increased by only 50 per cent. In many U.S. urban regions, the ratio between the rate of increase in the urban area and the rate

of increase in the population over the same period was higher: New York, 8 times; St. Louis, 10 times; Chicago, 11 times. Some urban regions, e.g., Cleveland, recorded an increase in the extent of the urbanized area even though their population fell during that period.[56] Urban sprawl is a feature of almost all OECD countries.

A major challenge in addressing urban form is the time taken to effect change. Even in North America where, compared with Europe, household mobility is high, cultural roots are shallow, and structures are built more for time-limited functionality, measures to alter characteristics of an urban region can take many decades to have an effect. Moreover, the experience across the world in reversing a trend of low-density development is limited. Thus, the barrier posed by the inherently slow rate of change in urban form means that the contribution of instruments directed towards changing urban form must for the short and medium term be limited.

Finally among societal barriers can be included several barriers to do with the methods societies use to organise their transport and related arrangements. These **methodological barriers** include a lack of appropriate performance indicators and targets, the use of perverse indicators of well-being, and the absence of full-cost accounting procedures.

Box 30
Barriers to and stimulants of intensive urban development.
▼

Barriers	Stimulants
Global manufacturing and international economic interdependency that emphasizes 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.

Provision of performance indicators and targets is a matter addressed directly by the EST project. A barrier here is that the kinds of indicators and targets being proposed are novel and to some extent alien to the cultures for which they are intended. Recent human history has been characterised by extraordinary increases in transport activity and little experience of moderation of this trend, successful or otherwise. Except generally in time of war, more specifically in the former command economies, and in the exceptional cases of a few countries, notably Singapore, there has been little in the way of attempts to restrain overall transport activity. Accordingly, targets related to transport activity and performance indicators of progress towards the targets have not been developed.

Targets have been used with success on the technological side of the ledger, to be discussed further below. The technical performance of vehicles has improved dramatically during the last several decades. Some of the improvement has resulted in reduction in environmental impacts; more has been used to increase the comfort and power of vehicles, offsetting potential environmental gains. This technological success has itself become a barrier in that it supports arguments that EST can be achieved entirely through improved vehicles, fuels, and infrastructure.

Use of the Gross Domestic Product indicator (GDP) as a barrier

Trends towards greater transport activity may well have been reinforced by the indicators used in OECD Member countries to assess and signal progress. Gross Domestic Product (GDP) is the best know such aggregate indicator. It is increased by expenditures on transport, and thus causes car use to be seen as making a stronger contribution to progress than walking or bicycling, and fuel-intensive car use to be making a stronger contribution than fuel-efficient use. The strongest criticism of GDP is that it treats the depletion of natural resources—including oil—as income rather than as the depreciation of an asset, violating both basic accounting principles and common sense.

This barrier can be breached by the use of alternatives such as the *Genuine Progress Indicator*, for which the costs of several adverse outcomes of human activity are *subtracted* from the total of expenditures, including resource depletion and also "crime, divorce, legal fees, and other signs of social breakdown … car wrecks, medical costs, locks and security systems, and insurance".[57] Such indicators show a levelling off in the 1970s with a later decline, suggesting an overall loss of welfare.

Lack of integrated transport planning

The last methodological barrier that has been identified concerns the nature of assessment of the impacts of transport. The particular focus has been the slow uptake in the transport sector

of what has been named integrated transport planning (ITP). This is a procedure similar to what has been developed and refined in the electric-power generation sector. 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.

4.3. Technological barriers to attainment of EST

The barriers set out in this section are concerned with realisation of the significant component of the effort towards attainment of EST that will have to come from improvements in technology. Some of the contributing factors are as much human factors as those contributing to the barriers noted in the previous two sections—e.g., investment in technology and resistance to the adoption of new practices—but are more logically considered with technological issues. Four types or sources of barrier have been identified:

- Costs and lead times for development of appropriate technology
- Lack of common standards
- Inappropriate safety requirements
- Barriers associated with telecommunications

Barriers posed by high development costs and long lead times

The technological barrier mentioned most often in the course of the EST project has been the **insufficient progress and high cost of technological development**. Added to this can be the slow rate of replacement, particularly replacement of transport infrastructure in urban areas. Increased and targetted investment can help overcome both types of barrier.

Some technological achievements are intrinsically difficult to secure, including renewable fuels, fuel distribution systems, and high-capacity batteries for storing electrical energy. Some carry the burden of requiring changes in transport and related behaviour, such as the overnight charging and shorter journeys between refuelling required by the use of electric vehicles.

A barrier identified as impeding rapid technological development has been the **lack of common standards** for vehicles, fuels, and infrastructure. Globalisation of manufacturing and international agreements are serving to breach this barrier but, as noted, they can be offset by local variations in requirements concerning emissions and other impacts.[58]

Perverse safety standards as a barrier

Some standards are considered perverse from the perspective of attainment of EST. **Safety standards** that favour larger, heavier cars have been noted as one example, in that they impede development of smaller lighter cars and the creation of a transport environment that makes such cars as safe as heavier cars are today.

Among the most rapid changes in technology are those concerning electronics and telecommunications, sometimes linked together by the term '**telematics**'. Many features of telematics facilitate progress towards EST. Telecommunications can substitute for transport and make transport more fuel-efficient and more benign in other ways.

As well, trends in telecommunications appear to be facilitating transport both by creating the need for transport and by reducing its transaction costs.

Analysis of the impacts of telecommunications on transport is at a preliminary stage. After considerable optimism, the present conclusion is that the positive and negative features with respect to attainment of EST may roughly offset each other.[59] Because there are positive and negative features, it is possible to consider developing strategies that focus on the former and attempt to minimize those that present barriers to attainment.

4.4. Gaps in knowledge

Lack of sufficient technical knowledge may be the most evident gap

Lack of knowledge relevant to the attainment of sustainable transportation is a general barrier to attainment of EST. This may be most evident with respect to technological improvement, which for all of the Member country teams in the EST project would be responsible for a substantial part of the effort required to move towards EST. As shown here in Box 9, technological improvements are foreseen on average to contribute the largest part of the effort towards achieving EST: 41 per cent of the total effort with respect to the movement of people and 47 per cent for the movement of freight.

Faith in technology can be both valuable and counterproductive

Technology poses a special paradox because of the widespread belief that issues of sustainability can be resolved by such innovations as fuel cells and alternative fuels. Too often, the expectations of performance are not supported by realistic assessments of their potential. The faith in technology is valuable when it spurs needed research and development, but counterproductive when it causes other components of the effort to be slighted.

Other factors noted in Box 9 are also instances of insufficient knowledge. Too little is known about how to achieve reductions in activity (i.e., transport avoidance and prevention), shifts towards modes with less environmental impact, and increases in the average occupancy or loading of vehicles.

Economists and engineers provide most explanations of transport-related behaviour

These other factors depend for the most part on changes in human behaviour. Numerous academic disciplines, notably psychology, are concerned with the explanation of human behaviour. For the most part these disciplines have paid little attention to transport activity. The relevant explanations of human behaviour provided by economists and engineers are more likely to receive attention from policy makers.

Transport professionals of various kinds are often inclined to support trends towards increases in transport activity. For example, economists are usually disposed to favour any economic activity, and in doing so support increases in transport volume rather than reductions. Transport engineers are inclined to accommodate ongoing trends with expansions in infrastructure that reinforce the trends, and to resolve all problems with improved technology. Most economists and engineers tend not to ask questions relevant to the attainment of EST. The result is a huge gap in our knowledge as to how to make transport sustainable. Here are some of the many things we do not know:

Several things we do not know

- How to make public transport, bicycling, and walking more appealing than automobile use.
- How to substitute for the particular appeal of car ownership in a well-endowed society.
- How to replace the particular pleasures of driving a car, and the appeal of speedy transport by air.
- How to reduce the appeal of products imported from distant places
- How to make local leisure activities more appealing than those in distant places.

Several more things we do not know

There are several other gaps in knowledge, among them the following:

- How to organise efficient production and distribution systems that do not depend on readily available, low-cost transport
- What might be the detailed effects of innovative policy instruments, such as a tradeable permit system for CO_2 emissions and ecological tax reforms that price use of resources higher that the external costs of the use.

- What would be the detailed effects of progress towards EST on other sectors of the economy
- The various interrelationships between land use and transport as they are relevant to EST.
- How to induce a culture that pays regard to the longer term and makes decisions accordingly.

These last topics are among our greatest areas of ignorance. The one concerning land use is particularly paradoxical because there is much work that initially appears to be relevant in both the land-use planning and transport literatures, but on further investigation little in the way of solid information and advice as to how to change urban form so that it becomes compatible with EST. A key concept in assessment of urban form could be the notion of accessibility, definable loosely as opportunities for social and economic interaction. Maintenance of accessibility is likely to be an objective of planning for EST, but there are no good indicators of this feature and no clear guidance as to how it could be maintained with reduced transport activity.

New kinds of human ingenuity may be required

Readily available transport of people and freight may have been the Pandora's box of the 20th century, or at least the genie out of the bottle. Human ingenuity released what appeared to be an extraordinary array of gifts. While still desirable, these gifts are now burdening the planet with a wide range of assaults. Nevertheless, almost all residents of OECD Member countries enjoy comfort and convenience in transport that were unknown even to royalty in former times. Residents of other countries are aware of these features and want them. Now that the benefits of easy transport have been experienced, there may be no going back. The way forward, if it is to be sustainable, will likely require quite different forms of human ingenuity from those that have given us our present transport systems.

4.5. Conclusions concerning barriers and gaps in knowledge

Numerous barriers to attainment of EST and numerous relevant gaps in knowledge have been identified in the course of the EST project. The general conclusions that can be drawn from the above review of the barrier and gaps are these:

- Lack of relevant knowledge is itself a major barrier to attainment of EST, whether technical knowledge that could enable needed improvements in vehicles, fuels, and infrastructure or knowledge about human behaviour and societal

organisation that could help policy-makers secure needed changes.

- Individual and societal factors predominate in the consideration of both barriers and gaps. There is a major question as to whether policy-makers are receiving advice from appropriate quarters. Much advice appears to be provided by professions prevalent in the transport sector, such as engineering and economics, whose practitioners may not have relevant training and experience in matters concerning human behaviour and societal organisation, as well as the environmental impacts of transport and sustainability requirements.

- Among the largest barriers to change is the comfort and efficiency provided by present transport arrangements in OECD Member countries. There is not the evident need for change in systems that many regard as mostly satisfactory. Simple warnings of future distress appear insufficient to impel change.

- Two things are required. One is a better understanding of how to make potential future distress relevant to present circumstances. The other is a more appealing vision of sustainable transportation, its benefits and advantages.

- Even if these conditions for change were met, there could still be substantial resistance. Present transport practices have a formidable momentum that has deep psychological, social, and technological characteristics.

5. The way ahead

This chapter discusses how the concepts and strategies developed during the EST project can be translated into action. It recapitulates the work of the Member country project teams summarized in Chapter 2, and then suggests how the many of the barriers identified in Chapter 4 may be overcome. It goes on to emphasis the importance of the implementation process, and concludes by assessing the prospects for implementation of EST.

5.1. Strategies for achieving EST

Section 2.6 set out the conclusions from the work of the Member country project teams on the development of their implementation strategies and provided a general conclusion, which is worth restating here:

Recapitulation of conclusions concerning the project teams' development of implementation strategies

EST could be attainable, although only with a concerted commitment involving many sectors of society. Member country teams of experts working on how this can be done have developed a wide range of strategies for moving towards EST, involving promotion of relevant technology and innovative means of mobility management, as well as information, communication, and awareness raising. The most important challenges lie in the acceptability of the strategies and their component instruments rather than in the effectiveness of the instruments themselves. Issues of acceptability are best addressed by careful phasing of the application of instruments across the whole implementation period until 2030. Issues of effectiveness are best addressed by careful monitoring of the effects of instruments and appropriate adjustment of the vigour of their implementation.

Three of the particular conclusions from the development of the implementation strategies—Nos. 1, 3, and 8 in Section 2.6—are worth highlighting, as follows:

- All nine Member country teams have met the challenge of devising instrument packages that can secure attainment of EST. None of the reporting teams has claimed that attainment of EST is impossible or impracticable. However, the teams noted several important requirements for success, in-

cluding: (i) the pace of technological progress must increase; (ii) mobility patterns must change radically; (iii) international economic structures must change; and (iv) there must be changes in other sectors, notably energy, agriculture, and international trade.

- The Member country teams have developed instrument packages of considerable diversity. Their common feature is that the scope and stringency of the proposed instruments is far beyond what is currently deployed. This is to be expected if the dramatic changes required for conformity with the EST criteria are to be achieved.

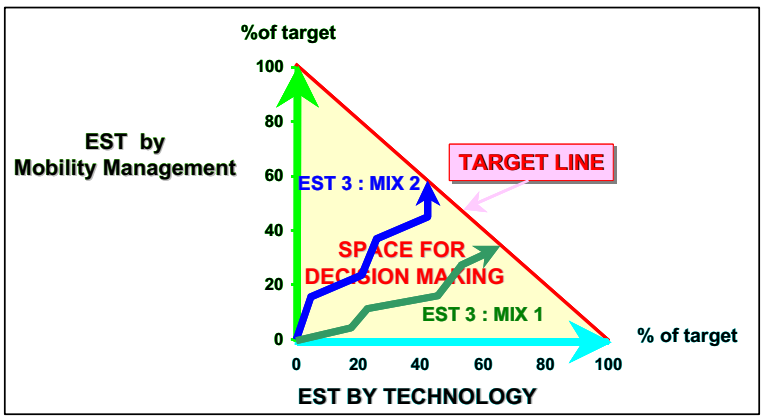
- An overriding concern in the implementation of the instrument strategies is their political and public acceptability. This is closely linked to how the most stringent and potentially most unpopular are phased in. Almost all of the teams have proposed complex phasing arrangements to facilitate acceptance.

Diversity of team's approaches is of special note

The diversity of the developed instrument packages is of special note: **there is no one path to attainment of EST**. The different Member country teams adopted different priorities for action, according to particular national circumstances. The numbers of instruments proposed for deployment varied substantially among the teams. Several teams focused on sophisticated rationing schemes (i.e., tradeable emissions permits). Others did not. Common features among most of the teams included **a focus on early action**, on the movement of people rather than freight, on regulatory rather than fiscal instruments, and on achieving mode shifts (e.g., from car to public transport and from road to rail freight).

Technological improvements were given some emphasis, particularly for the shorter term, but the major part of the effort towards achieving EST will, according to the project teams, have to come from the mobility management and the substitution of access for mobility, in part through changes in how land is used.

▶ Box 31
The backcasting space



How the backcasting method can allow for a range of pathways towards attainment of EST is illustrated schematically in Box 31. The target line determines the end points from the balance of effort analysis, i.e., the contribution of each of technology and demand management towards meeting the EST goals. Many policy pathways for meeting the target are possible within the boundaries defined by the overall EST targets and the contributions from technology and demand management. Backcasting of packages of instruments within these boundaries provides an action space within which the many pathways will ensure that targets are met.

5.2. Overcoming barriers

A formidable total of 19 types or sources of barrier to attainment of EST were identified in Chapter 4: nine individual, six societal, and four technological. They are listed by title in Box 32.

Changing public attitudes will be the key to overcoming—directly and indirectly—many of the barriers identified in Chapter 4 and listed in Box 32. This factor is discussed separately below in Section 0.

Barriers to do with human nature and people's perceptions:	**Barriers to do with how society is organised:**
➢ Lack of awareness of the need for change	➢ Political factors
➢ Cognitive dissonance	➢ Institutional barriers
➢ Lack of concern for future generations	➢ Ongoing societal trends
➢ Fear of change, and thus resistance to change	➢ Urban form
➢ Attractiveness of present transport modes	➢ Methodological barriers
➢ Absence of transport alternatives	➢ Professional barriers
➢ Resistance to collective alternatives	**Barriers to do with technology:**
➢ Car ownership	➢ Costs and lead times for development of appropriate technology
➢ Lack of adequate professional advice	➢ Lack of common standards
	➢ Inappropriate safety requirements
	➢ Barriers associated with telecommunications

◀
Box 32
The barriers to attainment of EST discussed here in Chapter 4

Other significant factors will be investment in appropriate infrastructure and technological improvement, discussed below in Section 0.

Of special importance in making progress will be illustrations of present good practices together with appropriate demonstra-

Good practices and demonstration projects

tion projects. The OECD International Conference, *est! Futures, Strategies, and Best Practices*, held in Vienna in October 2000, provided numerous examples of these under the following heads:[60]

- Communication and awareness-raising
- Mobility management for passenger and freight transport
- Technology and infrastructure
- Youth and education
- Culture and the arts.

Combinations of approaches may be required

In many cases, overcoming barriers will require a combination of approaches. For example, the individual barrier noted as 'resistance to collective alternatives' concerns the present superiority of private over public transport in matters of privacy, comfort, convenience, and perceived personal safety. A key factor here is the quality of public transport: whether there is always a comfortable seat, whether waiting times are short, etc. A change in attitudes would stimulate public and private investment in public transport that would improve its quality and thus its acceptance and use, thereby increasing safety and perceptions of safety. All of this would further strengthen positive attitudes towards collective transport alternatives. As important in the acceptance of collective alternatives are the relative quality and cost of private transport. Thus addressing the barrier posed by resistance to collective alternatives requires a combination of many kinds of approach.

One of the main messages to come out of the EST project is the need for *comprehensive* strategies to overcome barriers and move towards EST. This message is reinforced in Section 0 below.

5.3. Changing public attitudes

Direct and indirect affects of changing attitudes

Changing public attitudes is the key to overcoming many of the barriers identified in Chapter 4 and are listed by topic in Box 32. For some barriers, attitude change is directly relevant, including the following individual barriers:

- Lack of awareness of the need for change
- Cognitive dissonance
- Lack of concern for future generations

- Fear of change
- Resistance to collective alternatives

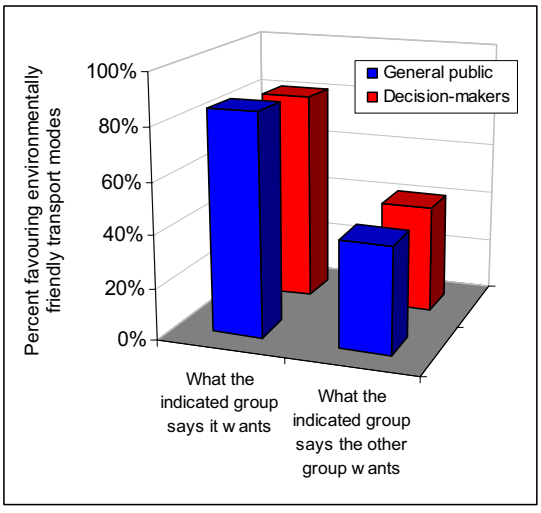
As significant, however, is the role of public attitudes as a facilitator of political and institutional change. Public attitudes have an important role too in determining investments in public transport, the role of the private automobile, and safety standards. Public attitudes, through consumer behaviour, even play a role in technological development.

The various publics in OECD countries are not yet ready for EST. (If they were, it could be argued, then EST would be happening.) However, there are indications that there may be more readiness than is often supposed. Two kinds of indication are particularly significant. One is evidence that there can be a major mismatch between what attitudes to transport are believed to be and what they actually are.

Box 33 shows the results of surveys across the European Union of the general public and decision-makers as to whether government policies should favour environmentally friendly transport modes over motorized modes.[61] Both groups overwhelmingly said preference should be given to environmentally friendly modes (respectively 85 and 81 per cent). Each group was also asked what the other group thought. On average, both groups said that only 41 per cent of the other group favoured environmentally friendly modes.

Box 33
Mismatch of attitudes and perceived attitudes towards environmentally friendly transport modes

The results of this and similar studies offer grounds for optimism. It may be easier to change what a person believes someone else to think that to change what the person thinks. Such studies indicate the possibility of widespread support for environmentally friendly transport that may not be reflected in the actions and pronouncements of governments. Moreover, a potential reason for the inaction of governments is made clear: they may misunderstand those on behalf of whom they are acting. How this may happen was touched on in Chapter 4. Politicians are often more concerned about losers than winners, not the least because losers are inclined to make more noise than winners. It follows that accurate reporting on attitudes should be a strong feature of campaigns to change public attitudes.



The second kind of indication is touched on in Note 52, where evidence of attitude change among leaders of major corporations is reported. Decision-makers are

believed to be heavily influenced by large corporations. To the extent this is true, there is evidently hope for progress towards EST.

There are several other indications of potential attitude change. Growing public discomfort with transport trends is palpable in OECD Member countries. Congestion and pollution are ubiquitous everyday issues. Noise is a major concern, particularly in Europe. Safety, particularly in relation to growth in traffic involving heavy-duty vehicles is another widespread concern. Transport's potential contribution to climate change is another emerging issue.

Present transport practices are increasingly considered to be harmful to the people who engage in them, as well as to the general local and global environments. Children are a particular cause for concern. They are spending larger parts of each day in vehicles, cars and buses, inside which pollution levels are often higher than levels outside.[62] Children's dependence on motorised transport is believed to be a partial cause of what has been described as an epidemic of obesity.[63]

In short, public opinion in OECD countries may be moving towards ripeness for acceptance of alternative attitudes to transport, of ways of living that above all rely less on motorised transport but also require transport that is less harmful. What may be preventing full expression of emerging changes in public attitudes may be lack of evidently feasible alternatives to present trends. The EST project and, in particular, the EST Guidelines noted below in Section 0 provide the basis for development of such alternatives.

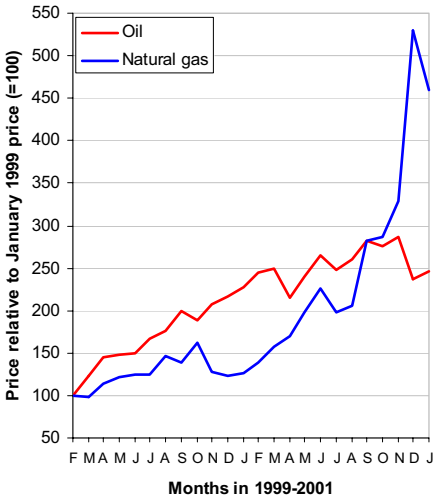
Economic, social, and environmental globalisation

Yet another factor that could be contributing to incipient changes in public attitudes is a remarkable development of the late 20th century, namely the growth in comprehension of a single human community sharing a constrained biosphere that exists only in an insignificant corner of the universe. The view of Earth from space impelled this thinking, but it has been complemented by economic and cultural globalisation and by concern for the global impacts of human activity. Human development has been an associated theme. It embraces the powerful notion that all of humanity should aspire to the benefits enjoyed by its richest portion.

Make the poor like the rich in terms of comfort and convenience, but the rich like the poor in terms of transport's impacts

As these ideas unfold, awareness grows that the present patterns of transport activity in rich countries could not be enjoyed by poor countries without environmental and resource catastrophes. The alternative of denying the aspirations of poorer countries seems increasingly untenable. Thus, the only resolution will be for rich countries to provide more sustainable transport model for poorer countries.

Presently, international aid and economic globalisation seem fashioned to make the poor like the rich, and perhaps to make the rich richer in the process. In several respects, e.g., education and nutrition, such an objective may be sustainable. In others, notably transportation, the only rational approach may be for the rich countries to provide a more sustainable model. Thus, human development in transportation may well become a matter not of making the Third World like the First World, but rather making the latter like the former in terms of transport's overall impacts, while ensuring that the comfort and convenience enjoyed by residents of the richer countries become enjoyed by all.



▲
Box 34
Monthly spot prices of crude oil (West Texas) and natural gas (Alberta) relative to February 1999.

Present trends suggest a strong chance that this line of thinking will take hold in developed countries during the present decade. The need to provide developing countries with a sustainable transport model could thus become an important factor in securing the changes required in the period 2010-2030.

Globalisation has an environmental as well as an economic and social aspect. The view from space is increasingly the view of a warmer planet, with climates that are being changed by human action. Transport contributes a large portion of the greenhouse gases that are contributing to climate change, especially in OECD countries. Increasing media prominence is being given to reports of the Intergovernmental Panel on Climate Change and to the issues raised by the IPCC.[64] This media prominence can play a significant part in creating attitudes towards actions necessary for the attainment of EST.

At a more local level, a significant move is the reaction against urban sprawl that is gaining hold in North America. It is associated with a movement known as 'Smart Growth', which refers to patterns of development that are denser and less automobile-dependent than those of the recent past.[65] This movement is gaining hold, and fostering positive attitudes towards measures consistent with EST.[66]

A final potentially contributing factor to attitude change could be the growing turmoil in energy supply. The last two years have seen astonishing increases in wholesale energy prices, as evidenced in Box 34 for oil worldwide and for natural gas in North America.[67] Changes in electricity prices in parts of the U.S. have been even more dramatic, fuelled largely by increases in natural gas prices.

In the case of oil—which fuels almost all transport—these

increases may well portend what several experts believe to be an early peak in worldwide production, coincident with depletion of about half of the total amount of petroleum that could be recovered. Other experts contend that the peak is not imminent, or that improvements in extraction technology will compensate for intractability in supply, or both, but only a few suggest that oil will ever be as cheap again as it was a few years ago.[68]

The prospect of much higher oil prices offers governments valuable opportunities to help citizens develop new attitudes towards energy use. Growth in energy-intensiveness has been a defining characteristic of our modern civilisation. (World oil consumption, in particular, grew by a factor of about 150 during the 20th century,[69] with most of it being used for transport.[70]) Among humanity's major challenges for the 21st century is to continue sustainable progress with use of much less energy. The move to EST will be a critical part of that endeavour. Changing public attitudes towards acceptance of EST will be a significant way in which governments will be able to help break the strong links between energy consumption and human development.

5.4. Infrastructure investment and technological development

Investment in rail required

The infrastructure requirements for EST will be substantially different from present transport infrastructure. The most conspicuous differences will concern the use of rail tracks rather than roads, particularly for freight movement but also for the movement of people. Rail movement is inherently more efficient than movement by road, but its stronger feature could be the opportunity it provides for the use of renewable energy sources. Electrified rail systems can make use of any means of producing electricity, whether wind generators and photovoltaic arrays or hydroelectric dams and biomass combustion.

One challenge is the long lead times required to approve and implement investments of the required scale. A decade or more can be required between initiation and execution, pointing to the necessity for early action.

Much smaller-scale but important investments can be realised at earlier dates. These involve several kinds of improvement to local public transport, including important ancillary features such as waiting areas and information systems. Early progress can also be made with improvements to infrastructure for pedestrians and cyclists.

Short-term gains from technology are available

For the shorter term, improvements in automotive technology—for all kinds of road vehicles—can make a strong contribution. **A key technology for timely improvement—the gasoline-**

electric hybrid vehicle—is already being marketed by Japanese manufacturers, and is near marketing by other manufacturers. Versions using other fuels—diesel and natural gas—and suitable for heavy-duty vehicles are in advanced stages of development.[71] Coupled with downsizing of personal vehicles, use of hybrid drive-trains has the potential of reducing fuel use, and thus emissions, by an overall amount in the order of 50 per cent during the next decade or so, thereby offsetting recent substantial increases in emissions in OECD countries.[72] Imposition of stringent fuel-efficiency standards on all new road vehicles may be required to ensure that early advantage is taken of this technology,[73] perhaps with enhanced vehicle-scrapping programmes to ensure timely replacement of the on-road fleet.[74]

Modest increases in fuel prices will be required to avoid a 'rebound' effect and thus ensure that the improved fuel efficiency does not result in increased transport activity. Complementary tightening of noise and safety regulations may also be required to avoid potential adverse outcomes of an overall downsizing of the personal vehicle fleet.

Downsizing heavy-duty fleets could be counterproductive in that it could result in increased fuel use per tonne-kilometre moved. For such vehicles, early advantage can be taken of **another available technology, informatics,** to ensure that loads are carried with reduced fuel use. Appropriate educational, driver-training, and other programs would help ensure fuel-efficient operation and widespread penetration of information technology designed to improve fleet logistics.[75]

Beyond the next decade or so, prospects for further improvements in fuel efficiency through technology seem less available. Much hope is being attached to the use of fuel cells as vehicle power sources. However, fueling and production issues are far from resolved, and reliance on this technology for attainment of EST could be premature.[76]

Longer-term gains from technology are questionable

5.5. Comprehensive strategies are required

There is no one path to EST and there is no one tool that will do the work. Even where project teams in the EST project have emphasized a particular instrument for attainment of EST—e.g., The Netherlands team's reliance on a tradeable permits system—many other instruments were also proposed for deployment in order to 'pave the way' for use of the preferred measure. Moreover, single instruments or groups of instruments are unlikely to be as useful when they are deployed outside the context of a target-focused strategy. Targets stimulate effective action, and allow evaluation of the effectiveness of action.

As well, merely changing public attitudes through media, education programs, and the like is inadequate in a democracy and probably less than optimally effective in any political system. Much work in the political and social sciences shows that desired action is more likely to be taken and sustained if the actors are part of making the necessary decisions.

Implementation of EST requires an inclusive, continuing process

Thus, what is required for attainment of EST is not merely a strategy for the implementation of a range of instruments, but a *process* that lays the foundation for the required changes in society, the economy, and transport activity. Such a process needs to begin with the fashioning of the implementation strategy and to continue throughout the implementation strategy. The move towards EST must thus be a focus of political action in the widest sense of the term.

5.6. Guidelines for moving towards EST

To provide a framework for overcoming the barriers to attainment of EST, and more generally to show the way ahead towards EST, a set of ten guidelines for attainment of EST—the EST Guidelines—were developed as a key outcome of the EST project. Box 35 sets out the EST Guidelines, as adopted at the OECD International Conference *est! Futures, Strategies, and Best Practices*, held in Vienna, Austria, in October 2000.[77]

Three critical elements for attainment of EST

The Guidelines expand the three critical elements of the approach towards attainment of EST that arises from the EST project: (1) set targets; (2) develop a carefully phased, comprehensive plan to meet the targets; (3) give the highest priority to changing public attitudes. Above all, they speak to the need for a continuing process, beginning with the participatory development of a long-term vision and continuing throughout the implementation of the publicly accepted strategy.

5.7. Prospects for progress towards EST

The EST project—and specifically the Guidelines resulting from the project—point the way ahead towards transport systems that are compatible with sustainable development. Achieving such development is becoming humanity's global mission. The challenges posed by this mission are perhaps more daunting for transport than for any other sector.

It is nevertheless possible to face these challenges with some optimism. The EST project has shown that the stringent requirements required by sustainability can be met by the transport sector in ways that are consistent with social and economic progress. EST is not a matter of reducing transport activity to

the point where loss and deprivation occur. Rather, it is a matter of changing and in many respects improving transport systems so as to continue the numerous benefits of good transport while reducing transport's present huge health and environmental impacts to sustainable levels.

Acceptance and implementation of EST will require profound changes in attitude, investment, and, above all, fortitude on the part of decision-makers. Progress towards EST will require an early start, open minds, and emergence of a firm sense of what has to be achieved. To the extent that these things fall into place, the prospects for attainment of EST are good.

(Box 35 is on the next page)

Box 35
The EST Guildeines adopted at the Vienna conference

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

6. Conclusions

Phase 3 of the EST project has mostly concerned how environmentally sustainable transport, as defined and elaborated in Phases 1 and 2, could be achieved. A subsidiary feature of the Phase 3 work has been preliminary assessment of the economic and social implications of attainment of EST. This brief chapter sets out some of the conclusions that can be drawn from the Phase 3 work. It summarises the concluding comments in Chapters 2,3, and 4 of this report.

The main conclusion from Phase 3 of the project is the general conclusion provided at the end of Chapter 2, repeated here:

A. EST could be attainable, although only with a concerted commitment involving many sectors of society. Member country teams working on how this can be done have developed a wide range of strategies for moving towards EST. The most important challenges lie in the acceptability of the strategies and their component instruments rather than in the effectiveness of the instruments themselves. Issues of acceptability are best addressed by careful phasing of the application of instruments across the whole implementation period until 2030. Issues of effectiveness are best addressed by careful monitoring of the effects of instruments and appropriate adjustment of the vigour of their implementation.

Several more specific conclusions were drawn in Chapter 2. They can be summarised as follows:

B. Two major questions arise from the development by the Member country teams of packages of instruments for the attainment of EST: whether or not to invoke a form of rationing of transport such as tradeable entitlements to emit carbon dioxide, and whether to lay out a detailed implementation strategy in advance or to determine details of later phases of implementation when the results of earlier stages are apparent.

The following conclusion characterises the teams' instrument packages, *albeit with many specific exceptions*:

C. The instruments included in the teams' packages were for the most part: (i) directed at the movement of people

rather than freight; (ii) regulatory rather than fiscal in nature, although usually involving a combination of both types of instrument supplemented by investment in infrastructure; (iii) directed towards achieving mode shifts and favouring non-motorised alternatives rather than towards numerous other objectives; (iv) supportive of technological change, such as development of fuel-cell systems, stimulated by regulatory and fiscal measures; and (v) designated as being the responsibility of national or sub-national governments and agencies rather than international agencies, on the one hand, or local or regional governments or agencies, on the other hand. It was recognised that some key instruments nevertheless require coordinated international action.

The overall conclusions from the very preliminary assessments of the economic and social implications of attaining EST reported in Chapter 3 are as follows:

D. The overall economic effects on the transport-related sectors of the Member country's economies as a result of proceeding towards EST rather than BAU are estimated to be slight. On average across the countries, annual GDP would hardly change, although there was considerable variation in the results obtained.

E. Social conditions could be more benign with EST compared with BAU, and perhaps more than now. Continuation of BAU could result in loss of independent mobility among the elderly and particularly children. With movement towards EST, on the other hand, life could become more healthful, safe, convivial, and child-friendly, at least in comparison with BAU, although some individuals would experience negative effects from reduced opportunity for mobility.

The overall conclusion from Chapter 4 on barriers to attainment of EST and relevant gaps in knowledge is this:

F. Present transport practices have a formidable momentum that has deep psychological, social, and technological characteristics. Lack of relevant knowledge is itself a major barrier to attainment of EST, whether technical knowledge that could enable needed improvements in vehicles, fuels, and infrastructure or, even more, knowledge about human behaviour and societal organisation that could help policy-makers secure needed changes. Three things are required. One is a better understanding of how to make potential future distress relevant to present circumstances. Another is a more appealing vision of sustainable transportation. The third, following

from the first two, is greater interest among the public generally, and transport industries in particular, in moving towards sustainable transportation.

It should be stressed that the foregoing very broad characterisation of the teams' work far from does justice to the breadth, depth, richness, and diversity of the Member country contributions to the EST project, which can be assessed directly through review of the individual reports.

Appendix A: Detailed tables

Table 1. Instruments proposed by the Austrian team

A key to the assessments in the six right-most columns in Table 1 to Table 9 appears in Table 10.

Minor editing of the instruments and assessments in Table 1 to Table 9 has been done by the OECD Secretariat.

Bolded instruments in Table 1 are regarded as higher-priority instruments by the Austrian team.

AUSTRIA **Instrument**	**Pass. or Freight**	**Phasing**	**Type of instrument**	**Type of effect**	**Responsibility**	**Readiness**
Road pricing for Heavy Duty Vehicles on motorways [1,20 / 2,40 ATS/vehicle-km]	F	S	F	A	N	A
Road pricing for passenger cars on motorways (long term)	P	M	F	E	N	B
Extension of road pricing to the whole road network (long term)	P	M	F	E	N	C
Coverage of infrastructure maintenance costs of freight and passenger transport, internalising external environmental and health costs of freight and passenger transport (e.g., road pricing)	F	S	F	A	N	A
Tradeable permit system for CO_2 emissions from HDV (long term)	F	L	F	A	N	C
Tradeable permit system for CO_2 emissions from passenger cars (long term)	P	L	F	A	N	C
Parking management and imposing parking fees in some towns	P	G	F	E	L	A
Parking management and imposing parking fees in all towns >10,000 inhabitants	P	G	F	E	L	C
Restructuring and ensuring adequate financing of public transport	P	S	F	G	L	A
Financing of extended public transport services	P	G	F	G	L	C
Incentives for buying ultra low emission and zero emission vehicles (e.g. hybrid and fuel-cell-powered HDV, LDV, and cars): pilot actions, then potential implementation on a large scale	B	L	F	A	N	B
Reorientation and restructuring of public subsidies and provincial support (e.g., for housing) to facilitate sustainable development	P	L	F	H	N	C
Modification of the fuel-consumption-based car purchase tax	P	L	F	A	N	B
Ecotax-reform, raising energy costs and lowering labour costs, eco-bonus	B	L	F	J	N	B
Promotion of measures to reduce the average fuel consumption of vehicles	B	S	F	A	N	A
Promotion of introduction of new technologies (e.g., ZEV) in general and for special purposes: pilot actions, then potential implementation on a large scale	B	G	F	B	N	A
Establishing criteria for “low-noise motor vehicles” and incentives for operating such vehicles: pilot actions, then potential implementation on a large scale	B	S	F	I	I	A
Promotion of alternative fuels (H2, RME, CNG, LPG, etc.): pilot actions, then potential implementation on a large scale	B	S	F	B	N	A
Campaigning and marketing for preference changes in housing and land use	B	G	E	H	N	C
Raising public awareness of traffic-related environmental impacts	B	G	E	J	N	B
Fuel-efficient driving training	B	S	E	A	N	A
Provision of consumer information about CO_2-efficient cars	P	M	E	A	N	B

Incorporation of environment impact and sustainable mobility into teaching materials, methods, and lessons from kindergarten to university: pilot actions, then potential implementation on a large scale	P	S	E	J	N	B
Voluntary agreements to improve environmental performance	B	G	E	A	N	A
Mobility management for enterprises: pilot actions, then promotional programmes and incentives, then potential mandatory implementation	P	S	E	C	L	A
Implementation of a nation-wide travel information system	P	S	E	C	N	B
Establishing a database impacts of transport on environment	B	S	E	J	N	B
Public participation in transport planning: pilot action, then potential implementation on a large scale	B	S	E	J	N	A
Establishment of mobility management centres: pilot actions, then potential implementation on a large scale	P	S	E	C	N	B
Substitution for physical transport: teleworking	P	M	G	F	N	B
Integration of environment targets and requirements into transport policies and programmes (e.g., strategic environmental impact assessments): pilot studies, then potential integration into transport policies	B	G	G	H	N	A
Use of an ecopoint system for freight transit lorries	F	S	F	B	N	A
Development of market-based mechanisms to limit traffic through ecologically sensitive regions on an EU-wide basis	B	M	G	G	I	C
Giving priority to landscape compatibility in planning and building traffic infrastructure	B	S	G	H	N	A
Integration of environmentally oriented transport and land use planning	B	G	G	J	N	C
Implementation of specific action plans in areas where air pollution concentration levels and noise exposure levels are exceeded: pilot actions, then potential implementation on a large scale	B	S	G	K	N	B
Evaluation and control of achievement of the environmental targets: pilot actions, then potential implementation	B	G	G	J	N	A
Implementation of action plans based on international commitments (e.g., Kyoto protocol, UN-ECE Vienna Declaration, WHO-Charter Transport/Environment/Health)	B	G	G	J	I	B
Promoting pilot projects and actions for sustainable transport and broad implementation of their results	B	G	G	J	N	A
Improvement and extension of rail-road intermodality inside and outside the Alpine Region	F	G	I	C	I	B
Extension of rail infrastructure	B	G	I	C	N	B
Improvement of rail service quality for freight transport (regularity etc.)	F	S	I	C	N	B
Providing road infrastructure for traffic calming in towns and settlements	B	S	I	J	L	A
Improvement of infrastructure for walking and cycling	P	G	I	F	L	B
Improvement of public transport infrastructure (stations, rolling stock etc.)	P	G	I	C	L	B
Improvement of combined transport infrastructure (terminals, new loading technologies)	F	G	I	C	N	B
Improvement of public transport service and operation (regularity, safety, etc.)	P	G	I	C	L	B
Introduction of road traffic management systems	B	G	I	D	L	B
Land use and zoning: higher density, promotion of mixed-use areas	P	G	R	H	L	C
Promotion of new forms of passenger transport: pilot actions re. car sharing, then potential implementation at a large scale	P	G	I	D	N	A
Promotion of new forms of passenger transport: pilot actions re. flexible demand-oriented systems, then potential implementation on a large scale	P	G	I	D	N	A
Promotion of new forms of passenger transport: pilot actions re. measures for car-free tourism (charter-trains etc.), then potential implementation on a large scale	P	G	I	F	N	A
Promotion of research into and development of non-fossil-fuel-driven engines: pilot actions, then potential implementation on a large scale	B	S	I	A	N	B
Promotion of research into and development of noise abatement: pilot actions, then potential implementation on a large scale	B	S	I	I	N	A
Installation of permanent recording stations to monitor noise	B	S	I	I	N	B
Night ban on noisy lorries	F	S	R	B	L	A
Night ban for all lorries in sensitive areas	F	S	R	B	L	C
Regulations for noise from road and rail vehicles: introduction and then potential strengthening of standards	B	G	R	I	I	A

Regulations for noise from tyres	B	G	R	I	N	B
Regulations for noise from road surfaces	B	G	R	I	N	C
International specification of measuring methods and limit values for noise, establishing testing procedures and noise limits for tyres	B	M	R	I	I	C
Introduction of regular control of noise from all motor vehicles in use	B	S	R	I	N	C
Industrial location policy and zoning: railway connections for industrial parks and commercial areas	F	L	R	C	L	C
Parking management in towns, reducing the number of parking spaces	P	G	R	H	L	C
Review and adaptation of public transport legislation	P	G	R	C	N	A
New design standards for transport infrastructure	B	G	R	J	N	C
Harmonisation of rail regulations in Europe	B	S	G	C	I	B
Promotion of cooperation between transport branches: support for an interlinked freight logistics system	F	M	G	D	N	B
Routine control of track conditions, implementation of maintenance measures in residential areas	B	S	R	I	N	A
Development of guidelines for management of traffic according to ecological requirements	B	M	G	B	L	C
Review and adaptation of traffic regulations, land-use legislation, and infrastructure guidelines	B	M	R	H	N	B
Review and adaptation of parking and garage legislation	B	M	R	H	N	B
Speed limits along critical stretches	B	S	R	B	N	A
Reduction of speed limits on roads in general	B	M	R	B	L	C
Introduction of mandatory, routine inspection schemes for pollutant emissions of registered vehicles: introduction, then potential mandatory inspection and maintenance programme	B	S	R	B	N	A
Improvement of exhaust emission testing procedures for pollutant emissions of all road vehicles: introduction, then potential mandatory inspection and maintenance programme	B	S	R	B	N	A
Investigation of the impact of dust due to grit, oil, road and tyre wear, and particulate pollutants	B	S	R	J	N	B
Regulations for NO_X, VOC, PM10 emissions for all kinds of vehicles: EURO III and IV, then potential further strengthening	B	G	R	B	I	A
Development of emission standards for ultra-fine particulates based on number, size, and composition	B	G	R	B	I	C
EU exhaust emission limits for off-road motor vehicles: introduction of mandatory standards, then potential strengthening of the standards	B	M	R	B	I	A
Setting of minimum standards for vehicles entering the EU from non-member states	B	S	R	B	N	B
Further lowering of sulphur content in fuel (<10 ppm)	B	M	R	B	N	B
Stricter requirements for fuel quality in sensitive areas	B	M	R	B	L	C
Voluntary agreement by EU and ACEA for reducing specific CO_2 emissions of cars to 140 g CO_2/100 km in 2008	P	M	R	B	I	A
CO_2 emission standards for cars and LDV	P	G	R	A	N	C

Table 2. Instruments proposed by the Canadian team

CANADA Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Road tolls: on urban expressways	B	S	F	E	L	B
Road tolls: on urban arterials	B	M	F	E	L	B
Road tolls: on key intercity highways	B	L	F	E	N	B
Fuel pricing: 2¢/l/y on petrol and diesel	B	G	F	A	N	B
Tradeable CO2 permits	B	L	B	A	N	C
Taxes/incentives for employee travel: tax parking, allow pass as deduction	P	S	F	C	N	B
Reduce annual licence fees for low-emission vehicles	B	S	F	B	N	A
Variabilise insurance	P	L	F	E	N	B
Set minimum urban parking prices	P	S	F	G	L	B
Set minimum rural parking prices	P	M	F	G	L	C
Reduce zoning requirements for parking	P	S	R	H	L	B
Mandatory emissions inspection	B	S	R	B	N	A
Reduce intercity speeds	B	S	R	A	N	C
Require environmental assessment of new development	B	M	R	H	N	B
Restructure land taxation (provide “fuller cost” taxation)	B	L	F	H	N	C
Stricter land use controls: growth boundaries and minimum densities	B	L	R	H	L	B
Encourage employer sponsored trip-reduction programs	P	S	E	C	N	B
Implement walking school bus programs unilaterally	P	S	E	F	L	A
Provide incentives for fleet turnover	P	L	F	B	N	C
Impose strict fuel-efficiency standards	B	G	R	A	I	A
Promote penetration of alternative fuels	B	M	E	B	N	A
Provide incentives for fuel cells for HDVs	F	S	F	B	N	C
Develop MoU with vehicle manufacturers for enhanced PNGV	P	S	E	B	I	A
Establish full PT integration within urban regions	P	S	G	C	L	B
Improve bicycle lanes and other facilities	P	S	I	F	L	A
Provide funds for rapid transit expansion	P	G	I	C	N	B
Provide tax incentives for privately run railways	F	S	F	C	N	C
HOV/HOT lanes for all urban expressways	P	M	R	D	L	C
Mandate in-vehicle technology to modify driver behaviour	B	M	R	B	N	B
Traffic calm city streets	B	G	R	G	L	A
Require EST instruction in schools	P	S	E	J	N	B
Require 50% car/truck advertising to be for ‘clean’ vehicles	P	M	R	B	N	C
Implement nationwide awareness programme	B	S	E	J	N	B
Recognize community “champions”	B	S	E	J	L	A
Establish data centre	B	S	I	K	N	B
Establish coordinating board for EST attainment	B	S	G	K	N	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 3. Instruments proposed by the French team

FRANCE Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Tradeable CO_2 permits, energy industries	B	M	B	A	N	B
Tradeable emission quotas for CO_2	B	M	B	A	I	B
Heavy-duty vehicle tax based on tonne-kilometres transported	F	S	F	A	N	B
Road pricing for heavy-duty vehicles	F	L	F	E	N	C
Subsidies to promote multi-modal transport	F	G	F	C	N	A
Restructure land taxation (provide “fuller cost” taxation)	P	G	F	H	N	B
Land use: tax parking opportunities	P	G	F	H	L	A
Set minimum urban parking prices	P	M	F	G	L	B
Tax reduction on LPG, GNV	B	S	F	B	N	A
Taxes/subsidies non-renewable/renewable energy	B	S	F	A	N	B
Remove tax benefit for diesel fuel	B	S	F	E	N	A
Fuel-tax harmonisation at upper level in the European Union	B	G	F	E	I	A
Subsidies for electric vehicles	B	S	F	B	N	A
Fuel tax reduction for public transportation	P	S	F	B	N	A
Subsidies for urban-only cars	P	S	F	B	N	B
Incentives for hybrid power trains and fuel cells for heavy-duty vehicles	F	V	F	A	N	C
Incentives for hybrid and electric cars	P	M	F	A	N	A
Subsidies to early replacement of older cars	P	M	F	B	N	A
Annual licence fee for cars based on emission levels	P	M	F	B	N	B
Road tolls on urban expressways	B	M	F	E	L	B
Road tolls on urban arterial roads	B	L	F	E	L	C
Road tolls on key intercity highways	B	S	F	E	N	A
Taxes/incentives for employee travel; tax on employee parking	P	M	F	E	N	C
CO2 standards for passenger cars	P	L	R	A	I	C
Exhaust standards for NO_x and VOCs	B	M	R	B	I	B
On-the-road inspection of heavy-duty vehicle emissions	F	S	R	B	N	A
On-the-road inspection of light-duty vehicle emissions, carbon monoxide and smoke	F	S	R	B	N	A
Mandatory emissions inspection	B	L	R	B	N	C
Priority for urban cars	P	G	R	B	N	B
Access restrictions for conventional vehicles in urban areas	P	M	R	E	L	B
Reform of development regulations concerning parking facilities	P	M	R	H	N	B
Reduce intercity speeds	B	S	R	A	N	B
Strict control of speeds and driving times of heavy-duty vehicles	F	S	E	A	I	A
Noise: regulations for rail vehicles	B	G	R	I	N	B
Noise: regulations for road vehicles	B	G	R	I	N	B
Noise: regulations for tyres	B	G	R	I	N	C
Noise: regulation for surfaces	B	G	R	I	N	C
Tighter noise requirements for environmental zones	B	M	R	I	N	B
Car-free urban centres	P	S	R	F	L	A
Traffic calming in towns: 30km/h limit	B	M	R	G	L	A

Reduce zoning requirements for parking	P	M	R	G	L	A
Location policy for companies that relocate	F	L	R	H	N	C
Location policy for existing companies and for new industries	F	L	R	H	N	C
Expansion of rail infrastructure for freight and passenger	B	G	I	C	N	A
Expansion of TGV infrastructure	P	G	I	C	N	A
Expansion of network of road-rail and road-water transfer terminals	F	G	I	C	N	A
Railways: better service and improved logistics for freight	F	G	I	C	N	A
Priority for public transport vehicles	P	S	R	C	L	A
Provide funds for rapid expansion of public transport	P	G	I	C	L	B
Public transport: increasing frequency, extending networks	P	G	I	C	L	A
Improve bicycle lanes and other facilities	P	S	I	F	L	A
Investments in biofuels	B	S	I	A	N	B
Land use: promote compact urban development	P	G	E	H	L	A
Plans for urban mobility in towns with more than 100,000 inhabitants	P	S	G	H	L	A
Organise transport at the European level	B	G	G	C	I	A
Railways: international harmonisation of regulations	B	G	G	C	I	A
Promote use of biofuels in the public sector	P	S	E	A	L	B
Voluntary CO_2 emission level standards for passenger cars	P	M	E	A	I	A
Implement nationwide awareness programme	B	G	E	J	N	A
Education and information programmes	B	G	E	J	N	A

A key to the assessments in the six right-most columns appears in Table 10.

Table 4. Instruments proposed by the German team

GERMANY Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
CO_2 standards for vehicles	B	G	R	A	I	B
Fuel taxation	B	G	F	E	N	A
Road pricing for heavy duty vehicles	F	G	F	E	N	B
Traffic calming in towns: 30 km/h limit	B	S	R	F	N	A
Traffic calming in towns: parking management	P	M	R	G	L	A
Traffic calming in towns: increase areas for pedestrians, cyclists, and public transport	B	M	I	F	L	A
Traffic calming in towns: motor traffic bans	B	M	R	F	L	A
Public transport: priority for PT vehicles	P	S	R	C	L	A
Public transport: improving information systems	P	M	I	C	L	A
Public transport: increasing frequency, extending networks	P	M	I	C	L	A
Public transport: service agencies for sustainable mobility	P	S	I	C	L	A
Railways: extension of rail infrastructure	B	M	I	C	N	A
Railways: improve rail-road intermodality	F	M	I	C	L	A
Railways: international harmonisation of regulations and technology	F	M	G	C	I	B
Railways: introduce competition	B	S	R	C	N	A
Railways: improve service and logistics	B	S	I	D	L	A
Regional economics: reform subsidy programmes	F	M	F	H	N	C
Regional economics: support regional markets	F	M	I	H	N	A
Regional tourism: provide support	P	S	I	H	L	A
Regional tourism: improve nature conservation	P	S	I	H	L	A
Land use: charges in land use	B	M	F	H	N	C
Land use: planning for low traffic levels	B	S	R	H	L	A
Land use: improve co-operation among regional planning institutions	B	M	G	H	L	A
Land use: reform construction planning regulations	P	S	R	H	N	A
Land use: tax parking opportunities	P	M	F	H	N	C
Land use: reform housing subsidy programs	P	M	F	H	N	A
Land use: promote town reconstruction and housing	P	S	F	H	L	A
Energy supply: reform energy legislation	B	S	R	A	N	B
Energy supply: subsidise energy saving technology	B	S	I	A	N	A
Energy supply: tax on CO_2 emissions or on energy use	B	G	F	A	N	A
Noise: regulations for rail vehicles	B	G	R	I	I	B
Noise: regulations for road vehicles	B	G	R	I	I	A
Noise: regulations for tires	B	G	R	I	I	B
Noise: regulations for surfaces	B	G	R	I	I	C
Aviation: exhaust standards for NO_x and CO_2	P	G	R	A	I	C
Aviation: emission-related charges	P	G	F	A	I	C
Aviation: taxation of kerosene	P	S	F	A	I	B
Aviation: optimise air transport management system	P	S	I	D	I	B
Aviation: tradeable permits for CO_2 emissions	P	V	B	A	I	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 5. Instruments proposed by the Italian team

ITALY Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Road pricing on motorways	P	S	F	E	N	B
Road pricing for roads with high environmental/social interest	P	M	F	E	L	C
Internalising external environmental and health costs of freight and passenger transport	B	S	F	A	N	C
Tradeable permit system for CO_2 emissions from heavy-duty vehicles and passenger cars	B	L	F	A	N	C
Parking management and parking fees in towns	P	G	F	E	L	B
Incentives for ultra-low and zero emission vehicles (e.g., electric mopeds, electric and hybrid cars)	P	S	F	A	N	B
Incentives for public transport fleet renewal	P	S	F	C	N	A
Incentives for converting cars from petrol to LPG and methane	P	S	F	B	N	A
Taxing car use instead of car ownership	P	M	F	E	N	B
Carbon tax	B	S	F	A	N	B
Promotion of alternative fuels (e.g., H_2, biofuels)	B	S	F	A	N	C
Public awareness raising for traffic-related environmental impacts	B	G	E	J	N	C
Car-free day initiatives	P	S	E	J	L	A
Consumer information on CO_2-efficient cars	P	M	E	A	N	A
Introduction of environment impacts and sustainable mobility into teaching materials, methods, and lessons	P	M	E	J	N	C
Implementation of a nation-wide travel information system	B	S	E	C	N	A
Substitution teleworking for physical transport	P	M	G	F	N	C
Integration of environment targets and requirements into transport policies and programmes (e.g., strategic environmental assessments)	B	G	G	H	N	B
Ecopoint system for freight transport lorries	F	S	G	B	N	B
Integration of environmentally oriented transport and land-use planning	B	G	G	H	N	C
Evaluation and control of the achievement of the environmental targets	B	G	G	J	N	B
Improvement and expansion of rail-road intermodality in and outside the Alpine Region	F	G	I	C	N	C
Expansion of rail infrastructure	B	S	I	C	N	C
Improvement of rail service quality for freight transport (regularity etc.)	F	S	I	C	N	C
Improvement of pedestrian and cycling infrastructure	P	G	I	F	L	C
Improvement of public transport infrastructure	P	S	I	C	N	C
Improvement of combined transport infrastructure (terminals, new loading technologies)	F	G	I	C	N	C
Improvement of public transport: service and operations	P	S	I	C	N	B
Promotion of new forms of passenger transport: car sharing	P	M	I	D	N	C
Promotion of new forms of passenger transport: measures for car-free tourism (charter-trains, etc.)	P	G	I	F	N	C
Monitoring noise emissions	B	S	I	I	N	B
Regulations for noise emissions from road and rail vehicles	B	G	R	I	N	B
Regulations for noise emissions from tyres	B	G	R	I	N	B
Regulations for noise emissions from road surfaces	B	G	R	I	N	B

Control of noise emissions of aircraft and rail vehicles (continuous control) and road vehicles (spot control)	B	S	R	I	N	A
Industrial location policy and zoning: transport infrastructure connections for industrial and commercial areas	F	M	R	H	N	C
Harmonisation of rail regulations in Europe	B	S	R	C	I	B
Introduce competition in railways systems	B	S	R	C	N	A
Promotion of cooperation among transport branches: support of an interlinked freight logistics system	F	M	R	D	N	C
Speed limits along critical stretches	B	S	R	B	N	A
Car-free urban centres	P	G	R	G	L	B
Implementation of specific action plans in areas where air pollution and noise standards are exceeded	B	S	G	B	L	A
Introduction of mandatory, routine inspection schemes for emissions from registered vehicles	B	S	R	B	L	A
Regulations for NO_x, VOCs, and PM10 emissions from all kinds of vehicles: EURO III and IV	B	G	R	B	I	A
Further strengthening of regulations for NO_x, VOCs, and PM10 emissions from all kinds of vehicles	B	M	R	B	N	B
Further strengthening of regulations concerning emissions of all aromatic hydrocarbons	B	S	R	B	N	A
Development of emission standards for ultra-fine particulates based on number, size, and composition	B	G	R	B	N	C
EU exhaust emission limits for off-road motor vehicles: mandatory standards	B	S	R	B	I	A
Setting of minimum standards for vehicles entering the EU from non-member states	B	M	R	B	I	B
Voluntary agreement by EU and ACEA for reducing CO_2 emissions of cars to 140 g CO2/100km by 2008	P	M	R	B	I	A
Voluntary agreements to improve environmental performance of two-wheeled vehicles and cars	P	S	R	B	N	C
Implementation of action plans based on the Kyoto Protocol	B	G	R	J	N	A
Promotion of measures to reduce the average fuel consumption of vehicles	B	G	R	J	N	C
Promotion of downsizing of vehicles	B	G	R	J	N	B
Enforcement of speed limits and other traffic regulations (higher fines, stricter controls over speed. parking, etc.)	B	S	R	J	N	A

A key to the assessments in the six right-most columns appears in Table 10.

Table 6. Instruments proposed by the Netherlands team

NETHERLANDS Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Access restrictions for combustion vehicles in urban areas	B	V	R	G	L	C
Car-free urban centres	P	M	R	G	L	A
CO_2 taxation on fuels	B	M	F	E	I	C
Creation of network of urban distribution centres	F	S	I	D	N	C
Education/information (especially re. CO_2 tradeable permits)	B	S	E	J	N	A
Energy-efficiency regulations for road vehicles	B	M	R	A	I	B
Expansion of non-motorised infrastructure	P	S	I	F	L	A
Expansion of rail infrastructure	P	S	I	C	N	A
Expansion of transfer terminal networks (e.g., road to rail and water)	F	S	I	C	N	A
Fiscal instruments for flexible housing and job markets	P	S	F	H	N	C
Fiscal instruments for hybrid and electric cars	P	S	F	A	N	C
Fiscal instruments for hybrid and hydrogen freight vehicles	F	S	F	A	N	C
Fiscal instruments of information technology (EDI)	F	S	F	D	N	C
Improvement of the international organisation of rail transport	F	S	I	K	I	C
Information technology to reduce long-distance air transport	B	S	I	F	N	C
Infrastructure for rigid airships	B	M	I	C	N	C
Intelligent speed-adaptation systems	P	V	I	A	N	C
Investments in renewable energy applications for transport	B	M	I	A	N	C
Land use/fiscal policies for scaling down of activities	P	S	R	H	L	C
Location policy for companies that relocate	P	S	R	H	N	A
Location policy for existing companies	B	M	R	H	N	C
Location policy for transport companies	F	S	R	H	N	C
Lower motorway speeds with on-board limiters	B	M	R	A	N	C
Lower speeds on all road types with on-board limiters	B	V	R	A	N	C
Measures to reduce industrial emissions	F	S	R	K	N	A
NO_x and VOC emission regulations for road vehicles	B	V	R	B	I	A
NO_x and VOC emission regulations for ships	F	S	G	B	I	A
Restriction of lorry use in residential areas to daytime	F	M	R	I	L	C
Road pricing	B	M	F	E	N	B
Subsidies to promote containerisation	F	S	F	C	N	A
Subsidies to promote multi-modal transport (companies)	F	S	F	C	N	A
Taxes/subsidies for non-renewable/renewable energy use for all purposes	B	S	F	A	N	A
Taxes/subsidies for non-durable/durable goods	F	M	F	J	N	C
Tradeable CO_2 permits (households and commercial)	B	L	B	A	N	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 7. Instruments proposed by the Norwegian team

NORWAY Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Land use regulation, implementation of a simplified ABC system	P	G	R	H	L	B
Improvements to public transport, new routes	P	M	I	C	L	B
Improvements to public transport, increased frequency of service	P	M	I	C	L	B
Higher parking fees	P	S	F	G	L	A
Increase length of cycle paths	P	G	I	F	L	A
Encourage increased car occupancy by introducing HOV lanes	P	M	R	D	L	C
Technological improvements to vehicles and fuels	P	G	I	A	I	A
Increased telecommuting	P	G	B	F	L	A
Use of information technology to improve traffic management	P	M	I	D	L	A
Use of information technology to improve driver performance	P	M	I	D	L	C
Use of information technology to improve freight logistics (dynamic freight management)	F	M	I	D	L	A
Increased CO_2 tax on fuel	B	G	F	E	N	A
Increased toll rates	P	G	F	E	L	A
Transfer of freight from road to rail	F	G	B	C	L	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 8. Instruments proposed by the Swedish team

SWEDEN Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Increased taxes on petrol and diesel	B	S	F	A	N	A
Scrap subsidies re NO_x and VOCs	B	S	F	B	N	C
Require low level of bio-fuel additive	B	S	R	A	N	B
Establish 'environmental zone' where heavy-duty vehicles are severely restricted	F	S	R	G	L	A
Introduce road tolls	B	S	F	E	N	B
Reduce sulphur in bunker oil	F	S	R	B	I	A
Impose noise-differentiated aircraft landing charges	P	S	F	I	N	A
Improve planning around airports	P	S	R	H	L	A
Provide better organisation of infrastructure planning	B	S	G	C	N	A
Establish a road-pricing scheme in bigger cities for all kinds of vehicles	B	M	R	G	L	B
Reintroduce vehicle tax as part of scrapping program	P	M	F	B	N	C
Address cold-start issue with voluntary requirement for pre-heaters	P	M	E	B	N	A
Tighter emission requirements for road vehicles for NO_x and VOCs	B	M	R	B	I	A
Remove subsidies for pleasure boats	P	M	F	B	N	C
Revise planning laws	B	M	R	H	L	C
Tradeable emission quotas for CO_2	B	L	B	A	N	C
Requirement for biofuel operation in the public sector	B	L	R	A	N	B
Remove tax benefit for diesel fuel	B	L	F	B	N	B
Impose exhaust requirements for vessels re. NO_x and sulphur	B	L	R	B	N	B
Impose exhaust requirements for VOCs from pleasure boats	P	L	R	B	N	B
Impose tighter noise requirements for environmental zones	B	L	R	I	L	B
Impose road charges throughout the country	B	L	F	E	N	C
Auction landing rights to reduce noise	P	L	B	I	N	C
Refine landscape categories	B	L	R	H	L	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 9. Instruments proposed by the Swiss team

SWITZERLAND Instrument	Pass. or Freight	Phasing	Type of instrument	Type of effect	Responsibility	Readiness
Heavy goods vehicle (HGV) tax based on the number of kilometres travelled in Switzerland	F	S	F	E	N	A
European wide HGV tax based on the number of kilometres travelled	F	G	F	E	I	B
CO_2/energy tax	B	G	F	A	N	A
Annual licence fee for cars corresponding to emission levels	B	M	F	C	N	C
Road pricing in urban areas	B	L	F	G	N	C
Railways: improve rail-road intermodality inside and outside Switzerland	F	M	I	C	I	A
Railways: international harmonisation of regulations	B	S	G	C	I	A
Railways: introduce competition	B	S	R	C	N	A
Railways: improvement of service and logistics	B	S	I	C	N	A
Exhaust standards for CO_2	B	G	R	A	I	C
Energy supply: subsidise production of renewable energy	B	S	I	A	N	B
Energy supply: subsidise development of energy efficient technology	B	S	I	A	N	A
Traffic calming in towns: 30km/h limit	B	S	R	G	L	A
Traffic calming in towns: reducing parking space	P	M	R	G	L	C
Traffic calming in towns: reducing road space for cars, providing more for others	B	M	R	G	L	C
Traffic calming in towns: motor traffic bans, pedestrian zones	B	S	R	G	L	A
Traffic calming in towns: improving route networks and other facilities for pedestrians and cyclists	P	M	I	F	L	A
Traffic calming in towns: improving city-logistics	F	L	I	D	L	C
Public transport: priority for public transit vehicles	P	S	R	C	L	A
Public transport: improving information systems	P	M	I	C	L	A
Public transport: increasing frequency, extending networks	P	M	I	C	L	A
Public transport: service agencies for sustainable mobility	P	S	I	C	L	A
Public transport: expanded car-sharing network	P	M	I	C	N	A
Education: Training drivers in eco-efficient driving	P	S	E	A	N	A
Regional tourism: car-free tourist resorts	P	S	R	F	L	C
Regional tourism: expanded cycle route network	P	S	I	F	L	A
Land use: planning for low traffic levels	B	G	R	H	L	A
Land use: reform construction regulations concerning the providing of parking facilities	B	M	R	H	L	C
Land use: promote housing and town development	B	M	E	H	L	A
Noise: regulations for road vehicles	B	G	R	I	I	C
Noise: regulations for tyres	B	G	R	I	I	C
Noise: regulation for surfaces	B	G	R	I	N	C

A key to the assessments in the six right-most columns appears in Table 10.

Table 10. Key to assessments of instruments in Tables 1-9

Passenger or freight: P = Passenger; **F** = Freight; **B** = Both.

Phasing of implementation: G = Gradually, over the period 2000-2030; **S** = short term (<2005); **M** = medium term (2005-2009); **L** = long term (2010-2014); **V** = very long term (>2014).

Type of instrument: F = Fiscal (fee or subsidy); **R** = Regulatory; **B** = Both fiscal and regulatory; **I** = Investment, usually by government; **E** = Educational or hortatory; **G** = Involving a change in governance arrangements.

Type of effect sought: A = Reduce the impacts of motorised transport activity on the global environment by specific measures; **B** = Reduce the impacts of motorised transport activity on the regional and local environment by specific measures; **C** = Improve the environmental performance of motorised transport activity by mode shifts; **D** = Reduce overall motorised transport activity by increasing occupancy or otherwise improving logistics; **E** = Reduce overall motorised transport activity by raising its cost or by imposing other penalties; **F** = Reduce overall motorised transport activity by favouring non-motorised alternatives; **G** = Reduce motor transport activity in specific locations; **H** = Make land use or economic arrangements more conducive to sustainable transportation; **I =** Reduce noise; **J** = Other types of effect including changing attitudes, culture, ways of living, and acceptance of strong measures; **K** = General actions, or specific actions not included above.

Responsibility for action: I = International; **N** = National/state/provincial; **L** = Local/regional

Readiness: A = instrument already in use; **B** = instrument now under consideration; **C** = instrument not yet under consideration.

Table 11. Instruments used in Phase 3 of the EST project organised by type of effect and type of instrument

Austria (Au), Canada (Ca), France (Fr), Germany (Ge), Italy (It), Netherlands (Ne), Norway (No), Sweden (Se), Switzerland (Sw)

Type of effect	Type of instrument	Instrument	Country
Reduce the impacts of motorised transport activity on the global environment by specific measures	Both fiscal and regulatory	Tradable CO_2 permits	Ca
		Aviation: tradable permits for CO_2 emissions	Ge
		Tradable CO_2 permits (households and commercial)	Ne
		Tradable emission quotas for CO_2	Se
		Tradable CO_2 permits, energy industries	Fr
		Tradable emission quotas for CO_2	Fr
	Educational or hortatory	Fuel-efficient driving training	Au
		Provision of consumer information about CO_2-efficient cars	Au
		Voluntary agreements to improve environmental performance	Au
		Education: Training drivers in eco-efficient driving	Sw
		Strict control of speeds and driving times of heavy-duty vehicles	Fr
		Promote use of biofuels in the public sector	Fr
		Voluntary CO_2 emission level standards for passenger cars	Fr
		Consumer information on CO_2-efficient cars	It
	Fiscal (fee or subsidy)	Road pricing for Heavy Duty Vehicles (HDV) on motorways	Au
		Coverage of infrastructure maintenance costs of freight and passenger transport, internalising external environmental and health costs of freight and passenger transport (e.g., road pricing)	Au
		Tradable permit system for CO_2 emissions from HDV (long term)	Au
		Tradable permit system for CO_2 emissions from passenger cars (long term)	Au
		Incentives for buying ultra low emission and zero emission vehicles (e.g. hybrid and fuel-cell-powered HDV, LDV, and cars): pilot actions, then potential implementation on a large scale	Au
		Modification of the fuel-consumption-based car purchase tax	Au
		Promotion of measures to reduce the average fuel consumption of vehicles	Au
		Fuel pricing: 2¢/l/y on petrol and diesel	Ca
		Energy supply: tax on CO_2 emissions or on energy use	Ge
		Aviation: emission-related charges	Ge
		Aviation: taxation of kerosene	Ge
		Fiscal instruments for hybrid and electric cars	Ne
		Fiscal instruments for hybrid and hydrogen freight vehicles	Ne
		Taxes/subsidies for non-renewable/renewable energy use for all purposes	Ne
		Increased taxes on petrol and diesel	Se
		CO_2/energy tax	Sw
		Heavy-duty vehicle tax based on tonne-kilometres transported	Fr
		Taxes/subsidies non-renewable/renewable energy	Fr
		Incentives for hybrid power trains and fuel cells for heavy-duty vehicles	Fr
		Incentives for hybrid and electric cars	Fr
		Internalising external environmental and health costs of freight and passenger transport	It
		Tradable permit system for CO_2 emissions from heavy-duty vehicles and passenger cars	It
		Incentives for ultra-low and zero emission vehicles (e.g., electric mopeds, electric and hybrid cars)	It
		Carbon tax	It
		Promotion of alternative fuels (e.g., H_2, biofuels)	It
	Investment, usually by government	Promotion of research into and development of non-fossil-fuel-driven engines: pilot actions, then potential implementation on a large scale	Au

		Energy supply: subsidise energy saving technology	Ge
		Intelligent speed-adaptation systems	Ne
		Investments in renewable energy applications for transport	Ne
		Technological improvements to vehicles and fuels	No
		Energy supply: subsidise production of renewable energy	Sw
		Energy supply: subsidise development of energy efficient technology	Sw
		Investments in biofuels	Fr
	Regulatory	CO_2 emission standards for cars and LDV	Au
		Reduce intercity speeds	Ca
		Impose strict fuel-efficiency standards	Ca
		CO_2 standards for vehicles	Ge
		Energy supply: reform energy legislation	Ge
		Aviation: exhaust standards for NO_x and CO_2	Ge
		Energy-efficiency regulations for road vehicles	Ne
		Lower motorway speeds with on-board limiters	Ne
		Lower speeds on all road types with on-board limiters	Ne
		Require low level of bio-fuel additive	Se
		Requirement for biofuel operation in the public sector	Se
		Exhaust standards for CO_2	Sw
		CO_2 standards for passenger cars	Fr
		Reduce intercity speeds	Fr
Reduce the impacts of motorised transport activity on the regional and local environment by specific measures	Educational or hortatory	Promote penetration of alternative fuels	Ca
		Develop MoU with vehicle manufacturers for enhanced PNGV	Ca
		Address cold-start issue with voluntary requirement for pre-heaters	Se
	Fiscal (fee or subsidy)	Promotion of introduction of new technologies (e.g., ZEV) in general and for special purposes: pilot actions, then potential implementation on a large scale	Au
		Promotion of alternative fuels (H_2, RME, CNG, LPG, etc.): pilot actions, then potential implementation on a large scale	Au
		Use of an ecopoint system for freight transit lorries	Au
		Reduce annual licence fees for low-emission vehicles	Ca
		Provide incentives for fleet turnover	Ca
		Provide incentives for fuel cells for HDVs	Ca
		Scrap subsidies re NO_x and VOCs	Se
		Reintroduce vehicle tax as part of scrapping program	Se
		Remove subsidies for pleasure boats	Se
		Remove tax benefit for diesel fuel	Se
		Tax reduction on LPG, GNV	Fr
		Subsidies for electric vehicles	Fr
		Fuel tax reduction for public transportation	Fr
		Subsidies for urban-only cars	Fr
		Subsidies to early replacement of older cars	Fr
		Annual licence fee for cars based on emission levels	Fr
		Incentives for converting cars from petrol to LPG and methane	It
	Involving a change in governance arrangements	Development of guidelines for management of traffic according to ecological requirements	Au
		NO_x and VOC emission regulations for ships	Ne
		Ecopoint system for freight transport lorries	It
		Implementation of specific action plans in areas where air pollution and noise standards are exceeded	It
	Regulatory	Night ban on noisy lorries	Au
		Night ban for all lorries in sensitive areas	Au
		Speed limits along critical stretches	Au
		Reduction of speed limits on roads in general	Au

		Introduction of mandatory, routine inspection schemes for pollutant emissions of registered vehicles: introduction, then potential mandatory inspection and maintenance programme	Au
		Improvement of exhaust emission testing procedures for pollutant emissions of all road vehicles: introduction, then potential mandatory inspection and maintenance programme	Au
		Regulations for NO_x, VOCs, PM_{10} emissions for all kinds of vehicles: EURO III and IV, then potential further strengthening	Au
		Development of emission standards for ultra-fine particulates based on number, size, and composition	Au
		EU exhaust emission limits for off-road motor vehicles: introduction of mandatory standards, then potential strengthening of the standards	Au
		Setting of minimum standards for vehicles entering the EU from non-member states	Au
		Further lowering of sulphur content in fuel (<10 ppm)	Au
		Stricter requirements for fuel quality in sensitive areas	Au
		Voluntary agreement by EU and ACEA for reducing specific CO_2 emissions of cars to 140 g CO_2/100 km in 2008	Au
		Mandatory emissions inspection	Ca
		Mandate in-vehicle technology to modify driver behaviour	Ca
		Require 50% car/truck advertising to be for 'clean' vehicles	Ca
		NOx and VOCs emission regulations for road vehicles	Ne
		Reduce sulphur in bunker oil	Se
		Tighter emission requirements for road vehicles for NO_x and VOCs	Se
		Impose exhaust requirements for vessels re. NOx and sulphur	Se
		Impose exhaust requirements for VOCs from pleasure boats	Se
		Exhaust standards for NO_x and VOCs	Fr
		On-the-road inspection of heavy-duty vehicle emissions	Fr
		On-the-road inspection of light-duty vehicle emissions, carbon monoxide and smoke	Fr
		Mandatory emissions inspection	Fr
		Priority for urban cars	Fr
		Speed limits along critical stretches	It
		Introduction of mandatory, routine inspection schemes for emissions from registered vehicles	It
		Regulations for NO_x, VOCs, and PM_{10} emissions from all kinds of vehicles: EURO III and IV	It
		Further strengthening of regulations for NO_x, VOCs, and PM_{10} emissions from all kinds of vehicles	It
		Further strengthening of regulations concerning emissions of all aromatic hydrocarbons	It
		Development of emission standards for ultra-fine particulates based on number, size, and composition	It
		EU exhaust emission limits for off-road motor vehicles: mandatory standards	It
		Setting of minimum standards for vehicles entering the EU from non-member states	It
		Voluntary agreement by EU and ACEA for reducing CO2 emissions of cars to 140 g CO_2/100km by 2008	It
		Voluntary agreements to improve environmental performance of two-wheeled vehicles and cars	It
Improve the environmental performance of motorised transport activity by mode shifts	Both fiscal and regulatory	Transfer of freight from road to rail	No
	Educational or hortatory	Mobility management for enterprises: pilot actions, then promotional programmes and incentives, then potential mandatory implementation	Au
		Implementation of a nation-wide travel information system	Au
		Establishment of mobility management centres: pilot actions, then potential implementation on a large scale	Au
		Encourage employer sponsored trip-reduction programs	Ca
		Implementation of a nation-wide travel information system	It

	Fiscal (fee or subsidy)	Taxes/incentives for employee travel: tax parking, allow pass as deduction	Ca
		Provide tax incentives for privately run railways	Ca
		Subsidies to promote containerisation	Ne
		Subsidies to promote multi-modal transport (companies)	Ne
		Annual licence fee for cars corresponding to emission levels	Sw
		Subsidies to promote multi-modal transport	Fr
		Incentives for public transport fleet renewal	It
	Involving a change in governance arrangements	Harmonisation of rail regulations in Europe	Au
		Establish full PT integration within urban regions	Ca
		Railways: international harmonisation of regulations and technology	Ge
		Provide better organisation of infrastructure planning	Se
		Railways: international harmonisation of regulations	Sw
		Organise transport at the European level	Fr
		Railways: international harmonisation of regulations	Fr
	Investment, usually by government	Improvement and extension of rail-road intermodality inside and outside the Alpine Region	Au
		Extension of rail infrastructure	Au
		Improvement of rail service quality for freight transport (regularity etc.)	Au
		Improvement of public transport infrastructure (stations, rolling stock etc.)	Au
		Improvement of combined transport infrastructure (terminals, new loading technologies)	Au
		Improvement of public transport service and operation (regularity, safety, etc.)	Au
		Provide funds for rapid transit expansion	Ca
		Public transport: improving information systems	Ge
		Public transport: increasing frequency, extending networks	Ge
		Public transport: service agencies for sustainable mobility	Ge
		Railways: extension of rail infrastructure	Ge
		Railways: improve rail-road intermodality	Ge
		Expansion of rail infrastructure	Ne
		Expansion of transfer terminal networks (e.g., road to rail and water)	Ne
		Infrastructure for rigid airships	Ne
		Improvements to public transport, new routes	No
		Improvements to public transport, increased frequency of service	No
		Railways: improve rail-road intermodality inside and outside Switzerland	Sw
		Railways: improvement of service and logistics	Sw
		Public transport: improving information systems	Sw
		Public transport: increasing frequency, extending networks	Sw
		Public transport: service agencies for sustainable mobility	Sw
		Public transport: expanded car-sharing network	Sw
		Expansion of rail infrastructure for freight and passenger	Fr
		Expansion of TGV infrastructure	Fr
		Expansion of network of road-rail and road-water transfer terminals	Fr
		Railways: better service and improved logistics for freight	Fr
		Provide funds for rapid expansion of public transport	Fr
		Public transport: increasing frequency, extending networks	Fr
		Improvement and expansion of rail-road intermodality in and outside the Alpine Region	It
		Expansion of rail infrastructure	It
		Improvement of rail service quality for freight transport (regularity etc.)	It
		Improvement of public transport infrastructure	It
		Improvement of combined transport infrastructure (terminals, new loading technologies)	It

		Improvement of public transport: service and operations	It
	Regulatory	Industrial location policy and zoning: railway connections for industrial parks and commercial areas	Au
		Review and adaptation of public transport legislation	Au
		Public transport: priority for PT vehicles	Ge
		Railways: introduce competition	Ge
		Railways: introduce competition	Sw
		Public transport: priority for public transit vehicles	Sw
		Priority for public transport vehicles	Fr
		Harmonisation of rail regulations in Europe	It
		Introduce competition in railways systems	It
Minimize overall motorised transport activity by increasing occupancy or otherwise improving logistics	Educational or hortatory	Freight consolidation	No
	Fiscal (fee or subsidy)	Fiscal instruments of information technology (EDI)	Ne
	Involving a change in governance arrangements	Promotion of cooperation between transport branches: support for an interlinked freight logistics system	Au
	Investment, usually by government	Introduction of road traffic management systems	Au
		Promotion of new forms of passenger transport: pilot actions re. car sharing, then potential implementation at a large scale	Au
		Promotion of new forms of passenger transport: pilot actions re. flexible demand-oriented systems, then potential implementation on a large scale	Au
		Railways: improve service and logistics	Ge
		Aviation: optimise air transport management system	Ge
		Creation of network of urban distribution centres	Ne
		Use of information technology to improve traffic management	No
		Use of information technology to improve driver performance	No
		Use of information technology to improve freight logistics (dynamic freight management)	No
		Traffic calming in towns: improving city-logistics	Sw
		Promotion of new forms of passenger transport: car sharing	It
	Regulatory	HOV/HOT lanes for all urban expressways	Ca
		Encourage increased car occupancy by introducing HOV lanes	No
		Promotion of cooperation among transport branches: support of an inter-linked freight logistics system	It
MInimize overall motorised transport activity by raising its cost or by imposing other penalties	Fiscal (fee or subsidy)	Road pricing for passenger cars on motorways	Au
		Extension of road pricing to the whole road network	Au
		Parking management and imposing parking fees in some towns	Au
		Parking management and imposing parking fees in all towns >10,000 inhabitants	Au
		Road tolls: on urban expressways	Ca
		Road tolls: on urban arterials	Ca
		Road tolls: on key intercity highways	Ca
		Variabilise insurance	Ca
		Fuel taxation	Ge
		Road pricing for heavy duty vehicles	Ge
		CO_2 taxation on fuels	Ne
		Road pricing	Ne
		Increased CO_2 tax on fuel	No
		Increased toll rates	No
		Introduce road tolls	Se
		Impose road charges throughout the country	Se
		Heavy goods vehicle (HGV) tax based on the number of kilometres travelled in Switzerland	Sw

		European wide HGV tax based on the number of kilometres travelled	Sw
		Road pricing for heavy-duty vehicles	Fr
		Remove tax benefit for diesel fuel	Fr
		Fuel-tax harmonisation at upper level in the EU	Fr
		Road tolls on urban expressways	Fr
		Road tolls on urban arterial roads	Fr
		Road tolls on key intercity highways	Fr
		Taxes/incentives for employee travel; tax on employee parking	Fr
		Road pricing on motorways	It
		Road pricing for roads with high environmental/social interest	It
		Parking management and parking fees in towns	It
		Taxing car use instead of car ownership	It
	Regulatory	Access restrictions for conventional vehicles in urban areas	Fr
Minimize overall motorised transport activity by favouring non-motorised alternatives	Both fiscal and regulatory	Increased telecommuting	No
	Educational or hortatory	Implement walking school bus programs unilaterally	Ca
	Involving a change in governance arrangements	Substitution for physical transport: teleworking	Au
		Substitution of teleworking for physical transport	It
	Investment, usually by government	Improvement of infrastructure for walking and cycling	Au
		Promotion of new forms of passenger transport: pilot actions re. measures for car-free tourism (charter-trains etc.), then potential implementation on a large scale	Au
		Improve bicycle lanes and other facilities	Ca
		Traffic calming in towns: increase areas for pedestrians, cyclists, and public transport	Ge
		Expansion of non-motorised infrastructure	Ne
		Information technology to reduce long-distance air transport	Ne
		Increase length of cycle paths	No
		Traffic calming in towns: improving route networks and other facilities for pedestrians and cyclists	Sw
		Regional tourism: expanded cycle route network	Sw
		Improve bicycle lanes and other facilities	Fr
		Improvement of pedestrian and cycling infrastructure	It
		Promotion of new forms of passenger transport: measures for car-free tourism (charter-trains, etc.)	It
	Regulatory	Traffic calming in towns: 30 km/h limit	Ge
		Traffic calming in towns: motor traffic bans	Ge
		Regional tourism: car-free tourist resorts	Sw
		Car-free urban centres	Fr
Reduce motorised transport activity in specific locations	Fiscal (fee or subsidy)	Restructuring and ensuring adequate financing of public transport	Au
		Financing of extended public transport services	Au
		Set minimum urban parking prices	Ca
		Set minimum rural parking prices	Ca
		Higher parking fees	No
		Road pricing in urban areas	Sw
		Set minimum urban parking prices	Fr
	Involving a change in governance arrangements	Development of market-based mechanisms to limit traffic through ecologically sensitive regions on an EU-wide basis	Au
	Regulatory	Traffic calm city streets	Ca
		Traffic calming in towns: parking management	Ge
		Access restrictions for combustion vehicles in urban areas	Ne
		Car-free urban centres	Ne

		Establish 'environmental zone' where heavy-duty vehicles are severely restricted	Se
		Establish a road-pricing scheme in bigger cities for all kinds of vehicles	Se
		Traffic calming in towns: 30km/h limit	Sw
		Traffic calming in towns: reducing parking space	Sw
		Traffic calming in towns: reducing road space for cars, providing more for others	Sw
		Traffic calming in towns: motor traffic bans, pedestrian zones	Sw
		Traffic calming in towns: 30km/h limit	Fr
		Reduce zoning requirements for parking	Fr
		Car-free urban centres	It
Make land use or economic arrangements more conducive to sustainable transportation	Educational or hortatory	Campaigning and marketing for preference changes in housing and land use	Au
		Land use: promote housing and town development	Sw
		Land use: promote compact urban development	Fr
	Fiscal (fee or subsidy)	Reorientation and restructuring of public subsidies and provincial support (e.g., for housing) to facilitate sustainable development	Au
		Restructure land taxation (provide "fuller cost" taxation)	Ca
		Regional economics: reform subsidy programmes	Ge
		Land use: charges in land use	Ge
		Land use: tax parking opportunities	Ge
		Land use: reform housing subsidy programs	Ge
		Land use: promote town reconstruction and housing	Ge
		Fiscal instruments for flexible housing and job markets	Ne
		Restructure land taxation (provide "fuller cost" taxation)	Fr
		Land use: tax parking opportunities	Fr
	Involving a change in governance arrangements	Integration of environment targets and requirements into transport policies and programmes (e.g., strategic environmental impact assessments): pilot studies, then potential integration into transport policies	Au
		Giving priority to landscape compatibility in planning and building traffic infrastructure	Au
		Land use: improve co-operation among regional planning institutions	Ge
		Plans for urban mobility in towns with more than 100,000 inhabitants	Fr
		Integration of environment targets and requirements into transport policies and programmes (e.g., strategic environmental assessments)	It
		Integration of environmentally oriented transport and land-use planning	It
	Investment, usually by government	Regional economics: support regional markets	Ge
		Regional tourism: provide support	Ge
		Regional tourism: improve nature conservation	Ge
	Regulatory	Land use and zoning: higher density, promotion of mixed-use areas	Au
		Parking management in towns, reducing the number of parking spaces	Au
		Review and adaptation of traffic regulations, land-use legislation, and infrastructure guidelines	Au
		Review and adaptation of parking and garage legislation	Au
		Reduce zoning requirements for parking	Ca
		Require environmental assessment of new development	Ca
		Stricter land use controls: growth boundaries and minimum densities	Ca
		Land use: planning for low traffic levels	Ge
		Land use: reform construction planning regulations	Ge
		Land use/fiscal policies for scaling down of activities	Ne
		Location policy for companies that relocate	Ne
		Location policy for existing companies	Ne
		Location policy for transport companies	Ne
		Land use regulation, implementation of a simplified ABC system	No
		Improve planning around airports	Se

		Revise planning laws	Se
		Refine landscape categories	Se
		Land use: planning for low traffic levels	Sw
		Land use: reform construction regulations concerning the providing of parking facilities	Sw
		Reform of development regulations concerning parking facilities	Fr
		Location policy for companies that relocate	Fr
		Location policy for existing companies and for new industries	Fr
		Industrial location policy and zoning: transport infrastructure connections for industrial and commercial areas	It
Reduce noise	Both fiscal and regulatory	Auction landing rights to reduce noise	Se
	Fiscal (fee or subsidy)	Establishing criteria for "low-noise motor vehicles" and incentives for operating such vehicles: pilot actions, then potential implementation on a large scale	Au
		Impose noise-differentiated aircraft landing charges	Se
	Investment, usually by government	Promotion of research into and development of noise abatement: pilot actions, then potential implementation on a large scale	Au
		Installation of permanent recording stations to monitor noise	Au
		Monitoring noise emissions	It
	Regulatory	Regulations for noise from road and rail vehicles: introduction and then potential strengthening of standards	Au
		Regulations for noise from tyres	Au
		Regulations for noise from road surfaces	Au
		International specification of measuring methods and limit values for noise, establishing testing procedures and noise limits for tyres	Au
		Introduction of regular control of noise from all motor vehicles in use	Au
		Routine control of track conditions, implementation of maintenance measures in residential areas	Au
		Noise: regulations for rail vehicles	Ge
		Noise: regulations for road vehicles	Ge
		Noise: regulations for tires	Ge
		Noise: regulations for surfaces	Ge
		Restriction of lorry use in residential areas to daytime	Ne
		Impose tighter noise requirements for environmental zones	Se
		Noise: regulations for road vehicles	Sw
		Noise: regulations for tyres	Sw
		Noise: regulation for surfaces	Sw
		Noise: regulations for rail vehicles	Fr
		Noise: regulations for road vehicles	Fr
		Noise: regulations for tyres	Fr
		Noise: regulation for surfaces	Fr
		Tighter noise requirements for environmental zones	Fr
		Regulations for noise emissions from road and rail vehicles	It
		Regulations for noise emissions from tyres	It
		Regulations for noise emissions from road surfaces	It
		Control of noise emissions of aircraft and rail vehicles (continuous control) and road vehicles (spot control)	It
Other types of effect including changing attitudes, culture, ways of living, and acceptance of strong measures	Educational or hortatory	Raising public awareness of traffic-related environmental impacts	Au
		Incorporation of environment impact and sustainable mobility into teaching materials, methods, and lessons from kindergarten to university: pilot actions, then potential implementation on a large scale	Au
		Establishing a database impacts of transport on environment	Au
		Public participation in transport planning: pilot action, then potential implementation on a large scale	Au
		Require EST instruction in schools	Ca

		Implement nationwide awareness programme	Ca
		Recognize community "champions"	Ca
		Education/information (especially re. CO2 tradeable permits)	Ne
		Implement nationwide awareness programme	Fr
		Education and information programmes	Fr
		Public awareness raising for traffic-related environmental impacts	It
		Car-free day initiatives	It
		Introduction of environment impacts and sustainable mobility into teaching materials, methods, and lessons	It
	Fiscal (fee or subsidy)	Ecotax-reform, raising energy costs and lowering labour costs, eco-bonus	Au
		Taxes/subsidies for non-durable/durable goods	Ne
	Involving a change in governance arrangements	Integration of environmentally oriented transport and land use planning	Au
		Evaluation and control of achievement of the environmental targets: pilot actions, then potential implementation	Au
		Implementation of action plans based on international commitments (e.g., Kyoto protocol, UN-ECE Vienna Declaration, WHO-Charter Trans-port/Environment/Health)	Au
		Promoting pilot projects and actions for sustainable transport and broad implementation of their results	Au
		Evaluation and control of the achievement of the environmental targets	It
	Investment, usually by government	Providing road infrastructure for traffic calming in towns and settlements	Au
	Regulatory	New design standards for transport infrastructure	Au
		Investigation of the impact of dust due to grit, oil, road and tyre wear, and particulate pollutants	Au
		Implementation of action plans based on the Kyoto Protocol	It
		Promotion of measures to reduce the average fuel consumption of vehicles	It
		Promotion of downsizing of vehicles	It
		Enforcement of speed limits and other traffic regulations (higher fines, stricter controls over speed. parking, etc.)	It
General actions, or specific actions not included above	Involving a change in governance arrangements	Implementation of specific action plans in areas where air pollution concen-tration levels and noise exposure levels are exceeded: pilot actions, then potential implementation on a large scale	Au
		Establish coordinating board for EST attainment	Ca
	Investment, usually by government	Establish data centre	Ca
		Improvement of the international organisation of rail transport	Ne
	Regulatory	Measures to reduce industrial emissions	Ne

End of Table 11

Appendix B: Economic Analyses

NOTE: Appendix B comprises reports on assessment of the economic implications of EST (Part I) and estimation of external costs of EST (Part II), both in relation to BAU. The reports have been prepared by the OECD Secretariat based on the EST case studies conducted by the nine participating countries. Each of the two Parts of Appendix B is self-contained with respect to the numbering of sections and illustrative material. References (on Page 164) are common to the two Parts, but do not relate to the End Notes for the main report (which begin on Page 165).

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PART I:

ASSESSMENT OF THE ECONOMIC IMPLICATIONS OF EST

SUMMARY

The purpose of this part of the report is to present the main conclusions of the impact assessment carried out by the country teams participating in the EST project. Sections 2-4 provide a review of economic models and their methodology for evaluating the economic effects of the EST scenarios, including Classical Assessment Methods and System Dynamics Modelling with an application variant, Impact Path Analysis. Sections 5 and 6 present application of the models to individual case studies. Section 7 presents the principal results. The conclusion drawn from the assessments is that overall the economic implications of the implementation of EST will be slight, although the transition to EST will require significant structural adjustments. The latter could be easily reduced if EST objectives were to be less ambitious or their attainment spread over a long time period.

1. CONTEXT

The EST project was initiated in late 1994 to address the problem of unsustainable transport trends. It used a backcasting methodology, which consists of defining EST, characterising it in terms of criteria that serve as concrete targets, and identifying and applying the instruments required to achieve the wanted future (OECD, 1996, 1998/99). The projections of current 'business-as-usual' (BAU) trends to 2030 suggest significant increases in carbon dioxide emissions, noise, land take, and resource use, with some reductions in emissions of other pollutants. To realise an EST system in the long term, ecological limits must be met, pollution and noise must be prevented, and land take must be minimised.

Teams from nine countries developed case studies that describe how an environmentally desirable future could be achieved: Sweden, The Netherlands, Germany, the Quebec-Windsor corridor in Canada, the Greater Oslo region, and the Alpine region comprising all or parts of Austria, Italy, France, and Switzerland.

The Norwegian study covered the moderately congested urban area of Greater Oslo. The studies for Canada and the Alpine region (including Austria, parts of southeast France and northern Italy, and Switzerland) were corridor studies. Those for Germany, The Netherlands, and Sweden covered the entire countries. Thus, the regional scope and nature of environmental problems differed considerably among these studies.

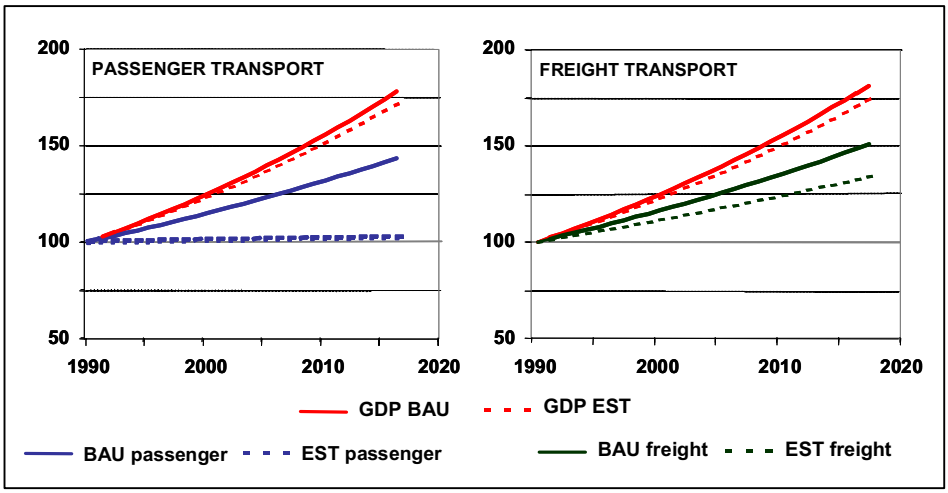
In most of the case studies, all transport modes were considered (road, rail, waterways, and air transport) with some variants for each study. In the Alpine study, the analysis also distinguished inner and intra-Alpine passenger and trans-alpine freight transport by rail and road.

Characteristics of the EST Scenario compared to the Business-as-Usual (BAU) trend

Three EST scenarios were constructed for the year 2030 as well as a BAU scenario The BAU scenario was characterised as the transport system in 2030 assuming present and planned technology and legislation supplemented by likely changes. The final EST scenario developed—the one used in the economic analyses—incorporated the most realistic elements of the technology and the mobility management scenarios.

The BAU trend projections were based on economic forecasting. They showed that passenger and freight transport will increase significantly but with lower growth rates than in the past. The EST scenarios projected much less growth of transport activity due to significant mode shifts, transport avoidance, and increasing load factors and efficiency. Figure 1 shows the projected increases in passenger and freight movement (as indexed passenger-kilometres and tonne-kilometres) for the BAU and the EST scenarios over the next few decades. Figure 1 also shows GDP projections under BAU and EST, to be discussed below.

Figure 1. Economic and transport activity projections for the BAU and EST scenarios (1990 values = 100)



In the BAU scenarios, approximately 80% of transport will more environmentally harmful (i.e., passenger cars, airplanes, light-duty commercial vehicles, and heavy-duty trucks), whereas in the EST scenarios, these modes are replaced by less environmentally harmful modes so that 60% of transport activity will come from the latter. The EST scenarios maintain the high mobility level of today for passenger and freight movements and even project overall increases of 21% compared to 1990 levels (OECD, 2001).

The **EST scenarios** are characterised as follows: There is a significant change in current forms of individual motorised transport (i.e., car ownership and use) towards new forms of integrated multi-modal mobility using public-private vehicles having hybrid electric-ICE (internal combustion engine) drive-trains or fuel cell systems, resulting in significantly fewer environmental impacts. Air travel and long-distance passenger and freight movement by road are substantially reduced and replaced by other modes (e.g., highly performing rail-based systems).

Generally, transport in 2030 is characterised by a massive shift from less sustainable to more sustainable modes accompanied by a relative decrease in transport activity compared to the BAU projections, but overall higher mobility levels than in 1990. Changes in transport activity and modal split will be important in EST. Therefore, different methods have to be examined for assessment of the economic implications of the EST scenario compared with the BAU scenario.

The main focus of the assessment is to evaluate the economic impacts of attaining EST as compared with continuation of current trends towards BAU. This requires evaluation of the impacts in terms of indicators of material wealth (consumption, employment) and non-material wealth (lives saved, health improved, and natural resources preserved, etc.) as discussed in Chapter 3 of the main report.

Methods used for economic assessment of the EST and BAU scenarios

The **assessment** addressed the following issues: the differences in the economy under the EST and

BAU scenarios; the economic costs and benefits of the two scenarios at various levels (i.e., for individuals and households, for business of all sizes, and for local, regional, and national governments); the impacts on employment levels and other indicators, and who would be winners and losers under the BAU and EST scenarios.

Methods of two types were reviewed to evaluate the economic effects of the EST scenarios:

- classical methods such as private rate of return (PRR), cost-benefit analysis (CBA), cost-efficiency analysis (CEA), and multi-criteria analysis (MCA) with cardinal/ordinal scales; and
- System Dynamics Modelling and Simplified Cybernetic Modelling (specifically Impact Path Analysis).

This report presents these two types of method, their methodology, and the principal results of the application of them to the Member country case studies.

2. CLASSICAL ASSESSMENT METHODS

Classical methods reviewed for the EST project include the following: private rate of return (PRR), cost-benefit analysis (CBA), multi-criteria analysis with cardinal scales and ordinal scales, and cost-efficiency analysis (CEA). Private rate of return (PRR) and cost benefit analysis (CBA) presuppose monetary valuation of all effects. PRR methods allow assessors to evaluate the direct effects, whereas CBA can be used when evaluating indirect effects. Applied to EST they require a projection of the impacted demand and supply functions in order to derive the consumer and producer surpluses (positive and negative) for each market considered. A major problem is that many measures for estimating the reactions of consumers to changes in the state of the world are calibrated on the basis of past surveys whose results cannot reasonably be projected forward over long time periods.

In many cases, monetary valuation is not possible for reasons of data availability. Then, multi-criteria analysis (MCA) can be applied using cardinal or ordinal scales. A utility index is constructed that allows for ranking of the alternatives for decision-making. The values are estimated by expert judgements.

Cost-efficiency analysis (CEA) is a variant of CBA and MCA. This method allows assessors to subdivide objectives into cost-related and efficiency-related objectives. Two indicators are constructed, a cost indicator and an efficiency indicator. If the alternatives show the same costs, then the alternative associated with the maximum efficiency is chosen. If cost and efficiency indicators are equal, the alternative with lower costs is the rational choice.

Monetary evaluation of the economic impacts of EST can be estimated using these four methods. For other effects, a quantitative evaluation is possible but not in monetary terms. Use of cardinal scales enables assessment of them through summarising all monetary and cardinal evaluation to provide a cardinal measure of utility. However, some effects cannot be measured in terms of money or cardinal utility. An example is visual intrusion in urban environments or in rural landscape. Only nominal or ordinal scales can be applied (using the judgements better, equal or worse). The final aggregation of the individual impacts has to be performed in this case using ordinal scales (MCAO).

To conclude, classical methods are more appropriate for assessing marginal changes in the state of the world. They cannot be used to assess the economic implications of EST, which will involve major changes from present systems. Classical methods follow one-directional impacts and do not take account of feedback mechanisms such as exist among transport, the socio-economic system, and the ecological system. Furthermore, classical assessment methods can be applied forward for a period of only ten to fifteen years, whereas the time horizon of the BAU and EST scenarios is about 35 years and could easily extend to 50 years.

3. ASSESSMENT USING SYSTEM DYNAMIC MODELLING

System Dynamics Modelling (SDM) is based on a mathematical set of dynamic equations. It can show the dynamic behaviour of complex systems such as the biological, biophysical, and social systems. It was used to develop the long-term forecasts of the Club of Rome and has been used in bio-cybernetic experiments concerning the social impacts of industrial and transport development.

The basic elements of a SDM consist of sets of variables—state variables (levels, reservoirs, e.g., population), flow variables (rates, changes, e.g., population growth), and auxiliary variables (e.g., mobility rates of population cohorts)—and the dynamic relationships among them. The dynamic relationships are represented as feedback loops that can be positive or negative, i.e., self-reinforcing or dampening.

Relationships among transport infrastructure, traffic growth, and changes in spatial development patterns illustrate self-reinforcing feedback loops. Positive and negative impacts both play important roles in the balance of the system. SDM takes into account the major feedback mechanisms that govern the relationships between the socio-economic and the ecological systems in the long run.

Dealing with complex systems requires decomposition of them into significant subsystems (or modules) to render them manageable. The complex dynamic relationships need to be divided into simpler subsystems, and the plausibility of the chosen inputs checked in order to define the links among the various subsystems.

For example, a possible structure of a SDM could include four subsystems: population/society, economy, spatial patterns, and transport. Time profiles for all defined variables are obtained by resolving the dynamic equations that characterise this mathematical system. The second step consists of choosing a small set of performance indicators to aggregate the dynamic profiles generated by the SDM.

This procedure results in an appraisal that summarises the economic assessment. For example, an approximate dynamic **cost-benefit calculation** scheme can be developed to evaluate infrastructure and operation costs, time consumption, internal traffic-activity benefits, and external costs of accidents and environment impacts.

The most important **drawback** of SDM is its requirement for information. It requires substantial resources for its application and the input of data that may not be available. The modeller can try to compensate for this by introducing data in the form of curves that represent observations of the past or subjective value judgements. If this is done, accuracy can be lost and the quantitative form of SDM can lose its justification.

4. SIMPLIFIED CYBERNETIC MODELLING – IMPACT PATH ANALYSIS

Simplified Cybernetic Modelling (SCM) is used to avoid SDM's high demand for information. Instead of introducing functional terms for describing relationships among variables, the level of aggregation is increased to reduce the complexity of the model. In addition, the feedback relationships among system variables are organised in a matrix. A qualitative analysis is used to indicate their strength according to a scale (0, 1, 2, 3…n), with zero denoting that there is no influence and n indicating that there is a very strong influence of one variable on another. SCM can be reduced to a method of generation of qualitative rankings by means of expert questioning and evaluation of the results by active/passive influence indicators or by positive/negative feedback analysis. Applied in this way, SCM will not provide quantitative evaluation in terms of a social profitability.

An application of SCM, Impact Path Analysis (IPA), allows the EST case studies to exploit all elaborated information as deeply as possible. IPA can be extended to a full SDM for selected case studies when required information is available. Assessors using IPA followed the chain of impacts from the micro to the macro level of the economic system to determine aggregate economic indicators and assess the order of magnitude of their changes. IPA assesses only economic impacts and is based on the following assumptions to ensure that all EST criteria are met by 2030: policy actions are designed exogenously; there are no secondary effects from control technologies; and the aggregation from micro to meso levels and then to macro levels is possible through expert judgement.

The IPA assessment procedure is divided in two parts: Direct Impact Analysis, and Interdependence Analysis.

4.1. Direct Impact Analysis

Direct Impact Analysis estimates the impacts of EST measures and conditions by **pursuing a one-directional impact path through the micro, meso, and macro levels.** The system is highly simplified by using only six levels addressing micro, meso, and macro economic issues:

- The micro level comprises changes in transport technology and transport behaviour (Level 1) and change in transport market supply (Level 2).
- The meso level includes changes in transport market demand (Level 3) and changes in affected markets (Level 4).
- The macro level includes aggregate economic indicators (Level 5) and environmental indicators (Level 6).

The assessment begins with a concrete definition of policy actions and the intensities with which they should be applied. The aim of DIA is to estimate the impacts of the EST structure and conditions while following a one-directional impact path from micro, meso, to macro level (see Figure 2). The political actions to achieve EST provide the basic conditions for the analysis at the various levels. At this step, the policy actions have to be translated into changes of transport technology and transport behaviour. The BAU scenario serves as a basis for comparative evaluation.

At the **micro level** the analysis includes the following steps:

- *Level 1: Changes in transport technology and individual behaviour.* This level focuses on the micro-world of decision-making by individual consumers and producers. Individuals affected by the policy actions respond according to their preferences and to production technologies.
- *Level 2: Changes in transport market supply*. The influence of technological and behavioural changes on the supply side of the transport system is assessed and expressed in percentage changes from the BAU scenario.

At the **meso level** the analysis examines the impacts on other markets:

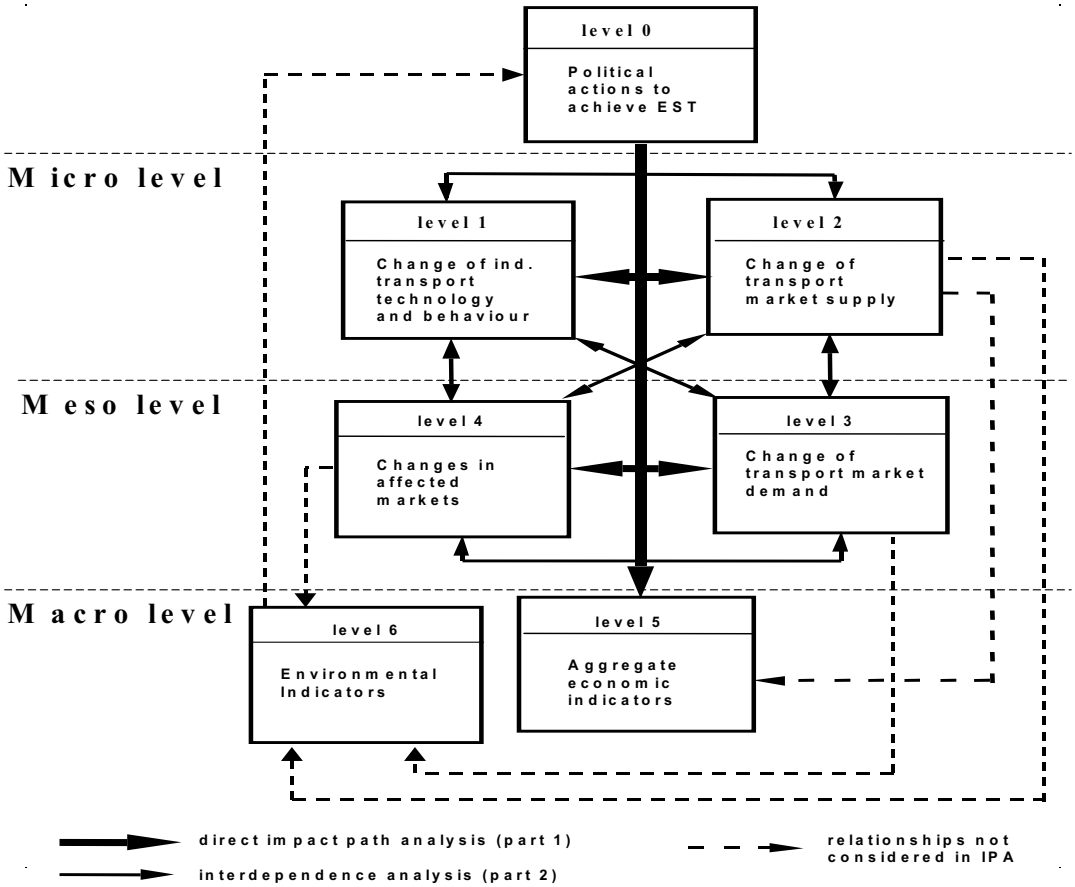
- *Level 3: Changes of transport market demand*. This level summarises the main features and the modal structure of the scenarios using transport technology and transport demand that are consistent with the environmentally sustainable goals. It translates the technological, mobility management, and travel behavioural changes into categories of transport demand for passenger and freight. Effects are measured in passenger- or tonne-kilometres and in percentage changes from the BAU scenario.
- *Level 4: Changes in affected markets*. This level analyses the relationships between the changes in transport demand and the affected industries. The effects can be positive (e.g., for the railway industry) or negative (e.g., for the road-vehicle manufacturing and airline industries). This level evaluates the expected changes in markets by estimating the complementary and substitution effects.

At the **macro level** the results from the earlier steps of the analysis are aggregated and the overall impact assessed:

- *Level 5: Changes in aggregate economic indicators.* The results from Level 4 have to be transformed into aggregate macro indicators using the assumption that IPA is not an econometric analysis and, therefore, the result will not be expressed in terms of accurate absolute changes. Nevertheless, the analysis should be detailed enough to generate information in the order of magnitude of the expected changes.
- *Level 6: Changes of environmental indicators*. From the start, environmental criteria are set according to targets for environmental sustainability. These targets are not questioned in the economic assessment process. As no feedback interaction is included between policy actions and environmental criteria, it is not possible to use IPA to determine least-cost policy actions. In other words, it is not possible to design policy instruments in a way that the environmental goals are achieved at minimum economic costs. In a complete SDM procedure, Level 6 would be included in the interaction scheme.

The DIA work requires the research teams to provide the results of the respective analyses for every level of the assessment (e.g., by using an evaluation sheet). Taking the BAU scenario as a reference case, the evaluations for the EST scenario are stated as percentage deviations from the BAU scenario. The result of aggregation are not measured in terms of exact changes, but provide information as to orders of magnitude of the expected deviations from BAU and the directions of the deviations.

Figure 2. Flow diagram of the Impact Path Analysis (IPA)



4.2. Interdependence Analysis

The Interdependence Analysis is designed to determine the interactions among all levels of the analysis (i.e., the system variables) and their exposure to exogenous influences (e.g., policy actions, institutions, individual/societal preferences, and the influence of lobby groups). The activities at Levels 1 to 4 (variables of the economic system) are closely interrelated, i.e., the microeconomic decision-making of consumers and all aspects addressed at these levels affect producers, and vice versa.

The aims of the Interdependence Analysis are threefold: first, to examine whether the expectations of EST are realistic or unreasonably high; second, to identify the key variables that have to be controlled over time to move the system along the sustainability path; and third, to identify critical factors that act in a counterproductive manner and prevent the system from moving towards sustainability.

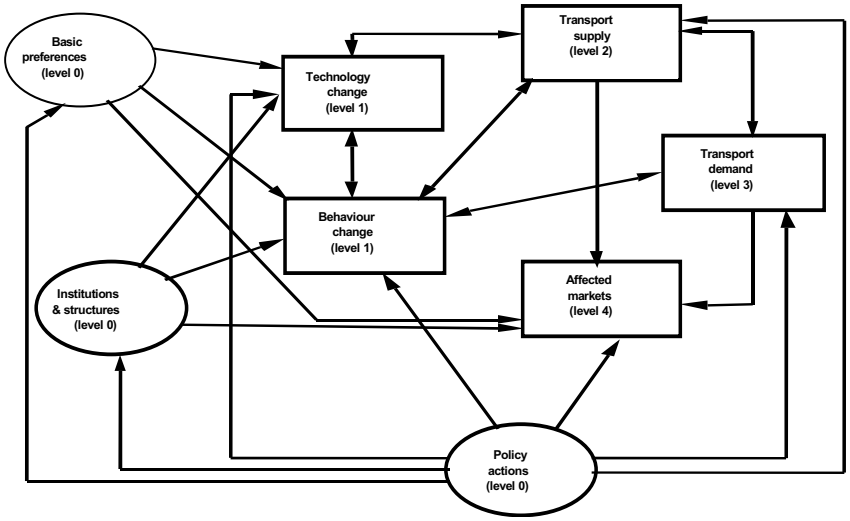
The Interdependence Analysis takes into account three categories of external force: policy actions, institutions and structures, and basic preferences, all of which influence the interrelationships among the variables of Levels 1 to 4.

Methodology of the Assessment

The influence of policy actions on the system variables of Levels 1 to 4 had been assessed in the DIA (see the previous section, and also OECD, 1998). **Policy actions** can influence institutions/structures and basic preferences. **Institutions and structures** include factors such as the influence of lobby groups, the structure and organisation of industries, and the relevance of environmentally oriented production for an economy; together these factors determine the diffusion of new technology and individual behaviour. Finally, the **basic preferences** of consumers and producers determine the elasticities of reactions of demand and supply.

The three categories of external force strongly influence the other levels of the system. Policy actions by governments are regarded being completely exogenous to the transport system (see Figure 3). They gradually influence basic preferences and institutions/structures. Policy actions, basic preferences, and institutions/structures are exogenous to Levels 1 to 4. The Level 1-3 variables are assumed to interact in both directions. This means that micro and meso spheres of the transport system are closely interrelated. All Level 4 variables are assumed to be entirely passive, which means that related markets react to changes in the transport market, but there is no feedback to the transport system.

Figure 3. Macro-structure of the Interdependence Analysis in IPA



The system variables from the different levels (micro-, meso-, and macroeconomic) are ordered in terms of a matrix. They are listed in the rows of the matrix and the passive or influenced variables are listed in the columns.

The examination of the matrix results in identification of the variables that have the strongest active or passive influences, identification of positive or negative feedback loops, and identification of the variables that contribute the most to positive (reinforcing) or negative (dampening) feedback. From this process, conclusions can be drawn as to the range of policy variables necessary to bring the system to the sustainability trajectory, and as to which variables have to be controlled most strongly to prevent the system from departing from a sustainability path.

5. APPLICATION OF IMPACT PATH ANALYSIS TO THE INDIVIDUAL CASE STUDIES

5.1. Methodology and results of use of IPA and SDM for Germany

This section presents first the policy instruments that were considered and a description of proposed instruments with the degree of their implementation by the year 2030, and second a summary of the results from the IPA assessment (OECD, 2001*b*).

For the purpose of this analysis ten different policy instruments and measures were examined, as follows:

- *Introduction of a CO_2 emission regulation* that will reduce fuel consumption and CO_2 emissions of an average car by more than 75%.
- *Fuel taxes* that double the fuel costs per vehicle-kilometre by 2030, to achieve the activity changes needed for EST.
- *Road pricing* for heavy-duty vehicles that will be introduced stepwise and attenuated by fuel tax refunds.
- *Road and rail infrastructure:* extension of road infrastructure is halted; the required extension of rail infrastructure is assumed to be half finished by 2030.
- *Large-scale integrated traffic restraint strategies in towns*, including reduction in traffic speed, reduced space for private cars, and reduced numbers of parking places.
- *Support for public transport services* involving significant improvements in and expansion of public transport that will enable attainment of 90% of the required changes.
- *Improvement of rail services for freight transport* by introducing start-up subsidies to help establish a multi-modal transport system to cope with the increase of rail traffic.
- *Improvement of regional economic structures* so that the exchange of goods is organised in a less transport-intensive way.
- *Development of local and regional tourist and recreation areas* that help avoid an increase in air and other long-distance travel and travel by providing less resource-consuming ways to taking holidays.
- *Changes in land use patterns,* notwithstanding the long time taken for an effect,such as only 30% of the whole influence of this instrument could be realised by 2020.

Summary of results from the IPA assessment

Change of transport technology and travel behaviour (Level 1): On the **technology side,** the scenario puts much emphasis on alternative transport modes including rail and waterway transport.

Significant improvements in car technology play an important role. On the travel **behaviour side**, the major challenge is a reduction of current forms of motorised transport by car and trucks as well as air travel, and replacement of them by more environmentally friendly modes.

Change of transport market supply (Level 2): The real costs of car travel will have to increase by at least 100% compared to BAU to achieve the changes of technology and travel behaviour assumed in Level 1. The generalised costs of air traffic will have to increase by at least 400% to stop the fast growth of air travel.

Change in transport market demand (Level 3). The German team estimated the following changes in traffic as a consequence of EST measures: +50% for non-motorised transport, +170% for light rail and bus transport, +247% for heavy rail passengers, +348% for rail freight, -54% for cars and motor bikes, -73% for trucking, -59% for air traffic, and +88% for inland waterway.

Changes in affected markets in 2020 (Level 4): For the road-vehicle sector, the reduced motorization in EST will lead to a decrease in sales by 22%. Railway industry activity could increase by 45%. Higher prices will result in decrease of about 35% of sales in the air industry sector.

Changes of macroeconomic indicators in 2020 (Level 5): The compilation of the results from the lower levels was estimated to result in the loss of 161,700 jobs under EST compared to BAU. This result may be unreasonably high because it does not take into account dynamic changes in the production structure, e.g., inventions of new products. Application of SDM (see below) resulted in changes in the production sector that would lead to an increase of some 165,000 jobs.

External costs savings: The sum of external cost savings is between 4.5% and 6.5% of GDP in Germany, taking into account the EST assumptions and scenario results.

Results from the SDM assessment

The German team carried out the assessment using both the IPA and SDM methods in order to compare the results. **System dynamics modelling** (SDM)—also called for Germany ESCOT—is based on four different modules: macroeconomics, regional economics, environment, and transport. The macroeconomic model provides information at the global level (e.g., national income). Nine functional types of region are defined (e.g., rural regions and highly agglomerated areas). Distinctions are made among different transport modes (road, rail, water, and air) and different types of infrastructure link (e.g., high-speed links between agglomerations). The environmental model contains data about emissions from motor vehicles. The policy module has links to the other models, mainly the transport modules.

On the demand side the principal interactions are among government spending, final demand, export, consumption, investment, and gross value. On the supply side, the main interactions are among employment, gross domestic product, capital, and productivity. National income interacts with both the demand and the supply side. The most important changes in the BAU/EST ESCOT model take place in the transport sector, caused directly by policy measures. The principal reasons for different development of the BAU and EST scenarios are an increase in fuel tax (the average cost per kilometre including car price, fuel price, and other prices increased about 35%), a doubling of the length of the rail network, improvements in rail services, train frequencies, and travel times, and an increase in the cost of air travel by 500% over the period considered.

The overall impacts of the policy measures at the macroeconomic level in the EST scenario are decreases in consumption in the chemical and mineral oil industry by 11%, in the automobile industry by 45%, caused by a lower rate of car ownership, but an increase in the traffic service sector by 2.7%. The decreases in consumption in the transport sectors result in an increase in consumption in other sectors. Overall, total consumption increases by 1.1%.

Comparison of the results from the SDM and IPA methods up to the year 2015

The SDM method indicated rather low effects for all indicators, with negative effects decreasing over time. For final demand they are lower than calculated with IPA. This difference is due to structural changes and dynamic developments that are not considered in the IPA method. Changes by 2030 in consumption, investment, and final demand were estimated to be +1.1, +1.3, and -0.8 per cent, respectively, with a loss by 2030 of 335 000 jobs. A second SDM analysis was carried out, loosening the timeframe for meeting the CO_2 reduction target. This analysis is based on the assumption that by 2030 CO_2 emissions from transport are to be reduced by 50% compared to 1990 (rather than by 80%). The results for all indicators (except export) are positive in this case, with positive tendencies increasing over time. Changes in 2030 in consumption, investment, and final demand were estimated to be +2.8, +0.5 and +0.6, respectively, with a gain of 335 000 jobs.

Use of the IPA method estimated negative effects for all indicators on the demand side, intensifying over time. Consumption decreases by -0.6 % in 2015, whereas SDM shows an increase of 0.6%. Investment decreases by -0.9% in 2015, whereas SDM shows an increase of 0.1%. The results for exports in 2020 are -1.6% with the IPA method and -2% with the SDM method. Final demand in 2020 shows decreases of -0.7% with IPA and -0.1% with SDM.

Results from the more sophisticated SDM approach suggest that the differences between EST and BAU will be smaller than estimated using the IPA approach. In the IPA analysis structural changes and dynamic developments were not considered. There is more influence of the first round effects, which are governed by the negative factors of higher prices and restrictions on the demand side. The SDM analysis includes positive stimulation of market forces by environmental policy, leading to an increase of productivity. In the long run, the productivity gain and the associated stimulation of production may more than offset the initial reduction of demand.

The conclusions from the German results were as follows: Sectoral restructuring of economy will be necessary. There will be winner sectors (service sectors above all) and loser sectors (car manufacturers). This will result in economic frictions, with sectoral and regional unemployment at the beginning of the process. The restructuring activities, however, would not be much different from those usually taking place in modern economies. Governments can smooth these frictions and support restructuring. EST policy may result in positive effects on employment and economic growth if restrictions are well balanced with stimulation of technological progress. This is more likely to be achieved if the process of change is slightly slower than proposed in the EST scenario, which aims at an 80% reduction of CO_2 emissions by 2030.

Results from another independent study: the Öko-scenario "Chief benefits for the future"

An independent study was carried out in 1998 by the Öko-Institut and VCD confirming the results of the German study. The research project entitled "Chief benefits for the future: New jobs created with environmentally compatible traffic" developed scenarios for mobility in the year 2010 and calculated the effects that the suggested measures will have on job-creation (VCD/OKO, 1998). The authors have contrasted a scenario called *Move* with a *Trend* scenario, which assumes that Germany's current traffic policy of will change only a little. The number of journey made in the *Move* scenario remains at the same level, but the lengths of journeys are reduced and there are more choices of means of transport.

The car will continue to remain the method of transportation used most, but pedestrian and bicycle traffic as well as bus and the rail traffic increase considerably. In the Öko-scenario, citizens would leave their car behind for three trips a week and use local public transport for part of the journey twice a month. Modes of transport are selected according to their specific advantages and availability, and are combined with each other to form links of the journey. These links could differ by journey depending on destination, time of day, and weather conditions.

To move towards this scenario, a mix of measures is required. The first component is innovation in new mobility services, which will be systematically developed and promoted and priority given to

energy efficiency and emissions reduction. The second component would be integration of the different means of public transport with supplementary modes of transport to create a network of public transport whose elements can be substituted one for the other.

The third component would involve investments made to meet the mobility requirements of train passengers, pedestrians, and bicyclists, providing more space and attractive walkways and bicycle paths. The fourth component is improvement in the information provided by traffic companies and local administration agencies that provides advice and information on the range of public transport available in the region, taking advantage of modern communication technology. The fifth component is an increase in taxes on actions causing damage to the environment, with some focus on use of energy and other resources.

The results of this study show that if the traffic in Germany were to be reorganised so that it became more environmentally compatible, over 200 000 jobs would be created (338 000 added and 130 000 lost) and CO_2 emissions from traffic would be reduced by 30%. The *Move* scenario will make a considerable contribution to the preservation of the environment. Moreover, as a result of the decrease in motorised traffic, speed reduction, and noise prevention, quality of life will improve.

5.2. Results for The Netherlands

The Netherlands team applied the IPA method in a preliminary assessment of its EST scenario. The policy instruments were: fixed pricing policy (e.g., vehicle taxation), standards for behaviour, management efficiency gain, land use change, investments in alternative modes, and education (OECD, 2001*c*).

Change of transport technology and travel behaviour (Level 1): Reductions in transport activity contribute 20% to the total CO_2 emission reduction, technological changes 50%, higher occupancies 21%, and mode shifts 9%.

Change of transport market supply (Level 2): Using a fuel-price elasticity of -0.9, a fuel-cost increase of 60% is necessary to reduce car vehicle kilometres by 50%. If a fuel-price cross elasticity of -0.1 is assumed**, rail use would increase by about 12%.** The cost of **air passenger transport** will have to show an increase of 760% to attain the assumed 76% reduction in air passenger transport.

Change in transport market demand (Level 3): The changes in transport demand by 2020 are as follows: 100% for walking cycling, 102% for light rail buses, 0% for railway, -23% for cars and motorcycles, 386% for railway freight, -27% for inland shipping, -75% for road freight, and -76% for air transport.

Changes in affected markets (Level 4): The total value-added for the transport and storage sector will decline by more than 70%, and for the trade and industry sector by more than 45%. This results in a 6% loss of GDP for the EST scenario compared to BAU.

Changes in macroeconomic indicators (Level 5): The total loss of gross production value (GPV), including direct and indirect effects, will be 10% to 12% of the total GPV. Total employment will be reduced by 150 000 to 345 000 jobs, or 2-5% of the expected Dutch total in 2030. For **macroeconomic impacts that assume structural changes**, the contribution of dynamic changes in the production structure would be a gain of roughly 110 000 jobs, reducing the net job loss by 30-70%.

External cost savings: Total external cost savings in 2030 under EST will be 13-40 billion guilders, which is 12-14% of the total added value of the transport sector and 1-4% of Dutch GDP in 2030. The total non-material cost savings do not cover the total material welfare losses (i.e., there would be a net 4-8% reduction in GDP).

The results of use of the IPA method show that environmentally sustainable transport will significantly affect material welfare expressed by macroeconomic indicators (e.g., GDP and employment). If dynamic changes in the economy, substitution effects, and non-material indicators are taken into account, the effect on total welfare in 2030 will be relatively small.

5.3. Results for Sweden

The Swedish team used the CO_2 target as the only environmental target, to reduce the complexity of the study and the policy instruments to be evaluated (OECD, 2001*d*).

Change of transport technology and behaviour (Level 1): Concerning **cars**, a system of emission rights is assumed to increase the prices of petrol by 118% and of diesel fuel by 195%. Cost increases for **aviation** are expected to result in the use of more energy-efficient aircraft (16%), higher occupancy (38%), a decrease in passenger-kilometres (32%), and a mode shift to rail (14%).

Change of transport market supplies (Level 2): Compared with BAU, the fuel price for **private cars** is expected to increase by 118%. The reduction in **air transport** activity results from regulation of the number of takeoffs and landings. The number of take-off and landings will decrease by about 50% and the number of trips by 33%. This decrease in transport activity corresponds to a price increase of 32%.

Change in transport market demand (Level 3): It is assumed that 50% of the decrease of road freight will be transferred to rail and the rest will be accommodated by more effective logistics, rationalisation of material handling, and lower production levels.

Changes in affected markets (Level 4): With the assumption of no changes outside Sweden and a domestic sale share of about 10% of Swedish production, this means a decrease of value-added by 1% for the vehicle manufacturing in Sweden. The production of **biofuels** will play an important role; in 2026, more than 20% of the energy used in the road transport will come from engine alcohol.

Changes in macroeconomic indicators (Level 5): The results show that the EST scenario would have a minor effect on employment. The **total loss of employment is -0.15%** of the total employment in Sweden. The change in national income is approximately +0.2%. This is the result of a static analysis and does not take into account dynamic changes in production technology induced by the environmental policy.

In conclusion, the impact on the total economy would be modest with a change in national income of less than one percent and a small decrease, -0.15%, in employment. The scenario has an important impact on road and air traffic, which decreases by about a third. Use of environmentally more friendly modes will increase. For example, rail activity will increase by 10% for freight and by 20% for passengers.

5.4. Results for Canada

The Canadian team used two approaches, the Impact Path Analysis and the Surplus Value Model. The first is based on a traditional input-output model. The second is based on the extrapolation of cost-benefit analysis principles to a 30-year macroeconomic assessment (OECD, 2001*e)*.

Several points should be emphasised in understanding the Canadian assessment. First, there is a strong relationship between the transport sector and the Canadian economy as a whole. Transport services and infrastructure account for 16% of Canadian GDP.

Second, transport equipment in Canada represents 22% of all manufactured goods with most of the auto-related industries located in the QWC. It is essential to assess production issues for their impact on the QWC economy.

Third, the Canadian analysis concluded, there is a strong need to apply the EST process to other countries as globalisation does not allow a single country to attain EST while remaining economically competitive.

Results from the IPA approach

The Canadian team used two approaches. The first, Direct Impact Assessment, consisted of estimation of the impacts of EST following a one-directional impact path from micro-, to meso-, to macroeconomic levels starting from policy actions. The second, Interdependence Analysis, comprised analysis of the interdependencies among major variables and the most important feedback mechanisms.

To carry out the IPA, an input-output model was used to generate the baseline economic information. The Statistics Canada Inter-Provincial Input-Output (SCIPIO) model was used because it takes into account inter-provincial flows. It was applied to three scenarios: baseline, BAU, and EST. Comparisons were then made between the EST and BAU scenarios.

The SCIPIO model projected that gross industry output of the two Canadian provinces containing the QWC—Ontario and Quebec—would be lower under the EST scenario than under the BAU scenario, a decrease of 0.4% in the year 2030. Most industries would experience a 0.1-0.3% decrease in output in 2030. The largest impacts would be in transport and in the storage industry with an overall decrease of 6.6%. Specific transport sectors that would experience reduced activity compared to BAU are air transport and trucking.

Result from the SVM approach

Recognising the limitations of the input-output model, a preliminary assessment of the induced effects of environmental policies on changes in technology was conducted using a macroeconomic approach. The intent was to show that environmental policies could have positive side effects. For example, technical progress may lead to savings in resources; revenues from ecological taxation may reduce labour costs (e.g., by reducing taxes on labour).

The second approach used to examine the economic implications of EST made use of the Surplus Value Model (SVM). This approach is based on the principles of cost-benefit analysis, as commonly used in evaluating the economic impacts of a project or policy proposal. In the case of the EST assessment, the environmental benefit of achieving EST was not part of the evaluation. The concept and method of cost-benefit analysis was applied to evaluate other components.

Cost-benefit analysis uses the notion of ‘surplus value’ to indicate the changes associated with large price movements, such as those that would occur under EST. The SVM approach attempts to establish what the government would have to pay individuals to make them as well off under EST as in the BAU scenario. Alternatively, this can be stated as the amount that individuals would be willing to pay to keep from switching to EST.

The results of the SVM approach suggest a more substantial impact on the economy than the IPA approach. The net cost of introducing EST would be $51.9 billion annually in 2030, in 1994 prices. If real growth at 2% a year is assumed, Ontario’s and Quebec’s GDP in that year will total about C$977 billion in 2030 (in 1994 dollars). The net cost of EST is estimated to be 5.3% of GDP. This figure could be reduced if environmental taxes (e.g., charges, tolls) were used to replace other taxes. A conservative estimate of this reduction suggests that the net cost of EST would be $39.1 billion or less than 4% of GDP.

Comparison of the IPA and SVM results

The IPA and SVM approaches both have advantages and limitations. The major attraction of the IPA approach is its use of a well-tried input-output model. However, input-output models are not normally used to examine changes as large as those that would happen with EST.

The most attractive feature of the SVM approach is that all assumptions are clearly discernible. The most negative feature is the uncertainty regarding the long-term elasticities of the various sectors. Another limitation is that it does not consider the impacts of EST on non-transport markets, which could be positive or negative.

The IPA approach suggests that the economic effect of EST compared to BAU will be almost negligible (0.4% reduction in GDP in 2030). The results from the SVM approach suggest that the consequences will be similar to those of a significant recession (a 5% reduction in GDP in 2030). These results should not be interpreted outside of the context of the models.

A significant limitation of both approaches is that they do not attempt to estimate the economic benefits of reducing ground-level air pollution, which has significant health impacts, or climate change, which could have serious long-term negative consequences.

6. OTHER MODELS USED IN THE COUNTRY CASE STUDIES

6.1. Assessment methods used for the Alpine region

The expected annual GDP growth rate is 2.3% for Switzerland, 2.2 % for France, and 2.3 % for Austria (OECD, 2001*f)*. An elasticity of freight traffic to GDP of +1.2 was assumed. This corresponds to an overall growth in trans-Alpine freight traffic from 69 million tonnes (1994) to 188 million tonnes (2030), an annual growth rate of 2.8% per year over the period of 36 years. The statistical correlation between the import-export traffic among countries and trade of goods is around +0.6. This means that when trade between two countries increases by 1% in monetary terms, the related traffic increases by 0.6%.

The road network is assumed to be completed as soon as possible by guaranteeing the financing of expansion and applying financing instruments (e.g., road pricing). Legislation concerning financing of rail infrastructure will be adopted.

Instruments to attain EST

The instruments for implementing the measures considered in the EST scenarios will have three major effects: reducing transport volume, modal shift towards more sustainable transport means, and application of the best available technology (BAT). The instruments considered are of three types: economic instruments, investment in infrastructure supply and quality, and regulative and organising policy.

Economic instruments: Heavy-duty vehicle taxes and charges, and tradable permits

Economic instruments seek to reduce traffic volume by improving efficiency and inducing modal shifts. **Heavy-duty vehicle charges** can be based on distance, weight or emissions, or on the vehicle type, providing an economic incentive for the use of BAT. Heavy-duty vehicle tax is a fixed user charge, having one of two forms: a purchase tax and an annual registration or use fee.

Here are the economic instruments designed to achieve a shift from road to rail:

- **The Eco-point system** was introduced in 1993 to limit the harmful effects of lorries passing through Austria, particularly from NO_x emissions. The EU distributes the Eco-points among its member states, which distribute them to the haulage companies. They cannot be traded.

- The **CO_2 credit card** is an Eco-point system based on CO_2 emissions. Given the anticipated level of the CO_2 emissions in the BAU scenario in 2030, road transport would be at least 15 times more expensive as rail.
- **The linked railroad transit permit** is a tradable permit. The relation between the amount transported by rail and the amount transported by road is fixed, as is the total amount transported every year.

Infrastructure supply and quality

The rail infrastructure and the supply of transport services are assumed to be considerably extended and improved to facilitate the shift from road to rail.

The capacity of the existing rail lines is increased through the implementation of a new signal system based upon the security distance between two trains.

The linertrain is an operating system for combined transport in which containers do not have to stay on the same rail-car for the whole trip. They can be loaded on and off and indeed change trains as do passengers in an intercity-train-network. Use of the linertrain system could lead to an improvement in the productivity of combined transport.

The enhancement of information flows through use of electronic control systems has a high importance in freight transport. Electronic systems such as the Vehicle Information and Advance Notice System (FIV) and the Disposition and Information System for Combined Transport (DISK) would be improved and extended.

Regulatory measures

Enforcement of existing laws concerning drivers' working time, technical standards, and vehicle speed and weight limits would have major impacts on road freight transport. It would lead to an increase in transport price by 25% and a reduction in emissions, especially CO_2 emissions, the result of lower speeds and consequent lower fuel consumption. Enforcement of laws on weight limits will remove distortions in the competition between road and rail.

Assessment of economic impacts

The methodology used to assess economic impacts embraced qualitative and quantitative approaches. The qualitative assessment involved classification of the instruments according to criteria related to the economic categories considered and to the quality or direction of the impacts, each instrument being taken separately.

Qualitative analysis of freight transport beyond 2015 and passenger transport suggested that:

- In the long run, overall well-being is higher under the EST scenario, but there could be difficulties in the transition to EST.
- Employment will increase at least in the transport sector due to rising service intensity and transport logistics.
- There is mutual reinforcement between the achievement of sustainability objectives in the transport sector and in the organic farming and forestry sectors, on the one hand, and improvements in environmental technologies, on the other hand.

Results of the general equilibrium model used by Austria

The Austrian team undertook an economic modelling exercise to assess the consequences of EST on freight transport, with a horizon of 2015. Performed with a general equilibrium model, this assessment confirmed that structural changes are to be expected in household consumption and in the

production of industry and services. GDP growth would decline slightly, while the unemployment rate would decrease slightly in 2015, from 6.3% to 5.9%.

Illustration of the economic conditions in EST: the story of the Alpine families

In illustrations developed for the Alpine qualitative study, the automotive industry had undergone a massive reorganisation along with general adoption of hybrid electric-ICE propulsion. Regulations had been introduced that increased road safety, e.g., a driver could drive no more than two hours consecutively. A Trans-European Freight Railways Network (TEFRAN) had been created in 2002, dedicated to freight transport and using three different loading systems: a traditional one, a rail motorway, and a combined railroad with only trailers or containers on the train. Industrial sites and subcontractors are relocated near or at TEFRAN. Average transport distance is reduced substantially leading to gains in time and money. Industries are connected both to each other and to the multi-modal logistic centre, permitting them to integrate transport into the whole production process.

From a macroeconomic point of view, the increase in road transport costs has inflationary effects, limited by the competition among rail companies. Deflationary effects associated with road transport offset these inflationary effects. The contribution of the transport sector to GDP increases, while the contribution of public services decreases in similar proportion.

From a sectoral point of view, the turnover and value-added of the transport sector increases, with a transfer from road to rail transport services. A larger part of the revenues of road transport services is transferred through taxes and fees. These transfers compensate for the loss of tax revenues resulting from reduced transport volume.

Examples of daily life under EST

The Alpine study team illustrated the results of the assessment of the economic implications of EST by translating them into depictions of the conditions of life in EST and the economic implications of EST. Four households were imagined: the Alpentrees, an upper middle class family; Mrs Alpinerock, a single woman with a baby; the Alpinesuns, a retired couple; and Mr. Lowland, a single male.

The Alpentrees are a typical upper middle-class family living in 2030 in a mid-sized town called Estepolis with their two teenage children. Many pedestrian areas have been created, accompanied by many tramway lines. The car-free area was doubled between 2001 and 2006. The town is a good illustration of an attractive place where quality of life has improved with increased safety allowing parents to let their children walk alone on the street or use their bicycles. Due to the development of the TGV networks, the European cities are closely linked for comfortable and fast trips.

Retail shops have increases their turnover by 50% because of the development of pedestrian areas, resulting in an overall increase in wealth and employment. High public transport patronage contributes to the increase in employment.

Public transport companies have a tariff system that includes monthly and yearly mobility packages, providing the family with zero marginal costs for using public transport. At the same time, increased parking fees have almost doubled the marginal costs of using cars. The car-rental industry has developed rapidly, with strong competition among rental companies and attractive conditions for their customers. As a consequence of these measures, the family's annual transport budget decreased from 58 000 to 50 000 euros per year.

The second household is that of **Mrs. Alpinerock,** a young woman living alone with a child. She has a modest salary and cannot afford to live downtown. She has two options for sending her four-year-old son to school: to let him go alone to the school at the edge of the town, safely thanks to the absence of motorised vehicles; and to send him to a school downtown using a special service called

'a bus for a child' provided by the Tramway Company, which provides an agent to take care of children during the whole trip.

The Apinesuns are a retired couple with a modest pension. This couple lives in a village 50 kilometres from a mid-sized town. Half their income goes on transport, including the cost of their two cars. If they are too tired to drive, they can use FRUITS (Flexible Rural Integrated Transport Services), a rural network of demand-driven minibuses. If they travel far they prefer to use the TGV. Then, they can use ELCAR LEASE, a service providing small electric cars for rent at the station. They pay for kilometres driven and time spent in the car, and can leave it at any of the parking places reserved for these cars within the town and the surrounding suburbs. This all brings them independence, freedom of movements, and even foreign travel opportunities.

The fourth example of a household in 2030 is that of **Mr. Lowland,** a single young man of 30 years living in a small city. This story describes the planning for his winter holidays in the mountains, organised entirely through the Internet, which offers him several possibilities for routes and accommodation. For moving around the town by day and night, he has many options, including rental of a small electric car and use of taxis at night.

These ways of living save money while providing for urban existence that is less polluted, quieter, safe, and highly mobile.

6.2. Assessment for the Greater Oslo region of Norway

The Norwegian case study focused mainly on reduction of CO_2 emissions. It was assumed that if the CO_2 criterion were reached the other criteria—those for NO_x, VOCs, and PM—would also be met (OECD, 2001*g*). The economic assessment covered the period to 2020 only; accordingly, CO_2 emissions were to be reduced by 60% compared with 1990, rather than by 80%. Norway's Phase 3 work revisited some of the assumptions made in Phase 2, notably the assumption that EST will experience the same economic growth of BAU.

A two-stage procedure was used. In stage one, a national model was used to determine the effect of technology and the level of taxes that must be introduced to achieve the Kyoto targets for Norway (i.e., the BAU assessment). An econometric model (GODMOD) was used to calculate the national costs in the form of the GNP changes by 2020. This model was designed to determine the tax increase needed for achieving the necessary CO_2 reduction and to assess the implications on employment and production. In stage two, a traffic model, the Regional Transport Model for Oslo and Akershus (RETRO), was used to calculate the tax-induced changes in costs in 2020 for the Greater Oslo area.

The induced economic costs of achieving the CO_2 reduction goal included two components: the costs of transition and the costs of living in the EST scenario rather than in the BAU scenario. Each component incorporated financial costs, as reflected in people's expenditures and the GNP, and loss of utility caused by reduced car-based mobility.

The macroeconomic model for assessing technology and tax impacts

A one-period, static, general equilibrium model or a computable general equilibrium model (GODMOD) was used to handle the interactions among production, consumption, and transport sectors in Norway. The production sector includes eight sub-sectors for freight transport, seven production sectors for passenger travel, a public sector, and fifteen sectors concerning the production of goods and services. A private, public, and a foreign consumption sector represents the consumption side.

Each transport activity produces one type of transport service and transport users have a choice among these services. The flexibility of choice is described by elasticities of substitution among

different transport services. Technological development is exogenous to the model and is handled by productivity coefficients that increase over time. Endogenous technological change is restricted to adaptations of the factors used consistent with a new price structure. Production of transport services is described by a function accounting for inputs of capital (e.g. vehicle stock, infrastructure), labour (e.g., workforce), goods (e.g., transport equipment), services (e.g., logistics, insurance), and energy.

BAU forecasts suggested that the number of light vehicles will increase by 1.2% per year until 2010 and then by 1.0% per year until 2020. The number of heavy vehicles will increase by 1.8% and 1.5% per year, respectively. Annual growth in GNP will be 2.7% until 2010 and 1.9% from 2010 to 2020. Over the same periods, the annual growth in private consumption will be 3.2% and 2.3%, respectively.

According to the Kyoto agreement, Norway's CO_2-equivalent emissions of greenhouse gases should not increase by more than 1% from 1990 to 2010. The model estimated that CO_2 emissions in 2010 must be reduced by 19% compared with the BAU emissions. **The necessary CO_2 tax for achieving such a target would results in a reduction of GNP of 0.7% compared to the BAU in 2020. Private consumption would be reduced by 1.1% in the same year.**

The impact of a reduction in CO_2 emissions to 45% of the 1990 levels by 2010 and maintained until 2020 was also studied. In this alternative, the $Kyoto_{max}$ scenario, the necessary tax for achieving this reduction was estimated at 7517 NOK per tonne of CO_2 in 2020. The effects on GNP and on private consumption are larger than those from attainment of the Kyoto target. GNP would be reduced by 5% in 2020 compared with BAU. Private consumption is reduced by 8.5%. GNP is expected to more than double from 1990 to 2020; thus a reduction of 5% from the BAU level in 2020 would still leave GNP in 2020 at twice the level of 1990.

In these calculations, alternative car technologies are not taken into account and traditional technologies are assumed to be developed as in the BAU case. Introduction of four alternative technologies in four different scenarios (electric car, hybrid electric-ICE, natural gas, and hydrogen) would lead to different outcomes. Because a larger part of the CO_2 emission reductions would be achieved by technological improvements, the necessary taxes and the consequences for the GNP and private consumption are smaller. **Achieving the CO_2 emission reductions required by the Kyoto protocol through use of advanced technologies such as hybrid cars (the $Kyoto_{hy}$ scenario), will lead to an increase in private consumption by 0.7% and in GNP by 3%.**

The regional passenger traffic model and comparisons between scenarios

For passenger travel, a regional model, RETRO, was used to estimate traffic in the region of Oslo and Akershus. It estimates trip frequency, destination choice, and mode choice, based on socio-economic and demographic data and the generalised costs of travelling between zones.

The RETRO model is based on a nested logic model for destination and mode choice. The mode choices are car, public transport, and non-motorised modes (walking/bicycling). The model divides the region into 49 zones. It generates the number of trips between and within zones by each mode. Peak and off-peak traffic load are handled separately. RETRO is a disaggregated model because the calculations are based on the expected number of trips per person. A sub-model calculates the generalised costs of travel between zones on the basis of an origin-destination matrix determined by the RETRO model.

The model calculated the change in net benefit in the EST scenario compared with BAU taking into account scenarios with alternative passenger cars in 2020. In addition to the main existing fuels, petrol and diesel, consideration was given to alternative fuels, for example alcohol fuels (ethanol and methanol), biodiesel, liquefied petroleum gas (LPG), and compressed natural gas (CNG). These fuels can be used with traditional combustion engine technology.

Alternative engine technologies were also considered: electric cars powered by batteries or fuel cells and hybrid electric-ICE cars.

Use of the RETRO model allowed development of a framework for assessing transport measures in the Greater Oslo area. The assessment is based on the evaluation of the differences in costs and benefits between the different scenarios. The costs and benefits considered were:

- Net monetary benefits for car drivers and public transport travellers in peak and off-peak periods.
- Time savings for car drivers and public transport travellers in peak and off-peak periods.
- Investments by public transport operators, operating costs in the parking sector, and operating costs of the road toll scheme.
- Revenue from time-dependent car taxes and the present value of infrastructure investments.
- Money savings for parking operators and tolling companies, revenue from congestion pricing, government revenue or costs with respect to public transport.
- Environmental cost savings (costs of damage).

Considering the $Kyoto_{hy}$ scenario in the RETRO model, the scenario that entails the largest increase in GNP, the benefit is 240 million NOK. Currently, the annual regional GNP is approximately 1000 billion NOK and will be about 70% higher in 2020. For the $Kyoto_{hy}$ scenario the benefit for the Greater Oslo area is therefore only 0.02% of GNP.

GODMOD was used to calculate the changes in GDP due to the CO_2 tax in 2020. The introduction of electric or hybrid cars increases the GNP compared with the BAU. Considering the $Kyoto_{el}$ and the $Kyoto_{hy}$ scenarios with a CO_2 tax of respectively 0.37 and 0.42 euro per litre of petrol, the increases in GNP would be 1.2% and 3%, respectively. Private consumption would fall by 1.1% in 2020. In terms of change in GNP, the $Kyoto_{hy}$ scenario is the best scenario. Combined with local instruments it achieves the criterion for CO_2 emissions.

In summary, it would be possible to reduce CO_2 emissions in the Greater Oslo area by more than 60% by 2020 compared with 1990 levels. This can be achieved by technological improvements to traditional engines, by a national tax on CO_2 emissions, and by application of local instruments, including land-use regulation, encouragement of public transport, development of cycle paths, and encouragement of telecommuting.

7. CONCLUSIONS

The case studies emphasise that EST is not a revolution but a set of gradual changes that ensure the same level of mobility but with use of different transport modes that protect the well-being of present and future generations. Figure 1 shows in terms of GDP that the overall economic impacts of achieving the EST scenario would be little different from those of the BAU trend projections. Economic growth would continue under EST almost as much as under BAU. There would be a high level of economic output in 2020 compared to 1990, a high level of mobility—albeit with a different modal split for both passengers and freight—and attainment of ambitious environmental goals.

EST stresses the need for use of environmentally more friendly transport modes such as public transport combined with car-sharing and with other new public-private mobility forms. In spite of the stringent EST objectives, which will entail significant changes in transport organisation, the economic analysis shows that the economic repercussions are small. Moreover, if the objectives of EST are made less ambitious, the economic effects will be less significant. The flexibility of the analysis using SDM demonstrated that negative effects are reduced and can be mitigated over time.

The economic impacts of EST are in the extreme case equal to the avoided external costs. In the case of EST, these are reduced considerably compared to the BAU trends.

PART II:

ESTIMATION OF EXTERNAL COSTS FOR THE EST CASE STUDIES

SUMMARY

This part of the analysis of EST case studies focuses on an estimation of external costs (i.e., environmental and health costs) induced by the implementation of EST by 2015, and compares these costs with those of the BAU trend in 2015 and those in the base year of 1990. Consistent with the economic assessment, the estimates of external costs are only extended until 2015. The costs of the scenarios are estimated using country-specific cost factors for the different externalities developed in a recent study by INFRAS-Zurich and IWW-Karlsruhe (INFRAS/IWW, 2000). Sections 1-3 provide a brief review of the externalities considered—including noise, air pollution, climate change, accidents, and impacts from upstream processes—and the cost factors. Section 4 presents the principal results of the estimates of external costs. The overall conclusion is that total external costs in the case of the BAU trend are estimated to increase by almost 30% compared to the costs estimated for the 1990 base year. In the case of EST they will decrease by almost 40% by 2015, and are projected to decline farther on.

1. DEFINITIONS OF EXTERNALITIES

External effects occur if an individual's well-being, or the conditions of production of a firm, are affected by the action of an economic actor who does not bear the consequences of that action. Therefore, the effects are not associated with a monetary transfer. The utility or production functions of the actors are influenced by factors outside the market and over which they have no control. The decisions taken on the basis of such utility are considered inefficient from the social point of view, and overall resource allocation could be improved if these externalities were internalised.

The social costs of transport comprise all the costs stemming from the supply of infrastructure (investment, operation, and maintenance) and its use during transport activities. These social costs can be divided into two categories: private costs, which are partly covered by the price of the product, and external costs, which represent the part not reflected in the price.

Why do external costs of transport have to be evaluated?

Transport provides access to goods, places, services and activities, and opportunities for education and employment. It helps determine where people live, shop, work, and go to school. Adequate mobility is essential for people to participate in society as citizens, employees, consumers, and community members. The demand for mobility, and for motorised travel in particular, has substantially increased over the last century. A fair market for transport services requires that the prices of transport include all social costs, i.e., both private and external costs, so that consumers and producers can make decisions with the maximum of information.

Market-based systems are usually assumed to provide an efficient way of dealing with the allocation of almost all resources, goods, and services. Price mechanisms and the interplay of supply and demand in a free market, with perfect information and perfect competition, are believed to produce an efficient, welfare-maximising situation. A requirement is that prices reflect the totality of costs generated by production and consumption.

Concerning transport, as long as there are costs that transport users impose on others outside of

market mechanisms—i.e., external costs—the market system will fail to reach its optimal state. Non-internalisation of external costs in the transport sector can cause wrong market signals, and thus lead to inefficiencies in the form of congestion, lack of safety, and health and environmental impacts.

The external effects of transport are numerous and concern air pollution (local, regional, and global), noise, accidents, congestion, solid waste generation, and water pollution. As well, they include disruption of human communities and natural ecosystems by infrastructure and traffic flows, altered land use, and aesthetic impacts of infrastructure and traffic.

Individuals and firms make decisions concerning their travel arrangements and shipping orders on the basis of market prices and market qualities, without accounting for the costs to others. Many trips would be avoided, or carried out by more environmentally friendly transport means, if drivers were forced to consider the full costs of their actions and had to pay prices that reflected all costs. To correct such market failures and to maximise policy decisions, it is necessary both to assess the effects of transport activities on the environment in money terms and to reflect these effects in prices, i.e., to internalise the external costs so that polluters pay the full marginal external costs of their activities.

2. IMPACTS CONSIDERED

2.1. Noise

The health effects of transport noise are not well understood. Transport noise imposes undesired social disturbances and influences individual well-being by causing physical and psychological health damages. Noise levels above 85 dB(A) can cause hearing defects. Levels above 60 dB(A) can cause stress reactions such as increases in heart rate. Exposure to such noise increases the risk of cardiovascular disease. Recent studies in Germany confirmed several health concerns, and showed that a reduction in transport noise to below 65 dB(A) during the day and 55 dB(A) at night would decrease cardiac fatalities in Germany by 3%.

The duration, frequency, and regularity of noise are aspects of noise problems that are difficult to evaluate. The most common methods of monetary valuation involve assessment of effects on the market value of a building, valuation of actions necessary to eliminate or attenuate noise, and valuation of the damage caused by noise and the costs of corrective action (ECMT, 1998).

The assessment of noise impacts across a country in monetary terms depends on the degree of urbanisation and the geographical structure of the country. One of the main challenges for the assessment of noise is the conversion of exposure data into exposure estimates.

In 1999, 120 million people in the EU, i.e., more than 30% of the total population, were exposed to road traffic noise levels above 55 dB(A). More than 50 million people werre exposed to noise levels above 65 dB(A), and approximately 32% of the EU population is exposed to road noise levels above 55 dB(A) at their homes. Traffic noise continues as a major environmental problem as transport demand grows.

Improvements in vehicle technology and infrastructure planning are beginning to play important roles in noise abatement. However, the effectiveness of measures such as lower speed limits are being offset by the rapid growth in traffic.

2.2. Air pollution

The transport sector is a major source of air pollution, and the dominant source in urban areas. Local

pollution from transport involves a wide range of pollutants emitted by ICE vehicles. The pollutants include exhaust gases and particles, evaporative emissions, and dust (particles produced by wear on tyres, brake linings, etc.). Emissions per vehicle-kilometre are expected to fall in the European Union and in many non-EU countries, because of increasingly strict regulation of emissions. However, considerable external costs remain from such pollution, mainly from NO_x, VOCs, and particulates. Exposure to air pollution can cause adverse health effects—particularly in children, asthmatics, and the elderly—and can damage vegetation and other material.

Within the transport sector, road traffic is the most important contributor to urban air pollution. Although stricter vehicle emissions standards have reduced pollution, since 1970 car and heavy goods vehicle traffic has more than doubled and air pollution remains a major problem.

Two main methods are used for measuring the economic impacts of local pollution: prevention cost estimates and damage cost estimates.

In 1999, a study of the conditions of life in Austria, France, and Switzerland concluded that pollution is killing more people than accidents (WHO, 1999). One-third of air pollution in the form of PM_{10} (particulate matter with a diameter of less than 10 micrometres) is caused by road traffic, as much as 50 per cent in cities. Increasingly used catalytic converters reduce carbon monoxide emissions substantially. Such technological progress to reduce polluting emissions is a factor that enters into valuations of external costs as preventive technology costs.

2.3. Climate change

CO_2 emissions are the main product of transport activity responsible for enhancing the greenhouse effect. The volume of CO_2 emissions from the transport sector is directly related to fossil fuel use, which in turn depends mostly on the volume of road traffic and the fuel consumption of individual vehicles, but also on vehicle speed and driving style. Each litre of gasoline used results in emission of 2.34 kilograms of CO_2 (ECMT, 1998). For diesel fuel and LPG the respective emissions factors are 2.62 kg/l and 1.62 kg/l.

Neither the physical extent nor the economic impact of the greenhouse effect is fully understood. The consequences of global warming will likely be world-wide and include such threats as extinction of species, damage to agricultural crops, and rise in sea levels.

Estimates of global warming effects range from 0.1-0.5°C per decade. The consequences of this warming are difficult to quantify. They include: certain species would disappear and others would develop; harmful effects on agriculture; increased exposure to sunlight; a rise in sea level; and possible feedback mechanisms that would accelerate the temperature rise.

To estimate external costs, damage cost and avoidance cost approaches are generally applied. Compared to the other costs evaluated, the estimation of the costs of climate change involves many uncertainties. The damage cost approach is limited because long-term climate change risks are difficult to estimate. The INFRAS/IWW study used the avoidance cost method, based on a CO_2 reduction targets of 50% by 2030 compared to 1990 levels.

CO_2 emissions from transport in the EU increased by 41% between 1985 and 1996, making the transport sector the fastest growing source of emissions. Road transport accounts for 85% of all transport CO_2 emissions; aviation is the second largest transport CO_2 source (12%). The upward trend in CO_2 emissions from transport is almost entirely the result of growing traffic volumes; there has been little change in average fuel use per vehicle-kilometre.

2.4. Accidents

In 1995, over two million people were injured from road traffic accidents in the 27 European countries, 67 000 of them fatally. Since the early 1970s, as a result of safety measures introduced by most governments (speed limits, mandatory use of sea belts, etc.), the number of people involved in accidents in western Europe each year has fallen by a total nearly 35%, despite a steady increase in road traffic.

Road accidents are by far the major contributors to transport accident costs. The costs arise specifically from: damage to vehicles and to the immediate vicinity; police and emergency service expenditures; loss of economic output; legal, insurance, and funeral costs; medical treatment; compensation for pain, grief, and suffering to those involved in accidents and their relatives; and compensation for death.

The methods used to estimate the cost of accidents generally involve cost estimation for fatalities, injured people, and material damage. The evaluation of material accidents is usually assumed to be equivalent to the monetary costs of the damage. As regards the costs for death and injuries, the estimates typically cover the direct costs (medical care, transportation costs, etc,); the indirect costs (production losses); and, occasionally, an evaluation of the worth of a life to the community.

2.5. Impacts from upstream processes

Upstream processes include such factors as energy production and distribution, vehicle production, and infrastructure construction and maintenance. They are generally the indirect effects of transport that can cause additional external effects.

Energy production has environmental impacts from extraction and transmission. They depend directly on the amount of energy used. These effects are relevant for all transport means. Railways (mostly electrified) are treated differently. Because the emissions from electricity production for railways operation are already considered within air pollution and climate costs, only risk elements (e.g., nuclear risks) are considered.

Vehicle production and maintenance have environmental impacts from energy use and from the release of materials. The monetary values are based on the values used for air pollution and climate change costs. In addition, specific shadow prices are used for the estimation of nuclear power risks, estimated according to the percentage of indirect emissions.

Infrastructure construction and maintenance produce emissions and also affect ecosystems and landscape directly; costs are estimated in appropriate ways.

3. COST FACTORS USED TO ESTIMATE EXTERNALITIES

The individual cost factors used in this paper are taken from the study by INFRAS/IWW, adapted to conditions of the EST project. Average 1990 cost factors for the nine countries participating in the project are shown in Table 1.[†] For passenger transport, cars account for the highest contribution: 0.10 euros per passenger-kilometre. Aviation is next with 0.05 euros/pkm. Public transport costs are 0.03 euros/pkm. For railways, the largest costs are from upstream processes and from noise and air pollution; together they are much less than the costs associated with road transport. For aviation, the predominant cost factor is climate change.

[†] Tables 1-3 and Figures 1-6 for Part II of Appendix B are on Pages 157-163.

For freight transport, the largest contribution comes from light and heavy trucks; their external costs are significantly higher than those of all other means of transport. The total costs of heavy-duty vehicles are 0.08 euros per tonne-kilometre and 0.51 euros/tkm for light-duty vehicles, which have the highest costs of all. The most important impact is air pollution, followed by climate change, and accidents. Road freight's external costs per unit are almost ten times higher than those from rail freight, and almost forty times higher than those from waterways.

Concerning the forecasted values for BAU in 2015, expected technical improvements in pollution controls have been taken into account; on average, an increase of 30% of costs compared to 1990 levels were estimated. Cost factors were adjusted accordingly, reducing their relative contribution to total costs. For air pollution, a cost factor of 0.6 for BAU and 0.3 for EST in 2015 is applied (40% and 70% reduction); and for climate change, 0.9 for BAU and 0.6 for EST in 2015 is applied (10% and 40% reduction). Nevertheless, the expected growth in traffic will largely outweigh the technical gains in the BAU scenario. Thus, overall costs are expected to increase significantly also after 2015.

For the EST scenario, the criteria for emission reductions of air pollutants (90%) and CO_2 (80%) were taken into account in adjusting unit emission factors and related costs. Accidents and impacts from upstream processes become the most important contributors to total costs. For the latter, the expected emission reductions of air pollutants and CO_2 are assumed not to apply.

4. PRINCIPAL RESULTS AND FUTURE TRENDS OF EXTERNAL COSTS

The aim of the analysis was to estimate the external costs of transport for the EST case studies for the base year 1990 and for the BAU and EST scenarios. Total costs in 1990 and estimated trends for the BAU and EST scenarios in 2015 are presented in Table 3 and Figures 1-3, based on the activity data of the nine participating countries (Table 2). Different transport modes have been estimated separately, as shown. For waterborne transport, only inland waterways for freight have been considered. The external costs of motorcycles and air freight have not been included, nor the effects on nature and landscape and congestion, because relevant data were not available in the case studies.

In each of Figures 1-3, the upper panel shows costs in relation to impacts and the lower panel shows costs in relation to mode.

4.1. Analysis by impacts

The dominant impact, in terms of external costs, is accidents, followed by climate change and air pollution. Total external costs, excluding congestion costs, amount to 222.8 billion euros in 1990 (Table 3 and Figure 1). They rise to 288.4 billion euros in the case of the BAU trend in 2015 (Table 3 and Figure 2), but fall to 136.72 billion euro in the case of the EST scenario (Table 3 and Figure 3). The total of external costs for the six study areas represents approximately 6% of total GDP in 1990 and 4% under BAU 2015, but only 2% under EST, assuming 80% growth in GDP for the period 1990 to 2015. Two thirds of these costs are caused by passenger transport, and one third by freight transport.

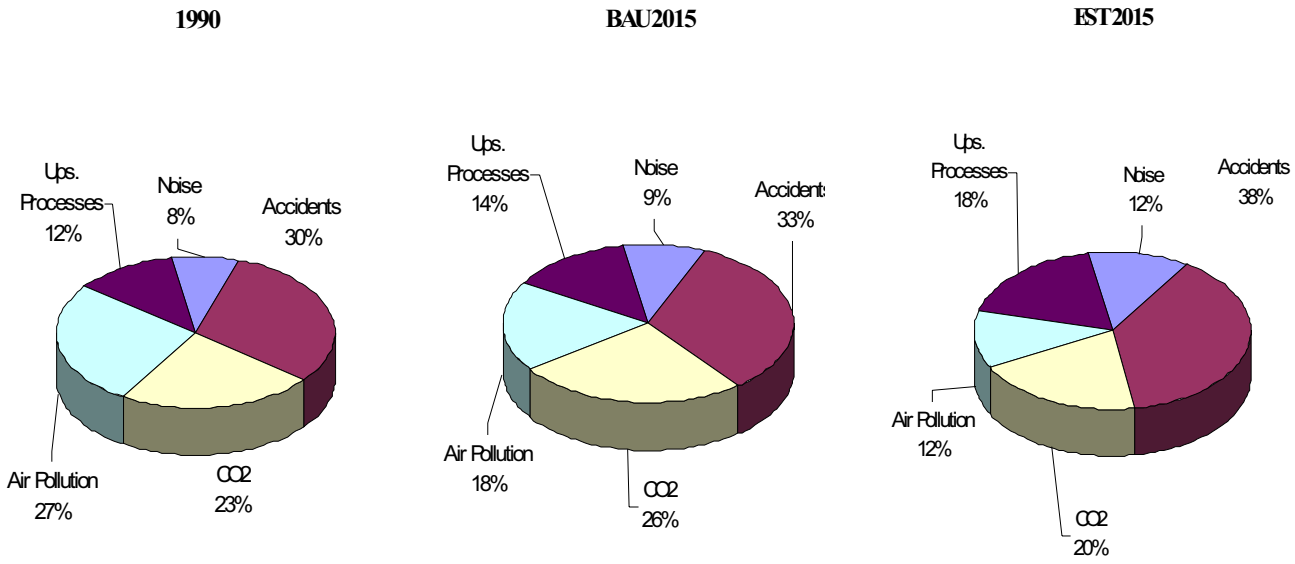
In 1990, accidents were the most important cost category, contributing 31% of the total costs. Accident costs werre particularly significant for cars, representing 43% of the external costs from car use. The second most important cost category in 1990 was air pollution, representing 27% of the external costs from car use. The external costs of climate change werre of a similar order, but those of noise were of lesser importance.

Under the BAU scenario, the distribution of costs would be similar to that in the base year except that costs related to air pollution are much less important.

Under the EST scenario, the distribution of costs would be similar to that for the BAU scenario except that costs related to CO_2 emissions are much less important.

Thus, accident costs (as the major category of external cost), upstream processes, and noise maintain their importance in all three scenarios, as can be seen from Figure 4 below.

Figure 4. Distribution of external costs of transport by type of impact



4.2. Analysis by mode

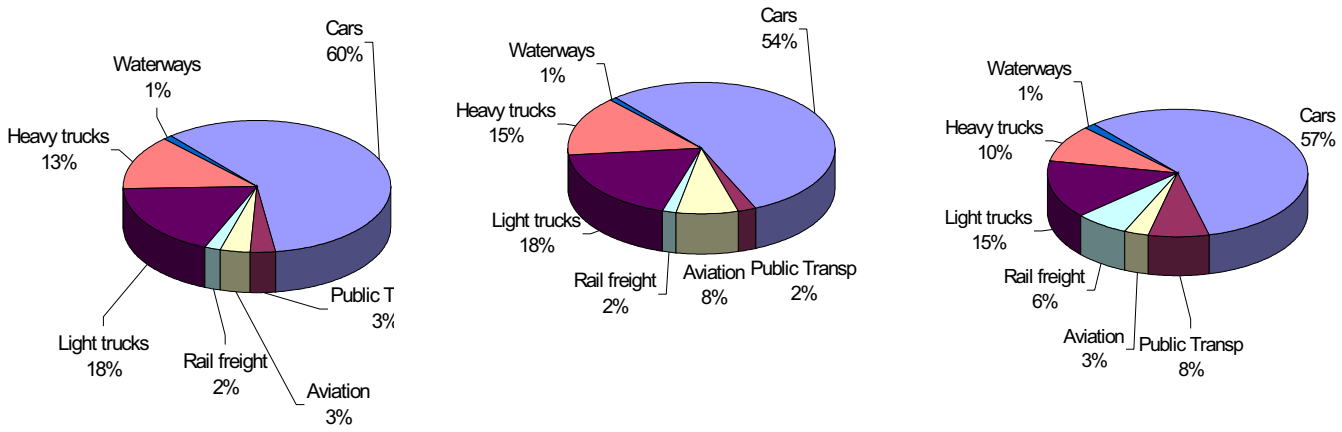
For the three cases—the base year, BAU, and EST—road transport accounts for the highest contribution to external costs, dominating all other modes. The most important mode in terms of financial costs is car travel, comprising 60% of the total costs in 1990, 54% in BAU, and 57% in EST (see Figures 1-4 on subsequent pages and Figure 5 below). The two other modes of **passenger transport** represent only a minor part of total costs. Public transport comprises no more than 8% (in EST), and aviation no more than 8% (in BAU).

Concerning **freight transport**, the most important costs are those related to use of light- and heavy-duty trucks and heavy trucks. Together, they comprised 31% of total costs in 1990, 33% under BAU, and 25% under EST.

Rail freight costs represent a minor part of the total external costs, as low as 2% in 1990 and under the BAU scenario, and rising to 6% under the EST scenario. Upstream costs are a more important component of rail modes than other modes.

Figure 5. Distribution of external costs of transport by mode

1990 **BAU 2015** **EST 2015**



5. CONCLUDING REMARKS

The results of this study on the external costs of transport in 1990 and under the BAU and EST scenarios supplement the analyses of economic implications up to 2015. They reinforce conclusions that EST constitutes a net benefit for the environment, for quality of life in general and for the well-being of society. Substantial improvements in quality of life are accompanied by important decreases in the financial costs imposed by transport on society: 53% of the BAU level, and 39% of the 1990 level. This means that some direct and indirect taxes and charges could be significantly reduced with the implementation of EST. The net benefit could be transferred to key areas of the economy including consumption, saving, and investment, in ways that would enhance overall well-being.

6. TABLES AND FIGURES

Table 1. Average external costs* in 9 countries participating in the EST project
(in euros per passenger-kilometre or tonne-kilometre)

	Noise	Accidents	Air pollution	Climate change	Ups.process	All impacts
Cars	0.0068	0.0417	0.0200	0.0185	0.0101	**0.0971**
Public transport	0.0030	0.0019	0.0122	0.0068	0.0042	**0.0281**
Aviation	0.0063	0.0007	0.0011	0.0351	0.0049	**0.0480**
Light trucks	0.0395	0.1111	0.1538	0.1321	0.0733	**0.5098**
Heavy trucks	0.0067	0.0079	0.0380	0.0167	0.0098	**0.0791**
Rail freight	0.0039	0.0000	0.0046	0.0056	0.0060	**0.0201**
Waterways	0.0000	0.0000	0.0106	0.0037	0.0026	**0.0169**
All modes	**0.0662**	**0.1633**	**0.2404**	**0.2183**	**0.1109**	**0.7991**

*) Note: Cost factors vary around these mean values for individual countries depending on the specific situation.

Table 2. Transport Activity in the Participating Countries
(Billions of passenger- or tonne-kilometres)

Mode	1990	BAU 2015	EST 2015	*BAU 2030*	*EST 2030*
Non-motorised	67.90	63.25	94.41	*60.47*	*110.31*
Private	1351.27	1801.67	1063.68	*2071.91*	*891.13*
Surface public	252.59	310.80	611.20	*345.73*	*826.37*
Aviation	159.81	497.55	123.80	*700.20*	*102.20*
Total pass	**1831.57**	**2673.28**	**1893.09**	*3178.31*	*1929.98*
Light-duty road	78.88	121.76	58.50	*147.49*	*46.28*
Heavy-duty road	370.56	682.83	292.28	*870.19*	*245.31*
Rail freight	233.45	277.00	563.39	*303.13*	*761.35*
Water-borne	156.66	206.20	217.67	*235.92*	*254.28*
Total freight	**839.55**	**1287.79**	**1131.84**	*1556.73*	*1307.70*
Total	**2671.12**	**3961.07**	**3024.94**	*4735.03*	*3237.68*

Table 3.Total external costs in 1990, BAU and EST in 2015
(Data for the nine case studies in billions of euros)

1990

	Noise	Accidents	CO2	Air pollution	Ups.processes	Total
Cars	9.23	56.30	24.95	27.04	13.67	**131.20**
Public Transport	0.77	0.47	1.72	3.08	1.05	**7.09**
Aviation	1.01	0.11	5.60	0.17	0.78	**7.68**
Rail freight	0.91	0.00	1.30	1.08	1.40	**4.68**
Light trucks	3.12	8.77	10.42	12.13	5.78	**40.22**
Heavy trucks	2.47	2.94	6.18	14.09	3.64	**29.31**
Waterways	0.00	0.00	0.58	1.66	0.41	**2.65**
Total	**17.50**	**68.59**	**50.74**	**59.26**	**26.73**	**222.82**

BAU 2015

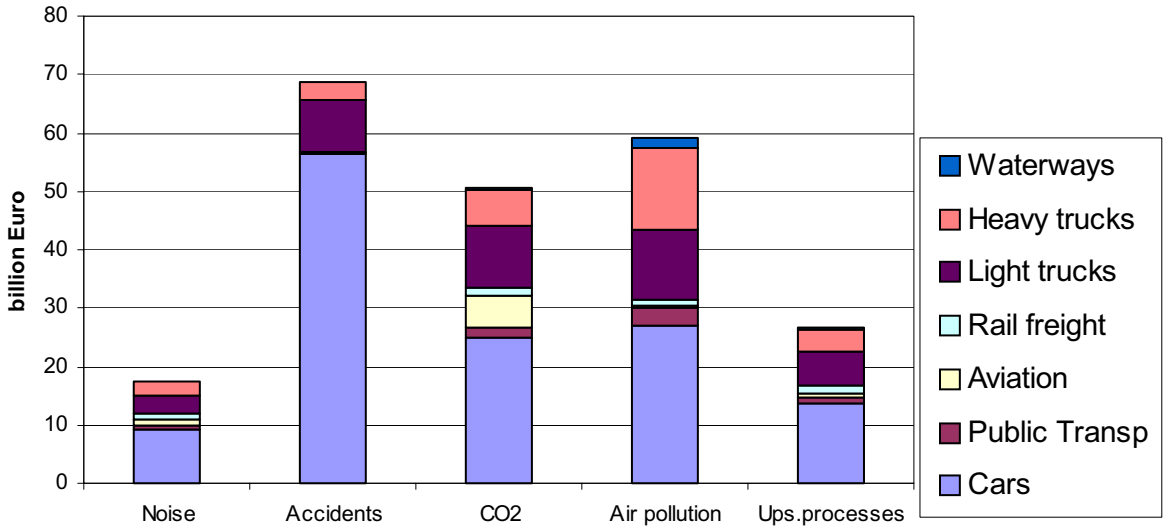
	Noise	Accidents	CO2	Air pollution	Ups.processes	Total
Cars	12.34	74.89	29.82	21.53	18.13	156.71
Public Transport	0.93	0.58	1.86	2.25	1.28	6.90
Aviation	3.06	0.35	15.58	0.31	2.39	21.69
Rail freight	1.05	0.00	1.31	0.73	1.59	4.68
Light trucks	4.76	13.60	14.49	11.35	8.97	53.17
Heavy trucks	4.56	5.44	10.25	15.63	6.72	42.59
Waterways	0.00	0.00	0.70	1.35	0.55	2.60
Total	**26.70**	**94.86**	**74.00**	**53.15**	**39.63**	**288.35**

EST 2015

	Noise	Accidents	CO2	Air pollution	Ups.processes	Total
Cars	7.06	42.79	11.54	6.27	10.50	**78.16**
Public Transport	1.97	1.19	2.52	2.26	2.51	**10.44**
Aviation	0.80	0.09	2.62	0.04	0.61	**4.16**
Rail freight	2.34	0.00	2.05	0.85	3.63	**8.87**
Light trucks	2.26	6.31	4.64	2.66	4.26	**20.13**
Heavy trucks	1.86	2.25	2.92	3.29	2.86	**13.18**
Waterways	0.00	0.00	0.50	0.71	0.58	**1.79**
Total	**16.29**	**52.62**	**26.79**	**16.08**	**24.95**	**136.72**

Figure 1. External costs by impacts and by mode in 1990
(Data for the 9 case studies in billions of euros)

IMPACTS in 1990



MODES in 1990

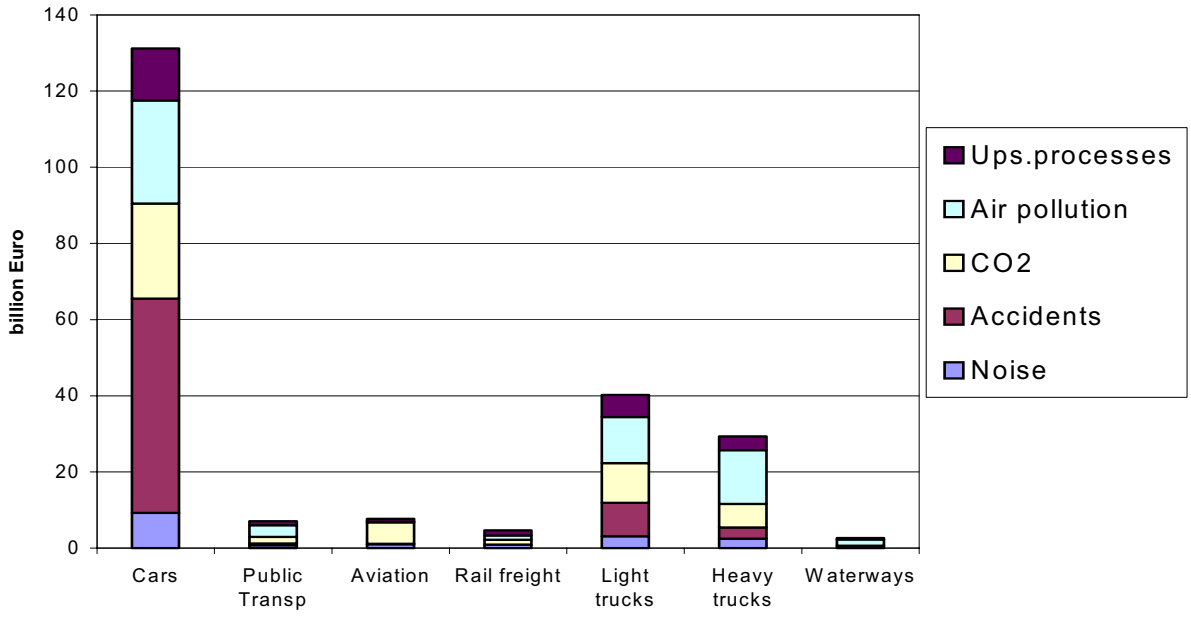
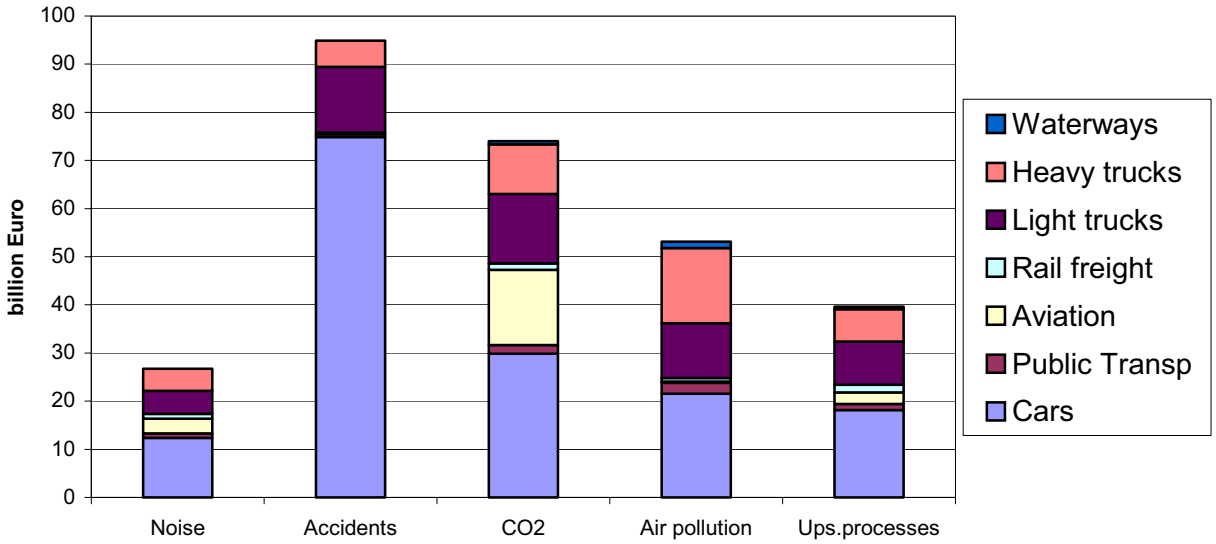


Figure 2. External costs by impacts and by mode in BAU in 2015
(Data for the six case studies in billions of euros)

IMPACTS from BAU in 2015



MODES for BAU in 2015

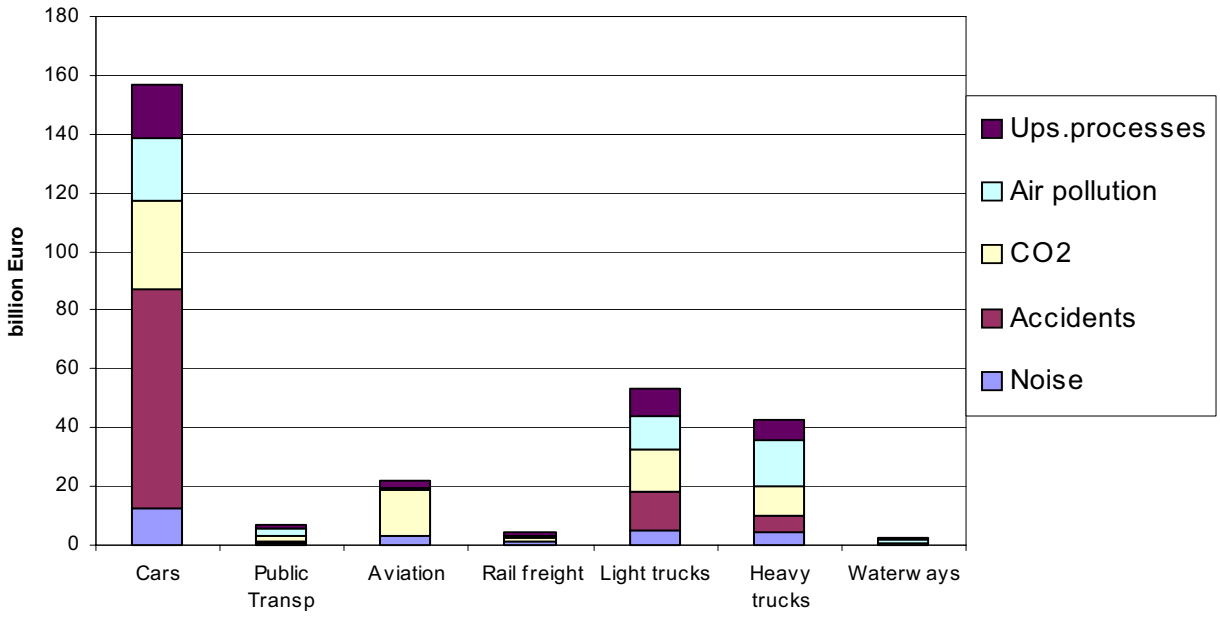
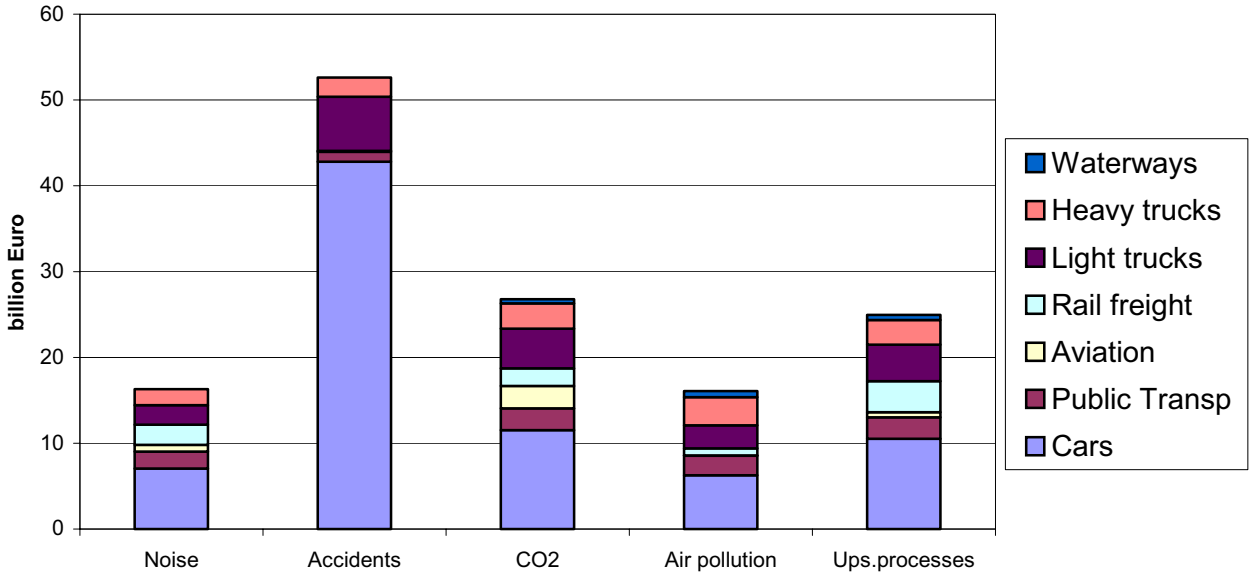


Figure 3. External costs by impacts and by mode in EST in 2015
(Data for the 9 case studies in billions of euros)

IMPACTS from EST in 2015



MODES for EST in 2015

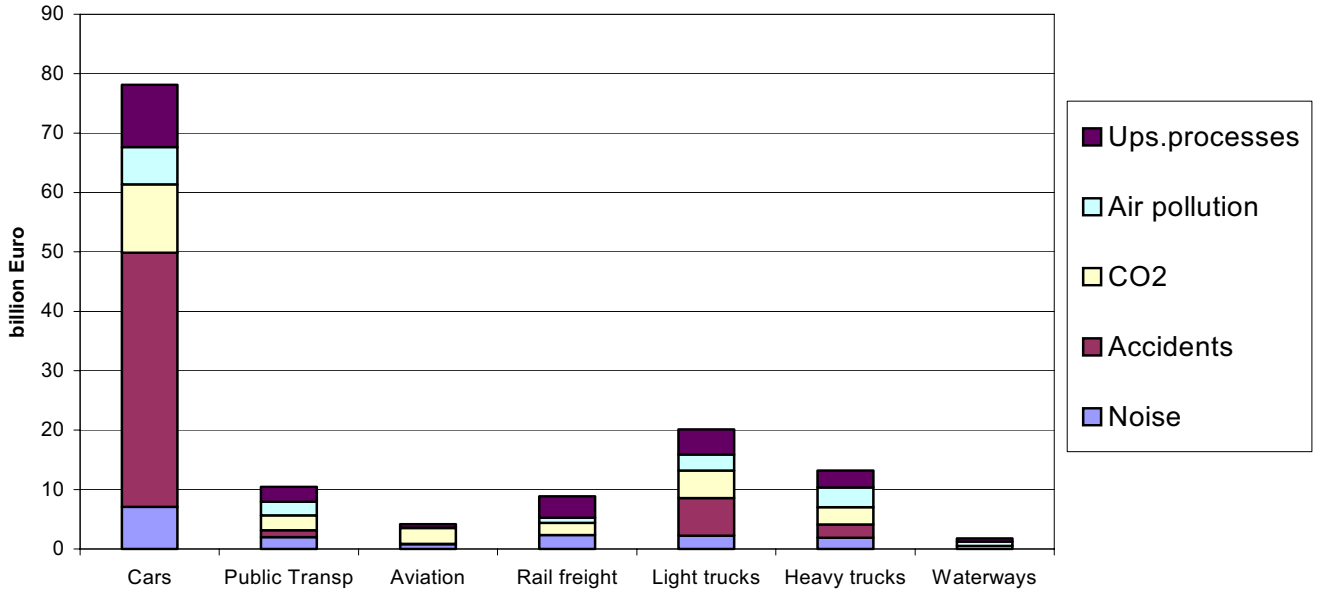


Figure 4. Total External Costs of Transport by impact and mode in 1990, BAU 2015 and EST 2015

(Data for the 9 case studies in billions of euros)

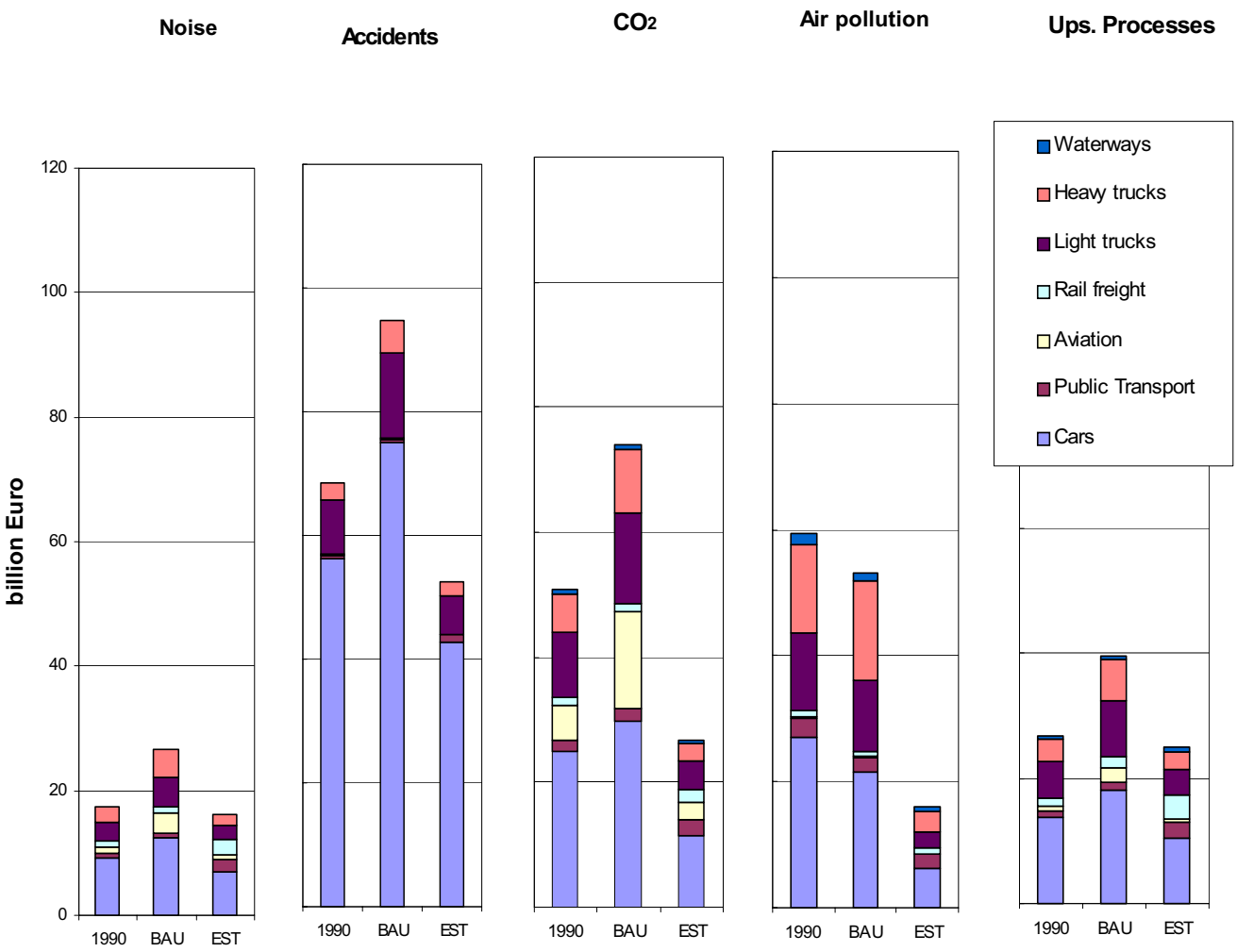


Figure 5. Total External Costs of Transport by impact in 1990, BAU 2015 and EST 2015
(Data for the 9 case studies in billions of euros)

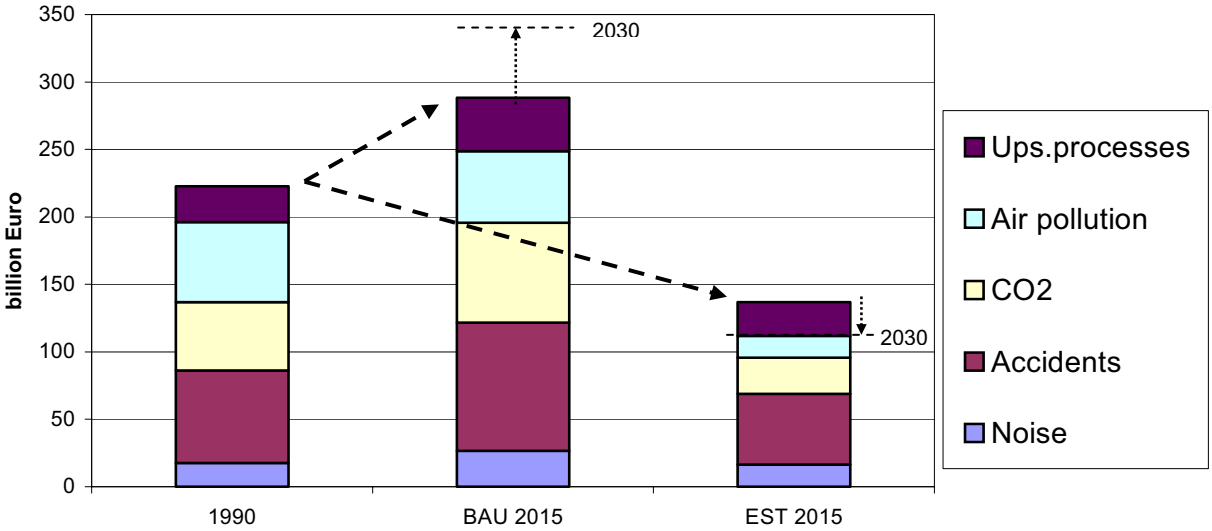
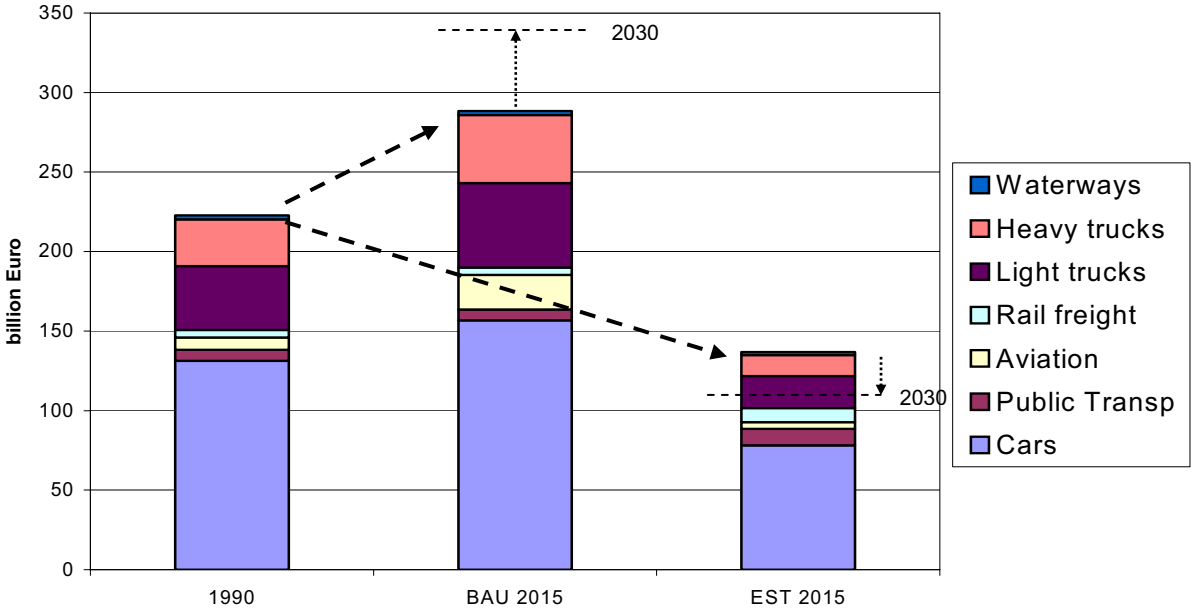


Figure 6. Total External Costs of Transport by mode in 1990, BAU 2015 and EST 2015
(Data for the 9 case studies in billion of euros)



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End notes

[1] OECD, *Environmental Criteria for Sustainable Transport.* Organisation for Economic Cooperation and Development, Paris, 1996.

[2] OECD, *Compendium of Expert Papers: Studies presented in the context of the OECD's Environment Directorate's EST project.* Organisation for Economic Cooperation and Development, Paris, 1996.

[3] OECD, *Scenarios for Environmentally Sustainable Transport: Volume 1, Synthesis Report.* Organisation for Economic Cooperation and Development, Paris, 1999.

[4] OECD, *Scenarios for Environmentally Sustainable Transport: Volume 2, Individual Project Case Studies.* Organisation for Economic Cooperation and Development, Paris, 1999.

[5] OECD, *Economic and Social Implications of Environmentally Sustainable Transport* (report on the EST Workshop held in Ottawa, Canada, October 1998). Organisation for Economic Cooperation and Development, Paris, 1999.

[6] OECD, *Policy Instruments for Achieving EST: Volume 2, Individual Case Studies.* Organisation for Economic Cooperation and Development, Paris, 2000.

[7] OECD and BLFUW, *Synthesis Report*. Prepared for the OECD International Conference held in Vienna, Austria, 4-6 October, 2000, entitled *est! Futures, Strategies, and Best Practices*. Organisation for Economic Cooperation and Development, Paris, and Austrian Federal Ministry for Environment, Forestry, Environment and Water Management (BLFUW), Vienna, 2001.

[8] OECD, *est! Futures, Strategies, and Best Practices*. Report on the OECD International Conference held in Vienna, Austria, 4-6 October, 2000. Organisation for Economic Cooperation and Development, Paris, 2001.

[9] Details of the annex volume to this report are in Note 6.

[10] The various reports on Phases 1 and 2 of the EST project are detailed in Notes 1, 3, and 4.

[11] Box 2 is based on Box 9 of Centre for Sustainable Transportation, *Sustainable Transportation Monitor,* Issue No. 3, March 2000. (available at <www.cstctd.org>), and Figure 1 of Gilbert R, "Sustainable Transportation", in Volume 5 of *Encyclopaedia of Global Environmental Change*. Wiley, London, UK, 2001. The principal source of the data in Box 2 is Mitchell BR, *International Historical Statistics* (3 volumes). Macmillan, London, UK, 1992-5.

[12] Greene DL, Wegener M, Sustainable transport, *Journal of Transport Geography*, 5(3), pp. 177-190, 1997.

[13] For example, Peter Drucker, the dean of management consultants, wrote, "There are five basic operations in the work of a manager. … A manager, in the first place sets objectives. He determines what the objectives should be. … He decides what has to be done to reach these objectives. …" (*Management: Tasks, Responsibilities, Practices* New York, Harper & Row, 1973, p. 400).

[14] The notion of a peak in mobility benefits is a feature of the work of John Adams, whose contribution to the EST project is described here in Chapter 3. See also his paper in the document detailed in Note 5.

[15] See, for example, *World Energy Outlook.* International Energy Agency, 1998 (p. 413). This source suggests that production of conventional oil may peak in or near 2013. The analysis is based on the work of U.S. geologist M. King Hubbert. Another authoritative analysis based on Hubbert's work points to an earlier peak: see Campbell CJ, Laherrère JH, The End of Cheap Oil. *Scientific American*, March 1998, pp. 78-83, and sources. Projections that world production of conventional oil will peak before 2013 appear to be gaining favour. See, for example, Rubin J, Buchanan P, *Why oil prices will have to go higher*, Occasional Report #28, CIBC World Markets Inc., Toronto, Canada. On the other hand, the latest issue of the IEA's *World Energy Outlook* (2000) does not include the projection of a possible production peak. It

concludes, "Although oil industries in some countries and regions are maturing, the resource base of the world as a whole is not a constraining factor. One need expect no global 'resource crunch'. … the international crude oil price [will remain] flat at US$21/barrel in today's money until 2010". (In mid-2001, the international crude oil price had been well above this level for more than 18 months.) See also Notes 67 and 68and the associated text in Section 5.3.

16 Robinson JB *et al*., *Life in 2030: Exploring a Sustainable Future for Canada*, UBC Press, Vancouver, Canada, 1996.

17 von Weizsäcker E, Lovins A, Lovins H, *Factor Four: Doubling Wealth, Halving Resource Use*. Earthscan, London UK, 1998.

18 The volume of expert papers is detailed in Note 2.

19 The term *scenario* has been used in the EST project as a synonym for "scene"—i.e., scenario construction involved the painting of scenes of what transportation might be like in 2030. *Scenario* is more often used to describe a possible unfolding of events, as in "Let's imagine the scenario of unilateral action by the Netherlands with respect to vehicle emissions standards." In this sense, scenario refers to the whole sequence of events that might transpire if there were unilateral action by the Netherlands. The backcasting literature is confusing as to which is the more appropriate use of *scenario*. John Robinson, who introduced the term *backcasting*, uses scenario in both ways. Chapter 5 of his latest book (*Life in 2030: Exploring a Sustainable Future for Canada*. UBC Press, 1996) is entitled "Life in 2030: the sustainability scenario." It includes such phrases as "an integrated scenario of a sustainable society in 2030 was produced." Here Robinson used *scenario* is being used in the way we have used it in the EST study—as a picture of a desirable future. But, elsewhere in the book *scenario* is used for an unfolding of events. What is meant by *scenario* in the EST project corresponds closely to the term *image of the future* as used by Dreborg KH, Essence of backcasting, *Futures*, vol. 28(29), 1996, pp. 813-828.

20 The individual country reports can be found in the companion volume to the present report detailed in Note 6.

21 For a fuller account of the 'balance-of-effort' analysis, see the report on Phase 2 of the EST project detailed in Note 3. Where in the present report there is a reference to six rather than nine project teams, this means that the work of the Alpine countries (Austria, France, Italy, and Switzerland) has been consolidated as the Alpine project team.

22 See the details of Volume II of the present report in Note 6.

23 The proceedings of the Ottawa workshop are detailed in Note 5.

24 The method of *structured brainstorming* was initially developed by Bert van Wee and Karst Guers of RIVM, The Netherlands.

25 These plans were: for France, the transport section of the national plan concerning climate change; for Italy, the National Transport Plan.

26 The analysis concerning the convergence of the strategies of the four Alpine countries appears in the Synthesis Report on Phase 3 of the work of the Alpine Teams. See the companion volume to this report, detailed in Note 6.

27 See Note 24 for the authors of *structured brainstorming*.

28 Table 1 to Table 9, and the summary in Box 14, provide in some cases simplified versions of the lists of and assessments of the instruments. In particular, many assessments had dual ratings but are represented here for ease of presentation and analysis as having only one rating. (E.g., an instrument was rated 'S/M' as lying between short and medium term in its effect, or having both effects, but is shown here as only 'S' or 'M', according to which in context was considered to be the most appropriate single rating.) Reference should be made to the individual Member country reports, detailed in Note 6, for the full lists and assessments.

29 The derivation of the matrix in Box 15 was quite complex. In the absence of a standard method for assessing interrelationships of this kind, an ad hoc analysis was used. It comprised first noting all the *pairs* of features in the characterisation of a team's instruments (e.g., how many times an instru-

ment was considered to be both for the long term and for local implementation). Then each team's pairs were weighted to compensate for the number of instruments proposed. Weighted pairings were aggregated and their incidence compared with what might be expected from the frequency of use of the component features. Finally, pairs were selected whose actual frequency was at least 33 per cent higher or lower than might be expected (an arbitrary criterion), excluding pairs with low expected frequencies (i.e., less than 20 per cent of the total number of pairs) in order to avoid inclusion of large swings resulting from small denominators.

30 See, for example, Nivola P, Crandall R, *The Extra Mile: Rethinking Energy Policy for Automotive Transportation*, Brookings Institution, Washington D.C., 1995. These authors argued that the apparent success of the U.S. CAFE standards was due to coincident fuel price increases, and that better planned increases would have been more successful in improving fuel efficiency.

31 Skinner I, Fergusson M, *Instruments for Sustainable Transport in Europe*, Swedish Environmental Protection Agency, Report 4977, May 1999 (available at < www. euroest.environ.se/pdf/4977.pdf>).

32 See the source detailed in Note 17 (von Weizsäcker et al).

33 For a discussion of the impact of CAFE standards, see Issue No. 2 of the *Sustainable Transportation Monitor*, Centre for Sustainable Transportation, Toronto, Canada February 1999. See also the source detailed in Note 30 (Nivola and Crandall).

34 For a further discussion on the role of ownership, see Gilbert R, Reduced Car Ownership as a Route to Clean Transport, *World Transport Policy and Practice*, October 1998.

35 For a further discussion of reducing car ownership by changing land uses, see the source in Note 34, and also Gilbert R, Reducing automobile use in urban areas by reducing automobile ownership: The EANO Principle, in Odile Adndan et al. (eds.), *L'avenir des déplacements en ville*, Laboratoire d'économie des transports, Lyon, France, 2000 (tome 2, pp. 31-47).

36 Trade is also advocated as beneficial to the environment because it helps with the spread of benign practices and technology. Whether this beneficial factor is offset by the environment costs of the large amount of transport activity required to support the trade has not been determined. See, for example, the article "Embracing greenery", *The Economist,* October 9, 1999.

37 *Motor Vehicle Pollution*. OECD, 1995. See especially Table 14, pp. 82-83.

38 For further discussion of oil availability and prices, and sources, see Note 15.

39 In respect of assessment of instruments, of interest may be the recent exercise conducted in connection with attainment of Canada's emissions reduction target in the Kyoto Protocol. The exercise assessed reductions in CO_2 and several local and regional pollutants that could be expected from the application of each of 113 instruments, as well as reductions associated with various scenarios for fuel tax increases. The focus was on reductions expected in 2010, but reductions expected from continued application until 2020 were also estimated. See *Transportation and Climate Change: Options for Action*, produced by the Transportation Table of the National Climate Change Process, Government of Canada, Ottawa, November 1999, available at <www.nccp.ca/html/tables/pdf/options/Trans_Final_OR-en.pdf.

40 Many economists do not share this view, believing that economic factors are at least equal in importance to environmental and resource factors. See, for example, Samuelson P, Nordhaus W, *Economics*. New York, McGraw-Hill, 1998.

41 The proceedings of the Ottawa workshop are detailed in Note 5.

42 INFRAS/IWW, *External Costs of Transport: Accident, Environmental and Congestion Costs in Western Europe* (report for the International Union of Railways, Paris, France). INFRAS, Zurich, Switzerland, and IWW, Karlsruhe, Germany, 2000.

43 Concerning Box 29: agreement with respect to a proposition was said to have occurred when three quarters of responses were definite (i.e., agree or disagree) and three quar-

ters of the definite responses were in the same direction (i.e., agreement or disagreement).

[44] *Towards Sustainable Transportation,* proceedings of an international conference held in Vancouver, Canada, March 1996. Environment Canada and OECD, Ottawa and Paris, 1997.

[45] Use of catalytic converters can increase vehicle energy consumption and result in formation of nitrous oxide. See Intergovernmental Panel on Climate Change, *Special Report on Emissions Scenarios*, IPCC, Geneva, 2000.

[46] See, for example, Vlek, C, Steg L, Societal Reasons, conditions and policy strategies for reducing the use of motor vehicles. *Towards Sustainable Transportation*, Vancouver, Canada, March 24-27, 1996; Tertoolen, G, van Kreveld, D, Verstraten B, Psychological resistance against attempts to reduce private car use. *Transportation Research - A*, Vol. 32 (No. 3), pp. 171-181, 1998.

[47] See by contrast the 'seven generations' thinking of many native peoples (e.g., Joe Sheridan, Dan Oronhiakehwen Longboat, Pauline Shirt, *The Past Didn't Go Anywhere: A Rationale for Temporal Equity in Environmental Education*. On-line Colloquium on The Future of Environmental Education in a Postmodern World, organised by Environment Canada, 19-30 October, 1998). See also Williams P, Nelson C, *Kaswentha*, a 1995 report commissioned for and cited Volume 2 of Royal Commission on Aboriginal Peoples, *For Seven Generations*, , Government of Canada, 1997. See specifically the reference to the Kaianerekowa—or Great Law of Peace—of the Haudenosaunee (Iroquois) Confederacy, which included the following: "The lawmakers, in weighing any decision, must cast their minds seven generations ahead, to consider its effects on the coming faces. The lawmakers must consider the effects of each decision on the natural world."

[48] An indication of the concern of insurance companies can be found in the document *Topics 2000* produced by the Munich Re insurance company. Increasing trend lines for economic loss and insured losses from "great natural catastrophes" are illustrated, with worldwide economic losses rising from $73.1 billion in 1960-1969 to $629.2 billion in 1990-1999, and insured losses rising from $7.0 billion to $118.8 billion over the same period (all amounts in US$, 2000 values). Some of the increases are attributed to climate change.

[49] An example is the presentation on 'The need for change' by UK prime minister Tony Blair at the World Economic Forum, Davos, Switzerland, in January 2000.

[50] Hermann Knoflacher, Technical University of Vienna, presentation at an OECD-ECMT workshop entitled *Land-use Planning for Sustainable Urban Transport*, Linz, Austria, September 1998.

[51] There is sub-discipline of *transport psychology*, concerned mostly with such matters as how to help elderly people drive more safely at night. Its practitioners may thus be more a part of the problem than any solution. Notable exceptions are the authors cited here in Note 46.

[52] A notable example of a repositioning of an oil company is BP Amoco, for whom 'BP' is now asserted to mean 'Beyond Petroleum' rather than 'British Petroleum'. Another example is an presentation by Shell Chemicals to the International Institute for Sustainable Development (Winnipeg, Canada) entitled *Business as usual is no longer an option*, in which the case is made that progress towards sustainable development provides 'real business value' and is not mere "window dressing". Also notable as an example of the repositioning of a company is a speech made to a Greenpeace meeting in London, England, by the chairman of the Ford Motor Company on October 5, 2000. Bill Ford said that "the automobile has had a serious negative impact on the environment, and that his industry had wrongly played down the threat from global warming … [that] the Kyoto Protocol would not provide deep enough cuts to halt global warming … that the day will come when the whole notion of car ownership is antiquated … people will not want to own cars, but merely have access to mobility." (report by Michael McCarthy in *The Independent* (UK) newspaper, October 6, 2000). A further noteworthy undertaking is the Sustainable

Mobility project of the World Business Council for Sustainable Development (Geneva, Switzerland), based in part on the OECD's EST project and sponsored by several automotive manufacturers and resource companies.

[53] Of particular note are the subsidies implicit in the military protection of trade and resource exploration. For trade, see the submission of Admiral J. Paul Reason to the Military Readiness Subcommittee of the U.S. House of Representatives on March 22, 1999. Admiral Reason argued that, "A key part of the global economy's growth has been the proliferation of multinational corporations, many U.S.-owned or partnered. They have improved profitability and efficiency through the free exchange of goods and services around the entire world. And this was made possible by the freedom of the seas, guaranteed by your United States Navy. In short, the navy has been and continues to be a sine qua non, a necessary precondition, of global prosperity and U.S. national security." (Miro Cernetic, *Globe & Mail*, Toronto, Canada, October 20, 2000). A review of several estimates of the military subsidy involved in the importation of oil into the U.S. from the Persian Gulf concluded that the 1996 cost was in the order of US$32 billion (Hu, PS, *Estimates of 1996 U.S. Military Expenditures on Defending Oil Supplies from the Middle East: Literature Review*. Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, August 1997, available at <www-cta.ornl.gov/Publications/military.pdf>). Approximately 0.58 billion barrels of oil was imported into the U.S. from the Persian Gulf in 1996 (Transport Energy Data Book 20, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, 2000, Table 1.5). Thus the U.S. military subsidy per barrel of Persian Gulf oil in 1996 was in the order of US$55 per barrel, or about three times the wholesale price per barrel in that year. See also *The Real Cost of Gasoline*, International Center for Technology Assessment, available at < www.icta.org/projects/trans/realpricegas.pdf>.

[54] See, for example, Litman T, *Distance-based charges: a practical strategy for more optimal vehicle pricing*. Presentation to the annual meeting of the Transportation Research Board, Washington D.C., January 1999. See also the Victoria Transport Policy Institute's online *Transportation Demand Management Encyclopedia* at <www.vtpi.org/tdm/>.

[55] This definition of urban sprawl is from Gilbert R, Wood H, Brugmann J, *Urban land management and global sustainability.* Report prepared by the International Council for Local Environmental Initiatives for the 8th session of the United Nations Commission on Sustainable Development, April 2000.

[56] Data for the U.S. urban regions are from "Transportation's effects on our environment" at the Web site of the Surface Transportation Policy Project, <www.transact.org/er.te.htm>, visited on December 14, 1999.

[57] Clifford Cobb, Gary Sue Goodman, and Mathis Wackernagel, *Why Bigger Isn't Better: The Genuine Progress Indicator—1999 Update*. Redefining Progress, San Francisco, November 1999 (from <www.rprogress.org> visited on Jan. 11, 2000)

[58] See, for example, the work of the Working Party on Technical Harmonisation and Standardisation Policies of the United Nations Economic Commission for Europe.

[59] See, for example, Mokhtarian P, A synthetic approach to estimating the impacts of telecommuting on travel. *Urban Studies*, 35(2), 1998, pp. 215-241.

[60] The best practices and demonstration projects are described in the document detailed in Note 7.

[61] The data in Box 33 were presented by Marion Schädler of SocialData, Zurich, at the Vienna conference whose proceedings are detailed in Note 8.

[62] See, for example, Solomon GM et al, *No breathing in the aisles: Diesel exhaust inside school buses*. National Resources Defense Council, Washington DC, January 2001.

[63] National Center for Chronic Diseases Prevention and Health Promotion, Preventing Obesity Among Children, *Chronic Diseases Notes & Reports*, vol. 13, Winter 2000..

[64] The latest significant IPCC report is *Summary for Policymakers* prepared by the IPCC's Working Group 1 as part of the

IPCC's *Third Assessment Report,* available at <www.usgcrp. gov/ipcc/wg1spm.pdf>.

65 See, for example, Chen DDT, The Science of Smart Growth, *Scientific American*, December 2000, pp. 84-91.

66 In the November 2000 elections, 553 growth-related measures were on ballots in 38 U.S. states; 72% of them passed (White B, Sprawl got space on ballots, *Washington Post*, February 27, 2001). The new federal administration has promised state governors substantial investment to help states decrease sprawl, expand public transportation, and reinvest in blighted urban areas (Lester W, Bush officials tell governors to expect money for 'smart growth' aid, *San Francisco Chronicle*, February 26, 2001).

67 Crude oil prices in Box 34 are those for West Texas crude and were provided by the State of Alaska Department of Revenue at <www.revenue.state.ak.us/oil). Natural gas prices (Intra-Alberta Index) are from *PriceLine Daily* (available on subscription at <www.enerdata.com>). The respective average February 1999 and January 2001 prices were: oil, US$12.00 and US$29.56 per barrel; natural gas, Can$2.24 and Can$10.31 per gigaJoule. U.S. growth in natural gas use is being supported almost entirely by increased Canadian supplies. For a discussion of the emerging imbalance of Canadian supply and demand for natural gas see Woronuk RH, *Canadian gas supply: going up? or going down?* Presentation to the Ontario Petroleum Institute, Niagara Fall, Ontario, December 1999 (available at <tabla.geo.ucalgary.ca/NatGasCan/opipaper.pdf>).

68 See, for example, Vaithesswaran V, "A Survey of Energy", *The Economist*, February 10, 2001. See also Campbell C, "Peak Oil: A Turning Point for Mankind". Presentation at the Technical University of Clausthal, Germany, December 2000 (available at <energy-crisis.org/de/lecture.html>); Campbell C, "The imminent peak of world oil production", presentation to an all-party committee of the UK House of Commons, July 7, 1999 (available at <www.hubbertpeak.com/ campbell/ commons.htm>); and Smil V, Energy in the Twentieth Century: Resources, Conversions, Costs, Uses, and Consequences, *Annual Review of Energy and Environment*, 2000, pp. 21-51. (See also Note 15 and associated text.)

69 According to Table 1 of Smil (detailed in Note 58), worldwide use of oil and gas (i.e., oil) comprised about 1.1 exaJoules in 1900. According to the International Energy Agency (at <www.iea.org/statist/keyworld/6b.gif>), worldwide primary oil consumption in 1998 was 3.4 billion tonnes or about 150 eJs, an increase by almost 150 times. World population increased by a factor of 3.8 during the 20th century, but efficiency of oil use may have increased by a similar factor. Thus, the average per capita energy derived from oil may have increased by about 150 times, albeit with wide individual variation.

70 According to *World Energy Outlook 2000* (see Note 15; p. 354), in 1997 transport uses comprised 56 per cent of final oil consumption (45 per cent of oil production, i.e., before oil use for fossil fuel extraction and electricity generation), and oil comprised 96 per cent of the fuel used for transport.

71 Of interest is the recent call for proposals by FedEx Express, which claims to be the world's largest express transportation company and is noted for its applications of sophisticated freight transport logistics. Manufacturers are invited to design and develop a delivery truck that uses 50 per cent less fuel than current models and produces 90 per cent less emissions. (See <www.environmentaldefense.org/Alliance/cleanertrucks.html>.)

72 For example, CO_2 emissions from transport in 15 EU countries increased by an average of 14.2% between 1990 and 1997. The range was -4.2% to +55.0% with only one country (Finland) not showing an increase (*Are we moving in the right direction? Indicators on transport and environment integration in the EU*, European Environment Agency (EEA), Copenhagen, Denmark, May 2000, p. 20). CO_2 emissions from transport in the U.S. rose by 12.2% between 1990 and 1998 (Davis SC, *Transportation Energy Databook 20*, Oak Ridge National Laboratory, Oak ridge, Tennessee, October 2000, Table 3.6). CO_2 emissions from transport in Canada grew by an estimated 27% during the 1990s (Gilbert R, *Background Paper for a Post-*

Kyoto Transport Strategy, Centre for Sustainable Transportation, Toronto, May 2001).

[73] Such standards—known as Corporate Average Fuel Efficiency (CAFE) standards in the U.S. and as Corporate Average Fuel Consumption (CAFC) standards in Canada—has been in place in North America for many years with public support. In the U.S., the standards are backed by fines imposed on manufacturers who exceed required fleet averages. The CAFC program is voluntary, but due to the high level of integration between Canadian and U.S. automotive industries it is essentially an extension of the CAFE program. The CAFE standards were introduced in 1978, but fleet average consumption began to decline steeply soon after the program was announced in 1973. The CAFE/CAFC standard for new cars was set at 13.1 litres per 100 kilometres in 1978 and was tightened progressively to 8.6 l/100 km in 1985 where it has remained. Light trucks, minivans, and sport utility vehicles have a more relaxed standard, which has been stiffened slightly since 1985 and is now 11.4 l/100 km. The fuel efficiency of automobile engines has continued to improve since 1985 but it has been applied almost entirely to increase the weight and the power of vehicles rather than reducing their fuel consumption (Walsh M, *Car Lines*, December 2000). Moreover, the proportion of personal 4-wheeled vehicles that are *not* regular automobiles—i.e., they are minivans, light trucks or sport utility vehicles—increased in North America from less than 20% of vehicles sold in 1980 to more that 45% of vehicles sold in 2000 (Walsh M, *Car Lines*, December 2000). A July 1998 agreement between the European Commission and the European Automobile Manufacturers Association speaks to an 18-per-cent reduction in average fuel use per new vehicle by 2008 and a 30-per-cent reduction by 2012 (see <www.cse.org/informed/210. html>).

[74] Vehicle-scrapping programmes have to be carefully evaluated to ensure that they result in a net energy benefit, i.e., the energy benefits of reduced fuel consumption during operation are larger than the additional energy costs of the increased production resulting from accelerated vehicle turnover (see Van Wee B, Moll HC, Dirks J, Environmental impact of scrapping old cars. *Transportation Research Part D*, 5, 2000, pp. 137-143).

[75] Two examples of commercial fleet management for reduced fuel use and emissions were among the best practices highlighted at the OECD International Conference, *est! Futures, Strategies, and Best Practices,* held in Vienna, Austria, 4-6 October, 2000, as part of the EST project. (See the sources detailed in Notes 7 and 8.)

[76] See, for example, the prospectus for a share issue by Ballard Power Systems, a leader in the development of fuel-cell technology, issued in March 2000. It contained the following: "We do not know when or whether we will successfully complete research and development of commercially viable proton exchange membrane (PEM) fuel cell systems for any of our target and prospective markets. Despite our accomplishments, we and our alliance partners [DaimlerChrysler and Ford] must develop or otherwise acquire access to substantial technological advances in relation to our systems, particularly in the area of fuel processing and systems integration, before we are able to produce a commercially viable product. … A mass market for PEM fuel cells and PEM fuel-cell systems may never develop or may take longer to develop than we anticipate." (cited by Richard Feast, "The Intel of the automotive world", *Automotive World*, November 2000). A particular issue is the availability of platinum, present on the surfaces of the fuel cell's proton exchange membrane to catalyse the dissociation and ionisation of molecular hydrogen. According to Robert Borgwardt of the U.S. Environmental Protection Agency, "If US platinum consumption were to remain at its current level of 16% of annual world production, fleet conversion would require 146 years. … fuel cells alone cannot adequately address the issues facing the current system of road transport (Borgwardt RH, Platinum, fuel cells, and future US road transport. *Transportation Research Part D*, 6, 2001, pp. 199-207).

[77] The Guidelines are reported on in the document detailed in Note 8.

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