Environmentally Sustainable Transport (EST): Concept, Goal, and Strategy – The OECD's EST Project[1]

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OECD countries recognized in the mid-1990s that transport trends were not sustainable and that existing policy frameworks seemed unlikely to be able to move society towards more sustainable transport systems. A new approach to transport policy was required that would be consistent with the broad definition of sustainable development. To this end, the project on Environmentally Sustainable Transport (EST) was initiated to give some precision to the concept of EST through the use of criteria that have environmental significance and can be quantified. A method known as 'backcasting' was used to develop policies and strategies for achieving a desired future state through targeted action. This paper summarizes the results of the project, which involved twelve OECD countries that undertook case studies at local, regional, national and international scales.
The project concluded that some 40 per cent of the effort necessary to meet the EST criteria will come from technology and 60 per cent from demand-side management and a shift towards more sustainable transport modes. EST is attainable, but only if a broad range of

[1] The views expressed are those of the authors and not necessarily those of the organisation or its member countries.

instruments is deployed. These include regulations and standards, fiscal measures, changes in governance arrangements, and education, the provision of information, awareness raising, and attitude change, all assembled into coherent packages of instruments applied with careful consideration to phasing.

1. The EST Project

Several OECD countries concluded in the mid-1990s that current policy frameworks seemed likely not to be able to move society towards more sustainable transport systems. In part this was because there was no definition of sustainable transport and no clear targets for achieving it. Recognising these gaps, the OECD Environmental Policy Committee's Task Force on Transport initiated the project on Environmentally Sustainable Transport (EST) to give some precision to the concept of EST through the use of criteria that have environmental significance and can be quantified. Unlike conventional approaches to transport policy development, the EST project began with a vision of environmentally sustainable transport in 2030 and with establishment of corresponding EST criteria. Teams in nine countries undertook case studies (the Quebec Windsor corridor in Canada, the greater Oslo region, Sweden, the Netherlands, Germany and the Alpine region comprising Austria, parts of France, Italy, and Switzerland) to describe how EST could be achieved (see the project documentation at www.oecd.org/env/transport). Related studies were carried out by Austria, France, Japan and the Central and Eastern European region (UNEP/OECD/Austria, 1999).

The EST project concluded that there is a better way towards a sustainable transport future. It involves defining what is meant by environmentally sustainable transport, developing a vision with clear objectives, criteria and targets, and then identifying ways and means to re-alise them (OECD/ENV, 1996 to 2001). The better way also involves assessment of the eco-nomic and social implications of EST. The method used is 'backcasting' to develop policies and strategies for achieving a desired future state through targeted action, in contrast to the conventional methods involving forecasting and amelioration the effects of assumed trends. The EST project concluded with the development of guidelines for moving towards EST (OECD/BMLFUW, 2000). These EST Guidelines were endorsed by OECD's Environment Ministers at their meeting in May 2001.

Figure 1 depicts in a schematic diagram the individual steps carried out in the project: i) definition of the environmental dimension of EST with quantified criteria and targets; ii) developing a vision for EST in 2030, its structure (modal split) and requirements, iii) project likely trends (Business-as-usual BAU); and iv) elaborate possible policy pathways, policies and strategies to achieve EST.

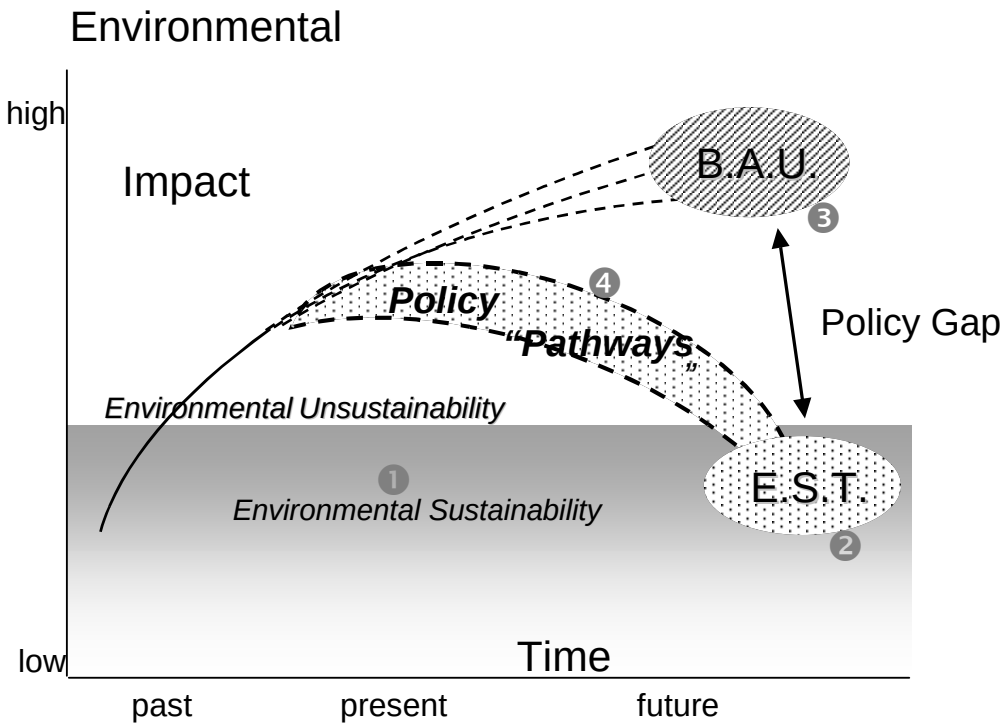


Figure 1. The EST concept and approach -Environmental sustainability targets and backcasting method

2. Environmentally Sustainable Transport: Definition, criteria, goals and targets

Consistent with the broad definition of sustainable development (WCED, 1987), the specification for a sustainable transport system requires that the movement of people and goods is provided in an environmentally, socially, and economically viable way; mobility for any purpose is to be considered as a means rather than an end. Environmentally sustainable mobility implies changes in behaviour and new innovative approaches at all levels of society and sectors of the economy. Important prerequisite for realising an EST system in the long term are conformity with ecological limits (critical levels and loads) and the prevention of pollution.

A sustainable transport system is one that

- provides for safe, economically viable, and socially acceptable access to people, places, goods, and services;
- meets generally accepted objectives for health and environmental quality (e.g., those concerning air pollutants and noise put forward by the World Health Organization);
- protects ecosystems by avoiding exceedences of critical loads and levels for ecosystem integrity, e.g., those adopted by the UNECE for acidification, eutrophication, and ground-level ozone; and
- does not aggravate adverse global phenomena such as climate change, stratospheric ozone depletion, and the spread of persistent organic pollutants.

Alternatively, an environmentally sustainable transport system is one where

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

Internationally agreed goals, guidelines, and standards—such as those defined by WHO and adopted by the European Union, the UNECE Convention on Long-Range Transboundary Air Pollution, and the UN Framework Convention on Climate Change—have been used to operationalise this definition and to set goals and long-term environmental and health targets.

3. Criteria for EST

Six criteria for the transport sector were developed during the EST project as being the minimum number required to encompass the wide range of health and environmental impacts of transport. These criteria were selected to address local, regional, and global concerns, notably land use, local noise and air quality, regional acidification and eutrophication, and tropospheric ozone and global climate change.

Using existing international goals, guidelines, and standards relevant to these impacts, the criteria and targets were developed concerning emissions of carbon dioxide, nitrogen oxides, volatile organic compounds, carcinogenic particulate matter, noise, and land use (see Table 1). Criteria for other important impacts such as ultra-fine particulate emissions, waste generation, water and soil pollution, biodiversity, habitat fragmentation, and releases of persistent organic pollutants could not be quantified without further analysis.

These criteria illustrate how EST criteria and targets can be linked to significant environmental and health quality objectives. The targets are long-term; specific intermediate targets and milestones should be set to focus action. The quantitative target levels shown are not prescriptive and can be adapted according to national, regional, and local circumstances. Each of the six criterion described in Table 1 is accompanied by an explanatory note in ital

Table 1. Illustrative long-term environment and health quality objectives, criteria, and derived operational targets for EST

CO2	***Nox***
Climate change is prevented by reducing carbon dioxide emissions so that atmospheric concentrations of CO_2 are stabilised at or below their 1990 levels. Accordingly, total emissions of CO_2 from transport should not exceed 20% to 50% of such emissions in 1990 depending on specific national conditions.[2]	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. [3]

[2] The Second Assessment Report of the Intergovernmental Panel on Climate Change (1996) maintains that, in order to stabilise atmospheric CO2 concentrations at near current levels, world-wide CO2 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). 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

VOCs	***Particulates***
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).[4]	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.[5]
Noise	***Landuse/Landtake***
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.[6]	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, eco-system and biodiversity protection are met. Compared to 1990 levels, this will likely entail the restoration and expansion of green spaces in built-up areas.[7]

4. The modal split of EST in 2030

Environmentally sustainable transport doesn't necessarily mean less mobility than we have today, but it will mean different transport and new types of mobility in 2030. EST will, by definition, meet all six of the EST criteria. In building a vision of such a system, two alternate pathways were explored: the first focused on reaching the EST criteria solely through technological means; the second used primarily demand-side management measures. The final EST scenario included a combination of some of the most promising existing and tested technological features of the technology scenario with the more politically acceptable features of the demand-side management scenario.

EST in 2030 is characterised by a modal split that is significantly different from today's situation and from projected BAU trends (see Figure 2 for the modal split of passenger and freight). The mode split for the BAU trends is likely to be similar to current situation with a

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 situation (e.g. as was suggested by the EST pilot study for the countries of the Central and Eastern European region).

[3] This criterion is set in line with the WHO guidelines for human health regarding Nox 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).

[4] This criterion is set in line with the WHO guidelines for human health regarding VOC's and Ozone (WHO, 1996) and the UNECE protocols under the Convention on Long-Range Transboundary Air Pollution for ecosystem protection regarding critical levels of ozone (UNECE, LRTAP Convention, 1999).

[5] WHO advises that no safe threshold level can be set for fine particulate matter (smaller than PM10) and ultrafine particles (smaller than PM 2.5) below which health effects (including cancer) do not occur. However, 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).

[6] 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).

[7] Quantification of the land use criterion requires further research.

dominance of road transport both for passenger and freight (about 70%), and a significant increase in aviation (about 20%). Consequently, BAU won't meet sustainability criteria and causes large externalities. In contrast, EST would have a more balanced modal split and a higher share of new mobility for passenger transport (about 50% would be public/private types). For the movement of freight, the emphasis would be on rail-based or combined transport (about 60%) and waterborne transport (20%). Overall, passenger transport activity (in terms of passenger-km) could remain at the present high mobility levels, and the level of freight activity (in terms of tonne-km) could significantly increase (by more than 50%), provided this activity is performed with considerably less harmful modes.

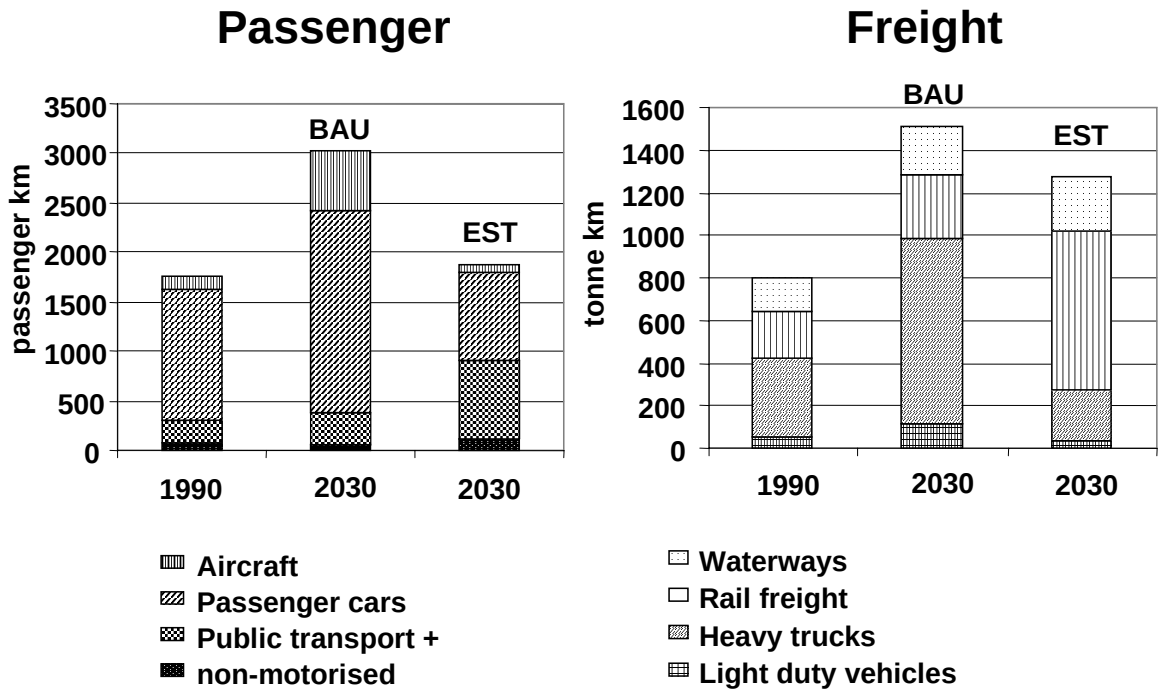


Figure 2. Comparison of transport activity changes in the EST3 scenario and the expected trend ("Business-as-usual") in 2030 compared to the situation in 1990.

Note: Public transport + means new mobility schemes that are practiced in a number of countries, including integrated mobility services that provide access to mass transit as well as individual car use, and thus ensuring a high-level of mobility, while providing significant environmental advantages and reduced individual costs.
Rail freight includes also a large amount of combined transport.

If EST is to be achieved over the next three decades, transport in 2030 could be characterised by:

- A significant change in the type of passenger transport provided. Many passenger cars would have more fuel-efficient conventional engines, hybrid-electric engines, electric engines (e.g., powered by fuel cells). There would be much greater use of non-motorised means for short distance trips together with supporting infrastructure.
- Public transport, including new forms of integrated public and individual transport such as 'public cars', would increasingly provide integrated mobility services.

- Significantly more efficient longer-distance freight movements due to increasing load factors, better logistics, and more use of rail-based modes. Hydrogen would be used as a fuel both directly and in fuel cells.
- Almost all rail transport would be electric, with increased use of high speed modes, especially for freight.
- More efficient and less polluting inland and coastal shipping vessels would be used; hydrogen may also be used as a fuel.
- Long-distance air travel for business purposes would be largely obsolete, with information technology used for communication instead. Multi-modal freight logistics would be used for air cargo. Aircraft in use would be much more fuel efficient, conventional types, and rigid airships may be used for specific purposes.

Additional policies and measures in other sectors of the economy would support and accompany the shift towards more environmentally sustainable transport, while not necessarily decreasing economic and social welfare. These measures could include the following:

- Electric power for transport would be generated with much greater efficiency than at present, using a high proportion of renewable fuels.
- Relatively small changes in the form of settlements would have been implemented to reduce the need for movement of people and freight.
- Greater use of telecommunications would help avoid both passenger travel and the movement of goods.
- Regionalisation of production would help avoid long-distance freight movement, and there would be a greater focus on service provision.
- Continuing public education campaigns would have been implemented to encourage both lower levels of travel and more environmentally sustainable consumption (with less need for goods transport).

It is worth noting that the EST in 2030 assumes a growth in total transport activity of some 23% compared to 1990 levels, but with emphasis on more environmentally sound modes (see Figure 2). Generally, transport in 2030 is characterised by a large shift from less sustainable to more sustainable modes accompanied by a relative decrease in transport activity of the unsustainable modes, while other modes increase significantly compared to current levels and to the projected business-as-usual trend.

5. Economic and social implications of the BAU and EST scenarios

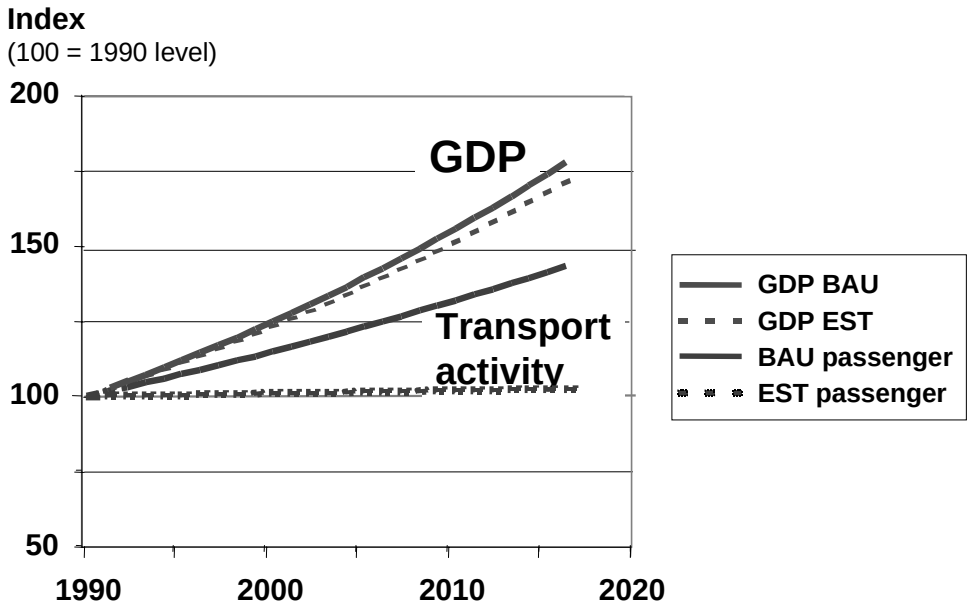
Sustainability requires consideration of environmental, social, and economic aspects. Ultimately, however, the environmental component must prevail, for environmental factors provide the limiting conditions for other activity. An assessment of economic implications of EST was considered important, although preliminary and cursory at this stage, especially given the uncertainties for time period considered for EST. Different methods were applied by the expert teams ranging from use of sophisticated system dynamics and general equilibrium models to semi-quantitative and qualitative assessments (OECD/ENV, 1999). Despite

the variety of methods used, the outcomes and overall conclusions concerning the economic implications of the scenarios were similar. They are shown in Figure 3.

Figure 3 shows that the overall economic impacts of achieving the EST scenario in terms of GDP 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 over the next decades compared to 1990, a high level of mobility—albeit with a different modal split for both passenger and freight—and attainment of concrete and ambitious environmental goals.

The EST case studies stress the need for greater use of more environmentally friendly and flexible transport modes such as public transport combined with car-sharing. In spite of these ambitious EST goals, the economic analysis shows that the economic repercussions are small compared to the projected BAU trends. Moreover, if the objectives of EST are made less ambitious, the economic effects will be even smaller. The economic analysis also demonstrated that the negative effects can be mitigated over time and externalities such as environmental and social costs avoided.

Passenger Transport



Freight Transport

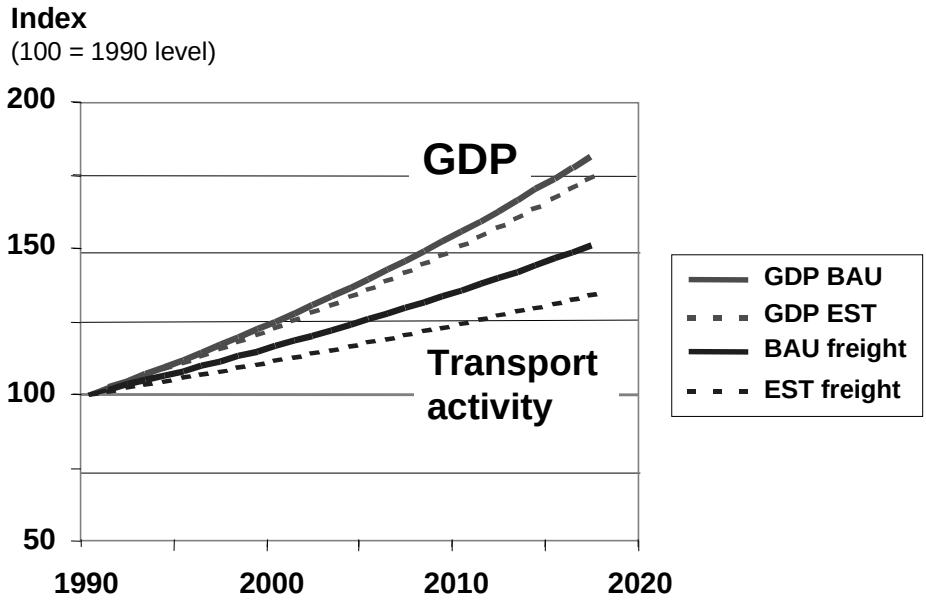


Figure 3. Evidence for relative "decoupling" of transport demand from economic growth (results from EST case studies)

The project also assessed the *health and environmental externalities* (i.e., the unpaid social costs): the external costs of transport for the BAU trend and EST scenarios until the year 2015, a time horizon considered feasible for a quantitative assessment and that is consistent with the broader economic analysis (OECD/ENV, 1999 and 2001). External costs of accidents, noise, air pollution, and climate impacts (but excluding congestion costs) were estimated for the various transport modes making use of a recent analysis for Western Europe (INFRAS/IWW, 2000). The dominant aspects are accidents, followed by climate change and air pollution. Total external costs (excluding congestion costs) amounted to 222 billion euro in 1990 (see Figure 4). They would rise to 304 billion euro (+31%) in 2015 in the case of the BAU trend, but would decline to 154 billion euro (-37%) in the case of the EST scenario.
Two thirds of these costs are attributable to passenger transport and one third to freight movements. In 1990, accidents were the most important cost category, contributing 31% of the external costs from car use. The second most important cost category was air pollution, representing 27% of the external costs from car use. Climate change impacts were estimated to be of a similar order, but those for noise were of lesser importance. Under the BAU scenario, the contributions of the various impacts would be similar to that in the base year of 1990 except that costs related to air pollution would be less important. Under the EST scenario, the cost attributions would be similar to that for the BAU scenario except that costs related to CO_2 emissions would be much less important. Thus, accident costs (as the major category), upstream processes, and noise remain important in all three scenarios.

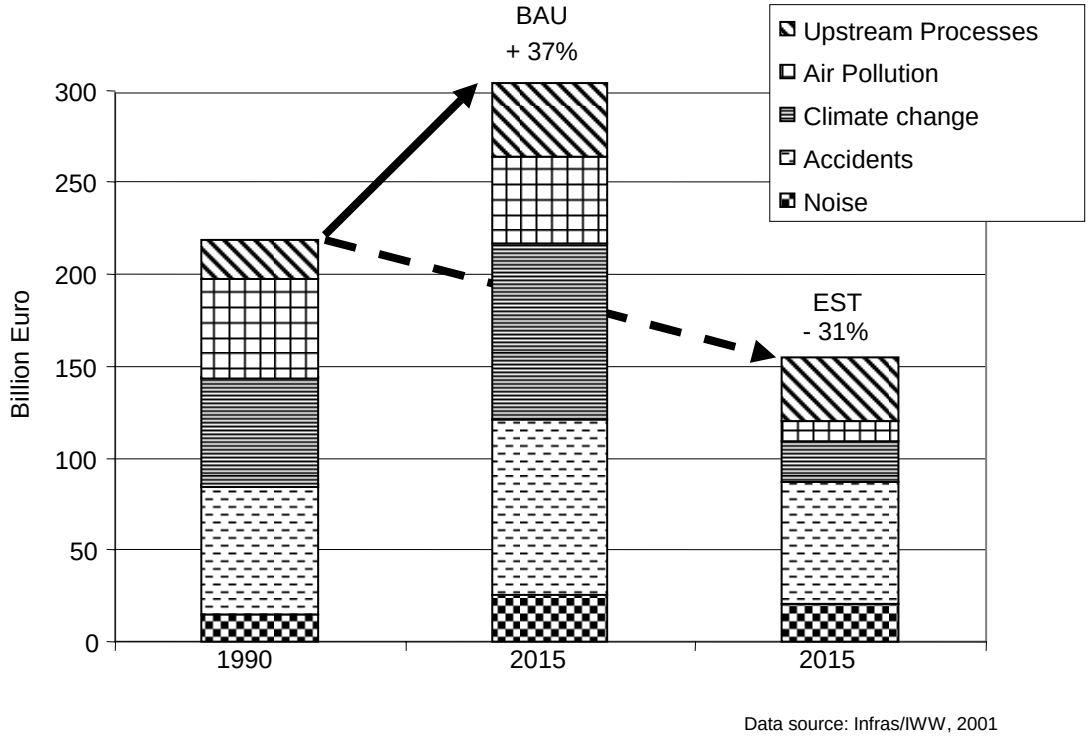


Figure 4. External costs of transport: Environmental and health costs of the BAU and EST scenarios by impact category

The external costs for the nine participating countries represent approximately 6% of total GDP in 1990, and 5% under the BAU scenario in 2015, but only 2% under the EST scenario, assuming a 80% growth in GDP during the period 1990 to 2015.

The analysis for the EST project concluded that EST will have considerably lower external costs compared to the projected business-as-usual (BAU) trends. The results of this analysis on the external costs of the EST case studies in 1990 and under the BAU and EST scenarios supplement the assessments of *economic implications*. They confirm the conclusion 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 on society by transport. Thus, EST will provide major savings for the society as a whole. Significant structural changes and adaptations will be required to realise EST. These changes will provide major opportunities for new business, including integrated mobility services, freight logistics, and information technology so that transport can be provided in a more environmentally friendly way.

The overall economic effects on 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. Employment would be down slightly compared to the BAU scenario, but much higher than today's levels. However, external costs would be reduced significantly under EST compared to the BAU trend. 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 in ways that would enhance overall well-being.

Consideration was also given to the *social implications* of the different scenarios. The preliminary conclusions were that social conditions will worsen with BAU and will be more benign with EST, certainly more benign than with BAU and perhaps more than now. Continuation of BAU could result in growing social disparity and alienation, and loss of independent mobility among the elderly and particularly children. With movement towards EST, on the other hand, life could become more egalitarian, convivial, and child-friendly, at least in comparison with BAU.

6. Policies and strategies - the critical path to EST

The EST criteria will likely not be met by technology alone. Indeed, contrary to the direction of much of current transport and environment policy, achieving environmentally sustainable transport will require greater demand-side than supply-side measures. Overall, the project participants concluded that some 40 per cent of the effort necessary to meet the EST criteria will come from technology and 60 per cent from demand-side management and a shift towards more sustainable transport modes (see Figure 5). Mobility management measures for passenger transport include increasing occupancy levels, traffic avoidance, and downsizing of vehicles. For freight transport, increasing load factors and transport avoidance through better logistics and freight bundling will contribute to achieving the EST targets. This conclusion could be an important guide to governments as they develop mid- to long-term policy strategies for transport.

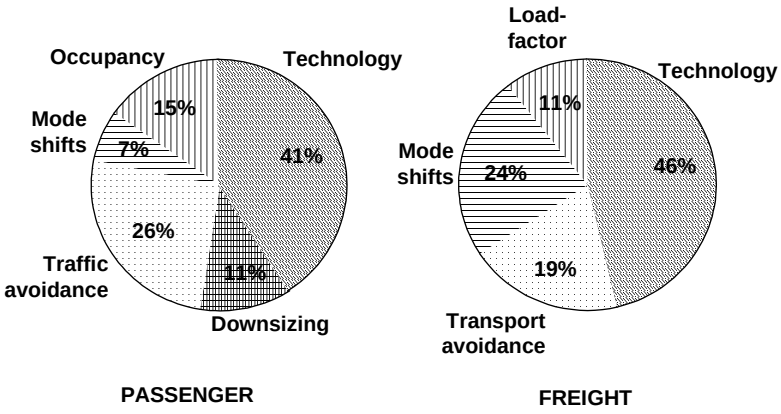


Figure 5. Contribution of technology and mobility management measures to EST in 2030.

Implementing EST will require a broad range of instruments assembled as a coherent package of measures combining regulations and standards, fiscal instruments, changes in governance arrangements, and instruments involving education, the provision of information, awareness raising, and attitude change. Most of the instruments proposed in the case studies are already used or are being discussed; only about one third would be new.

There are several views on the effectiveness of particular instruments in achieving a desired outcome. Figure 6 shows how classes of instruments were proposed by the expert teams for application in the EST project.

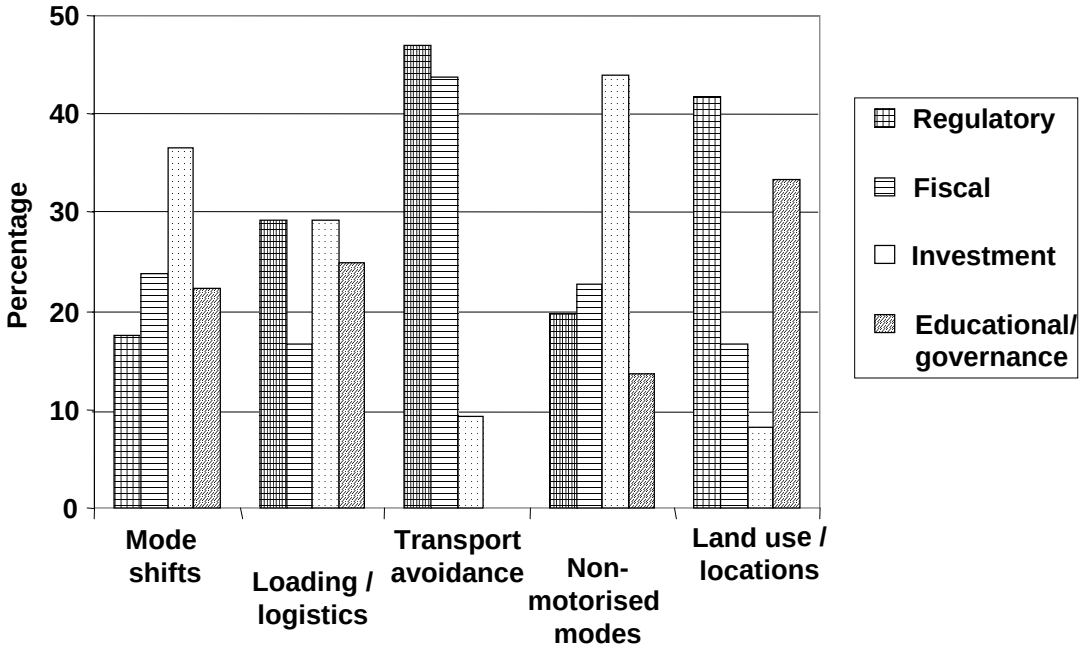


Figure 6. Type of instrument to achieve a specific effect

The analysis of the case studies showed that:

- inducing mode shifts and promoting non-motorised modes will require targeted investments in environmentally sustainable modes;
- improving efficiency through increased load factors and logistics will require a combination of regulation, investment, and information/education;
- preventing or avoiding transport will likely require a focus on regulatory and fiscal instruments including taxes and pricing (e.g., distance-related vehicle taxes);
- change land use and the location of facilities will require land-use regulation as well as information, education, and training.

For all the cases considered to achieve a specific effect, investments in new transport infrastructure play an important role, and this raises questions about the generation of public revenue for financing them under EST. Several counties recur to innovative fees and charges systems that take into account externalities (e.g. London cordon charging for urban vehicles; the Swiss heavy-duty vehicle fee). This revenue is used for financing maintenance of existing networks as well as cross-financing of new infrastructure for other modes. An overall conclusion from this work is that a broad range of instruments will be needed that have to be deployed in a consistent manner and their focus maintained over time.

Conclusions

The EST project concluded that EST is attainable, although only with a broad-based and concerted commitment. Member country teams working on how this can be done developed a broad variety of policy instruments and strategies capable for achieving EST. The instruments addressed technological breakthroughs, mobility management, and awareness raising and

education. In most cases, the proposed packages of instruments included regulations (e.g., emissions standards and limit values), economic instruments (e.g., fuel and road pricing and fiscal incentives), changes in infrastructure investment policies, and land-use planning. Information and education to raise public awareness about the problems and possible solutions and alternatives played a key role in the proposed strategies.

The most important challenges lie in the acceptability of the goals, targets, and strategies and their component instruments. 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.

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. 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.

The EST project has uncovered a substantial gap between those conditions likely to come about as a result of current and future transport trends, on the one hand, and the conditions necessary for achieving environmentally sustainable transport, on the other hand. The project concluded with the development of Guidelines for moving towards environmentally sustainable transport, designed to assist government at all levels in the development and implementation of appropriate strategies towards EST (see Table 2). They were presented and discussed at the OECD Conference on "EST, Futures, Strategies and Best Practice" held in Vienna in October 2000 (OECD/BMLFUW, 2000), and were endorsed by OECD Environment Ministers in May 2001. Their effective implementation requires strategies that accommodate the particular geographic and socio-economic conditions of countries and regions and the involvement of all affected parties. Securing an environmentally sustainable transport system is one of the principal transport policy challenges facing many countries at the outset of the 21st century.

Table 2: The Guidelines on Environmentally Sustainable Transport

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 and traffic management, improvement of public transport, and encouragement of walking and cycling; capture synergies (e.g., those contributing to improved road safety) and avoid counteracting effects among instruments.
Guideline 8.	Develop an implementation plan that involves the well-phased application of packages of instruments capable of achieving EST taking into account local, regional, and national circumstances. Set a clear timetable and assign responsibilities for implementation. Assess whether proposed policies, plans, and 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.

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