THEMATIC SYNTHESIS OF TRANSPORT RESEARCH RESULTS

PAPER 2 OF 10

ECONOMIC ASPECTS OF SUSTAINABLE MOBILITY

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Contents

EXECUTIVE SUMMARY

This paper provides a structured guide to the findings and policy implications of research carried out in the Transport RTD Programme[1] that relate to the economic aspects of sustainable mobility. (See Section 1 for advice on how to use the paper.)

Mobility plays a major role throughout the economy, and has tended to increase in line with overall output. In addition, it generates substantial employment, and contributes to trade and regional links within the European Union. Competition within the sector is driving down the costs to industry and making Europe more competitive. On the other hand, traffic growth is making congestion worse, and imposing other costs on the economy e.g. as a result of increasing emissions of greenhouse gases. Policy actions have to strike a balance between the positive and negative impacts of transport, while ensuring that wider economic effects (such as employment, regional development and long term trends in land use) are taken into account. RTD is providing a vital foundation for this, developing guidelines and tools to support the implementation of policy measures, and demonstrating their likely impacts.

In this paper, results are reviewed for "clusters" of research projects in six inter-related areas:

Land use and macroeconomic effects
A "reference scenario" has been developed for the effects of current trends in the European transport sector to the year 2020, to provide a baseline for future work on policy assessment. In addition, alternative scenarios have been devised to help policy-makers explore the consequences of uncertainty in future socio-economic and political developments. New modelling tools are available to quantify the relations between transport activity and other branches of the economy, and good practice in controlling the interaction between land-use and transport has been identified.

Regional linking
Methods and tools have been demonstrated for evaluating the impacts of major investments in transport infrastructure, such as the Trans-European Transport Network, at both corridor and policy levels. Outputs include indicators of regional economic development, employment, accessibility and cohesion. This has been complemented by assessments of current market conditions and barriers to multi-modal transport on major routes.

Completion of the Single Market
The Transport RTD Programme has made recommendations on taking forward the liberalisation of both the rail sector and public transport. For the rail sector, tools were devised to support the implementation of policy, and the concept of a dedicated rail freight network was shown to have the potential to reverse current downwards trends in the market share of rail. In the case of public transport, the work concluded that "limited competition", where authorities invite tenders for specified services, is to be preferred over full regulation or full deregulation. This work has been influential in the subsequent revision of the regulatory framework. Barriers to interoperability in a variety of other transport markets were also identified, with regulatory reform emerging as a key requirement.

[1] Part of the Fourth Framework Programme for Community activities in the field of research, technological development and demonstration for the period 1994 to 1998.

EU competitiveness, employment and innovation

Extensive surveys have identified critical factors influencing the economic performance of European transport markets. Methods and tools have been provided to help operators improve their competitiveness, and recommendations made for policy changes. New technologies with high potential have been identified, with advanced telematics solutions looking particularly promising.

External trade

A demonstration voyage was made to assess the viability of opening up routes for importing oil and gas by ship through the Russian Arctic. The work showed that such transportation is technically viable and safe, but the costs are extremely high, and necessary investments would first require a change in the legal framework and business environment to reduce the commercial risk. New support tools for routing through ice-infested waters proved successful.

Pricing, financing and external costs

The Transport RTD Programme has been the focal point for European research on the use of pricing instruments to promote more sustainable travel choices. The work has identified the potential for optimising taxes, charges and tariff structures to influence transport demand and travel patterns, and has indicated the effects on different modes of transport. Prices could go either up or down, depending on the context and the current level of charges. Practical guidelines and calculation methods have been devised to support pricing reform, and demonstration projects have shown the likely impacts. The implications for the financing of transport systems have also been identified.

1. INTRODUCTION – HOW TO USE THIS PAPER

This paper provides a structured guide to the results of Research and Technical Development (RTD) projects relating to the *economic aspects of sustainable mobility*, carried out in the European Community's Transport RTD Programme. It is one of a series of papers:

Paper no.	Theme
1	Sustainable mobility – integrated perspective
2	Sustainable mobility – economic perspective
3	Sustainable mobility – social perspective
4	Sustainable mobility – environmental perspective
5	Urban transport
6	Efficiency and quality
7	Safety and security
8	Human factors
9	Interoperability
10	Freight intermodality

Of the 275 projects within the Programme, 47 dealt (partly or fully) with specific economic issues. Most of these projects were finalised in the year 2000.

How to use this paper:
You are recommended to use this paper to locate RTD results on topics where you have a particular interest, rather than reading the paper from start to finish:

- Start in Section 5 to get an overview of the topics addressed by "clusters" of RTD projects.
- Read the part of Section 6 that summarises the findings for each topic of interest to you.
- Use Annex 1 to identify the individual projects relating to that topic.
- Use Annex 2 to review the key results from each of these projects.

Further details on individual projects can be obtained from their web sites (noted in Annex 2, where available) and from the following Commission web sites:

- http://europa.eu.int/comm/transport/extra/home.html, which includes summaries and the full final reports of individual projects, as well as a variety of analyses and publications prepared by the EXTRA project;
- http://cordis.lu/transport/src/project.htm, which provides the project objectives and summary results as compiled by the RTD project teams.

The other Sections of this paper can help you to gain an overall picture of the urban transport theme, associated policy issues and the objectives for RTD.

The analysis in this paper is the responsibility of the EXTRA project team, and does not represent the official viewpoint of the European Commission.

2. SCOPE OF THE THEME

2.1 Definition of economic aspects

Mobility and sustainability

Mobility is playing an increasing role in human activities. While transportation infrastructure and services are increasing in efficiency, speed and comfort, with decreasing costs, a series of adverse impacts are leading to social concern. There is an emerging dilemma that growth in demand for transport (illustrated in Table 1) could slowly strangle the transport system itself, constraining economic growth, damaging the environment and threatening mobility.

Table 1: Main modes of transport (in billions of passenger-kilometres)

	Car	%	Bus and coach	%	Tram/ metro	%	Rail	%	Air	%	Total pkm
1970	1583	74	270	13	38	2	217	10	43	2	2151
1997	3787	79	393	8	41	1	282	6	322	7	4825
Growth	140%		46%		8%		30%		650%		120%

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

The negative side effects of the increasing demand for mobility have become widely known in the last two decades, triggered by air quality concerns and serious congestion problems. For example, Table 2 records nearly 200% growth in the transport of goods by road since 1970. This has led to a change in social and political attitudes, and to a series of changes in mobility policies.

Table 2: Evolution of the transport of goods in the European Union (in tonne-km)

	Road	Rail	Inland waterways	Pipelines	Intra-European sea	Total tkm
1970	412	283	103	66	472	1336
1997	1202	237	119	86	1124	2768
Growth	190%	-16%	16%	30%	140%	110%

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

Concept of sustainable development

In parallel to the changes in attitudes to transport, a new consciousness towards the environment and the use of natural resources has led to the development of the concept of sustainable development. This was first put forward by the World Commission on Environment and Development (the 'Brundtland Commission') in 1987 and defined as:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Following the definition established by the World Commission, sustainable development is generally considered to comprise two main elements:

- minimising environmental impacts;
- making the *most economic* and most equitable use of resources.

In promoting sustainable development, the challenge for policy-makers is to reconcile three objectives:

- securing higher standards of living through economic development;
- protecting and enhancing the environment;
- ensuring an equitable distribution of the benefits between present and future generations.

Subsequently, the Amsterdam Treaty explicitly included sustainable development for the first time as one of the European Union's main objectives.

Concept of sustainable mobility

The objective of sustainable mobility is closely linked to the objective of sustainable development. Both objectives aim to allow consumption needs linked to economic activity to be met without threatening other socio-economic needs. In the case of transport, the term 'sustainable' implies the prevention or rectification of economic, environmental and social side effects, such as those listed in Table 3 below.

Table 3: List of potential negative impacts of mobility

Primary level (basic impacts)

1 Nuisances affecting potentially everybody:

a) Localised such as: smell, noise, visual disturbance, noxious emissions (toxic, corrosive), electro-magnetic disturbances, contamination, vibrations, risk of accident (fire, collision).

b) Non-localised such as: reduction of non-renewable natural resources, non-recyclable waste, production of inferior quality energy or material, noxious emissions damaging the ozone layer.

2 Nuisances affecting mobility in particular:

Congestion of routes, severance of communication links, road accidents.

Secondary level (effects of basic impacts)

1 Nuisances affecting potentially everybody:

a) Localised such as: weather change (local, regional), stress/health hazards (allergies, lung cancer), damage to natural resources (water, fish, game), increase of crime level/insecurity level (real and felt).

b) Non-localised such as: climate change (global), floods, storms.

2 Nuisances affecting mobility in particular:

General increase in traffic (mainly road).

Tertiary level (macro-economic long-term consequences)

1 Nuisances affecting potentially everybody:

Town centre disaffection/urban spread, social exclusion, need to adapt housing, segregation of functions (office/administrative quarters, housing areas, commercial centres), natural hazards due to weather/climate change, health hazards (skin cancer), diminution or extermination of species/break in food chains.

2 Nuisances affecting mobility in particular:

Need for more transport because of longer distances (between home and school/work).

The causes of these problems are relatively well known and solutions have been suggested. One notable example is the set of solutions defined at the UN Conference for Environment and Development in June 1992, and formulated in the document known as ‘Agenda 21’.

In the formal Agenda 21 document, six objectives are set for transportation. In order to make transportation more sustainable or to make it less unsustainable, Agenda 21 requires society:

- to reduce transportation demand;
- to develop public transport;
- to promote non-motorised transport (cycling and walking);
- to integrate all aspects in planning and to maintain public infrastructure;
- to develop and communicate processes between the different countries/communities;
- to change the patterns of consumption and production in our societies.

Thus, the term sustainable mobility stands for a process and a path to be followed, rather than simply representing a vision of a future situation. The following objectives can be mapped out for this path:

1. *To provide access to goods, resources and services, while reducing the need to travel - such that **economic**, environmental and social **needs** can be met efficiently and in an integrated manner.*
2. *To ensure that transport infrastructure and travel use do not exceed the capacity of the environment to withstand their impact.*
3. *To ensure that users pay the social and environmental costs of their transport decisions **without making industry uncompetitive** or preventing those on low incomes from meeting their transport needs.*
4. *To reduce the growth in car and lorry traffic to sustainable levels.*
5. *To ensure that **transport infrastructure investments** take proper account of environmental aspects.*
6. *To increase the choice, and encourage the use, of **economically**, environmentally and socially **efficient** transport modes.*
7. *To protect critical natural and physical capital.*
8. *To meet environmental quality standards based on critical ecological limits and precautionary public health requirements.*
9. *To ensure that renewable natural resources are used in ways which do not diminish the capacity of ecological systems to continue providing those resources over time.*
10. *To ensure that non-renewable natural resources are used in ways that account for future needs and the availability of alternative resources.*
11. *To enhance public health and safety, reduce accidents and improve security.*
12. *To ensure the **economic** and social **acceptability** of new measures.*

Based on these objectives, sustainable mobility can be defined in practical terms as:

A transport system and transport patterns that can provide the means and opportunities to meet economic, environmental and social needs efficiently and equitably, while minimising avoidable or unnecessary adverse impacts and their associated costs, over relevant spatial and time scales.

Definition of economic aspects of sustainable mobility

The development of mobility influences, and is influenced by, the path of economic development in general. Therefore, in order to take effective policy action, we need to understand the impacts of mobility on economic activity as well as the drivers of mobility. For example:

- As mobility is central to many **economic activities** (private and professional trips, delivery of goods, access for customers, delivery of services, etc.), it interacts with policy towards land use, urban structure, economic regeneration, housing, tourism, leisure and natural resources.
- As mobility can also be a **cohesive factor** between regions, it contributes to the completion of the European Single Market and external trade links.

- Mobility is provided by **the transport sector**, which itself plays an important role in the economy through its contribution to:
  - the competitiveness of the European economy (through user transport costs)
  - production of goods and services (vehicles, infrastructure, passenger and freight services, support services and technologies for operations etc.)
  - export potential and employment.

The impacts of mobility problems on economic activity (e.g. through increased transport costs and delivery delays resulting from traffic congestion) are estimated to be substantial. Consequently, ways must be explored to minimise the problems while fulfilling mobility needs in an effective and efficient way, in the short and long term, both locally and globally.

The issue of ensuring sustainable mobility can be viewed from both a macro-economic and a micro-economic perspective. This Thematic Paper focuses primarily on macro-economic aspects, while another Thematic Paper looks at the efficiency of the transport sector.

2.2 Topics included in the theme

The impact of mobility on land use

Mobility is sometimes referred to as the 'lifeblood' of economic activity because it plays a major role in almost every type of activity. Business costs are affected by the accessibility of any location for employees, suppliers, services and customers. Therefore the availability of good transport links will affect location decisions for industry, services and residential areas. In turn, these decisions will affect the future development of transport patterns, car dependency and congestion.

Regional and interregional links

The extension of the trans-European transport network, reductions in border delays and improvements in transport interoperability between countries are expected to have considerable impacts on EU Member States, ranging from a higher level of traffic to new opportunities for economic integration, trade and globalisation of production.

The Single Market

The implications of lifting intra-European barriers will be changes in economic activities such as marketing and production. This will lead to changes in employment opportunities as sectors of the economy grow, diminish and shift geographically (e.g. between Member States). Increased mobility will facilitate such structural changes in the economy, but can also help companies and workers to adapt their modes of working in response.

The environmental aspects

Pollution, noise and other adverse environmental impacts caused by transport activities have direct financial effects on society.

2.3 Significance of the theme

The significance of the mobility of people and goods

The mobility of people and goods has reached a level where society is increasingly questioning its necessity, the means used and their consequences. For example, the specialisation of production in certain countries, just-in-time production and the increasing volume of transit packaging all have one result: they contribute to an increasing need for mobility of goods. In addition, commuter travel has increased rapidly over the last century. This evolution has happened because of the relative reduction in transport costs brought about by technological advances and economies of scale. Good transport links have also enabled people to travel further within a limited time budget.

A good illustration of the scale of this daily movement is given by the average time spent commuting to and from work, shown in Table 4.

Table 4: Average time spent commuting to and from work (minutes per day, 1996)

	B	DK	D	GR	E	F	IRL	I	L	NL	A	P	FI	S	UK	EU
Average time to commute	39	38	45	40	33	36	40	23	40	44	36	33	41	40	46	38
Time relative to EU = 100	103	100	118	105	87	95	105	61	105	116	95	87	108	105	121	100

Source: EU transport in figures, Statistical pocketbook, European Commission.

A large amount of time is spent each day in commuting to and from work. There are major differences between the Member States of the European Union, reaching an average of 46 minutes in the United Kingdom. Intuitively, such commuting must have an economic as well as a social impact.

The economic significance of the transport sector

Of a total gross domestic product (GDP) of 7.5 trillion ECU (i.e. 20,200 Euro GDP per person), the value created by the transport services sector in 1998 was 300 billion ECU (i.e. 4% of total GDP). In addition, the value created in own-account transport represented 1% of total GDP. This shows clearly the important role played by the transport sector.

Table 5: Statistical overview of the transport sector in the European Union in 1998

Domain	Importance expressed in figures
Value created	Total GDP is 7 trillion Euros or 20,200 ECU per person: - of which value created by the transport services sector was 4%; - in addition, value created by own-account transport was 1%.
Employment	6 million people are employed in the transport services sector (4% of all people employed). In addition, 2 million people are employed in the transport equipment industry, and over 6 million in transport-related industries.
Investment in transport infrastructure	Investment in transport infrastructure is ca. 1% of GDP: - of which 65% is in roads, 25% in rail and 10% in other modes.
Household expenditure	Private households in the European Union spend 600 billion Euros per year or 14% of their income on transport: - of which about 500 billion Euros is for private transport (mainly cars) and 90 billion Euros is for public transport.
Goods transport	Transport demand is 3 trillion tkm or 7,700 tkm per person (20 tkm per person/day): - of which 44% is by road, 41% by sea, 8% by rail, 4% by inland waterways, and 3% by pipelines.
Passenger transport	Transport demand is ca. 5 trillion pkm or 13,000 pkm per person (35 pkm per person/day): - of which 79% is by car, 9% by bus and coach, 5% by air, 6% by railway and 1% by tram and metro.
Transport growth	Goods transport: ca. 3% per year (1990-98) - over 100% growth since 1970. Passenger transport: ca. 2% per year (1990-98) - over 120% growth since 1970.

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

Transport activity also represents a significant proportion of total household expenditure, while varying considerably between Member States, as shown in Table 6.

Table 6: Household expenditure on transport in the European Union in 1996

	B	DK	D	GR	E	F	IRL	I	L	NL	A	P	FIN	S	UK	EU
Transport (%)[1]	12	16	14	9	15	15	12	11	20	11	14	15	14	15	15	13.7
Transport expenditure, in billions of Euros																
TOTAL	15	12	163	7	45	110	4	65	1	21	15	8	7	15	85	571
Transport expenditure per capita, in 1000 Euros																
TOTAL	1.5	2.2	2.0	0.7	1.1	1.9	1.0	1.1	2.6	1.3	1.8	0.8	1.4	1.7	1.5	1.5

[1] *Percentage of expenditure on transport out of total household expenditure in 1996.*

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

Some determining factors

Table 7 gives a series of data about the distribution of the EU population. Of the 375 million people, some 17% are in the age range 0-14 years old, 67% 15-64 years old and 16% 65+ years old. The age distribution varies between Member States.

Table 7: Socio-demographic data

	B	DK	D	GR	E	F	IRL	I	L	NL	A	P	FIN	S	UK	EU
Population (millions)	10	5	82	11	39	59	4	58	0.4	16	8	10	5	9	59	375
Structure of the population (% of total)																
Urban	97	85	87	60	77	75	58	67	88	89	64	37	64	83	89	78

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

The information provided in Table 7 is important in the context of an analysis of the economic effects of mobility, from several aspects. First, the structure of transport systems and infrastructure and their use are closely linked to land use patterns and urbanisation. Thus, a country such as Portugal with a level of urbanisation of 37% will have very different mobility needs and, therefore, different requirements in terms of transport systems and infrastructure to those of a country such as Belgium, which has a level of urbanisation of 97%.

A second major aspect may be age division. For example, 15-64 year old people travel more by individual transport (car) than the over 65's, who are more often dependent on public transport.

A third important factor influencing the mobility of people and their choice of transport modes is household structure and size. Table 8 shows disparities between the Member States in this respect. Whereas there are, on average, two people per household in Denmark, there are more than three people per household in Spain. The percentage of households that cannot afford a car gives an important indication of their reliance on public transport systems.

Table 8: Households in the European Union and car ownership

	B	DK	D	GR	E	F	IR	I	L	NL	A	P	FI	S	UK	EU
Average no. of people per household	2.5	2.0	2.2	2.6	3.1	2.4	3.0	2.7	2.6	2.3	2.5	2.9	2.1	2.1	2.4	2.6
Car ownership (%)																
Own a car	76	58	74	55	68	78	66	78	83	58	65	55	na	na	70	72
Unable to afford a car	7	16	5	24	16	7	18	4	4	7	na	28	na	na	11	9

Source: EU transport in figures, Statistical pocketbook, European Commission, 1999.

3. POLICY CONTEXT

3.1 Policy objectives related to the theme

Since the 1992 White Paper on the Common Transport Policy (CTP), the objectives for sustainable mobility have been set firmly in transport policy documents. Economic efficiency in the development of transport systems will be pursued particularly through reform of transport charges, such as taxation of vehicles and fuels, with the general objective of internalisation of external costs. This approach has been developed particularly in policy documents on fair and efficient pricing and charging for the use of infrastructure, issued in 1995 and 1998.

Nevertheless, some policy objectives are commonly pursued by regulation rather than by economic instruments, and these can affect the costs of the transport industry directly. For example, safety standards and vehicle emission standards may increase the costs of vehicle production and operation. For this reason, the European Commission has played a major international role in pursuing dialogue between governments and transport-related industries. For example, these efforts led to a voluntary agreement with the car manufacturers on fuel efficiency targets to be reached by the year 2008. Similarly, the Auto-Oil programmes established a dialogue with the fuel and automotive industries, looking at the cost-effectiveness of improving air quality through tighter standards on vehicle emissions and fuel quality.

In the Commission's 1995 Green Paper on the Citizen's Network, the promotion of urban public transport was addressed with a view to reducing traffic congestion and impacts on the environment. In this area, a key economic challenge is to reconcile the benefits of public intervention with the need for efficient competition between transport operators.

Most recently, the Commission has adopted policy guidelines for a new White Paper on the Common Transport Policy. These concern around 60 proposals that will be detailed in the CTP White Paper due in 2001. The aim is to provide the European Community with a programme of actions to gradually decouple growth in traffic from economic growth. Highlighted actions include:

- revitalising the railways, particularly by opening up the markets and creating routes dedicated to freight transport;
- promoting transport by sea and inland waterway, with the creation of sea motorways;
- making air traffic management more efficient;
- turning intermodality into reality, by ensuring technical harmonisation and interoperability and by Community support for innovative initiatives;
- completing the priority work on the Trans-European Transport Network, such as the removal of bottlenecks on the railways and improving links to Central and Eastern Europe;
- adopting a policy on effective charging for transport, including the harmonisation of fuel taxation for commercial users and making charges reflect the real costs of transport.

3.2 Policy issues related to the theme

The transport sector faces a series of dilemmas of an economic nature:

- The European Union is seeking economic growth. The development of a Single Market requires good transport links, which is a driving force for the deregulation of the transport industry and promotion of interoperability across national borders. Yet the consequent growth in traffic such as long-distance road freight is threatening to stifle this economic success through congestion. The question is how to create the market conditions in which passengers and goods are moved by the most efficient means.
- Linked to the growth in traffic, the transport sector is a significant contributor to the growth in greenhouse gas emissions. It contributes 28% of the man-made CO_2 emissions in the European Union. The challenge is to identify the most *cost-effective* means of carbon abatement, to avoid imposing *excessive* costs on the economy.
- More generally, the transport sector is imposing external costs (environmental damage, health effects, accidents and delays due to congestion) that the user is not paying in full. As a result, decisions on the choice of transport mode, the time of day for travelling and the route are not being made with maximum economic efficiency. In other words, external costs are higher than they need to be. Governments would like to correct the situation using pricing measures, but face uncertainties: How can public acceptance be gained? Are there adequate technologies for making charges that will really influence consumer choices at the point of decision? What is the appropriate balance of charges across the different transport modes? What is the efficient way of deregulating transport so that pricing policies can act through market forces?
- Congestion is increasingly seen as a key problem. This occurs mainly in urban areas, but is also a growing problem for the Trans-European Transport Network: some 10% of the road network is affected daily by traffic jams, and there are bottlenecks on the railways and at airports. Altogether the delays result in an extra 6% of fuel consumption, and there is a serious risk that Europe will lose economic competitiveness. The most recent study on the subject showed that the societal costs of road traffic congestion alone amount to 0.5% of Community GDP, increasing to 1% over the next ten years if nothing is done.
- The development of good transport links influences the location decisions of households and companies. In turn, this can "lock in" patterns of land use that are dependent on extensive travel by road. This can create a barrier to the greater use of public transport and non-road modes.

The policy approaches to deal with these dilemmas are known in principle, but the detail of their implementation requires careful study. As an example, the carbon tax solution may appear effective in theory because it addresses the CO_2 problem directly through a price mechanism that is fairly distributed among sectors and countries. However, it is proving to be difficult to implement in practice:

- The percentage change in prices due to a carbon tax would vary greatly by industry sector – a carbon tax would have relatively little effect on consumer prices and behaviour in the transport sector (except air transport), because taxes on petroleum fuels are already high in the sector. Also, research indicates that the cost-effectiveness of carbon abatement measures may be lower in sectors other than transport. This is in conflict with the common desire of decision-makers, who consider that road transport is a major sector within which curbing growth is a priority.
- Recent fuel protests have illustrated limits on consumer acceptance of fuel taxation.

Pricing and taxation is also an issue across the transport modes. Prices are currently perceived to be biased in favour of road and air transport because insufficient account is taken of environmental and infrastructure costs**,** but at the same time public money is provided to subsidise rail companies and this has also to be corrected to maintain fair competition. Short sea shipping appears to be an important European mode in pursuit of more sustainable development, but liberalisation in this sector is slow.

One major area of European investment has been the trans-European transport networks. These are aimed at supporting economic growth, trans-boundary links and regional cohesion. Yet fears remain about the environmental consequences of fostering an economy that is transport-intensive. One consequence is an increasing emphasis on *pan-European transport*, covering the entire trip from origin to destination. This may require further economic reforms to encourage market actors to develop the most efficient door-to-door services rather than focusing on specific modes.

4. RTD OBJECTIVES

Many of the broad economic aspects of transport are addressed by projects of a strategic nature within the Transport RTD Programme, although economic analysis is also present in other more specialised (e.g. mode-specific) projects.

The main objectives are:

- to understand the economic aspects of transport sector activities (such as competitiveness);
- to evaluate policy options that will promote economic objectives (such as reform of transport pricing);
- to assess the economic side-effects of policies being pursued for other reasons;
- to develop models and methodologies to support the policy assessments.

5. SUMMARY OF RESEARCH CLUSTERS

5.1 Overview

The RTD projects contributing to the development of an understanding of the economic aspects of sustainable mobility can be considered within six topic areas or "clusters". These clusters are:

Clusters

Land use and macroeconomic effects

Regional linking

Completion of the Single Market

EU competitiveness, employment and innovation

External trade

Pricing, financing and external costs

5.2 RTD clusters

This Section defines the scope of research in each cluster. More specific objectives are given in Section 6. The titles and objectives of relevant RTD projects are listed in Annex 1, together with a Table identifying the cluster(s) to which each project contributes most strongly.

Land use and macroeconomic effects

Research in this area looks at the interaction between transport and external factors. In one direction, it considers the effects of socio-economic developments (location of economic centres, increasing wealth, tourism etc.) on transport flows, and the ability of land use planning, pricing and transport investment policies to influence the outcome. In the reverse direction, the research looks at the effects of transport strategies (investment in the Trans-European Network, pricing etc.) on social outcomes and domestic economic activity. The aim is to be able to predict what might happen and optimise strategies for the future.

Regional linking

Transport plays a critical role in linking regions within the European Union and across its external borders. The main goal of research in this area is to assess the impact of investments in major transport corridors and hubs (such as the Trans-European Network), particularly on socio-economic activity and regional development.

Completion of the Single Market

The transport sector in Europe has a heritage of significant market regulation. This has limited both the competitive pressures to improve efficiency and the interoperability of the transport system across national boundaries. Single Market objectives are leading to greater liberalisation, with new forms of market organisation and harmonisation of policies between Member States. Research is needed to evaluate the likely impacts of liberalisation on the

costs, efficiency and safety of transport, and to identify the optimal policy balance between competition and regulation.

EU competitiveness, employment and innovation

The overall industrial competitiveness of the EU is influenced by the cost of transport services to the consumer. In turn, this depends on the efficiency of service operators and the costs imposed through policy actions. Research can help to identify and promote the most efficient ways of organising transport services, evaluate the drivers of transport costs, and establish the most efficient levels of taxation. It can also help policy-makers to understand the likely effects on employment of current trends and policy options.

Linked to this, research is also needed to identify the most promising technological innovations, their likely market share and the associated impacts, and assess the consequences for policy.

External trade

Research in this area focuses on the contribution of maritime transport to the external trade links of the European Union. For example, Europe imports the major share of its energy needs, and shipping provides a primary means of transport. In order to underpin year-round energy supply, shipping needs to be maintained through icy Arctic waters to the petroleum reserves of Northern Asia. Research projects are helping to establish the viability of such routes, aided by new technologies. In parallel, some of the research on EU competitiveness is examining the commercial position of European shippers and ports, and identifying ways in which this can be enhanced.

Pricing, financing and external costs

Transport generates external costs such as delays due to congestion and the environmental damage caused by vehicle exhaust emissions. These costs inflict a significant penalty on the European economy. Pricing policies are seen as an economically efficient way of controlling external costs, the overall demand for transport and the split between modes. Research in this area aims to identify how pricing should be implemented, seeking to get external costs taken into account in the decisions that people make about their transport choices. Studies are also identifying financing mechanisms that are compatible with the reform of pricing.

6. SYNTHESIS OF FINDINGS FROM COMPLETED PROJECTS

This Section provides a synthesis of the research objectives and main findings from completed projects for each of the RTD clusters defined in Section 5. The key results, policy implications and achievements of individual projects are summarised in Annex 2.

Results from the following projects have been included in this Thematic Paper:

Clusters	**Relevant RTD projects**
Land use and macro-economic effects	ARTIST, ASTRA, ECONOMETRIST, ECOPAC, POSSUM, SCENARIOS, SESAME, STREAMS, TRANSLAND
Regional linking	CODE-TEN, EUDET, EUNET, EUROSIL, SCANDINET, TENASSESS
Completion of the Single Market	EUFRANET, ISOTOPE, LIBERAIL, MAICA, MINIMISE, SORT-IT
EU competitiveness, employment and innovation	ASDSS, EUROPE-TRIP, FANTASIE, MASSOP, PRORATA, RECONNECT, REDEFINE, SOFTICE
External trade	ARCDEV, ICE ROUTES
Pricing, financing and external costs	AFFORD, CAPRI, EUROTOLL, FATIMA, FISCUS, OPTIMA, PETS, QUITS, START, TRACE, TRENEN

6.1 Land use and macroeconomic effects

Research objectives

Objectives in this area are:

- to develop scenarios of socio-economic and political developments and identify their consequences for the transport sector;
- to estimate the impacts of policy-related changes in transport sector activity and infrastructure investment on domestic economic activity;
- to understand the interaction between land use and transport.

Main findings

A "reference scenario" has been developed for the European transport sector for the year 2020. This is based on the projection of current trends up to the horizon year, and covers socio-economic variables, regional effects, transport supply and demand, and the effects of European liberalisation and harmonisation policies.

For passenger transport, anticipated trends are:

- increasing journey lengths, due to improved transport links and urban sprawl;
- increasing car dependency, due to ageing of the population, lifestyle changes and income effects;
- increasing long distance trips, due to globalisation of business and growing demand for international holiday travel.

For freight transport, key influences are:

- globalisation of production and markets;
- networking to rationalise business processes;
- new information and communication technologies;
- "greening" of the business context.

Most of these influences point to an increase in freight transport, especially long-distance trips. Electronic commerce and "green" pressures may slightly reduce the growth rate.

In parallel, projections were made for the evolution of technologies, not based on trends, but rather on the conditions for their entry to the market. Intelligent transport systems are expected to have the most significant impact on transport in the year 2020. On the other hand, information services (such as teleworking and teleshopping) are expected to have only limited *overall* effect on transport demand.

The reference scenario has been used in the European Commission's pilot Strategic Environmental Assessment of the Trans-European Transport Network. For the road sector, the scenario shows a decrease or no change in costs under liberalisation policy, and an increase in costs due to harmonisation measures. For rail, costs will increase under liberalisation but remain stable under harmonisation.

To support the use of the reference scenario in policy development, the scenario assumptions have been incorporated in a software model of transport supply and demand in Europe, suitable for forecasting *aggregate* statistics. This shows a 50% increase in passenger-kilometres from 1994 levels in the year 2020, and a doubling of freight tonne-kilometres. The

number of kilometres of "overloaded" transport links is predicted to double to 9% of the network.

In contrast to a *reference* scenario, *alternative* or *contrasting* scenarios help policy-makers to explore the consequences of uncertainty in future socio-economic and political developments. For this purpose, a set of such scenarios has been developed for the European transport system through to the year 2020, showing how it is possible to meet CTP objectives for economic efficiency, regional development and environmental protection. The scenarios explore alternative social and political developments outside the transport sector, and show what transport policies would then deliver the targeted outcomes. A number of early policy actions would be appropriate across all scenarios:

- Tax reform – a shift of the tax base from labour to the use of natural resources in order to strengthen incentives for dematerialization and energy conservation.
- Experiments with low emission zones – providing an incentive for the market to select clean vehicle technologies.
- Tele-commuting – experimenting with tele-working options in conjunction with land-use planning.
- Road pricing – taxation on the use of congested urban roads, coupled with measures that provide alternatives (such as quality public transport).
- Actions to provide integrated information systems.

Some key conclusions for policy towards sustainable mobility were as follows:

- Both new technologies *and* the decoupling of transport growth from economic growth are needed to achieve sustainability targets.
- For technological innovation, action is needed at the European level to build consensus and provide incentives for rapid movement along clear technology trajectories. Support for innovation may need to precede open market developments.
- The CTP must be complemented by measures outside the transport sector (such as tax reform, regulation of information technology, and land-use planning).
- Those measures that have a long lead time (e.g. aimed at changes in behaviour) must start early.
- Measures should be adapted to local conditions where uniform national or European policies would be inefficient.
- The Trans European Networks must form part of an integrated transport strategy, such that they do not simply encourage more travel overall.
- The growth in air travel and the increased demand for leisure activities (e.g. from an ageing population) will act as other major constraints on the achievement of sustainable mobility targets.

To complement the scenario approach, a number of methods have been developed for quantifying the relationship between transport activity and economic activity:

One method estimates changes in employment attributable to new transport investments, particularly the changes due to increased investment by other sectors of the economy in the vicinity of new transport infrastructure. On average, the method suggests that around 7,200 new jobs could be created as the result of building a 100km stretch of motorway in an area of some 200,000 workers. A similar benefit could be achieved by investing in a high-speed rail link.

However, there are two effects that constrain the overall benefit for employment. First, the grouping of investments close to new transport infrastructure may take place at the expense of other areas. And secondly, selecting one region for transport investment may limit the transport spend in other regions. The research found that these "dampening" effects could not readily be assessed. Therefore, the *average* results may be useful for the initial *screening* of future infrastructure investments, but more tailored studies are needed to provide an accurate assessment for a specific location.

A second research activity looked at extending the "input-output" methodology, based on macro-economic statistics, to allow more detailed simulation of the broad impacts *throughout the economy* resulting from policy-related changes in transport activity. This revealed the methodological difficulties of making a comprehensive economic assessment in a *dynamic* world, and more work would be needed to provide a realistic tool.

Nevertheless, a third activity showed that the long-term interactions between the transport sector and other branches of the economy *could* be modelled successfully. The resulting software tool uses a "system dynamics" methodology to assess the wider socio-economic and environmental impacts of transport policy packages over a 25-year time horizon. This is achieved by linking sub-models covering macro-economic activity, regional economics and land-use, transport demand and environmental impacts, and using feedback loops to capture the inter-relations between variables. Outputs include economic, social and employment indicators.

The tool was used to simulate the effects of policy packages of varying complexity. Overall, a fully integrated set of measures produced the best results. The policy packages changed the average annual GDP growth rate by 0.2% at most between the "best" and "worst" policy options.

One important interaction between transport and the economy is the way in which changes in land use can influence patterns of mobility. Land use depends on a wide range of factors, including the location of transport infrastructure investments and the availability of different modes of transport. Therefore land use planning linked to transport planning is increasingly perceived as an important means of influencing transport demand *in the long term*.

However, relatively little is known about the effects of such planning measures. Therefore research has focused on providing data and sharing good practice.

A common set of indicators and methods was developed, together with sample database of values for those indicators, covering 40 European cities. From the analysis of the data, it was concluded that:

- Lower population densities and a higher concentration of jobs in sub-centres tend to increase the use of the car relative to public transport. Small cities have a higher share of car use than larger cities.
- The level/frequency of service in public transport has a strong effect in increasing patronage and decreasing the use of private cars. The extent of the public transport network is not the key issue.
- An increased supply of primary road is associated with a higher share for cars in the modal split.

A review of existing practice in the combined planning of land-use and transport led to the following conclusions:

- Combined land-use and transport policies are only successful in reducing travel distances and the share of car travel if they make car travel less attractive (more expensive or slower).
- Land-use policies to increase urban density or mixed land-use (e.g. locating homes near factories and services) without accompanying measures to discourage car use have only little effect.
- Transport policies to make car travel less attractive depend on trip start and end points not being excessively dispersed already. Co-location of specialist businesses in certain areas and the increase in multiple worker households also set limits on the co-ordination of work places and residences.
- Large dispersed retail and leisure facilities increase the distances travelled by cars and the share of car travel. Land-use policies to prevent the development of such facilities are more effective than land-use policies aimed at promoting high-density mixed-use development.
- Fears that policies to constrain the use of cars in city centres are detrimental to the economic viability of those centres have in no case been confirmed by reality, except where massive out-of-town retail developments have been approved at the same time.
- Transport policies to improve the attractiveness of public transport have in general not led to a major reduction of car travel, but have contributed to further suburbanisation of the population.

Overall though, transport policies have been found to be more direct and efficient than land-use planning controls in moving towards a sustainable urban transport system. However, land-use policies are seen as an essential accompanying strategy for creating less car-dependent cities in the long run. Information policies are also necessary, both to influence behaviour and to increase social acceptance of other tougher measures.

Despite this interest in land-use controls, research has shown that planning systems are often weak, in that they fail to integrate spatial development with transport and environmental aspects. For example, planning approvals may not require new developments to be sited adjacent to public transport or to have limited parking provision. The Netherlands and the UK were identified as examples of promising practice in this respect.

6.2 Regional linking

Research objectives

Studies on *regional linking* aim to support decisions in the following areas:

- strategic assessment of corridor investments and related policies, including the Trans-European Transport Network, links to Central and Eastern Europe, and the use of the Danube;
- evaluation of the socio-economic and spatial impacts of investments in transport system infrastructure, including the effects on regional development.

Main findings

Much of the research in this area has been directed towards developing and testing evaluation tools. In the past, most transport investments have taken place at a national level, and historically the evaluation has focused on the local and direct benefits of individual projects, usually in economic terms. However, the development of the Single European Market, increasing trade links with the Baltic and Central European countries, and the promotion of the Trans-European Transport Network (TEN-T) as a means of economic growth and regional cohesion are now requiring evaluation to be done on a broader geographic scale. Moreover, in the context of *network* development, a more strategic assessment method is needed, taking account of long-term and system-wide effects on socio-economic, environmental and traffic outcomes. This can support the evaluation both of an overall strategy and of each part of a phased programme of investment.

Therefore one of the research outputs is a methodology for assessing the strategic impacts of the development of pan-European multi-modal corridors. A scenario approach was used to elaborate consistent images of the future through to the year 2015, featuring high or low rates of economic growth and fast or slow integration of neighbouring countries into the EU. Using these images, alternatives for corridor development can be subjected to impact assessment. The results are intended to help decision-making in the face of uncertainty.

The methodology is supported by a comprehensive information system covering 30 European countries, held on a CD-ROM. This provides information on politics, regional socio-economic data, regional road information, foreign trade, transport costs, resource costs, networks and maps. It has been used to support in-depth corridor studies for the TEN-T. Combinations of road and rail projects were generally found to offer the greatest benefits. The method could also be applied more generally to other infrastructure programmes.

The methodology is also supported by guidelines for evaluating the impacts of multi-modal links on regional development. A review of current evaluation methods in Member States revealed significant deficiencies in this area.

To complement the corridor-level methodology, prototype software has been developed to *calculate* the impacts of corridor investments. The modelling system includes:

- methods for valuing socio-economic effects;
- a tool for estimating spatially-resolved indicators of regional accessibility and social cohesion, including effects on national output and employment;
- a new approach to regional economic modelling, where the sources of potential travel growth are identified separately as a function of specific social and economic activities;

- a database for estimating the costs of vehicle and infrastructure operation, by country, through to 2020.

The software was demonstrated for the Trans-Pennine corridor in the UK and for long-distance freight movements in Finland.

A second software development took a more global view of the impacts across Europe of large transport investments, such as the entire TEN-T strategy. The model covers the whole EU, sub-divided into 201 regions, and provides forecasts to the year 2016. Innovative attributes include:

- the prediction of regional unemployment;
- the estimation of the spatial redistribution effects of the TEN-T;
- the calculation of accessibility taking account of proximity to nodes of the transport network;
- the calculation of indicators of cohesion for the European Union.

The model was used to assess some scenarios for extension of the TEN-T. The development trajectories of the European regions were similar in all scenarios, showing that macro-economic trends (such as ageing of the population) have a much stronger impact on cohesion than different transport infrastructure strategies. In all scenarios, most regions will improve their accessibility and economic performance in absolute terms, but with some changes in their *relative* position. The maximum TEN-T investment leads to a slightly less polarised distribution of accessibility and economic output among the regions, but this slight cohesion effect would not, however, be able to reverse the general trend towards economic polarisation in the EU.

Of course, it is not sufficient just to *calculate* impacts, since indicators can be *interpreted* in different ways. Research has shown that many of the problems in developing pan-European transport relate to the variation in policy processes between Member States. The following aspects have particular importance:

- the distribution of responsibility between national and lower levels;
- the extent of master planning and standardised evaluation frameworks for transport;
- the degree of stakeholder (including public) involvement in decision processes.

This leads particularly to conflicts over the relative role of European, national, regional and local levels, the trade-off between economic and environmental objectives, and the rate of deregulation and restructuring of the transport market. Such conflicts damage the prospects for strengthening regional links through better cross-border transport.

To help to overcome some of these conflicts, a tool has been developed for assessing the effectiveness of different measures and investments against policy objectives. The model helps different stakeholders to make explicit how they rate specific policy objectives and project impacts. A related software tool helps users anticipate barriers in the *implementation* of transport infrastructure projects and policy initiatives.

It was concluded that a clearer distinction is needed between policy plans and infrastructure plans. Policy plans should be enhanced to include measurable objectives and performance indicators. Infrastructure plans should show a closer consideration of strategic policy goals (such as regional linkage), e.g. through the process of Strategic Environmental Assessment.

The final research activity in the area of regional linking has been the assessment of the current market situation in Europe. Studies have been made of previous multi-modal investments and major corridors (such as the Danube, and freight flows to and from the Nordic countries). These have shown the potential for increasing the use of multi-modal links, as well as highlighting a number of barriers:

- inadequate information flows between the variety of actors;
- problems with slow procedures at border crossings;
- differences in technical standards and regulations between Member States;
- a lack of co-ordination at interchanges (such as different companies working different hours);
- a lack of interoperability between modes, for instance concerning ticketing and information systems;
- problems with track charging and slot allocation systems on the railways.

6.3 Completion of the Single Market

Research objectives

Research in this area focuses on the effects of *completion of the Single Market* in the transport sector. Studies were aimed at:

- assessing the experiences of the liberalisation of rail infrastructure, and proposing improvements;
- making recommendations on the legal and organisational structures for public transport operations;
- identifying measures to promote interoperability across the European transport system;
- devising strategic options for developing a trans-European railway network mainly dedicated to freight;
- evaluating the effects of European developments in air traffic management on the performance of the system.

Main findings

Liberalisation of the rail transport market is hindered by the historical management of national networks and by the high costs of infrastructure investments. As a result, the implementation of recent EC Directives is far from complete. The Transport RTD programme has assessed Member State experiences to date in order to identify opportunities for improving the situation.

The financing of interoperability was identified as a particular "brake" in the liberalisation process. In addition, methods for calculating full and marginal costs need to be clarified and harmonised, and the extent of the infrastructure manager's role needs to be explicitly stated. Three tools were suggested for calculating rail capacity, and proposals were made for allocating costs.

The work identified the following items as requiring clarification in future Directives:

- the responsibilities for safety applying to the different parties;
- the different treatment of passenger and freight transport;
- the length of the periods for assigning exclusive rights;
- the cost basis for charging, including the treatment of short-term versus long-term marginal costs, public subsidies and the incentives for parties to invest for the long term;
- the path allocation procedure in relation to parental rights, route categorisation and the value of the service offered;
- how to ensure the pursuit of policy objectives for network integration and environmental and social benefits;
- the identification of indicators for benchmarking of performance.

Similar issues of liberalisation are being faced in urban public transport (UPT), where policy-makers face the challenge of balancing market efficiency with public goals and the associated use of subsidies. Research into the legal and organisational frameworks for UPT concluded that:

- the initiative for creating and specifying the UPT network should rest with local authorities – a fully deregulated system was found not to address collective goals and system integration in an adequate way;

- a regime of "limited competition" (where authorities define the transport service to be delivered and invite tenders for its execution by candidate operators) is to be preferred over full regulation (monopoly supply) or full deregulation;
- partnerships between operators and authorities should be established that include clear definitions of standards of service and responsibilities.

These findings have been influential in the development of Commission proposals to revise Regulation 1191/69 on the organisation of public transport. It was concluded that reductions in unit operating costs of around 15% are feasible over fully regulated operations, even with no redundancies or wage reductions. However, the transition costs may be significant, with improved data collection needed for the assessment of the quality of services provided.

One of the critical barriers to completion of the Single Market, as indicated above, results from the various impediments to *interoperability* in trans-European transport. These have been highlighted through detailed case studies and extensive interviews. Cost-benefit evaluation indicated a range of worthwhile measures to improve interoperability, and the following recommendations were made for policy actions:

- for *parcel services*, further liberalisation of the letter market, simplification of border crossing procedures, and abolition of regulatory requirements for documentation of parcels in some Member States;
- for *road freight*, funding the faster introduction of information technology, investing in border crossing facilities with Eastern Europe, and reform of regulatory controls on vehicle operations (possibly including tighter entry requirements such as vehicle age limits);
- for *rail transport*, applying a competition regime (e.g. concerning State Aid and market organisation) that creates an efficient single market;
- for *waterborne transport*, promoting the use of information technology, reducing and harmonising customs paperwork, and harmonising port and customs operating practices while minimising restrictive labour regulations and practices;
- for *intermodal transport*, setting up a competitive and non-discriminatory process for the management of infrastructure (such as rail freight freeways) and for the allocation of scarce capacity;
- for *air transport*, improving the systems for pricing the use of infrastructure and for slot allocation, improving air traffic control, and collecting more extensive statistical data to support policy development;
- for *public transport*, encouraging deregulation through franchising of routes, and promoting the appointment of transport authorities to manage through-ticketing structures and the use of smartcard ticketing.

In addition, deregulation should be pursued in input markets, including vehicle leasing, labour and ancillary markets such as baggage handling. Entry barriers to congested air, sea and rail infrastructure need to be reduced, possibly through the use of auctioning systems.

For the particular case of interoperability in the air sector, new systems and concepts could help to harmonise operations across Europe. The performance of four such innovations has been simulated: the autonomous aircraft; dynamic sectorisation; the future aviation surveillance system; and the “required navigation performance”.

The simulations confirmed the operational potential of these concepts, and provided a first quantitative assessment of their impacts on airspace and airport capacity, fuel consumption, time of flight and fleet utilisation. All concepts showed positive effects on capacity. The simulations also led to the identification of the main blocking points to be overcome prior to implementation of these concepts.

For the rail sector, another Single Market innovation has been evaluated. This is the development of a trans-European rail network mainly dedicated to freight transportation. The goal would be to overcome the poor performance of international rail freight, highlighted in a survey of shippers. The problems of rail freight were further underlined by a simulation of the demand for freight transport through to 2020. Under a "current trends" scenario, rail would continue to lose market share to the road sector, falling from 14 to 9%.

A new assignment of routes to different services was then devised, based on three sub-networks:

- a core network dedicated to freight, covering the industrial regions of central Europe;
- an intermediate network mainly dedicated to freight but also carrying local passenger trains;
- a mixed network on which passenger trains would normally have priority.

Modelling indicated that journey times for traffic on the dedicated network could be cut by 20 to 30%. Overall, the decline in modal share of rail could be reversed, taking the share back up to 16%. Gains in national markets would be of the same order of magnitude as gains in international transport, though varying between Member States.

The implementation of such a dedicated freight network and operating system would require a number of actions:

- infrastructure investment to remove bottlenecks (for instance crossing the Pyrenees and the Alps);
- the agreement and implementation of standards and systems to overcome a lack of interoperability across the network;
- the introduction of a slot scheduling and assignment method for international services;
- some degree of harmonisation of the subsystems used by the train operators (pricing, information, reservation, tracking and tracing etc.)

6.4 EU competitiveness, employment and innovation

Research objectives

Objectives in this area are:

- to evaluate the factors affecting freight transport demand and costs in different Member States;
- to identify the potential for increasing competitiveness in specific transport markets, such as long-distance rail passenger services, short-sea shipping and container shipping;
- to identify the effects on employment of market trends and actions to promote specific modes;
- to identify the potential of new technologies and transport concepts which could have a major impact on EU transport systems.

Main findings

Growth in freight transport, especially road freight, has been one of the factors supporting European economic development. It is also one of the factors that threatens serious congestion on the roads. Therefore there is strong interest in identifying ways of switching traffic to other modes as well as making road transport more efficient. In order to understand the possibilities, significant RTD has looked at the dynamics of the transport market.

Factors relating changes in the structure of industry and supply chain logistics to changes in road freight demand were shown to be complex. Quantitatively different behaviour is found in different countries and between different types of commodity. *Simple* explanations, such as ascribing traffic growth to the increase in Just-In-Time production, were shown not to be valid – multiple factors have to be considered. An increase in the average length of haul (typically 20-40%) was identified as the single most important contributor to increased road freight demand in recent years.

Over the period 1995 to 2005, the costs of congestion are expected to increase by nearly 50% as a consequence of increased freight traffic. Research indicated the following measures would be highly effective in almost all supply chains (in descending order of effectiveness) in alleviating the adverse impacts of growth in demand:

- Introduce on-board measuring and debiting for emissions.
- Increase fuel tax generally.
- Introduce an “eco-label” for companies achieving best practice in their logistic operations.
- Introduce tradeable emissions permits.

The research also looked at factors affecting road freight costs and the consequences of different tax policies on the freight market. Survey results showed that drivers’ wages are the largest single cost factor (especially for collection/distribution operations), and fuel is the next largest factor (especially in long distance haulage). These factors, and consequently cost-competitiveness, vary substantially between countries. Total tax costs also vary between countries, ranging from 10% to 25% of the total operating cost of long haulage trucks. For 100km distance, EU prices are between 3 and 8 times higher than in Eastern European countries, but prices are closer for long distance freight. Typically, transport costs account for around 3% of the total costs of industrial production, but with significant variations by industry sector. Case studies suggested that systematic violation of traffic rules could reduce costs per tonne-kilometre by up to 30-40% in some countries.

Feedback from shippers indicated that, when faced with policy changes or traffic problems, they are more willing to consider measures like increasing transport prices or changing shipping times than anything to do with modal transfer. The unwillingness to change mode is largely attributed to bad experience with other (non-road) transport modes, no matter whether that experience has been directly suffered or just reported by other companies.

Survey responses indicated that internalisation of the external costs of road transport (environmental damage, infrastructure costs) is increasingly considered by freight operators as a fair principle and an effective means of fighting congestion. However, the magnitude of price increases that operators would expect in inter-urban transport would not cause major modal transfers – and there is a lack of non-road alternatives for urban freight. A strong improvement in efficiency and quality from other modes is necessary in parallel for shippers to consider the scale of modal transfers (from road) thought desirable to meet policy goals.

Such an improvement is intended to come from the restructuring of the European railways. The process is based on the principle of separation between the management of infrastructure and the provision of transport services, and has been driven by the EU Directives 91/440 and 95/19. In support of this, research has provided tools to help the infrastructure manager to put the new policy principles into practice.

A model has been demonstrated that is able to simulate the strategies of the infrastructure manager and options for access-to-infrastructure policies. This simulation model focuses on the relations between the infrastructure manager, the train operators and the regulatory authorities, and presents financial ratios and other business trends with a long-term perspective.

Approaches have also been developed and tested for:

- analysing the competition among train operators and their interaction with the infrastructure manager;
- providing information about operators' access values through an auction procedure;
- estimating and allocating line capacity using scheduling models and simulation;
- analysing the costs of using infrastructure on a life-cycle basis

In parallel, support has been given to the railway operators, particularly aimed at increasing their competitiveness in long-distance and international traffic. A methodology was developed to analyse the current situation of a railway and to select an optimal path towards greater commercial relevance in the market place. The methodology is based on benchmarking, and provides a set of comparative indicators of operational and financial performance. It also includes advice on change management and implementation.

Case studies identified two sets of concepts to make rail a more competitive mode:

- generic concepts which can be introduced irrespective of organisational structure or institutional framework (e.g. total quality management), and
- strategic concepts which are associated with changes in organisational structure or institutional framework.

Research on competitiveness in the maritime sector has looked at the supply/demand situation affecting the EU container shipping industry. It was concluded that pressure on shipping rates and poor profitability have been substantially due to intense cost-based rivalry, while capacity

utilisation has been good. Services are not strongly differentiated, and cost improvements have been easily copied across the industry. Operators continue to respond to the situation by concentrating on cost reduction. As a result, the outlook is for continued poor profitability in the industry.

The proportion of the EU owned fleet that has flagged out is lower than the world average. As cost pressure continues, EU seafarer employment may be affected by further flagging out, although this cost category accounts for less than 5% of a major container line's costs. By comparison, on-shore personnel account for around 20% of costs. Therefore, the main future impact on EU jobs will be on-shore losses due to the rationalisation or merger of operators, use of new technologies and process redesign. The challenge for policy is to encourage EU operators to retain their on-shore control centres in Europe, rather than relocating them e.g. to the Far East.

As average vessel size has increased, total port calls by container vessels are decreasing. As a group and individually, the top ten North European ports have seen relatively small changes in overall market shares, while the top ten Southern European ports have gained share from smaller ports. Policy action is needed to improve land transport connections to major container terminals, since the increased volumes of inbound and outbound boxes associated with ever larger vessels are leading to bottlenecks and inefficiencies around these terminals.

One of the means by which the shipping industry can increase its competitiveness is by adopting new organisational structures to replace the traditional "command and control" hierarchy. Based on a major survey, the Transport RTD Programme has identified promising options in the following areas:

- improved processes for running ships and managing business operations;
- risk management procedures;
- the use of information systems, particularly web-based applications and systems to help implement the International Safety Management Code;
- improved communications and teamwork;
- improved training systems and actions to increase staff recruitment.

It was estimated that new structures for seaboard management could produce overall cost savings of up to 25%, partly through reduced manning levels and partly through the use of information technology. To support their implementation, a system was defined for developing a "learning organisation" within a shipping company. This is aimed at increasing the ability to adapt to new technologies, management concepts and regulations.

The sheer volume of regulatory matters was found to influence management structures in the maritime sector. Improved means of providing advice on new regulations and their implementation are needed, particularly to support management in small companies. Survey results also highlighted the need for greater involvement of seafarers in preparing and evaluating regulatory procedures, in order to gain acceptance.

In *all* modes, new technologies are expected to have an impact on costs, efficiency, working practices and employment. Therefore the Transport RTD Programme has studied their potential and the implications for policy. The most wide-ranging review identified and assessed new technologies that could have a *major* impact on transport systems in Europe over the next 30 years. This provided a wealth of information covering specific technologies,

vehicle and system concepts, their market shares, and the aggregate impacts on safety, efficiency and the environment across the EU.

Particularly promising technologies were seen as:

- telematic technologies – likely to be of benefit across all impact categories – such as on-board emissions management, multi-modal traveller information and trip planning, dynamic route planning and navigation, electronic tolling, anti-collision systems, smart cards, intelligent cruise control and traffic management systems;
- fuel cell and hybrid propulsion systems, offering significant energy and environmental benefits;
- improvements in the conventional all-purpose car, such as advanced turbo-diesel engines, direct injection gasoline engines and reduced weight;
- tilt rotor technologies for air transport, giving significant fuel savings and noise reduction;
- airships for moving heavy and bulky loads;
- new systems for personal rapid transit;
- road trains.

New transport concepts could also help to tackle congestion. Comparative assessment showed that high capacity elevated passenger transport systems (such as the H-Bahn Dortmund and the Wuppertaler Schwebebahn) offer good potential for reducing congestion in urban environments, as the backbone of the public transport system. Nevertheless, the infrastructure needs and total costs are high. For freight, underground concepts (such as the Underground Logistics System proposed in Amsterdam) provide an efficient means of distribution. Again, infrastructure costs are fairly high, but can be reduced using new small-bore tunnelling technologies.

In contrast, airships are promising for point-to-point operations in both passenger and freight transport, and their costs are *not* particularly high. For example, they may allow bulky and heavy items to be taken to the final destination, replacing a whole shipment chain.

Financial and commercial hurdles pose the biggest obstacle to these new concepts, particularly for public transport. However, tailor-made transport services such as airships are proving more attractive to private investors. Regulatory barriers are also significant, particularly for automated and driver-less concepts.

6.5 External trade

Research objectives

Research to evaluate the effects of transport on European *external trade* has focused on the maritime sector. Some of the work on EU competitiveness covered in the previous Section is clearly relevant to trade. However, in this Section, the focus is on work to improve trade links. In particular, the aim has been to demonstrate the commercial viability of year-round navigation in Arctic waters, supported by new technologies for ice mapping and ship routing through icy waters. The reason for this work is as follows:

The oil and natural gas reserves in northern Russia and in the Russian sector of the Arctic Ocean are so large that they are viewed as a vital long-term energy source for Western Europe. Many oil companies prefer to transport the oil by icebreaking tankers instead of by pipelines through various foreign countries and across unsafe soil conditions.

The conditions for maritime operations are extremely harsh in this region, routes often being covered by thick ice. The current sea transportation system is based on heavily strengthened vessels, which are assisted by large icebreakers. Up to now, this shipping has been State controlled, and uneconomical by Western commercial standards. In order to make the route attractive for Western oil and shipping companies, the system has to be improved.

Main findings

The core of the RTD work was a demonstration voyage in the Russian Arctic along the Northern Sea Route. Associated research work covered:

- the legal and administrative aspects of navigating in the Russian Arctic, such as insurance issues when nuclear icebreakers are involved;
- the commercial viability of Arctic transportation for different hydrocarbon cargoes;
- determination and forecasting of ice conditions;
- the evaluation of the performance of tankers and icebreakers in various Arctic conditions;
- the assessment of different tanker loading systems and terminal types;
- testing the latest information technologies for remotely helping the maintenance personnel onboard or giving medical aid;
- the assessment of operational safety.

The work proved that maritime transportation of hydrocarbons from the Russian Arctic to Western Europe is technically possible and safe even in very hard ice conditions. However, transportation costs are extremely high due to several reasons:

- small cargo volumes;
- sailing distances doubling as a result of route selection in icy waters;
- low loading rates of the temporary loading facilities;
- high costs for icebreaker assistance;
- slow customs and immigration procedures.

To reduce costs, long-term investments in tankers, icebreakers and loading terminals would be required. To attract such investments, changes are needed in the legal framework and business environment. The work concluded that these changes can be achieved only through long-term co-operation and open discussion between EU and Russia.

Related research has demonstrated the feasibility of support tools for ship routing in ice-infested sea regions. These include:

- a computer program to identify and optimise vessel routes according to cost or time effectiveness;
- ice charting concepts that use artificial intelligence to supply satellite-based information for practical ship routing, without the need for human image interpretation (which can be time consuming, demanding and subject to ambiguity).

The work identified a practical approach for operational use in European and Russian Arctic waters in the *short term*. This combines computer-based, automatically generated ice information and manual interpretation of results by skilled experts. The recommendations take into account the foreseen International Polar Code of Navigation, and will ensure a consistent strategy for improving safety, efficiency and overall capability of maritime navigation in European and Russian Arctic waters.

6.6 Pricing, financing and external costs

Research objectives

The projects on *pricing, financing and external costs* cover a spectrum of inter-related objectives:

- to show that pricing at marginal social cost can, in practice, help to internalise the external costs of transport (such as congestion and environmental impacts), and can regulate demand in a way that is economically efficient and socially equitable;
- to identify the barriers to the implementation and acceptance of pricing instruments, and show how they can be overcome;
- to evaluate the current pricing of transport modes in Member States, and to forecast the changes resulting from a move to marginal cost pricing;
- to evaluate the effects of introducing new charging principles, pricing schemes and tolls on modal split, traffic volumes and trip patterns – including small-scale demonstration;
- to compile and disseminate good practice in the design and implementation of pricing and associated financing schemes;
- to provide modelling tools to help assess external costs, appropriate pricing and the transport consequences;
- to build consensus on the policy implications of the reform of transport pricing.

Main findings

The reform of transport pricing is seen as a central strategy for ensuring that the pursuit of sustainable mobility is consistent with, and promotes, economic efficiency. Research studies concluded that, in general, "push" measures to deter the use of vehicles (e.g. fuel taxes) are more effective than "pull" measures (e.g. improving alternative modes). Nevertheless, successful strategies are likely to contain a mixture of both "push" and "pull" measures, with the revenue from the former being used to fund the latter.

Research into pricing concluded that policy should be based on an understanding of "marginal social costs", where the user pays for the *additional* costs they cause through infrastructure use, including externalities such as accidents, air pollution, global warming and noise. Marginal social costs should be used as the starting point for price determination, with other important considerations such as financial needs being incorporated in a way that does least damage to society's welfare.

RTD results show that *all* of the main externalities can be taken into account in pricing structures, even though some uncertainty exists in their estimation. Specific evaluation methods have been recommended for particular impacts, and a handbook has been prepared giving practical guidelines on evaluation, aimed particularly at urban policy-makers, planners and transport operators. This handbook also advises on how to finance urban transport systems, covering new mechanisms (such as private finance and taxing land values) as well as the application of user charges and public budgets. Other work has similarly demonstrated practical methods for calculating marginal social cost for *all* modes, illustrated through case studies on transport corridors.

The projects commonly found that existing pricing mechanisms and levels are failing to provide appropriate signals to influence behaviour. For example, greater differentiation in road charges by time period and area is necessary to cope with congestion resulting from heavy peaks in travel demand. Electronic road pricing may form one part of the solution, but

other pricing measures such as parking and cordon charges can be more cost-effective and practical in many situations.

The current price of *inter-urban* car travel is estimated to be too high relative to the marginal social cost in 2010, partly as a result of tighter vehicle emissions regulations. On the other hand, the research confirmed the case for *urban* road pricing in congested cities. A substantial switching of trips onto public transport is justified only in the urban case, with a reduction of car traffic of up to 40%.

In the case of road freight, long-distance freight is generally under-charged (with the exception of the Transalpine corridors through Switzerland), because taxes do not increase sufficiently with vehicle weight and distance travelled.

For the railways and other public transport, efficient pricing is again likely to require greater peak/ off-peak differentials in tariffs, and also an element of public funding (particularly for short-distance urban services). Nevertheless, in some places existing subsidies are already excessive. Improving the service quality and investment in infrastructure may be the most important measures for improving modal shares, as opposed to internalisation of externalities for all modes via the pricing mechanism – this is particularly the case for freight transport.

Demonstrations and modelling work in various cities have shown that road pricing *can* change modal split from private car to public transport and Park & Ride, giving city centre traffic reductions of 5-30%. Nevertheless, the overall conclusion is that drivers tend to travel at different times or by different routes before considering switching to public transport.

Public acceptance of new pricing measures is low, particularly among motorists, even though pricing is perceived to be an effective tool. To increase acceptability, the introduction of pricing should be staged, starting with simple systems with low charge levels. In addition, the revenue should be earmarked (or "hypothecated") for specific spending programmes such as public transport, or returned to the local population in some other way. These findings on acceptability have been substantiated by the results of extensive user surveys in various cities.

Modelling work has shown that packages of pricing measures based on marginal cost pricing can give rise to substantial welfare benefits for the urban population. Annual gains may be up to 400 Euro per capita, depending on the city context and measures applied, and may be dominated by the environmental benefits. A major part of this gain may depend on the effective use of the revenues, for instance allowing a reduction in labour taxes.

The equity effects of pricing are estimated to be moderate (either negative or positive). Overall, accessibility is reduced, particularly for car users, due to the reduction in trips. However, if revenues are used to subsidise public transport services, then accessibility may even be increased for most of the population.

Surveys indicated that the legal and institutional frameworks required to implement marginal cost-based pricing (such as congestion charging) for transport have, so far, not been put in place. Therefore action is needed at a national level, for instance to introduce institutions with the powers to control transport pricing across urban regions and across transport modes.

The existing range of pricing policies in EU Member States is so varied that the impacts of introducing marginal cost pricing have to be assessed on a case-by-case basis. The extent and direction of any price changes will depend strongly on current levels of taxation and charging, and will not necessarily imply lower travel demand. Thus it is not universally true that the more environmentally friendly modes would uniformly benefit at the expense of other modes.

Nevertheless, as a broad conclusion, pricing reform to reflect social marginal cost is likely to involve:

- a decrease in prices for inter-urban road and rail passenger transport and an increase in the price of urban road travel (particularly for the private car and at peak periods of congestion);
- an increase in prices for both road and rail freight.

To support the evaluation of pricing measures, the Transport RTD Programme has developed and tested a methodology for assessing the various costs specific to *individual* journeys/routes, for different modes of transport, trip purposes, desired times of arrival and expected lengths of stay at destination. These costs include direct costs (e.g. fuel), the value of travel time, and external costs such as accidents, air pollution, noise and global warming. The methodology focuses on modal comparison, and is useful for benchmarking purposes. For instance, substantially lower externalities have been illustrated for rail compared to road transport on some routes.

Models have also been developed to illustrate the performance of different policy instruments in reflecting external costs in transport prices. Case studies gave the following results:

- *Parking policies*: making all road users pay for the resource cost of their parking place plus an extra charge can be very effective, achieving 1/3 to 2/3 of potential societal benefits and reducing congestion.
- *Emissions taxes and standards*: stimulating the use of cleaner cars is important for urban areas, but may not be cost-effective in non-urban areas.
- *Fuel tax policies*: higher fuel taxes could reduce car traffic in urban areas and on peak period inter-urban trips. However, other traffic (such as off-peak road freight) may also be unjustifiably inhibited. Fuel taxes are therefore not a good instrument for pricing reform, due to the lack of differentiation between different transport markets.
- *Reduced subsidies to public transport*: once the pricing of car transport has been corrected, public transport fares should not be set below the marginal social cost and should differ between peak and off-peak periods.
- *Simple congestion pricing*: cordon pricing in urban areas and congestion pricing on inter-urban highways can realise a substantial fraction of the benefits of optimum pricing.

Other modelling work has provided a methodology that, in many cases, cities can use to identify optimal strategies that can be *fully funded from user charges*. For other cities where private finance is needed for capital investment, the optimisation procedures can identify the appropriate modifications to the strategy to achieve the best performance within the financial constraint.

This methodology shows that private sector operation of public transport reduces the net social benefits of the optimal transport strategy, particularly under full deregulation. If a city authority decides that private operation of public transport *is* beneficial, it should ideally use a franchising model in which it specifies the objectives and the optimal service levels and fares.

Finally, modelling work has been underpinned by the compilation of a handbook and software tool providing "elasticities". These can be used for a *first order* assessment of the effects of changes in car travel time and cost on car travel demand and on demand for other modes.

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ANNEX 1 RTD PROJECTS CONTRIBUTING TO THE THEME

This Annex lists (in alphabetic order) the titles and objectives of RTD projects that contribute to our understanding of the economic aspects of sustainable mobility. The following Table identifies the RTD cluster(s) to which each project contributes significantly.

Clusters	**Relevant RTD projects**
Land use and macro-economic effects	ARTIST, ASTRA, E-EIS, ECONOMETRIST, ECOPAC, POSSUM, SCENARIOS, SCENES, SESAME, STREAMS, TRANSLAND
Regional linking	CODE-TEN, EUDET, EUNET, EUROSIL, SCANDINET, TENASSESS
Completion of the Single Market	EUFRANET, ISOTOPE, LIBERAIL, MAICA, MINIMISE, SORT-IT
EU competitiveness, employment and innovation	ASDSS, EMMA, EUROPE-TRIP, FANTASIE, MASSOP, PAV-ECO, PRORATA, RECONNECT, REDEFINE, SOFTICE
External trade	ARCDEV, ICE ROUTES
Pricing, financing and external costs	AFFORD, ATENCO, CAPRI, EUROTOLL, FATIMA, FISCUS, OPTIMA, PETS, QUITS, START, TRACE, TRENEN

Acronym	Title	Objective(s)
AFFORD	Acceptability of fiscal and financial measures and organisational requirements for demand management	The project aims to show that marginal cost based pricing measures are both efficient and feasible. The pricing methods to be considered include road user charges, parking fees, fuel taxes, vehicle taxes, and public transport fares and subsidies. In particular, it is intended to show that marginal cost pricing in combination with other fiscal and financial measures can effectively internalise transport externalities such as congestion and environmental impacts, and can regulate demand in a way that is socially efficient and equitable. An equally important aim is to identify the institutional and political barriers to the implementation and acceptance of such pricing measures in Europe, and to show how they can be overcome.
ARCDEV	Arctic demonstration and exploratory voyage	The main objective of ARCDEV is to demonstrate year-round navigation in the Arctic, with safe, reliable and commercially viable operations.
ARTIST	Agenda for research on tourism by integration of statistics/strategies for transport	The project aims to analyse the effects of tourism on mobility, to review existing visitor management practices, especially in European cities with a large tourist industry, and to demonstrate the need for a Community transport initiative on this issue.
ASDSS	Analysis of supply and demand of shipping services	The aims of the project are: • to assess the supply/demand situation in container shipping markets, with particular emphasis on European routes, and provide an outlook for future balances; • to assess the current competitive position of the European container shipping industry; • to review industry responses (e.g. capacity management, cost control, industry restructuring) and the possible effect on EU employment.
ASTRA	Assessment of transport strategies	The aim of the project is to develop a common methodology and tools for strategic policy impact assessment related to CTP targets and the TEN-T.
ATENCO	Analysis of the cost structures of the main TEN ports	The aim is to assess the positive and negative impacts resulting from the introduction of new charging and financing principles, both in the European port system as a whole and for different types of port.
CAPRI	Concerted action for transport pricing research integration	The aim is to facilitate dissemination to Member States of the results of projects dealing with the pricing of transport and to attempt to build up a consensus on the policy implications.

Acronym	Title	Objective(s)
CODE-TEN	Strategic assessment of corridor developments, TEN improvements and extensions to the CEEC/CIS	The project will provide a comprehensive strategic assessment methodology that can be applied to transport corridors, and will identify major policy-related issues as an aid to decision-makers. A tool for assessing interactions between policy instruments and corridor/network developments will be produced.
ECONOMETRIST	Economic evaluation of transport activities' impacts on Member States	The aim of the project is to assess the effects of transport sector activity on the domestic economic activity of Member States, including the impacts of new economic measures such as transport investment, pricing policies and internalisation of external costs.
ECOPAC	Economics of impacts	The project covers the provision of tools for measuring the socio-economic impact of transport infrastructure investments and transport system improvements (structuring effects).
E-EIS	European economic impact study for the European shipping sector	The aims of the study are: • to formulate a methodology for the assessment of the economic impact of shipping sector activities on the Member States and the European economy; • to provide a quantitative evaluation of the shipping sector in the Netherlands, Belgium, the UK and Italy; • to develop a set of recommendations for a European shipping policy and the assessment of the potential effects.
EMMA	European marine motorways; the potential for transferring freight from road to high-speed sea transport systems	The objectives are: • to analyse the existing volume of road freight and to identify those areas of the Community where transfer to sea routes could be feasible; • to carry out an in-depth study of three routes in different regions of the Community, and to survey the attitudes and requirements of potential users; • to research and specify the technology, infrastructure, service levels and operating costs required by the sea ferry and port operators to enable them to compete successfully with road transport; • to forecast demand for a sea ferry service on each route, analyse its commercial viability, identify any potential problems and recommend solutions; • to evaluate the impact of these services on road transport and employment, and to assess their feasibility.
EUDET	Evaluation of the Danube waterway as a key European transport resource	The research study EUDET will provide a comprehensive evaluation of the Danube waterway by identifying preconditions and measures that will turn the Danube into a key transport infrastructure for east-west-European transport flows on the south-east axis.

Acronym	Title	Objective(s)
EUFRANET	European freight railway network	The project aims to identify and evaluate strategic options for the development of a Trans-European rail network, mainly dedicated to freight transportation. It analyses the present situation and proposes concepts and solutions to reduce freight transport costs and improve quality and services. EUFRANET also deals with the improvement of rail freight transport organisation and interoperability, and the identification and evaluation of new rail technologies for freight.
EUNET-SASI	Socio-economic and spatial impacts of transport infrastructure investments and transport system improvements	The main objectives are: • to develop an innovative cost-benefit/multicriteria decision analysis methodology and to develop a database of cost models of the transport system; • to develop a comprehensive and transferable methodology for the study of socio-economic impacts of European transport system improvements, and to develop an interactive model with moderate data requirements for the simulation of these improvements.
EUROPE-TRIP	European railways optimisation planning environment – transportation railways integrated planning	The aim is to develop models and methods able to assist the infrastructure manager in putting into practice the new policy principles for liberalisation of the rail market, and in particular the principle of open access.
EUROSIL	European strategic intermodal links	This project will provide a set of guidelines, criteria, modelling and evaluation tools for analysing modal split, intermodality and interoperability in European transport networks.
EUROTOLL	European project for toll effects and pricing strategies	The objective is to assess the potential of tolls in achieving sustainable mobility, increasing the efficiency of the transport system, and managing demand and modal split.
FANTASIE	Assessment of new technologies and environmental issues	This project aims to identify new technologies that are expected to have a major impact on EU transport systems and the attainment of CTP objectives. It will also provide a forecast and impact assessment for possible future transport systems, identify policy implications, and recommend a methodology for transport Technology Assessment at a European level.
FATIMA	Financial assistance for transport integration in metropolitan areas	The project aims to provide recommendations on financing approaches, with particular regard to the private sector role, for optimal urban transport strategies. The benefits to the private sector of optimal urban transport strategies, and the potential for obtaining private sector funding to reflect those benefits will be identified. The differences between strategies optimised using public funds and those optimised within the constraints imposed by private funding initiatives will be determined. Mechanisms by which private sector funding can be provided will be proposed.

Acronym	Title	Objective(s)
FISCUS	Cost evaluation and financing schemes for urban transport systems	The project aims to analyse existing cost allocation methodologies and financing schemes for urban transport, and conceive new ones in response to identified gaps and weaknesses. The expected output is a European handbook for evaluating real urban transport costs and designing financing schemes.
ICE ROUTES	The application of advanced technologies to the routing of ships through sea ice	The aims of the project are: • to use artificial intelligence technologies to generate high-resolution, operational-quality ice information for ship routing, combining operational space radar with innovative computing techniques; • to create computer modelling techniques to allow identification and quantitative assessment of routes within areas of sea ice.
ISOTOPE	Improved structure and organisation for transport operations of passengers in Europe	The project aims to identify how organisational structures for urban public transport may be improved, in order to increase the role of public transport in European urban areas. The existing legal status and organisational structures for public transport operations in the European countries will be compared. The pros and cons of various organisational forms in terms of effectiveness and efficiency will be analysed; and a strategic approach to the development of public transport operations will be provided to political decision makers, transport planning authorities, public transport authorities and operators.
LIBERAIL	Liberalised and interoperable railways	The project aims to examine the performance of new operators and services, and changes in modal split. The impact on interoperability, cost of using infrastructure and level of service will be analysed. The medium and long-term effects of relevant Directives will be evaluated and any necessary corrective measures and new initiatives proposed.
MAICA	Modelling and analysis of the impact of changes in ATM	The aim of the MAICA project is to evaluate the capacity, efficiency, safety and further benefits arising from potential changes in ASM, ATC airports and aircraft under the ATM system.
MASSOP	Assessment and development of new concepts for management structures of ship-owners and ship operators	The MASSOP project aims to create workable new organisational procedures for the shipping industry on the basis that the traditional rigid 'command and control' hierarchy, both at sea and ashore, may not be the best solution for today's shipping world.
MINIMISE	Managing interoperability by improvements in transport system organisation in Europe	The aim of the project is to analyse the European transport market as a whole and to design specific measures in order to promote interoperability and economic efficiency of the trans-European transport system.

Acronym	Title	Objective(s)
OPTIMA	Optimisation of policies for transport integration in metropolitan areas	The project aims to identify optimal urban transport and land use strategies for a range of urban areas within the EU. The acceptability and feasibility for implementing these strategies, both in case study cities and more widely in the EU, will be assessed and guidelines for urban transport policy within the EU will be provided.
PAV-ECO	Economic evaluation of pavement maintenance and life-cycle cost at project and network level	The main objective of this contract is to develop an integrated road pavement maintenance system, looking at two different system levels: the project level and the network level.
PETS	Pricing European transport systems	The aim of the project is to evaluate the current pricing of transport modes in Member States, and to forecast the consequences of moving to a pricing structure and level which is more appropriate to the real internal and external costs.
POSSUM	Policy scenarios for sustainable mobility	The aim of the project is to develop a set of alternative policies to assist in decision-making on the CTP and the TEN. Policy objectives and targets will be based on criteria for sustainable mobility.
PRORATA	Profitability of rail transport and adaptability of railways	The principal goal of the PRORATA project is to study and propose measures to increase the competitiveness of railways in interregional international traffic, with a focus on long-distance passenger traffic. The scope of the work includes high-speed trains, conventional interregional passenger trains and night trains.
QUITS	Design and testing of an integrated methodology for the valuation of the quality of transport systems and services in Europe	The aim of the project is to develop and test a comprehensive methodology for the evaluation of the quality of the transport systems and services in Europe, and to develop a framework for incorporating externalities into the valuation of transport systems.
RECONNECT	Reducing congestion by introducing new concepts of transport	The aim is to identify the potential of new concepts such as underground logistics and airships in alleviating surface congestion, and to assess the requirements for their introduction.
REDEFINE	Relationship between demand for freight transport and industrial effects	The aim of the project is to model the factors affecting the increased demand for road freight transport and the way these factors relate to changes in industrial processes and logistics. Strategies and policies to simultaneously improve freight transport and logistics, improve economic competitiveness and reduce congestion will be developed and evaluated.

Acronym	Title	Objective(s)
SCANDINET	Promoting integrated transport in peripheral areas of the Union	The objectives of SCANDINET are: • to estimate actual and potential demand for intermodal transport services in peripheral and isolated areas of the EU; • to identify the possibilities for combining national, international and transit flows into selected corridors and terminals by using intermodal transport; • to assess the possibilities to extend the viable usage range of intermodal transport to below 700-800 km; • to identify the gaps and bottlenecks in information flows and to define a concept for operational organisation of real-time information services.
SCENARIOS	Scenarios for Trans-European Network	The aim is to develop a common 'reference' scenario for future European research on policy options in pursuit of sustainable mobility.
SCENES 10-11-12	Modelling and methodology for analysing the interrelationship between external developments and European transport	There are three main objectives: to produce transport demand scenarios for the EU for 2020 and beyond; to develop detailed forecasts of factors which will affect transport demand into the future; and to extend (to Eastern Europe) and enhance (with new data) a strategic transport model of the EU and carry out model runs based on the scenarios.
SESAME	Derivation of the relationship between land use, behaviour patterns and travel demand for political and investment decisions; construction of a European database	The project aims to provide an operational framework to support decision-making on local policies for land use and transport planning. The relationships between traffic, land use and externalities will be defined, and recommendations provided to planners on how to elaborate specific strategies using the SESAME tools and database.
SOFTICE	Survey on freight transport including a cost comparison for Europe	The aim of the project is to identify the main parameters affecting freight cost structure in EU Member States plus Switzerland and some CEE countries, and to identify the factors affecting freight transport demand. The effects of different policies for taxation and internalisation of costs on the spatial organisation of production will be identified, and an optimal country-related time path for the implementation of harmonisation policies defined.
SORT-IT	Strategic organisation and regulation in transport	The project aims: • to develop policy measures addressing the organisation of the European transport system; • to identify and assess the impact of deregulation and privatisation of transport infrastructure and operations in the EU and EFTA; • to determine the optimal balance between market competition and transport regulation; • to develop a series of analytical models which will assess the impacts of different organisational structures on costs, productivity, competition and interoperability.

Acronym	Title	Objective(s)
START	Development of strategies designed to avoid the need for travel	The aims of the project are: • to quantify the impact of road travel reduction strategies and analyse their wider impacts in order to highlight barriers to implementation and find ways of making the strategies more acceptable; • to assess the extent to which pricing and other travel reduction strategies may affect infrastructure financing and cost recovery plans, with particular emphasis on the road TEN; • to produce an Action Plan of policy packages to reduce road-based travel, covering all levels of decision making.
STREAMS	Strategic transport research for European Member States	The main goal is to develop a prototype model to predict the demand for transport across the EU and its broad distribution across the transport network. In addition, the project aims to produce a "reference scenario" for the year 2020.
TENASSESS	Policy assessment of Trans-European Networks and Common Transport Policy	The aim of the project is to develop a methodology that could be used in the assessment of policies and options related to decisions on transport infrastructure investments (especially TEN-T), and to provide a comprehensive assessment of the CTP.
TRACE	Costs of private road travel and their effects on demand, including short and long-term elasticities	The aims of the project are: • to understand and demonstrate the relationship between costs (both time and money) and the demand for car travel (long and short-term); • to produce a comprehensive review of empirical and modelling evidence of time and cost elasticities and 'values-of-time' (long and short-term); • to produce an easy-to-use Elasticity Handbook which includes values for elasticities for a range of 'prototypical contexts', to assist the assessment of first order impacts on car travel demand at different planning levels.
TRANSLAND	Integration of transport and land-use planning	This project aims to identify and recommend good practice in the integration of transport and land-use planning. It will cover both the choice of policies and measures, and the effectiveness of procedures and institutional arrangements.
TRENEN II STRAN	Models for transport, environment and energy – version 2. Strategic transport policy analysis	The aim of this project is to develop and apply a set of strategic models for transport policy assessment in the field of taxation, pricing, regulation and financing.

ANNEX 2 MAIN FINDINGS FROM COMPLETED RTD PROJECTS

This Annex summarises the findings from completed projects for which the Final Report has been approved or made available. Project web page references are provided where known. Summaries of all projects are available from the two web sites given in Section 1 of this paper.

Index of RTD project results:

Project acronym and title	Key results and policy implications
AFFORD: **Acceptability of fiscal and financial measures and organisational requirements for demand management**	***KEY RESULTS*** The aims of AFFORD were to define practical measures to implement marginal cost pricing for transport in cities, to assess the potential problems and to provide policy guidelines for introducing such measures. The project evaluated "first-best" and "second-best" policy packages based on marginal cost pricing, rather than assessing individual pricing measures. Results from modelling in four European cities (Athens, Edinburgh, Helsinki and Oslo) suggested that such packages give rise to substantial welfare benefits for the urban population. Annual gains typically vary between 100 and 400 Euros per capita, depending on the city context and measures applied. A major part of this gain may result from the effective use of the revenues, for instance allowing a reduction in labour taxes. (The benefits are therefore quite sensitive to the value or "shadow price" attributed to helping a government meet budget constraints without the need for distortionary taxation elsewhere in the economy.) The equity effects of pricing were estimated to be moderate (negative or positive). Environmental benefits constitute a significant part of the welfare gain, ranging between 15 and 95% depending on the city. Reductions in trips by private car range between 5 and 30%. Overall, accessibility is reduced, particularly for car users. However, if revenues are used to subsidise public transport services, then accessibility may even be increased for most of the population. Case studies and surveys in five cities indicated that the legal and institutional frameworks required to implement marginal cost-based pricing for urban transport have, so far, not been put in place. For example, these are different to the frameworks needed for road pricing on inter-urban motorways. Surveys of public, political and business acceptability of pricing were carried out in several cities. These showed a high awareness of the underlying pollution, congestion and parking problems, but relatively little knowledge of pricing instruments. In general, pricing was perceived to be effective, but likely to lead to disadvantages to stakeholders. A majority of motorists did not accept the proposed packages of pricing measures. ***POLICY IMPLICATIONS*** The dependence of the welfare benefits of pricing on how the revenue is used implies that urban transport pricing is a general policy issue that goes beyond the local policy level and also beyond the transport sector. AFFORD concluded that the introduction of marginal cost-based pricing will require the creation of supporting institutions and laws, and the removal of inconsistencies in national-level policies. For example, strong institutions are needed with the powers to control multi-modal transport pricing across urban regions, rather than trying to construct complex relationships across multiple local authorities. Successful pricing will also need effective communication to overcome public opposition. Marginal cost pricing, especially prior to implementation, will be regarded with a lot of scepticism and even hostility. It may be politically vital to redistribute a significant majority of revenues to the local or regional population that pays, whether or not the funds are used for transport. ***PROJECT WEB PAGE:*** http://www.vatt.fi/afford/

Project acronym and title	Key results and policy implications
ARCDEV:	***KEY RESULTS***
Arctic demonstration and exploratory voyage	The extensive oil and natural gas reserves in northern Russia and in the Russian sector of the Arctic Ocean are so large that they are viewed as the long-term energy supply source for Western Europe. Many oil companies prefer to transport the oil by icebreaking tankers instead of by pipelines through various foreign countries and across unsafe soil conditions. The conditions for maritime operations are extremely harsh in this region, routes being often covered by the thick ice. The current sea transportation system is based on heavily strengthened cargo vessels, which are assisted by large icebreakers. This shipping has been so far State-controlled, and was therefore uneconomical for western commercial standards. In order to make the tanker transportation of oil from the Russian Arctic attractive for western oil and shipping companies, this transportation system has to be improved in various aspects. The core of the ARCDEV project was a demonstration voyage in the Russian Arctic along the Northern Sea Route. Main areas of research work covered: • Legal and administrative aspects of navigating in Russian Arctic, with a specific focus on insurance issues when nuclear icebreakers are involved. • Economical and commercial attractiveness of Arctic transportation, for different hydrocarbons cargoes. • Ice conditions registration, analysis and forecasting, stressing strengths and weaknesses of several methods (satellite data, visual ice observations, electro-magnetic measurements, laser profilemeter flights, thermal drill measurements). • Tankers' and icebreakers' performance in various Arctic environmental conditions, quantifying average speed, power usage and energy per nautical mile for ships in the convoy, and analysing tankers' ice classes for a reliable, safe and efficient navigation. • Cargo handling operations, analysing different tanker loading systems and terminal types. • Remote service and maintenance systems, testing latest communication and IT technology for remotely helping the maintenance personnel onboard or giving medical aid. • Operational safety in means of environment, human lives and material preserve. ***POLICY IMPLICATIONS*** The ARCDEV project proved that marine transportation of hydrocarbons from the Russian Arctic to Western Europe is technically possible and safe even in very hard ice conditions. Transportation costs are, however, extremely high due to several reasons: • small cargo volumes (approx. 13,000 tons), • route selection resulting in sailing distance increased to double, • low loading rates of the temporary loading facilities, • high costs for icebreaker assistance, • slow custom and immigration procedures. To reduce costs, long-term investments in tankers, icebreakers and loading terminals are required. To attract such investments, changes are needed in the legal framework and business environment. These changes can be achieved only through long-term co-operation and open discussion between EU and Russia. The project team recommends the development of a platform to perform the technological development, to foster further the discussion and to demonstrate and validate the results.

Project acronym and title	Key results and policy implications
	PROJECT WEB-PAGE: http://www.arcdev.neste.com
ARTIST:	***KEY RESULTS***
Agenda for research on tourism by integration of statistics/ strategies for transport	The goal of ARTIST was to demonstrate how tourism statistics can be related to transport data, as well as providing lessons for urban and transport planners in managing tourism flows. Through an assessment of existing data and policies, the ARTIST project developed two sets of proposals, concerning: • the organisation of a research programme to underpin efficient and evaluated action in the tourism and transport sector, both at the European level and at the urban level; • research themes which can fill the major gaps in the know-how of those who are in charge of managing tourism/transport policies and those who organise and run the tourism/transport facilities. Concerning the first set of proposals, the project highlighted the lack of a global theory explaining the behaviour of travellers. Methods were proposed to investigate the different aspects of this behaviour, including data acquisition, analysis of travel patterns and analysis of impacts. Tools and models were investigated for monitoring and evaluating policies, strategies, measures and services, in order to steer the decision making process. For the second set of proposals, the ARTIST project selected 21 research themes. These cover a full range of concerns, ranging from the development of a set of adequate definitions, through survey and forecasting methods, to the design of information systems and safety policies. For each of the research themes, ARTIST described the problem, the objectives, the steps to be performed, the expected results and their possible use. ***POLICY IMPLICATIONS*** Consistent management of tourism statistics and related research activities across Europe will impact a wide range of policy areas: employment, regional development, education, environment, consumer protection, health, safety, culture, new technology, transport, finance and taxation, to name but a few. At a local level, such data management will allow a better use of existing programmes of policy support, particularly the EC Structural Funds that subsidise tourism activities under the control of local authorities in Member States.
ASDSS:	***KEY RESULTS***
Analysis of supply and demand for shipping services	The aims of the ASDSS project were to assess the supply/demand situation for container shipping and the current competitive position of the EU shipping industry, and to evaluate industry responses, including implications for flag selection, employment, port selection and policy. The study concluded that pressure on shipping rates and poor profitability have been substantially due to intense cost-based rivalry, while capacity utilisation has been good. On every major trade route, over 30 commercial entities compete with services that are not strongly differentiated. Cost improvements have been easily copied across the industry and then competed away through lower rates to customers. Although there has been significant partnering between carriers, this has focused on the use of vessels, while the resulting joint capacity is still divided up between many companies. Operators

Project acronym and title	Key results and policy implications

continue to respond to the situation by concentrating on cost reduction. As a result, the outlook is for continued poor profitability in the industry.

EU operators have increased their market share in recent years, while the proportion of the EU owned fleet that has flagged out is lower than the world average. As cost pressure continues, EU seafarer employment may be affected by further flagging out, although this cost category accounts for less than 5% of a major container line's costs. Instead, the main future impact on EU jobs will be on-shore losses due to the rationalisation or merger of operators, since on-shore personnel account for around 20% of costs.

As average vessel size has increased, total port calls by container vessels are decreasing. As a group and individually, the top ten North European ports have seen relatively small changes in overall market shares, while the top ten Southern European ports have gained share from smaller ports.

No evidence was found that container operators are particularly high risk in terms of shipping accidents, and the accident profile of EU container operators is comparable to that of non-EU operators. Therefore policy on maritime safety would seem to cover container shipping adequately.

POLICY IMPLICATIONS

ASDSS concluded that a set of European operators is well positioned, either as emerging global players or niche operators. Owing to continued cost competition, they may continue the trend of flagging out to reduce crew costs. However, the next major cost rationalisations will hit on-shore personnel, through economies of scale, IT solutions and process redesign. The challenge for policy is to encourage EU operators to retain their on-shore control centres in Europe, rather than relocating them e.g. to the Far East.

In addition, policy action is needed to improve land transport connections to major container terminals, since the increased volumes of inbound and outbound boxes associated with ever larger vessels are leading to bottlenecks and inefficiencies around these terminals. Intermodal solutions involving rail and barge would be significant in taking the pressure off the dominant road links.

ASTRA:

Assessment of transport strategies

KEY RESULTS

The aim of the ASTRA project was to develop a system dynamics tool capable of analysing the long-term effects of the EU's Common Transport Policy, not only for the transport system but also for the most important connected systems. The tool was also intended to support the comparison of developments *over time*, not just the static comparison of outcomes in some horizon year (which has been common practice in transport assessments).

ASTRA developed a system dynamics modelling platform integrating four sub-models (covering macro-economic activity, regional economics and land-use, transport demand and environmental impacts). The interfaces between the sub-models allow feedback loops to be established, thereby capturing the inter-relations between variables. Output indicators include traffic volumes, vehicle numbers, environmental impacts, and economic, social and employment indicators. Forecasts are produced from a base year of 1996 to a time horizon of 2026. Important attributes include short run-times for some types of policy test, and the ability to simulate the gradual introduction of a policy measure.

The ASTRA model was demonstrated by simulating the effects of five policy packages

Project acronym and title	Key results and policy implications

(each consisting of sets of policy measures) and also a more comprehensive set of measures. The scenarios addressed policy decisions in the fields of taxation, construction of the Trans-European Transport Network, mitigation of air pollution and safety improvement. As an example of the system dynamics approach, the simulations considered different ways of spending the revenue from increased taxation – either for a reduction in labour costs or for construction of new transport infrastructure.

Overall, the fully integrated set of measures produced the best results across the range of economic, environmental and employment indicators. Other significant points from the policy analysis were as follows:

- None of the tested packages was able to meet the Kyoto requirements for abatement of greenhouse gas emissions.
- No further significant improvement could be identified for road accidents.
- Air transport growth would be significant in all scenarios, and in some cases would counterbalance most of the environmental benefits of policies giving a reduction in road transport.
- The effects of the policy packages on the economy change the average annual GDP growth rate by 0.2% at most between the "best" and "worst" policy options.

POLICY IMPLICATIONS

ASTRA has shown that the system dynamics methodology allows for a long-term assessment of the wider socio-economic and environmental impacts of transport policy packages, and provides inherently consistent indicators to enable a direct assessment by the policy-maker. Moreover, the methodology is available in an operational software model for policy assessment on a European scale. This can be used to forecast the "what-if" consequences of planned policies, or be run in a "backcasting" mode to identify measures that will achieve a desired end-state.

PROJECT WEB PAGE: http://www.iww.uni-karlsruhe.de/ASTRA

ATENCO:

Analysis of the cost structures of the main TEN ports

The final results of this project were not available when this Thematic Paper was prepared.

CAPRI:

Concerted Action on transport pricing research integration

KEY RESULTS

The purpose of CAPRI was to facilitate the transfer of information from research projects dealing with the pricing of transport. Key objectives were:

- to aid dissemination of results to Member States and other stakeholders;
- to develop a synthesis of research findings;
- to help to build a consensus on the implications for policy.

CAPRI drew conclusions in six areas (pricing principles, valuation of externalities, road pricing, rail and other public transport, air transport, and the likely impacts of pricing policy). These were based on EC-funded research as well as other evidence from inside and outside the EU.

Pricing principles: Pricing policy should be based on an understanding of marginal social costs, where the user pays the costs that they cause through additional infrastructure use. This will not deter trips that offer a net benefit to society, but it will discourage trips where the benefit to the individual user is less than the cost to society as

Project acronym and title	Key results and policy implications

a whole. Marginal social costs should be used as the starting point for price determination, with other important considerations such as financial needs incorporated in a way that does least damage to society's welfare. One of the main implications of pricing based on social costs is that prices should vary to a greater extent according to location and travel time.

Valuation of externalities: All of the main externalities (air pollution, global warming, congestion, accidents etc.) can be taken into account in pricing structures, even though some uncertainty exists in their estimation. CAPRI recommended specific evaluation methods for particular impacts.

Road pricing: Greater differentiation in road charges by time period and area is necessary to cope with congestion resulting from heavy peaks in travel demand. The main impact is likely to be travel at different times or by different routes, rather than a change in mode. To increase acceptability, the introduction of pricing should be staged, starting with simple systems with low charge levels, and the revenue should be earmarked for specific spending programmes such as public transport.

Rail and other public transport: Efficient pricing is likely to require greater peak/ off-peak differentials, and also an element of government funding (particularly for short-distance urban services). Improving the service quality and investment in infrastructure may be the most important measures for improving modal shares, as opposed to internalisation of externalities for all modes via the pricing mechanism – this is particularly the case for freight transport.

Air transport: Environmental pricing can be based on kerosene consumption and/or landing and take-off operations, but policy development in this area requires further research.

Likely impacts of implementing efficient pricing: Pricing based on marginal costs may result in price reductions for some modes as well as price rises for some others. For example, inter-urban passenger travel in uncongested conditions, by road or rail, is typically *over-priced* at present. For inter-urban freight transport, evidence suggests that there is often significant *under-charging* for both road and rail. Finally, urban transport by means of road-based modes is typically *dramatically under-charged*, particularly in congested conditions.

POLICY IMPLICATIONS

The existing range of pricing policies in EU Member States is so varied that the impacts of marginal cost pricing have to be assessed on a case-by-case basis. The extent and direction of any price changes will depend strongly on current levels of taxation and charging, and will not necessarily imply lower travel demand. Nevertheless, as a broad conclusion, pricing reform to reflect social marginal cost would involve:

- a decrease in prices for inter-urban road and rail passenger transport and an increase in the price of urban road travel (particularly for the private car);
- an increase in prices for both road and rail freight.

Regulatory policy may often be more powerful than pricing policy in the control or reduction of some categories of environmental emission, such as noise. For emissions of greenhouse gases, CAPRI recommended that pricing should be based on political decisions about target emission levels, given the lack of consensus about the values to be placed on each tonne of pollutant.

PROJECT WEB PAGE: http://www.its.leeds.ac.uk/projects/capri

Project acronym and title	Key results and policy implications
CODE-TEN: **Strategic assessment of corridor developments, TEN improvements and extensions to the CEEC/CIS**	***KEY RESULTS*** Multi-modal corridors across Europe represent costly infrastructure investments that require phasing. Classically, economic evaluations are critical in decisions on prioritising projects. However, in the context of *network* development, a more strategic assessment method is needed. Therefore CODE-TEN has developed a strategic policy assessment tool for assessing the impacts of the development of pan-European corridors. The tool applies a scenario approach to elaborate consistent images of the future that combine information on three aspects: socio-economic development, policy development and infrastructure planning. Using these images, the alternatives for corridor development are subjected to impact assessment to help in decision-making. The images build on 4 scenarios of socio-economic and political developments through to the year 2015, named: • Renaissance – high economic growth and fast integration of neighbouring countries into the EU; • Dilution – high growth and slow integration; • Solidarity – low growth and fast integration; • Fragmentation – low growth and slow or no integration. A comprehensive information system was produced on a CD-ROM covering 30 European countries. This provides information on politics, regional socio-economic data, regional road information, foreign trade, transport costs, resource costs, networks and maps. It has supported in-depth corridor studies on: Via Baltica, Berlin-Warsaw-Moscow, Dresden - Budapest - Istanbul, Venice – Kiev, The Danube Waterway, Copenhagen - Stockholm - Helsinki - Moscow, Salzburg - Belgrade - Thessaloniki, the Mediterranean short sea shipping and the Lisbon-Madrid-Paris Trans-European link. Descriptions of infrastructure strategies and traffic flow estimations (based on the development of the various scenarios and corridors until the year 2015) have led to the impact assessment of the various alternatives for corridor development, focusing on accessibility, environment and socio-economic factors. Combinations of road and rail projects were generally found to offer the greatest benefits. ***POLICY IMPLICATIONS*** CODE-TEN gives guidelines for assessing transport investments to support the policy of expanding the European Union to Baltic and Central European countries. The method could also be applied more generally to other infrastructure programmes. CODE-TEN recommended that, in addition to project-specific assessment, the whole set of related projects should be subject to strategic assessment. The DECODE method elaborated in CODE-TEN is one method for carrying out this analysis. ***PROJECT WEB PAGE:*** http://www.iccr-international.org/code-ten/

Project acronym and title	Key results and policy implications
ECONOMETRIST:	***KEY RESULTS***
Economic evaluation of the impacts of transport activities on Member States	The activity in ECONOMETRIST was split into two discrete elements: • The development and demonstration of a short-term and *static* methodology for evaluating the impacts of transport activities throughout a national economy. • The definition of a methodology for a more comprehensive economic assessment in a *dynamic* world. This approach is more representative of real-world behaviour. The *static* methodology was demonstrated for Spain, the United Kingdom, Italy and the Netherlands. Internally consistent input-output tables were produced, extending the 25 branches of economic activity proposed by EUROSTAT to 31 branches by introducing a greater disaggregation of the transport sector. Public transport services were estimated to account for 4–6.5% of economic activity as a whole. A 5% increase in energy costs would increase rail costs by around 1% and road, sea and air costs by around 0.5%. ***POLICY IMPLICATIONS*** The project indicated that input-output tables *could* be extended to allow more detailed simulation of the broad economic impacts of policy-related changes in transport activity. However, to make this a realistic tool, further work would be needed to develop the *dynamic* modelling methodology (rather than using a static approach).
ECOPAC:	***KEY RESULTS***
Econometrics of impacts	ECOPAC developed and demonstrated a method for estimating changes in employment attributable to new transport investments, particularly the "structuring" effect on employment due to increased investment by other sectors of the economy in the vicinity of new transport infrastructure. This method is based on regression analysis, seeking to explain the total change in employment in a region in terms of explanatory factors such as the initial structure of the economy, non-transport investments, skill levels and accessibility. The project showed that values could be derived for the number of jobs created per unit length of new infrastructure. The method was applied to regions of France, Spain, Germany, Finland and the United Kingdom, analysing historical data. The number of jobs created by one km of new road in 10 years in an employment area of 10,000 people was estimated to range from two to eleven. On average, the method suggests that around 7,200 new jobs could be created as the result of building a 100km stretch of motorway in a NUTS3 zone of some 200,000 workers. A similar benefit can be achieved by investing in a high-speed rail link. ECOPAC also considered two "dampening" effects: • The grouping of investments close to new transport infrastructure may take place at the expense of other areas. • Selecting one region for transport investment may limit the transport spend in other regions. The project concluded that these dampening effects cannot readily be assessed using current methods. ***POLICY IMPLICATIONS*** ECOPAC has shown that the indirect effects on employment due to new transport infrastructure can be estimated from historical data, and the average results may provide an input to the cost-benefit analysis for future infrastructure investments. Nevertheless, the evidence of significant regional variations and the uncertainty in the dampening

Project acronym and title	Key results and policy implications
	effects indicate that more tailored studies may be needed to provide an accurate assessment for a specific location.
E-EIS: **European economic impact study for the European shipping sector**	*The final results of this project were not available when this Thematic Paper was prepared.*
EMMA: **European marine motorways: the potential for transferring freight from road to high-speed sea transport systems**	*The final results of this project were not available when this Thematic Paper was prepared.*
EUDET: **Evaluation of the Danube waterway as a key European transport resource**	***KEY RESULTS*** EUDET has: • performed an in-depth analysis of existing waterway infrastructures on the Danube river and adjacent canals, with respect to - transport capacity per section, depending on waterway width and depth, the capacity of locks, and headroom below bridges, - existing ports, their facilities, typical goods and capacities; • analysed inland ship fleets – i.e. fleet structures and their capacity – per country, design aspects in ship and transhipment technology, existing shipyards, and infrastructure bottlenecks related to the interaction of ports and current fleets; • analysed the prevailing transport market conditions in the Danube corridor, e.g. - recent economic developments in bordering states, - the current structure of transport markets per country, - the inland navigation market compared to the rail sector, - Danube river to sea connections, especially to North Sea and Mediterranean sea ports, with a focus on multi-modal services; • performed an analysis of trade and transport flows in the Danube region; • forecast future trade flows based on developed scenarios for the Danube corridor; • analysed and modelled potential transport volume and summarised the waterway's potential on a per country basis; and • elaborated recommendations for initiatives aiming to improve the Danube's competitiveness, by identifying needs for investment and schemes for market restructuring. ***POLICY IMPLICATIONS*** Currently there is a unique possibility to create a powerful inland waterway backbone along the Danube river, as long as road and rail networks in South-Eastern Europe have not reached Western standards. This would require a single regulatory framework for EU countries, acknowledged accession countries and countries such as the Ukraine, alike. A logical next step would be the promotion of trans-national infrastructure and fleet investments to cope with the forecast growth in transport on the Danube. Finally, new organisational structures and logistics concepts are essential to close perceived

Project acronym and title	Key results and policy implications

entrepreneurial gaps.

PROJECT WEB-PAGE: http://www.impetus.gr/eudet.htm

EUFRANET:

European freight railway network

KEY RESULTS

The aims of EUFRANET were to identify and evaluate conditions for the development of a trans-European rail network mainly dedicated to freight transportation and to establish a strategy for its implementation.

An initial market survey showed that the majority of shippers interviewed are satisfied with domestic rail transport, but regard the quality of international rail transport as inadequate. Main criticisms included poor flexibility and reliability, a lack of co-ordination between operators, inadequate information, high costs, unreliable pricing policies, and a failure to co-operate in exploiting logistical systems.

EUFRANET modelled the development of demand for freight transport in 2020. Under a "current trends" scenario, rail would continue to lose market share to the road sector, falling from 14 to 9%. By combining the demand model with a model of the railway network, the project then evaluated the potential effects of changes in rail infrastructure and operations. A new assignment of routes to different services was devised, based on three sub-networks:

- a core network strongly dedicated to freight, covering the industrial regions of central Europe;
- an intermediate network mainly dedicated to freight but also carrying local passenger trains;
- a mixed network on which passenger trains would normally have priority.

The modelling results indicated that traffic on the dedicated network could increase significantly, accounting for 85% of total freight traffic on just 20% of the rail network. Journey times on this network could be cut by 20 to 30%. The decline in modal share of rail could be reversed, taking the share back up to 16%. Gains in national markets would be of the same order of magnitude as gains in international transport, though varying between Member States.

POLICY IMPLICATIONS

The implementation of a dedicated freight network and operating system would require a number of actions:

- infrastructure investment to remove bottlenecks (for instance crossing the Pyrenees and the Alps);
- the agreement and implementation of standards and systems to overcome a lack of interoperability across the network;
- the introduction of a slot scheduling and assignment method for international services;
- some degree of harmonisation of the subsystems used by the train operators (pricing, information, reservation, tracking and tracing etc.)

PROJECT WEB-PAGE: http://www.inrets.fr:80/ur/dest/eufranet.htm

Project acronym and title	Key results and policy implications
EUNET/SASI:	***KEY RESULTS***
Socio-economic and spatial impacts of transport	EUNET/SASI involved two sub-projects with the following main aims: • *EUNET*: To develop a comprehensive methodology and model for assessing the impacts of transport initiatives (including infrastructure investments, regulatory and fiscal policies). • *SASI*: To develop a specialised methodology and model for forecasting the socio-economic and spatial impacts of large transport investments in Europe, particularly to support the assessment of options for the TEN-T. By comparison, EUNET took a regional/corridor view and focused on the demonstration of methodology, while SASI took a more global view of impacts across Europe. ***EUNET*** A broad-based modelling system was developed in the form of prototype software to support policy decisions. This included: • methods for valuing socio-economic effects; • a tool for estimating spatially-resolved indicators of regional accessibility and social cohesion, including effects on national output and employment; • a new approach to regional economic modelling, where the sources of potential travel growth are identified separately as a function of specific social and economic activities; • a database for estimating the costs of vehicle and infrastructure operation, by country, through to 2020; • an assessment framework combining both cost-benefit and multi-criteria analysis methods. The model was demonstrated for the Trans-Pennine corridor in the UK and for long-distance freight movements in Finland. In addition, the application of the methodology in areas with limited data availability was assessed in a desktop study for an area of Greece. EUNET also provided an overview of current practice across Member States in appraising major transport projects and deriving monetary values for impacts. ***SASI*** In this sub-project, software was devised for predicting the impacts of transport infrastructure investments and transport system improvements on socio-economic activities and development, including the spatial distribution of impacts. The model covers the whole EU at the NUTS-2 level of geographic disaggregation (dividing the Member States into 201 regions), and provides forecasts to the year 2016. Innovative attributes include: • the prediction of regional unemployment; • the estimation of the spatial redistribution effects of the TEN-T; • the calculation of accessibility taking account of proximity to nodes of the transport network; • the calculation of indicators of cohesion for the European Union; • *dynamic* modelling of the development of the transport network and socio-economic impacts over time. The model was used to assess some scenarios for extension of the TEN-T. The development trajectories of the European regions were similar in all scenarios, showing that macro-economic trends (such as ageing of the population) have a much stronger impact on cohesion than different transport infrastructure strategies. In all scenarios, most regions will improve their accessibility and economic performance in absolute terms, but with some changes in their *relative* position. The maximum TEN-T

Project acronym and title	Key results and policy implications

investment leads to a slightly less polarised distribution of accessibility and economic output among the regions, but this slight cohesion effect would not, however, be able to reverse the general trend towards economic polarisation in the EU.

A case study on the Oresund crossing in Sweden showed that the model is sufficiently sensitive to assess individual infrastructure projects with regard to their impact on accessibility and regional economic development.

POLICY IMPLICATIONS

EUNET/SASI has provided new methods for assessing the complex relationship between transport infrastructure and regional development and the effects of policy initiatives such as infrastructure investment.

The project recommended that transport statistical data should be collected and published in a more standardised way, to make their use in modelling and policy support more cost-effective.

PROJECT WEB-PAGE: http://fpiv.meap.co.uk/fpiv/EUNET.htm

EUROPE-TRIP:

European railways optimisation planning environment – transportation railways integrated planning

KEY RESULTS

The European railway industry is in the midst of a process of restructuring and commercialisation. The process is based on the principle of separation between the management of the infrastructure and the provision of transport services. The process has been driven by the EU Directives 91/440 and 95/19, which have set down the principles for the liberalisation of the market for providing rail services and for implementing the access-to-infrastructure procedure. The European Parliament and the Council agreed on a set of rail infrastructure Directives in February 2001.

The general aim of EUROPE-TRIP was to develop a framework able to assist the infrastructure manager in putting the new policy principles into practice, and in particular the principle of open access.

A business planning model, able to simulate the strategies of the IM and options for access-to-infrastructure policies, has been developed and a demonstrator set up. The model, based on the "system dynamics" micro-simulation method, focuses on the role of the IM and his relations with train operators and the regulatory authorities, and represents financial ratios and other business trends with a long-term perspective. The model can be used as platform to conduct strategic studies on European rail transport and corridors, e.g. freight freeways.

Two approaches have been developed and tested for the analysis of the behavioural structure of the access-to-infrastructure:

- an analytic model based on game theory, which represents the competition among train operators and their interaction with the IM, and
- an auction model based on experimental economics, where an auction procedure is applied to provide information about operators' access values.

A multi-layer approach has been developed and tested as a unified methodology to estimate line capacity from aggregate to detailed analysis, including analytic methods, scheduling models and simulation. The potential of state-of-the-art scheduling models has been highlighted.

A framework of definitions for cost analysis has been tested in a real case study of a

Project acronym and title	Key results and policy implications

European corridor. The need for regarding infrastructure costs on a life-cycle basis and the requirement for setting up a common European reference framework and implementing benchmarking analysis have been stressed. The costs of using intermodal inland terminals have been outlined and a "data envelopment analysis" technique has been demonstrated for studying the comparative efficiency of infrastructure managing units.

POLICY IMPLICATIONS

The EUROPE-TRIP results are a significant contribution to the development of innovative management techniques as required by the proposed Directive for the railway sector put forward by the Commission in August 1998 (COM480), concerning the allocation of railway infrastructure capacity and levying of charges for the infrastructure use. Some of the EUROPE-TRIP models and approaches are truly innovative, having been developed for the first time in the project.

The implementation of the principles set out in the proposed Directive can be supported by the project results, in particular those on:

- the inter-relation between residual capacity and short-notice capacity management,
- the relationships between capacity allocation and charging method, and
- the operational definitions of "co-ordinated" and "constrained" infrastructure.

The possibility of exploiting the results of the project depends on the co-ordination of the infrastructure managers and their willingness to participate in common ventures. The infrastructure managers should also be ready to identify themselves as one European network system.

PROJECT WEB-PAGE: http://www.srd.it/TRISprj/trip.html

EUROSIL:

European strategic intermodal links

KEY RESULTS

EUROSIL aimed to develop robust guidelines to support decision-making on TEN-T and other transport investments, which would take into account the impacts of multi-modal links on regional development.

Through a series of 12 case studies, EUROSIL identified examples of good practice in appraising the benefits of multi-modal transport investments. However, it was clear that few of the current modelling approaches deal explicitly with regional development effects, and there are further deficiencies in the evaluation of those impacts.

Therefore EUROSIL developed an evaluation framework and software tool to support a structured approach to the assessment of regional development effects. This covers the selection of criteria for the evaluation, the estimation of impacts, and the definition of weighting factors for combining different impacts according to the selected criteria. Guidance is provided on the choice of traffic modelling methods.

For those cases where the decision-maker requires a quick low-cost evaluation of alternatives rather than a sophisticated evaluation, EUROSIL has constructed a simplified set of guidelines.

POLICY IMPLICATIONS

The case studies highlighted a number of barriers to intermodality:

- inadequate information flows between the variety of actors;
- problems with slow procedures at border crossings;

Project acronym and title	Key results and policy implications
	• differences in technical standards and regulations between Member States, e.g. for vehicle size and weight; • a lack of co-ordination at interchanges (such as different companies working different hours); • a lack of interoperability between modes, for instance concerning ticketing and information systems. The EUROSIL evaluation framework is now available for use in real-life decisions on the TEN-T and other major long-distance transport projects. Its incorporation into new developments of user-friendly investment appraisal tools is recommended.
EUROTOLL: **European research project for toll effects and pricing strategies**	***KEY RESULTS*** EUROTOLL aimed at providing transport policy-makers with information on the potential effects of different types of road pricing and tolling strategies. The main findings relating to road user behaviour were: • if tariffs vary throughout the day according to demand, car drivers will re-schedule departure times, which leads to less traffic congestion; • if tariff systems reward re-routing, a significant number of car drivers will do so, which again reduces congestion; • road pricing has not been observed to lead to significant modal shift; • it takes time for users to change their behaviour in response to price signals - car drivers are more sensitive than occasional drivers and truck drivers. In addition, EUROTOLL has demonstrated that strategies to integrate pricing measures and transport information applications are able to reinforce the positive effects of both. ***POLICY IMPLICATIONS*** For future pricing strategies, the following recommendations should be considered: • the reason why a pricing measure is introduced has to be clearly explained to users and the general public; • during a trip, more frequent road users of an area or route need less information to react to changed conditions than occasional users; • users who make the same trip frequently will change their behaviour more quickly; • information strategies have to be designed as a combination of pre- and on-trip information; • travellers have to be given sufficient information about the pricing scheme and alternative travel possibilities if behaviour is to change; • alternatives (e.g. routes) and the advantages of alternatives have to be demonstrated and promoted. EUROTOLL concluded that the principles recommended by the EC White Paper on transport pricing could be implemented through a combination of practical pricing methods.
FANTASIE: **Forecasting and assessment of new technologies and transport systems and impacts on the environment**	***KEY RESULTS*** FANTASIE identified and assessed new technologies that could have a major impact on transport systems in Europe and the attainment of CTP objectives. The project produced a wealth of information covering specific technologies (such as propulsion and information systems), vehicle concepts and transport system concepts, for a range of time horizons (2005, 2020 and 2030), journey types (urban, inter-urban etc.) and socio-economic scenarios.

Project acronym and title	Key results and policy implications

Particularly promising technologies were seen as:

- telematic technologies – likely to be of benefit across all impact categories – such as on-board emissions management, multi-modal traveller information and trip planning, dynamic route planning and navigation, electronic tolling, anti-collision systems, smart cards, intelligent cruise control and traffic management systems;
- fuel cell and hybrid propulsion systems, offering significant energy and environmental benefits;
- improvements in the conventional all-purpose car, such as advanced turbo-diesel engines, direct injection gasoline engines and reduced weight;
- tilt rotor technologies for air transport, giving significant fuel savings and noise reduction;
- airships for moving heavy and bulky loads;
- new systems for personal rapid transit;
- road trains.

Quantitative estimates of market shares and impacts at a European level were prepared.

POLICY IMPLICATIONS

Policy options to promote new technologies can be generic (trying to improve the conditions for innovation) or specific to certain selected technologies. Some experts on technology policy prefer generic options because these allow the market actors to come up with new ideas and the most cost-effective solution. However, the realisation of specific technologies often requires changes in legislation and regulations to remove barriers – generic policy action may be insufficient. Therefore FANTASIE recommended a combination of the two approaches:

- Generic measures are needed across the transport sector, such as standardisation, R&D funding, pilots and demonstrations.
- Packages of policy measures should be directed towards specific clusters of technologies, such as propulsion systems, urban transport technologies, intermodal systems, air traffic management systems, travel information, and road traffic management and payment systems.

Specific policy proposals are included in the project Deliverables.

PROJECT WEB PAGE: http://www.etsu.com/fantasie/fantasie.htm

FATIMA:

Financial assistance for transport integration in metropolitan areas

KEY RESULTS

The aim of FATIMA was to identify the differences between urban transport strategies optimised using public funds and those requiring private funding, and to provide guidance on how best to use private sector funding.

Conclusions were drawn from modelling studies in nine cities: Edinburgh, Eisenstadt, Helsinki, Merseyside, Oslo, Salerno, Torino, Tromso and Vienna. In six of these cities, optimal policies could be funded by road pricing or increased parking charges with no net additional financial support (over a 30-year time horizon), allowing public transport services to be increased or fares decreased.

In the other three cities, the optimal strategy would require greater funding than the do-minimum case. Where cities face constraints on capital investment, private sector finance could be used, with part of the cost being met from public funds and part from user revenues. However, if the private sector requires a higher rate of return than the public sector, the optimal strategy may well be constrained, resulting in lower social

Project acronym and title	Key results and policy implications

benefits. In this case, an alternative is to raise additional finance through value capture (such as taxing land values that benefit from transport infrastructure investment). However, the modelling suggested that value capture is beneficial in only a limited range of city situations.

FATIMA also studied the merits of private sector operation of public transport, whether implemented through deregulation, in which operators are free to determine service levels and fares, or through franchising, where the city authority specifies them. Results indicated that private sector operation reduces the net social benefits of the optimal transport strategy, particularly under deregulation. No convincing evidence was found for a reduction in operating costs, for a given level of service, due to private operation. Moreover, sensitivity tests indicated that such cost savings would have relatively little impact on social benefit.

POLICY IMPLICATIONS

FATIMA made a series of recommendations for the design of optimal transport strategies, the involvement of the private sector, methodology for strategy optimisation and priorities for further research. These included the following:

- Strategies should be based on combinations of measures, with public transport measures and car user charges as key elements.
- There should be a greater distinction between peak and off-peak charges and fares.
- In many cities it will be possible to identify optimal strategies that can be fully funded from user charges, using the FATIMA methodology.
- If private finance is needed for capital investment, optimisation procedures can identify the appropriate modifications to the strategy to achieve the best performance within the financial constraint. However, such a strategy will usually have smaller social benefits than in the absence of the constraint.
- Value capture may help to raise additional finance in cases where strategies are not self-funding and require private financing.
- If a city authority decides that private operation of public transport is beneficial, it should ideally use a franchising model in which it specifies the objectives and the optimal service levels and fares.
- However, if national law requires deregulation, the city authority should identify which of the possible combinations of fares and frequency (at a given level of profitability) best support public policy objectives.
- Future development of the optimisation procedure should incorporate issues of equity. This means that transport models need to output values for appropriate indicators.
- A comprehensive assessment of the consequences of private sector operation of public transport is required.

PROJECT WEB PAGE: http://www.its.leeds.ac.uk/projects/pastpres.html

FISCUS:

Cost evaluation and financing schemes for urban transport systems

KEY RESULTS

FISCUS has produced a handbook giving practical guidelines on evaluating the costs of urban mobility and selecting ways to finance it. This is intended particularly for policy-makers, planners and the managers of operating companies. The handbook covers two main issues: who pays for what, and who puts up the money (e.g. for new investments).

Seven types of cost are addressed, i.e. those associated with infrastructure, vehicle-related operations, congestion, accidents, emissions, noise and other external effects. The reader is given a step-by-step method of estimating these costs for their own city, with worked examples. Given that the availability of data may vary from city to city, the

Project acronym and title	Key results and policy implications

handbook offers two levels of assessment with different data input requirements (light and full). The results show the extent to which users bear the costs they cause – whether full costs, external costs (such as environmental damage) or variable costs.

FISCUS reported evidence that existing pricing mechanisms and levels are failing to provide appropriate signals to influence behaviour. For example, prices need to show greater differentiation according to the time of day and current traffic levels. Also, existing financing mechanisms (which typically rely on user charges and public budgets) are often not providing sufficient funding for the infrastructure and services that would support an optimal mix of traffic. Therefore the relative merits of new mechanisms such as private finance, value capture (such as taxing land values that benefit from transport infrastructure investment) and cross funding (e.g. from private to public transport) are explained.

FISCUS identified three financing *packages* for consideration, each combining various pricing mechanisms and sources of finance. The circumstances in which each package might work well are described.

- One is based on electronic road pricing, parking/cordon charges and public transport tariffs all being differentiated by time of day, with public budgets providing subsidies and capital as necessary.
- Another is again based on differentiated charges, but with private finance and value capture.
- The third is based on making each mode commercially viable, with no subsidies or cross financing.

The first two packages are given preference (against criteria of economic efficiency, acceptability and practical feasibility), with the choice depending primarily on the adequacy of funds for investing in the transport system.

POLICY IMPLICATIONS

The FISCUS handbook aims to provide practical support for both long-term mobility planning and short-term operational decisions. By promoting the harmonisation of the knowledge base for policy decisions across Europe, it should increase efficiency and fair competition between operators and modes.

Electronic road pricing is often seen as the most powerful way of implementing efficient pricing. However, this will not necessarily be the most cost-effective or practical solution in many situations. Therefore FISCUS gives advice on simpler pricing solutions (such as parking and cordon charges), depending on city characteristics such as size, severity of environmental problems and the financial position of public transport.

FISCUS concluded that there will be many cases where marginal cost pricing leaves a need for additional funding. In most cases a mix of financing measures will be required, and FISCUS gives advice on when each mechanism is most likely to be appropriate. Public funding is seen as having many attractions, but may not provide adequate resources for investment, in which case a mix of private sector funding and simple approaches to value capture are recommended.

ICE ROUTES:	***KEY RESULTS***
The ice routes project	ICE ROUTES has demonstrated the feasibility of an ice routing tool that would provide safer and more efficient ship transport in ice-infested sea regions. The project has produced:

- an analysis of current ice charting and ship routing in the Northern Sea Route, which

Project acronym and title	Key results and policy implications

relies on manually interpreting sea ice conditions and the characteristics of icebreakers and convoy ships. This task included analysis of helicopter ice reconnaissance and high resolution Synthetic Aperture Radar (SAR) images used for tactical navigation

- a computer program called FRAM to identify and optimise vessel routes in ice-infested sea by calculating a set of alternative routes and selecting the most appropriate for specified preferences related to cost or time effectiveness; FRAM is a prototype which is not capable of covering all aspects necessary for commercial application, but which demonstrates the principal possibilities and advantages of the automatic solution
- two ice charting concepts, i.e. the Fuzzy Expert System (FES) and Neural Networks (NN), that build on artificial intelligence to deliver satellite-based information for practical ship routing without the need for human image interpretation, which is found to be very time consuming, demanding and subject to ambiguity

POLICY IMPLICATIONS

The study has identified a feasible approach for short-term operational use that will build on a combination of computer-based, automatically generated ice information and manual interpretation of results by skilled experts. All recommendations aim at further advancing ship route modelling techniques, taking into account the foreseen International Polar Code of Navigation, which will ensure a consistent strategy for improving safety, efficiency and overall capability of maritime navigation in European and Russian arctic waters.

ISOTOPE:

Improved structure and organization for urban transport operations of passengers in Europe

KEY RESULTS

ISOTOPE concluded that:

- the initiative for creating and specifying the urban public transport (UPT) network should rest with local authorities – a fully deregulated system was found not to address collective goals and system integration in an adequate way;
- network design should be under the control of the administrative authority, although the design work may be contracted out;
- a UPT authority must include representation from the communities directly affected by the UPT system;
- traffic management and parking should be controlled by the same authority as UPT, in order to integrate the management of urban mobility;
- a regime of "limited competition" (where authorities define the transport product to be delivered and invite tenders for its execution by candidate operators) is to be preferred over full regulation (monopoly supply) or full deregulation;
- in order to tackle urban mobility problems, partnerships between operators and authorities should be established that include clear definitions of standards of service and responsibilities.

Overall, the project found support for the Citizens' Network (EC Green Paper) preference for some form of limited competition. Various forms of contract appropriate to this regime were identified, with special consideration to the case of rail-based systems. ISOTOPE concluded that reductions in unit operating costs of around 15% are feasible over fully regulated operations, even with no redundancies or wage reductions.

POLICY IMPLICATIONS

The project presents limited competition as a preferred regime. However, it is acknowledged that transition costs are significant.

Project acronym and title	Key results and policy implications
	Policy goals like fare integration, concessionary fares and employment of minorities can be accommodated within the tender conditions of limited competition. Improved access to development areas, congestion and pollution issues can be handled by retaining public control of network design. Any move to comprehensive competitive tendering would require improved data collection, to enable value for money to be assessed in the use of taxpayers' money.
LIBERAIL:	***KEY RESULTS***
Liberalised and interoperable railways	Liberalisation of the transport market, which is a key objective of the EU, is hindered by the historical management of national networks and by high costs of infrastructure investments. The implementation of the EC Directives that have introduced flexibility in the rail sector (EC 91/440, 95/18 and 95/19) is far from complete. The LIBERAIL project aimed to assess the experiences of liberalisation of the infrastructure use and propose improvements. The state of the level of implementation of the EC Directives in the various Member States has been assessed. In particular, the financing of interoperability has been identified as a "brake" in the liberalisation process. According to their approach to implementation, EU countries have been grouped into four scenarios: • "the wise state and lean railway" (Sweden, The Netherlands and Portugal) • "rail unbundling and privatisation" (United Kingdom) • "the vertically integrated commercially oriented railways holding" (Austria, Belgium, Finland, France, Greece, Ireland, Italy and Spain) • "commercialisation of public utility and third party access" (Germany). Common to all scenarios is the replacement of general subsidisation by contractualisation and the transfer of public service obligation to regional and local authorities. LIBERAIL has suggested three tools for calculating rail capacity: • schedule building on line sections or divisions; • simulation to assess the network effects • identification of long-distance paths that meet predefined quality and priority rules. The project has also recommended the harmonisation of the calculation methods of full and marginal costs together with the explicit statement of the perimeter and contents of the infrastructure manager real estate and core activities. Proposals have been: • each cost component should have an identified status, some components being reflected in the final price entirely and others partially, • a geographical solution consisting in a full recovery for some sections and a variable one for others according to the strategic value of each section. ***POLICY IMPLICATIONS*** One of the keys to further progress in implementing the EC Directives is to ensure that competition works on a similar basis for all, to avoid "cherry picking" and to mitigate the feared social impacts of liberalisation. Until now, only very few countries have adapted their regulations and corresponding bodies in this direction. In addition, authorities should prevent misuses such as prohibitive pricing or dumping. New Directives should include guidelines for railway reforms and common operational, managerial, and performance indicators, so as to enable benchmarking.

Project acronym and title	Key results and policy implications
	Under the present circumstances in many countries the overall costs of the infrastructure cannot be fully raised within the railway system itself. At least during a transition period, the infrastructure manager has to be compensated as long as the capabilities of operators to pay is below the real costs of the infrastructure. As investment for railway infrastructure has to compete with all other state expenditure, effective long-term planning has to be ensured by statutory policies. The price instrument can be used by public authorities to influence transport policies as well as external consequences on the environment and on regional development. The following items should be addressed in more detail by new Directive and clarification and direction provided: • tasks, obligations and responsibilities to guarantee safety applying to the different parties; • different treatment of passenger and freight transport; • length of the periods of exclusive rights assignment; • cost basis for charging, as short-term marginal costs hampers privately-owned infrastructure managers to ensure the long-term existence of their network and requires subsidies; • basis for short-term and long-term marginal cost definition; • path allocation procedure in relation to parental rights and in relation to route categorisation in turn linked to the value of the service offered; • ensuring network integration and environmental and social policy objectives.
MAICA: **Modelling and analysis of the impact of changes in ATM**	***KEY RESULTS*** MAICA addressed four new concepts: • the autonomous aircraft; • the dynamic sectorisation; • the future aviation surveillance system (FASS); • the required navigation performance (RNP-1). The four sets of simulations have confirmed the operational interests of the selected changes, providing a first quantitative assessment of their impacts on system capacity and efficiency, or validating their applicability to the European Civil Aviation Conference (ECAC) airspace. The performance criteria addressed include airspace capacity, control capacity, airport capacity, fuel consumption, time of flight, fleet utilisation and flexibility. All concepts showed positive effects on capacity. ***POLICY IMPLICATIONS*** The simulation assumptions and results also led to the statement of important recommendations on the implementation of these changes, and to the identification of the main blocking points which will have to be investigated in future studies to remove some uncertainties on the feasibility, acceptability and impact of new concepts. Moreover MAICA has permitted the development or enhancement of simulation tools which will be useful for future studies, on the same changes or for other purposes which have been identified. It has also enabled to establish interfaces between existing and new software to build genuine simulation chains allowing to study complex phenomena. Finally it has provided interesting ideas for the future developments of these tools.

Project acronym and title	Key results and policy implications
MASSOP: **Assessment and development of new concepts for management structures of ship owners and ship operators**	***KEY RESULTS*** The aim of MASSOP was to promote workable new organisational structures for the shipping industry, as an alternative to the traditional "command and control" hierarchy commonly in use. Based on a survey of over 950 members of the Baltic and International Maritime Council (representing a significant proportion of world shipping companies), MASSOP developed recommendations in the following areas: • improved processes for running ships and managing business operations; • risk management procedures; • the use of information systems, particularly web-based applications and systems to help implement the International Safety Management Code; • improved communications and teamwork; • improved training systems and actions to increase staff recruitment. MASSOP defined a system for developing a "learning organisation" within a shipping company, to increase the ability to adapt to new technologies, management concepts and regulations. This includes actions for the short, medium and long term, together with a syllabus for in-house courses. The project estimated that new structures for seaboard management could produce overall cost savings of up to 25%, partly through reduced manning levels and partly through the use of information technology. The project developed a periodic newsletter, providing guidance for more than 1500 companies and individuals. This newsletter is expected to continue into the future. ***POLICY IMPLICATIONS*** The project highlighted the impact of the International Safety Management Code on maritime operations, aimed at creating a safety culture and allowing ships to trade world-wide under a single set of safety regulations. Many seafarers consider that the documentation for the Code has been "dumped" on them, without any opportunity to participate in the preparation of procedures or to provide feedback on its implementation. The recommended solution is to open up channels of communication and promote seminars to look at experiences. The sheer volume of regulatory matters was found to influence management structures. Improved means of providing advice on new regulations and their implementation are needed, particularly to support management in small companies. As part of a strategy to increase recruitment of manpower, MASSOP noted the need for agreement on a common structure for certification of European ships' officers. In addition, certification and operating procedures should support more flexible multi-skilled manning.
MINIMISE: **Managing interoperability by improvements in transport system organisation in Europe**	***KEY RESULTS*** MINIMISE identified impediments to interoperability in the European transport system, and evaluated the costs and benefits of changes and policy actions that would improve interoperability and economic efficiency. The project generated detailed case studies and policy recommendations for seven (trans-European) transport applications: parcel services, road freight, rail transport, waterborne transport, intermodal transport, air transport, and urban/inter-urban public transport.

Project acronym and title	Key results and policy implications

Cost-benefit evaluations were produced for individual measures to improve interoperability (such as improved border control facilities, harmonisation of regulations and investment in Electronic Data Interchange). In a second step, benefit/cost ratios were assessed for packages of policy measures:

- 26 (of 28) measures were shown to have a positive benefit/cost ratio;
- 19 measures would require little public investment;
- 21 measures have a benefit/cost ratio greater than 20;
- 17 of the measures would give significant reductions in environmental impacts;
- only 14 measures would provide benefits for both the consumers and the service providers.

POLICY IMPLICATIONS

The project made recommendations for actions by the European Commission in the following areas:

- stimulating the use of telematics;
- stimulating the increased use of modern transport equipment;
- promoting improved interconnectivity and interoperability of transport networks;
- harmonising organisational structures;
- harmonising regulatory frameworks.

Specific policy recommendations included:

- for *parcel services*, further liberalisation of the letter market, simplification of border crossing procedures, and abolition of regulatory requirements for documentation of parcels in some Member States;
- for *road freight*, funding the faster introduction of information technology, investing in border crossing facilities with Eastern Europe, and reform of regulatory controls on vehicle operations;
- for *rail transport*, applying a competition regime (e.g. concerning State Aid and market organisation) that creates an efficient single market;
- for *waterborne transport*, promoting the use of information technology, reducing and harmonising customs paperwork, and harmonising port and customs operating practices while minimising restrictive labour regulations and practices;
- for *intermodal transport*, setting up a competitive and non-discriminatory process for the management of infrastructure (such as rail freight freeways) and for the allocation of scarce capacity;
- for *air transport*, improving the systems for pricing the use of infrastructure and for slot allocation, improving air traffic control, and collecting more extensive statistical data to support policy development;
- for *public transport*, encouraging deregulation through franchising of routes, and promoting the appointment of transport authorities to manage through-ticketing structures and the use of smartcard ticketing.

OPTIMA:

Optimisation of policies for transport integration in metropolitan areas

KEY RESULTS

Optimal city transport strategies involve a combination of measures. Also, there is no single best measure or strategy for general application. Nevertheless, some general recommendations can be drawn:

- *economically efficient* strategies can be expected to include low cost improvements to road capacity, improvements in public transport (increased service levels or reductions in fares), and increases in the cost of car use (either road pricing or increased parking charges);
- public transport infrastructure investment is not likely, in most cases, to be a key element in these strategies;
- reductions in capacity to discourage car use are not likely to be economically

Project acronym and title	Key results and policy implications

efficient;

- the optimal changes in service levels and fares for public transport will depend on the current level of subsidy - in some cases a reduction in service levels or an increase in fares may be justified on economic grounds;
- the optimal increase in costs of car use will depend in part on current levels of congestion;
- in most cases, economically efficient strategies can be designed which are financially feasible, provided that revenues can be used to finance other strategy elements;
- the pursuit of *sustainability* (rather than pre economic efficiency) is likely to justify investment in public transport infrastructure, further improvements to public transport services and/or fares, and further increases in the cost of car use;
- availability of finance will be a major barrier to implementation of many sustainability-optimal strategies.

POLICY IMPLICATIONS

The main implications are:

- legislation will be needed to enable implementation of road pricing and to control parking charges; in the UK and Italy there is also a case for changing legislation to permit economically more efficient public transport strategies;
- public acceptability will be a significant barrier with those measures which reduce service levels or increase costs - this implies the need for effective public relations campaigns, and carefully designed implementation programmes;
- detailed local measures to improve the environment and provide better facilities for cyclists, pedestrians and disabled people should be determined once the optimal strategy has been defined at a more aggregate level.

PAV-ECO:

Economic evaluation of pavement maintenance and life-cycle cost at project and network level

The final results of this project were not available when this Thematic Paper was prepared.

PROJECT WEB-PAGES:
http://lavocwww.epfl.ch/ProjetsEuropeens/pav-eco/default.htm
http://civ-hrg.bham.ac.uk/rimes/

PETS:

Pricing European transport systems

KEY RESULTS

The main objectives of PETS were:

- to report on the current pricing situation of passenger and freight transport in Member States;
- to assess whether such prices provide appropriate price signals in the light of all relevant internal and external costs;
- to forecast the consequences of moving to a more appropriate price level and structure in the face of external constraints and developments.

Through case studies on five transport corridors, PETS has shown that a practical methodology to calculate marginal social cost (the basis for efficient pricing policies) for all modes does exist, although many of the valuations remain subject to considerable uncertainty.

The case studies covered cross-Channel passenger and freight, Transalpine freight, Finnish passenger and freight, Tagus passenger crossing and Oslo-Gothenburg passenger traffic. Four pricing scenarios were used, comparing current pricing with “pure”

Project acronym and title	Key results and policy implications

marginal cost pricing and "full" cost recovery from users.

PETS also demonstrated that a purely commercial approach to transport pricing is not appropriate and may push prices in the wrong direction. However, the effects of moving to a more efficient pricing system are likely to be diverse, depending on the national context and the current level of prices and subsidies. Thus it is not universally true that the more environmentally friendly modes would uniformly benefit at the expense of other modes.

For instance, the current price of inter-urban car travel is estimated to be too high relative to the marginal social cost in 2010, partly as a result of tighter vehicle emissions regulations. On the other hand, PETS confirmed the case for urban road pricing in congested cities. Similarly whilst there is generally a case for lower prices for public transport (bus, rail and air), in some places existing subsidies are already excessive. A substantial switching of trips onto public transport is justified only in the urban case, with a reduction of car traffic of up to 40% and a similar percentage increase in public transport.

In the case of road freight, long-distance freight is generally under-charged (with the exception of the Transalpine corridors through Switzerland), because taxes do not increase sufficiently with vehicle weight and distance travelled. For the cross-Channel services, the existing charges for Le Shuttle (for both passengers and freight) are significantly above the marginal cost-based charges that would maximise economic efficiency.

The modelling results also indicated that further extension of deregulation might not necessarily benefit rail transport in terms of the relative pricing compared with other modes, reflecting the different starting points in terms of pricing policies and subsidies between the modes.

POLICY IMPLICATIONS

The evidence from PETS demolishes the argument that marginal cost pricing cannot be implemented in practice because such prices cannot be measured. However, this does not mean that all the relevant agencies currently possess the information and ability to estimate marginal social cost, so further efforts will be needed on disseminating the methodology. In addition, further research is needed, for instance to refine the estimates of external costs and the estimation of prices on a countrywide basis.

One of the critical conclusions is that the appropriate level of charges is *strongly* dependent on the *local* context. Current charges can be too high in sparsely populated regions with limited traffic, and too low in busier areas.

PETS concluded that there is a clear case for reform of road freight vehicle taxation, to introduce a charge based both on vehicle characteristics and distance travelled.

POSSUM:

KEY RESULTS

Policy scenarios for sustainable mobility

POSSUM developed so-called policy paths (comprising packages of policy measures) linking Images of the Future in 2020 to the present day. The project showed that this methodology provides an effective means of establishing options for transport development in relation to developments in society.

Three Images were prepared, involving different combinations of technological innovation and decoupling of transport growth from economic growth. POSSUM then applied "backcasting" techniques to work backwards from the desirable future end-states

Project acronym and title	Key results and policy implications

to determine feasible means of achieving those outcomes. In this way, POSSUM provided a set of policy scenarios for the European transport system through to the year 2020 that could meet CTP objectives for economic efficiency, regional development and environmental protection. The scenarios explore alternative social and political developments outside the transport sector, and show what transport policies would then deliver the targeted outcomes. In particular, the relative roles of technology and reductions in the transport intensity of the economy are described.

The project identified a number of early policy actions that would be appropriate across all scenarios:

- Tax reform – a shift of the tax base from labour to the use of natural resources in order to strengthen incentives for dematerialization and energy conservation.
- Experiments with low emission zones – providing an incentive for the market to select clean vehicle technologies.
- Tele-commuting – experimenting with tele-working options in conjunction with land-use planning.
- Road pricing – taxation on the use of congested urban roads, coupled with measures that provide alternatives (such as quality public transport).
- Actions to provide integrated information systems.

Stakeholder consultations indicated that scenario building does generate innovative thinking on longer-term transport issues.

POLICY IMPLICATIONS

POSSUM characterised the CTP as facing large uncertainty with high potential impact. In this situation, the appropriate strategy is to proceed in small steps with frequent re-evaluations. It is also preferable to try several solutions in order to learn – the role of public policy is then to set targets that promote innovation and selection through market forces.

The main policy conclusions were:

- Both new technologies *and* the decoupling of transport growth from economic growth are needed to achieve sustainability targets.
- For technological innovation, action is needed at the European level to build consensus and provide incentives for rapid movement along clear technology trajectories. Support for innovation may need to precede open market developments.
- The CTP must be complemented by measures outside the transport sector (such as tax reform, regulation of information technology, and land-use planning).
- Those measures that have a long lead time (e.g. aimed at changes in behaviour) must start early.
- Measures should be adapted to local conditions where uniform national or European policies would be inefficient.
- The Trans European Networks must form part of an integrated transport strategy, such that they do not simply encourage more travel overall.
- The growth in air travel and the increased demand for leisure activities (e.g. from an ageing population) will act as other major constraints on the achievement of sustainable mobility targets.

PRORATA:	***KEY RESULTS***
Profitability of rail transport and adaptability of railways	The aim of the project was to propose measures to increase the competitiveness of railways in long-distance and international traffic. In particular the project aimed to identify existing and new marketing strategies for rail and to develop practical action plans for implementation.

Project acronym and title	**Key results and policy implications**
	The project has developed a methodology to analyse the current situation of a railway and to select an optimal path towards greater commercial relevance in the transport market place and towards enhanced profitability. The PRORATA methodology involves the identification of product, marketing and organisational concepts. The starting point of the methodology is benchmarking. PRORATA has presented a sample set of comparative performance measures that give an indication of the areas of operational and financial concern in the railway performance. A relationship between profitability and efficiency on the one hand and the institutional framework, represented by the railway adaptability, on the other has been identified. The adaptability has been defined in terms of power and accountability, provided that an organisation cannot adapt if it does not have the power to do so and if it is not accountable for its performance. Two main categories of concepts to make rail a more competitive mode have been identified: • generic concepts which can be introduced irrespective of organisational structure or institutional framework (e.g. total quality management), and • strategic concepts which are associated with changes in organisational structure or institutional framework. The practical applicability of the PRORATA methodology has been demonstrated in case studies. These have shown the selection and successful application of concepts that the PRORATA methodology would have recommended. ***POLICY IMPLICATIONS*** The demonstrated relationship between efficiency and adaptability implies that it is possible to make efficiency gains by increasing railway power to change and accountability. The proposed methodology draws on best practice from across the rail sector and is therefore recommended. Moreover, as the case studies have shown, a more rigorous application of the methodology could bring about additional efficiency gains. The methodology involves process re-engineering and includes change management and implementation advice. The appropriateness and likelihood to succeed of the different concepts suggested will be depending on the railway current level of efficiency and adaptability and the political, social and economic context in which it operates. Priority should be given to developing an overall strategy in which each of the concepts then fit. The following recommendations have been made: • to improve the comparability of corporate data on EU railways and update benchmarking, • to add econometric analysis of market and revenue benefits from restructuring, • to apply the method to freight and urban railway, and • to expand the adaptability analysis to other sectors (e.g. power and telecoms).
QUITS:	***KEY RESULTS***
Quality indicators for transport systems	Decision-making on mode, technology and journey choices will be improved if all costs are taken into account - for a single journey, this means the direct costs (e.g. fuel and highway tolls), the value of travel time, and the external costs (e.g. air pollution and

Project acronym and title	Key results and policy implications

climate change). QUITS has demonstrated the viability of making a detailed bottom-up assessment of a wide range of such cost factors specific to individual journeys/routes, for different modes of transport, trip purposes, desired times of arrival and expected lengths of stay at destination. The QUITS methodology focuses on modal comparison, and therefore is useful for benchmarking purposes.

Case study calculations showed substantial reductions in external costs (due to air pollution, global warming, noise and accidents) for rail compared to road transport on selected major European routes. This applied to both passenger and goods transport, with savings of 50% or more. The total external costs for road transport on selected major European routes lay in the range 20-45 Euro per 1000 passenger/tonne-kilometres. The relative importance of each cost category varied with mode and route.

The bottom-up approach has provided far greater accuracy than previous top-down approaches, but includes the risk that the data collection effort could exceed the potential benefits. To overcome this issue, an intermediate approach is recommended, where "typical" values are identified for clusters of routes with similar characteristics and then used to generalise cost valuation on all routes.

POLICY IMPLICATIONS

The ability to value external costs is an essential prerequisite to the use of pricing measures to control environmental damage (as foreseen in the EC Green Paper "Towards Fair and Efficient Pricing in Transport"). QUITS has demonstrated the feasibility of evaluating external costs for journeys along specific routes, as part of the research base for the implementation of economically-efficient pricing measures in the European transport sector. However, the project has also identified the need for further research - both on the valuation methods used, and on the generalisation of the methodology for simplified application to other journeys. For example, the evaluation of *perceived* quality and security requires development work.

RECONNECT:

Reducing congestion by introducing new concepts of transport

KEY RESULTS

RECONNECT aimed to identify and assess new means of transport that have potential to ease congestion, including their feasibility, suitable areas of application, impacts and needs for policy intervention.

The project provided a structured overview of the potential of new transport concepts, with a particular focus on innovative concepts that are already significantly advanced (such as elevated public transport, underground freight systems and airships). Some 100 concepts were surveyed, and 21 concepts were selected for comparative assessment (as representatives of classes of new means of transport).

High capacity elevated passenger transport systems (such as the H-Bahn Dortmund and the Wuppertaler Schwebebahn) offer good potential for reducing congestion in urban environments, as the backbone of the public transport system. Nevertheless, the infrastructure needs and total costs are high. Guided and road-based people movers are seen as complementary solutions for feeder and shuttle services.

Underground concepts (such as the Underground Logistics System proposed in Amsterdam) provide an efficient means of freight distribution. They rely on automated and driver-less electric vehicles that run in tunnels. Again, infrastructure costs are fairly high, but can be reduced using new small-bore tunnelling technologies.

Finally, airships are promising for point-to-point operations in both passenger and freight transport, and their costs are not particularly high. For example, the CargoLifter allows

Project acronym and title	Key results and policy implications

bulky and heavy items to be taken to the final destination, replacing a whole shipment chain. Other versatile airships may contribute to traveller intermodality in remote regions.

Financial and commercial hurdles pose the biggest obstacle, particularly for public transport. However, tailor-made transport services such as airships are proving more attractive to private investors. Regulatory barriers are also significant, particularly for automated and driver-less concepts.

POLICY IMPLICATIONS

To overcome the barriers to market penetration, the priority is to make "seed" funding available. Public-private partnerships are seen as one way forward on this. Regulatory barriers need stakeholder consultation at an early stage, and would benefit from Government agencies (such as strategic rail authorities) being assigned responsibility to tackle the legal issues.

Further RTD is needed to reduce uncertainties and technology costs. Important areas for research are:

- vehicle automation and guidance systems, communications and control systems;
- development of standards (e.g. for the safety requirements for new vehicle concepts);
- in-depth assessment of the environmental, noise and safety impacts of new concepts;
- the development of technologies for underground infrastructure (ground exploration, tunnel driving, tunnel lining and standardisation of dimensions).

RECONNECT proposed that demonstration projects be funded for the most promising ground level concepts ready for market introduction in the near future: road-based people movers, on-demand rental cars (like Praxitele), automated vehicle guidance for cars on public roads, and man-wide cars.

PROJECT WEB PAGE: http://www.etsu.co.uk/reconnect/reconnect.html

REDEFINE:

KEY RESULTS

Relationship between demand for freight transport and industrial effects

REDEFINE aimed to model and quantify the factors relating changes in the structure of industry and supply chain logistics to changes in road freight demand.

The project examined the economic, trade and freight transport data of France, Germany, the Netherlands, Sweden and the United Kingdom for the period 1985-1995. The relationship between the value of produced and imported goods and the consequent vehicle kilometres was shown to be complex, with different behaviour in different countries and between different types of commodity. *Simple* explanations, such as ascribing traffic growth to the increase in Just-In-Time production, were shown not to be valid – multiple factors have to be considered. An increase in the average length of haul (typically 20-40%) was identified as the single most important contributor to increased road freight demand.

Forecasts were prepared for the growth in road freight from 1995 to 2005 for the sectors of agricultural products, food and drink, building materials, and transport equipment. In a majority of cases, tonne-kilometres are expected to grow faster than production, but vehicle-kilometre activity will show a similar growth path to production. Sweden is the exception, requiring fewer vehicle-kilometres per unit of production as time progresses.

The marginal costs of congestion due to increased freight traffic are expected to increase by nearly 50% over the forecasting period. CO_2 emissions will follow the growth in

Project acronym and title	Key results and policy implications

vehicle kilometres, while regulated pollutants such as NO_x will decrease dramatically as cleaner vehicles are introduced.

POLICY IMPLICATIONS

REDEFINE assessed policy measures aimed at reducing transport intensity (i.e. the amount of transport needed per unit of production), shifting freight between modes, increasing the efficiency of transport organisation, making better use of vehicles, and using better vehicles and fuels. The following measures were found to be highly effective in almost all supply chains (in descending order of effectiveness):

- Introduce on-board measuring and debiting for emissions.
- Increase fuel tax generally.
- Introduce an "eco-label" for companies achieving best practice in their logistic operations.
- Introduce tradeable emissions permits.

The following measures were evaluated as effective across a significant number of supply chains (again in descending order of effectiveness):

- Introduce road pricing.
- Introduce tradeable vehicle-km permits.
- Introduce congestion pricing.
- Co-ordinate land-use planning and transport planning.
- Encourage the siting of transport-intensive production and logistics activities at suitable locations.
- Standardise load units (intermodal equipment, pallets etc.)
- Introduce annual road prices.
- Increase vehicle tax generally.

SCANDINET:

Promoting integrated transport in peripheral areas of the Union

KEY RESULTS

SCANDINET demonstrated the viability of creating intermodal transport services in peripheral areas and over short distances on a commercial basis. A study of freight flows revealed a number of factors that are important to the success of intermodal freight transport between the Nordic countries and the Continent:

- reasonable intermodal track rates;
- a fair railway slot practice;
- consolidation of flows into fewer terminals and corridors like continental freight freeways;
- correct and relevant information in different phases of the transport chain;
- closer co-operation between intermodal operators.

By identifying and quantifying important service characteristics for both single-mode and intermodal freight transport, SCANDINET showed that a gap exists between the quality of service desired and the quality of services supplied. Ultimately, successful operators will be those who combine assurance in meeting service vector requirements with the lowest price.

POLICY IMPLICATIONS

SCANDINET has demonstrated that there is a need for policy-oriented actions in peripheral areas and over short and medium distances for the development of intermodal freight transport, in spite of small flows, large areas and sparse population in the Scandinavian countries. New fixed links will improve connections from Scandinavia to the European mainland. As all transport from the Nordic countries to continental Europe involves at least one sea leg, port terminals should be considered in all policy measures

Project acronym and title	Key results and policy implications

promoting intermodal transport, because problems arise from incompatibility between ferry and rail terminals. Currently, no port in the Baltic Sea operates a full-size intermodal terminal that is able to handle complete block trains.

Such policy actions will be integrated into the decision by the European Commission to develop short-sea shipping inside the EU (Green Paper, December 1997) and, particularly, with the Nordic countries. From a legislative point of view, the imbalance between transport modes will have to be redressed, either by the re-imposition of certain restrictions on road-freight or via the accelerated liberalisation of the rail sector – probably the best solution will involve a combination of both policies.

SCANDINET recommended that the European Commission should speed up initiatives for improving the collection of statistics on international flows of Intermodal Transport Units, in order to support better targeting of policy action.

SCENARIOS: ***KEY RESULTS***

Scenarios for trans-European network

To support decision-making on transport policy, SCENARIOS developed a "reference scenario" (i.e. the projection of current trends for selected variables for a future horizon year) for the European transport sector for the year 2020. This scenario covers:

- socio-economic variables;
- regional dynamics and spatial elements;
- transport supply and demand;
- transport policy trends (e.g. European liberalisation and harmonisation policies).

For a 2020 horizon, GDP is expected to increase steadily, but population will decline slightly from around 2010, although with significant regional variations. The growth of cities is expected to continue, especially at the periphery.

For passenger transport, anticipated trends are:

- increasing journey lengths, due to improved transport links and urban sprawl;
- increasing car dependency, due to ageing of the population, lifestyle changes and income effects;
- increasing long distance trips, due to globalisation of business and growing demand for international holiday travel.

For freight transport, key influences are:

- globalisation of production and markets;
- networking to rationalise business processes;
- new information and communication technologies;
- "greening" of the business context.

Most of these influences point to an increase in freight transport, especially long-distance trips. Electronic commerce and "green" pressures may slightly reduce the growth rate.

The project also developed projections of the evolution of technologies, not based on trends, but rather on the conditions for their entry to the market. The main conclusions are as follows:

- Intelligent transport systems will have the most significant impact on transport in the year 2020. Their use for traffic and safety regulation will depend on European-wide agreement on standards and financing schemes.
- The contribution of intermodality will be a matter of improved organisation rather than technology, and will depend primarily on the extent of policy support.
- Information technologies (teleservices) are expected to play a key role in society as a whole, but not so much in the transport system. Teleworking and videoconferencing

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may become a substitute for some business traffic, but they may also foster traffic generation by making more time available.

- Magnetic levitation technologies are difficult to finance and environmental concerns are leading to the development of underground solutions. They will not have a significant influence on transport supply in Europe by 2020.
- Autonomous urban transport systems are expected to spread from 2010 onwards. This will follow the standardisation of telematic systems, especially automatic debiting systems, on which they rely heavily for operation.

POLICY IMPLICATIONS

SCENARIOS concluded that, in the current political climate in Europe, the most likely policy measures for transport involve demand regulation and pricing to alter modal shares. Support for public transport infrastructure seems less likely.

SCENARIOS also defined a "European trend policy scenario", assessing the effects of current policies on liberalisation and harmonisation. This policy scenario was applied in the European Commission's pilot Strategic Environmental Assessment of the trans-European transport network. For the road sector, the scenario showed a decrease or no change in costs under liberalisation policy, followed by an increase in costs due to harmonisation measures. For rail, costs will increase under liberalisation but remain stable under harmonisation.

PROJECT WEB PAGE: http://www.inrets.fr/infos/PCRD/4eme_pcrd_mc.html

SCENES:

Modelling and methodology for analysing the interrelationship between external developments and European transport

The final results of this project were not available when this Thematic Paper was prepared.

PROJECT WEB-PAGE: http://www.iww.uni-karlsruhe.de/SCENES/

SESAME:

Derivation of the relationship between land use, behaviour patterns and travel demand for political and investment decisions

KEY RESULTS

SESAME has provided:

- A recommended set of indicators on transport and land-use.
- A sample database of values for those indicators, covering 40 European cities.
- Analysis of the relationships between indicators.
- Recommendations concerning data collection methods and policy measures.

The main findings concerning land-use/transport interactions are as follows:

- *Use of modes*: the car faces strong competition from non-motorised modes, particularly in the city centre and for trips of less than 5 km. Lower population densities and a higher concentration of jobs in sub-centres tend to increase the use of the car relative to public transport. Small cities have a higher share of car use than larger cities
- *Public transport provision*: the level/frequency of service in public transport has a strong effect in increasing patronage and decreasing the use of private cars. The length of public transport lines is not the key issue.
- *Vehicle ownership*: car ownership per household is strongly correlated with car use. A similar relationship holds for bicycle ownership and use.

Project acronym and title	Key results and policy implications

Recommendations about data collection mainly concern availability, harmonisation and zoning:

- Travel demand surveys should be harmonised, should include all age groups, weekend days and the separate transport modes, and should be repeated every five years.
- Data are needed concerning the travel behaviour of people coming from outside the urban area.
- Public transport suppliers should use a single definition for vehicle-kilometres, with a complete tram or train defined as a single vehicle.
- Improved data are needed on parking places.
- Data about the built-up surface should be collected on the basis of a common definition.

POLICY IMPLICATIONS

Provision of new transport infrastructure clearly affects the pattern of travel and therefore urban form. SESAME has shown that the supply of primary road kilometres is associated with a higher share for cars in the modal split. In contrast, cities actively promoting public transport seem to be achieving higher shares for this mode. SESAME has particularly pointed to the benefit of improving service levels, without the need for additional service lines, in encouraging a modal switch. Strategies such as benchmarking and the provision of better information can be effective low-cost measures in this respect.

Cities with parking management and traffic calming policies seem to be associated with lower shares of car use. Cycle promotion policies seem to have had a similar effect in the cities studied.

One of the major outputs of SESAME has been to illustrate the relationship between urban form and mode use. Mode share is especially related to city density, the concentration of urban activities and the concentration of jobs in sub-centres. City planners therefore have a powerful means of influencing mobility through their control of new developments.

PROJECT WEB PAGE: http://www.arttic.com/projects/sesame

SOFTICE:

Survey on freight transport including cost comparison for Europe

KEY RESULTS

SOFTICE had two main goals:

- to identify the factors affecting road freight costs and their interaction with production costs and demand;
- to identify the consequences of different policies for taxation on the freight market.

Survey results showed that drivers' wages are the largest single cost factor (especially for collection/distribution operations), and fuel is the next largest factor (especially in long distance haulage). These factors vary substantially between countries. Total tax costs also vary between countries, ranging from 10% to 25% of the total operating cost of long haulage trucks. For 100km distance, EU prices are between 3 and 8 times higher than in Eastern European countries, but prices are closer for long distance freight. Typically, transport costs account for around 3% of the total costs of industrial production, but with significant variations by industry sector.

Shippers were asked about the expected effects of a reduction in the allowable number of working hours. Less than 10% suggested lower demand and/or modal shift, while around 60% foresaw only cost increases. Case studies suggested that systematic violation of

Project acronym and title	Key results and policy implications

traffic rules could reduce costs per tonne-kilometre by up to 30-40% in some countries.

Feedback from shippers indicated, when faced with policy changes or traffic problems, they are more willing to consider measures like increasing transport prices or changing shipping times than anything to do with modal transfer. The unwillingness to change mode is largely attributed to bad experience with other transport modes, no matter whether that experience has been directly suffered or just reported by other companies.

POLICY IMPLICATIONS

The analysis of cost factors shows different levels of cost-competitiveness between Member States – but the underlying reasons for this require further study. Uniform changes in taxation across the EU would penalise those countries where the tax burden is already relatively high.

Harmonising the enforcement of regulations such as driving hours, speed limits and maximum loads is important in ensuring fair competition in the EU internal market. In addition, safety and CO_2 improvements would arise.

On average, a 10% increase in total taxation would increase the operating cost of long distance hauliers in the EU by 1.7%. However, the diversity and adaptability of road freight operations generally makes it difficult to produce quantitative estimates of reactions to policy.

SOFTICE found that internalisation of external costs of road transport (environmental damage, infrastructure costs) is increasingly considered as a fair principle and an effective means of fighting congestion. However, the expected magnitude of price increases in inter-urban transport is not such that it will cause major modal transfers – and there is a lack of non-road alternatives for urban freight.

More generally, the project concluded that the application of intensive policy measures to "push" freight off the roads, for example through higher taxation, is insufficient to achieve significant changes in modal split. A strong improvement in efficiency and quality from other modes is necessary in parallel for shippers to consider the scale of modal transfers thought desirable to meet policy goals. This implies changes such as liberalisation of access to the railways. SME's are particularly reluctant to change mode.

SORT-IT:

Strategic organisation and regulation in transport

KEY RESULTS

SORT-IT aimed to develop policy measures addressing the organisation of the European transport system that promote interoperability and economic efficiency. The project carried out 152 interviews with national government departments and major transport companies covering characteristics such as legislation, type of regulation and organisation, type of ownership, market structure, and the reasons for perceived barriers to interoperability and interconnection. It also provided a literature review for the same topics, and used models to assess specific aspects of intermodal transport, e.g. costs and productivity, competition, interoperability and demand.

The project made the following findings and recommendations:

- policies of commercialisation and privatisation should continue to be pursued, particularly in air, rail and express coach operations,
- competition should be promoted particularly through extending cabotage and deregulation in inland waterways, rail and express coach operations;
- deregulation should also be pursued in input markets, including vehicle leasing, labour and ancillary markets such as baggage handling,

Project acronym and title	Key results and policy implications

- with respect to urban and regional transport, tendering/franchising should be promoted rather than head-on competition,
- with respect to rail, horizontal and vertical separation should be considered, along with network re-configuration,
- entry barriers need to be reduced with respect to congested air, sea and rail infrastructure possibly through the use of auctioning systems. Entry requirements (vehicle age limits for example) may need to be tightened in the road freight and waterborne freight industries.

POLICY IMPLICATIONS

SORT-IT concluded that policy priority should be placed on completing the liberalisation of the European transport market, with emphasis on inland waterways, short sea shipping and passenger road transport. Once the strategic reorganisation of the transport market is consolidated, focus should switch to increasing interoperability, interconnection and intermodality, which have already been widely established for the air and road freight sectors.

START:

KEY RESULTS

Development of strategies designed to avoid the need for road travel

START found that the most cost-effective policies to reduce road traffic and deal with congested traffic in cities are based on pricing. Road pricing per kilometre or at a city cordon is favoured, while parking charges have a less direct impact and may not work where there is extensive private off-street parking within the congested area. Subsidies to urban public transport are considerably less effective.

On inter-urban roads, the use of tolls to reduce traffic is more problematic. The dominant response from users is likely to be a diversion to alternative routes rather than a switch to alternative modes or a reduction in the total amount of travel. This is likely to be counter-productive in terms of environmental and congestion costs. In addition, it would create a barrier to the use of private finance in the development of road infrastructure, requiring the public sector to take on the financial risk associated with uncertainties in future traffic levels.

In general, “push” measures to deter the use of vehicles (e.g. fuel taxes) are seen as more effective than “pull” measures (e.g. improving alternative modes). Nevertheless, successful strategies are likely to contain a mixture of both “push” and “pull” measures, with the revenue from the former being used to fund the latter. Experience has also shown that a mix of different types of measure works best – pricing, capacity management, public transport, telecommunications and land use planning.

“Push” measures face problems of public acceptance. However, research has indicated that as people become better informed about the likely cost-effectiveness of ways of dealing with transport problems, their opposition to restraint measures tends to decrease.

The project devised four scenarios of traffic reduction in the short and medium term, identifying packages of measures required to achieve certain economic and environmental objectives. Compared to “do-minimum” and “green” strategies, the best outcome was assessed to result from a strategy based on internalisation of congestion costs and environmental costs by the road user.

Most of the reported travel reductions are only of the order of one or two years’ growth in (unconstrained) demand. Policy actions may still be desirable, but the lesson is that there is no simple strategy that will dramatically affect levels of urban congestion.

Project acronym and title	Key results and policy implications
	POLICY IMPLICATIONS
	The design of packages of measures is the key to success in travel reduction. Evidence suggests that a combination of constraints on vehicle use and provision of attractive alternative modes work well. In addition, land use planning measures are needed to constrain the decentralisation of population and economic activity to locations beyond the area in which the restrictive policies apply. Fuel taxes, vehicle taxes and road pricing need to be co-ordinated so that the right signals are sent to vehicle users in congested areas, while avoiding inefficiently high taxation in uncongested rural areas.
	Within a policy framework that aims to reduce growth in road traffic while maintaining private sector interest in the financing and management of road infrastructure projects, the public sector will need to develop new ways to pay for roads. Otherwise would-be investors will be deterred by the sensitivity of income projections to new traffic reduction initiatives.
	PROJECT WEB PAGE: http://fpiv.meap.co.uk/fpiv/START.htm
STREAMS:	***KEY RESULTS***
Strategic transport research for European Member States	The main goal of STREAMS was to develop a prototype model to predict the demand for transport across the EU and its broad distribution across the transport network. In addition, STREAMS aimed to produce a "reference scenario" for the year 2020, providing an initial forecast for selected transport variables.
	The project developed and validated a model covering all travel within EU Member States and across its borders (all modes, passenger and freight transport, including short trips and walking). There are two main modules – one determines transport demand, and the other assigns the demand to the transport network. The model is disaggregated at the NUTS2 level used in transport statistics, dividing the EU into some 200 zones and thousands of links representing physical connections and terminals (such as roads and airports). The model is therefore suitable for forecasting *aggregate* transport statistics for the EU as a whole.
	The model was calibrated for a base year of 1994. The resulting output data were shown to match well with various sets of "observed" transport statistics. Projections for 2020 were reasonably comparable with those from other smaller-scale models.
	The reference scenario for 2020 gave the following key results for passenger transport: • an increase in passenger-kilometres of 50% from 1994 levels, due to increases in trip distances (primarily) and in the number of trips; • a 5% overall increase in the modal share of the car (e.g. due to increases in business, shopping and leisure trips), largely at the expense of walking and cycling; • significant increases in the modal shares of rail and air for longer trips.
	For freight, the 2020 projection indicated: • a doubling of freight tonne-km, and a 60% increase in tonnage moved, with the greatest increases in the international sector (especially exports/imports to the EU); • only minor changes in overall modal shares, with trucks gaining share in the intra-EU freight market but losing share to rail transport in the international market.
	The STREAMS model can make rough estimates of the proportion of the road network that is congested. Between 1994 and 2020, the number of kilometres of "overloaded" links is predicted to double to 9% of the network.

Project acronym and title	Key results and policy implications
	POLICY IMPLICATIONS
	The STREAMS model has been used by the European Commission to produce traffic forecasts for the whole of the European Union, as part of a pilot Strategic Environmental Assessment of the Trans-European Transport Network. The model has since been developed further in the SCENES project.
	The model is best suited to applications which require an overview forecast of transport in the EU or Member States as a whole. For example, it can be used to look at policies aimed at modal shift and demand management, or the impacts of socio-economic change. On the other hand, it is less well suited to studying local policy options or assessing the effect of a particular piece of infrastructure.
	PROJECT WEB PAGE: http://fpiv.meap.co.uk/fpiv/streams3.htm
TENASSESS:	***KEY RESULTS***
Policy assessment of TEN and Common Transport Policy	TENASSESS had two main objectives: • to characterise policy processes and identify implications for decision-making on the Trans-European Transport Networks (TEN-T) and the Common Transport Policy (CTP); • to develop and test decision support tools.
	TENASSESS found that many of the problems with CTP development relate to the variation in policy processes between Member States. The following aspects have specific importance: • the distribution of responsibility between national and lower levels; • the extent of master planning and evaluation frameworks for transport; • the degree of stakeholder (including public) involvement in decision processes.
	This leads particularly to conflicts over the relative role of European, national, regional and local levels, the trade-off between economic and environmental objectives, and the rate of deregulation and restructuring of the transport market.
	A policy assessment model has been developed for assessing the effectiveness of different policy measures and projects against CTP objectives. The model helps users to make explicit the extent to which an option fulfils stated objectives, and the influence of wider socio-political considerations on an otherwise "objective" decision. The critical feature is a transparent weighting system that shows how different decision-makers rate specific policy objectives and project impacts. The model has been tested and refined on a series of case studies.
	Another software tool has been developed to help anticipate barriers in the *implementation* of transport infrastructure projects and policy initiatives. Through interactive gaming, the user is able to understand where to concentrate efforts to deal with likely problems. The analytical model was based on case study evidence and then tested on further case studies to show that it is robust.
	POLICY IMPLICATIONS
	TENASSESS concluded that the goal of sustainable mobility requires a more integrated approach to transport policy. This can only be realised by organisational reforms – the responsibilities of different political levels need to be clarified, and stronger procedures introduced for strategic co-ordination.

Project acronym and title	Key results and policy implications
	A clearer distinction is needed between policy plans and infrastructure plans. Policy plans should be enhanced to include measurable objectives and performance indicators. Infrastructure plans should show a closer consideration of strategic policy goals, e.g. through the process of Strategic Environmental Assessment. The links between national and European policy plans should be made explicit, so that variations in national strategies can be understood and co-ordinated where appropriate. Mechanisms should be established to make effective the participation of citizens in decision processes on transport policy. Information dissemination and project-specific public enquiries are insufficient to build trust in radical changes. Communication with the public should be entrusted to an organisation that is not involved in the decision process. Many of the barriers in TEN-T and CTP implementation have emerged in the area of financing. TENASSESS recommended that the evaluation of costs and benefits of different options should be separated from the question of how to arrange the funding. Nevertheless the expert appraisal of projects should address these issues in parallel, with input from potential financiers. Where partnerships emerge to share the financial burden, the sharing of risk should be specified alongside the sharing of costs.
TRACE: **Costs of private road travel and their effects on demand, including short and long term elasticities**	***KEY RESULTS*** The aim of TRACE was to provide elasticities that can be used for a first order assessment of the effects of changes in car travel time and car travel cost (including parking charges) on car travel demand and on demand for other modes, for a range of contexts. The project reviewed the available evidence concerning elasticities of private car travel demand, and supplemented this with calculations using national and regional traffic models. The findings were summarised in an Elasticity Handbook, aimed at national and regional authorities in Europe. In addition, a software tool (called TRACER) was developed to provide elasticities for new contexts not covered by existing traffic models. This contains a databank with many thousands of elasticity values (impacts on trips and kilometres, with segmentation by mode, trip purpose, distance class, urbanisation, parking class and public transport quality). Elasticities are provided for both the short and long term. The long term is defined as including the option to change the choice of destination, and not just the mode or distance travelled. Elasticities are defined in terms of three policy variables: the fuel price for cars, travel time by car and car parking charges. Consequently, all other polices to be evaluated have first to be translated in terms of one of these three variables. For example, speed limits can be simulated in terms of their effect on average travel time. TRACE found that almost all elasticities have been derived using some kind of modelling – there are few values that result from direct before and after observation. A 10% change in car travel time was found to have a bigger impact on trips and kilometres travelled than a 10% change in the cost of car travel. The short-term elasticities of distance travelled by car are around 50% of the values for the long run. ***POLICY IMPLICATIONS*** The elasticities presented by TRACE were derived from a finite number of simulations. Assessments based on these elasticities must therefore be considered as first order approximations in discussions on policy options. When a potentially successful policy has been identified using the elasticity approach, it will often be necessary to conduct

Project acronym and title	Key results and policy implications

further studies to take account of specific local circumstances. Nevertheless, the outputs from TRACE provide an effective and user-friendly screening tool.

PROJECT WEB-PAGE: http://www.hcg.nl/projects/trace/trace1.htm

TRANSLAND:

Integration of transport and land-use planning

KEY RESULTS

TRANSLAND had two main objectives:

- to identify examples of (transferable) good practice in combined planning of land-use and transport;
- to advise on planning practice for the future and recommend further research.

A detailed review of 26 case studies and previous research led to the following conclusions:

- Combined land-use and transport policies are only successful in reducing travel distances and the share of car travel if they make car travel less attractive (more expensive or slower).
- Land-use policies to increase urban density or mixed land-use (e.g. locating homes near factories and services) without accompanying measures to discourage car use have only little effect.
- Transport policies to make car travel less attractive depend on trip start and end points not being excessively dispersed already. Co-location of specialist businesses in certain areas and the increase in multiple worker households also set limits on the co-ordination of work places and residences.
- Large dispersed retail and leisure facilities increase the distances travelled by cars and the share of car travel. Land-use policies to prevent the development of such facilities are more effective than land-use policies aimed at promoting high-density mixed-use development.
- Fears that policies to constrain the use of cars in city centres are detrimental to the economic viability of those centres have in no case been confirmed by reality, except where massive out-of-town retail developments have been approved at the same time.
- Transport policies to improve the attractiveness of public transport have in general not led to a major reduction of car travel, but have contributed to further suburbanisation of the population.

POLICY IMPLICATIONS

Overall, TRANSLAND concluded that transport policies are more direct and efficient than land-use planning controls in moving towards a sustainable urban transport system. However, land-use policies are essential as an accompanying strategy for creating less car-dependent cities in the long run. Information policies are an additional tool, important for influencing behaviour and increasing social acceptance of other tougher measures.

The institutional possibilities for co-ordinating land use and transport policies at the urban or regional level vary between EU Member States. Ten countries have formal regional planning with binding plans, and these have the highest potential for implementing effective policies and exchanging examples of good practice.

TRANSLAND identified 16 areas for further study, ranging from the modelling of land use/transport interactions, to target setting and the redesign of the planning process.

PROJECT WEB PAGE: http://www.inro.tno.nl/transland/

Project acronym and title	Key results and policy implications
TRENEN II STRAN: **Models for transport, environment and energy – version 2 – strategic transport policy analysis**	***KEY RESULTS*** Econometric models have been developed which compute optimum prices for transport in specific cities and countries. These prices take account of external costs (such as congestion, pollution, noise and accidents) as well as taxes and resource costs. In a series of case studies, comparisons have been made between current and optimum prices. Typically, the consumer price for using a car in a city in peak periods covers only one third to half of the full marginal social cost. There are two main sources for this discrepancy: unpaid parking and the external costs of congestion. In off-peak periods, prices and social costs are much closer. By comparison, for bus travel, prices are similar to social costs. In an optimal pricing scenario, prices for car travel typically could rise by 100-250% in peak periods, depending on the city context. Current transport taxes in European cities are more or less equal between peak and off-peak. This implies that society would benefit from raising the price of using a car in peak periods. Cordon pricing (for urban access, differentiated between peak and off-peak) combined with charging for parking at resource cost is found to achieve the majority of the theoretical maximum benefit. For inter-urban transport, pricing inefficiencies are generally less significant. Prices of peak period car and truck use do not cover congestion costs. Bus transport is typically heavily subsidised and under-priced. Rail freight and inland waterways have prices that are reasonably in line with social costs. ***POLICY IMPLICATIONS*** The case studies indicate the relative performance of different pricing policy instruments: • *Parking policies*: making all road users pay for the resource cost of their parking place plus an extra charge can be very effective, achieving 1/3 to 2/3 of potential societal benefits and reducing congestion. • *Emissions taxes and standards*: stimulating the use of cleaner cars is important for urban areas, but may not be cost-effective in non-urban areas. • *Fuel tax policies*: higher fuel taxes could reduce car traffic in urban areas and on peak period inter-urban trips. However, other traffic (such as off-peak road freight) may also be unjustifiably inhibited. Fuel taxes are therefore not a good instrument for pricing reform, due to the lack of differentiation between different transport markets. Tax evasion may also result, across international borders and through non cost-effective investment in highly fuel-efficient vehicles. • *Reduced subsidies to public transport*: once the pricing of car transport can be corrected, public transport fares should not be set below the marginal social cost and should differ between peak and off-peak periods. • *Simple congestion pricing*: cordon pricing in urban areas and congestion pricing on inter-urban highways can realise a substantial fraction of the benefits of optimum pricing.