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DG Energy and Transport**

**Specific Support Action  
Transport Research  
Knowledge Centre**

**Thematic Research  
Summary:**

# **Environmental Aspects**

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## Foreword

This paper has been produced as part of the activities of the TRKC (Transport Research Knowledge Centre) project of the Sixth Framework Programme, priority thematic area “Sustainable Development, Global Change and Ecosystems”.

The aim of TRKC, as its predecessor project EXTR@Web, is to collect, structure, analyse and disseminate transport research results. It covers EU-supported research as well as key research activities at the national level in the European Research Area (ERA) and selected global programmes. The main dissemination tool used by TRKC is the web portal at <http://www.transport-research.info/web/index.cfm>.

The approach to dissemination of results of research projects adopted by the TRKC team includes the following three levels of analysis:

- Project Analysis, which provides, project by project, information on research background, objectives, results, technical and policy implications;
- **Thematic Analysis**, which pools findings of research projects according to a classification scheme based on thirty themes, fixed for the project life time; the product of this analysis activity is the set of **Thematic Research Summaries (TRS)**; the present document belongs to this set;
- Policy Analysis, which pools findings of research projects according to combinations of themes based on ad-hoc policy priorities which are agreed with DGTREN of the European Commission and a representative group of research users.

This Thematic Research Summary deals with Environmental Aspects. The aim is to provide the reader with a synthesis of results of completed European and national projects related to the theme of Environmental Aspects. The paper is intended for policy makers at the European, national and local levels, as well as any interested reader from other stakeholders and from the academic and research communities.

### ***Disclaimer and acknowledgement***

The TRKC team is fully responsible for the content of this paper. The content of this paper does not represent the official viewpoint of the European Commission and has not been approved by the coordinators of the research projects reviewed.

The first issue of this TRS paper was externally reviewed by Mr Istvan Ritz of the European Commission.

## Executive Summary

This Thematic Research Summary on the environmental aspects of transport and sustainable mobility aims to provide the reader with a synthesis of results of completed European research projects related to that theme. It consists of two main parts. The first part includes a brief overview of the scope of the theme and summarises the main policy developments at EU level relevant to the theme. The second part contains a synthesis of the main findings and policy implications from research projects and identifies the implications for further research. The research projects for which the synthesis is provided are European (EU-funded and national) projects that are completed and with results publicly available. The EU projects have been funded by the Fourth, Fifth and the Sixth Framework Programmes. Projects that had been reviewed in the related paper produced within the predecessor project EXTR@Web are only briefly summarised in the background section for each sub-theme.

Environmental aspects include all the adverse side effects of transport on the environment, including air and water pollution, noise, vibration, visual impacts, social impacts and waste disposal. The contribution of transport to climate change is also included. Research includes assessment of the severity of these impacts, analysis of mitigation measures and the development of environmentally-friendly technologies and transport concepts.

The environment impact of transport has become fundamental to the development of European transport policy and has been considered in various policy documents such as the White Paper “European transport policy for 2010: time to decide” and the “Mid-term Review of the European Commission’s 2001 White Paper on Transport”. The package of proposals put forward in the White Paper is designed to re-direct the common transport policy towards sustainability. Difficult choices will need to be made between maintaining the status quo and making changes that will result in a sustainable system. Bearing in mind the current insufficient account taken of environmental protection and the need to ensure greater security of supply, environmental considerations need to be integrated into Community policies. Environmental aspects feature prominently in transport fiscal policy in the White Paper, which states that the internalisation of external costs must encourage the use of modes of lesser environmental impact. There is considerable and justifiable emphasis in the White Paper on issues relating to air transport, given the rapid current expansion of this mode. Shifting freight from road to rail is also advocated, and particularly for freight there is also considerable emphasis on the scope for water transport possibilities where current capacity is largely underutilised. Within each mode, the development of alternative fuels and environmentally friendly vehicles as well as infrastructure is advocated. More recently, the general context of EU transport policy

established in the 2001 Transport White Paper has changed. To be able to adapt the instruments of the 2001 White Paper to the new context, the European Commission has identified the need for additional policy tools to help ensure that these changes can be achieved.

Three sub-themes are considered in the synthesis of the findings from research projects.

The first sub-theme relates to the **assessment of the environmental impacts associated with transport**. A wide range of methodologies has been developed and tested for such assessment, often based on Cost-Benefit Analysis (CBA) or Multi-Criteria Analysis (MCA), and many have been implemented as tools available to other analysts and researchers. Such tools are often spreadsheet based and increasingly available online. The costs imposed on society by the environmental impacts are typically shown to be high but vary significantly depending on mode, on circumstance and by location. Global warming is identified as an increasingly severe problem.

The second sub-theme is concerned with reviewing potential strategies for the **mitigation and abatement of environmental problems**. The key finding from research in this field is that such mitigation requires not only significant research and development of new transport technologies, but also considerable changes in operating practices in the transport industry as well as changes in transport behaviour, both in the shorter term through mode switching and in the longer term, such as through changes in land-use planning.

The final sub-theme reviews research into the development, encouragement and use of **more environment-friendly forms of transport**. Findings highlight the need for more research into new environment-friendly transport technologies, across all modes. In addition, innovations such as car sharing or car pooling schemes can help to reduce environmental impacts, and there is also considerable scope for greater use of non-motorised modes of transport (walking and cycling), especially in urban areas.

The implications of research findings for policymaking and future research activities have also been considered.





## Acronyms

CBA	Cost-Benefit Analysis
CEC	Commission of the European Communities (= EC)
CO <sub>2</sub>	Carbon Dioxide
DfT	(UK) Department for Transport
DGMOVE	Directorate General for Mobility and Transport (European Commission DG from 2010)
DGTREN	Directorate General Transport and Energy (European Commission DG up to end of 2009)
EC	European Commission (= CEC)
EEA	European Environment Agency
EIA	Environmental Impact Assessment
ERA	European Research Area (EU, EFTA and CEECs)
EU	European Union
EXTR@Web	Exploitation of Transport Research Results via the Web (DG TREN FP 5 Accompanying Measure project, predecessor to TRKC)
FP5	Fifth Framework Programme
FP6	Sixth Framework Programme
FSEA	Formal Safety and Environmental Assessment
GDP	Gross Domestic Product
GIS	Geographical Information System
HGV	Heavy Goods Vehicle
ICT	Information and Communication Technologies
ITS	Intelligent Transport Systems
JEGTE	Joint Expert Group on Transport and Environment
KA	Key Action (sub-groupings in FP5)
MCA	Multi-Criteria Analysis
OECD	Organisation for Economic Co-operation and Development
PTA	Priority Thematic Area (sub-groupings in FP6)
RTD	Research and Technological Development
SEA	Strategic Environmental Assessment
TEN	Trans-European transport Networks
TERM	Transport and Environment Reporting Mechanism
TRKC	Transport Research Knowledge Centre
TRS	Thematic Research Summary

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# 1. Introduction

This paper is the second version of the Thematic Research Summary (TRS) on Environmental Aspects produced within the TRKC project. It provides a structured review of the research relating to environmental aspects of transport and sustainable mobility, carried out in EU-funded and national transport research projects. The theme “environmental aspects” is one of the thirty themes in the classification scheme adopted by the TRKC project. The full scheme is shown in the table below.

*Table 1. The classification scheme adopted in TRKC*

<i>Sectors</i>
<ul style="list-style-type: none"> <li>• passenger transport</li> <li>• freight transport</li> </ul>
<i>Geographic</i>
<ul style="list-style-type: none"> <li>• urban transport</li> <li>• rural transport</li> <li>• regional transport</li> <li>• long-distance transport</li> <li>• EU accession issues</li> </ul>
<i>Modes</i>
<ul style="list-style-type: none"> <li>• air transport</li> <li>• rail transport</li> <li>• road transport including walking and cycling</li> <li>• waterborne transport</li> <li>• innovative modes</li> <li>• intermodal freight transport</li> </ul>
<i>Sustainability policy objectives</i>
<ul style="list-style-type: none"> <li>• economic aspects</li> <li>• efficiency</li> <li>• equity and accessibility</li> <li>• <b>environmental aspects</b></li> <li>• user aspects</li> <li>• safety and security</li> </ul>
<i>Tools</i>
<ul style="list-style-type: none"> <li>• decision support tools</li> <li>• financing tools</li> <li>• information and awareness</li> <li>• infrastructure provision including Trans-European Networks (TENs)</li> <li>• integration and policy development</li> <li>• Intelligent Transport Systems ITS</li> <li>• regulation/deregulation</li> <li>• land-use planning</li> <li>• transport management</li> <li>• pricing and taxation</li> <li>• vehicle technology</li> </ul>



The categories in the classification scheme shown in the above table have been adopted to enable comprehensive searching for project information available through the TRKC portal, and to ensure comprehensive coverage of research results and appropriate policy analysis in the Thematic Research Summaries (TRSs). Definitions for each category (which is also a theme in its own right) can be found on the TRKC website available at [http://www.transport-research.info/web/projects/transport\\_themes.cfm](http://www.transport-research.info/web/projects/transport_themes.cfm).

The TRKC project has produced final versions of the TRSs for 28 of the 30 themes during 2010 (EU accession issues and Innovative modes not being covered due to lack of projects), with some of the TRSs treating two themes together where there are low numbers of contributing projects and where similarities exist between the themes. This is the final version of the TRS on Environmental Aspects and replaces the first version issued in October 2008.

A large number of research projects have been related to the theme addressed by this paper. The thematic research summary on Environmental Aspects produced in the predecessor project EXTR@Web (EXTR@Web, 2006) had reviewed research from European projects belonging to the Fourth and Fifth Framework Programmes (FP4 and FP5) and selected national projects. The paper here adds new projects to the analysis that have reported since that paper, including various European projects from FP5 and FP6 and national projects.

The research reviewed in this paper does not represent the whole range of research dealing with environmental aspects carried out in the ERA. The paper focuses on research from those projects which have made documentation on results available to the TRKC team after the issue of the EXTR@Web paper (EXTR@Web, 2006). A summary of the research reported on in the EXTR@Web paper is also included to make the reader aware of a wider range of research relevant to the theme.

The paper is organised as follows. Section 2 includes a brief analysis of the scope of the theme. Section 3 provides an overview of the relevant policy developments at EU level, explaining at the same time why the theme is important from a policy viewpoint. The sources for this section are principally European Commission documents which have set the policy agenda such as white papers, green papers and communications.

Section 4 reports on the results from research projects. The section is structured according to sub-themes to make the broad area of research which has dealt with environmental aspects more manageable.



The following three sub-themes have been considered:

- Sub-theme 1: Environmental impact assessment;
- Sub-theme 2: Mitigation measures;
- Sub-theme 3: Development of environment-friendly forms of transport.

For each sub-theme research objectives are reported on and findings from research projects are synthesised. A special focus is given to the policy implications of research results. Section 4 concludes with an overview of the research gaps which could be identified from the projects, and hence topics for future research. Sources for Section 4 are documents available from the projects and reporting on achievements, essentially the project final reports and other selected deliverables were appropriate.

The European research projects listed under each of the three sub-themes are shown in the Annex to this paper. Hyperlinks to project websites (if available) are also included. In several cases these websites make the project documentation available to the public. This may include final reports and other project deliverables.



## 2. Scope of theme “Environmental Aspects”

### 2.1 Definition of theme

The **Environmental aspects** of transport are concerned with sustainability. Currently, negative impacts of transport have significant detrimental effects on the environment (both built and natural) and hence individuals’ lives, making transport unsustainable in the long term without mitigation measures. Sustainable transport can be defined as a system with associated travel patterns that can meet transport needs efficiently, whilst minimising avoidable or unnecessary adverse impacts and their associated costs over relevant space and time scales.

The environmental aspects of transport sustainability are concerned with local atmospheric pollution, more global impacts such as the contribution of transport to global warming, noise pollution, land take, impacts on flora and fauna, the effects of waste disposal (both scrapped vehicles and production waste) on the natural environment and safety implications. The needs for recycling to mitigate waste disposal impacts, for the development of alternative fuels to reduce reliance on non-renewable resources and to reduce pollution from the burning of fossil fuels, and the effects of all of the above, are all relevant. These environmental aspects of transport affect the lives of individuals through health impacts and nuisance.

The theme typically covers:

- the introduction of new environment-friendly technologies and transport concepts to reduce energy resource use for transport, improve air quality, reduce transport related noise, avoid waste and recycle waste related to transport;
- the acquisition of knowledge, and development of methodologies and tools to support environmental impact assessment;
- the formulation of integrated strategies for impact abatement;
- the development of mitigation measures, such as the control of vehicle emissions.

## 2.2 Topics included in theme

Environmental aspects include all the adverse side effects of transport on the environment. They include air and water pollution, noise, vibration, visual impacts, social impacts and waste disposal. On a wider scale they also include the contribution of transport to climate change.

Topics within the theme of environmental aspects encompass three main groups of issues.

The first group is concerned with the assessment of the severity of the impacts of transport on the environment and relates to the development, validation and testing of methodologies and frameworks for such assessment. It is essential that such assessment tools are available to researchers and practitioners for the actual estimation of environmental impacts and the measurement of the effects of mitigation strategies. Another dimension of the efforts to measure the impact of transport on the environment is concerned with the estimation of costs imposed on society by the environmental impacts associated with transport.

The second group of issues relates to the analysis of mitigation measures and includes a wide range of potential strategies for the mitigation and abatement of environmental problems as well as various policy measures available to governments at various levels, such as those concerned with transport regulation, transport pricing and demand management.

The third group is concerned with the development, encouragement and use of more environment-friendly forms of transport. These innovative solutions encompass new more environment-friendly transport technologies (and also innovative transport concepts with potential for lower environmental impacts, such as car sharing or car pooling schemes) as well as non-motorised modes of transport such as walking and cycling.

The above summary of topics describes the principal breakdown of technical, organisational and managerial aspects that come under the theme, whereas Section 4 of this document reflects sub-themes according to actual priorities identified through review of relevant transport research projects.

### 3. Policy context

The impact of transport on the environment has become fundamental to the development of European transport policy and has been considered in various policy documents such as the White Paper “European transport policy for 2010: time to decide” and the “Mid-term Review of the European Commission’s 2001 White Paper on Transport”.

The European Transport White Paper, “European Transport Policy for 2010: time to decide” states early on in its policy guidelines that “a modern transport system must be sustainable from an economic and social as well as an environmental viewpoint”, thus according equal importance to environmental aspects alongside economic and social aspects. In addition to the overarching role of environmental aspects in the drive for sustainability, they are also important in many of the White Paper’s more specific guidelines, one of which is concerned entirely with environmental aspects: “developing medium and long-term environmental objectives for a sustainable transport system” (CEC, 2001). The overall package of proposals put forward in the White Paper is designed to re-direct the common transport policy towards sustainability, but specific attention is drawn to the need to tackle the following:

- “The risk of congestion on the major arteries and regional imbalance;
- the conditions for shifting the balance between modes;
- the priority to be given to clearing bottlenecks;
- the new place given to users, at the heart of transport policy; and
- the need to manage the effects of transport globalisation” (CEC, 2001).

It is noted that hard choices will need to be made between maintaining the status quo and making changes that will result in a sustainable system. In particular, new forms of regulation will be needed to “channel future demand for mobility and to ensure that the whole of Europe’s economy develops in a sustainable fashion” (CEC, 2001). However, with regard to existing regulations, it is noted that international agreements are often focused on facilitating trade and commerce, rather than environmental protection. Thus, insufficient account is currently taken of environmental protection, and the associated security of supply concerns (CEC, 2001).

With this in mind, environmental considerations need to be integrated into Community policies (CEC, 2001). In 1999, the Transport Council highlighted five areas in which

measures should be pursued: “(i) growth in CO<sub>2</sub> emissions from transport, (ii) pollutant emissions and their effects on health, (iii) anticipated growth in transport, in particular due to enlargement, (iv) modal distribution and its development, and (v) noise in transport” (CEC, 2001). There appears to be a bias here in favour of environmental aspects concerned with atmospheric and noise pollution. Whilst growth in transport and trends in modal split both lead to social effects arising from environmental impacts, these social aspects are not specifically referenced, thus potentially leaving readers with the view that growth and modal split are purely an issue in the pollution context.

Environmental aspects are also given prominence in transport fiscal policy in the White Paper; “budget and fiscal policy [should] achieve full internalisation of external – in particular environmental – costs” (CEC, 2001). With regard to the Trans-European Network, the White Paper also states that “the Community rules will be amended to open up the possibility of allocating part of the revenue from user charges to construction of the most environmentally-friendly infrastructure” (CEC, 2001). The White Paper goes on to state that “the integration of external costs must also encourage the use of modes of lesser environmental impact” (CEC, 2001).

Specific modes are also focused on in terms of environmental policy. Modal shift away from over-dependence on motorised road transport, and revitalisation of the railways are both highlighted, as is achieving a balance between growth in air transport and the environment (CEC, 2001). With regard to air quality, the emphasis is on reducing the environmental impacts of engine noise, and emissions, including fuel consumption improvements. This is most likely to be achieved through the adoption of stricter standards (CEC, 2001). However, the need to restrain air traffic growth through competition regulation is also acknowledged; “the growth in road and air traffic must ... be brought under control, and rail and other environmentally friendly modes given the means to become competitive alternatives” (CEC, 2001). However, the White Paper is merely advocating controlled growth, rather than advising against growth in air traffic per se.

Indeed, the White Paper states clearly that “Europe will not be able to cope without new airport infrastructure” (CEC, 2001). New regulatory frameworks focused on the way in which slots are allocated will be needed to make more efficient use of airport capacity, including measures to avoid the development of hub airports, and the ground and sky congestion that is associated with such airports (CEC, 2001). Furthermore, airport charges should change to avoid bunching of flights, and intermodality with rail should be encouraged to facilitate the development of high-speed rail links between cities, focusing air links on routes where rail is not feasible. Yet at the same time, environmental rules should “encourage efforts to find alternative measures before restricting operators at an airport” (CEC, 2001). The issues surrounding the taxation on aviation kerosene also need to be addressed.



As reflected here, there is considerable emphasis on air transport in the White Paper, and rightly so, given the rapid expansion air is currently experiencing. However, there is also considerable emphasis on water transport possibilities, especially with regard to freight, since the current capacity is underutilised. Shifting freight from road to rail is also advocated. Furthermore, the development of alternative fuels, environmentally friendly infrastructure and vehicles is advocated.

The development of the policy summarised here, and set out in considerably more detail in the White Paper, goes back to the European Council Cardiff Summit in 1998. The Council stipulated that the Commission and transport ministers should focus their efforts on developing integrated transport and environment strategies (CEC, 2002). A strategy towards this end was adopted by the Transport Council in 1999, and the report, "Recommendations for actions towards sustainable transport: A strategy review", was released by the JEGTE (established in 1998) in 2000. At the April 2001 meeting of the Transport Council, a resolution was passed to agree pursuit of: integration by the Commission, the development of long-term and intermediate environmental targets for transport, and further development of TERM, the transport and environment reporting mechanism. Within all of this, consideration of the impacts of e-commerce, as stipulated under the eEurope 2002 Action Plan (adopted by the Heads of state and Government at the Feira European Council in June 2000), was requested.

More recently, the general context of EU transport policy established in the 2001 Transport White Paper has changed to include issues such as:

- The accession of new member states;
- consolidation of the transport industry at European level;
- technological innovations in transport which have brought along economic, environmental and social benefits;
- international environmental commitments under the Kyoto protocol which must be integrated into transport policy;
- security of supply and sustainability of energy resources;
- changes in the international context such as the sustained threat from terrorism, economic globalisation, the extension of the internal transport market to accession and candidate countries; and
- the evolving nature of European governance and the need to assist the implementation of the acquis (CEC, 2006).

The objectives, however, of EU transport policy set up by the 1992 and 2001 White Papers remain valid. The mid-term review of the European Commission's 2001 Transport White Paper restates these objectives which aim to provide the European citizens with "efficient and effective transportation systems that:

- Offer a high level of **mobility** to people and businesses throughout the Union;
- **protect** the environment, ensure energy security, promote minimum labour standards for the sector and protect the passenger and the citizen;
- **innovate** in support of the first two aims of mobility and protection by increasing the efficiency and sustainability of the growing transport sector; and
- **connect** internationally, projecting the Union's policies to reinforce sustainable mobility, protection and innovation, by participating in the international organisations." (CEC, 2006)

To be able to adapt the instruments of the 2001 White Paper to the new context, the European Commission has identified the need for additional policy tools. CEC (2006) concludes that "A European sustainable mobility policy therefore needs to build on a broader range of policy tools achieving shifts to more environmentally friendly modes where appropriate, especially long distance, in urban areas and on congested corridors. At the same time each transport mode must be optimised. All modes must become more environmentally friendly, safe and energy efficient. Finally, co-modality, i.e. the efficient use of different modes on their own and in combination, will result in an optimal and sustainable utilisation of resources. This approach offers the best guarantees to achieve at the same time a high level of both mobility and environmental protection."

Since the publication of the 2001 White Paper, the European Environment Agency (EEA) has been closely following the trends in the development of the transport sector in Europe and has been regularly reporting on its impact on the environment (EEA, 2004a; EEA, 2004b; EEA, 2006; EEA, 2007; EEA, 2008; EEA, 2009). The EEA's summary of progress towards environmental transport objectives over the past decade suggests that transport policy with regard to environmental aspects is not likely to change significantly in the near future. In the slightly more medium term, it could be that policy shifts to favour environmentally friendly modes even more, with higher taxation or other tariffs on road and air transport modes.

Increasing attention is being paid to the sector's contribution to climate change. Following the Copenhagen accord in December 2009, the EU is pressing for a post 2012 worldwide agreement that should aim to keep global warming below 2°C above the pre-industrial temperature, equivalent to less than 1.2°C above today's level. Regarding transport, this would involve further efforts to develop infrastructure for less polluting transport modes, investing in and promoting public transport and Intelligent Transport Systems (ITS), promoting research and development into clean transport and using Cohesion Funds in a way which promotes environmentally friendly transport solutions (CEC, 2010).

## 4. Research findings

### 4.1 Introduction

The research which is synthesised in this paper is reported according to three sub-themes.

The first sub-theme relates to the **assessment of the environmental impacts associated with transport**. Included in this sub-theme is research into the development, validation and testing of methodologies and frameworks for such assessment, as well as research that has led to the development of assessment tools available to other researchers and practitioners for the actual estimation of environmental impacts and the measurement of the effects of mitigation strategies. Finally, research evidence on the costs imposed on society by the environmental impacts associated with transport is presented.

The second sub-theme is concerned with reviewing potential strategies for **the mitigation and abatement of environmental problems**. Within this sub-theme the various policy measures available to governments at various levels, such as those concerned with transport regulation, transport pricing and demand management are also considered.

The final sub-theme reviews research into the development, encouragement and use of **more environment-friendly forms of transport**. There are two main strands to this research. The first is research into new, more environment-friendly, transport technologies (and also innovative transport concepts with potential for lower environmental impacts, such as car sharing or car pooling schemes). The second relates to non-motorised modes of transport -walking and cycling.

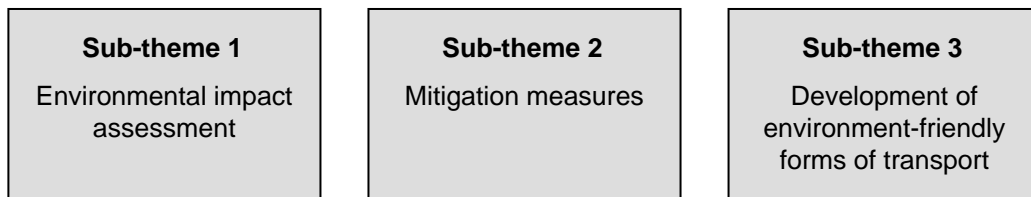


Table 2. EU-funded projects relevant to the theme

Sub-theme	Contributing projects
Environmental impact assessment	<p><u>Projects covered in this TRS paper:</u>            COMMUTE; COST 346; CP/37;            D4(NRP41); ECO; ENVIRONMENT AND LANDSCAPE; HEAVEN; NPF-URBAN TRANSPORT; PARTICULATES; SEAM; SILENCE; STAIRRS; SVI 2001/533; TRIAS;            Costs imposed by heavy goods vehicles;            Evaluation of Options for Reducing Irish Diesel Particulate Emissions; Integrated Traffic, Regional Economic and Impact Models; Policy and Project Appraisal at Regional Level; Research of environmental burden of transportation;</p> <p><u>Projects covered in the previous TRS paper (EXTR@Web, 2006):</u>            AEROCERT; EMARC; H-SENSE; MEET; POLMIT; PROPOLIS</p>
Mitigation measures	<p><u>Projects covered in this TRS paper:</u>            AEROFIL; AIDA; CANTIQUE; CELINA; CUTE; ECO; ELODIT; FURORE; HEAVYROUTE; HYNET; ICARO; METKA; NAUPLIOS; PREMIA; REDUCE; SAFED; SCATTER; SILENCE(R); SPREEX;</p>

	<p>START; STEPS; TOSCA; TRANSPLUS;; TRENDSETTER; Commuting, teleworking and transport; Review of research on school travel;</p> <p><u>Project covered in the previous TRS paper (EXTR@Web, 2006):</u> SPRITE</p>
<p>Development of environment-friendly forms of transport</p>	<p><u>Projects covered in this TRS paper:</u> ADONIS; ASTUTE; CUTE; FURORE; SPICYCLES; TAXEL; TELLUS (RESULTS 6); TOSCA; TRENDSETTER;</p> <p><u>Projects covered in the previous TRS paper (EXTR@Web, 2006):</u> COMPOSIT; ECTOS; UTOPIA;</p>

The research projects listed under each of the three sub-themes are shown in the Annex to this paper. Hyperlinks to project websites (if available) are also included.

## 4.2 Sub-theme 1: Environmental Impact Assessment

### 4.2.1 Background

Research reported in the Thematic Research Summary on Environmental Aspects produced in EXTR@Web (the predecessor of the TRKC project) was concerned with the acquisition of knowledge and development of methodologies and tools to support environmental impact assessment.

Research reported in that TRS has developed a set of decision-making tools that can support the achievement of sustainability by allowing the analysis of different potential scenarios.

A number of EU-funded projects have developed tools and methodologies for evaluating and measuring the impact of transport on the environment across a variety of modes. For example, in the air transport domain, a Europe wide methodology for calculating traffic emissions and energy consumption, and hence evaluating the impact of transport on air pollution, has been developed. In the context of waterborne transport, the effects of the MARPOL (the International Convention for the Prevention of Pollution from Ships) regulations on port environments have been assessed and systems for the management

of ship waste have been investigated. A harbour sediment database which will allow modelling and statistical evaluations relating to sediment settlement, dredging, traffic management and release of pollutants has also been developed. Research has also developed and improved methodologies and techniques for measurement of railway exterior noise for the purpose of type testing, monitoring and diagnostics.

Some work was motivated by the health impacts of Particulate Matters (PMs) and the need to develop effective reduction scenarios. The key results demonstrated that urban and sub-urban models were successful and differentiation between the contribution of light and heavy vehicles was possible.

#### **4.2.2 Research objectives**

The development of strategies to reduce the environmental impacts of transport requires an understanding of the costs associated with such impacts, not only in an absolute sense but also in a relative sense so that priorities can be drawn up. Ideally, monetarised valuations of impacts are required so that policies can be subjected to cost/benefit analysis. Hence the objectives of research include not only the evaluation of external costs, but also the development of assessment techniques and methodologies and the creation of evaluation tools. As the latter two of these are essential for achieving the first of these three objectives, it is unsurprising that many projects address all three of them during the course of their research (COMMUTE). Other approaches which focus primarily on the valuation of external effects rely largely on the existence of methodologies (NENAGH BYPASS – NOISE ASPECTS). In fields where methods are not available or are felt to be inadequate, emphasis is on the design and testing of new methodologies and toolkits (EVALUATION OF OPTIONS FOR REDUCING IRISH DIESEL PARTICULATE EMISSIONS - UTILISING MEASUREMENT AND MODELLING METHODS). In many European countries, there is an important regional dimension to consider and hence evaluation methods have been devised which take regional differences in environmental impact into account (D4 (NRP41); INTEGRATED TRAFFIC, REGIONAL ECONOMIC AND IMPACT MODELS). In addition, advantage has been taken of the huge strides in ICT in recent years to develop toolkits which make effective use of systems such as GIS, internet and advanced messaging (ECO; SVI 2001/533; SEAM).

#### **4.2.3 Research results**

##### **Assessment techniques**

Rigorous research into the environmental impacts of transport is not possible without suitable techniques for the assessment of such impacts, and therefore considerable



research effort has been put into the development and enhancement of such techniques at both national and supranational levels. For example in EU funded research a methodology has been produced and tested for the strategic environmental assessment (SEA) of transport policies, plans and programmes. This methodology comprises a framework covering the basic methodological requirements for SEA of multi-modal transport developments, together with guidelines on how to integrate various analytical approaches such as cost-benefit analysis (CBA) and multi-criteria analysis (MCA) and detailed methods for assessing major types of environmental impact (emissions, energy, noise, safety) for road, rail, air and waterborne transport. Outline methods for assessment of other categories of impact, such as land use and ecological damage have also been provided (COMMUTE). At the local municipality level, an integrated methodology for the evaluation of local traffic plans of cities and municipalities has been developed and demonstrated in Belgium, allowing the assessment of various categories of impact in greater detail than was previously possible (CP/37).

Also at the EU level, there has been research into methodology for the assessment of various environmental impacts of maritime transport, most particularly on the hazards and risks associated with the use of antifouling paints, the discharge of ballast water and emissions from ship exhaust (due to part to the use of poor quality fuels). A Formal Safety and Environmental Assessment (FSEA) methodology has been proposed as a structured approach to these issues and use has also been made of Environmental Impact Assessment (EIA) to assist in scientific and technical evaluation in this field (SEAM).

At the national level, Switzerland has undertaken wide-ranging research into the assessment and monetarisation of the environmental impacts of transport under the umbrella of a research programme investigating fair and efficient prices for transportation, which demands that the costs of environmental damage can be ascertained. Assessment of air pollution costs (specifically the health costs caused by traffic-related air pollution in Switzerland) has entailed use of pollution exposure models. In another project, attempts were made to monetarise the external costs of noise pollution due to road and rail traffic in Switzerland in the year 2000, though this assessment was limited to two main areas - residential impacts (through calculation of the number of homes affected by road and rail transport noise and the reduction in rent payments for homes exposed to noise) and human health impacts (through the effects of noise on physical and mental health disorders and the costs associated death and illness as a result of these effects). In a further project, estimates were made of the costs associated with building damage due to road and rail transport in Switzerland, again for the year 2000. Methodology in this case involved estimating the costs of repairing and cleaning building facades exposed to high levels of traffic, base on expert opinion and a commercial database of buildings. Yet another Swiss project has estimated the external costs of transport on the landscape and natural environment, focusing most particularly on habitat loss and reduced quality of

natural habitats. Habitat loss is monetarised by estimating the costs of repairing habitat damage. Fragmentation of natural habitats has been estimated through the use of aerial photography, and the costs associated with such fragmentation estimated with reference to the costs of re-linking the separated sections. It proved impossible to monetarise the costs associated with reduced quality of habitat (ENVIRONMENT AND LANDSCAPE).

A common method of measuring noise impacts uses the A-weighted decibel measure: dB(A). The L10 dB(A) measure calculates the noise level exceeded for 10% of the time. An example of such research into noise monitoring is the study into the impact of the Nenagh by-pass in Ireland, on noise reduction in the town. In this project, noise measurements were taken at five locations in the town in June 2000 (prior to the bypass opening) and October 2000 (after the opening), and the data used to calculate L10 (18 hour) dB(A) values (the mean of the hourly L10 levels in the period 06:00 hours to midnight) (NENAGH BYPASS – NOISE ASPECTS).

Many transport environmental impacts are at local or regional rather than national level, and research has been undertaken to determine the regional dimension. Research in Denmark, for example, has led to the development of methodologies for the assessment of the environmental and economic impacts of transport system changes and changes in the regulation of the transport system, which are likely to be implemented at a regional level. The approach taken in this work has been to conduct a case study centred on a (hypothetical) road pricing system in Denmark. A key aspect of this work is that the evaluation of user benefits from transport activities has been extended to include option values and existence values (INTEGRATED TRAFFIC, REGIONAL ECONOMIC AND IMPACT MODELS).

Many parts of Europe are heavily dependent on the diesel engine. Ireland is one such country and the Irish government has sponsored research into options for reducing diesel particulate emissions. A new system for measuring diesel particulates has been developed and tested, and the results have been compared with those from more established measurement techniques. Further work has included the design and construction of a diesel engine test facility (EVALUATION OF OPTIONS FOR REDUCING IRISH DIESEL PARTICULATE EMISSIONS).

More technologically-based research into the assessment of impacts includes research into the development of emissions models, both at individual vehicle level and for fleets, and the enlargement of emissions data bases (COST 346) as well as improved methods for sampling and measurement of particulate emissions in order to determine the effectiveness of technical measures for reducing such emissions (PARTICULATES). An integrated model-based approach for the assessment of environmental, economic and social impacts has been designed in order to test strategies for the reduction of

greenhouse gas emissions and noxious emissions from transport based, across a wide range of transport, technology and energy scenarios (TRIAS).

### **Evaluation tools**

The European COMMUTE project, which has developed SEA methodology for the examination of the environmental impacts of transport policy options, has provided a software tool for assessment of air pollutant emissions, energy consumption, noise and safety impacts. The tool contains detailed methods, and focuses on impacts at European, national, regional and corridor levels, aggregated upwards from the impacts associated with individual transport links and nodes (such as urban roads, harbours and airports). Various external input data including traffic flows and vehicle fleet composition must be provided. The calculation includes the life-cycle emissions for power stations and refineries in order to capture fuel use impacts. Output data are presented in a Geographical Information System, and which can differentiate according to the height of emission into the atmosphere (COMMUTE).

Other environmental assessment tools have been produced as a result of research in into maritime transport, including a numerical model which has been developed for the evaluation of risk control measures. This model is based on scientific methodologies for the evaluation of environmental risks and is interfaced with a Geographical Information System (GIS) in order to understand how to reduce the frequency of incidents such as the release of pollutants and to mitigate the effects of such problems. A CBA can be undertaken for each risk control measure and for those entities of interest which are influenced the most by identified hazards (SEAM). Another European project has provided a web-based information system that incorporates a method allowing ports to self-diagnose their environmental situation and performance and to periodically review progress. Data has been made available to allow each port to benchmark their environmental performance against other European ports. A database contains around 100 short case studies of successful projects and providing practical advice on environmental matters. These have been provided, and are updated on-line, by various ports involved in the research. A methodological guide assists port authorities in the process of analysing the nature and extent of an environmental issue (such as dredging), the risks from specific port activities (such as painting), and appropriate monitoring methods. A communication platform and contact details for professionals in European ports dealing with environmental management have also been provided (ECO).

A web-based tool has been developed as a step towards a robust European methodology for vehicle environmental rating in order to draw attention to cleaner vehicles and technologies (CLEANER DRIVE).

A decision-making tool for use in assessment of transport policy initiatives and transport sector projects has been created by Danish researchers. This takes into account both the economic and the environmental consequences of alternative decisions, by linking together three existing models (the Danish National Transport Model, the Interregional Economic Model LINE, and an Environmental and Economic Impact Assessment tool) to produce an integrated model which can be tested and applied in case study work (INTEGRATED TRAFFIC, REGIONAL ECONOMIC AND IMPACT MODELS)

METKOM and ŽELMET methodologies have been applied in research conducted in the Czech Republic. These can be used as a basis for selecting the road and rail sections which are most likely to cause danger for water and mineral quality. Other tools developed in this research allow noise data to be obtained from traffic and to determine the number of inhabitants exposed to noise from such traffic. Overall, a set of indicators has been designed for the assessment of transport in relation to sustainable development (RESEARCH OF ENVIRONMENTAL BURDEN OF TRANSPORTATION).

The UK Department for Transport (DfT) sponsored research has produced a model for the calculation of the costs imposed by heavy goods vehicles, encompassing both road wear and a range of environmental impacts. This Excel-based model can distinguish between 33 different classes of heavy goods vehicle according to gross vehicle weight and axle configuration, and 16 different vintages for each. Track costs are allocated to four road types, whilst emissions initially covered NO<sub>x</sub>, PM<sub>10</sub> and CO<sub>2</sub>, subsequently extended to include non-methane VOCs, CO, benzene, butadiene and sulphur dioxide. Monetary values are applied to these emission rates in order to estimate both health and non-health impacts. The model also takes into account estimates of noise associated with HGVs (COSTS IMPOSED BY HEAVY GOODS VEHICLES).

Pollution dispersion models suitable for the examination of relevant policy scenarios have been developed in Ireland for the analysis of options for reducing diesel particulate emissions. These have been created by customising existing models. Models have been developed for analysis at both micro level (localised particulate emissions produced by individual vehicles in a testbed environment) and macro level (adapting existing transport models to determine particulate emissions levels for a city as a whole). Cost-Benefit Analysis (CBA) has been used to determine the most cost effective ways of reducing such emissions (EVALUATION OF OPTIONS FOR REDUCING IRISH DIESEL PARTICULATE EMISSIONS).

A significant amount of research has been conducted in recent years into the evaluation of noise pollution. A decision support system (DSS) has been developed and demonstrated

which can evaluate environmental effects such as noise quality due to changes in Transportation Demand Management Strategies (TDMS) in large urban areas (HEAVEN). The SILENCE project has developed an integrated methodology for improved control of surface transport noise in urban areas, focusing on noise control at source, noise propagation, noise emission and human perception of noise. The STAIRRS project has developed a decision support system to help railway operators and infrastructure owners determine the most cost-effective way to introduce an optimal blend of noise reduction measures and to understand the potential costs of meeting any proposed noise legislation.

### **Evaluation of external costs**

Research using the assessment methodologies and tools developed and tested in EU research projects has provided an initial quantification of the impacts of TEN transport projects as well as demonstrating the feasibility of SEA methods. The TEN transport projects are projected to increase overall passenger and freight travel demand, but with a substantial shift to rail and a reduction in road network congestion. Road vehicle emissions (other than CO<sub>2</sub>) will fall, while the air sector will see substantial increases in total emissions. The projects are estimated to reduce CO<sub>2</sub> emissions relative to a do-nothing scenario, and to improve transport safety (COMMUTE).

Swiss research has resulted in estimation of monetary values for many of the external costs of transport. The project investigating the external health costs of airborne pollutants has found that these costs are highly significant, with by far the largest proportion of being attributable to the intangible costs of premature death or years of life lost. Chronic bronchitis among adults is the next largest cost, with all other health outcomes being far less costly to society. The corresponding study into noise costs has found that the external costs of (road and rail) transport noise amount to some 0.25% of national GDP, with some 88% of this attributable to reduced house rental values and 12% down to various health costs associated with noise. A similar study into building damage caused by transport found that by far the largest impact was caused by air pollution, with over 90% of this emanating from road traffic (mostly in urban areas) and much smaller effects from rail and air transport.

Additional Swiss research has studied the regional impacts of such external costs and how they might be internalised. The study found that the costs of transport not covered by transport-related taxes can differ very significantly between the various regions of Switzerland, with mountain regions suffering more than the central regions from environmental damage and particularly from the expected global warming and damage to forests. Urban areas also suffer high costs, because of high air pollution and other factors (D4 (NRP41)). Danish research into policy and project appraisal at regional level has

similarly found major differences in external costs from region to region (INTEGRATED TRAFFIC, REGIONAL ECONOMIC AND IMPACT MODELS).

Research in Ireland into strategies for reducing diesel particulate emissions has estimated that in 2003 over 3000 tonnes of diesel particulate matter was emitted nationally by the fleet of some half a million diesel vehicles. The majority of these emissions occurred in urban areas and from light goods vehicles (responsible for 60% of all emissions). Older vehicles with EURO1 or older engines were responsible for some 55% of these emissions. These issues suggest that emissions reduction strategies can be broadly grouped under the categories of technological improvements to vehicles, use of cleaner fuels, better inspection and maintenance programmes and better fleet management. Such research has also highlighted the danger of focusing particulate emission reduction strategies on reducing the total mass of emissions, without sufficient attention to the most damaging volatile matter (EVALUATION OF OPTIONS FOR REDUCING IRISH DIESEL PARTICULATE EMISSIONS).

#### **4.2.4 Policy implications**

Policy implications stemming from this sub-theme relate primarily to the valuation of environmental impacts. Research findings confirm that the external costs of transport activity in terms of environmental impact are high, and this lends support to EU policy priorities to reduce such costs through the development of improved technologies, relevant new transport investments (including the TEN investments) and the internalisation of external costs to influence transport use and travel behaviour. Application of environmental impact assessment methodologies has demonstrated that whilst the TEN investments will lead to an overall increase in passenger and freight travel demand, there will also be a substantial shift to rail and a reduction in road congestion and improvement in road safety, all current policy priority areas. As a result, road vehicle emissions (other than CO<sub>2</sub>) will fall. Whilst the TEN investments will reduce CO<sub>2</sub> emissions relative to a do-nothing scenario, there will be substantial increases in emissions from the air transport which will need to be addressed (COMMUTE).

There are many uncertainties attached to the monetarisation of environmental impacts, such that prioritisation of action can be difficult. However, many policies offer the benefit of reducing several different impacts at the same time. An integrated unified approach to reducing environmental impact, applying packages of relevant measures, may be the way forward (RESEARCH OF ENVIRONMENTAL BURDEN OF TRANSPORTATION; D4 (NRP41)).

The regional dimension is important in many parts of Europe, and it has been shown that environmental impacts can vary significantly from region to region, even within individual



European countries. Policy formulation therefore needs to take regional impacts into consideration (POLICY AND PROJECT APPRAISAL AT REGIONAL LEVEL).

## 4.3 Sub-theme 2: Mitigation measures

### 4.3.1 Background

The synthesis of project results reported in EXTR@Web by Jopson, 2006 has focused on the development of mitigation measures, such as the methods of reducing the level of emissions from vehicles and the formulation of more integrated strategies for impact abatement.

Research offered an insight into a wide-ranging set of mitigation measures to deal with waste from fleet turnover, oil spillages, atmospheric pollution (more specifically measures to decrease CO<sub>2</sub> and tropospheric ozone), noise and vibration (including recommendations and guidelines to tackle nuisance due to traffic induced vibrations in buildings).

A number of measures aimed at separating transport intensity and economic growth have been identified by EU-funded research. An integrated approach that combines two or more measures to separate transport intensity from GDP has been advocated.

In the area of sustainable mobility, which is in the heart of the European transport policy, research has found that strategies targeting sustainable recreational traffic should focus on the essential requirements of people in their leisure activities. Research into the evaluation of the effects of local mobility plans on traffic viability and the environment has developed an instrument that assessed impacts on accessibility, traffic viability, noise nuisance, air quality, mobility and road safety. A study conducted in a UK context argued in favour of improving interchanges and their role in promoting seamless travel.

A Swiss study of transport and land use interactions has identified a number of key challenges for the regional planning and transport policies.

### 4.3.2 Research objectives

A key objective of much of the research into future transport technologies is concerned with developing a full understanding of future requirements and hence the specifications that vehicles and systems will need to achieve and which technologies might be placed to fulfil such needs (FUIRORE; ELODIT). In addition, the infrastructure requirements and the amount of public financial and other support that might be needed to bring new

technologies fully to market also need to be understood (HYPNET; PREMIA). Such research requires massive collaboration between stakeholders so is designed to be undertaken at a pre-competitive stage of technological development.

Within the constraints of existing technologies, it is also important to determine the potential contributions of non-technological factors to the reducing environmental impacts. Examples include the contributions of traffic management (CANTIQUE), car sharing or car-pooling schemes (ICARO; TOSCA) and transfer to more environmentally friendly modes (CANTIQUE; TRENDSETTER; REVIEW OF RESEARCH ON SCHOOL TRAVEL). The potential impacts of improved operating and fuel management practices, including effective monitoring of fuel use, driver awareness, training and incentive schemes, and preventive maintenance also need to be investigated (SAFED; REDUCE).

There is vast potential to utilise web-based information and other ICT technologies, which needs to be determined. Relevant applications include communication systems and benchmarking tools for the provision of management information and evidence on best practice for reducing environmental damage (ECO), ICT systems for the provision of information on ship positioning and safe navigation (NAUPLIOS; SPREEX), ICT-based reservation systems and payment processing to support car sharing schemes (TOSCA).

In addition, there is a need to explore the links between transport environmental impact and land-use planning (TRANSPLUS; SCATTER) and the potential impacts of increased levels of tele-working (COMMUTING, TELEWORKING AND TRANSPORT).

### **4.3.3 Research results**

#### **Technology improvements and optimum technology choice**

A great deal of research will need to be undertaken to produce technological advancements which will ensure that environmental impacts resulting from the use of transport vehicles are minimised, both for conventional (internal combustion engine) vehicles and for vehicles powered by alternative systems in the future (FUORE). Engine and powertrain research will be needed to improve conventional technologies, but research investment in completely new technologies is also important to promote sustainable advances in environmental performance and energy security. The main challenge for electric vehicles is the development of cost effective advanced batteries / energy storage systems. For fuel cell and hydrogen based systems, improvements in terms of production and distribution will make them a competitive alternative and the sustainability of fuel production must also be ensured. For all vehicles, vehicle weight has important implications for both fuel consumption and safety, and in terms of vehicle manufacturing there is a need for intensive research into new materials and production



weight reduction, hence offering better fuel efficiency. Examples include research into new filter systems for aircraft hydraulics systems (AEROFIL), improved ducting systems for jet engines (AIDA) and research into the potential use of fuel cell technologies for providing more environmentally-friendly power supply for aircraft systems (CELINA).

A range of technologies for reduced aircraft noise have been investigated in the SILENCE(R) project, identifying a combined potential for a 5 dB noise reduction.

### **Improved operating and fuel management practices**

Other research into mitigation of environmental impacts has focused not on technological change but on improved operating and fuel management practices, including effective monitoring of fuel use, driver awareness, training and incentive schemes, and preventive maintenance. Establishment and dissemination of best practice in such aspects of transport management can yield major environmental benefits, including around 10% reduction in fuel use (and hence associated reduction in pollution and CO<sub>2</sub>) through the use of driver training in fuel efficient driving techniques alone. Such schemes also bring important health and safety benefits (SAFED). Such driver training can be linked to data on driving behaviour and fuel consumption collected by telematic on-vehicle equipment and fed back to drivers either in real time or through subsequent de-briefing (REDUCE).

Web-based information and communication systems can be extremely useful in providing management information and evidence on best practice for reducing environmental damage. Self-diagnosis tools available on a European scale have been made available to support many aspects of improved environmental management of ports, helping them towards the achievement of ISO14000 certification (ECO).

### **Traffic management schemes to promote smoother traffic flow**

Non-technical measures such as traffic management, pricing measures and promotion of public transport offer ways of supplementing the gains from vehicle technology by acting on modal split and / or the total demand for travel.

European experiences of the effectiveness of such non-technical measures in reducing traffic emissions have been extensively reviewed. Parking charges, parking management regulations, road pricing and low emission zones have been found to be the most cost-effective measures to reduce CO<sub>2</sub>, CO and NO<sub>x</sub> emissions, although cost-benefit ratios vary greatly from city to city, especially for road pricing initiatives (CANTIQUE). Integrated land-use and transport modelling of various future scenarios for fuel technologies and fuel prices has shown that demand management appears to be more cost-effective in the long

term than investment in new technology, because new technologies may possibly increase the demand for long distance travel (STEPS).

On the evidence available to date, infrastructure-based measures such as bus lanes and the establishment of freight distribution centres appear to be less cost-effective ways of achieving environmental objectives. Regulatory measures have given emissions reductions up to 6%, with parking management and traffic control working best in highly congested cities, while speed limits have greater impact in less congested cities. Pricing measures may reduce emissions by up to 14%, particularly through road pricing and parking charges in cities with a high degree of car use. Model-based extrapolation of evidence from various cities studied in such research suggests that at a European level there is potential for an average 16% abatement of the CO<sub>2</sub> emissions from transport in cities across Europe, equating to a 6% contribution to the achievement of Kyoto targets (CANTIQUE).

Specifically in terms of freight activity in urban areas, demonstration projects in a range of European cities participating in the START project have identified traffic reductions and associated environmental benefits from a range of initiatives such as access controls, freight priority measures and load consolidation (START).

#### **Optimising travel routes e.g. using routing software, vehicle location and direction systems, and traffic information systems**

Following a number of maritime accidents around the coasts of Europe, there has been an evaluation of the potential safety contribution of improved monitoring and surveillance of hazardous goods and in particular how tracking systems, possibly using the GALILEO system, could offer benefits in terms of minimising the impact of spillages and improving maritime navigation security more generally. This could be achieved through use of a system architecture involving a positioning system, satellite communications and long-range messaging based on the Automatic Identification System (AIS). Such proposals have been tested in a six-month demonstration campaign involving six different types of vessel relevant to European maritime trade and have been subjected to cost/benefit analysis on the assumption that by 2008 all vessels in European waters will be equipped with a suitably modified AIS terminal (NAUPLIOS; SPREEX).

For road freight, the HEAVYROUTE project has applied and combined existing and newly developed systems, technologies, databases and models to develop an advanced HGV management and route guidance system. This system has been applied in areas such as pre-trip route planning to optimise schedules and real time instructions and advice to drivers whilst en route.



### **Improving load factors**

Given the high level and attractiveness of private car use, car sharing or car-pooling are amongst the most attractive options for better vehicle utilisation. Car-pooling has been found to work best for employees from the same work place and hence initiatives are best targeted on the workplace. The willingness to car-pool increases with the distance between home and work. Initiatives that can be linked with car sharing or car-pooling schemes include the use of High Occupancy Vehicle (HOV) lanes, preferential work place parking for scheme participants and formalised workplace 'Green Commuter Plans' or 'Travelwise' campaigns, particularly as more general marketing of schemes appears to be relatively ineffective. Tax incentive and insurance implications of car sharing or car-pooling schemes need to be determined at national level to encourage their uptake (ICARO).

Car sharing can be made to work on a relatively informal basis, but there has also been research into how car sharing can benefit from more formalised technological and operational support and the adoption of IT-based technologies in areas such as reservation systems and payment processing, including a demonstration study undertaken in Bologna with the support of the public transport operator and taxi operators (TOSCA).

For freight deliveries in urban areas, reduction in vehicle trips through improved load factors has been a feature of the START demonstration projects in various European cities (START).

### **Mode switching**

Improvements in public transport have given emissions reductions of up to 6%, but can be less effective in highly congested cities (CANTIQUE). Other research in European cities which have made large efforts to improve the public transport system in order to attract more passengers has demonstrated that it is important to improve access to public transport, provide enhanced safety and security, introduce integrated fares and ticketing systems and to create bus lanes, Park & Ride facilities and improved multimodal nodes. In addition, public transport service quality must be constantly monitored and maintained. Information offices, real-time public transport information systems and trip-planning tools on the web can all help boost patronage, and marketing activities have been shown to be an effective way of changing peoples' behaviour and encouraging them to choose public transport (TRENDSETTER).



### **Land-use planning**

Research has been conducted to identify best practices towards land use and transport policy in order to achieve a sustainable pattern of transport and land use in European cities and regions, promoting environmental as well as economic and social improvement. Trends in land use and transport planning have been analysed and likely future trends have been considered. Best practice case studies relating to integrated land use and transport policies and to overcoming the barriers to successful implementation of such policies have been disseminated. Consideration has been given to the development of a consistent set of indicators for the evaluation of integrated land use and transport policy packages and to ways of promoting consistency and transferability of approaches between countries (TRANSPLUS).

Urban sprawl is a major challenge to transport planners in European metropolitan areas because it is problematic for the implementation of improved suburban public transport. The mechanisms by which urban sprawl works and its impacts on transport have been evaluated in order to design effective measures for its control or reduction. Policy recommendations have been made available to cities to assist them in improving public transport services in sprawling urban areas. An integrated approach to the problem is advocated, using a range of measures such as transport pricing (both of public and private transport), office location strategies, design of housing estates and influencing suburban residential development through fiscal policy (SCATTER). In Finland, the METKA-model has been developed for the assessment of alternative approaches to the structure of metropolitan regions in order to promote greater sustainability (METKA).

### **Travel substitution methods such as tele-working**

Research conducted in Denmark has constructed a model of commuting which incorporates tele-working as one of the modal options. This allows the future impact of tele-working on transport, and hence the impact of this on emissions, to be estimated. As part of this research, the causal mechanisms behind the growth of tele-working have been analysed, the types and characteristics of firms or organisations which promote tele-working have been investigated and the barriers to its implementation have been studied. Whilst tele-working leads to an overall reduction in transport use, the net effect is reduced because often a family car becomes available for other travel purposes (COMMUTING, TELEWORKING AND TRANSPORT).



### **Influencing travel choice (mode, time, route) in order to reduce congestion**

Use of the car for travel to and from school has been increasing and this is a growing cause for environmental concern. UK and international research on school travel published since 1995 has been reviewed in order to identify factors affecting school travel and the effectiveness of school travel initiatives. Factors influencing school travel choice were found to include organisational changes within education, planning policy factors and social, economic and demographic trends. The growth in car travel to school mirrors substantial growth in car ownership and particularly the growing number of two-car households. Whilst many children would like to walk and cycle more, the balance between car travel and other modes still appears to favour the speed and convenience of car travel for an increasing number of trips. In addition it is often perceived that car travel is safer than such alternatives, though actual risks may not match such perceptions. School bus travel tends to have a negative image, and delivering the required change in image will call for significant changes in the ways that services are provided and operated (REVIEW OF RESEARCH ON SCHOOL TRAVEL).

#### **4.3.4 Policy implications**

Transport in Europe will remain heavily dependent on the internal combustion engine for many years to come, but in the future more propulsion technologies will be in use and it will be important for policymakers to decide on appropriate incentive/disincentive structures in each case. New propulsion technologies are able to contribute significantly to the mitigation of the environmental problems caused by transport activity, but will need much more research in order to bring them fully to market. The rate of technological progress can be accelerated through the promotion of a systems approach to such research which integrates the concerned stakeholders (infrastructure, vehicle manufacturers, research providers etc.) and the concerned scientific areas (materials, electronics, telematics etc.) (FUORE).

EU policy considerations regarding energy security, resource depletion and the need to reduce greenhouse gas emissions in the medium and long term mean that a transition to low CO<sub>2</sub> or CO<sub>2</sub> neutral technologies will be required. Action is required urgently to ensure the future of hydrogen technologies in the transport field. This involves further technological research but also policies to support the introduction of such technology before it can become fully cost competitive (HYNET). Demonstration projects and trials will need to be sponsored to prove new technologies in practical situations (ELODIT)



Governments can play major roles in ensuring the dissemination and encouragement of best practice, for example in transport energy use, by a wide variety of methods such as the development of sponsored driver training programmes (SAFED; REDUCE).

ICT is a potent tool for the making information and spreading environmental best practice in a quick and cheap way, and hence needs to be embraced as fully as possible in these respects (NAUPLIOS; ECO). ICT can also support the implementation of various policies such as car sharing (TOSCA).

Many new technologies offer only a longer-term prospect of environmental improvement. Hence policymakers should continue to make use of the wide range of non-technical measures such as regulatory policies (such as parking controls), pricing policies (such as road pricing and parking pricing to move towards the internalisation of external costs) and the promotion of public transport (to meet the priority objective of modal shift), according to the characteristics of the city in question (CANTIQUE). Communication, information and marketing are all important when trying to increase the use of public transport and other modes of sustainable transport. Such soft measures are relative inexpensive and are efficient, especially when combined with other measures such as infrastructure improvements (TRENDSETTER). Policies need to be designed carefully to avoid unwanted effects; for example, car sharing may reduce the use of public transport (ICARO), whilst encouragement of tele-working may simply divert car use to other trips (COMMUTING, TELEWORKING AND TRANSPORT).

Continued use of integrated land-use and transport planning is required in order to encourage development that is most amenable to the use of public transport, walking and cycling (TRANSPLUS; SCATTER).

Finally, governments need to ensure that fiscal regimes are suitably aligned to transport policy, so that for example there are no tax-based disincentives to the use of car sharing (ICARO).

## 4.4 Sub-theme 3: Development of environment-friendly forms of transport

### 4.4.1 Background

Research results reported in the former thematic paper (EXTR@WEB, 2006) had been concerned with the introduction of new environment-friendly technologies and transport

concepts to reduce energy resource use for transport, improve air quality, reduce transport related noise, avoid waste and recycle waste related to transport.

More specifically, EU-funded research demonstrated and evaluated the social, environmental and economic factors affecting the viability of hydrogen based bus service, including the refuelling infrastructure. The study has concluded that the costs of hydrogen infrastructure and bus operations are not yet commercially viable.

Measures to improve sustainable urban mobility through the use of electric vehicles, car sharing and promotion of walking and cycling have been the focus of research in a number of European projects.

Technological developments that can contribute to more environmentally friendly transportation have also been investigated. An example is the use of composites (fibreglass, for instance) in manufacturing resulting in lighter vehicles and thus lower fuel consumption.

#### **4.4.2 Research objectives**

A key research need is to understand the future mix of transport technologies, including the extent to which Europe will continue to rely on the internal combustion engine, the extent to which the various alternative technologies will be able to penetrate the market, the amount of support they will need to achieve this and the likely environmental impacts if they do (FURORE; TRENDSETTER; TAXEL).

It is also important to determine the contribution that can be made by transport concepts such as car sharing or car pooling which may also need considerable public support to reach viability as a means of environmental improvement (TOSCA). In addition, greater use of non-motorised modes (walking and cycling) offers great potential for environmental improvement, and hence it is important to learn how they can be promoted to best advantage (ADONIS; TRENDSETTER).

#### **4.4.3 Research results**

##### **New technologies and transport concepts**

Considerable research effort has been devoted to developing an understanding of the research needs for development of vehicles for the future (i.e. year 2020 and beyond) (FURORE). This research has served as a platform for European stakeholders to discuss breakthrough technologies and has drawn up a roadmap of future research needs.

Emphasis has been largely on vehicles with internal combustion engines but other technologies have also been considered, with the scope of the research encompassing energy and fuels, current and potential future powertrain technologies and other aspects of vehicle technology including vehicle structures and noise and safety performance.

The general conclusions from such research is that whilst there will be a greater mix of fuels and technologies in use by the year 2020, there will still be a need for a significant amount of research into new technologies to bring them into mainstream use and hence there will still be heavy dependence on the internal combustion engine. Research needs to address many aspects of vehicle design and technology in a highly integrated way and there is great scope for collaborative research in a pre-competitive environment (FUORE).

Many different aspects of the use of alternative fuel cleaner vehicles have been trialled in Europe with research undertaken on their impacts (TRENDSETTER), including the use of biofuels for public transport vehicles, commercial freight vehicles, refuse collection vehicles and other vehicles in municipal fleets. It has been shown that use of such vehicles by municipal authorities can promote their use by private operators as well, and that such use can be encouraged, for example by exemptions from congestion charges. Given the growing concern over the environmental merits of biofuels, it is important to ensure that such fuels are derived from sustainable sources (TRENDSETTER). Hydrogen fuelled buses have been trialled in various European cities, with generally successful results and many lessons learned for the future more general introduction of such vehicle fleets (CUTE).

A small research project in France has focused on potential designs for electric powered taxi vehicles (TAXEL). Building on a comprehensive user needs analysis and field research on taxi operations in Paris, a set of basic performance requirements were been set out for such vehicles, alongside the basic technological characteristics such as battery, engine and transmission and braking systems. The potential driving range of such vehicles (some 200 – 300 km per charge) remains a limitation of such vehicles. Some exploratory research has also been undertaken into the potential for hybrid (diesel/electric) and fuel cell taxi vehicles (TAXEL). In Rotterdam, electric two-wheel vehicles have been trialled, though with little success for a variety of technical and consumer acceptance reasons (TELLUS Results 6).

Car sharing is often cited as a means of reducing traffic levels and hence also pollution levels, especially in peak periods, but its organisation can benefit from the use of IT based systems, for instance for trip matching. Hence there has been research into the provision of technological and operational support for car sharing schemes. Such systems aim to increase overall awareness of the benefits of car sharing, as well as providing the



undertake trials to prove their utility, how to bring them to market and how to incentivise their use (FUORE; TAXEL). Public sector organisations can be encouraged to introduce cleaner vehicles into their fleets (TRENDSETTER).

Policymakers could do much more to promote walking and cycling as transport modes, and clear recognition needs to be given to such modes within local and national transport policies and plans. In addition to more active marketing and promotion and the use of many positive measures such as cycle lanes, in some places it may be necessary to restrict vehicle access in order to reduce the disincentives to walking and cycling (ADONIS).

The research discussed in this section and the resulting policy implications are most relevant to the policy priorities relating to mode shift and the reduction of congestion.

#### 4.5 Implications for further research

For the first sub-theme, which deals with the assessment, measurement and valuation of the impacts of transport on the environment, much emphasis has been placed on engine emissions and their impacts at the more local level, for example on health, and also on noise impacts. As a result, many mitigation policies have been implemented in these areas. Global warming is now acknowledged to be an urgent issue, but this is not yet feeding through into research findings and there is a more urgent need for research into carbon creation in transport and its impacts on global warming. In similar vein, the need to act swiftly on the findings from the large and growing amount of research into the rapid expansion of air transport, its environmental impacts and how they might be mitigated is becoming more pressing. More research on how to cost carbon emitted from transport most meaningfully is also required.

For the second sub-theme, which deals with mitigation and abatement strategies, much of the requirement for fundamental research appears to have been met. There is still a need for much research into new environment-friendly vehicle designs and new propulsion technologies, though over time the emphasis will need to shift from more fundamental research towards the testing of concepts, demonstration projects and trials and other pre-market activities to allow cost-effective implementation. There are however growing concerns over the true sustainability of alternative fuels. These concerns relate to both hydrogen, where the issue hinges on how the fuel is created, and to biofuels, where there are important concerns relating to the sustainability of the farming practices involved as well as issues relating to the pressure being placed on food production and food prices. Some previous research in these areas may have to be revisited and additional research into the life-cycle sustainability of such fuels may be called for.



Whilst there is now a good body of evidence on the efficacy of the many and varied policy measures that can be used to mitigate environmental impacts, we know far less about the public understanding of why such measures need to be implemented, their attitudes to the need for behaviour change in the face of the growing evidence of the impacts of global warming, and how people can be motivated to change their behaviour in a beneficial way.

For the third sub-theme, which deals in part with cycling and walking, much work needs to be done to overcome a wide range of barriers to the greater use of such modes (ASTUTE). It is clear that we need to develop a better understanding of how strategies for the promotion of such modes can be embedded successfully into overall transport strategies, and how to achieve an appropriate balance between promoting environment-friendly modes and penalising the use of less sustainable methods.

## 5. References

ADONIS, 'Analysis and Development of a New Insight into the Substitution of Short Car Trips by Cycling and Walking', Fourth Framework Programme Research Project.

[www.vejdirektoratet.dk/dokument.asp?page=document&objno=7134](http://www.vejdirektoratet.dk/dokument.asp?page=document&objno=7134)

AEROCERT, 'Aircraft Environmental Impacts and Certification Criteria', Fourth Framework Programme Research Project.

AEROFIL, 'New Concept of High Pressure Hydraulic Filter for Aeronautics Preserving Environment', Fifth Framework Programme Research Project.

AIDA, 'Aggressive Intermediate Duct Aerodynamics for Competitive and Environmentally Friendly Jet Engines', Sixth Framework Programme Research Project.

ASTUTE, 'Advancing Sustainable Transport in Urban Areas To Promote Energy Efficiency', funded by the Intelligent Energy Europe (IEE) Research Programme.

[www.astute-eu.org](http://www.astute-eu.org)

CANTIQUÉ, 'Concerted Action on Non-Technical Measures and Their Impact on Air Quality and Emissions', Fourth Framework Programme Research Project.

CELINA, 'Fuel cell application in a new configured aircraft', Sixth Framework Programme Research Project.

'Costs imposed by heavy goods vehicles', funded by the Department for Transport - Cleaner Fuels and Vehicles Research Programme, United Kingdom.

Commission of the European Communities (CEC) (2001), 'White Paper – European transport policy for 2010: time to decide'. Luxembourg: Office for Official Publications of the European Communities.

Commission of the European Communities (CEC) (2002) 'Integration: towards an operational approach', Joint Expert Group on Transport and Environment, Office for Official Publications of the European Communities, Luxembourg.

Commission of the European Communities (CEC) (2006), 'Keep Europe Moving – Sustainable Mobility for Our Continent. Mid-term review of the European Commission's 2001 Transport White Paper'. Luxembourg: Office for Official Publications of the European Communities.

Commission of the European Communities (CEC) (2008) 'EU Energy and Transport in Figures' – Statistical pocketbook 2007/2008, DG TREN in co-operation with Eurostat, Luxembourg.

Commission of the European Communities (CEC) (2010) 'Communication from the European Commission to the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage. COM(2010) 265 final, Brussels.

COMMUTE, 'Common Methodology for Multi-modal Transport Environmental Impact Assessment', Fourth Framework Programme Research Project.

'Commuting, Teleworking and Transport', Research Project under the 'Transport Research on Environmental and Health Impacts and Policy' research programme, Denmark.

COMPOSIT, 'The Future Use of Composites in Transport', Fifth Framework Programme Research Project.

COST 346, 'Emissions and Fuel Consumption from Heavy Duty Vehicles', funded by the COST - Co-operation in science and technology Research Programme.

CP/37, 'An integrated instrument for the environmental evaluation of local traffic plans', research project funded by the Second Scientific Support Plan for a Sustainable Development Policy (SPSD2) Research Programme, Belgium.  
[www.belspo.be/belspo/fedra/proj.asp?l=en&COD=CP/37](http://www.belspo.be/belspo/fedra/proj.asp?l=en&COD=CP/37)

CUTE, 'Clean Urban Transport for Europe', Fifth Framework Programme Research Project.

D4 (NRP41), 'External Costs and Internalisation: Regional Impacts', research project funded by the NRP 41 - Transport and Environment (internal research plan) Research Programme, Switzerland.

ECO, 'Information in European Ports', Fourth Framework Programme Research Project.  
[www.ecoport.com/page.ocl?pageID=2&mode=&version=&MenuID=0](http://www.ecoport.com/page.ocl?pageID=2&mode=&version=&MenuID=0)

ECTOS, 'Ecological City Transport', Fifth Framework Programme Research Project.  
[www.ectos.is](http://www.ectos.is)

ELODIT, 'High-powered locomotive for non-electrified lines', French Technologies for goods transportation (Operational Group 6) Research Project.

EMARC, 'MARPOL Rules and Ship-Generated Waste', Fourth Framework Programme Research Project.

ENVIRONMENT AND LANDSCAPE, 'External costs of transport in the domain of environment and landscape', research project funded by the Fair and efficient prices for transportation (internal research plan) Research Programme, Switzerland.

European Environment Agency (2004a) 'Transport and Environment in Europe', Briefing 03, European Environment Agency, Copenhagen [online]  
[reports.eea.eu.int/briefing\\_2004\\_3/en/Briefing-TERM2004web.pdf](http://reports.eea.eu.int/briefing_2004_3/en/Briefing-TERM2004web.pdf) (July 2008).

European Environment Agency (2004b) 'Ten key transport and environment issues for policy-makers. TERM 2004: Indicators tracking transport and environment integration in the European Union' Report 03, European Environment Agency, Copenhagen [online]  
[reports.eea.eu.int/TERM2004/en/TERM2004web.pdf](http://reports.eea.eu.int/TERM2004/en/TERM2004web.pdf) (July 2008).

European Environment Agency (2006) 'Transport and environment: facing a dilemma. TERM 2005: indicators tracking transport and environment in the European Union' Report 03, European Environment Agency, Copenhagen [online]  
[http://reports.eea.europa.eu/eea\\_report\\_2006\\_3/en/term\\_2005.pdf](http://reports.eea.europa.eu/eea_report_2006_3/en/term_2005.pdf) (July 2008).

European Environment Agency (2007) 'Transport and environment: on the way to a new common transport policy. TERM 2006: indicators tracking transport and environment in the European Union' Report 01, European Environment Agency, Copenhagen [online]  
[http://reports.eea.europa.eu/eea\\_report\\_2007\\_1/en/eea\\_report\\_1\\_2007.pdf](http://reports.eea.europa.eu/eea_report_2007_1/en/eea_report_1_2007.pdf) (July 2008).

European Environment Agency (2008) 'Climate for a transport change. TERM 2007: indicators tracking transport and environment in the European Union' Report 01, European Environment Agency, Copenhagen [online]

[http://reports.eea.europa.eu/eea\\_report\\_2008\\_1/en/EEA\\_report\\_1\\_2008\\_TERM.PDF](http://reports.eea.europa.eu/eea_report_2008_1/en/EEA_report_1_2008_TERM.PDF) (July 2008).

European Environment Agency (2009), Transport at a crossroads. TERM 2008: indicators tracking transport and environment in the European Union. Report 03, European Environment Agency, Copenhagen (June 2009).

'Evaluation of Options for Reducing Irish Diesel Particulate Emissions - Utilising Measurement and Modelling Methods', research project funded by the Environmental Research Technological Development and Innovation (ERTDI) Research Programme, Ireland.

EXTR@Web (2006) 'Third Annual Thematic Research Summary – Environmental Aspects', Deliverable D2.E-3.4 of the EXTR@Web project.

FURORE, 'Future Road Vehicle Research - A roadmap for the future', Fifth Framework Programme Research Project.

HEAVEN, 'Healthier Environment through Abatement of Vehicle Emission and Noise', Fifth Framework Programme Research Project. [heaven.rec.org](http://heaven.rec.org)

HEAVYROUTE, 'Intelligent Route Guidance of Heavy Vehicles', Sixth Framework Programme Research Project.

H-SENSE, 'Harbours - Silting and Environmental Sedimentology', Fourth Framework Programme Research Project.

HYNET, 'European Hydrogen Energy Thematic Network', Fifth Framework Programme Research Project. [www.hynet.info](http://www.hynet.info)

'Integrated Traffic, Regional Economic and Impact Models', research project funded by the Transport Research on environmental and health Impacts and Policy (TRIP) Research Programme, Denmark.

ICARO, 'Increase of Car Occupancy through Innovative Measures and Technical Instruments', Fourth Framework Programme Research Project.  
[www.boku.ac.at/verkehr/icaro.htm](http://www.boku.ac.at/verkehr/icaro.htm)

METKA, 'Sustainable Structure for the Metropolitan Area', research project funded by the Ecologically Efficient and Safe Transport System (EKOTULI) Research Programme, Finland.

MEET, 'Methodology for Calculating Transport Emissions and Energy Consumption', Fourth Framework Programme Research Project.

NAUPLIOS, 'Navigation and Perilous Goods Input and Output System', Fifth Framework Programme Research Project. <http://nauplios.cnes.fr>

'Nenagh ByPass - Noise Aspects', research project funded by the 'National Development Plan 2002-2006' research programme, Ireland.  
[www.ndp.ie/docs/NDP\\_Homepage/1131.htm](http://www.ndp.ie/docs/NDP_Homepage/1131.htm)

NPF - URBAN TRANSPORT, 'National Policy Frameworks for Urban Transport', Fifth Framework Programme Research Project.

PARTICULATES, 'Characterisation of Exhaust Particulate Emissions from Road Vehicles', Fifth Framework Programme Research Project.

'Policy and Project Appraisal at Regional Level', research project funded by the TRIP - Transport Research on environmental and health Impacts and Policy Research Programme, Denmark.

POLMIT, 'Highway Pollutants', Fourth Framework Programme Research Project.

PREMIA, 'Assessment of Initiatives to Facilitate and Secure the Introduction of Alternative Motor Fuels in the European Union', Sixth Framework Programme Research Project.

PROPOLIS, 'Planning and Research for Land Use and Transport for Increasing Urban Sustainability', Fifth Framework Programme Research Project.  
[www.wspgroup.fi/lt/propolis/index.htm](http://www.wspgroup.fi/lt/propolis/index.htm)

REDUCE, 'Active reduction of fuel consumption and exhaust emission for trucks', research project funded by the SRA/Vägverket 2000-2009 - SRA Research and development programme 2000-2009 Research Programme, Sweden.

'Research of Environmental Burden of Transportation', research project under the 'Optimisation of the transport system and its sustainable development' research programme, Czech Republic.

'Review of Research on School Travel', research project under the Scottish Government Transport research programme, United Kingdom.

SAFED, 'The Safe and Fuel Efficient Driving Standard', research project under the Department for Transport Freight Logistics Research Programme, United Kingdom.

SCATTER, 'Sprawling Cities and Transport: from Evaluation to Recommendations', Fifth Framework Programme Research Project. [www.casa.ucl.ac.uk/scatter](http://www.casa.ucl.ac.uk/scatter)

SEAM, 'Assessing concepts, systems and tools for a safer, efficient and environmentally aware and friendly maritime transport', Fifth Framework Programme Research Project. <http://seam.mettle.org>

SILENCE(R), 'Significantly lower community exposure to aircraft noise', Fifth Framework Programme Research Project.

SILENCE, 'Quieter Surface Transport in Urban Areas', Sixth Framework Programme Research Project. [www.silence-ip.org/site](http://www.silence-ip.org/site)

STAIRRS, 'Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems', Fifth Framework Programme Research Project.

SPICYCLES, 'Sustainable Planning & Innovation for Bicycles', research project funded by the Intelligent Energy Europe (IEE) Research Programme.

SPREEX, 'Spill Response Experience and Research for Preparedness', Sixth Framework Programme Research Project. <http://spreex.net>

SPRITE, 'Separating the intensity of transport from economic growth', Fifth Framework Programme Research Project. [www.its.leeds.ac.uk/projects/sprite](http://www.its.leeds.ac.uk/projects/sprite)

START, 'Short-Term Actions to Re-organise Transport of Goods', research project funded by the Intelligent Energy Europe (IEE) Research Programme.

STEPS, 'Scenarios for the Transport System and Energy Supply and their Potential Effects', Sixth Framework Programme Research Project. <http://www.steps-eu.com/>

SVI 2001/533, 'Cleaner Drive', research project funded by the SVI - Swiss Association of Transportation Engineers Research Programme, Switzerland.



TAXEL, 'Research into an Electric Taxi', research project under the 'PREDIT 2: GT1 - Strategic research (thematic group 1)' research programme, France.

TELLUS (RESULTS 6), 'Transport and Environment Alliance for Urban Sustainability', Fifth Framework Programme Research Project.

TOSCA, 'Technological and Operational Support for Car Sharing', Fifth Framework Programme Research Project. [www.atc.bo.it/tosca/deliverable7\\_1.pdf](http://www.atc.bo.it/tosca/deliverable7_1.pdf)

TRANSPLUS, 'Transport Planning, Land Use and Sustainability', Fifth Framework Programme Research Project.

TRENDSETTER, 'Setting Trends for Sustainable Urban Mobility', Fifth Framework Programme Research Project. [www.trendsetter-europe.org](http://www.trendsetter-europe.org)

TRIAS, 'Sustainability Impact Assessment of Strategies Integrating Transport, Technology and Energy Scenarios', Sixth Framework Programme Research Project.

UNITE, 'Unification of Accounts and Marginal Costs for Transport Efficiency', Fifth Framework Programme Research Project.

UTOPIA, 'Urban Transport: Options for Propulsion Systems and Instruments for Analysis', Fourth Framework Programme Research Project.

## Annex: List of projects by sub-theme

Sub-theme 1: Environmental impact assessment				
Project acronym	Project title	Programme	Project website	Coverage
AEROCERT	Aircraft Environmental Impacts and Certification Criteria	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper
COMMUTE	Common Methodology for Multi-Modal Transport Environmental Impact Assessment	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in this paper
COST 346	Emissions and Fuel Consumption from Heavy Duty Vehicles	COST - Co-operation in science and technology	n/a	Covered in this paper
CP/37	An integrated instrument for the environmental evaluation of local traffic plans	National (Belguim): SPSD2 - Second Scienific Support Plan for a Sustainable Development Policy	<a href="http://www.belspo.be/belspo/fedra/proj.asp?l=en&amp;COD=CP/37">www.belspo.be/belspo/fedra/proj.asp?l=en&amp;COD=CP/37</a>	Covered in this paper
D4 (NRP 41)	External Costs and Internalisation: Regional Impacts	National (Switzerland): NRP 41 - Transport and Environment (internal research plan)	<a href="http://www.nfp41.ch">www.nfp41.ch</a>	Covered in this paper
ECO	Information in European Ports	FP4 - TRANSPORT RTD - Transport Research and Technological Development	<a href="http://www.ecoport.com">www.ecoport.com</a>	Covered in this paper

<b>Sub-theme 1: Environmental impact assessment</b>				
Project acronym	Project title	Programme	Project website	Coverage
EMARC	MARPOL Rules and Ship-Generated Waste	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper
ENVIRONMENT AND LANDSCAPE	External costs of transport in the domain of environment and landscape	National (Switzerland): FAIR & EFFICIENT PRICES - Fair and efficient prices for transportation (internal research plan)	n/a	Covered in this paper
HEAVEN	Healthier Environment through Abatement of Vehicle Emission and Noise	FP5 - IST - KA1 - Systems and services for the citizens	heaven.rec.org	Covered in this paper
H-SENSE	Harbours - Silting and Environmental Sedimentology	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper
MEET	Methodology for Calculating Transport Emissions and Energy Consumption	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper
NPF-URBAN TRANSPORT	National Policy Frameworks for Urban Transport	DGTREN - Energy & Transport DG - Miscellaneous projects	n/a	Covered in this paper
PARTICULATES	Characterisation of Exhaust Particulate Emissions from Road Vehicles	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	n/a	Covered in this paper

Sub-theme 1: Environmental impact assessment				
Project acronym	Project title	Programme	Project website	Coverage
POLMIT	Highway Pollutants	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper
PROPOLIS	Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	<a href="http://www.ltcon.fi/propolis">www.ltcon.fi/propolis</a>	Covered in the EXTR@Web paper
SEAM	Assessing concepts, systems and tools for a safer, efficient and environmentally aware and friendly maritime transport	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	seam.mettle.org	Covered in this paper
SILENCE	Quieter Surface Transport in Urban Areas	FP6-SUSTDEV-3 - Global Change and Ecosystems	www.silence-ip.org	Covered in this paper
STAIRRS	Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	n/a	Covered in this paper
SVI 2001/533	Cleaner Drive	National (Switzerland): SVI - Swiss Association of Transportation Engineers	www.aramis.admin.ch/default.aspx?page=Grunddaten&projectid=2457	Covered in this paper
TRIAS	Sustainability Impact Assessment of Strategies Integrating Transport, Technology and Energy Scenarios	FP6-SUSTDEV-3 - Global Change and Ecosystems	<a href="http://www.isi.fhg.de/trias/deliverables.htm">www.isi.fhg.de/trias/deliverables.htm</a>	Covered in this paper



Sub-theme 2: Mitigation measures				
Project acronym	Project title	Programme	Project website	Coverage
AEROFIL	New Concept of High Pressure Hydraulic Filter for Aeronautics Preserving Environment	FP5 - GROWTH - KA4 (AERONAUTICS) - New Perspectives in Aeronautics	n/a	Covered in this paper
AIDA	Aggressive Intermediate Duct Aerodynamics for Competitive and Environmentally Friendly Jet Engines	FP6-AERO-1.2 - Improving environmental impact with regard to emissions and noise	n/a	Covered in this paper
CANTIQUE	Concerted Action on Non-Technical Measures and Their Impact on Air Quality and Emissions	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in this paper
CELINA	Fuel cell application in a new configured aircraft	FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)	n/a	Covered in this paper
CUTE	Clean Urban Transport for Europe	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	n/a	Covered in this paper
ECO	Information in European Ports	FP4 - TRANSPORT RTD - Transport Research and Technological Development	<a href="http://www.ecoport.com/page.ocl?pageID=2&amp;mode=&amp;version=&amp;MenuID=0">www.ecoport.com/page.ocl?pageID=2&amp;mode=&amp;version=&amp;MenuID=0</a>	Covered in this paper
ELODIT	High-powered locomotive for non-electrified lines	National (France): PREDIT 3: G.O.6 - Technologies for goods transportation (Operational Group 6)	n/a	Covered in this paper

Sub-theme 2: Mitigation measures				
Project acronym	Project title	Programme	Project website	Coverage
FURORE	Future Road Vehicle Research - A roadmap for the future	FP5 - GROWTH - KA3 - Land transport and marine technologies	n/a	Covered in this paper
HEAVYROUTE	Intelligent Route Guidance of Heavy Vehicles	FP6-SUSTDEV-2 - Sustainable Surface Transport	heavyroute.fehrl.org	Covered in this paper
HYNET	Towards a European Hydrogen Energy Roadmap	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	<a href="http://www.hyways.de/hynet">www.hyways.de/hynet</a>	Covered in this paper
ICARO	Increase of Car Occupancy through Innovative Measures and Technical Instruments	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in this paper
METKA	Sustainable Structure for the Metropolitan Area	EKOTULI - An Ecologically Efficient and Safe Transport System	<a href="http://www.metkaprojekti.info/">http://www.metkaprojekti.info/</a>	Covered in this paper
NAUPLIOS	Navigation and perilous goods input and output system	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	nauplios.cnes.fr	Covered in this paper
PREMIA	Assessment of Initiatives to Facilitate and Secure the Introduction of Alternative Motor Fuels in the European Union	FP6-SUSTDEV-1 - Sustainable Energy Systems	n/a	Covered in this paper



REDUCE	Active reduction of fuel consumption and exhaust emission for trucks	National (Sweden): SRA/Vägverket 2000-2009 - SRA Research and development programme 2000-2009	n/a	Covered in this paper
SAFED	The Safe and Fuel Efficient Driving Standard (GPG 2100)	National (United Kingdom): DfT Freight Logistics - Department for Transport - Freight Logistics	n/a	Covered in this paper
SCATTER	Sprawling Cities And Transport: from Evaluation to Recommendations	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	<a href="http://www.casa.ucl.ac.uk/scatter">www.casa.ucl.ac.uk/scatter</a>	Covered in this paper
SILENCE(R)	Significantly lower community exposure to aircraft noise	FP5 - GROWTH - KA4 (AERONAUTICS) - New Perspectives in Aeronautics	n/a	Covered in this paper
SPREEX	Spill Response Experience	FP6-SUSTDEV-3 - Global Change and Ecosystems	spreex.net	Covered in this paper
SPRITE	Separating the Intensity of Transport from Economic Growth	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	<a href="http://www.its.leeds.ac.uk/projects/sprite">www.its.leeds.ac.uk/projects/sprite</a>	Covered in the EXTR@Web paper
START	Short-Term Actions to Re-organise Transport of goods	IEE - Intelligent Energy Europe	www.start-project.org	Covered in this paper
STEPS	Scenarios for the Transport System and Energy Supply and their Potential Effects	FP6-SUSTDEV-2 - Sustainable Surface Transport	<a href="http://www.steps-eu.com">www.steps-eu.com</a>	Covered in this paper

TOSCA	Technological and operational support for car sharing	FP5 - IST - KA1 - Systems and services for the citizens	<a href="http://www.atc.bo.it/tosca/deliverable7_1.pdf">www.atc.bo.it/tosca/deliverable7_1.pdf</a>	Covered in this paper
TRANSPLUS	Transport Planning, Land Use and Sustainability	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	<a href="http://www.transplus.net">www.transplus.net</a>	Covered in this paper
TRENDSETTER	Setting Trends for a Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	n/a	Covered in this paper
-	Review of Research on School Travel	National (United Kingdom): Scottish Government (Transport)	n/a	Covered in this paper
-	Commuting, Teleworking and Transport	National (Denmark): TRIP - Transport Research on environmental and health Impacts and Policy	n/a	Covered in this paper

<b>Sub-theme 3: Development of environment-friendly forms of transport</b>				
Project acronym	Project title	Programme	Project website	Coverage
ADONIS	Analysis and Development of a New Insight into the Substitution of Short Car Trips by Cycling and Walking	FP4 - TRANSPORT RTD - Transport Research and Technological Development	<a href="http://www.vejdirektoratet.dk/dokument.asp?page=document&amp;objno=7134">www.vejdirektoratet.dk/dokument.asp?page=document&amp;objno=7134</a>	Covered in this paper
ASTUTE	Advancing Sustainable Transport in Urban Areas To Promote Energy Efficiency	IEE - Intelligent Energy Europe	<a href="http://www.astute-eu.org">www.astute-eu.org</a>	Covered in this paper

Sub-theme 3: Development of environment-friendly forms of transport				
Project acronym	Project title	Programme	Project website	Coverage
COMPOSIT	The Future Use of Composites in Transport	FP5 - GROWTH - KA4 (AERONAUTICS) - New Perspectives in Aeronautics	<a href="http://www.compositn.net">www.compositn.net</a>	Covered in the EXTR@Web paper
CUTE	Clean Urban Transport for Europe	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	n/a	Covered in this paper
ECTOS	Ecological City Transport System	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	<a href="http://www.fuelcelltoday.com/online/industry-directory/organisations/ec/EC/TOS----Ecological-City-TranspO">www.fuelcelltoday.com/online/industry-directory/organisations/ec/EC/TOS----Ecological-City-TranspO</a>	Covered in the EXTR@Web paper
FURORE	Future Road Vehicle Research - A roadmap for the future	FP5 - GROWTH - KA3 - Land transport and marine technologies	n/a	Covered in this paper
SPICYCLES	Sustainable Planning & Innovation for Bicycles	IEE - Intelligent Energy Europe	<a href="http://spicycles.velo.info">spicycles.velo.info</a>	Covered in this paper
TAXEL	Research into an electric taxi	National (France): PREDIT 2: GT1 - Strategic research (thematic group 1)	n/a	Covered in this paper
TELLUS (RESULTS 6)	Transport and Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	<a href="http://www.civitas-initiative.org">www.civitas-initiative.org</a>	Covered in this paper

TOSCA	Technological and operational support for car sharing	FP5 - IST - KA1 - Systems and services for the citizens	<a href="http://www.atc.bo.it/tosca/deliverable7_1.pdf">www.atc.bo.it/tosca/deliverable7_1.pdf</a>	Covered in this paper
TRENDSETTER	Setting Trends for a Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	n/a	Covered in this paper
UTOPIA	Urban Transport: Options for Propulsion Systems and Instruments for Analysis	FP4 - TRANSPORT RTD - Transport Research and Technological Development	n/a	Covered in the EXTR@Web paper