Transport Research Knowledge Centre

URBAN TRANSPORT
THEMATIC RESEARCH SUMMARY

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Thematic Research Summary:

Urban Transport

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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 research financed nationally in the European Research Area (ERA) and selected global RTD programmes. The main dissemination tool used by TRKC is the web portal at www.transport-research.info.

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 life time of the TRKC project; 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 particular Thematic Research Summary deals with urban transport. The aim is to provide the reader with a synthesis of results of completed EU-funded projects and a selection of national projects related to the theme of urban transport. 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.

The authors acknowledge the review of an initial draft of this paper by Carlo Sessa, ISIS.

Disclaimer

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.

Executive summary

This Thematic Research Summary on urban transport 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 projects that are completed and with results publicly available. The EU projects have been funded by the Fifth and the Sixth Framework Programmes. Also a few national projects are reported on. 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.

Urban Transport is concerned with passenger and freight transport internal to built-up areas, and those trips having at least one end in an urban area. Typically wholly urban trips are no longer than 15 km. The main elements of urban transport are motorised private traffic, public transport, non-motorised transport, service vehicle traffic, last-mile freight traffic.

The challenges and related options for intervention in urban transport are discussed in a number of policy papers issued by the European Commission, the earliest being the 1995 Citizens' Network Green Paper, the latest being the Green Paper "Towards a new culture for urban mobility". In the light of the subsidiarity principle the EU must play a facilitating role without imposing top-down solutions which may not be appropriate for the diverse local situations. Thus the EU promotes the exchange of good practice and the harmonisation of technical standards, provides research funds, and adopts legislation. The CIVITAS programme is a major research initiative which provides support to the implementation and evaluation of innovative measures. Since 2002 it has seen the participation of 61 cities. Recently adopted legislation include Regulation 1370/2007 concerning the award of public transport services of general interest, and the Directive 2009/33 on procurement of clean and energy-efficient road vehicles. The European Commission is currently preparing an Action Plan on Urban Mobility.

Eight sub-themes are considered in the synthesis of the findings from research projects. The main achievements in each sub-theme are summarised below.

In the sub-theme concerning **access restrictions and integrated pricing strategies**, successful schemes to improve the quality of life in urban areas have been illustrated. Research has also investigated and demonstrated alternative charging systems for public transport (PT) users and has introduced schemes aiming at internalising external costs of transport. Furthermore, a European cross-site assessment of city demonstration project results has been carried out to enhance knowledge on urban transport pricing schemes, and best practices, success criteria and barriers concerning the introduction of access restriction measures have been identified.

In the sub-theme relating to **public transport**, issues concerning the integration of light and heavy rail networks have been investigated, and a European standard for tram-train vehicles to maximise market size and significantly reduce unit costs has been defined. Research has also focused on the enhancement of development of technologies to be used in PT, such as a modular, multi-application in-vehicle terminal (IVT) for demand responsive transport (DRT). Furthermore, measures to increase patronage of PT have been implemented. Finally, PT services using alternative modes (e.g. waterborne) or encouraging the use of other modes in combination with PT (e.g. park and ride) have been demonstrated.

In the sub-theme concerning **new forms of vehicle use and/or ownership**, research has focused on demonstrating measures to introduce or enhance car-sharing service, and has investigated the possibility to integrate car-sharing into urban planning and development.

In the sub-theme relating to **mobility management and soft measures for managing mobility demand**, research has investigated the potential of the TUC (Traffic-responsive Urban Control) strategy. Research has also demonstrated an innovative multimodal and intermodal transport software platform that offers a number of integrated services and information for trip planning. Furthermore, research has developed and evaluated a set of mobility management measures to encourage the use of modes of transport other than car. Finally, a number of individual or integrated measures have been demonstrated.

In the sub-theme dealing with **goods transport**, research has implemented a number of individual and integrated measures, and has identified best practices for improving urban freight transport. Furthermore, tools for planning and managing delivery trips have been developed, as well as vehicles which ensure efficient delivery operations and low impact on the quality of life in cities.

In the sub-theme concerning **low environmental impact vehicles and infrastructure**, research has developed an integrated methodology for improving the control of noise

caused by surface transport in urban areas, and has investigated suitable technologies. Research has also demonstrated and evaluated the potential benefits of electric two-wheelers. Research has also focused on the development of more environmentally-friendly PT systems. Furthermore, individual and integrated measures for encouraging the use and purchase of low or zero environmental impact vehicles have been demonstrated, and success criteria and barriers in relation to the introduction of environmentally-friendly vehicles have been identified through the analysis of case studies.

In the sub-theme concerning **policy facilitation**, research has investigated and developed methods for the assessment of the Quality of Life (QoL) in relation to different types of public measures in the area of transport and mobility. Research has also developed an approach for designing and managing arterial streets from a people-oriented perspective, and has developed new tools and generic solutions to help designers, planners and decision makers to identify and solve problems when developing and implementing measures relating to urban pedestrian environments. Furthermore, the BYPAD platform for the evaluation of local and regional cycling policy has been enhanced.

In the sub-theme relating to **transport systems of the future**, research has focused on the development, demonstration and implementation of new sustainable transport systems based on cybercars. Research has also assessed to what extent ADAS (Advanced Driver Assistance Systems) and AVG (Automated Vehicle Guidance) systems can contribute to a sustainable urban development in terms of various aspects, such as improved traffic conditions, a better environment, social life, safety, etc.

Finally, research has also identified a number of areas for further research. In particular, research has developed strategic research agendas which identify priority research areas to improve urban mobility (EURFORUM, 2006; ERTRAC, 2004; ERTRAC, 2008). Some of the recommended research activities are:

- development of innovative strategies for clean urban transport and the reduction of negative impacts of urban transport;
- investigation on how incentives can be used to influence transport behaviour;
- alternatives to private cars;
- information technology applications to provide advanced information services;
- integration of urban traffic management systems;
- new design and concepts for goods vehicles;
- better understanding of policy measures on mobility behaviour, as well as of the interaction between urban land use and transport.

Abbreviations and acronyms used

ACARE	The Advisory Council for Aeronautics Research in Europe
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
AVG	Automatic Vehicle Guidance
AVL	Automatic Vehicle Location
AVM	Automatic Vehicle Monitoring
CCTV	Closed Circuit Television
CEC	Commission of the European Communities
CNG	Compressed Natural Gas
CRT	Continuous Regenerative Traps
CTS	Cybernetic Transport System
DG TREN	Directorate-General for Transport and Energy
DRT	Demand Responsive Transport
EC	European Commission
EFV	Environmentally-Friendly Vehicle
EIRAC	The European Intermodal Research Advisory Council
ERA	European Research Area
ERRAC	The European Rail Research Advisory Council
ERTRAC	The European Road Transport Research Advisory Council
EU	European Union
EXTR@Web	Exploitation of Transport Research Results via the Web (DG TREN FP5 Accompanying Measure project – predecessor to TRKC)
FP	Framework Programme
FP4	Fourth Framework Programme
FP5	Fifth Framework Programme
FP6	Sixth Framework Programme

GDP	Gross Domestic Product
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Service
GPS	Global Positioning System
HDV	Heavy Duty Vehicle
ICT	Information and Communication Technology
ISA	Intelligent Speed Adaptation
ISTAG	Information Society Technologies Advisory Group
IT	Information Technology
ITS	Intelligent Transport Systems
IVT	In Vehicle Terminal
LEZ	Low Emission Zone
LPG	Liquefied Petroleum Gas
LTZ	Limited Traffic Zone
PC	Personal Computer
P&R	Park and Ride
PT	Public Transport
QoL	Quality of Life
R&D	Research and Development
RSD	Remote Sensing Device
RTD	Research and Technical Development
SoA	State of the Art
SRA	Strategic Research Agenda
SUTP	Sustainable Urban Transport Plan
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Travel Demand Management
T&T	Tracking and Tracing

TRKC	Transport Research Knowledge Centre; TRKC website at www.transport-research.info
TRS	Thematic Research Summary
TUC	Traffic-responsive Urban Control
UMTS	Universal Mobile Telecommunications System
VMS	Variable Message Sign
VOC	Volatile Organic Compounds
WATERBORNE-TP	Waterborne Technology Platform
WATERBORNE	Advisory Council for Waterborne Transport

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1. Introduction

This paper is the first version of the Thematic Research Summary (TRS) on Urban Transport produced within the TRKC project. It provides a structured review of the research relating to urban transport, carried out in EU-funded transport research projects. The theme "urban transport" 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

Sectors
• passenger transport • freight transport
Geographic
• **urban transport** • rural transport • regional transport • long-distance transport • EU accession issues
Modes
• air transport • rail transport • road transport including walking and cycling • waterborne transport • innovative modes • intermodal freight transport
Sustainability policy objectives
• economic • efficiency • equity and accessibility • environmental aspects • user aspects • safety and security
Tools
• decision support tools • financing tools • information and awareness • infrastructure provision including TEN-T • integration and policy development • Intelligent Transport Systems ITS • regulation/deregulation • land-use planning • transport management

- pricing and taxation
- vehicle technology

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 www.transport-research.info.

In the predecessor project EXTR@Web, TRSs have been produced for 28 out of the 30 themes (the reduced number of TRSs resulting from merging of some themes into a single TRS). The TRKC project has produced first versions of TRSs for a sub-set of themes for which a critical mass of results from projects is available by December 2008. For this subset of themes the preparation of final versions is planned by the end of the TRKC project in June 2010.

This is the final version of the TRS on the “Urban Transport” theme which includes results from projects available by August 2009. A large number of research projects have been related to the theme addressed by this paper. The TRS “Urban Transport” produced in the predecessor project EXTR@Web (EXTR@Web, 2006) had reviewed research from European projects belonging to the Fourth and Fifth Framework Programme (FP4, FP5) and selected national projects. This paper adds new projects to the analysis that have reported since that paper, including various European projects from FP5 and FP6, and a small selection of national projects.

The research reviewed in this paper does not represent the whole gamut of research dealing with urban transport carried out in the European Research Area (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 on urban transport is also included to make the reader aware of a wider range of research relevant to the theme. For completeness, FP6 projects, either on-going or for which results are not yet publicly available, have also been considered.

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. EU legislation - directives, regulations, etc - is mentioned where relevant.

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 urban transport more manageable.

The following eight sub-themes have been considered:

- Sub-theme 1: Access restrictions and integrated pricing strategies and measures;
- Sub-theme 2: Public transport;
- Sub-theme 3: New forms of vehicle use and/or ownership;
- Sub-theme 4: Transport management and soft measures for managing mobility demand;
- Sub-theme 5: Goods transport;
- Sub-theme 6: Low environmental impact vehicles and infrastructure;
- Sub-theme 7: Policy facilitation;
- Sub-theme 8: Transport systems of the future.

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 selected deliverables.

The research projects listed under each of the eight 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 the theme

Urban Transport is concerned with passenger and freight transport internal to built-up areas, and longer trips having at least one end in an urban area. Wholly urban trips are typically no longer than 15 km. Transport in small towns is regarded as urban if it is not feasible to walk for any trip within the town and therefore the town has its own public transport network (conversely, if it is reasonable for an average person to walk for any distance within the town, it is regarded as rural). The main elements of urban transport are motorised private traffic, public transport, non-motorised transport, service vehicle traffic, and last-mile freight traffic.

The demographic and economic significance of urban transport together with the range of environmental and social impacts provide the reasons for the importance of sustainable mobility in urban areas.

According to the recent European Commission's Green Paper "Towards a new culture for urban mobility" (CEC, 2007b):

- 60% of the EU population lives in urban areas;
- 85% of EU's gross domestic product (GDP) is created in urban areas;
- every year €100 billions, or 1% of the EU GDP, are lost to the European economy as a result of delays and pollution related to urban traffic;
- urban traffic is responsible for 40% of CO_2 emissions and 70% of other pollutants arising from road transport.

In addition, road traffic contributes to degradation of the local environment, particularly through noise and visual intrusion, and to risks of accidents and intimidation of vulnerable road users.

The challenge is to ensure accessibility to people, and goods with high quality, efficient transport services, while at the same time minimising the negative impacts on the environment and safety, and preserving quality of life.

Cities are places where people gather together for the purpose of economic and social interaction. Trip makers include residents, commuters and the so called city users, i.e. those travelling into the city for business, social, leisure and tourism purposes, and professional, trade, cultural, scientific and political events.

Social transformations have led to a growth in the levels of mobility together with a spread of the peaks over space (due to decentralisation of service and industrial activities) and time (due to a more 24-hour society). Extending personal motorised mobility to the people has been the freedom offered. As a result, cities have experienced the growth of an institutional system supporting the production, design and financing of transport infrastructure built on the assumption that fossil-fuelled mobility could continue forever. The growth of car traffic has been accompanied by increased urban sprawl and commuting and, often, the expansion in public transport networks, frequencies, quality, etc have not been developed at the same rate.

Developments in urban transport policy are being driven by a series of perceived needs. These are to:

- change the modal split in favour of public transport and non-motorised transport;
- increase safety and security for users and non-users, including public transport staff;
- improve environmental quality and reduce health impacts;
- improve the quality and human aspects of transport services (such as information, accessibility, comfort and speed);
- increase the efficiency and competitiveness of transport services;
- enhance the economic and social dimensions of city life;
- explore the scope for reducing the scale of overall movement.

Associated measures include:

- access restriction measures to limit transport demand, reduce congestion and influence modal split;
- fair and efficient pricing within and between modes to promote economically efficient decision-making (e.g. concerning modal choice and route selection);
- promotion of new transport concepts and technologies, such as car-sharing and alternative fuels;
- promotion of mobility management strategies based on information, dissemination of good practice, and convergence of public and self-interest;
- use of land-use planning to modify the need for transport;
- improvements in infrastructure and traffic management to influence modal choice, assist modal interchange, and control traffic flows;
- adaptation of organisational structures and institutional frameworks, including new arrangements to provide public services and financing urban infrastructure;
- organisational measures aimed at the reduction of the congestion and environmental impacts of “last-mile” freight traffic, including load consolidation, route optimisation and parking control.

The above summary of topics describes the principal breakdown of technical, organisational and managerial aspects that come under the theme, whereas Chapter 4 of this document reflects sub-themes according to actual priorities in transport research policy.

3. Policy context

3.1 The EU strategy for urban transport

The first EU policy documents focusing on urban transport were the Citizen's Network Green Paper (CEC, 1995) and the subsequent Communication on Developing the Citizens' Network (CEC, 1998a). These stated, as key points, that:

- good local and regional passenger transport is an essential part of Europe's transport system;
- local and regional transport is primarily a matter for local, regional and national authorities, working with transport operators and users;
- the Commission's role is to provide useful tools for authorities, operators and user groups, and to establish the right policy framework for sustainable mobility.

The measures suggested to establish the policy framework, included:

- addressing the transport aspects of land use planning;
- encouraging mobility management schemes;
- supporting fairer and more efficient transport pricing;
- promoting applications of transport telematics (or ITS – Intelligent Transport Systems);
- setting harmonised standards for vehicle design;
- ensuring appropriate competition in public transport;
- addressing the transport needs of women and of people with reduced mobility.

To underpin this policy approach, initiatives were advocated on information exchange, support for benchmarking based on self-assessment, and the targeted use of structural and research funds.

Environmental objectives have been set as a priority in the urban transport policy agenda. The Communication on transport and CO_2 (CEC, 1998b) identified a series of urban-specific measures to reduce CO_2 emissions, such as:

- promotion of intermodality in the passenger and freight sectors – such as city logistics schemes and improved terminals;

- mobility management schemes, and the promotion and improvement of public transport and non-motorised modes;
- urban traffic management measures to improve flow;
- demand management measures such as parking controls and access restrictions;
- land-use planning to minimise the need to travel and facilitate collective transport.

The Communication noted that the economic justification and political acceptability of such measures is enhanced in the urban context, where traffic growth has already given rise to an unsustainable situation. The potential was underlined for non-technical measures to simultaneously reduce CO_2 and local pollutant emissions, ease congestion and reduce noise, and thereby offer a good cost-benefit performance.

The 2001 White Paper "European transport policy for 2010: time to decide" (CEC, 2001) aimed at adapting the direction of the European transport policy to the new challenges. The objective stated in the White Paper was to gradually break the link between growth in transport and economic growth through a mix of strategies including shifting the balance of transport modes, eliminating bottlenecks and placing users at the heart of transport policy. However, in the 2006 midterm review of the White Paper (CEC, 2006) the principle of decoupling transport and economic growth has been reformulated more restrictively: the negative impacts of transport activity need to be disconnected from mobility.

Specifically on urban transport, the White Paper stressed that, in line with the principle of subsidiarity and aware that most measures will fall within the jurisdiction of the national, regional or local authorities, the role of the Commission is (i) to provide support, using Community funds, for pioneering towns and cities, and (ii) to promote identification and dissemination of best urban transport system practice, including urban and regional rail services, and best practice in management of the relevant infrastructure. An emphasised aim of the EU policy is to encourage the increased use of clean vehicles and of forms of public transport accessible to all users, including people with reduced mobility (especially those with disabilities and the elderly).

Within the 6th Environment Action Programme the Commission has suggested actions for a set of priority themes including transport in the Communication "Towards a Thematic Strategy on the Urban Environment" (CEC, 2004). The following tools to achieve the objectives of sustainable urban transport are mentioned:

- promoting a more rational use of private cars, and favouring clean, quiet energy-efficient vehicles powered by renewable or alternative fuels;
- providing a regular, frequent, comfortable, modern, competitively priced, well linked network of public transport;
- strengthening the share of non-motorised transport (walking and cycling);
- making the most efficient use of land;

- managing transport demand through the use of economic instruments and plans for behavioural change and mobility management;
- being actively managed, in an integrated manner, with the participation of all the stakeholders;
- quantifying short, medium and long-term objectives, with an effective monitoring system.

The European Commission's Thematic Strategy on the Urban Environment (CEC, 2005) was adopted at the beginning of 2006 and described a number of common environmental challenges and problems faced by most European conurbations although the scale and intensity of these problems vary. These issues comprise: poor air quality, traffic volumes and congestion, high levels of ambient noise, neglect of the built environment, high level of greenhouse gas emissions, social exclusion and urban sprawl. The Thematic Strategy stressed that urban mobility contributes significantly to these pressures. That is why it recommended the development and implementation of Sustainable Urban Transport Plans (SUTP). Guidance to help local authorities in preparing SUTP was published in 2007 (CEC, 2007a).

The 2006 midterm review of the 2001 White Paper (CEC, 2006) had announced a Green Paper on urban transport. The Green Paper, titled “Towards a new culture for urban mobility”, was then published in 2007 (CEC, 2007b). The Green Paper sets out a series of questions and issues on urban mobility and highlights related options. The following five main challenges serve to structure the document:

- free-flowing towns and cities: alternatives to private car use, such as collective transport, walking, cycling, should be made attractive and safe; interchange between modes should be seamless;
- greener towns and cities: measures are required to reduce the impacts of traffic on the environment and on citizens’ health; new vehicle technologies should be promoted, and supported by green public procurement, new ways of driving, traffic restrictions;
- smarter urban transport: innovative solutions are required to increase the efficiency of urban transport so that space is used more efficiently; charging systems and better information services for travellers are among the solutions;
- accessible urban transport: collective transport must be accessible and seamless; transport infrastructure must be safe for walking and cycling not just for private vehicles; more flexible solutions, such as bus rapid transit and demand responsive transport, are needed;
- safe and secure urban transport: measures are needed to improve the safety of urban transport systems and to increase the perceived sense of security for collective passenger transport.

In addition, issues relating to the creation of an urban mobility culture, possibly by a European observatory, and to financing are dealt with. The Green Paper ends with the launch of a consultation exercise and with the announcement of the development of a European Action Plan on Urban Mobility.

Among the main initiatives that have been launched at EU level are:

- the CIVITAS programme which was started in 2002 to help realise innovative projects on Clean Urban Transport across Europe; the projects, which are funded under the umbrella of the Commission's Framework Programmes, involve integrated demonstrations of technology and policy measures in both fields of energy and transport.
- ELTIS, the European Local Transport Information Service, which is a guide to current transport measures, policies and practices implemented in cities and regions across Europe;
- the Citizens Network Benchmarking Initiative which developed indicators to compare one local passenger transport system with another;
- EPOMM, the European platform on mobility management, aimed at promoting and developing the concept of mobility management in Europe and at fine-tuning its implementation.

3.2 Contracting in urban public transport

The 2001 White Paper (CEC, 2001) has set the principles of the EU policy relating to contracts for the award of public transport services, including those in urban areas. To guarantee users a high-quality and affordable public transport service and one which complies with the Community competition rules, transport services should be governed by the following principles: (i) use of the tendering procedure within a clear legal framework defined at Community level, (ii) granting of exceptions or exclusive rights where necessary, (iii) awarding financial compensation to operators responsible for performing public service tasks.

Regulation 1191/69 had set rules for the content of public service contracts that incorporate public service obligations and for compensation. The regulation did not say how the contracts should be awarded. Widespread use of competitive tendering in public transport had not been achieved as the public procurement directives (Directives 92/50 and 93/38) foresaw a series of exemptions.

The orientation stated in the White Paper has been followed up by a proposal of the European Commission (CEC, 2002) for a new Regulation (to replace 1191/69) concerning public service requirements and the award of public service contract. The proposal would require the majority of urban public transport services to be opened to competition with some exemptions including contracts for low-value routes or networks. A ruling of the European Court of Justice of July 2003 on subsidies for public transport services (the Altmark case) supported the Commission's proposal. The Court ruled that subsidies can be paid without breaking competition rules but only if they are for clearly-defined public service obligations.

In 2007 the EU adopted a new regulation (1370/2007). The purpose of the regulation is twofold:

- to determine how competent authorities may act in the field of public transport to guarantee the provision of services of general interest;
- to lay down the conditions under which competent authorities, when contracting for public service obligations, compensate operators for the costs incurred or grant exclusive rights.

3.3 Environmental legislation

In 1996 the Environment Council adopted the Framework Directive 96/62 on ambient air quality assessment and management. This Directive covers the revision of existing legislation and introduces new air quality standards setting the timetable for the development of daughter directives on a range of pollutants. The objectives of the daughter directives are to harmonise monitoring strategies, measuring methods, calibration and quality assessment methods throughout the EU and to provide for good public information.

The Directive 1999/30 is the first daughter directive and sets ambient air limit values for sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and oxide of nitrogen (NO_x), particulate matter (PM_{10}) and lead (Pb). The second daughter Directive (2000/69) establishes limit values for concentrations of benzene (C_6H_6) and carbon monoxide (CO). The third daughter Directive (2002/3) relating to ozone, sets long-term objectives equivalent to the World Health Organisation's new guideline values and target values for ozone to be attained where possible by 2010. These targets follow Directive 2001/81 on national emission thresholds.

In 2009 the EU adopted a directive on procurement (Directive 2009/33) aimed at the promotion of clean and energy-efficient road vehicles. The directive covers vehicles purchased by entities providing a transport service to the public, irrespective of whether the entities are public or private. The directive requires taking into account lifetime energy and environmental impacts (including energy consumption, emissions of CO_2, and emissions of NO_x, non-methane hydrocarbons - NMHC - and particulate matter) in purchasing decisions for road vehicles.

4. Research findings

4.1 Introduction

The research which is synthesised in this paper is reported according to 8 sub-themes (see figure 1).

The first sub-theme deals with strategies and measures relating to **access restriction and integrated pricing**. Access restriction measures to protect inner city areas and other sensitive zones can actually help to improve mobility and at the same time reduce the negative impacts of traffic, improving quality of life and making city centres more attractive and accessible. The use of financial incentives and disincentives can produce different positive impacts such as increasing the economic efficiency of transport systems through the internalisation of the costs generated by motorists, contributing to the protection of the environment and the reduction of pollutant emissions, creating revenue.

The second sub-theme reviews research on strategies and measures to **enhance and promote public transport**. High quality public transport makes cities more accessible and increases the quality of life.

The third sub-theme deals with strategies and measures for **promoting new forms of vehicle use and/or ownership**. Increasing private car ownership and use is a serious problem in most European cities, so the introduction of new ways to provide citizens with access to cars without owning them can contribute to reduce the impacts of such a problem.

The fourth sub-theme relates to strategies and measures for **mobility management and for the integration of transport management systems** including related information system and passenger services. Mobility management is an innovative demand-oriented approach to enhance and promote sustainable mobility, and is a very cost-effective way of guiding or changing citizens' transport behaviour. Intelligent Transport Systems (ITS) can have a beneficial impact on the transport system by making its operation and management more efficient through the provision of real-time information.

The fifth sub-theme is concerned with the development and implementation of **new concepts and solutions for the distribution of goods**. It is more and more necessary to rationalise and make efficient the distribution of goods in inner city areas in order to reduce its impacts on levels of traffic congestion, noise and pollution.

The sixth sub-theme is concerned with **low environmental impact vehicles and infrastructure**. Clean vehicles can significantly reduce pollutant emissions, but technical, economic and political issues hinder their implementation and use. Therefore, research has focused on developing strategies and measures for adopting and providing the necessary energy infrastructure for public and/or private passenger or freight vehicle fleets using alternative fuels.

The seventh sub-theme is concerned with **policy facilitation**. Appropriate tools and methodologies for analysing, assessing, and forecasting socio-economic, environmental and technological impacts of policies can facilitate their efficient and effective implementation.

The eighth sub-theme reviews research on **transport systems of the future**. In order to reduce pollution, noise, safety and general degradation of the quality of life in urban environment, research is trying to develop alternative solutions to the private cars able to ensure the same flexibility.

A large part of the available results come from the projects of CIVITAS. CIVITAS (CIty-VITAlity-Sustainability) is an initiative co-funded by the EC whose overall objective is to achieve a radical change in urban transport through the implementation of integrated sustainable urban transport strategies and measures. This initiative started in 2002 within the FP5, continued during FP6 with the project CIVITAS II, and is ongoing within the FP7 with CIVITAS PLUS started in late 2008. Within CIVITAS I (2002-2006) 19 cities were involved and clustered in 4 demonstration projects (MIRACLES, TELLUS, TRENDSETTER, VIVALDI); within CIVITAS II (2005-2009) 17 cities were involved in 4 demonstration projects (CARAVEL, MOBILIS, SMILE, SUCCESS); within CIVITAS PLUS (2008-2012) 25 cities are involved in 5 demonstration projects (ARCHIMEDES, ELAN, MIMOSA, MODERN, RENAISSANCE). Furthermore, accompanying measures (METEOR and CIVITAS GUARD projects) were designed to support EC in the monitoring, evaluation and dissemination activities concerning the CIVITAS projects (an assessment framework and guidelines for cross-site evaluation of the performance of the cities participating to the CIVITAS Initiative has been developed). Specific objectives of CIVITAS are:

- to promote and implement sustainable, clean and energy efficient urban transport measures;

- to implement integrated packages of technology and policy measures in the field of energy and transport in 8 categories of measures;
- to build up critical mass and markets for innovation.

The first six sub-themes in this TRS cover the eight thematic areas under which were grouped the integrated measures and strategies implemented by cities within CIVITAS, which are:

1. clean fuels and vehicles (sub-theme 6);
2. access restrictions (sub-theme 1);
3. integrated pricing strategies (also sub-theme 1, clustered with measure 1 above);
4. collective passenger transport (sub-theme 2);
5. less car intensive lifestyle (sub-theme 3);
6. transport management (sub-theme 4);
7. soft measures (also sub-theme 4, clustered with measure 6 above);
8. urban Goods Transport (sub-theme 5).

This TRS has only reviewed results from CIVITAS I, because CIVITAS II final results are not yet publicly available.

Within CIVITAS I, the involved cities developed 212 transport-related measures, which involved about 100 public and private organisations and more than 500 experts. Thanks to CIVITAS, cities, individuals and organisations have created networks of contacts for successful partnership. The CIVITAS I efforts were spent in all eight thematic areas, but particularly in enhancing public transport and in encouraging the use of alternative fuels. The assessment of the implementation process allowed to identify a number of factors which affect positively or negatively the implementation of measures (the main barriers have been planning technicalities, the lack of firm and reliable funding sources, and strong political opposition, while the main drivers have been the strong commitment of responsible politicians, synergies between policies, the promotion of local partnerships, and the involvement of final users). The overall results of the measure implemented within CIVITAS and which can be transferred to other European cities have contributed to make cities more attractive through the improvement of quality of life (by reduced congestion, pollutant and noise emissions, reduced energy consumption, better PT, etc.) (METEOR, 2007).

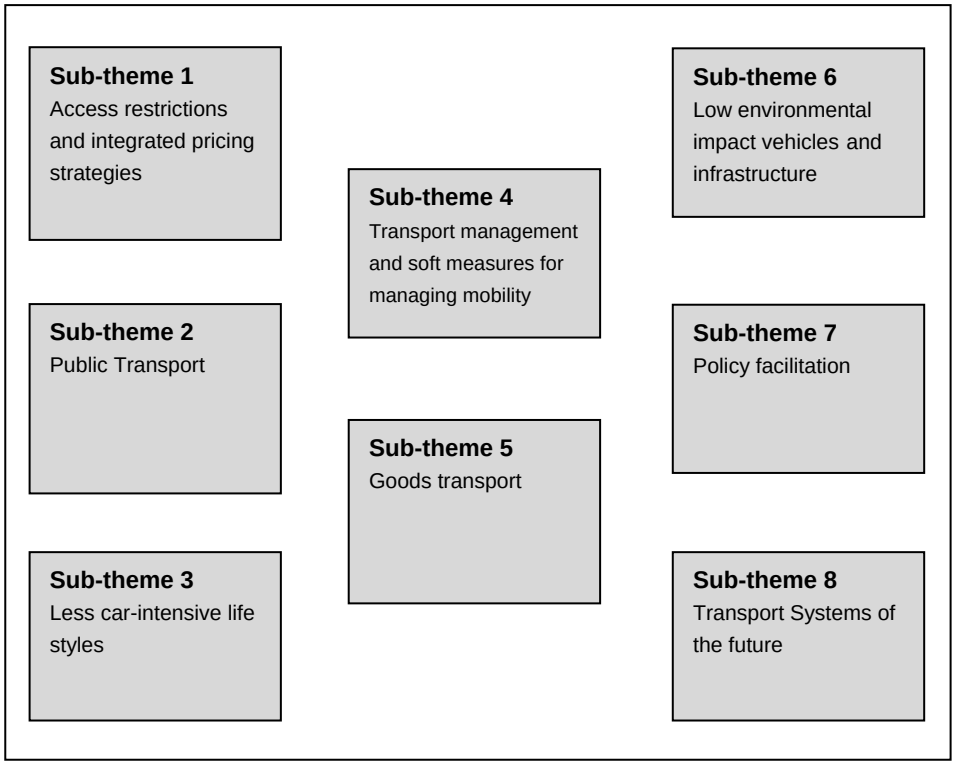

Figure 1: Sub-themes considered in the synthesis of findings from research projects

Table 2 below shows the EU-funded projects together with a limited selection of national projects, which have dealt with each sub-theme. The Table includes:

- completed projects which are synthesised in this TRS and for which the following sub-sections report on research objectives, research results, policy implications and implications for further research;
- projects which had been synthesised in the EXTR@web TRS on urban transport and which are briefly summarised in the background of the following sub-sections[1];
- other EU-funded projects which have not yet made results publicly available.

[1] The TRS on urban transport produced in EXTR@web (EXTR@Web, 2006) included the sub-themes “Assessment and demonstration of individual and integrated measures” and “The CIVITAS Initiative”. In order to better present the results of the reviewed projects, it has been decided was decided to restructure the paper by replacing these two sub-themes with six new sub-themes corresponding to the categories of measures introduced by CIVITAS. Furthermore, in order to place the proper emphasis on the measure implemented within the CIVITAS initiative, each of the eight sub-themes include a specific paragraph dedicated to the CIVITAS measures. Furthermore, the former TRS reviewed a number of research projects on land use and transport planning. Since there is currently no new project on this topic to review, it has only been included in table 2 to list the projects reviewed in the previous paper.

Table 2. Research projects relevant to the theme

Sub-theme	Contributing projects
Access restrictions and integrated pricing strategies	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), BESTUFS II; CUPID; CURACAO. Projects covered in the EXTR@Web paper: BESTUFS; PROGRESS; UG346 (UK). Other FP6 projects with results not yet available: *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS).
Public transport	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), CROSSRAIL; INVETE. Projects covered in the EXTR@Web paper: HITRANS; LIBERTIN; PRISCILLA; TRENDSETTER (CIVITAS I). Other FP6 projects with results not yet available: *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS).
Less car-intensive life style	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), MOSES. Projects covered in the EXTR@Web paper: UG293 (UK). Other FP6 projects with results not yet available: *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS).
Transport management and soft measures for managing mobility demand	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), EMMA (SE), SMART NETS; TARGET 2; TRASCOM. Projects covered in the EXTR@Web paper: INTERCEPT; PRISCILLA; TRENDSETTER (CIVITAS I); UG207 (UK); UG293 (UK); Effects of cycle parking arrangements on bicycle use (FI); Review of Research on School Travel (UK). Other FP6 projects with results not yet available: *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS).
Goods transport	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), BESTUFS II; eDRUL; FIDEUS; HOST. Projects covered in the EXTR@Web paper:

Sub-theme	Contributing projects
	BESTUFS; City Box (NL); CITY FREIGHT; IDIOMA; MOSCA; TRENDSETTER (CIVITAS I). Other FP6 projects with results not yet available: *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS).
Low environmental impact vehicles and infrastructure	Projects covered in this paper: *CIVITAS I projects* (MIRACLES, TELLUS, VIVALDI), BESTUFS II; CUTE; E-TOUR; SILENCE. Projects covered in the EXTR@Web paper: BESTUFS; TRENDSETTER (CIVITAS I). Other FP6 projects with results not yet available: BIOGASMAX ; *CIVITAS II projects* (CARAVEL; MOBILIS; SMILE; SUCCESS); FUEL CELL BUS.
Land use and transport planning	Projects covered in this paper: - Projects covered in the EXTR@Web paper: ECOCITY; MD/DD/16 (BE); PLUME; PROPOLIS; SCATTER; SUTRA; TRANSPLUS.
Policy facilitation	Projects covered in this paper: ARTISTS; ASI; BYPAD Platform; NICHES; PROMPT. Projects covered in the EXTR@Web paper: CP/37 (CH); ISHTAR; NPF – Urban Transport; PROSPECTS; TRANSECON; Urban Transport Benchmarking Initiative.
Transport systems of the future	Projects covered in this paper: CYBERCARS; CYBERMOVE; STARDUST. Projects covered in the EXTR@Web paper: EDICT; NETMOBIL; SVI 1998/091. Other FP6 projects with results not yet available: CITYMOBIL.

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

4.2 Sub-theme 1: Access restrictions and integrated pricing strategies

4.2.1 Background

Research reported in the Thematic Research Summary on urban transport produced in

Extr@Web (EXTR@Web, 2006) investigated issues relating to the implementation of urban road pricing on the basis of case studies, such as legal, organisational and financing aspects, as well as consultation, marketing, charging technologies, and caused impacts. A number of recommendations for the successful implementation of pricing schemes were also made. Finally a small but particularly successful road user charge scheme implemented in Durham City (UK) was described showing the achieved results.

4.2.2 Research objectives

A first objective of research has concerned with the improvement of quality of life in residential areas through the implementation of appropriate access restriction schemes. In the UK, the implementation of “home zones” schemes is increasing. These schemes aim at making residential roads more liveable places for people, rather than just thoroughfares for vehicles, by designing them for a range of activities and only permitting very slow vehicle speeds. Research has demonstrated such a scheme in the city of Bristol (VIVALDI, 2006). Other schemes have aimed at improving the liveability in a campus area in the city of Nantes (VIVALDI, 2006). The city of Rome has demonstrated the “city centre clean zone” measure and the “Night Central Limited Traffic Zone Access Control System and Road Pricing” scheme to improve traffic mobility and decrease traffic-related pollution (MIRACLES, 2006). Also measures introducing parking restrictions have been implemented (TELLUS, 2005b; TELLUS, 2005d; TELLUS, 2006), and a new definition of environmentally sensitive zone has been developed to better protect city areas (TELLUS, 2005c).

A second objective has been to investigate an alternative charging system for PT users (VIVALDI, 2006), as well as new parking management systems (TELLUS, 2005a; VIVALDI 2006), and P&R pricing strategies (TELLUS, 2006).

A third objective was to introduce pricing schemes for Heavy Duty Vehicles (HDV) capable of internalising external costs of transport (TELLUS, 2005a).

Another objective was to enhance the knowledge on urban transport pricing schemes through a European cross-site assessment of city demonstration project results (CUPID), as well as through a state of the art report and analyses of case studies them (CURACAO, 2009). Research was motivated by the fact that, even though in recent years many urban pricing projects have been implemented, many uncertainties still remain concerning the terms and conditions for successful implementation of urban pricing policies and the effective design and implementation of schemes.

4.2.3 Research results

4.2.3.1 CIVITAS Initiative

The Home Zone scheme implemented in the city of Bristol has consisted in the remodelling of seven streets in a residential area surrounded by light industrial businesses. The remodelling has involved the use of new surface materials to create more contrast between elements of the street, the reduction of sight lines for drivers to encourage lower vehicle speeds various street furniture and new street lighting, a link to a cycle/walkway, improved amenities, and a public artwork (to enhance the landscape and the identity and community ownership of the area). The results of this measure have been an improved quality of the environment in which residents live, which not only keeps cars moving slowly, but also gives equal priority to motor vehicles, cyclists, and pedestrians. Furthermore, this measure has contributed to demonstrate the positive impact that residents can have on the successful implementation of local transport measures and their positive attitude towards the improvement of their local environment (VIVALDI, 2006).

In the city of Nantes, the large space in front of the university buildings (in the centre of the Tertre campus), which was previously used as car park, has been redesigned to reduce the number of parking spaces (from 2 000 to 1 600) and make space to an esplanade for pedestrians. The measure has also involved the construction of new accommodation and a shopping area linked to the tram station, as well as the installation of new street furniture and 200 bike racks. As a result of the new layout and parking restrictions, the number of students travelling by car to the area has decreased from 22% to 17% (VIVALDI, 2006).

Very positive results were achieved in Rome with the implementation of the city centre clean zone measure involving access control interventions using Access Gate Systems. Ex-post surveys carried out in 2005 has shown in comparison to 2002, a decrease in the modal share of private cars in the central zone by 5% (from 27% to 22%) and an increase in the modal share of walking by 3% (from 20% to 23%), and this suggests that citizens reduced their car use for trips of short distances. Access restrictions have decreased peak traffic flows by 20% during the restriction periods and by 15% in the morning rush hours. For through-traffic, surveys have shown a 50% reduction in the number of vehicles illegally accessing the Central LTZ (limited traffic zone). Furthermore, there have been small increases in traffic flow along the main axes around the restricted area, as well as an increase in the number of PT passengers. In addition, pollution and noise emissions generally have decreased (MIRACLES, 2006).

The “Night Central Limited Traffic Zone Access Control System and Road Pricing” scheme has involved road pricing measures for tourist coaches, and during evening and night hours (when there are still high level of congestion in city centre above all during weekends), as well as the use of an OCR (optical character recognition) camera to control two-wheeled vehicles within the central LTZ. During the first year since the implementation of the scheme (June 2005), a reduction of 50% (from 10 000 to 5 000) in the number of four-wheeled vehicles was recorded, although two-wheeled vehicle traffic increased. It has also been estimated that this measure contributed to the 10% reduction in the number of high polluting vehicles circulating in the LTZ. The test of the OCR camera to capture images of mopeds and motorcycles number plates has been successful. Recorded data have shown that two-wheeled access was substantial during the morning peak hours (07:30 to 10:30) and during evening hours (20:00 to midnight), and represents about 30% of the whole access demand. About the road pricing schemes for tourist coaches it has been found technology and regulatory aspects play a major role. The new Tourist Bus Plan regulating access control to the LTZ involves measure such as limited-time parking areas, new structure of charges (e.g. the introduction of a charge for coaches less than 7m in length), the introduction of new weekly, monthly and yearly passes, and eventually the new management of special events (MIRACLES, 2006).

In the city of Bucharest a measure has been implemented to improve the traffic conditions and to promote PT use in the historical area by reducing the number of vehicles parked on the streets. The measure has combined parking restrictions with the provision of a parking facility (construction of a parking garage outside the historical area with about 1 000 parking spaces). Unfortunately the measurements on vehicle speed or congestion level before and after the parking construction showed that the measure had small positive impacts (some of the indicators even showed negative results). The reason for this has been identified in the more and more increase in vehicle ownership. It has been concluded that it is necessary to combine this kind of measures with complementary ones to obtain significantly positive results (TELLUS, 2005b).

In order to make its city centre more tourist and city friendly, the city of Gdynia (Poland), implemented a set of actions ranging from reorganisation of the traffic by discouraging the use of private cars to the improvement of the quality of PT. Positive results have been achieved. The reorganisation of parking places and improvement in PT quality contributed to reduce congestion (traffic flows decreased by 9% between 2000 and 2003, and the average peak and off-peak vehicle speed increased slightly), and to prevent cars from parking on pavements. The new trolley-buses have made the PT more reliable and attractive (the number of passengers using the trolley-bus line crossing the main city street increased by 13.2%, and a lower number of private vehicles circulate), and have reduced

noise levels (by 6 dB during the day, and by 1 dB during the night) (TELLUS, 2005d).

In the city of Rotterdam, a demonstration measure has been implemented to reduce truck parking in residential areas. More specifically, the measure has consisted in better accommodating trucks and better regulating their movements from the highways to the port area with the creation of the Truckpark Fruitport. The result has been less parking movements in the surrounding residential areas and, as a consequence, an improvement of the quality of life of residents. In 2004 over 9 000 trucks used the Truck-park, and the occupancy rate of the 60 parking spaces was on average about 50 to 60%, but it proved to be essential for meeting the extra demand for space during peak hours (TELLUS, 2006).

In order to expand their existing environmental zone, the cities of Gothenburg, Stockholm, Malmö and Lund have developed a new definition of a special environmentally sensitive area which permits not only the inclusion of areas where large numbers of people live, but also areas where people work or locations near traffic routes. This definition states, "*A special environmentally-sensitive area is an area which contains parks, green areas, dwellings, streets with many road-users, sensitive buildings, places of work, and areas which are exposed to noise and emissions or where there is a risk of the European Commission Air Quality Norm not being fulfilled*" (TELLUS, 2005c). They also introduced new criteria for controlling the access of vehicles into the environmental zones[2]. Finally, a device for mobile measurement of NO_x emissions from "Heavy Duty" diesel vehicles has been developed, consisting of a NO_x sensor (with built-in lambda sensor), a pressure sensor, a speed sensor, a PC logger and other accessories. Two buses operating in Gothenburg in regular traffic conditions were equipped with this device, which proved to work well, even if fine-tuning and further development are needed (TELLUS, 2005c).

A new PT charging system has been implemented in the city of Bremen. It consists of a card, called the BOB[3] card, which is a sort of debit smartcard which permits easy PT use by avoiding the need to pay for tickets in advance. The customer(s) entering the PT vehicle electronically books the journey by specifying the destination and the number of passengers. This information is stored on the BOB card and recorded in a database for the monthly bill charged on customer's bank account. When customers make several journeys a day they are charged by the system with the cheaper day ticket instead of several single tickets. The results have been an impressive growing number of subscribers and an

[2] The main criterion is that all types of vehicles are allowed to enter environmental zones, but the cleanest vehicles are allowed for a longer period. For non euro-classed vehicles, only those no older than 6 years are allowed to enter (exceptions to this rule are based on vehicle emissions), while euro-classed vehicles are allowed to enter with higher age limits varying according to the euro-class (for example 9 years for Euro IV, 10 years for Euro V).

[3] BOB in German stands for "Bequem Ohne Bargeld", which means "convenient without cash" (VIVALDI, 2006).

increase in the use of PT for irregular journeys (mainly by residents close to the city centre (it has been estimated that more than 6% of all trips would have been made using another mode of transport if the BOB card had not been available) (VIVALDI,2006).

In Berlin, a demonstration measure has involved the introduction of a new parking management system, which enables a more flexible and more cost-efficient management of charged parking. Using mobile communication devices, the system essentially makes use of an on-board unit to be installed in cars or trucks and a central computing unit. When activated, the on-board unit displays parking rates and the maximum allowed time; when deactivated it displays the amount of the parking charge. Current municipal parking fees are transmitted from and to the central computing unit, which records users' parking transactions. This system not only allows precise accounting but also an efficient way of treating illegal or fraudulent on-street parking, and more flexibility regarding the application of variable pricing schemes for influencing the parking demand. The system has been tested in a specified area within the city centre to assess its functioning and user acceptance. Regarding the customer acceptance, in just about eight months about 5 600 users subscribed. A survey showed that respondents used the system regularly (mostly 1 to 3 times a week) and almost 90% of them rated "excellent" and "good" the easiness of handling, the possibility of cashless payment, the attained cost transparency, the customer service and the fact that is not necessary to estimate the parking time. The respondents found particularly advantageous the cashless payment and the fact that they do not have to estimate parking time in advance. As for the willingness to pay for the service, only 27% of respondents agreed with the suggested monthly rate of €0.50 (51% did not agree, and 22% were indecisive) (TELLUS, 2005a).

An innovative parking management/parking payment scheme accessible by mobile phone technology has also been demonstrated in the city of Cork. Subscribers can pay for on-street parking and access system information using their phones. The scheme was implemented in 2005 in 60 streets. In the first two months of operation 500 people registered. 30% of them have used the service "frequently" (i.e. once a week or more), 30% "occasionally" (i.e. once per fortnight), and 35% had never used the service in the first three months of operation. In February 2006 1 634 parking instances for the services occurred. The measure has also involved web and automated phone based payment of parking fines, which has also permitted a quicker processing of them. 69% of users has rated the service as 'very easy' to use (a further 10% has rated it as 'fairly easy'. 79% have stated that the main reason for using the service was that it is faster/easier than disc parking, while 18% stated that they particularly appreciated the possibility of remote topping-up. 99% have declared that they would use Park by Phone again (MIRACLES, 2006).

Berlin has also developed a concept for Heavy Duty Vehicles (HDV) vehicles road pricing

with a view to internalising external costs of transport. This concept is a multi-functional road pricing scheme which takes into account noise and emission profiles of the used HDV, as well as their actual driving behaviour and the actual exposition of citizens along the HDV-routes. The concept involves an analysis of different forms of traffic management aspects (e.g. traffic light priority, one-way-streets, night-time-lorry-ban, speed-limits of 30 km/h, limitation of gross vehicle weight, infrastructural measures such as number of lanes and closing/blocking of side-streets), and the utilisation of different communication means (maps, guidelines, agreements), in order to limit the transit of HDV in the city centre and in other sensible areas. Furthermore, the possibility to introduce tolls depending on exhaust and noise standards of the vehicle, gross-vehicle-weight, time of travel and distance of travel has been analysed. The impacts of the developed HDV road pricing concept have been assessed through modelling. The input parameters (e.g. the value of time and distance for HDV and passenger cars) were mainly based on theoretical studies. The main impacts are economic benefits, due to the reduction of distances run by HDVs, changed congestion levels, and the reduction in air and noise pollution. Nonetheless, compared to the installation and operational costs, the potential benefits seem to be very small. So the demonstrator concluded that an implementation of the explored environmentally oriented HDV charging system cannot be recommended without any adjustments concerning e.g. the inclusion of effects from congestion relief into the calculations and moreover, a pricing of passenger cars as well (TELLUS, 2005a).

In the city of Rotterdam a P&R pricing strategy has been implemented in order to ensure the availability of parking spaces for PT users at the P&R site “Rotterdam Alexander”. In fact, this P&R, which is near a metro/intercity train station and has 535 parking spaces, was also used by non PT users to go shopping or working in the area; these non PT users were likely to take away parking spaces from PT users. The main measured impacts of the measure were an occupancy rate of 64%, which is considerably lower than the 100% rate in the ex-ante situation, and 95% of the users was actually using PT to continue their journey (the ex-ante value was about 60%). Furthermore, the extensive counting in residential and shopping areas in the surroundings (about 12 000 parking spaces) showed that the occupancy rates in these areas did not increase (TELLUS, 2006).

4.2.3.2 Other projects

Through the analysis of the art of the knowledge on urban transport pricing schemes, research has investigated a number of key issues relating to the design and implementation of pricing schemes. These include:

- *Charge and exemption target groups*. Most cities seem to agree on the exemption target groups (bicycles, buses, emergency vehicles, and disabled drivers), while the most controversial issue relates to exemptions for residents living within the charge area or immediately outside (CUPID). Exemptions and discounts can

increase acceptability, but it is necessary to be careful to prevent them from imposing excessive costs (CURACAO, 2009).

- *Charged areas*. This issue depends on urban form and objective, although, in general, there are three charging areas: central area, citywide area, and metropolitan area. When the main objective is to reduce congestion, city centre or citywide charging schemes are appropriate. If the main objective is 'mobility management' (thus reducing the output of gases that contribute to global warming), then metropolitan area charging schemes are more appropriate, using distance-based charging (CUPID).
- *Charging systems*. Although various solutions are available (e.g. point charges, cordons, area pricing or distance-based pricing), in general the more conventional seem to be generally adopted, such as DSRC (Dedicated Short-Range Communication). The VPS (Vehicle Positioning System) is still not a sufficiently mature technology, and this hinders the feasibility of distance-based charging, which seems to be the most efficient solution (CUPID; CURACAO, 2009). Whatever the charging system, the charging fees, location and time of day, exemptions and discounts affect the effectiveness of the scheme and its acceptability (CURACAO, 2009).
- *Enforcement*. Most cities currently feel that ANPR (Automatic Number Plate Recognition) is the optimum approach (CUPID), and actually remains the principal tool for enforcement (CURACAO, 2009).
- *Charging time*. Most cities enforce charging schemes during the working days, all day long or exclusively in the morning peak. An open issue is whether enforce charging in the evening, which strictly depends on the characteristics of evening traffic, and the city authority's attitude towards limiting or encouraging evening traffic (CUPID).
- *Charging fees*. Cities with fixed price schemes suggest daily charges of about €1 to €3, except for London which has adopted a higher fee (about €7). As distance-based charging, fees between €0.01 and €0.60 per km are suggested depending on the size of the charging area (CUPID).
- *Use of raised revenue*. There is a general consensus that revenue raised by road pricing should be used within the transport system in particular to enhance public transport (CUPID).
- *Privacy*. Although all cities involved in the assessment process are concerned about privacy, it does not seem to represent a fundamental barrier (CUPID).
- *Road pricing reasons*. The main reasons for introducing pricing schemes are the reduction of congestion, and the improvement of the environment. In the second instance, there are revenue raising, maintaining economic vitality, discouraging through traffic, and improvement of liveability, safety, healthiness, and equity/social inclusion (CUPID; CURACAO, 2009).

- *Road pricing introduction*. Most cities recommended that road pricing should be introduced as part of a package of measures including infrastructure investment. In particular it has been pointed out that in Norway all successful pricing schemes have been locally initiated, and, so the introduction of road pricing should be founded on local initiatives rather than governmental (CUPID).
- *Traffic impacts*. Charging schemes aimed at reducing traffic entering the charged zone have typically obtained reductions by between 14% and 23%. Effects on speeds and congestion have been more variable (CURACAO, 2009).
- *Impacts on economy*. Although there is still limited evidence, impacts of charging schemes on the urban economy seem to be small and, however, much smaller than those predicted by the business community (CURACAO, 2009).
- *Equity issues*. For many relevant groups the prediction of impacts remains uncertain. However, evidence suggests that "horizontal" factors (such as location, demography and transport needs) are more likely to generate inequities than "vertical" factors related to income. In general, potential inequities can be reduced by modifying the scheme design, revising charge levels and exemptions, and using the revenues to provide alternatives and complementary policies (CURACAO, 2009).
- *Pricing scheme implementation barriers*. Cities have identified in public acceptance, political problems, technical problems, delays in funding alternative access modes the main barriers in implementing pricing schemes (CUPID).
- *Key success factors for successful implementation of pricing schemes*. The key success factors identified by more than one involved city were: positive public consultation and discussion, strong political will and/or agreement, the success of road pricing in other cities (CUPID).
- *Monitoring and evaluation*. Effective monitoring of impacts is important for sustaining and enhancing the scheme, and is essential for increasing the body of empirical evidence on urban road user charging schemes, which will support other cities in implementing such schemes (CURACAO, 2009).
- *Transferability*. The transferability of results from one city to another is still a little understood aspect of urban road user charging policy, because, among other things, of the lack of empirical results (CURACAO, 2009).
- *Prediction*. The success of charging schemes critically depends on the change of behaviour induced. Drivers (and other modes users such as PT, walking, and cycling) are likely to change mode, route, destination, timing and number of journeys. Also second order effects can be expected, such as changes in vehicle ownership and fleet composition, and location of economic activities, homes and jobs. Conventional prediction methods of impacts of charging schemes seem to be not much reliable because of the complexities of road user charging. The prediction of economic, distributional and equity impacts remains a real challenge (CURACAO, 2009).

- *Acceptability*. One conclusion of the assessment process is that activities finalised to increase acceptability of pricing schemes should not only focus on traffic problems and environmental problems, but also on financing problems (e.g. to maintain road infrastructure and extend public transport) and equity problems (external costs of road transport). Furthermore, it would be profitable to show how pricing can provide personal advantages in addition to societal advantages. Major adjustments to already defined pricing schemes negatively affect acceptability, because people feel that rules of transparency and credibility are violated (CUPID). Finally, the role of complementary policy instruments and as well as the ways road user charging revenue are used, are critical to increasing acceptability (CURACAO, 2009).

A very successful city access charge scheme has been the London Congestion Charging System (BESTUFS II, 2006). This scheme, aimed at reducing traffic congestion and the related environmental impacts, is targeted to both individual road traffic and urban freight transport and entering the city of London. All drivers must pay a certain amount a day (at the beginning of the scheme in 2003 the amount was £5 - about €7.5 -, but in 2005 it was increased to £8 - about €12) to access the charging zone between 07:00 and 18:00 of each working day (the access is free at weekends or on public holidays). However, exemptions and special tariffs are available for special transport vehicles. There are no barriers around the charging zone. Drivers or vehicle operators pay to register their vehicle number plate on a database for a single day or multiple charging days. Receipts must be only kept in case it is necessary to prove the payment of the charge for the correct vehicle on the date of travel, because drivers are not required to display it and they do not have to stop at a barrier, gantry or toll booth. In fact, the number plates of vehicles entering or moving within the central zone are controlled by a network of 700 fixed and mobile cameras. The number plates collected by the cameras are then be checked against those registered on the database. If the number plate of the vehicle observed by cameras does not match any in the database, the owner is liable to a penalty charge unless he has been exempted. However, drivers entering the charging zone without registering and paying the charge can do it until the end of the day. Those who failed to do it have to pay a surcharge between £40 ÷ £120 (about €70 ÷ €190). The system is managed by a private company on behalf of Transport for London (TfL). Finally, this charging scheme is accompanied by other measures aiming at making more attractive public transport and other alternatives to the detriment of private cars. Since the introduction this scheme, the volume of traffic entering the charging zone during charging hours has decreased by about 18% (in comparison to levels in 2002 before its implementation). TfL has also calculated that there has been a 30% reduction to delivery delays inside the charging zone during charging hours, and bus patronage has significantly increased. Furthermore, a TfL research shows that this scheme has had a broadly neutral impact on overall business performance in the charging zone.

4.2.4 Policy implications

4.2.4.1 CIVITAS Initiative

A set of recommendations targeted to different stakeholders were made in order to assure the success of large investments such as parking construction (TELLUS, 2005b):

- It is recommended to obtain the necessary political support during the entire period of implementation also in case of political changes;
- It is necessary to assure communication between partners involved in project;
- It is recommended to foresee the required time for user awareness campaign before implementing the project;
- It is advisable to consider Public Private Partnership above all when the setting up funds becomes problematic;
- It is important to integrate the measure with public transport measures to maximise the benefits.

Form the demonstration relating to the transformation of the city centre of Gdynia into a clean Urban Transport Area, the following recommendations were made (TELLUS, 2005c):

- To improve the liveability of the city centre it is very important to implement a combination of measures targeting various stakeholders (e.g. wide pavements comfortable for pedestrians, implementation of access restrictions, etc.).
- In order to avoid public opposition when implementing access restrictions to establish a clean, environment friendly zone in the city centre, it is essential to find effective ways to ensure wide acceptance among people. This issue is critical above all in the new member countries of the European Union since car ownership is increasing and cars represents a status symbol.

4.2.4.2 Other projects

Research has formulated the following policy recommendations concerning pricing schemes:

- Pricing has proved to be a valid tool for reducing urban congestion and environmental impact (CUPID).
- When considering the introduction of urban road user charging schemes, the City and Regional Authorities must clearly specify the objectives and adhere to them consistently (CURACAO, 2009).

- A road user charging scheme should not be designed considering the entire range of complementary policies that will support it (CURACAO, 2009).
- Acceptability should be addressed at the outset. Both positive and negative impacts must be clearly identified and effectively communicated. Also a permanent dialogue with the public, pressure groups, politicians and the media is needed (in particular politicians should understand, but not overestimate, the concerns of the public) (CURACAO, 2009).
- The use of charging revenues significantly affects the acceptability and effectiveness of a scheme (CURACAO, 2009).
- It is necessary to plan and implement pricing schemes according to the specific political context (CUPID).
- There is a need for transparency and accountability in the allocation of revenues (in general the use of revenues within the transport sector is seen as a priority) (CUPID).
- A quick and extensive process, combining awareness raising with effective project management can increase the chance of success of the implementation of pricing schemes (CUPID).
- Top-down political support to local decision-makers is necessary if pricing is to become widespread in the short to medium term (CUPID).

Research also recommends the European Commission give financial support to (CURACAO, 2009):

- cities for carrying out research and demonstration projects that specifically address key issues such as acceptability, governance requirements for effective implementation, economic and equity impacts of pricing schemes;
- educational campaigns, training schemes and toolkits explaining the rationale behind urban road user charging;
- research into standardisation and interoperability of road user charging systems and technologies.

4.3 Sub-theme 2: Public transport

4.3.1 Background

Research reviewed in the Thematic Research Summary on urban transport produced in Extr@Web (EXTR@Web, 2006) produced a best practice guide covering areas such as public transport and land use planning, PT transport network planning, PT and urban design, identification of requirements of both users and non-users of PT for the provision

of high-quality services and technical solutions. Research also established a Thematic Network to enhance the competitiveness of the light rail mode. A number of measures were implemented aiming at improving safety and security, integrating fare system, enhancing or creating P&R facilities, improving or creating multimodal nodes, and encouraging the use of different forms of PT. Finally, other measures aimed at increasing the quality of PT services by providing real-time information at bus stops and on the Internet.

4.3.2 Research objectives

A strand of research focused on investigating the integration of light and heavy rail networks, and defining a European standard for tram-train vehicles to maximise market size and significantly reduce unit costs. Research was motivated by the fact that this new model of transport, which links and integrates tram/light railway systems with conventional ones, can offer a public transport service which better match the needs and expectations of the modern traveller by reducing mode changes, providing better accessibility, and improving journey times, which become comparable or even better than those achievable using private cars (CrossRail, 2001).

Another strand of research focused on the development or improvement of the technologies used in PT. More specifically, research has developed and demonstrated a modular, multi-application in-vehicle terminal (IVT), which meets the needs of fleet operators and drivers, and the requirements of the transport services and on-board telematic devices (INVETE, 2002). A further objective was to improve PT station security by using video surveillance technologies (MIRACLES, 2006).

A further strand of research has concerned with solutions to increase the patronage of PT by offering better or integrated services. A number of demonstration measures have been implemented in the city of Bremen, Nantes, Bristol (VIVALDI, 2006), Rome, Barcelona and Winchester (MIRACLES, 2006).

Finally, a strand of research has demonstrated innovative PT services (MIRACLES, 2006), PT services using alternative modes such as waterborne (TELLUS, 2005c; TELLUS, 2006), or services encouraging the use of other modes in combination with PT (TELLUS, 2006; MIRACLES, 2006).

4.3.3 Research results

4.3.3.1 CIVITAS Initiative

In the city of Rome, an implemented measure involved the demonstration of an innovative automatic security and safety video surveillance system able to analyse user behaviour through the "understanding" of video information. The system, which can be used to monitor passengers in indoor areas of metro and railway stations, substitutes the traditional CCTV system manually managed by an operator, and is based on the application of a computerised image processor using complex software, which permits different standard situations to be recognised and the operators to be alerted by an audio-video alarm, whenever unexpected events occurred. However, it can be used not only for prevention and control, but also for detecting and monitoring travellers' habits in order to improve the quality of PT services. The system has been tested at the Termini subway station, and the results have shown that the system is able to recognise and codify a wide range of events (between 81% and 94%), such as overcrowding, isolated groups of standing people, etc. (MIRACLES, 2006).

In the city of Bremen, measures have been implemented in order to increase PT patronage. A first measure consisted in the integration of PT with a car-sharing service through the creation of a combined offer for people using both services. More in detail, PT and car-sharing users benefit from more convenient fares when using respectively the car-sharing service and PT, and they can use a smartcard to access both services. The result has been an increase in the frequency of PT use (except for trains), confirming that car-sharing complements PT rather than competing with it (VIVALDI, 2006).

Another measures consisting in the extension of a tramline in the city of Bremen, has shown that tram attracts significantly more residents than the bus, since residents who had never used buses before the extension of the tramline, started using the tram after the extension was implemented, moreover to the detriment of private car (a survey reported that the number of residents who used PT after the extension of the tramline increased by 7.5% and the journey frequency increased by about 12.4%. Furthermore, 27% of residents declared that they had reduced their car usage because of the new tram) (VIVALDI, 2006).

The metropolitan Transport Authority of Barcelona has introduced a modern tramway in the city (The "Trambaix" scheme), combining the latest tram vehicle technologies with a reallocation of street space to offer better accessibility for citizens. The 15 km long tramway line has a total 25 stops and has started its service on 3rd April 2004. The

passengers per day transported by the tramway on the average working day have increased from about 20 000 in the first month of operation to over 41 000 in October 2005. The average tram commercial speed has been slightly below the initial target of 20 km/h (17.9 km/h). Regarding integration with other modes, surveys have shown that about 50% of the trips involved a combination of walking (of more than 5 minutes) and tram, 10% tram and metro, 10% tram and bus, and about 8% are tram and other means of transport (the remaining 22% were tram single-stage trips). The on-tram passenger surveys have shown that more than one-third of passengers were making trips they did not previously made. The reallocation of street space to offer better accessibility has been estimated to have generated more than 11 000 passenger trips per day. As for the other two-thirds of tram users 18% used to travel by car and 3% by motorcycle. Finally, 53% of surveyed passengers declared that their main motivation for using the tramway was its higher speed (MIRACLES, 2006).

Also in Bristol and Nantes measures were implemented to increase the patronage of PT respectively with the introduction of a Showcase bus and the Chronobus route. A Showcase bus route was introduced to improve bus service quality and attractiveness by providing improved information, better priority for buses, and improved waiting facilities. The results have been an increase in the number of passengers (passenger growth reached the peak of 10.8% in January 2005), and improved journey times. A survey has shown that thanks to the better quality services, 24% of people used the bus more than they had previously (a third of them previously used car, so, through a rough estimation, it was calculated a reduction of car trip equal to about 30 000 vehicle kilometres per year) (VIVALDI, 2006).

The concept of “Chronobus” introduced in two main bus routes in the city of Nantes ensures passengers a high level of service quality (frequency, regularity, comfort, and short journey time). To this aim a number of interventions were made on the two lines, like the introduction of CNG buses with low floor, kneeling system, and on-board information systems, as well as some changes in the layout of streets (bus lanes, bus priority, staff training for new operating conditions, quality certification, and promotion campaigns) (VIVALDI, 2006).

Furthermore, the construction of two new railway stations, which use existing rail tracks on the national Nantes to Bordeaux line, with parking facilities designed for car drivers and cyclists and connections with existing bus stops, resulted, in just one year, in a threefold increase in the number of passengers, and 29% of interviewed passengers who did the same journey the year before, declared that they used a private car (VIVALDI, 2006).

Another measure implemented in Bristol aimed at promoting Park and Ride. Two already existing structures were improved through the enhancement of cycling and walking links,

increase in capacity, introduction of an information kiosk, and VMS information. The result was that, according to a survey, about half of the passengers of bus lines serving the P&R facilities declared that they would have used the car before deciding to use P&R (this means a saving of about 220 car journeys per day) (VIVALDI, 2006).

The city of Rome (developed by ATAC), as further enhanced its INFOPOINT database to provide multi-modal information (bike & ride information as well as information regarding accessibility to PT services for the disabled), and has implemented an on-board MOBY system to provide bus passengers with en-route transit information and news. The objectives have been to improve PT information services, to make the PT network more accessible to the disabled, and to increase the attractiveness of PT. The main enhancement of the INFOPOINT has concerned increased quantity and quality of the information, a better accessibility for impaired people to the information stored in the database (by phone, internet and ordinary mail), as well as the improvement of the "material" access to transit facilities and vehicles. As a result, there has been a substantial increase in the number of visitors of the INFOPOINT website (from about 48 000 in January 2002 to 200 000 in 2005). Such an increase has been ascribed to the high quality of information. A large number of users visited the web pages on cycling information and accessible bus stops. Furthermore 100 buses have been equipped with Braille dots to make them accessible to visually impaired people. Under the MOBY system, real-time information and news were provided by 200 new video units installed on buses. The information, which has been rated to be very good, included continuously updated news, events (exhibitions, entertainments, etc), routes, timetable and connections to reach main public and private facilities (such as hospitals, museums, public offices) and also targeted tourists (MIRACLES, 2006).

In the city of Rome, a "collective taxi" service has been demonstrated. This service consists of a fleet of cars, each with a capacity of eight passengers. Eight operating lines have been implemented, connecting northern districts of the city to central areas. The results of this implementation have been an increase in the total number of trips per day from 160 in 2002 to 752 in 2005, and a reduction of journey times from 1 hour in 2002 to 20 minutes in 2005 (this has been attributed to a slight increase in average speed and to more direct connections). The total distance travelled per day increased from 2 270 km in 2002 to 5 989 km in 2005. Such improvements were accompanied by a reduction of service costs by 33%. Users' acceptance has been estimated to be good. In spite of this, this kind of service is still too much limited in extension to have a significant impact on travel patterns in Rome (e.g. 100 000 passengers per year travel on collective taxis covering 3 million vkm/year, whereas 873 million per year travel on buses covering 133 million vkm/year) (MIRACLES, 2006).

In the city of Winchester, integrated measures were implemented to improve bus service quality and information with a view to increasing PT patronage and user satisfaction. This scheme has consisted of the purchase of 13 new buses serving city centre routes, improved infrastructure and bus information, and car park extension of a P&R. As a result, PT patronage has increased by an average of 6% on the three demonstration routes, while other two 'control' routes has shown an average decrease in patronage by 6% (which was in line with the reported national 2% reduction in bus passengers per annum during the 2002-2005 period). 87% of the passengers rated the service as 'good' or 'very good'. Furthermore, for demonstration city centre routes, revenue has increased by an average of 27%, while the revenue generated on the two 'control' routes has only increased by 16% (mainly ascribable to the fare increase by 20% between 2001 to 2005). Ticket sales at the extended P&R site have also increased substantially (by 43%). It has also estimated that the investment in the 13 new buses should be recovered within 12 years thanks to the additional revenue generated by the increased patronage (the expected life of the vehicles is 15 years), while there have not been enough additional revenues from ticket sales to recover the investment made in extending the P&R car park (MIRACLES, 2006).

In the city of Rotterdam a water taxi service has been implemented in order to enhance the PT over water. The service is similar to that offered by regular taxis (passengers choose the landing stage to embark and disembark). The measure has involved the construction and operation of a network of 30 water taxi landing stages (including the 8 already existing and serving the Waternet service for tourist transport over water) served by 10 boats. The operation of the Water taxi service has been a successful demonstration of PT over water (in 2003, 280 000 passenger kilometres were travelled by the water taxis), and a valid alternative to cars or conventional taxis (40% of passengers would have chosen a car or a conventional taxi if the service would have not been available, and 13% of the passengers would have not travelled at all). Furthermore, the occupancy rate of the average water taxi was higher than that of the average car. Finally, the harbour and the broad river passing the city centre of Rotterdam create perfect scenery for high-speed boats, which people enjoyed watching; this was an important driver for the municipality to support the project. The main barriers to the implementation were the costs and the complex process to implement a new landing stage; the main drawback was the low environmentally-friendliness of the boat engines (TELLUS, 2006).

The city of Gothenburg has carried out a feasibility study for implementing an environmentally friendly ferry shuttle connecting the northern river bank with the central areas of the city to meet the increased demand of PT and reduce the environmental impacts. The idea was to test the CNG or Biogas propulsion for use on marine vessels, because so far this has been done only for buses. An in-depth analysis of present and

future mobility demands across the river led to conclude that the costs for developing a CNG ferry are too high to be accepted by the local political and municipal authorities. However, the measure has contributed to increase knowledge of this kind of environmental-friendly ferries, as well as knowledge of optimised diesel engines for boats, which constitutes a useful basis for starting other initiatives aimed at introducing environmentally optimised ferries in other cities (TELLUS, 2005c).

In the city of Rotterdam, measures have been implemented to encourage the use of other modes in combination with the PT. A first measure aimed at expanding and enhancing park & ride (P&R) in order to encourage more car drivers to also use PT for their trips. Another measure aimed at encouraging the use of bicycles in combination with PT by providing good quality bicycle parking to reduce the currently considerable risk of bicycle theft (especially in the inner city areas) and the nuisances caused by uncontrolled bicycle parking. Besides developing a strategy for parking locations and exploitation, this measure involved the creation of guarded bicycle parking stands, and the extension of bicycle parking at many PT locations. The majority of interviewed people (96%) use the bicycle parking in combination with the metro. In general people are satisfied with the bicycle parking and are very satisfied about the distance between the parking and the metro. Some respondents said that the renewal of the parking caused them to use it more (and using their car less). Most of the people using the parking are regular users (in summer and winter), and 65% of the interviewees use the parking at least 4 times per week. Although people are satisfied with the neatness, the covering, the ease of attaching the lock and the ease of getting the bicycle in and out the rack, they are least satisfied with the number of covered spaces. Some people said that the bicycles should be better guarded, for example by cameras, surveillance or closed parking (TELLUS, 2006).

In the city of Cork, a new P&R near the City Centre has been created, which provides about 900 parking spaces with a view to reducing congestion and promoting sustainable modes of transport. In November 2005, the daily patronage was about 500 vehicles per day, saving about 450/475 trips each way to the City Centre. The presence of the P&R facility not only has reduced the demand on inner city parking, but it has also encouraged the use of more sustainable modes of transport. 83% of surveyed users rated the overall quality of the P&R service as “very good” (the remaining 17% rated it as “good” or “satisfactory”). 99% stated that they would use P&R again. The user and operator acceptance of this measure were very positive. The service is mainly used by females (79%) and 71% of respondents were travelling alone. Finally, reliability, cost, perception of security and frequency of the bus service were all significant factors for the success of this service (MIRACLES, 2006).

4.3.3.2 Other projects

Research concerning the integration of tram/light railway networks with conventional railway networks (tram-train schemes) has led to the following findings (CrossRail, 2001). The analysis of existing schemes (18 case studies across Europe) has shown many similarities between successful schemes, although the number of vehicles is low (an average of 10 per scheme) and they are custom built to fit specific local infrastructure requirements. The user benefit study has concluded that tram-train schemes can offer considerable benefits (they provide faster end-to-end journey times, they reduce the need of changing mode, they improve the accessibility by increasing frequency and stops, finally their capital cost can be reduced by maximising the use of existing conventional railway infrastructure) which make them attractive to travellers and can increase the patronage of PT to private car use detriment. Furthermore, barriers to the implementation of tram-train schemes have identified, like the lack of political and organisational support, the lack of an appropriate regulatory framework, technical problems (which is possible to overcome, although they increase realisation costs), lack of standards in the tram-train design. In a cross-border context these barriers become more serious. Also the market potential of this scheme has been assessed in different scenarios, and the conclusion was that even in the best conditions the number of sales is expected to be low, so the economies of scale would be limited, and as a consequence, the cost of tram-trains quite high. Finally, the functional design specifications have been identified, and they mainly relate to the light and heavy rail infrastructure interface. Besides vehicle specifications, a set of recommendations concerning the criteria to follow when designing new urban infrastructure have been produced. Their adoption when designing any tram-train scheme would ensure a certain level of standardisation and harmonisation of tram-train rolling stock across Europe, which would optimise the overall costs of the projects.

Research has also developed and demonstrated (in two different DRT services in the Italian city of Florence, and in a DRT service and in regular line buses in Finland) an IVT terminal consisting in (INVETE, 2002):

- The base module, which performs the basic and real-time functions and provides all the services needed in the DRT or AVL/AVM (Automatic Vehicle Location / Automatic Vehicle Monitoring) applications.
- The application module, which provides the driver with the appropriate interface. When used for DRT services, the application module, connected to the base module with an Ethernet link, hosts a commercial operating system and has advanced graphical possibilities. When used for regular PT applications, the module uses a smaller graphical or text display and a serial link connection to the base module. Software is developed according to the specific needs.

The main feature of this IVT is the modularity both at hardware level (e.g. separate modules for interfacing functionalities, and modular construction of the terminals), and at software level (e.g. use of socket-based services and the development of a TCP/IP based protocol), which permits easy adaptation of the terminal to the requirements of the different PT operators and services. Indicators concerning the technical performance, the user acceptance and cost-benefits of this platform have been positively assessed in the different sites, and transferability of the platform to an existing environment has been analysed. The overall conclusion is that the developed IVT provides valuable support and advance to both regular PT and DRT services operations.

4.3.4 Policy implications

4.3.4.1 CIVITAS Initiative

The implementation of PT measures can be a real challenge in terms of technical and economic planning. The complexity of large-scale PT measures requires huge financial resources and long implementation timescales, which always imply political fluctuations. Consequently, when designing a PT system, a general recommendation is to ensure a good coordination and co-operation between the main stakeholders (e.g. involved actors, transport authorities, public transport companies and operators), and to involve politicians supporting long-term mobility strategies. Naturally, it is also critical to meet passengers' needs (METEOR, 2007).

General conclusions from the implemented CIVITAS measures concerning PT are (MIRACLES, 2006; VIVALDI, 2005):

- The improvement of the quality of bus service and information contributes to an increase in patronage;
- P&R sites proved to be well-accepted and popular among public;
- The introduction of a tramway scheme can contribute to significantly reduce the use of cars.

The main recommendations when constructing an environmentally optimised ferry are (TELLUS, 2005c):

- It is recommended to review the costs at an early stage and to check if there are sufficient funds for the project;
- It is better to investigate other means of public transport and make sure there are no better options than ferries before starting the project;
- It is advisable to investigate if the existing infrastructure is appropriate.

4.3.4.2 Other projects

The development and demonstration of the modular, multi-application IVT for collective transport fleets, has led to recommend to authorities and public transport operators taking the entire life cycle of the system into account when implementing or updating monitoring systems for regular and/or flexible public transport, mainly considering features such as modularity, compliance to standards, possibility to make updating, and flexibility (INVETE, 2002).

4.4 Sub-theme 3: Less car-intensive life style

4.4.1 Background

Research reviewed in the former Thematic Research Summary on urban transport (EXTR@Web, 2006) focused on investigating potential and impacts of car-sharing.

4.4.2 Research objectives

A contribution to the reduction of polluting emissions can be made by measures finalised to rationalise the use of private cars. Car-sharing is a measure which can reduce the number of vehicles on urban roads contributing to urban sustainability strategies. As a consequence, a research objective has concerned with the demonstration of measure to introduce car-sharing services (VIVALDI, 2006; MIRACLES, 2006) or car-pooling services (MIRACLES, 2006), as well as measures to enhance or extend existing ones (TELLUS, 2006; VIVALDI, 2006). Another objective was to demonstrate new forms of collective transport and vehicle use to offer new choices to urban travellers (TELLUS, 2005a).

A further research objective has related to the further development and extension of the concept of car-sharing to all Europe, including the EU candidate countries, with particular emphasis on the integration of car-sharing into urban planning and development (MOSES). Research was motivated by the fact that measures and strategies for promoting new forms of vehicle use and/or ownership are more and more required to contrast the increasing use and ownership of private cars and the resulting serious negative impacts.

4.4.3 Research results

4.4.3.1 CIVITAS Initiative

Car-sharing services have been successfully demonstrated in the city of Ålborg (DK), Bremen, and Bristol (VIVALDI (2006). The service consists of 11 cars and 7 car sharing sites. Users are given a personal smartcard and a PIN to use the car booked on the Internet or telephone. The system records the distance and time which are charged on the bill sent to the users. This initiative has produced positive results:

- a reduction of the total fuel consumption for transport of about 1%;
- using environmentally friendly cars, energy consumption has been about 2.4 MJ/km (quite less than the average value for the private vehicle fleet in Ålborg which is 3.1 MJ/km);
- thanks to a marketing strategy users of a monthly PT ticket could join the car sharing scheme at a convenient rate, and this resulted in 30% more potential car owners who having joined the scheme have postponed the purchase of a car.

In the city of Rome, car-pooling and car-sharing services have been demonstrated. The car-pooling service, which consists in the shared use of private vehicles to make home-to-work trips, has been managed by the Municipality of Rome and has involved a number of companies.

The pilot car-sharing service has consisted of 10 cars and seven parking areas accessible 24 hours a day, and it has been implemented in the III district. A call centre has been set up to make reservations. The most important result has been the increased attractiveness to these services among users (in spite of the limited extension of these two pilots, the number of participants has steadily increased). The number of car poolers has increased during the project lifetime from 750 to 1 180 corresponding to 360 crews. The car-sharing users increased from 140 users to 247 (62 were regular users). The high number of car poolers resulted in a very high occupancy rate (about 75%). The users' perception of these services has been very positive (the value of the "satisfaction level" indicator has been quite high) (MIRACLES, 2006).

In Bremen the existing car sharing service have been extended with new locations and 33 vehicles involving also more peripheral zones. This measure has focused on encouraging special target groups such as business people, cyclists, and commuters to join the service, for example, by introducing a new tariff for business users in order to increase the use of the service during weekdays. This initiative resulted in an increase of the number of car-

sharing users and a decline in private car dependence (it has been estimated that about 500 000 vkm/year have been saved thanks to the service, and, considering that each car-sharing car replaces 9.5 private cars, a reduction of emissions of CO_2 of 185 000 kg per year) (VIVALDI, 2006).

In Bristol, the car-sharing service (City Car Club) has over 220 members, a fleet of 24 vehicles and operates in 8 city districts. The service users can book the car on the Internet or telephone, and can access the cars using their own smartcard and PIN. The Council has developed a mechanism to designate parking bays on the highway for the sole use of car club vehicles. On-street bays and the guarantee of a parking space increase the appeal of the service, particularly in heavily built up areas. In general the car-sharing service has contributed towards low car-intensive life style. Specific results have been as follows:

- about 60% of users had access to a car prior to joining the car-sharing, but now over half of them only use car-sharing;
- 61% of users do not own a private car;
- 19% of users thought to buy a car before joining the car club.

The city of Rotterdam implemented a measure to expand the car-sharing service in order to enhance the car-sharing service, which currently only serves the city centre and some surrounding districts in Rotterdam. The planned expansion of the current network of parking locations consisted in identifying the most suitable sites in relatively difficult areas in northern, southern and eastern parts of Rotterdam to create 50 new parking spaces (distribution portals), and increasing the vehicle fleet size with 50 additional cars. The expected result was to involve additional 750 citizens in the car-sharing programme. The partial fulfilment of the planned objectives (only 13 new cars were introduced) did not permit to achieve the expected result (only a total of 130 new subscribers were attracted). However, in general the majority of users were very satisfied about the service (91% were satisfied about the ease of reservation, 95% about availability of cars, and 82% were satisfied about the distance to access cars) (TELLUS, 2006).

Finally, although it has achieved a small degree of implementation, it is worth mentioning a measure implemented in the city of Berlin aimed at demonstrating new forms of collective transport and vehicle use to offer new choices to urban travellers. The measure “Car Modal Services” consisted of three alternative services:

- a collective taxi service (“CharterCab”);
- a virtual centre for car pooling based on private cars for collective use (“Fellow Passengership”);
- a car-rental system including the possibility to make one-way-trips without fixed return stations in the city centre (“Telematic Cashcar”).

All these alternative services make use of new communication technologies (GPRS, UMTS and Bluetooth). The analysis of the potential benefits of a flexible, demand oriented transport service like CharterCab showed that positive impacts are to be expected. However, calculations show that the environmental effects are less substantial than one would expect, because this service can only be implemented in specific, closely defined areas of the city (the periphery and suburban residential areas) (TELLUS, 2005a).

4.4.3.2 Other projects

Research has produced results on the further development and extension of car-sharing to all Europe. Many features related to car-sharing have been examined in different project test sites (Bremen, Bucharest, Genoa, the London Boroughs of Southwark and Sutton, Palermo, Turin, Stockholm, the Walloon Region of Belgium) in order to improve the overall quality of the car-sharing services and target a market breakthrough at European scale (for example, booking via mobile phone, integration with public transport, integration into urban development, car-sharing and electrical vehicles, collective taxi, on-demand shuttle service, waterborne transport). It has not been found a universal recipe for the introduction of car-sharing suitable for every urban transport situation. Research has also addressed issues related to the assessment of the needs of existing and potential car-sharing users, as well as the impact of car-sharing on the quality of life in the urban environment. Car-sharing contributes to sustainable development without restricting individual mobility (MOSES).

4.4.4 Policy implications

4.4.4.1 CIVITAS Initiative

A general conclusion from the implemented measures is that the car pooling / sharing schemes, although popular with users, did not significantly affect the modal split. In order to obtain positive impacts on modal split, it is recommendable to appropriately advertise the service in order to involve more travellers (MIRACLES, 2006).

Furthermore, potential growth for car sharing organisations has been identified in extending the service to suburban regions (VIVALDI, 2006). However, a focus group discussion carried out in Bremen in September 2005, concluded that car sharing organisations would find it difficult to attract new customer in the suburban region with only

market-based offers, and that the demand for car-sharing is too low from a business point of view.

4.4.4.2 Other projects

Even though the general attitude towards car-sharing is often positive and there seems to be a growing interest, the knowledge and awareness of car-sharing is in general low among politicians. As a consequence, it is necessary to raise awareness among politicians to effectively promote car-sharing (MOSES).

4.5 Sub-theme 4: Transport management and soft measures for managing mobility demand

4.5.1 Background

Research results illustrated in the former Thematic Research Summary on urban transport (EXTR@Web, 2006) assessed travel behaviour changes and user acceptance generated by the implementation of a combination of an internet-based PT trip planner with different transport services (e.g. information, electronic ticketing for PT, etc.). Research also provided a state of the art review on bus priority systems, analysing and comparing a wide range of systems. Furthermore, a study to assess the potential of car clubs and car sharing was conducted. Investigations on the potential of marketing activities as an effective way of changing people behaviour and encouraging them to choose PT were carried out, as well as mobility management initiatives for companies, schools and big events. Finally, research has also implemented measures to introduce real-time information systems, trip-planning tools on the web, and mobility centres.

4.5.2 Research objectives

A first group of objectives have focused on the improvement of the international state-of-the-art of real-time network-wide urban traffic control through the application of the Traffic-responsive Urban Control (TUC) strategy (SMART NETS). Research was motivated by the fact that current congestion problems in urban areas require the best possible use of existing infrastructure by using systems which permit to avoid oversaturation, increase throughput, and reduce travel times. Unfortunately, the existing real-time (traffic-responsive) urban control strategies have the following drawbacks:

- they do not directly address saturated traffic conditions;

- they are functionally decentralised, i.e. signal-setting decisions in each junction are based on the current traffic conditions in adjacent streets only;
- several of the currently available strategies require specific real-time measurements, or complex implementation software, which make difficult their transferability and increase their implementation costs.

By using the currently available ICT technologies it is possible to manage information and provide information services in order to help citizens to make the most rational and sensible choice when they plan their trips, and, as a consequence, reduce the traffic congestion in urban areas. Therefore, another group of objectives have concerned with the application of mobile technologies to the development of an innovative multimodal and intermodal transport software platform offering a number of integrated services and information for trip planning (TRASCOM).

Another group of objectives has related to the development, implementation and evaluation of a package of mobility management measures in order to promote, facilitate and encourage the use of alternative modes to the car (TARGET 2). Research was motivated by the fact that the development of sustainable urban transport requires changes of behaviour, attitude and culture in order to encourage modal shift towards more sustainable modes of transport.

Another research objective has been to investigate behavioural response to Travel Demand Management (TDM) policy measures (EMMA).

A final group of objectives has concerned with the assessment and/or demonstration of various individual or integrated measures (VIVALDI, 2006; MIRACLES, 2006).

4.5.3 Research results

4.5.3.1 CIVITAS Initiative

In the city of Ålborg in Denmark, a Real Time Passenger Information (RTPI) system has been demonstrated along with a bus priority scheme. This integrated scheme consisted of more than 200 buses equipped with computers able to communicate with a mobility centre, 32 signs and information kiosks with RTPI located at the most important bus stops and at the four local railway stations, and 51 intersections with bus priority. The result has been that PT users well accepted the system and were well aware of the opportunities offered by the information kiosks (on a monthly basis, 24 000 pages were activated at the terminal, mainly for searching itineraries and schedules). Regarding the bus priority system, it has been calculated that each day each bus passing the 51 intersections with priority saved

about 4 minutes (VIVALDI, 2006).

Research has also demonstrated traffic management measure targeting walking and cycling modes. In the city of Bremen, a contraflow lane for cyclists on a one-way street (Lahnstraße) has been created along with better cycling infrastructure and reallocation of road space to improve safety of cyclists. The overall result according to a survey is that the users of the new cycle lanes feel significantly safer (the share of those who feel “very safe” or “safe” has increased for Langemarckstraße from 17% to 79%, for Lahnstraße from 10% to 79% and for Hohentorsheerstraße from 39% to 71%) (VIVALDI, 2006).

Also the city of Cork has implemented measures to promote the use of sustainable transport modes by providing facilities for cyclists and pedestrians. Besides providing better footpaths for pedestrian, this measure has extended bicycle parking facilities in the city centre (264 bicycle parking places were available in October 2005), and has introduced in all city primary schools a Cycle Safety Training Programme (which has been positively accepted). 61% of surveyed users rated the new bicycle stands as “very good” (additional 29% rated it as “good”). An increase in cycling across the inner cordon by 47% (according to LUTS – Land Use and Transportation Study- classified traffic counts in October 2005) has been measured (MIRACLES, 2006).

In the city of Bristol, a demonstration involved the implementation of a wireless hotspot providing equipment and Internet access to local residents to widen participation and encouraging e-learning and use of other online services. A survey among residents involved in the initiative, has shown that (VIVALDI, 2006):

- 13% of participants have started to work from home, reducing the need to travel;
- 57% used the Internet for shopping and 35% used Internet banking facilities, which may lead to a reduced number of trips;
- 30% used the Internet to obtain travel information (this suggests that Internet access may make it easier for people to travel by public transport).

Furthermore, in order to give access to travel information for the bus, rail, and ferry services, as well as by bicycle or walking, the Intermodal Trip Planner (ITP) has been implemented. This planner is an Internet-based application which allows the user to plan door-to-door trips using addresses or places of interest. The outputs are full itineraries provided in textual or graphic form, and the system is able to provide information tailored to the individual traveller. It has been estimated that in a month an average of 600 journey requests have been hit (VIVALDI, 2006).

In the city of Nantes, a new system for real-time passenger information available on mobile phones called MOBITRANS has been implemented to provide better public transport information. The system provides information on the two next departures of any bus or

tram route from any stop on the urban network, warning messages about potential route disruptions, and the location of the nearest bus or tram stops from a given address. Interviews carried out to find out how the MOBITRANS service had been perceived by users showed that the information provided was considered reliable and accurate, and delivered in a user-friendly manner, thus enabling a better planning of journeys. However, users were worried about the potential costs of using the mobile phone to access the data. On average between 250 and 300 connections per day were made (VIVALDI, 2006).

A hard measure implemented in the city of Nantes involved the remodelling the historical axis from the city centre towards Brittany (the Vannes road) by assigning freight traffic and buses to a central road with local traffic on side lanes, enhancing pedestrian and cycling facilities, providing efficient connections between buses and tramline 3, and, finally, improving the urban landscape. The site measure included a Park and Ride facility (302 parking spaces, 10 bicycle parking spaces, and private parking with 98 spaces reserved for the shopping centre). Surveys showed a constant increase of the tramline patronage since it opened, and evidence that commuters have changed their behaviour: 13% of passengers surveyed were car users before the tramway (VIVALDI, 2006).

The city of Bucharest has implemented a modern positioning system based on GPS technology to be used for public transport vehicle prioritisation, fleet management and real time passenger information at stops. During the demonstration only the indicator “accuracy of time keeping” was assessed. The results of the measurements performed before and after the implementation of the system did not show significant improvement of the schedule adherence. This should prove that it is not possible to solve this problem by only introducing a vehicle positioning system, which only contributes to quantify this problem. Therefore the implementation of the system on the entire PT fleet can produce positive impacts only if appropriate complementary measures are implemented (e.g. preparation of schedules adapted to the real traffic situations, public transport vehicles’ prioritisation) (TELLUS, 2005b).

In the city of Rotterdam, a measure has been implemented involving the installation and operation of 5 Dynamic Route Information Panels (DRIP – also called variable message sign VMS) at main city roads leading towards the highway ring road. Since in the Rotterdam Region, there are two organisations which gather and manage real time traffic information (the National Road authority for the National Highway Network and the City Administration for the City Roads), but do not cooperate, the measure also aimed at establishing information exchange between these two organisations in order to give complete and integrated information about the flow of traffic on the ring road. This information will support users to make decisions on which direction of the ring road to choose, and this will result in better traffic flows on the ring road in both directions and therefore less congestion on the adjacent urban roads. Although no significant effects on

traffic could be assessed, the DRIPs, in case of accidents or road works on the ring road, can help to adequately redirect traffic with positive effects on transport, energy and environment. Furthermore, traffic situation in and around the city will certainly benefit from the cooperation between the abovementioned organisations, since high road traffic and urban traffic strongly interact with one another (TELLUS, 2006).

In the city of Rotterdam, a measure involved the introduction of real time arrival/departure information at the tram-stops of the high quality tramlines and at the metro stops in order to increase attractiveness of PT. The dynamic information system has been implemented at more than 70 metro and tram stops. The displayed information includes travel and departure times, as well as possible delays or special events. Also on-board communications systems were successfully implemented on 74 trams. A survey showed that the user acceptance was high as the information system led to a perception of shorter waiting times. Whether the number of passengers actually changed due to the information system could not be assessed (TELLUS, 2006).

In the city of Gothenburg, a measure has been implemented to improve the sustainability of the Environmental Zone established in the city centre by reducing the number of transport vehicles moving in the area. Studies show that most of the distribution vehicles have a low load factor. With more involvement of corporate consumers, a possible way of reducing the number of delivery vehicles circulating in the environmental zone is to induce consumers to demand a specific load factor for distribution vehicles delivering in the area by making the consumers aware of their part in the logistic chain and by making them change their purchase and delivery routines. A Mobility Centre base allows consumers to make free consultations on how to change purchase and delivery routines/behaviour. For example, companies which usually order office materials can renegotiate delivery frequencies on the basis of the consultations in order to decrease the number of deliveries. 17 companies in the Lundby area joined the measure on a voluntary basis and the majority of them showed a decrease of transport frequency of office material by 30% to 80% with an average of 41% (this means that if 100 deliveries per month were made before the measure, 59 per month were made after the implementation of the measure). Interviews carried out to assess what the users of the measure (the customer and wholesaler of office material) think of this measure showed that there was a very positive attitude towards the initiative (TELLUS, 2005c).

The city of Rotterdam as many other European cities has to confront with high level of traffic congestion in its densely populated region, to which commuters significantly contribute. The mobility advice centre for the greater Rotterdam region (VCC-R) acts as an intermediary between the local business community and public authorities and is specialised in helping employers and employees reducing car dependency. In order to enhance the access to information on mobility management, the city of Rotterdam has

implemented a measure to create and operate an Internet-based information service on mobility management in the region. The majority of users gave a positive rating to the website and its content. Most visitors searched information about biking. Nonetheless, considering that more than 45 000 employees have been approached about the website, there is a great potential that visitors will use the website to retrieve more information about commuting alternatives (TELLUS, 2006).

Furthermore, the city of Rotterdam has created an organisation called “Fileplan” to integrate public and private transport initiatives by facilitating an intensive co-operation between regional government, private companies and institutions and the national Ministry of Traffic and Transport. Its main activity consists in coordinating and supporting all relevant public and private entities in order to promote initiatives for the reduction of congestion. This cooperation improves the process of decision-making in various complex situations (TELLUS, 2006). In this regard also a measure to develop a new approach to integrated planning has been developed. In fact, urban development projects often are complex involving many aspects and stakeholders making it difficult to integrate spatial planning, traffic and environment issues. This new approach consists in the combination of smart land use and public-private cooperation in several areas where integrated planning is necessary in order to obtain synergetic financial, technical and communication effects. This new approach has been used in planning three strategic transport interchanges (the train station located at Alexander, the traffic and transport node on the location Kralingse Zoom, the area surrounding Ahoy-Zuidplein). This approach has helped to overcome hesitations and obstacles encountered during complex processes (TELLUS, 2006).

In the city of Rome, a measure has been implemented to promote mobility management among commuters, as well as to raise awareness of the need to rationalise home-to-work journeys among employees, decision makers, private transport companies and administrators. This measure has involved the development of commuting plans, the organisation of car pooling crews, provision of information on opportunities and initiatives for using collective transport. The results have been the development and operation of ten Home-To-Work Plans (HTWPs) involving private companies, administrative and research bodies. In 2005 the average number of participants involved in the HTWPs was 41 805 who produced 15 772 vkm (about 1 400 users shared HTWP daily). There has also been an increase in the number of managers involved in the creation of new HTWPs. Even though the impacts on traffic and the environment have not been actually assessed, it has been estimated that this measure should led to a reduction of 7.5 million of vkm a year, a decrease in CO and benzene emissions of about 67.2 t/year and 239.2 t/year respectively, as well as a reduction in fuel consumption of about 244 t/year (MIRACLES, 2006).

Also in the city of Cork, a measure was implemented to raise awareness of the need and potential of more sustainable transport among commuters, through the implementation of a

car-pooling scheme for Cork City Council employees in order to reduce the number of vehicle trips. In the baseline surveys, 70% of employees commuted by private cars (42% travelling alone), while the remaining 30% used sustainable modes (i.e. public transport, cycling, walking, and train). In the 2004 surveys, 61% used private cars (34% travelling alone) and 36% used sustainable modes. However, the change in modal split has been largely affected by the increased access restrictions in the city and from the reduction in parking spaces available to City Council employees (approximately a 20% reduction in parking spaces over 3 years). Unfortunately, the user acceptance of the car pooling scheme has been 'very negative'. People were mainly concerned about issues such as insurance and restrictions on the use of vehicles for work (MIRACLES, 2006).

The city of Winchester has set up a measure to investigate the impact of high polluting vehicles with a view to improving air quality in its city centre. Emissions from passing cars have been measured using a roadside Remote Sensing Device (RSD) installed on selected sites on main radial routes leading to the centre. The measurement results have been used for a number of feedback strategies to vehicle drivers, aiming at encouraging voluntary maintenance of high polluting vehicles or to prevent them from accessing the city centre, such as (MIRACLES; 2006):

- use of mobile visual management systems at roadsides to inform drivers on the levels of their emissions;
- use of a website based database to list emission readings from individual vehicles;
- provision of subsidised emissions checks and repair services to high polluting vehicles;
- instructions for high polluting vehicles to use P&R instead of travelling into the city centre.

Because of technical problems with the measurement equipment, the strategies could not be implemented on the road. However surveys have been conducted to understand the support and potential take up of the various feedback strategies. The cost of monitoring an individual vehicle's emissions using roadside RSD has been estimated to be £0.21 per measurement not considering the fixed equipment cost, and £3.75 (based on 35 000 measurements) including it. The surveys have shown that 80% of respondents strongly agreed or tended to agree with this scheme to assist and advise drivers to reduce pollution in the city centre. 73% of respondents declared that they would like to be informed of the level of their vehicles emissions, whilst 76% of respondents would be interested in a subsidy to inspect and repair their vehicle. 72% of respondents agreed that high polluting vehicles should be use P&R instead of entering the city centre. About 80% of respondents declared that they would voluntarily make check their cars if the roadside measurements (indicated via a visual management systems) indicated too much emission levels. About 60% of respondents stated that they would check their emission levels on the web service every month or less frequently. Only 6% of the respondents stated that they would not be

willing to have their vehicle checked under any circumstance based on the RSD measurement (MIRACLES, 2006).

4.5.3.2 Other projects

Research has developed, demonstrated and evaluated the innovative TUC (Traffic-responsive Urban Control) strategy (which also takes into account public transport priority measures) that can be easily and quickly implemented and can provide a significant reduction of travel times within urban traffic networks. The performance of this TUC strategy, which makes use of employs advanced automatic control methodologies, has been evaluated through simulations and demonstrations in three sites (Chania in Greece, Southampton in UK, Munich in Germany), producing positive results. In particular, it performed much better in comparison to the well-established and sophisticated resident systems in the three test sites, and user acceptance was generally high. Furthermore, the TUC has proved to be easily transferable to any type of network, because the test areas in the three test sites had very different characteristics in terms of network layout and traffic behaviour (SMART NETS).

Research has also successfully developed and validated an information platform which makes use of the most advanced mobile technologies and communication protocols (e.g. PDA, UMTS, Bluetooth, SWAP, Ethernet wireless) and offers services to support travellers and transport operators to efficiently plan their mobility choices by using a combination of all modes of transport. The platform architecture is universal, generic, open and scalable, and contributions to the standardisation of data exchange between the information systems of transport operators have been made (TRASCOM). New applications such as mobile electronic payments and real time assistance to traveller have been also developed.

Research has achieved important results in implementing a variety of travel solutions and has shown the positive impacts on modal shift towards more sustainable transport modes (TARGET 2). However, research activities have also shown that it does not exist a single solution which can be applied to all situations. For the implementation four linked transnational Work Areas have been established, each designed to target a specific population group with the most appropriate interventions to achieve the modal shift. These work areas are:

- Work Places. This area developed a model for working with key business sectors and developing travel options, such as car-pooling, bicycle usage and the promotion of greener fuels.
- Mobility Education. This area developed positive attitudes to sustainable transport modes by targeting households with information and school initiatives.

- Transport and Leisure. This area aimed to reduce car travel to a range of visitor attractions, for example, through logistics improvement.
- City Living. This area developed activities for urban areas such as improvement of information for walkers and cyclists, integrated ticketing and removing causes of social exclusion.

The main results obtained in the above mentioned areas are as follows. Successful marketing concepts that target specific groups and encourage participation have been demonstrated. Tailored, personalised campaigns targeted at individuals and groups of individuals, have created significant modal shift. Linking travel plans with discounted public transport tickets was a key factor in the success in West Yorkshire. By integrating alternative transport modes into the marketing and planning of developments, and using awareness campaigns over a period of time successfully increased the patronage at the venue and use of public transport (TARGET 2).

Finally, concerning the investigations on behavioural response to TDM policy measures, research has carried out empirical studies to better understand how car users respond to the following three TDM measures: individualised marketing, road pricing and prohibition. The main findings are as follows. Coercive measures have low impacts in terms of acceptance and adaptations. Furthermore, adaptations follow a psychological cost-minimisation principle, and the attractiveness of options such as more efficient car use, or use of PT depends on age of the car users, type of trip (work, shopping, leisure), and type of TDM measure (EMMA).

4.5.4 Policy implications

4.5.4.1 CIVITAS Initiative

Recommendations have been made in relation to the developed approach to integrated planning (TELLUS, 2006):

- It is recommendable to ensure that all policy makers (city districts, municipality, regional authority, etc.) and politicians are committed to the policy plan. The energy spent in gaining stakeholders commitment beforehand is only a fraction of the that needed to recover acceptance after the establishment of an undesired policy plan.
- It is recommendable to exploit pressure from market or market opportunities to enforce the planning process. The pressure of stakeholders from market can be very useful to gain political commitment and therewith accelerate the process.

Concerning the Internet-based information service on mobility management in the region, it

is recommendable to broaden the scope of the website which is currently mostly focused on biking and information about bicycle routes. For example success stories of individual companies working with commuter plans (e.g. examples about van-pooling, use of public transport, etc.) could help to attract other people and obtain more benefit from the mobility management point of view (TELLUS, 2006).

It is also recommended to maintain and improve cycling infrastructure, which are essential to keep cycling attractive for residents, and as a consequence to keep modal split for cycling at a high level or increase it (VIVALDI, 2006).

Finally, the demonstration of the mobility management measure in the city of Rome has achieved to involve just 2.7% (41 805) of all the potential users. Therefore, for future initiatives it is recommendable to develop campaigns to increase awareness among employees of better solutions other than driving alone to work, such as car pooling or collective taxis. These campaigns should be mainly targeted to commuters, and should stress on individual benefits from using collective modes as well as the positive outcomes on the environment (MIRACLES, 2006).

Regarding the car pooling demonstration, the scheme alone cannot achieve a significant shift in in modal split. It is recommended to implement car pooling schemes in combination with car restrictions (such as a reduction in parking, increase in cost) (MIRACLES, 2006).

4.5.4.2 Other projects

The successful demonstrations of the TUC system in the three test sites have shown that there is scope for the exploitation and further development of TUC. Research has produced the following recommendations for future TUC implementations (SMART NETS):

- to improve the interface of the TUC system in order to improve its user-friendliness;
- considering the positive results of the demonstration, it is necessary to raise awareness of urban control operators on the potential of TUC as a cost-effective answer to urban traffic and congestion problems, and encourage them to introduce TUC into their cities;
- the simulations showed that the most significant contribution of TUC to traffic control is its capability to prevent gridlock, but since no gridlock occurred in any of the test sites during the demonstration, it is necessary to find a test site where gridlock is a frequent problem in order to demonstrate this potential of TUC.

Research into the implementation of travel solutions to encourage modal shift towards more sustainable transport modes has identified three overarching themes of the

development of the sustainable transport agenda for the future (TARGET 2):

- Focused activities combined with sustained targeted marketing delivers modal shift.
- Behaviour, attitude and culture change are long term processes. They require continuous efforts and resources which start by raising awareness of sustainable transport options among young people and continue to by involving them throughout all stages of their lives.
- A strategic vision for sustainable transport must include a broader spatial development vision.

Finally, regarding the investigations on behavioural response to TDM policy measures, in order to achieve public acceptance, effectiveness, and political feasibility it is recommended to combine coercive TDM measures (prohibition and road pricing) with non-coercive (information) (EMMA).

4.6 Sub-theme 5: Goods transport

4.6.1 Background

Research reviewed in the Thematic Research Summary on urban transport produced in EXTR@Web (EXTR@Web, 2006) developed tools (shortest path finding, vehicle route planning, on-line vehicle routing planning, urban shop delivery planning, etc.) to support the planning process in realising efficient door-to-door transport of goods in urban areas. Furthermore, it analysed innovative concepts for improving the distribution of goods within urban areas and between intermodal/freight centres and urban areas, and has investigated consolidation practices.

4.6.2 Research objectives

Issues concerning the delivery and collection of goods within cities are becoming more and more stringent, because of their significant impacts on economics, society and environment, and in general on the quality of life of its inhabitants. Consequently research objectives have focused on carrying out demonstration of individual or integrated schemes (TELLUS, 2005a; TELLUS, 2005c; TELLUS, 2006; VIVALDI, 2006; MIRACLES, 2006), as well as on identifying, describing, and disseminating best practices for improving urban freight transport. This refers to access restriction schemes specific for goods vehicles and to waste collection. This latter is an important aspect of city logistics often overlooked. In

fact, the problem of waste disposal is becoming more and more urgent, and it is necessary to develop suitable waste management programmes to increase the sustainable development of cities (BESTUFS II, 2005).

Research objectives have also concerned with the development and application of technologies and technical solutions. More specifically research efforts have aimed at developing tools for planning and management of delivery trips (eDRUL), as well as appropriate vehicles to ensure efficient delivery operations and low impacts on quality of life in cities (FIDEUS; HOST, 2005).

4.6.3 Research results

4.6.3.1 CIVITAS Initiative

In the city of Bristol two schemes have been demonstrated: the City Logistics Scheme, and the Home Shopping scheme. The first scheme involved the development of a freight consolidation centre with the participation of key local and national stakeholders. This centre, which is located 11 km from the city centre, is operated by a private company, and serves more than 50 retailers in the Broadmead shopping area. The main result of the implementation of this scheme has been the reduction of the distances run by goods vehicles in the city centre and a consequent reduction in air pollution (VIVALDI, 2006).

The Home Shopping scheme was developed in response to the need of improving the Royal Mail parcel delivery service in terms of more convenience to customers, especially housebound people, and reduction of the number of journeys and distances run by goods transport vehicles. This scheme, which represents a straightforward alternative to Internet shopping, enables people to scan barcodes to select and order the desired goods from a catalogue of products stocked by a local supermarket using a barcode reader and computer called “Companion” appositely designed by the Brunel University. The ordered products are then sent to a local Post Office or to a secure Locker Bank (the scheme involved the installation of secure electronic lockers at locations that are more convenient for the customer than the nearest Royal Mail depot). The scheme demonstrated in Bristol formed one-third of a national trial, and only overall results are available, among which: 84% of users declared that the scheme made easier for them to do shopping; 28% have bought more through home shopping channels as a result of convenient delivery; 33% of users stopped using a car to collect items (VIVALDI, 2006).

A demonstration measure carried out in Berlin has developed a prototype of a telematics-based container tracking system that improves the efficiency and security of intermodal container transport. This prototype, which has been successfully tested, features

(TELLUS, 2005a):

- a movement and shock sensor which establishes proof of whether a container has been jolted during rail transport, with possible consequent damages to its content;
- an automatic door-opening control system which establishes proof of whether the container had been opened without authorisation (to prevent thefts);
- a loading space control system to optimise container loading capacity;
- low maintenance costs (furthermore, the system will be soon equipped with a solar cell to avoid frequent replacement of batteries).

The city of Gothenburg has demonstrated a scheme involving incentives for encouraging suppliers, haulers and retailers to better co-ordinate and consolidate their deliveries to the existing Environmental Zone in order to improve load factor of vehicles and reduce environmental impacts. The expected result was a reduction in the number of deliveries to the area without imposing restrictions on volume of goods or vehicle type, with consequent positive effects on congestion and total emissions. Unfortunately, the expected results in terms of reduction of emissions and number of freight movements have not been achieved. However, the acceptance of the measure from drivers, transport companies, the municipality and businesses has been very good (TELLUS, 2005c).

In the city of Rotterdam, a measure aimed at expanding the MultiCore tube system together and carrying out marketing initiatives in order to attract new clients and increase the volume of goods transported by the tube system. The MultiCore Tube is an underground distribution system consisting of 4 pipelines which was created to transport and distribute chemicals and gases between companies in the harbour areas. A company can lease a pipeline from MultiCore for a required distance and connect it to their installations. The rationale was to provide companies with a reliable, cost-effective and time saving alternative to trucks or inland shipping and to provide a positive effect on the environment and the accessibility of the harbour area. 13.5 km of additional pipelines were realised. Before using the pipeline system, Exxon used annually more than 150 barges to transport 250 000 tonnes of products from its main production plant to one of its auxiliary plants in the Rotterdam port area, each barge running 26 km and taking about 25 hours including the transhipment. By using the MultiCore tube system the same amount of annual product can be pumped as much as needed at specific moments using 14 km of pipeline, taking approximately 6 hours. This permitted to reduce water transport traffic by about 6 million tonne-km per year. The main drawback is the high investment cost, so it is not possible to reach the break-even point for the operational revenues in the short period (TELLUS, 2006).

In the city of Winchester, a concept has been implemented to reduce the number of missed home deliveries. This concept, named Collectpoint, has used a chain of local convenience stores as delivery points. Simulation found that if a fully operational scheme

had been implemented, potential benefits could be gained in terms of reduced time and distance travelled. Although it has been intensively promoted (flyers were distributed to about 20 000 households), only 75 people registered on the Collectpoint website and 8 used their voucher. This is quite strange, because questionnaires were distributed to 1 600 households, and on the basis of the answers, it was estimated that the average first-time failure rate of a typical home delivery was 20%, and that the majority of respondents declared that they would consider using the scheme (however, awareness surveys found that only 10% of the general public and only 3% of businesses were aware of the Collectpoint scheme).

Another measure has been successful. It was a waste recycling scheme, consisting in using an electric vehicle to collect waste cardboard and paper from city centre businesses. The service has involved 30 businesses in Winchester, and each month about 1 tonne of recyclable waste cardboard and paper has been collected. In addition to the environmental benefits, there has been some indication that the use of the electric van was an incentive to local businesses to participate since they perceived it as being a useful Public Relations exercise (MIRACLES, 2006).

4.6.3.2 Other projects

The analysis of case studies on access restriction schemes specific for goods vehicles has found that the most emerging concept is the Low Emission Zone (LEZ) scheme (or "Environmental Zone" scheme), of which a number of trials are ongoing (Successful examples came from Swedish cities - Stockholm, Gothenburg, Malmö, and Lund. Cities like London, Madrid, Paris, Copenhagen and a number of Norwegian cities have planned to implement this concept). Mainly driven by the intent to reduce air pollution and noise, LEZs may be based on (BESTUFS II, 2006):

- a geographical area;
- a time period;
- vehicle emission standards;
- vehicle types;
- loading factor / utilisation rate.

Furthermore, the analysis of the case studies also showed how the question of night deliveries is still very controversial. Its detractors declare that night deliveries cause noise emissions, while its supporters declare that they permit daytime traffic to be reduced and the efficiency of the delivery process to be enhanced. Examples of night deliveries only permitted in a limited geographical area (in non residential areas) have been identified. Furthermore, there is a case study which aimed at improving the cooperation not only between local operators and authorities, but also between municipalities (for example, by harmonising time-windows for deliveries among a number of cities) (BESTUFS II, 2006).

Case studies on enforcement and control concepts in urban transport showed that when the controlled area is wide, the most efficient solution is enforcement with the support of electronic equipment (video detection or electronic bollards). Furthermore, though expensive, several countries have begun to use it to overcome problems caused deficiencies of manual control and enforcement systems, or by the lack of human resources. Finally, regulations for the use of video enforcement vary according to countries, which often hinder its use for privacy reasons (BESTUFS II, 2006).

A finding from the analysis of case studies is that waste transport seems to be very suited to inland waterways and railway transport modes, and, in general, modal shift solutions for waste transport can enhance efficiency and reduce costs, as well as environmental impacts. Positive results can also be achieved using IT for planning and scheduling trips for collecting waste (BESTUFS II, 2005).

An achievement of research has been the development and validation of an e-logistics platform to improve the management of freight distribution in urban areas (eDRUL, 2002). This platform provides users with a wide range of ITS applications (from web-enabled information and booking services, through GPS-based or GSM/GPRS-based vehicle location systems, to trip planning and resource optimisation) which permit the management of users' logistics resources to realise flexible, demand-driven freight distribution schemes in different city distribution scenarios (e.g. city distribution in limited traffic areas under various access restriction measures, consumer-driven goods delivery services through the use of dedicated infrastructures such as pick-up points or take-away stations, optimisation of deliveries through cooperation of networked transport service providers, and others).

Research has also found that there is no single optimum vehicle to be used for freight distribution in cities. As a consequence, a complementary range of three vehicle types have been proposed, consisting in an innovative "clean" goods carrier, an adapted 3.5t van and a 12t truck. These vehicles are equipped with advanced technologies systems (including an innovative container for urban freight distribution) which enhance the operational efficiency and reduce the environmental impacts. As for logistics management aspects, it is necessary to achieve full vehicle load capacity, to enhance the efficiency of transhipment operations, and to integrate delivery operations within city traffic (FIDEUS). The results of the tests of the Low Noise Mode and Low Emission Mode (which forces the driver to limit speed and acceleration) vehicle features carried out in Lyon and Barcelona show a significant reduction of truck noise and emissions.

Research has also investigated the technical specifications and the potential market of an

innovative low polluting modular transport vehicle adaptable to the urban transport of both people and goods (HOST, 2005). The characteristics of the vehicle have been defined on the basis of user, market and driving needs identified considering four possible types of services (as freight services, daytime freight collection and distribution, and nocturnal garbage collection; as passenger services, nocturnal collective taxi, and daytime car sharing services). The driving needs analysis led to the identification of five parameters (HOST, 2005):

- thermal engine power (for all the proposed services the thermal engine power required is 9 kW);
- minimum needed battery capacity (this parameters changes according to the different services from 1 kWh when the vehicle works as a car sharing vehicle to 3 kWh for freight collection and distribution);
- maximum speed (120 km/h for car sharing and 80 km/h for the other three services);
- maximum traction power at wheels and maximum braking power at wheels (the value of these two last parameters is 66 kW for all the four services).

The vehicle dimensions, provided by the market needs analyses, are: vehicle length, wheelbase, width, front and rear wheel bases, floor height, maximum full load weight and tare. All these parameters vary with the specific service and can be obtained by appropriately defining the modularity of the vehicle. Finally, the handling parameters of the vehicle, identified by the user need analyses and applicable to all the four services, are the two safety systems ABS (anti-skid brake system) and EPS (electronic power steering), and the horizontal translation, which is an innovative capability of the vehicle. The user need analyses also identified auxiliary systems for the vehicles (the cabin air conditioned for all the services, a hydraulic tail lift and refrigerated boxes for freight collection and distribution, the impaired mobility accessibility system for collective taxi and a garbage collection system for the garbage collection). For performing the transhipment function, a new concept has been proposed, which consists of a compact folding capable of lifting up to 0.4 m a maximum load of 1 500 kg in 20 seconds (HOST, 2005).

4.6.4 Policy implications

4.6.4.1 CIVITAS Initiative

In spite of the technical problems which did not allow to assess the commercial viability of a fully working scheme of the concept “Collectpoint” (using a chain of local stores as delivery points), this scheme seems to be promising in terms of beneficial effects as indicated by the modelling study in order to reduce the number of trips of goods vehicles (MIRACLES, 2006).

The demonstration relating to the extension of the MultiCore tube system showed that a successful implementation of underground transport is only feasible in areas with companies of sufficient size which are able to sustain long term investments. Furthermore, an important driver for developing underground transport is the low vulnerability to accidents and incidents compared to road and water transport (TELLUS, 2006).

4.6.4.2 Other projects

The main policy implications made on the basis of the analysis of case studies on access restriction and enforcement are (BESTUFS II, 2006):

- To ensure a high level of acceptance of an access restriction scheme, it is recommended to have consultations with stakeholders (particularly businesses in the city centre and their transport operators) in an early stage of the planning process.
- To increase acceptance it is also recommendable to make an information campaign upon the introduction or change of a scheme, and encourage cooperation between cities for certain schemes (same environmental standards, weight and size restrictions, etc.).
- To improve transport efficiency and the quality of life in cities it is recommendable to also make use of innovative schemes based on environmental zones or charging approaches, besides the traditional access regulation schemes based on weight, size, and time restrictions
- To successfully implement a scheme it is crucial to consider the local context, making the required adjustments to the scheme according to the characteristics of the local industry and businesses. It is also necessary to develop enforcement concepts during the planning of a scheme, especially evaluating the costs of the enforcement activities.
- It is also recommendable to measure and evaluate the effects of a scheme for monitoring its success or failure and for making further improvements and adjustments.
- Finally, it is recommendable to introduce an enforcement and control scheme according to the function of the regulative measure and the size of the area (e.g., in a small city area that wants to control forbidden loading activities it is not cost-effective to introduce a high technology control system).

The analysis of case studies produced the following recommendations for improving waste transport and logistics (BESTUFS II, 2005).

- There is a lack of integrated logistics solutions. It is recommendable to develop integrated solutions and strategies, for example combining intermodal transport concepts, ITS-use and environment-friendly vehicles for the waste collection.
- It is recommendable to plan the location of landfill facilities in order to reduce negative impacts (vehicle kilometres, noise and exhaust emissions etc.). Spatial planning and transport activities, especially waste transport should be planned with a common approach.
- City authorities are often responsible for waste management, and they often outsource waste activities to private operators. As a consequence they have the opportunity to define in the tendering processes standards for collecting waste and technologies that can be used taking into account not only the operation costs, but also the environmental impacts, creating a sustainable approach in waste management and waste transport in their cities.
- Application. European countries should encourage and finance in co-operation with private operators national but also regional research activities in this field waste transport and logistics in order to find new sustainable solutions.

4.7 Sub-theme 6: Low environmental impact vehicles and infrastructure

4.7.1 Background

Research reviewed in the Thematic Research Summary on urban transport produced in EXTR@Web (EXTR@Web, 2006) demonstrated the use of bio-fuel, biodiesel, biogas, ethanol and electric hybrid vehicles for public and/or private transport. It also set up infrastructure for biodiesel and biogas. Measures involving incentives and promotion of clean vehicles were demonstrated.

4.7.2 Research objectives

In response to the EC Directive 2002/49 concerning the assessment and management of noise emissions, a research objective has been to develop an integrated methodology and investigate technologies for improving the control of noise caused by surface transport in urban areas (SILENCE), especially noise emissions from railways.

Another research objective has concerned solutions to reduce polluting emissions in urban areas due to motorised traffic. Apart from walking, bicycles are the best solution for environmentally friendly personal transport because they do not produce pollution and

noise, but their spread is hindered by the necessity of a physical effort (a particular issue in hilly cities), possible weather conditions which may make cycling unattractive, as well as perceived safety and security concerns (including risk of cycle theft). Motorised two-wheelers (motorcycles, scooters and mopeds) are a solution for congestion and parking problems, but in some cases they cause worse environmental problems than private cars. Electric two-wheelers seem to be a good trade-off, since they operate fully emission free and silently, and require less space and energy than cars. Consequently, research has demonstrated, evaluated and promoted the advantages of electric two-wheelers and their contribution to sustainable mobility in urban areas (E-TOUR, 2003).

Research has also focused on the development of more environmentally friendly PT systems in response to the more and more stringent issues concerning energy consumption and polluting emissions (CUTE, 2006).

Research has also aimed at assessing opportunities for improving the urban transport systems of cities by identifying, describing, and disseminating best practices, success criteria and barriers in relation to the introduction of environment-friendly vehicles (BESTUFS II, 2005), Research was motivated by the fact that high level of the quality of life in cities can only be achieved through an efficient and environment-friendly transport system.

Finally, an objective of research has been the assessment and/or demonstration of individual or integrated measures:

- schemes for encouraging the use or/and purchase of low environmental impact vehicles, in particular CNG and electric vehicles (VIVALDI, 2006; TELLUS, 2005a; TELLUS, 2005c; TELLUS, 2006; MIRACLES, 2006);
- schemes aimed at promoting the use of bicycles by enhancing cycling infrastructure or providing services, such as the Cycling Resource Centre in the city of Bristol (VIVALDI, 2006);
- measures aimed at introducing more energy efficient and environment-friendly vehicles into PT fleets (TELLUS, 2005b; MIRACLES, 2006; VIVALDI, 2006).

4.7.3 Research results

4.7.3.1 CIVITAS initiative

Regarding the promotion of the use and purchase of clean vehicles, research has demonstrated, in the city of Bremen in Germany, a scheme consisting in a financial incentive to buy CNG cars (€1 000 for private households and up to €2 500 for companies per car) together with the implementation of awareness campaigns using different media

and informative materials and the set-up of an information desk in the city centre to inform citizens about CNG cars (VIVALDI, 2006). As a result more than 300 applications for the incentive were received. Of the 297 approved, 231 were from commercial users and 66 from private users. Compared to a fleet made up of 60% petrol and 40% diesel cars, the estimated reduction of emissions with a CNG fleet is as follows:

- the reduction of CO_2 is slightly less than 100 kg (-17%);
- the reduction of NO_X is about 500 kg (-61%);
- the reduction of PM_{10} is about 354 kg (-98%).

Research has also demonstrated in the city of Bristol the use of electric vehicles (Reva G-Wiz cars), charged using renewable energy. These vehicles, based at three separate buildings, were used as pool cars for council. It has been estimated that these vehicles have consumed 502 kw/h of electricity; have an average operating cost of 0.03 €/km; and, at the point of use, they emit no pollutants at all (VIVALDI, 2006).

Also in the city of Gothenburg, a measure has been implemented to encourage local vendors to more actively market clean vehicles and to broaden knowledge of filling stations or economy concerning clean vehicles. The measure has involved general information and promotion activities (telephone marketing, newsletters, seminars, press activities, the development of a new national clean vehicle website, of the already existing incentives) targeted to private, public and company car users, car dealers and fuel suppliers, as well as the Swedish government and national authorities. The measure has positively influenced the clean vehicle market (retailers and purchasers) with 1 500 new private clean vehicles sold in one year (also thanks to new governmental taxation rules that make it easier for companies to purchase clean vehicles), and 200 new municipal clean vehicles introduced. Another result was the extensively increased awareness among public and politicians of clean vehicles issues (TELLUS, 2005c).

Research has implemented a measure to encourage the use of low environmental impact vehicles for urban goods distribution and waste collection. In Berlin, an integrated measure to encourage the purchase of at least 100 additional CNG-fuelled distribution trucks of different weight classes has been demonstrated. The measure consisted in a combination of an information campaign and financial assistance together with additional services like providing the purchasers with technical assistance. Besides the distribution of information material special information events for target groups and potential customers were organised. The idea behind this measure was that being CNG technology still unknown to the target groups (e.g. haulage carriers), besides financial incentives, it was necessary to inform potential users as it turned out at the beginning of the demonstration when there was a general reservation about the equivalent performance of CNG vehicles compared to conventional ones, and the tax advantages in using natural gas had not really been noticed. Thanks to the information campaign, these problems could be partly smoothed out

and the demand for CNG-trucks increased during the demonstration. Before the end of the demonstration period 91 additional CNG trucks were bought by haulage companies and 48 requests were under examination. Some synergetic effects during the demonstration can be ascribed to the contemporary enforcement of the air quality directive and the steady increase in fuel costs (TELLUS, 2005a).

In Gothenburg, a demonstration measure has involved the introduction and evaluation of 4 innovative clean waste collection vehicles to reduce emissions, energy use, and noise. These CNG-fuelled vehicles are equipped with electric powered bodywork, power steering, automatic turn-off of the main engine, and use water as hydraulic fluid instead of conventional oils. All 4 vehicles have been used for full-scale operation and, during one year of operation with satisfactory productivity, a single vehicle permits a reduction in emissions (in comparison to a conventional CNG vehicle) of particles, hydrocarbons, NO_x, and CO_2, respectively by 40% (34 g), 7% (4 kg), 52% (83 kg), and 49% (20 tonne), as well as a reduction of energy use of about 46%, also considering the electricity consumption. Furthermore, the electric hybrid technique has permitted to reduce noise emissions, and the use of water instead of oil in the hydraulic system has permitted to avoid polluting leakage of oil. Unfortunately, the cost of such vehicles currently requires an extra investment cost of about €100 000 compared to conventional diesel vehicles (TELLUS, 2005c).

In the city of Rotterdam, the introduction of electric vehicles for the distribution of goods in order to demonstrate the viability of using clean, quiet and energy efficient vehicles was not successful. The 7 electric vehicles experienced critical malfunctioning of the battery management system which resulted in frequent breakdowns. However, it was found out that the attitude of distribution companies, both managers and drivers towards the electric vehicles was basically positive, so the technical problems seems to be the main obstacle for the introduction of electric vehicles for city distribution. The initial high purchasing costs seems to be compensated by lower operating costs (TELLUS, 2006).

In the city of Rome, two new electric bus lines and a trolleybus line have been implemented. The electric bus lines have been operated in the Trastevere and San Lorenzo districts in accordance with the LTZ (Limited Traffic Zone) policy to reduce traffic and pollution in those areas, as well as for a night shuttle service within the LTZ, connecting P&R facilities. The trolleybus line has been operated in a corridor linking the suburbs to the city centre (Via Nomentana). About 10 000 to 12 000 passengers/day have been transported by the overall electric fleet (five lines), and about 32.000 by the trolleybuses, whose total corresponds to about 670 000 passengers/month. Furthermore, travel times have been reduced on average by 50%. Public awareness of the need to use clean transport services increased from 53% to 76%, and satisfaction increased by 10%). Finally, a survey to on users' perception and acceptance of the system has found that 86%

of the interviewees were in favour of the extension of the trolley line, thanks to the good performances of the line in terms of environmental friendly operations, low noise level, and quality of service (in terms of timekeeping, frequency, speed, and capacity) (MIRACLES, 2006).

In the city of Winchester (UK), a fleet of six clean vehicles has been purchased consisting of two LPG/petrol dual-fuel vehicles, two petrol/electric hybrid vehicles, and two electric vehicles (MIRACLES, 2006). The measure has aimed at encouraging businesses to use alternative fuel passenger vehicles and overcoming barriers to their introduction. Each participating business has been asked which factors would prevent them from purchasing a clean vehicle. The three most recurring answers have been operating costs, reliability and purchase cost. Successively each participating business has been given one of the six clean vehicles on loan for a one month trial. During the trial, 50% of the participating businesses have used the clean vehicle on a daily basis, and over 70% at least three days per week. 82% have rated the clean vehicle as generally good, 55% thought it was generally better than their conventional fleet vehicle, and 65% stated that they were likely to purchase a clean vehicle in the future for business use. However, the users generally perceived that their own fleet vehicle was better than the clean vehicle in terms of acceleration, handling in wet conditions, and availability and ease of refuelling. Finally, since an onboard tracking unit and a vehicle routing computer program permitted to collect route data during the trials, it has been possible to estimate emissions generated by the clean vehicles and compared them to those generated by conventional business fleet vehicles. The estimated reduction of CO_2, CO, $HC+NO_x$ emissions, and energy consumption have been on average (considering that emission data for vehicles older than five years – manufactured before 2000 - were not available, these reductions would have been more significant if all vehicles would have been considered):

- for the petrol/hybrid vehicle 40%, 20%, 70%, and 37% respectively;
- for the LPG/petrol dual fuel vehicle between 9% and 18%, 30% and 78%, 58% and 74%, 1% and 5% respectively;
- for the battery powered electric vehicles clearly 100% for each pollutant (it generates no emissions at all).

In terms of fuel cost per km compared to the usual vehicle, petrol hybrid vehicles and LPG/petrol dual fuel vehicles permit to achieve on average savings of about 40% and 20%, respectively (MIRACLES, 2006).

The city of Bristol has created the Cycle Resource Centre (CRC) at the Mud Dock, which provides a range of services for encouraging the use of bicycles. These services are secure parking, clothing lockers, shower and changing facilities, and on-site service and repair facilities (VIVALDI, 2006).

Since surveys showed that the lack of continuous high quality bicycle routes was an important reason for not using a bike, the city of Rotterdam has implemented a measure consisting in designing and realising 4 cycle routes to the central train station and other public points of interest in the city centre. Unfortunately only one of the planned routes could be realised, and with some delay since the local residents were not favourable to the construction of a bicycle lane in their street. The cyclists declared that the bicycle route was attractive and safe with high quality road surface separated by other traffic (TELLUS, 2006).

In the city of Winchester (UK), a bike-sharing scheme has been introduced (Bikeabout) with a view to increasing cycling modal share within Winchester and encouraging tourists and residents to use sustainable transport modes. The scheme has involved the introduction of 50 bicycles and two stations at main locations. The subscribers could borrow these bicycles for a one-day period (or longer). The scheme only required to pay a membership fee of £15. This measure was accompanied by the installation of additional cycle stands and the redesign of a Pocket Cycle map for Winchester. In 2005, this scheme had 160 members. During peak period of use almost all bicycles were being used. The average trip length was about 4.3 km approx (57% of journeys were round trips). Most users usually travelled by bicycle or foot within Winchester, and only three interviewees declared that they had switched from car. The majority (83%) of subscribers thought that the scheme was generally good. An awareness and acceptance surveys has shown that 38% of the public were aware of the Bikeabout scheme, and 66% generally agreed with it (MIRACLES, 2006).

As for the introduction of low environment impact vehicles into PT fleet, the city of Bucharest has demonstrated that it is necessary not only to pay attention to the polluting emissions but also to energy consumption when introducing clean vehicles. In fact, although Bucharest has a long tradition in using electric vehicles in PT transport (currently, more than 50% of PT passengers are transported using electric propulsion), the vehicles are old and have low reliability and consume too much energy. The introduction of new energy savings and silent vehicles (30 trams and 60 trolley buses, representing about 5% of RATB's fleet) the replacement of low energy efficient components in existing vehicles, and reconditioning work on infrastructure (tram tracks, electric network, electric substations, and tram stops platforms) resulted in a decrease by 10%, in electrical energy consumption for traction. Positive results were also obtained in relation to noise levels (compared to the old trams, the noise produced by the new ones has decreased by 6dB). The assessment of the impact of these measures on PT patronage showed that the number of passengers increased by 7.7% for trams and bus, and by 8.3% for trolley buses. The passenger capacity (km/day) has increased by 6.82% for trams and buses,

and by 10.34% for trolley buses (TELLUS, 2005b).

In the cities of Rome and Winchester, the bus fleet have been upgraded to the latest (in 2005) environmental standards (MIRACLES, 2006). The city of Rome has purchased 908 Euro III buses, 200 EURO III CRT (Continuous Regenerative Traps[4]) buses, 30 "new generation" bi-modal trolleybuses[5], and 10 electric buses (in 2005, 38% of the entire fleet consisted of new, eco-compatible vehicles, while only 12% consisted of Euro 0 and Euro 1 vehicles). Furthermore, all buses are equipped with air conditioning, low floor, two seats for disabled people, and on-board videos for providing information and news to the passengers. These features have increased public awareness and acceptance of clean vehicles. This measure has achieved (ex-post measurements), within the Rail Road area, a decrease in dust, VOC, NO_x, and CO by respectively 28%, 15%, 16%, and 18%, as well as a reduction of noise levels. The city of Winchester has purchased 13 new Euro III buses, 10 buses have been re-powered from Euro I to Euro III standard, and four Euro II buses have been fitted with Continuous Regenerative Traps (CRTs) (the entire fleet consists of 60 vehicles). The reduction of pollutant emissions have been estimated for a range of bus scenarios by a desktop study only on a key street in the centre of Winchester centre estimated. Emissions (in 2005 compared to 2002) of CO, HC, NO_x, PM and CO_2 have been estimated to decrease by respectively 44%, 42%, 26%, 53% and 2%.

In the city of Barcelona, the main bus operator (TMB) has introduced CNG buses into the PT fleet in order to achieve higher environmental standards and so to contribute to a more sustainable transport system. The demonstration has involved 160 CNG (standard 12m. long) buses between 2002 and 2005, as well as infrastructure improvements. A key successful factor was the establishment of a strategic partnership with an important gas utilities provider, because it permitted to operate the CNG buses with lower operating costs than diesel buses (the higher investment costs could be recovered within 5 years). However, the demonstrated CNG buses consumed more energy than conventional diesel buses, especially on hilly routes where the fuel consumption increased by about 50%. Nonetheless, significant reduction in pollutant emissions have been estimated, on the basis of fuel consumption measurements and models to estimate emissions compared to diesel buses running on the same lines (for the initially purchased batch of 70 CNG buses emissions were estimated to have decreased by 88% to 94%, depending on the particular type of emission). User surveys have shown high levels of CNG bus acceptance in terms of lower pollution levels, less smell from fumes, and reduced noise (MIRACLES, 2006).

[4] Is a device similar to particulate traps, but it also recirculates exhaust gases to further reduce emissions.

[5] Bi-modal systems (trolleys plus a rechargeable battery set) permit to simplify movement of buses in depots, or to avoid the installation of the line wiring in the historical town centres, limiting it to the suburbs.

In the city of Nantes CNG buses equipped with low floors, easy access (through a ramp and the kneeling system), provision of wheelchair spaces, and outside and inside electronic information displays have been introduced. 27 bus routes have adopted the CNG buses instead of the regular diesel vehicles (2001 to 2004). This demonstration has produced results in terms of emissions and social costs. The about 8 million kilometres run by the CNG buses resulted, in comparison with the current service, in (VIVALDI, 2006):

- a decrease by 7% of energy costs; a reduction of operating costs of 19%;
- 50% less non-methane hydrocarbon emissions;
- a decrease by 43% and 90% respectively for NO_x emissions and particulate emissions;
- a decrease by more than 20% in global social costs, including energy and pollutant emissions.

4.7.3.2 Other projects

Research has developed a technology platform for noise abatement in urban areas, which provides world-leading technologies to assure efficient control of surface transport noise, and innovative tools, methodologies, and input data for decision support systems, urban action plans and future noise scenarios (SILENCE). The main categories of urban traffic vehicles have been considered (such as cars, light duty trucks, buses, trams, metros, trains). Using models for individual traffic elements developed in previous EU projects, a global model has been developed capable of calculating the overall noise emission of complex traffic situations, and which can be used to apply the developed noise abatement technologies to reference urban noise scenarios, to calculate their noise reduction effects and to validate their noise reduction potentials. More in detail, research has carried out activities to evaluate noise perception and annoyance of residents in urban areas, to reduce noises produced by the tyre-road-interaction, to develop tools for noise source identification and reduction of their emissions, to investigate ways to reduce noise caused by rail vehicles and infrastructure in urban areas, to design and maintain low noise road surfaces, to develop management techniques for road traffic flow noise reduction, and to support decision making in city planning with respect to noise abatement. By combining the individual results, research has estimated a potential reduction of urban noise emissions of surface transport by up to 10 dB(A) in the near future.

Research has also demonstrated and evaluated the performances of more than 1 300 electric two-wheelers[6] in 10 test sites (cities in the Netherlands, Spain, Belgium, Italy, Germany, Sweden and Switzerland, and two islands in Italy and Greece). These

[6] About 700 e-bikes and 600 e-scooters.

demonstrations have proved that electric two-wheelers are competitive for short range trips in urban traffic (E-TOUR, 2003). More specifically, e-scooters are an almost perfect alternative to the ICE scooters or moped. For most common uses of e-scooters it is sufficient to have recharging facilities only at home for nightly (or weekend) recharging, so the lack of public recharging stations does not seem to be a concern. However, in specific cases like electric scooter use in rental services (centre of Rome), or in extended urban areas (Barcelona and again Rome), there is a clear need of public recharging facilities. Simple maintenance operations and savings in fuel costs for e-scooters, result in low service costs. Better energy/environmental balance for can be obtained by using renewable and/or sustainable energy sources. The main drawbacks of e-scooters are low speed and their high purchase costs (there are very few manufacturers in the market). As for e-bikes, the user acceptance is highly dependent upon the specific site mobility culture. The main conclusion is that the e-bike is not seen as a simple alternative for ordinary bikes, but a new means of transport, which has to gain its own market share. However, although they are rather heavy, e-bikes are easy to handle and the necessary physical effort and the energy use are very low. Drawbacks of e-bikes are the same as e-scooters (low speed and high purchase costs). Finally, e-bikes need separate safe route networks like normal bikes (E-TOUR, 2003).

Research has developed and demonstrated an emission-free and low-noise hydrogen-fuelled transport system, also including logistics aspects such as hydrogen production and refuelling infrastructure (CUTE, 2006). More than 4 million passengers in 9 cities were transported by 27 hydrogen fuel cell buses driven by regular bus drivers in regular traffic under normal operating conditions running a total distance of more than 895 000 km and a total number of operating hours of 64 000. The distance driven and the number of operating hours have produced a wealth of data and information, as well as a vast pool of experiences. The reliability and availability of buses was better than expected, as well as the longest lifetime of a single fuel cell stack (more than 3 200 operating hours). Furthermore, simulations showed that the fuel consumption could be reduced by up to 50% using hybridisation and more electric drive train related technology. Concerning the infrastructure, the hydrogen filling stations supplied more than 192 000 kg of hydrogen in more than 8 900 fillings (more than 40% of the energy for the hydrogen supply infrastructure came from renewable resources). The average availability of the filling stations was of about 80% during the 2 years of operation (most of them had an availability of more than 90%), while their reliability (in terms of successfully completed filling operations) was generally somewhat lower. The critical components were the compressors and the refuelling interface, which need to be improved, as well as the small scale steam reformers (the off-site large scale steam-reformer worked extremely well) (CUTE, 2006).

The analysis of case studies has shown that although many municipal and national initiatives have been successfully implemented to encourage the use of clean vehicles in

urban freight transport, it seems that private transport operators are not so willing to change their fleets towards this kind of vehicle. More in detail they seem to change their fleets and operating concepts only if (BESTUFS II, 2005):

- there is a clear financial benefit for them;
- there are enough filling stations in the area of operation;
- there are marketing effects and image benefits.

Furthermore, the analysis showed that only large courier companies have changed their fleets. This is due to the fact that only with large fleets it is possible to realise economies of scale and cost savings.

The case studies, in which an assessment of emissions and environmental impacts has been performed, have shown that the use of clean vehicles in urban freight transport generates high ecological benefits. In general these vehicles permit a reduction of CO_2 and noise emissions, as well as improved energy efficiency, but, on the other hand, they require higher operational and maintenance costs and an appropriate (and currently lacking) filling station network, and are prone to reliability problems and defects (BESTUFS II, 2005).

4.7.4 Policy implications

4.7.4.1 CIVITAS Initiative

General policy implications produced within the CIVITAS initiative are as follows (TELLUS, 2005).

- It is essential to create a market for clean vehicles. Cities can play an important role by converting their own vehicle fleets and organising promotion campaigns for encouraging other organisations and citizens to do the same.
- User surveys showed that one of the most important requirements to the spread of clean vehicles is an appropriate network of CNG filling stations. It is recommendable to take the due action to create this network. It is recommendable that governments introduce and maintain a reduced fuel tax for alternative fuels
- It is recommendable to combine clean vehicles activities with accompanying measures. The introduction of clean vehicles should be accompanied by measures like environmental zones or road pricing, special parking areas with lower parking fees for vehicles complying with low emission standards.
- It is recommendable to develop a common European definition for “clean vehicle” in order to facilitate the development of subsidy schemes and accompanying measures.

- Implementing new vehicle technologies is not the only solution. It is recommendable to consider also other aspects like also improving tram infrastructure to enhance energy efficiency and reduce emissions.

Concerning the use of CNG buses in PT fleets, the demonstration carried out in Barcelona has shown how convenient is to establish a strategic partnership with a utilities gas provider to reduce operating cost of CNG buses by supplying fuel at a reasonable price, and realising infrastructure improvements in order to make more efficient vehicle maintenance operations and refuelling (MIRACLES, 2006).

4.7.4.2 Other projects

Research into noise emission reduction, research has produced a practitioner handbook to support local authorities to set up noise action plans. Besides suggesting a step-by-step approach to the process of noise action planning and illustrating long-term strategies to avoid and abate noise (such as public awareness raising, land use planning and building design, promoting less noisy transport modes – modal shift, influencing driver behaviour, complaint management), the handbook recommends a number of concrete noise abatement measures, among which (SILENCE):

- Low-noise road surfaces. Noise reducing pavements can be a cheap and simple noise abatement measure to implement.
- Road surface maintenance. Accurate maintenance helps to keep the low-noise properties of road surfaces.
- Low-noise tracks for trams. These tracks do not produce the annoying low-frequency rumbling noise, even though the noise level in dB(A) remains the same.
- Railway and tram depots. Re-allocating the activities inside depots (e.g. putting the static activities in-line reduce the number of shunting movements), and the reduction of the number of movements in depots can contribute to noise reduction.
- Noise screens and tunnels. In theory, noise screens can reduce noise levels by up to 15 dB(A), but they are expensive.
- Building insulation (i.e. of the windows and outer walls of a building). It is the last alternative, when the other measures fail. They only reduce noise when they are closed.
- Low-noise trams. Compared to older tram vehicles, the noise emission of these trams is at least 10 dB lower.
- Low-noise waste collection vehicles. A reduction of up to 25 dB(A) has been observed compared to conventional vehicles. The vehicles cost about €22 000 to €32 000 (more than conventional vehicles), and maintenance is only slightly more expensive (during the lifetime of the vehicle of about 10 years, the batteries need to be replaced at least once at the cost of about €8 000).

- Check on noisy vehicles. Roadside enforcement checks are especially efficient for motorcycles. Measures to reduce the use of illegal silencers can reduce the noise caused by motorcycles up to about 5 to 10 dB(A).
- Low-noise night time delivery. Using low-noise vehicles and loading/unloading equipment and training the staff for quiet operation can make the delivery quieter, and acceptable during night time.
- Reducing and enforcing speed limits. Reducing speed can result in significant noise reduction. For example, reducing the driving speed from 50 to 40 km/h leads for passenger cars to a decrease of noise by 2.8 dB(A).
- Junction design. Results from surveys indicate that roundabouts without overrun areas may reduce noise levels by 1 to 4 dB(A) compared with ordinary intersections.

As for the reduction of the polluting emissions in urban areas, research recommends that all public authorities encourage the use of electric two-wheelers by providing incentives for buying and using these clean and silent vehicles as well as allowing them to access to city areas closed to ICE vehicles, such as city centres and other environmentally sensitive areas (E-TOUR, 2003).

On the basis of the information and data collected during the demonstration of a public transport system based on fuel cells and hydrogen, research has formulated the following general policy implications (CUTE, 2006):

- Community demand for the development of sustainable transport which uses hydrogen fuel cell vehicles must become stronger in order to accelerate the development and commercialisation of the relevant technology.
- It is not only necessary to increase community and political awareness, but also to plan long-term investments through the necessary legislative support in order to accelerate the roll out in mass production of the hydrogen fuel cell technology.

The analysis of case studies produced the following recommendations for encouraging the use of clean vehicles (BESTUFS II, 2005):

- National authorities must take over a leading role in supporting clean vehicles and the use of alternative fuels. They should support, with financial incentives, private operators and private industry to start-up initiatives, who in their turn should continue these initiatives investing their own resources.
- It is recommendable to exploit the synergetic effects deriving from the combination of measures and incentives. In fact, on the one hand, restrictive measures certainly force private transport operators to renovate their vehicle fleet; on the other hand, the higher operation costs due to necessity of renovating their fleet result in higher prices for customers.

- Programs which encourage the use of more environmentally-friendly vehicles should be further developed at European and national level. It is very important to involve also the New Member Countries in EU projects with focus on the use of clean vehicles in urban freight transport. Considering the restricted financial municipal and national budgets, it is recommendable that EU contributes to the funding of these projects.
- Although also smaller projects with few vehicles can be successful, financial support should be especially given to operators with big vehicle fleets, which produce a high number of vehicle-kilometres. Therefore, the negative impacts can be reduced more significantly in comparison to small projects.

4.8 Sub-theme 7: Policy facilitation

4.8.1 Background

Research reported in the Thematic Research Summary on urban transport produced in EXTR@Web (EXTR@Web, 2006) developed a methodology for planning optimal land use and transport strategies which takes into account indicators such as accessibility, air quality, noise nuisance and quality of life when assessing their socio-economic, environmental and technological impacts. Research also developed and tested software for analysing the effects of short term actions and long term policies to improve the quality of the environment, citizens' health, as well as conservation of monuments. Finally, research produced a state of the art review on policy appraisal and identified future research needs in the area of sustainable lands use and transport strategies.

4.8.2 Research objectives

A first group of objectives have concerned the investigation and development of methods for the assessment of the Quality of Life (QoL) in relation to different types of public measures in the area of transport and mobility. Research was motivated by the fact that transport and mobility significantly affect QoL, because they are key elements of the integration in society. Consequently, it is important to develop suitable tools and methods for assessing how the implementation of transport and mobility measures affects citizens' QoL in order to effectively and efficiently plan these measures (ASI).

Another group of objectives have focused on the development of an approach to the

design and management of arterial streets from a people-oriented perspective[7]. In fact, the efficient and effective design and management of arterial streets are challenging aspects of sustainable urban planning, because they must perform often conflicting functions (they provide a major channel for movement between different parts of the city; they provide access for employees, customers and deliveries; they represent a major public space that is visually dominant, culturally charged and of great importance for social interaction; they represent "the garden" for many residents). Unfortunately, conventional principles of design and management of streets have tended to separate the through traffic function of streets from the other urban street functions. In other words, arterial streets have often been re-engineered to optimise vehicle flows in order to increase traffic capacity, efficiency and safety of vehicle users, but often to the detriment of pedestrians, cyclists, and other urban activity performers. In order to reverse this trend it is necessary to develop a new approach to the design and management of arterial streets which appropriately combine mobility and access functions (ARTISTS, 2005).

Since 1999 European Commission has supported the creation and improvement of BYPAD (Bicycle Policy Audit), which is an instrument for the evaluation of local and regional cycling policies and their quality improvement, and has now become a European quality standard for cycling policies. Research has continued to finance this platform, which maintains its high quality by updating the audit method, training qualified auditors and offering a quality label (BYPAD, 2008). Its objectives remain:

- to provide more and better cycling audits in EU cities and regions;
- to train new auditors;
- to exchange knowledge on cycling policies;
- to expand the BYPAD-network to the new EU countries.

Another objective of research has been to find new ways of promoting walking in cities by improving the conditions and quality of urban public spaces, through the identification of best practices and the development of new tools and generic solutions to help designers, planners and decision makers to identify and solve problems when developing and implementing measures relating to urban pedestrian environments (PROMPT, 2005).

Finally, a research objective has been to support the development and adoption of innovative technology and policy-based urban transport concepts which contribute to establishing sustainable urban transport systems. Research was motivated by the fact that, although scientists, transport operators, the industry and policy makers have developed a wide range of innovative concepts to make urban transport more efficient,

[7] This means that the analysis, redesign, and management of street-space is more focused on people as users of streets than on cars. The aim is to design streets that offer a more positive contribution to sustainability, in all its dimensions (economic, social and environmental).

competitive and sustainable, a number of barriers have prevented the large scale implementation of these innovative concepts (NICHES, 2007).

4.8.3 Research results

Research has developed a user-friendly and easy-to-learn toolbox to support decision-makers, politicians and practitioners to better address QoL issues in implementing land use and transport planning measures and policies, with a view to increasing public acceptance and encouraging user behaviour changes (ASI, 2005). It has also developed guidelines for the implementation of land use and transport projects, which focus on QoL, as well as a databank concept containing comparable data on QoL to allow policy makers to build on experiences made in previous projects. The toolbox makes use of a set of basic indicators suitable for every context. However, toolbox users can select additional indicators from a list of suggested indicators, or, if necessary, define new ones. On the basis of the databank information it is possible to have an overview of how different implementations may affect QoL, and what should or could be done to improve QoL before actually implementing measures and policies, thus, significantly increasing their acceptability, effectiveness and efficiency. On the other hand, if the measures and policies have already been implemented, the toolbox helps to assess their impacts and develop plans for corrective actions. The tool can also be used for benchmarking exercises, comparing QoL indicators in different cities, regions and countries.

Research has also produced guidelines to support city authorities and other policy makers, practitioners and consultants to design and manage arterial streets considering all their urban functions and qualities and not only those relating to motorised traffic (ARTISTS, 2005), as conventional guidance does. These guidelines suggests principles and processes to classify arterial streets, set objectives for street management, generate design options, involve the public in participatory design processes, and select the best options for their design. The suggested principles and techniques can be individually selected according to the specific conditions and circumstances. The main contents of the guidelines are:

- a presentation of this innovative approach and its principles;
- a detailed description of how the design and management of arterial streets might be influenced by public participation;
- a framework for the functional classification of streets which gives indications to identify the different roles of each individual street and give them the right priority;
- illustration and explanation of the project stages of the redesign process;
- recommendations for demonstrating and making the new approaches operational.

Research has achieved positive results for what concern the improvement of the BYPAD

platform for the evaluation of local and regional cycling policy. In fact, it has expanded the BYPAD network to new countries (Spain, Greece, Kosovo, Hungary, Poland and Estonia), has trained 37 new auditors, and the BYPAD method has been adapted to regions (large metropolitan districts, counties, provinces, etc.) and small towns and appropriate manual and questionnaire prepared. Also the exchange of knowledge has improved with the development of a good practice database (which is feeding the ELTIS database with good practices on cycle policy), the organisation of three international seminars, production of newsletters, leaflets. About 100 cities, towns, and regions in 21 European countries have joined the BYPAD network. About 60 certified auditors were trained to supervise the audit process. BYPAD has become the quality standard for cycling policy. Different national and regional authorities (e.g. Austria, Germany, Czech Republic, etc.) suggest using BYPAD as a quality management tool to improve local cycling policies (BYPAD, 2008).

A guidebook to support designers, planners and decision makers to promote walking in cities by improving the conditions and quality of urban pedestrian environments has been produced (PROMPT, 2005). The basic approach has been to avoid finding partial solutions before becoming acquainted with all the problems inherent to the situation under examination, because the best results generally can be obtained if all the inherent problems are solved at the same time (some problems are more or less independent so that sometimes also partial solutions can often be successful). This approach has led to the identification of the prevailing problems in pedestrian environments, which have been analysed according to aspects such as safety, accessibility, comfort, attractiveness, intermodality, and implementation. The main solutions to these problems are included in the guidebook. So the users can find in this guidebook proper solutions to specific problems; most of them are current best practice examples, but there are also new and innovative solutions. The main clusters of problems for which holistic and coherent solution have been found are (PROMPT, 2005):

- lack of or scarce offer of physical and social space;
- lack of equipment and services in outdoor spaces;
- interference with motor vehicles;
- poor support by PT and connection to other modes of transport;
- poor natural, architectonic and psychological features of the environment;
- poor environmental performance.

Research has also facilitated the coordination of research activities of different stakeholders (e.g. academic institutions, industry, mobility operators and transport authorities) in the area of innovative urban transport concepts. It has also helped to identify and disseminate excellent, transferable examples of innovative transport measures in the most crucial areas of urban transport. More specifically, a “State of the Art in Developing Innovative Transport Concepts in Europe” has been made. This document provides an overview of the topic, and defines, describes and analyses the 12 selected innovative

concepts and examples of their successful implementation in cities across Europe. These innovative concepts are (NICHES, 2007):

- Urban Lift-sharing Services;
- Space Management for Urban Delivery;
- Policy Strategies for Clean Vehicles;
- Transportation Management Associations (TMAs);
- Public Bicycles;
- Inner-city Night Delivery;
- Biogas in Captive Fleets;
- Local Taxes or Charges, Ring-fenced for Transport;
- Call-a-bus Services;
- Alternative Solutions for Home Delivery;
- Joint Procurement of Clean Vehicles;
- City-wide Campaigns.

Research has identified the success factors and barriers for the implementation and transferability to various urban contexts of innovative urban transport concepts. Finally, integrated strategies combining the innovative concepts and measures to achieve specific objectives of urban transport and mobility policies have been identified, and a guide to develop innovative urban transport integrated strategies.

4.8.4 Policy implications

By investigating how QoL issues are considered in traffic and urban planning, and in relevant projects, research has found that social scientists are hardly involved. Since sustainable development requires balancing economic, environmental and social costs and benefits, it is recommended to create multidisciplinary teams including social scientists (ASI, 2005). Research has also found that many experts and practitioners experience significant problems when evaluating QoL impacts of policies, because currently there is not a common definition of QoL due to the fact that experts have different disciplinary backgrounds (e.g., architecture, town planning, transportation planning, civil engineering, economy), which result in different, and sometimes divergent definitions of QoL. It is recommendable to improve communications between stakeholders by setting common definitions and procedures. Furthermore, research has found that the assessment of objective conditions may differ from subjective judgements, i.e. citizens' perceptions of QoL. Consequently, it is recommended to appropriately take into account the subjective aspects of QoL, because they indicate to what extent people are actually satisfied with the quality of life (ASI, 2005).

The main recommendations concerning the design and management of arterial streets are

the following (ARTISTS, 2004):

- In order to follow the proposed "people-oriented approach", it is necessary to correctly quantify all users. It is then recommended that road authorities monitor street flows by counting the people inside vehicles (not just the vehicles), but also by counting pedestrians and cyclists. A future task would also be to identify new indicators for people movement and intensity and other types of activities (not transport related).
- Since it was pointed out the scarcity of urban street space, and the need to share it "spatially and temporally", it is also recommended that authorities explore the possibility of explicitly "calculating" the share of space and time given to different users.
- he proposed new functional street classification approach implies that authorities should, at least, reconsider how their street classification is currently done, and how closely it might be related to link status[8], and consider if they can introduce the new place status dimension. The overall classification process and the introduction of place status involve stakeholders' views and the engagement of the urban planning department in the discussion. With a street classification system including all streets in the city, it will be possible to decide how much motorised traffic the city can bear and which parts of the city are best suited to take this traffic. With a holistic perspective it will also be possible to better handle the migration of traffic when streets are redesigned (migration could be a variable under control and not an uncontrollable side effect).
- It is recommended to further elaborate sustainability indicators, because most sustainability indicators are still on link status (local application will produce valuable contributions to the definition of place status indicators).
- It is recommendable to incorporate this new approach in national guidelines.
- It is recommendable to extend this approach, so far carried out at European level, at national and city level to produce locally adapted guidelines. However, it is essential to always have a network at EU-level which coordinates activities and collect and spread the gained knowledge and experience.

The main policy implications produced by the BYPAD platform for the evaluation of local and regional cycling policy (BYPAD, 2008) are:

- The BYPAD-approach can be the basis for supporting local cycling policy. It helps to give a clear answer to which package of cycle measures is the most appropriate for a specific city, town or region.

[8] The new approach to classification is based on the recognition of the *link status* and *place status* of each street section in the street system. a link corresponds to a section of road between two junctions. A place status in a new dimension and typically corresponds to areas of homogeneous spatial character.

- The BYPAD platform does not provide a tool to compare performances of cities and regions from different countries. Nonetheless, some kind of competition has arisen amongst the BYPAD-cities, which want to be the best. However, this competition element could encourage investments in cycling policy. IT could also be the starting point for the establishment of a European Award for the best cycling cities and most promising cycling cities in Europe.
- In order to ensure the continuation of the platform on a permanent basis, even if EU funding should end, it is planned the creation of a legal body (the BYPAD-foundation). The financial basis of this foundation will come from membership fees of BYPAD-auditors and BYPAD cities, towns, regions. The European Cyclists' Federation will be one of the founding members. Furthermore, to avoid that a new city-network organisation will be created, an active co-operation with existing city-networks is necessary (POLIS, ICLEI, Energy-Cités, Eurocities, etc.).

Concerning the development and adoption of innovative technology and urban transport concepts the following policy recommendations to EU policy makers have been elaborated (NICHES, 2007).

- To provide clear EU-wide definitions of sustainable urban transport and clean vehicles.
- To strengthen the status of soft measures in EU policies. Soft measures have proven to be cost-efficient and effective tools to tackle urban transport problems. Nevertheless they often seem to be neglected in discussions about the future direction of EU policies in the field of urban transport.
- To encourage development of Sustainable Urban Transport Plans (SUTP).
- To foster EU-wide promotion of and training on sustainable urban transport.
- To continue support for EU-wide networking activities. A continued and stable support for thematic networks with a long-term perspective is recommended as efficient way to promote the exchange of experiences.
- To provide practical guidance on implementation. The EC should take a stronger role in providing practical guidance on implementing promising urban transport measures. This could be achieved by providing more project funding for such tasks.
- To support standardisation activities for clean vehicles and road pricing. Experts have identified some areas related to the innovative concepts, where standardisation is lacking and poses barriers to the uptake of clean vehicles and road pricing schemes. The EC should support standardisation activities in the following areas:
    - Standards for emission checks for clean vehicles in order to gain consistent results in Europe and to foster clean vehicle uptake;
    - Standards for noise emissions of vehicles (e.g. for night delivery services);

  - Standards for road pricing technologies to facilitate technical harmonisation and interoperability.
- To provide adequate framework for urban road pricing. The overarching legal framework for transport pricing is still very incomplete at the European level and relates entirely to heavy goods vehicles. The EU should, within the limitations given by the subsidiary principle, provide an enabling legislation for urban road pricing. This also requires addressing privacy concerns related to necessary monitoring and control within urban road pricing schemes. The EU should also continue work on the provision of a common methodology on charging.
- To review legislation and regulations for urban transport innovations. The project has highlighted that the current legal and regulatory frameworks at the EU and national levels are potential barriers for the uptake of some urban transport innovations. This concerns licensing issues, competition rules, tendering, access (physical or data), as well as taxing or the provision of incentives. This requires a closer look at the topic, e.g. through research projects.
- To strengthen green procurement activities of clean vehicles. One of the most common problems when starting the introduction of clean vehicles is to find the right vehicle models on the market. By gathering a substantial amount of buyers it is possible to create the necessary demand that drives the market introduction of clean vehicle models forward and helps to lower the prices for new technologies. EU should continue to strengthen its support for green procurement activities. This can, for example, take the form of funding projects that aim at facilitating large-scale procurements of clean vehicles with the participation of different European partners. EU should also consider promotional activities that spread good European examples and highlight the benefits of the procurement of clean vehicles for cities.

4.9 Sub-theme 8: Transport systems of the future

4.9.1 Background

Research reported in the Thematic Research Summary on urban transport produced in EXTR@Web (EXTR@Web, 2006) assessed to what extent ADAS (Advanced Driver Assistance Systems) and AVG (Automated Vehicle Guidance) systems can contribute to a sustainable urban development, as well as the potential of PRT in European cities. Research also investigated the effectiveness of Cybernetic Transport Systems (CTSs) in solving city mobility problems, and developed and tested several key technologies for the enhancement of automated vehicles. Finally research produced policy guidance for the

introduction of road-based automated PT, and has proposed new concepts of mobility integrating electric vehicles.

4.9.2 Research objectives

Research has focused on the development, implementation and demonstration of new sustainable transport systems based on cybercars, which are cleaner and safer than traditional cars and are accessible to everyone including people who cannot drive, providing a better level of service than private cars (door to door, individual, on-demand transportation). More specifically the objective was to demonstrate new technologies for cybercars in several European cities, to identify barriers to their implementation, such as technology confidence, landscape scenery, user-friendliness, regulations, etc (CYBERCARS), and accelerate their development and implementation (CYBERMOVE). Research was motivated by the fact that European cities are confronting every day with problems caused by the use of private vehicles, like road congestion, energy expenditure, noise and pollution, all of which degrade the quality of urban life. Intelligent transport systems are a good solution to alleviate the above-mentioned problems. The main features of these systems are the use of compact electric automated vehicles which run on the existing urban infrastructure, and are available on demand for door-to-door service in complement to public transportation. The deployment of such systems in urban areas can provide better urban environment and mobility for all users, better safety and security, and reduced dependency on oil resources, making European city-centres more accessible and attractive for business, culture and tourism. Experiments are under way in several places in Europe and in Japan and the first operational system (the ParkShuttles) has been in use in the Netherlands since the end of 1997 and is now being expanded.

Research has also assessed to what extent ADAS (Advanced Driver Assistance Systems) and AVG (Automated Vehicle Guidance) systems can contribute to a sustainable urban development in terms of impacts not only on traffic conditions and environment, but also in on social life, economic viability, safety, and other aspects (STARDUST). Research was motivated by the fact that the increasing problems of traffic pollution and congestion which European cities are facing need effective solutions.

4.9.3 Research results

Research has demonstrated the effectiveness of Cybernetic Transport Systems (CTSs) in solving city mobility problems and proved that they have now reached high levels of reliability, safety and user friendliness. Depending on how it is designed a CTS can virtually accomplish any transport task:

- it can provide a park shuttle service for an historic city centre or a business park;

- it can be a feeder for the main public transport network or the only available transport service in a quarter or a village;
- it can serve students and personnel in a campus;
- it can even be a city wide transport system.

For each of these services CyberMove experimented, tested or simulated different design solutions and can now provide, depending on them, figures on performances and costs (CYBERMOVE).

Research has also focussed on the improvement and testing of the technologies, on the certification procedures and on the dissemination for awareness raising. More in detail, several new techniques have been developed for better guidance, collision avoidance, platooning, vehicle control systems, energy utilisation and fleet management and the development of simple, standard user interfaces. The improvement consisted in better performances of these technical systems or reduced costs. A real size experiment in the city of Lausanne for detailed evaluations of the performance and users acceptability have been carried out. Furthermore, since the existing legal constraints can hamper the diffusion of such systems in cities, guidelines concerning the development of cybercars and their installation have been produced, which should lead to new certification procedures that might be accepted at European level. Finally, dissemination work has been performed in order to accelerate the implementation of these systems in European cities (CYBERCARS).

Research has also carried out a global evaluation of the opportunity of deploying ADAS/AVG systems. The impacts of the use of these systems in three case study cities have been assessed, focusing on aspects such as efficiency, safety, energy consumption, pollutants emission and regulations. The adopted approach has been a combination of microscopic and macroscopic analyses of drivers' behaviour. The most innovative in aspects of this evaluation has been the integration of end user potential acceptance analysis (carried out through preference surveys), investigation of the human factors issues (using data from instrumented vehicles, driving simulators, and microscopic modelling), and larger scale assessment of the impacts at city level (using network simulation models). A review and a synthesis of the existing analysis on the legal and institutional aspects of the deployment of ADAS and AVG systems have been also carried out (STARDUST). The main findings on traffic impacts are the following:

- Intelligent Speed Adaptation (ISA). The ISA for reducing excessive traffic speed in the network has led to longer journey times (the increase ranges between 4.3% and 6.0% at 80% of penetration level). The increase in journey times has been higher on high speed roads (e.g. motorways) than on low speed roads (e.g. urban streets). No significant changes in network distance were assessed and this means that ISA did not cause much change in the general patterns of assignments

(most of drivers followed their original routes). ISA was found to be more effective in non congested traffic conditions when drivers are able to exceed a speed limit.

- Stop&Go on urban roads. Stop&Go can increase saturation flows of signal controlled junctions, and the impacts of increased saturation flows at a signal controlled junction depend on the number of equipped vehicles in the queue. When 80% of vehicles operate the system, the network queuing times were reduced by up to 19% to 25%, and a reduction of journey times of 7.5% to 15%.
- ACC (Adaptive Cruise Control) together with Stop&Go on urban arterial and motorways. A combined system of ACC together with Stop&Go makes it possible to automate the task of car following at both high and low speeds. ACC + Stop&Go can smooth vehicle movements in both high and low speed traffic. The application of ACC + Stop&Go can have positive impacts on traffic efficiency in terms of reduced network journey times which depend on the headways chosen by drivers and how extensive the system is used.
- Lane Keeping. Lane Keeping can be used to help drivers to keep vehicles in narrow lanes which are assumed to be dedicated to public transport. A Lane Keeping based bus service has the potentials to reduce the private car use when urban roads become heavily congested or become restricted (e.g. congestion charges). To make it effective, large modal shifts are needed from private car to public transport. This requires however a substantial improvement in the travel time for buses compared to private cars.

Cybercars in city centre area. In a scenario in which city centre areas are reserved to public transport, cybercars can be used as a supplement to mass public transport by feeding and distribution. Simulations have shown cybercars have positive impacts on traffic at a network level in terms of reduced total trips and increased speeds.

4.9.4 Policy implications

Research has proved that a CTS is usually socio-economically viable and the community would benefit by its installation. In general, CTSs can be most successfully employed for two short distance transport services:

- as feeders for the main public transport network;
- as park shuttles linking car-parks to one or many destinations.

Interfacing a CTS with a low frequency bus line would waste the CTS benefits in terms of its attractiveness on the users. The service best accomplished by long distance CTSs is the city wide service. CTSs can provide a more convenient transport service than metros and, sometimes, even than cars, but they need dedicated and fully separated high speed infrastructures. In conclusion, the installation of CTS can effectively help local

administrations to invert the European tendency to travel more and more by car even inside the cities (CYBERMOVE).

Research has also highlighted some important issues regarding the deployment of ADAS/AVG systems. The use of driver support systems is likely to increase to a certain extent in the coming years. However, in order to achieve a level of use capable of producing effects on traffic flow and safety, it is necessary to further analyse and investigate issues concerning legislation (mandatory or not), infrastructure investments, combination with other applications, robustness of the systems in different traffic situations, liability, and market needs (user acceptance, training, long term effect, maintenance) (STARDUST). The following recommendations have been produced:

- Most ADAS/AVG systems offer potential benefits for the environment. Government policies should prioritised developments and implementation of environment-friendly systems such as Stop&Go (especially in urban areas).
- It is expected that the idea of “a car free city centre” would be accepted by more and more cities to protect urban environment. Under this condition, ADAS/AVG technology can provide good solutions, for example by using High Capacity Bus (based on ADAS technologies such as Lane Keeping, Platoon) and Cybercars.
- There is a need for harmonised standards for regulating the manufacturing and use of driver support systems.
- In order to accelerate the deployment of these systems, government should create regulations for making some of these systems mandatory (for safety systems such as ISA). It is also important that infrastructure owners to cooperate with vehicle manufacturers to increase the network benefits of ADAS/AVG systems (e.g. Lane Keeping systems).
- ISA can be used to reduce the number and severity of accidents. Using ISA can help local authorities to achieve the objective of increasing safety, especially on roads around schools.
- Lane Keeping systems would be useful for implementing narrow lanes in urban areas to improve bus efficiency and reliability in urban areas. This is particularly important in the scenario in which access to city centre areas is restricted.
- There are a number of applications that are vehicle based within the ADAS systems such as ACC, ISA, and Stop&Go. Local authorities can play an important role in identifying the opportunities to utilise a range of ADAS applications and to support the implementation of these advanced techniques.
- Research results show that drivers with experiences of recurrent long queues have higher levels of acceptance of Stop&Go systems than those without such experiences. With increased traffic congestion in urban areas, it is expected more and more people would accept Stop&Go systems. As a convenience featured system, Stop&Go can also contribute to improvement of safety by reductions of rear-end collisions and environment by smoothed vehicle movements. Stop and

Go may change the driving patterns, which impact may impact on the control algorithms. The local operators will have to understand the changes if full use of the application is to be achieved.

- Manufacturers are recommended to investigate how different systems can be combined in order to both achieve the benefits and minimise the liability concerns (e.g. longitudinal control systems like ACC and Stop&Go, and collision warning and avoidance systems) in order to develop more robust systems under different traffic situations.
- It is important that driving instructors and car manufacturers introduce drivers to the new technology. Many drivers still do not know how to operate ABS brakes or the ESP-system, several years after they became standard equipment.

4.10 Implications for further research

The information on implications for further research illustrated in this section has been collected from the projects reviewed in this report, as well as from the European Strategic Research Agenda (SRA) on road transport developed by the European technology platform[9] on Road Transport (ERTRAC, 2004; ERTRAC, 2008), and the SRA on urban mobility developed by the FP6 project EURFORUM (EURFORUM, 2006). Strategic research agendas identify priority research areas in order to be able to keep up with the pace of technological and social changes relating to a specific mode of transport. EU has already given its support to research co-operation and to encourage research excellence in surface transport by financing the development of modal European technology platforms such as ERRAC (rail), ERTRAC (road), WATERBORNE-TP (waterborne), ACARE (Air), and EIRAC (intermodal). However, since urban transport transversal issues were not fully covered by these platforms (stakeholders in the sector felt that there was a gap which needed to be filled) (EURFORUM, 2006), the EURFORUM project has developed a SRA specific to this topic.

[9] Technology platforms are frameworks to unite stakeholders around: a common “vision” for the technology concerned; mobilisation of a critical mass of research and innovation effort; definition of a Strategic Research Agenda (EC 2004). The rationale behind them is to contribute to competitiveness, boost research performance, concentrate efforts and address fragmentation (ibidem).

4.10.1 Implications for further research from projects reviewed

4.10.1.1 Access restrictions and integrated pricing strategies

As for pricing schemes, the following issues have been identified for further research (CUPID; CURACAO, 2009):

- decision-making structure and political process,
- techniques for stakeholder involvement,
- surveys on stakeholders' attitudes,
- charging structure (for example to investigate: how time-based charging might be implemented without encouraging unsafe driving; how distance-based charging might be made more flexible; GPS-based charging and enforcement systems);
- impacts of exemptions on travel patterns of those who benefit, resulting loss of benefits and implications for enforcement and compliance;
- operating and enforcement costs;
- optimal combinations of measures;
- impacts of road space re-allocation;
- measurements of congestion and reliability;
- how impacts are distributed across groups within society;
- transferability of charging schemes from one city to another;
- performance of new developments in technology;
- ways of reducing the costs of technology applications;
- the impacts on the urban economy, and in particular the differential effects by economic sector and size of firm;
- the effects of road user charging on different impact groups;
- acceptability and equity, and in particular the impact of scheme design on perceived inequity;
- ways of sustaining and adapting road user charging schemes once implemented;
- approaches to the design of overall strategies which include road user charging;
- methods for the design of road user charging schemes;
- prediction methods;
- the impacts of road user charging on liveability and health;
- the dynamics of acceptability over time and the particular role of referenda in testing and promoting acceptability;
- measurement of congestion and travel time reliability;
- development of best practices for evaluation of road user charging schemes.

4.10.1.2 Public transport

A demonstration of a public transport system based on fuel cells and hydrogen has identified the following topics for further research (CUTE, 2006):

- technical solutions for reducing costs of hydrogen production, hydrogen refuelling stations, and fuel cell vehicles (Target cost of 2.5 to 3 €/kg of refuelled hydrogen can't be realised with today's technology);
- significantly improvement of the overall efficiency of the hydrogen production and distribution;
- enhancement of the durability and power density of the fuel cells;
- simplification and reduction of costs of hydrogen storage systems;
- improvement of the electrical components of the drive train of future fuel cell buses (e.g. electric motors, high voltage battery systems and their associated control strategies).

As for demonstration of the CNG buses, further research is needed to improve the cost effectiveness of CNG vehicle maintenance, which currently is more expensive in comparison to diesel vehicles (VIVALDI, 2006).

The demonstration of the water taxi has highlighted the following points for further research and improvement (TELLUS, 2006):

- It is recommended investigate the possibility to replace the currently used boat engines with cleaner and more silent engines;
- It is also recommended to create some shelter on the landing stages in order to improve passengers' comfort, especially during bad weather conditions.
- In order to attract more passengers it is advisable to install signposts or other visual information means in the area around the river banks.

4.10.1.3 Low environmental impact vehicles and infrastructure

Concerning the use of electric two-wheelers in order to reduce the polluting emissions in urban areas, the following topics for further research have been proposed (E-TOUR, 2003):

- For future applications and successful adoption, it is crucial to improve the overall performances of electric two-wheelers, in particular those of the batteries. The development of more reliable and better performing batteries is the key to gain larger market share. It is also crucial to reduce the cost of e-bikes and e-scooters (most of the price is determined by the cost of batteries). However, better products can result into higher sales, which would in turn lower costs.

- Better insight in user needs is crucial for the successful development of new e-bike and e-scooter and for a large scale market introduction, so it is recommendable to encourage further research in this sense.

Concerning CNG vehicles, the main recommendations for further research are (VIVALDI, 2006):

- Even though experts are confident that car manufacturers can improve the operational performances of these vehicles (mileage, loading capacity, engine efficiency), it is necessary to increase their commitment to CNG cars in order to reach a market breakthrough.
- It is necessary to enhance and develop the appropriate supporting infrastructure (mainly fuelling stations) for CNG vehicles.

The demonstration carried out in Gothenburg concerning the introduction of clean waste collection vehicles, has highlighted that although these CNG-fuelled vehicles proved to be able to improve the environmental performance with respect to emissions, noise and fuel consumptions, there are still some potential to further improve performances (TELLUS, 2005c):

- The emission measurements showed rather high peaks of hydrocarbons, nitrogen oxides and carbon monoxide at the start of the engine. It is recommendable to optimise the CNG engine when used with hybrid technique (CNG engine combined with electric powered bodywork and water hydraulics).
- In the clean vehicles ordinary lead batteries were used, which have a total weight of about 1 100 kg. Further improvements of the vehicles should focus on better batteries (i.e. batteries with more power per unit of weight), as well as replacing the lead content with a more environmentally friendly material.
- The clean vehicles use electricity only during the actual waste collection operations (i.e. lifting and compacting waste). It is recommendable to carry out research to completely replace the fuel used in waste collection vehicles with electricity.
- When vehicles brake, the kinetic energy is currently lost (by friction), while it could be recovered and stored in a battery as electrical energy. As waste collection in densely populated areas is characterised by many stops, this is considered as a major area for further research.

4.10.1.4 Policy facilitation

Concerning the development and adoption of innovative technology and urban transport concepts the following topics for further research have been identified (NICHES, 2007):

- Improvement of the assessment methodologies and creation of practical decision support tools. In spite all the progress made concerning knowledge about the

impact of measures to tackle urban transport problems, adequate decision support tools are still lacking.

- Strengthen research on links between urban transport measures and urban development and land use planning.
- The understanding of change management is still lacking. Research should address this topic to a higher degree and try to understand the key drivers (and barriers) for change.
- Improvement of the understanding of the impact of demographic change on urban transport. Low birth rates and increasing life expectancy will result in new mobility patterns and demand for adequate and tailor-made mobility or delivery services.
- Valorisation of non-motorised transport giving them an appropriate status in research activities. Walking and cycling play a significant role in urban transport and have unexploited potential to contribute to more sustainable transport patterns.
- Strengthening of research on urban freight innovation. More dedicated research is required to better understand patterns of urban freight traffic, as well as research on technical solutions to facilitate innovation.
- Ethanol, biogas and biomass-to-liquid/gas (BTL/G) are alternatives to hydrogen that need further research and development to exploit the unexplored potential to increase energy efficiency and economic viability in the production and to decrease emissions from the vehicles.
- Profile the mobility culture and enhance understanding of mobility behaviour. Despite their crucial importance, behavioural aspects of transport and mobility are underestimated in a rather technology-oriented research arena.
- Foster interdisciplinary approaches. To effectively tackle complex problems, a better collaboration of a wide range of different disciplines and cross-sectoral thinking are needed.
- Currently, research too often only focus on the urban core city does not take into account the manifold interrelations with the surrounding regions.
- Applied science and practical demonstrations of urban transport innovation should be strengthened. “Practical experiments” can also contribute to a better uptake and testing of theoretical research result.

4.10.2 Summary of further research recommended by Strategic Research Agendas

4.10.2.1 Access restrictions and integrated pricing strategies and measures

The strategic research agenda on urban transport has pointed out the importance of understanding how incentives can be used to influence transport behaviour (ERTRAC,

2008).

4.10.2.2 New forms of vehicle use and/or ownership

The strategic research agenda on urban mobility stresses on carrying out further research for strengthening alternatives to the private car (including: pedestrians and cyclists, better data for improved public transport operation, taxis and alternative modes) (EURFORUM, 2006). The SRA on road transport points out the need of further research on the role and potential of real time car-sharing systems (ERTRAC, 2008).

4.10.2.3 Transport management and soft measures for managing mobility demand

The strategic research agenda on urban mobility has identified the following topics for further research (EURFORUM, 2006):

- better understanding of the mobility behaviour of individuals and firms;
- improving the accessibility and sustainability of our cities;
- market research to better know the user;
- how to actively influence user behaviour;
- user acceptance analyses;
- more efficient use of existing transport infrastructure;
- integration of urban transport networks (including: infrastructure sharing, funding, intermodality, intelligent integrated network management);
- organisational and regulatory framework for urban transport, innovations in public transport infrastructure and rolling stock;
- strengthening the understanding of user aspects by modelling user behaviour;
- developing approaches for integrated planning;
- fostering the use of integrated planning approaches;
- coordinated information and communication strategies targeting transport users, operators and infrastructure managers;
- seamless multimodal transport;
- compatible urban mobility services;
- customisation of services;
- technical issues (application of ITS) concerning mobility services.

The SRA on road transport has stressed on the need to further research in (ERTRAC, 2008) the following areas:

- information technology applications to provide travellers with up-to-date information on road network, PT, and other issues in order to encourage a more reasoned travel decisions (besides creating new products, it is also necessary to

make databases and interfaces as consistent as possible to better exploit the technological opportunities);
- new integrated urban traffic management systems, such as dynamic and flexible lane/road management, and vehicle and infrastructure technologies;
- provision and management of interchanges between services to encourage seamless sustainable multimodal journeys;
- new systems and services to satisfy urban mobility needs (such as demand responsive services involving fully automated vehicles);

4.10.2.4 Goods transport

The strategic research agenda on road transport has identified the need to develop new delivery vehicle design and concepts to better face the growth in urban deliveries due, among other things, to increased purchases made on the Internet (ERTRAC, 2008).

4.10.2.5 Low environmental impact vehicles and infrastructure

The strategic research agenda on urban mobility has identified the development of innovative strategies for clean urban transport and the reduction of negative impacts of urban transport (including: safety, security and environmental impacts) as crucial issues for enhancing urban transport (EURFORUM, 2006). Further research is needed to develop new concepts for developing low or zero carbon vehicles for urban transport, as well as for abating noise emissions (ERTRAC, 2008).

4.10.2.6 Policy facilitation

The strategic research agenda on urban mobility has identified the following topics for further research (EURFORUM, 2006):

- impact of policy measures and system innovations on mobility behaviour;
- impact of societal changes on mobility behaviour;
- analysis and assessment of interactions between urban land use and transport;
- improvement of data collection for passenger and freight transport;
- standardisation of survey design and indicators for passenger and freight transport;
- improving methods like data fusion and synthetic matching;
- improving complementary data collection and reliability of data;
- improvement of transport models integrating all fields of urban planning and management;
- reduction of barriers for practical use of up-to-date models;
- improvement of urban freight transport models and support of their application.

The SRA on road transport has pointed out how systems and services based on new technologies not only influence policy, but also to develop new urban policies. Research must also be carried out to provide evidence and information to orient the development of policies in a number of areas such as balancing infrastructure and demand, and active and effective management of congestion and environmental issues. It is also important to carry out research to better understand legislation and decision processes and security issues. Finally studies are needed to understand market factors and changes in behaviour at all stages of travel decision making (ERTRAC, 2008).

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Annex: List of projects by sub-theme

Sub-theme 1: Access restrictions and integrated pricing strategies				
Project acronym	Project title	Programme	Project website	Coverage
BESTUFS	Harmonisation of strategies and highlighting best practice to determine optimum Urban Freight Solutions (Thematic Network)	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.bestufs.net	Extr@web paper
BESTUFS II	BEST Urban Freight Solutions II	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.bestufs.net	This paper
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
CUPID	Co-ordinating urban pricing integrated demonstrations	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.transport-pricing.net/cupid.html	This paper
CURACAO	Coordination of Urban Road User Charging Organisational Issues	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.curacaoproject.eu	This paper
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available

Sub-theme 1: Access restrictions and integrated pricing strategies				
Project acronym	Project title	Programme	Project website	Coverage
PROGRESS	Pricing Regimes for Integrated Sustainable Mobility	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.progress-project.org	Extr@web paper
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
UG346	Monitoring Effects of Road User Charging in Durham	Project from the United Kingdom		Extr@web paper

Sub-theme 2: Public transport				
Project acronym	Project title	Programme	Project website	Coverage
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
CROSSRAIL	Integrating Local and Regional Rail Including Cross Border Aspects	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality		This paper
HITRANS	Development of principles and strategies for introducing high quality public transport in medium size cities and urban regions	INTERREG III - Community initiative INTERREG	www.hitrans.org	Extr@web paper
INVETE	Intelligent In-vehicle Terminal for Multimodal Flexible Collective Transport Services	FP5 - IST - KA1 - Systems and services for the citizens		This paper
LIBERTIN	Light Rail Thematic Network	FP5 - GROWTH - KA3 - Land transport and marine technologies	www.libertin.info	Extr@web paper
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
PRISCILLA	Bus Priority Strategies and Impact Scenarios Developed on a Large Urban Area	FP5 - IST - KA1 - Systems and services for the citizens	www.trg.soton.ac.uk/priscilla	Extr@web paper

Sub-theme 2: Public transport				
Project acronym	Project title	Programme	Project website	Coverage
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
TRENDSETTER (CIVITAS I)	Setting Trends for Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	www.civitas-initiative.org	Extr@web paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 3: Less car-intensive life style				
Project acronym	Project title	Programme	Project website	Coverage
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
MOSES	Mobility services for urban sustainability	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage		This paper
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
UG346	Monitoring Effects of Road User Charging in Durham	Project from the United Kingdom		Extr@web paper

Sub-theme 4: Transport management and soft measures for managing mobility demand				
Project acronym	Project title	Programme	Project website	Coverage
-	Effects of cycle parking arrangements on bicycle use	Project from Finland		Extr@web paper
-	Review of Research on School Travel	Project from the United Kingdom		Extr@web paper
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
EMMA	Evaluation of Measures for Controlling Private Car Use in Metropolitan Areas	Project from Sweden		This paper
INTERCEPT	Intermodal Concepts in European Passenger Transport	FP4 - TRANSPORT RTD - Transport Research and Technological Development		Extr@web paper
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
PRISCILLA	Bus Priority Strategies and Impact Scenarios Developed on a Large Urban Area	FP5 - IST - KA1 - Systems and services for the citizens	www.trg.soton.ac.uk/priscilla	Extr@web paper
SMART NETS	Signal Management in Real Time for Urban Traffic Networks	FP5 - IST - KA1 - Systems and services for the citizens		This paper

Sub-theme 4: Transport management and soft measures for managing mobility demand				
Project acronym	Project title	Programme	Project website	Coverage
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TARGET 2	Travel Awareness Regional Groups for Environmental Transport 2A	INTERREG III - Community initiative INTERREG		This paper
TRASCOM	Traveller Assistance for Combined Mobility in regional areas	FP5 - IST - KA1 - Systems and services for the citizens		This paper
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
TRENDSETTER (CIVITAS I)	Setting Trends for Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	www.civitas-initiative.org	Extr@web paper
UG293	Car share and car clubs – Potential and impacts	Project from the United Kingdom		Extr@web paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 5: Goods transport				
Project acronym	Project title	Programme	Project website	Coverage
BESTUFS	Harmonisation of strategies and highlighting best practice to determine optimum Urban Freight Solutions (Thematic Network)	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.bestufs.net	Extr@web paper
BESTUFS II	BEST Urban Freight Solutions II	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.bestufs.net	This paper
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
City Box	City Box - Small loading unit for urban distribution	Project from the Netherlands		Extr@web paper
CITYFREIGHT	Inter- and Intra-City Freight Distribution Networks	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	www.cityfreight.eu	Extr@web paper
FIDEUS	Freight innovative delivery in European urban space	FP6-SUSTDEV-2 - Sustainable Surface Transport		This paper
HOST	Human oriented sustainable transport means	FP6-SUSTDEV-2 - Sustainable Surface Transport		This paper
IDIOMA	Innovative distribution with intermodal freight operation in metropolitan areas	FP4 - TRANSPORT RTD - Transport Research and Technological Development		Extr@web paper
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 5: Goods transport				
Project acronym	Project title	Programme	Project website	Coverage
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
MOSCA	Decision-support system for integrated door-to-door delivery: planning and control in logistic chains	FP5 - IST - KA1 - Systems and services for the citizens	www.idsia.ch/mosca	Extr@web paper
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
TRENDSETTER (CIVITAS I)	Setting Trends for Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	www.civitas-initiative.org	Extr@web paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 6: Low environmental impact vehicles and infrastructure				
Project acronym	Project title	Programme	Project website	Coverage
BESTUFS	Harmonisation of strategies and highlighting best practice to determine optimum Urban Freight Solutions (Thematic Network)	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.bestufs.net	Extr@web paper
BESTUFS II	BEST Urban Freight Solutions II	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.bestufs.net	This paper
BIOGASMAX	Biogas Market Expansion to 2020	FP6-SUSTDEV-1 - Sustainable Energy Systems	www.biogasmax.eu	If reports become available
CARAVEL (CIVITAS II)	Travelling Towards a New Mobility	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
CUTE	Clean Urban Transport for Europe	FP5 EESD KA6 - Economic and efficient energy for a competitive Europe		This paper
E-TOUR	Electric Two-Wheelers on Urban Roads	FP5 EESD KA6 - Economic and efficient energy for a competitive Europe		This paper
FUEL CELL BUS	Fuel Cell Bus Project Berlin, Copenhagen, Lisbon	FP5 EESD KA6 - Economic and efficient energy for a competitive Europe		If reports become available
MIRACLES (CIVITAS I)	Multi Initiatives for Rationalised Accessibility and Clean, Liveable Environments	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 6: Low environmental impact vehicles and infrastructure				
Project acronym	Project title	Programme	Project website	Coverage
MOBILIS (CIVITAS II)	Mobility Initiatives for Local Integration and Sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SILENCE	Quieter Surface Transport in Urban Areas	FP6-SUSTDEV-3 - Global Change and Ecosystems	www.silence-ip.org	This paper
SMILE (CIVITAS II)	Sustainable urban transport for the Europe of tomorrow	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
SUCCESS (CIVITAS II)	Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.civitas-initiative.org	If reports become available
TELLUS (CIVITAS I)	Transport & Environment Alliance for Urban Sustainability	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper
TRENDSETTER (CIVITAS I)	Setting Trends for Sustainable Urban Mobility	FP5 - EESD KA6 - Economic and Efficient Energy for a Competitive Europe	www.civitas-initiative.org	Extr@web paper
VIVALDI (CIVITAS I)	Visionary and Vibrant Actions through Local transport Demonstration Initiatives	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.civitas-initiative.org	This paper

Sub-theme 7: Policy facilitation				
Project acronym	Project title	Programme	Project website	Coverage
ARTISTS	Arterial Streets towards Sustainability	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage		This paper
ASI	Assess implementations in the frame of the Cities-of-Tomorrow programme	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage		This paper
BYPAD Platform	Further implementation and improvement of cycling audits in EU cities and regions, training of certified auditors and continuous exchange of knowledge on cycling policy	FP5 EIE Intelligent Energy Europe	http://bypad.org	This paper
CP/37	An integrated instrument for the environmental evaluation of local traffic plans	Project from Belgium		Extr@web paper
ISHTAR	Integrated Software for Health, Transport efficiency and Artistic heritage Recovery	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	www.ishtar-fp5-eu.com	Extr@web paper
NICHES	New and innovative concepts for helping European transport sustainability	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.niches-transport.org	This paper
NPF – Urban Transport	National Policy Frameworks for Urban Transport	DGTREN - Energy & Transport DG - Miscellaneous projects		Extr@web paper

Sub-theme 7: Policy facilitation				
Project acronym	Project title	Programme	Project website	Coverage
PROMPT	New Means to Promote Pedestrian Traffic in Cities	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	http://prompt.vtt.fi	This paper
PROSPECTS	Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage		Extr@web paper
Urban Transport Benchmarking Initiative	The Urban Transport Benchmarking Initiative	DGTREN - Energy & Transport DG - Miscellaneous projects		Extr@web paper

Sub-theme 8: Transport systems of the future				
Project acronym	Project title	Programme	Project website	Coverage
CITYMOBIL	Towards Advanced Road Transport for the Urban Environment	FP6-SUSTDEV-3 - Global Change and Ecosystems	www.citymobil-project.eu	If reports become available
CYBERCARS	Cybernetic technologies for the car in the city	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	www.cybercars.org	This paper
CYBERMOVE	Cybernetic transport systems for the City of Tomorrow	FP5 - GROWTH - KA2 - Sustainable Mobility and Intermodality	www.cybermove.org	This paper
EDICT	Evaluation and demonstration of innovative city transport	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	www.cardiff.gov.uk/edict	Extr@web paper
NETMOBIL	"New transport system concepts for enhanced and sustainable personal urban mobility [cluster project]"	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage		Extr@web paper
SVI 1998/091	Electric vehicles and new mobility concepts	Project from Switzerland		Extr@web paper
STARDUST	Towards Sustainable Town Development: Research on Deployment of Urban Sustainable Transport	FP5 EESD KA4 - City of Tomorrow and Cultural Heritage	www.trg.soton.ac.uk/stardust	This paper

Note. The projects listed in the Annex are those that have had the focus on the theme “Urban”, as well as those who have addressed Urban as secondary topics to some extent. On the TRKC portal (www.transport-research.info) it is possible to use the “advanced search” functionality – with the option “Urban” – and find all research projects, EU-funded and national, which have treated, to a variable extent, aspects that can be related to the theme.