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Thematic Research Summary

Road transport

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Transport



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Preface

This Thematic Research Summary (TRS) has been produced as a part of the activities of the Transport Research and Innovation Portal (TRIP). TRIP collects, structures, analyses and disseminates the results of EU-supported transport research and research financed nationally in the European Research Area (ERA), and selected global research programmes. The main dissemination tool used by TRIP is the public web portal www.transport-research.info.

The Thematic Research Summaries provide a structured guide to the results of research projects carried out mainly at EU level, either as part of a framework programme or as a study commissioned by the European Commission (EC). These summaries are intended for policymakers at European, national and local levels, stakeholders and researchers.

The Thematic Research Summary on Road Transport is one of 24 themes, which provides:

- an overview of research activities in a specific aspect of transport focusing on EU-funded projects;
- analysis and compilation of research findings and recommendations.

An overview of the Thematic Research Summaries is presented in Table 1.

Table 1: Transport themes used in TRIP

Domains	TRIP Themes
Sector	Passenger transport
	Freight transport
Mode	Air transport
	Rail transport
	Road transport
	Urban transport
	Water transport (sea and inland)
	Multimodal transport
Policy	Financing, pricing and taxation
	Regulation, competition and public services
	Infrastructure and TEN-T
	Land use and transport planning
	Climate policy and energy efficiency
	Security and safety
	International cooperation and EU Neighbourhood Policy
	Awareness, information and user rights
Technology	Intelligent transport systems
	Innovative technologies
	Transport management
Evaluation	Long-term perspectives
	Assessment and decision support methodologies
	Environmental impacts
	Economic and regional impacts
	Accessibility, social and equity impacts

1. Introduction

Road transport is part of the lifeblood of the EU economy and single market, delivering goods across Europe fast, flexibly and efficiently. About 44% of freight transport in the EU is by road. People also travel mainly by road, with private cars accounting for 73% of passenger movements. Road transport is a vital sector in the economy, employing about 5 million people in the EU and generating almost 2% of GDP (EC, 2012a).

With many roads near or above capacity limits and since transport activities are projected to further increase in the coming decades, with 80% increase in freight transport and 51% increase in passenger movements by 2050 (EC, 2011b), the road transport sector faces considerable challenges. These are defined in the Transport White Paper as better integrating road together with other modes into door-to-door logistics chains, reducing CO₂ and other emissions from road transport, reducing the impact of climate change on future generations, decreasing fossil fuel use to improve Europe's fuel security, ensuring mobility and reducing traffic congestion, and reducing road fatalities (EC, 2011a).

Without measures to reduce emissions significantly, the transport sector is estimated to contribute up to 50% of all CO₂ emissions in the EU by 2050. The EU has made a commitment to reduce greenhouse gas emissions from transport by at least 60% by 2050 with respect to 1990 levels (EC, 2011a). Research initiatives focus on developing more efficient propulsion systems in general and electrification in particular. Related to this, research is directed to energy saving and improved electricity storage to extend the driving range of electric vehicles. To make road transport more efficient, research on vehicle technology is focusing on innovative design, weight and noise reduction, and improved aerodynamics and rolling resistance.

Traffic congestion is already hampering economic growth and mobility, requiring a better and smarter way of using existing infrastructure. Research on traffic and travel information systems focuses on developing tools to support managers and users of infrastructure. IT-based systems enable traffic managers and road operators to monitor and direct traffic flows on their networks, while other IT-based systems guide drivers to the most energy efficient routes and support them in avoiding congestion.

Road safety is another major societal issue. In 2011, more than 30 000 people died on EU roads, equivalent to the population of a medium-sized town. For every death on Europe's roads, there are an estimated four permanently disabling injuries, such as damage to the brain or spinal cord, ten serious injuries, and 40 minor injuries. The estimated economic cost to society is EUR 130 billion a year (EC, 2010). Research in this area focuses on safer vehicles, safer driver behaviour and safer roads. The security of IT-based systems is also an important research topic.

The EU-funded research projects and studies on road transport are grouped in three sub-themes:

- Vehicle technology
- Traffic and travel management
- Safety and security.

2. Sub-Theme: Vehicle technology

Research on vehicle technology focuses on reducing the environmental impact of road transport through innovations in propulsion and energy systems. Innovative design and construction contribute to reducing energy consumption and noise from road vehicles.

Road transport accounts for about 18% of all emissions in the EU. Thus, innovation in vehicle technology is essential in achieving the targets of 60% reduction in greenhouse gas emissions from transport system, and for gradually phasing out conventionally fuelled cars from cities by 2050 (EC, 2011a). The research projects and studies in this sub-theme are presented in the following two clusters:

- **Propulsion, energy saving and storage:** research on more efficient propulsion systems, and particularly electric propulsion, energy saving and improved electricity storage to extend the driving range of electric vehicles.
- **Vehicle design and construction:** research on weight and noise reduction, improved aerodynamics and rolling resistance to reduce energy consumption and noise.

Propulsion, energy saving and storage

AVTR (Optimal Electrical Power train via Adaptable Voltage and Transmission Ratio, European Green Cars Initiative, 2012–2015) is developing a complete electrical power train for vehicles weighing less than 1000 kg. The electric power train features: up to 20% energy saving in pure urban drive, with respect to state-of-the-art power trains with a fixed transmission ratio; fun-to-drive experience by adaptable transmission ratio, allowing high acceleration in all conditions; overall cost reduction per a defined range through a reduced battery capacity; and reduced cost of ownership and maintenance by a significant reduction of electro-mechanical stresses due to power/energy transients.

CONVENIENT (Complete Vehicle Energy-saving Technologies for Heavy-Trucks, FP7, 2012–2015) is targeting a 30% reduction in fuel consumption in vehicles for long-distance freight transport. An innovative heavy-truck prototype is being developed with a suite of innovative energy-saving technologies and solutions. These include hybrid transmissions, electrified auxiliaries, dual-level cooling, HVAC capable of working without the main engine running, energy harvesting devices, such as a photovoltaic solar roof for truck and semitrailer, aerodynamic devices and Predictive Driver Support.

CORE (CO₂ REduction for long distance transport, FP7, 2012–2015) is directed at substantially reducing CO₂ emissions, 15% improvement in fuel efficiency compared to a EURO V engine, and meeting EURO VI emission legislation. These goals are to be achieved by efficient air management, control of the combustion process for the diesel engine, by hybridisation of the powertrain, downsizing and electrification of auxiliaries, and alternative fuels.

COSIVU (Compact, Smart and Reliable Drive Unit for Fully Electric Vehicles, European Green Cars Initiative 2012–2015) is developing a new system architecture for drive-trains. This is to be achieved by developing a smart, compact and durable single-wheel drive unit with an integrated electric motor, a compact transmission, full SiC power electronics (switches and diodes), a novel control and health monitoring module with wireless communication, and an advanced ultra-compact cooling solution.

Eco-FEV (Efficient Cooperative Infrastructure for Fully Electric Vehicles, European Green Cars initiative 2012–2015) is developing an integrated e-mobility platform that enables connection and information exchange between multiple systems relevant to FEVs, such as road, EV backend and EV charging infrastructure.

EMERALD (Energy Management and Recharging for efficient electric car Driving, European Green Car Initiative, 2012–2015) is focusing on energy use optimisation and on the seamless integration of the FEV into the transport and energy infrastructure, to make it a successful commercial product.

EUROLIION (High Energy Density Li-Ion Cells for Traction, European Green Cars Initiative, 2011–2015) is developing a new Li-ion cell for traction purposes with high energy density (at least 200 Wh/kg), low cost (maximum 150 EUR/kWh) and improved safety, by shifting from carbon to the much higher capacity silicon-based anodes, and from cobalt-based to iron and/or manganese/nickel-based cathodes, and the use of novel electrolyte salts.

FASTINCHARGE (Innovative FAST INductive CHARGing solution for Electric vehicles, FP7, 2012–2015) is developing a high-performing inductive solution enabling up to 40 kW power transfers to vehicles in two charging scenarios: stationary and en route.

GREEN EMOTION (Green eMotion, FP7, 2011–2015) is defining Europe-wide standards for smart grid developments, innovative ICT solutions, different types of EVs, and urban mobility concepts.

GREENLION (Advanced manufacturing processes for Low Cost Greener Li-Ion batteries, European Green Cars Initiative, 2011–2015) is developing an advanced manufacturing process for greener and cheaper Li-Ion batteries for electric vehicle applications, using water soluble, fluorine-free, high thermally stable binders, which would eliminate the use of VOCs and reduce the cell assembly cost.

Mobility 2.0 (Co-operative ITS Systems for Enhanced Electric Vehicle Mobility, European Green Cars Initiative, 2013–2015) is developing and testing an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility.

NECOBAUT (New Concept of Metal-Air Battery for Automotive Application based on Advanced Nanomaterials, European Green Cars Initiative, 2012–2015) is developing a new battery concept for automotive application based on a new metal/air technology that overcomes the energy density limitation of the Li-ion battery used at present in electric vehicles.

NOWASTE (Engine Waste Heat Recovery and Re-Use, FP7, 2011–2015) is developing an engine waste-heat recovery and re-use system for automotive applications, and demonstrating the feasibility in a purpose-built test rig.

ODIN (Optimized electric Drivetrain by integration, European Green Cars Initiative, 2012–2015) is developing a compact, efficient, highly integrated electric motor for a typical urban electric vehicle by optimising the integration of mechanical and electrical components into one eDrive-housing. Innovative simulation and optimisation software tools are used in the concept phase to assess optimal design variations. The final design will be built as a prototype and tested in a demo car.

OPERA4FEV (OPerating Energy RACK for Full Electric Vehicle, FP7, 2011–2015) is developing thermoplastic battery racks on two functional demonstrators for a large scale vehicle from FIAT, and a 'niche' car, the F-City from FAM.

STABLE (STable high-capacity lithium-Air Batteries with Long cycle life for Electric cars, European Green Cars Initiative, 2012–2015) is focusing on innovations in battery anodes, cathodes, electrolyte materials and technologies that are crucial for battery performance, and reducing battery cost and environmental impact.

UNPLUGGED (Wireless charging for Electric Vehicles, European Green Cars Initiative, 2012–2015) is investigating how smart inductive charging infrastructure can facilitate full electric vehicle integration in the urban road systems while improving customer acceptance and perceived practicality.

AMELIE (Advanced Fluorinated Materials for High Safety, Energy and Calendar Life Lithium Ion Batteries, European Green Cars Initiative, 2011–2014) is developing fluorinated electrolyte/separators and binders in combination with active electrodes for high performance, safe and durable Li batteries. The main deliverables are cell prototypes with a capacity of over 10 Ah.

AUTOSUPERCAP (Development of High Energy/ High Density Supercapacitors for Automotive Applications, European Green Cars Initiative, 2011–2014) is contributing towards developing super-capacitors of both high power and high energy density at affordable levels, and of a higher durability than many current electrochemical storage devices.

CAPIRE (Coordination Action on PPP Implementation for Road-Transport Electrification, FP7 2010–2014) is directed to increasing the competitiveness of the European automotive industry in energy-efficient vehicles that are safe, non-polluting and CO₂-free. A Public Private Partnership (PPP) is being developed to support the implementation of road transport electrification, including a dedicated roadmap based on an elaborated analysis of R&D needs and containing milestones and supporting measures.

e-DASH (Electricity Demand and Supply Harmonization for EVs, European Green Cars Initiative, 2013–2014) is developing an intelligent charging system for electric vehicles to balance the grid in real-time, compensating for highly variable demand and supply due to spatially and temporally changing energy requirements.

ELECTROGRAPH (Graphene-based Electrodes for Application in Supercapacitors European Green Cars Initiative, 2011–2014) is developing a combination of graphene and graphene-based electrode materials with room temperature ionic liquid (RTILs) electrolytes to optimise the overall performance of super capacitors.

ELIBAMA (European Li-Ion Battery Advanced Manufacturing for Electric Vehicles, FP7, 2011–2014) is developing eco-friendly processes for electrode production, electrolyte manufacturing, fast and homogeneous electrolyte filling processes, cell design and assembly.

ESTRELIA (Energy Storage with Lowered Cost and Improved Safety and Reliability for Electrical Vehicles, European Green Cars Initiative, 2011–2014) is defining ways to improve storage, reliability and safety of energy and is offering new battery management solutions for FEVs. This includes a modular approach to develop amongst others an integrated flexible battery management system (BMS) for ultracapacitor cell balancing; a new ultracapacitor power cell pack design, targeting for 50% higher energy density; and a power pack in accordance with new standards and guidelines for robustness validation and lifetime cycle (ILCD).

LABOHR (Lithium-Air Batteries with split Oxygen Harvesting and Redox Processes, European Green Cars Initiative, 2011–2014) is developing ultra-high-energy battery systems for automotive applications. The concept employs environmentally benign ionic liquid (IL) electrolytes and nano-structured electrodes that harvest dry oxygen from air. Using this concept for O₂ harvesting enables the O₂-saturated electrolyte to circulate in a way that avoids cathode clogging, a common problem with conventional batteries.

LIBRALATO (Libralato Engine Prototype, European Green Cars Initiative, 2011–2014) is investigating the potential of a rotary eco-engine for the 21st century, with a new thermodynamic cycle and adjusted mechanical dynamics. The design potential of the Libralato engine is investigated through an iterative cycle of simulation and modelling, prototype construction and test bed evaluation.

MOTORBRAIN's (Nanoelectronics for electric vehicle intelligent failsafe power train, European Green Cars Initiative, 2011–2014) is developing an intrinsic fail-safe and fault-tolerant highly efficient propulsion system for electric vehicle powertrains based on an electrical motor, novel power electronic packaging and advanced control systems.

OpEneR (Optimal Energy Consumption and Recovery Based on System Network, European Green Cars Initiative, 2011–2014) is unlocking the market for electric vehicles by increasing the driving range without increasing battery size, and by developing an intelligent energy management and recovery system. This system provides advanced driver support based on a networked architecture comprising battery, e-machine, regenerative braking, satellite navigation and dashboard displays.

OPTIMORE (Optimised Modular Range Extender for every day Customer Usage, FP7, 2012–2014) is developing and optimising the concept of a fully integrated, range-extended, electrified light duty vehicle.

OSTLER (Optimised storage integration for the electric car, FP7, 2011–2014) is developing new solutions for mechanical, thermal and electrical integration of storage packs based on a modular concept of storage-centric design, in which the EV is built around the battery. The implications of removable storage packs are investigated, as well as the feasibility of removable concepts, such as quick drop and user-changeable packs.

SMART-LIC (Smart and Compact Battery Management System Module for Integration into Lithium-Ion Cell for Fully Electric Vehicles, European Green Cars Initiative, 2011–2014) is developing a new Battery Management System (BMS) by implementing the BMS module as a system-in-package (SiP) directly integrated into the lithium-ion cell for fully electric vehicles, by using advanced packaging technologies.

SMARTV2G (Smart Vehicle to Grid Interface, European Green Cars Initiative, 2011–2014) is connecting the electric vehicle to the grid by enabling controlled flow of energy and power through safe, secure, energy-efficient and convenient transfer of electricity and data.

SuperLIB (Smart Battery Control System Based on a Charge-equalization Circuit for an Advanced Dual-Cell Battery for Electric Vehicles, European Green Cars Initiative, 2011–2014) is developing a smart control system for a highly integrated battery with high power (HP) and high energy (HE) cells inside a joint package which share cooling and charge-equalization circuit. This combination significantly improves the lifetime, reliability and cost/performance ratio of the battery.

Apples (Advanced, High Performance, Polymer Lithium Batteries for Electrochemical Storage, European Green Cars Initiative, 2010–2013) is developing a lithium ion battery for application in electric vehicles. The project aims at the industrial production of a battery having an energy density of the order of 300 Wh/kg, costing much less than batteries already on the market and with improved environmental compatibility and highly reduced safety hazard.

CASTOR (Car Multi-Propulsion Integrated Power Train, European Green Cars Initiative, 2010–2013) achieved a 10 to 20% energy saving, 25% cost reduction, 15 to 20% improvement in vehicle range, and increased safety compared to current state-of-the-art EV propulsion systems. This was achieved by exploring architectural advantages of fully integrated powertrain electronics for distributed propulsion systems that enable future generations of electric vehicles.

EASYBAT (Models and generic interfaces for easy and safe Battery insertion and removal in electric vehicles, FP7, 2011–2013) is developing generic interfaces to improve the interoperability between battery system modules and on-board vehicle systems and is making new components for quick integration of the battery in the vehicle based on cost effective, environmental friendly switchable battery packs.

eLCAR (E-Mobility Life Cycle Assessment Recommendations, European Green Cars Initiative, 2012–2013) developed guidelines for assessment of the environmental impact of electric vehicles. The guidelines provide a coherent benchmark framework for ecological comparison of electric and other vehicles, such as bio-fuel propelled cars and hydrogen-based mobility.

HCV (Hybrid Commercial Vehicle, FP7, 2010–2013) developed urban buses and delivery vehicles with advanced second-generation, energy-efficient, hybrid electric powertrains. Innovative e-drives, energy-storage technologies, and auxiliary components were used and lightweight body technologies demonstrated.

HELIOS (High Energy Lithium-ION Storage Solutions, European Green Cars Initiative, 2009–2013) evaluated four lithium-based battery technologies to find the most promising for mass production. These were lithium nickel cobalt aluminium, lithium nickel manganese cobalt, lithium manganese spinel, and lithium iron phosphate. An EU standard was defined for safety and life tests of the batteries.

JOBVEHELEC (Job opportunities in vehicle electrification, FP7, 2011–2013)

raised awareness of future jobs in vehicle electrification and education pathways to these jobs for engineers and technicians.

POWERFUL (POWERtrain for FUTURE Light-duty vehicles, FP7, 2010–2013)

developed new powertrain concepts for light duty vehicles aiming at reducing CO₂ emissions. Three concepts were investigated: an advanced four-stroke SI (spark ignition) engine concept characterized by low-cost/low emissions; an advanced four-stroke CI (compression ignition) engine concept able to run also on new tailored fuels and integrating the LTC (low temperature combustion) mode in the CI combustion system; and an advanced two-stroke CI engine concept running on diesel fuel and integrating the LTCH (low thermal homogeneous combustion) mode in the CI system.

PowerUp (Specification, Implementation, Field Trial, and Standardization of the Vehicle-2-Grid Interface, European Green Cars Initiative 2011–2013)

developed a Vehicle-2-Grid (V2G) interface, involving a full development cycle of physical/link-layer specification, charging control protocol design, prototyping, conformance testing, field trials, and standardisation. This development will enable smooth integration of electric vehicles in emerging smart-grid networks.

SMARTOP (Self powered vehicle roof for on-board comfort and energy saving, FP7, 2010–2013)

developed technology to convert daylight into power using smart roof integrating solar cells.

SOMABAT (Development of novel SOLid MAterials for high power Li polymer BATteries. Recyclability of components, European Green Cars Initiative, 2011–2013)

developed more environmentally friendly, safer and better performing high power Li polymer battery. This was achieved with the development of novel recyclable solid materials for use as anode and cathode, a solid polymer electrolyte, new alternatives to recycle the battery components and life cycle analysis.

ELVIRE (ELECTric Vehicle communication to Infrastructure, Road services and Electricity supply, European Green Cars Initiative, 2010–2012)

developed an interactive electric energy ICT and Service interface between the vehicle and electricity infrastructure.

FUEREX (Multifuel Range Extender with High Efficiency and Ultra-Low Emissions, European Green Cars Initiative, 2011–2012) developed a low-cost, high-performance range extender for electric vehicles (EVs).

HEATRECAR (Reduced Energy Consumption by Massive Thermoelectric Waste Heat Recovery in Light Duty Trucks, FP7, 2009–2012) achieved reduction in vehicle energy consumption and CO₂ emissions by harvesting electrical energy from the exhaust system.

SMARTBATT (Smart and Safe Integration of Batteries in Electric Vehicles, FP7, 2011–2012) developed an innovative, multifunctional, light and safe concept for an energy storage system that is integrated in the structure of an electric car.

STORAGE (Composite structural power storage for hybrid vehicles, FP7, 2010–2012) developed a new concept for lightweight energy storage using multifunctional materials. The project integrated into the structural components of the vehicle four different energy storage devices: capacitors, batteries, super-capacitors and hybrid capacitors.

TIFFE (Thermal systems integration for fuel economy, FP7, 2009–2012) integrated vehicle thermal systems to improve on-board thermal management and energy efficiency.

BEAUTY (Bio-ethanol Engine for Advanced Urban Transport by Light Commercial Vehicle & Heavy Duty, FP7, 2009–2011) built engine solutions to meet targets on: future emission limits (Euro 6); fuel conversion efficiency (at least 10% higher than current engines running on equivalent bio-ethanol blends); and cold start ability down to –15 °C ambient temperature.

E³Car (Nanoelectronics for an Energy Efficient Electrical Car, European Green Cars Initiative 2009–2011) achieved 35% energy saving and increased integrability through the development of nano-electronic technologies, devices, circuit architectures and modules for electrical cars and vehicles, and demonstration of these modules in a final system, and new design and concepts for power trains, power conversion, power management and battery management.

EE-VERT (Energy efficient vehicles for road transport, FP7, 2009–2011) produced energy management strategies (thermal and electrical) for conventional and hybrid vehicles to reduce fuel consumption and CO₂ emissions.

TOSCA (Technology Opportunities and Strategies towards Climate-friendly Transport, FP7, 2009–2011) provided a strategic perspective on potential contributions of new technologies and fuels to reducing greenhouse gas emissions. These technologies include plug-in hybrid vehicles, electric vehicles, and second generation biofuels. The results indicated that policy interventions are required to exploit potential opportunities, and higher priority needs to be given to climate change mitigation even though such interventions may lead to additional public expenditure and higher prices.

Vehicle design and construction

ASTERICS (Ageing and efficiency Simulation & Testing under Real World Conditions for Innovative electric vehicle Components and Systems, European Green Cars Initiative, 2012–2015) explored the potential of fully electric vehicles, with the development of advanced modelling and testing tools and methods related to energy efficiency, performance and reliability.

AUTOMICS (Pragmatic solution for parasitic-immune design of electronics ICs for automotive, European Green Cars Initiative, 2012–2015) is studying the parasitic substrate coupling effects and enhancing the quality of Smart Power Integrated Circuits (ICs), by reducing risks related to reliability, safety and durability of fully electrical vehicles.

LORRY (Development of an innovative low rolling resistance truck tyre concept in combination with a full scale simulation tool box for tyre performance in function of material and road parameters, FP7, 2012–2015) is reducing the truck carbon footprint by developing an innovative low-rolling resistance tyre concept combined with a comprehensive toolbox for fuel-saving fleet management.

V-FEATHER (InnoVative Flexible Electric Transport, FP7, 2012–2015) is developing a vision on electric vehicle architecture for the design, construction and operation of urban light duty vehicles (LDV) for the near future. The vehicle is built on an active adaptive structural architecture (ADAPTecture) to replace the platform concept with a modular building block concept. The functional modules are part of the vehicle structure and thus reduce the frame weight. Payload modules can be removed or added, allowing the LDV to function in the entire supply chain run.

DELIVER (Design of Electric LIght Vans for Environment-impact Reduction, FP7, 2011–2014) is generating, investigating and analysing innovative design concepts for electric light duty vehicles with motorised wheels.

E-VECTOORC (Electric Vehicle Control of Individual Wheel Torque for On- and Off-Road Conditions, European Green Car Initiative, 2011–2014) is improving vehicle energy consumption, stopping distance, and acceleration times. This is being done by developing and demonstrating yaw rate and sideslip angle control algorithms, based on the combination of front/rear and left/right torque vectoring to improve overall vehicle dynamic performance. Furthermore, novel strategies are being developed for modulation of the torque output of individual electric motors to enhance brake energy recuperation, Anti-lock Brake function and Traction Control function.

FURBOT (Freight Urban RoBOTic vehicle, European Green Cars Initiative, 2011–2014) is proposing novel concept architecture for light-duty, full-electric vehicles for efficient sustainable urban freight transport. The vehicle is designed for fleet use to provide more sustainable urban freight transport. The system will be modelled and a simulator developed.

Hi-Wi (Materials and Drives for High & Wide Efficiency Electric Powertrains, European Green Cars Initiative, 2010–2014) is prototyping and demonstrating innovative motors; new approaches to the holistic design of motors and nano-scale materials advances to create magnets with reduced rare-earth content; micro/nano-scale manufacturing advances to create permanent magnets and integrated assemblies.

ICE (Magneto-Caloric Refrigeration for Efficient Electric Air Conditioning, European Green Cars Initiative, 2010–2014) is developing a new air conditioning and heat pump system based on the Magneto Caloric heat pump and a redesign of the cabin air conditioning.

MAENAD (Model-based Analysis & Engineering of Novel Architectures for Dependable Electric Vehicles, European Green Cars Initiative, 2010–2014) is supporting the automotive safety standard ISO 26262, prediction of dependability and performance, and automated design optimisation using these criteria. In addition, the project results are being demonstrated in an electrical vehicle design.

ECOSHELL (Development of new light high-performance environmentally benign composites made of bio-materials and bio-resins for electric car application, FP7, 2011–2013) investigated two major drawbacks of composites (production cost and safety) and added the environmental advantages by applying innovative biodegradable materials in the vehicle body.

EFUTURE (Safe and Efficient Electrical Vehicle, European Green Cars Initiative, 2010–2013) focused on intelligent vehicles that cope with safety requirements and adapt their energy needs by creating a platform which minimises energy requirements while dynamically balancing safety and energy efficiency needs.

E-LIGHT (Advanced Structural Light-Weight Architectures for Electric Vehicles, FP7, 2011–2013) explored all aspects and requirements for optimal electric vehicle architecture, focusing on modularity of components, ergonomic designs, innovative safety concepts, improved aerodynamic performance, and reduced weight.

ELVA (Advanced Electric Vehicle Architectures, European Green Cars Initiative, 2010–2013) developed architectures for electric vehicles based on analyses of the most important driving forces for future vehicle design; technology forecast in order to achieve a good understanding of the technologies available for electric vehicles in 2020; and market analyses for identification of customers' requirements and needs in 2020.

WIDE-MOB (Building blocks concepts for efficient and safe multiuse urban electrical vehicles, FP7, 2010–2013) addressed the design and development of the basic building blocks for electric vehicles. Activities included optimised aerodynamic bodies with embedded synthetic micro-jets, lightweight and low cost bodies, overall system optimisation, application of low frequency electromagnetic field (EMF) design concepts, modular and reconfigurable design to address the needs with ergonomic on-board space, and solar panels. Two prototype vehicles and guidelines for the concepts developed were delivered.

CITY MOVE (City multi-Role Optimized Vehicle, FP7, 2010–2012) developed a new concept for urban delivery vehicles, which can be adapted to the diverse needs of European cities.

CO2NTROL (Integrated solutions for noise and vibration control in vehicles, FP7, 2009–2012) combined advanced laboratory-level technologies in noise and vibration control in vehicles with conventional solutions for direct application to the next generation of city cars.

ID4EV (Intelligent Dynamics for Fully Electric Vehicles, European Green Cars Initiative 2010–2012) developed innovative FEV power train concepts to increase safety and comfort of fully electric vehicles, as well as to promote market acceptance and thus contribute to global reduction of CO₂ emissions.

PICAV (Personal Intelligent City Accessible Vehicle System, European Green Cars Initiative 2009–2012) worked on extending the public transport system to pedestrian environments with small, networked, mobile units, acting very much like pedestrians, offering instant access, open-ended reservation and one-way trips. The small dimensions and tiny footprint of the mobile units result in very low environmental impact.

QUIESST (Quietening the environment for a sustainable surface transport, FP7, 2009–2012) produced a guidebook on optimising noise reduction devices, such as barriers, claddings and covers, as a reference tool for noise mitigation.

Compare (Continuous Health Monitoring and Non-destructive Assessment of Composites and Composite Repairs on Surface Transport Applications, FP7, 2008–2011) manufactured a multi-axis robotic scanner for in-service inspection of composite components used in trains, buses, trucks and trams.

MID-MOD (Mid-frequency Vibro-acoustic Modelling Tools/Innovative CAE Methodologies to Strengthen European Competitiveness, FP7, 2009–2011) developed robust computer aided engineering (CAE) tools for analysis of mid-frequency noise and vibration in modern vehicle design.

3. Sub-Theme: Traffic and travel management

Research focuses on IT-based systems that enable traffic managers and road operators to manage traffic flows on their networks more efficiently. Other information systems support travellers in selecting the most efficient routes, and in avoiding traffic congestion.

Over decades, the road transport sector has developed to the benefit of trade, the general economy, and the freedom of movement. Traffic volumes are growing but so is congestion. To increase efficiency, the EU focuses on developing methods to make better use of infrastructure by means of intelligent transport systems. The research projects and studies in this sub-theme are presented in the following two clusters:

- **Traffic management:** development of IT-based systems for improved management of road networks and management of traffic flows. In addition to information about traffic flows, these systems provide information on actual and expected road and weather conditions, e.g. dynamic weight control systems support road operators in preventing damage to their network.
- **Travel management and intermodality:** development of systems that assist road users in choosing optimal routes by providing information on congestion, alternative routes and modes, services along the route, and informing drivers about optimum driving behaviour.

Traffic management

79GHZ (International automotive 79 GHz frequency harmonisation imitative and worldwide operating vehicular radar frequency standardisation platform, FP7, 2011–2014) is focusing on worldwide harmonisation of frequency allocation for automotive radar systems in the frequency range 77 GHz to 81 GHz (79 GHz). This will prevent market segmentation by country-specific frequency variants, which would affect production costs and reduce the competitiveness of European manufacturers.

CARBOTRAF (Decision Support System for Reducing CO₂ and Black Carbon Emissions by Adaptive Traffic Management, FP7, 2011–2014) developed a method, system and tools for adaptively influencing traffic in real-time to reduce CO₂ and black carbon (BC) emissions caused by road transport in urban and inter-urban areas. Starting with existing and new simulation models and tools linking traffic states to emission levels, a decision support system is developed for online prediction of emission levels using real-time and simulated traffic and air-quality data. The predictions are used to achieve a low emission traffic scenario by imposing ITS measures (re-routing, adjustment of traffic light sequences).

DECOMOBIL (Support action to contribute to the preparation of future community research programme in user centred Design for ECO-multimodal MOBILity, FP7, 2009–2014) is contributing to the acceptability and usability of ICT for cleaner and safer mobility. This is being done by identifying, discussing and disseminating up-to-date knowledge and know-how on human-machine interface (HMI) and Human Centred Design areas for the ITS community at EU and international levels.

FOTSIS (European Field Operational Test on Safe, Intelligent and Sustainable Road Operation, FP7, 2011–2014) is carrying out large-scale field tests of road infrastructure management systems needed for the operation of seven close-to-market cooperative I2V, V2I & I2I technologies (FOTs Services). The effectiveness and potential for full-scale deployment in Europe is being assessed.

TRIMM (Tomorrow's Road Infrastructure Monitoring and Management, FP7, 2011–2014) is developing new monitoring techniques that deliver key information to road management systems, based on the wide range of innovative sensing technologies and information processing techniques.

DRIVE C2X (DRIVE C2X DRIVING implementation and Evaluation of C2X communication technology in Europe, FP7, 2011–2013) made a comprehensive assessment of cooperative systems (communication between vehicles and between vehicles and infrastructure) in operational field tests in various places in Europe in order to verify the benefits and to pave the way for market implementation.

EUROPTIMA (European open platform for smart card ticketing, payment and multiservice in interoperable mass transit applications, FP7, 2011–2013) focused on pilots of modular, off-the-shelf, customisable and scalable components and interfaces for building fare collection systems based on CALYPSO specifications and other open industry standards for use in small-scale transport and mobility related operations. This included the definition of open hardware based on existing platforms, such as NFC telephones and bank POS.

SARTRE (Safe road trains for the environment; developing strategies and technologies to allow vehicle platoons to operate on normal public highways with significant environmental, safety and comfort benefits, FP7, 2009–2012) developed strategies and technologies to enable vehicle road trains to operate on public motorways with significant environmental, safety and comfort benefits.

GAMMA-A (Galileo Receiver for Mass Market Applications in the Automotive Area, FP7, 2009–2011) identified applications for multi-frequency receivers, such as e-call service, ghost driver emergency stop, automatic driving, green driving, automatic lane keeping and lane departure warning. Requirements with respect to accuracy, integrity and continuity were defined. Markets for applications were identified and recommendations on market introduction were made.

iTETRIS (An Integrated Wireless and Traffic Platform for Real-time Road Traffic Management Solutions, FP7, 2008–2011) integrated wireless communications and road traffic simulation platforms in an environment that is easily tailored for performance analysis of cooperative ITS in cities.

FOT-Net (Networking for Field Operational Tests, FP7, 2008–2010) created a platform for knowledge exchange on Field Operational Tests. These large-scale test programmes make comprehensive assessments of the efficiency, quality, robustness and acceptance of ICT solutions used for smarter, safer, cleaner and more comfortable transport solutions.

Travel management and intermodality

ECODRIVER (Supporting the driver in conserving energy and reducing emissions, FP7, 2011–2015) is optimising the driver-powertrain-environment feedback loop in order to deliver effective feedback to drivers on green driving.

ECOMPASS (eCO-friendly urban Multi-modal route PIAnning Services for Mobile uSers, FP7, 2011–2014) is delivering a comprehensive set of tools and services (navigation, route planning) for end users to enable eco-awareness in urban multimodal transport.

ECONAV (Ecological Aware Navigation: Usable Persuasive Trip Advisor for Reducing CO₂-consumption, FP7, 2011–2014) is providing travellers with personalised multimodal navigation tools for ecologically-friendly driving and travelling.

Enhanced WISETRIP (Enhancing Inter-modality of Content, Personalised Information and Functionality of WISETRIP Network of Journey Planning Engines, European Green Cars Initiative 2011–2014) is contributing to planning, booking and travelling multimodal journeys adapted to user needs, multiple trip criteria, environmental impact and personal preferences.

REDUCTION (Reducing Environmental Footprint based on Multi-Modal Fleet management System for Eco-Routing and Driver Behaviour Adaptation, FP7, 2011–2014) is directed to reducing CO₂ emissions by means of ICT solutions in managing multimodal fleets through optimising driving behaviour, eco-routing, and supporting multimodality.

COMPASS (Optimised CO-Modal PASSenger Transport for Reducing Carbon Emissions, FP7, 2011–2013) provided an overview of future travel needs in the light of key socio-economic trends. Application of Information Communication Technology (ICT) and Information Technology Services (ITS) was analysed to meet new demands and to promote integration of multimodal transport solutions. The contribution of these solutions to de-carbonising transport was assessed.

ECOGEM (Cooperative Advanced Driver Assistance System for Green Cars, FP7, 2010–2013) developed a system to assist drivers in reaching travel destinations via energy-efficient routes, and making use of contextual information and services, such as battery characteristics, location and availability of recharging points and stations, and booking of recharging slots while on the move.

ECOMOVE (Cooperative Mobility Systems and Services for Energy Efficiency, FP7, 2010–2013) developed systems and tools to support drivers to sustainably eliminate unnecessary fuel consumption (and thus CO₂ emissions), and to support road operators in energy-efficient traffic management.

4. Sub-Theme: Safety and Security

To improve traffic safety, research focuses on safer vehicles, safer roads and safer road user behaviour. In addition, research covers the security of vehicle-related IT systems to prevent unwanted influences.

Transport plays a major role in mobility and quality of daily life. Cars and motorbikes are the main transport in the daily activities of 55% of EU citizens, and 20% of people cycle and walk (EC, 2011c). Compared to other types of passenger transport, such as public transport, individual transport carries higher risks. Even though road deaths in the EU have almost halved in the last decade, many people still die on road. The Transport White Paper states that initiatives in technology, enforcement and education, particularly with regard to vulnerable road users, are essential in further reducing loss of life (EC, 2011a).

The research projects and studies in this sub-theme are presented in the following four clusters:

- **Safer vehicles:** research and innovation in vehicle design and construction, and advanced driver assistance systems.
- **Safer roads:** research and innovation in infrastructure.
- **Safer road users:** behaviour of drivers, passengers and other road users.
- **Improved security:** research on IT-based systems and their accessibility.

Safer vehicles

MATISSE (Modelling And Testing for Improved Safety of key composite StructurEs in alternatively powered vehicles, FP7, 2012–2015) is modelling, predicting and optimising the crash behaviour of mass produced fibre reinforced polymer (FRP) composite structures for extensive use in alternatively powered vehicles.

SafeEV (Safe Small Electric Vehicles through Advanced Simulation Methodologies, FP7, 2012–2015) is defining advanced test scenarios and evaluation criteria for the safety of vulnerable road users (VRU) and occupant of small electric vehicles (SEVs). This will be the basis for developing industrial applicable methods for virtual testing of these scenarios and criteria (e.g., a method for active occupant safety assessment). Dedicated best practice guidelines for VRU and occupant safety evaluation of SEVs needs to ensure a sustainable impact for industry and regulative organisations beyond the project duration.

ARTRAC (Advanced Radar Tracking and Classification for Enhanced Road Safety, FP7, 2011–2014) developed a new radar system for compact cars and light commercial vehicles, which helps to detect pedestrians and other vulnerable road users and, if necessary, automatically invokes braking or collision avoidance actions. The new system is sufficiently cost-effective to be commercially viable even for small or compact cars.

ASPECSS (Assessment methodologies for forward looking Integrated Pedestrian and further extension to Cyclists Safety Systems, FP7, 2011–2014) is developing harmonised test and assessment procedures for forward looking integrated pedestrian safety systems. These systems combine reducing impact speed by driver warning and/or autonomous braking with reducing impact on pedestrians by means of protective devices.

EM-SAFETY (EM safety and Hazards Mitigation by proper EV design, European Green Cars Initiative, 2011–2014) is increasing public confidence in the safety of electromagnetic fields (EMF) in fully electric vehicles (FEV), by assessing these fields under certain driving conditions, and in simulations based on these measurements. These inputs are to be used to minimise EMF in electric cars, and in studies on their effects.

EVADER (Electric Vehicle Alert for Detection and Emergency Response, FP7, 2011–2014) is investigating the interior and exterior soundscape of electric vehicles for safe operation, taking into account driver feedback, pedestrian reactions, driver and pedestrian warning systems, and pedestrian safety.

OPTIBODY (Optimized Structural components and add-ons to improve passive safety in new Electric Light Trucks and Vans (ELTVs), FP7, 2011–2014) is developing a modular structural architecture for electric light trucks and vans (ELTVs) to improve passive safety and thus contribute to reducing fatalities and severe injuries.

ADSEAT (Adaptive seat to reduce neck injuries for female and male occupants, FP7, 2009–2013) contributed to reducing the risk of whiplash injury for all vehicle occupants by preparing the groundwork and recommendations for evaluation of the effectiveness of anti-whiplash systems.

COVER (Coordination of Vehicle and Road Safety Initiatives, FP7, 2009–2013) brought together coordinators/key partners in four FP7 initiatives. Together with partners from the participating projects, the coordinators identified joint research activities to provide the required bio-mechanical know-how embedded in numerical and experimental tools for design and evaluation of new and improved vehicle safety technologies.

SAFETRIP (Satellite application for emergency handling, traffic alerts, road safety and incident prevention, FP7, 2009–2013) sought added value for driver assistance systems by combining information from vehicles and infrastructure. This was done using new satellite technology, and adopting a holistic approach to infrastructure, vehicle and driver in which all three play key roles in the safety chain.

2WIDE_SENSE (WIDE spectral band & WIDE dynamics multifunctional imaging SENSOR Enabling safer car transportation, FP7, 2010–2012) provided the European automotive industry with the next generation of imaging sensors beyond the current CMOS imagers. Applications included Lane Departure Warning and Traffic Sign Recognition.

ACTIVETEST (Dissemination of Performance Testing Methods for ICT-based Safety Functions in Road Vehicles, FP7, 2011–2012) disseminated performance testing methods for ICT-based safety functions in road vehicles.

ASSESS (Assessment of integrated vehicle safety systems for improved vehicle safety, FP7, 2009–2012) mobilised the European research community and car industry to develop and test assessment methods for a wide range of integrated vehicle safety systems. Procedures have been developed to evaluate driver behaviour, pre-crash system performance and crash performance.

FIMCAR (Frontal Impact and Compatibility Assessment Research, FP7, 2009–2012) analysed frontal impact test procedures and their potential in future legislation. Research focused on car-to-car frontal impact accidents. Test procedures were developed in combination with a crash test programme and numerical simulations.

MINIFAROS (Low-cost Miniature Laser scanner for Environment Perception, FP7, 2010–2012) developed and demonstrated a prototype of a low-cost miniature automotive laser scanner for environment perception. More specifically, a totally new low-cost miniature laser scanner technology is developed that opens up the Advanced Driver Assistance System (ADAS) market for small and medium size cars and broadens the range of possible applications by its low cost, low power, small size and robustness.

MOSARIM (MOre Safety for All by Radar Interference Mitigation, FP7, 2010–2012) generated a first assessment and common understanding of the radar interference effects that could hinder functioning of systems, such as adaptive cruise control, collision warning systems, and vulnerable road user detection. A set of recommendations and guidelines on preventing radar interference were published.

TELEFOT (Field Operational Tests of Aftermarket and Nomadic Devices in Vehicles, FP7, 2008–2012) is the largest pan-European field trial to date on the function of in-vehicle aftermarket and nomadic devices. The benefits of these devices to drivers were demonstrated.

ADOSE (Reliable Application Specific Detection of Road Users with Vehicle On-board Sensors, FP7, 2008–2011) is set out to enhancing Advanced Driver Assistance System (ADAS) functions through the development of high performance and low cost technologies suitable for reliable detection and classification of road users in hostile environments. To this end five sensor module prototypes were designed, fabricated and tested.

ASSET-ROAD (ASSET Advanced Safety and Driver Support in Essential Road Transport, FP7, 2008–2011) demonstrated that innovative sensor and monitoring systems can improve traffic safety and reduce the cost of infrastructure maintenance. These systems can assist drivers, support control and enforcement of maximum weight regulations for trucks, detect defective brakes, tyres, bearings, shafts and other vehicle elements, and supply road managers with data on network status.

euroFOT (European Large-Scale Field Operational Test on Active Safety Systems, FP7, 2008–2011) analysed data gathered under real traffic conditions with selected drivers to test functionalities of intelligent vehicle systems, such as adaptive cruise control and forward collision warning systems, navigation systems, blind spot information systems, speed regulation systems and curve speed warning systems.

HAVE-IT (Highly automated vehicles for intelligent transport, FP7, 2008–2011)

contributed to improving traffic safety and efficiency of passenger cars and trucks by focusing on advanced driver assistance systems (ADAS). For example, instead of switching off an ADAS system in a critical situation, a stepwise approach is used to transfer the driving task from the automated system to the driver.

HAVEit (Highly Automated Vehicles for Intelligent Transport, FP7, 2008–2011)

developed sensors, monitoring systems and a scalable vehicle architecture, and demonstrated an automated vehicle driving through a narrow construction site without driver interference.

ATESST2 (Advancing Traffic Efficiency and Safety through Software Technology Phase 2, FP7, 2008–2010)

developed modelling techniques to facilitate the design process for cooperative active safety systems.

Safer roads

INROADS (INtelligent Renewable Optical ADvisory System (INROADS), FP7, 2011–2014)

is developing Intelligent Road Studs (also known as cat's eyes and used worldwide in painted lines to delineate road space through retro-reflective spheres) that combine LED lighting, sensor systems and communication technologies. The IRS will integrate renewable energy technologies to either fully or partially power the devices, making them self-contained.

SKIDSAFE (Enhanced driver safety due to improved skid resistance, FP7, 2009–2013)

used experimental evidence and computational studies to investigate micro-mechanical factors controlling skid resistance at the tyre-pavement interface in asphalt-concrete pavements and related them to asphalt mix characteristics.

SMART RRS (Innovative concepts for smart road restraint systems to provide greater safety for vulnerable road users, FP7, 2008–2012)

focused on developing a smart road restraint system to reduce the number of injuries and deaths caused by road traffic accidents to vulnerable road users such as motorcyclists, cyclists and passengers.

This smart restraint was made to reduce the number of accidents through better information on the actual state of the road and traffic flow (climatic conditions, traffic flow, obstructions); eliminate dangerous profiles from road restraint systems (crash barriers) that currently endanger vulnerable road users; and optimise road safety by providing exact information on where and when accidents happen in real-time.

ROSATTE (ROad Safety ATTRIBUTES Exchange Infrastructure in Europe, FP7, 2008–2010) established an efficient and qualitative data supply chain from public authorities to commercial map providers on safety-related road characteristics.

TYROSAFE (Tyre and Road Surface Optimisation for Skid Resistance and Further Effects, FP7, 2008–2010) raised awareness on optimising assessment and management of tyre-road interaction parameters to increase safety and to support greening of road transport in Europe.

Safer road users

UDRIVE (eUropean naturalistic Driving and Riding for Infrastructure & Vehicle safety and Environment, FP7, 2012–2016) is gaining in-depth understanding of road user behaviour, building on experience in the PROLOGUE feasibility study and various Field Operational Tests (FOTs), and contributing to in-depth knowledge to meet EU reduction targets on crashes and vehicle emission levels.

HEMIS (Electrical powertrain Health Monitoring for Increased Safety of FEVs, European Green Cars initiative, 2012–2014) is designing the Prognostic Health Monitoring System to provide a fail-safe state for the electric powertrain and the emitted electromagnetic field, and to assess electromagnetic compatibility with and the impact of electromagnetic fields (including low frequency emissions) on human health.

CASPER (Child Advanced Safety Project for European Roads, FP7, 2009–2012) collected field studies from different countries on the use and misuse of child restraint systems, accident data on restrained children, and injury criteria for frontal impact. The Q-family dummy models were completed, and a system to evaluate the protection of the abdomen for children in cars was developed.

THOMO (Development of a finite element model of the human thorax and upper extremities, FP7, 2009–2012) improved finite element models of the human thorax including upper extremities based on research, development, and validation of the models for the 5th, 50th, and 95th percentile of each gender.

2-BE-SAFE (2-wheeler behaviour and safety, FP7, 2009–2011) identified accidents involving powered two wheelers (PTW), and identified and characterised behavioural dysfunctions, including human errors that underlie these crash types. Guidelines and recommendations were produced for developing countermeasures.

EPOCH (Enabling Protection for Older Children, FP7, 2009–2011) produced a dummy resembling a 10.5 year old (Q10), developed risk functions for older children, and criteria for the use of Q10 in regulation No 44 of the Economic Commission for Europe of the United Nations (UN/ECE).

SCVP (Smartest Cars Video Project, FP7, 2008–2010) produced a high quality one-hour TV programme for broadcasting throughout Europe, raising public awareness about dangers on the road and the greater safety offered by active safety systems, including electronic stability control, forward collision mitigation, lane departure prevention and eCall.

Improved security

PRESERVE (Preparing Secure Vehicle-to-X Communication Systems, FP7, 2011–2014) is bringing secure and privacy-protected V2X communication closer to reality by providing and field testing a security and privacy sub-system for V2X systems. The project is contributing to ongoing harmonisation and standardisation at EU level.

OVERSEE (Open Vehicular SEcurE platform, FP7, 2010–2012) produced an open vehicular IT platform that provides a protected standardised in-vehicle runtime environment and on-board access and communication point.

EVITA (E-safety Vehicle Intrusion proTected Applications, FP7, 2008–2011) designed and verified a prototype architecture for automotive on-board networks to protect security-relevant components from tampering, and from compromising sensitive data when transferred inside a vehicle.

5. Future Challenges for Research

Policy

By external expert John van Rijn

Given the continuing challenges in road transport of reducing greenhouse gas emissions and noise hindrance, the impact of traffic congestion on economic growth and mobility, and reducing road fatalities and injuries, further research is required on vehicle technology, traffic and travel management, integration of road transport in multimodal door-to-door transport chains and road safety.

Vehicle and Infrastructure Technology

Research needs to focus on improving vehicle efficiency through advanced cleaner propulsion technologies, including adaptation to alternative fuels. Substantial reduction in emissions should come from advanced ICEs and the next generation of hybrids and full electric vehicles. Improved vehicle efficiency through reduction in weight and in aerodynamic and rolling resistance offers potential to further reduce emissions and noise. In order to follow an integrated approach and recognise infrastructure-vehicle interaction (rolling noise emissions, rolling resistance), infrastructure needs to be prepared for the new vehicle concepts.

Research and development are needed to match vehicles and infrastructure to enable advanced operations, such as cooperative driving, platooning or operating green freight corridors, and integrating green vehicles with smart, green and integrated infrastructure.

Research is needed to maintain and gain leadership in transport technologies and services, which can ensure growth and employment in Europe for decades to come. This involves the ability to become a leader in the development of future transport, such as electric cars, hybrid vehicles, vehicles running on alternative fuels and automated vehicles, and linked to these challenges, the capacity to deploy on-board smart control systems. The other fundamental issue in industry competitiveness is the efficiency of advanced production processes in vehicle manufacturing and supply chain management, and in infrastructure.

Traffic and travel management

Infrastructure telematics systems are needed to provide real-time support to road users (such as travel information services and logistics routing) and road operators (road condition and traffic management). This calls for advanced infrastructure management systems.

To enable efficient mobility of people and goods, multimodal solutions should be enabled in a seamless urban mobility system. For this purpose, further research and innovation is needed in developing a fully integrated urban mobility system, providing solutions for integration of transport modes, services and networks. Innovative tools need to be developed to enable more efficient management of urban networks. This includes technological and non-technological tools to steer behaviour towards more efficient travel solutions. Innovative bus systems are considered to be a key element of future urban mobility scenarios. Efficient integration of urban freight deliveries in the urban transport system and in the logistic chain depends on the use of innovative solutions for quieter and more energy-efficient vehicles and operations. Tools need to be developed to enable further integration of the urban mobility system, increasing efficiency by providing efficient intermodal travel options. Transport authorities need to develop a coherent and consistent framework for land use and transport planning, and to execute consecutive infrastructure renewal and reconstruction works faster and cheaper than current practice.

Research needs to focus on improving transnational road links and deployment of a user-centric traffic management system in conjunction with the next generation road transport systems for freight and passengers. Key areas are the urban network, and the interfaces and interchanges. Solutions need to be found in co-modality and intelligent traffic management.

Research is needed to develop advanced logistic service concepts, such as a single window, single payment, e-freight, and dynamic routing. A key research area is the interfaces and interchanges to other transport modes to enable seamless transport from origin to destination, including the last mile, which is road transport.

Safety and Security

Continuous research is needed in the three areas – vehicles, users and infrastructure – and innovative research requires an integrated approach. Topics include safer vehicles (advanced driver assistance, active and passive safety, and safety of vulnerable road users), safe road users (eliminating human error as a factor in fatalities and severe injuries), and safe infrastructure (concept of “self-explaining and forgiving roads”). Furthermore, the increase in IT-based systems applied in vehicles and in infrastructure requires research on the security of these systems.

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Glossary

ADAS	Advanced driver assistance system
Ah	Ampere hour
CAE	Computer aided engineering
CMOS	Image sensor converting light to electrons in a digital camera
DG MOVE	Directorate General for Mobility and Transport
EC	European Commission
eCall	A European initiative intended to bring rapid assistance to motorists
ELTV	Electric light truck or van
EMF	Electromagnetic field
ERA	European Research Area
EU	European Union
EURO-VI	EU emission standard for trucks
EV	Electric Vehicle
FEV	Fully electric vehicles
FIR camera	Far range thermal camera
FOT	FOT Field Operational Test
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
FRP	Fibre Reinforced Polymer
GDP	Gross Domestic Product
GHG	Greenhouse gas
HCCI	Homogeneous charge compression ignition
HMI	Human-machine interface
HVAC	Heating Ventilation Air Conditioning

ICE	Internal Combustion Engine
ICT	Information and Communication Technologies
IRS	Intelligent road stud
IT	Information Technology
ITS	Intelligent Transport Systems
LDV	Light Duty Vehicle
LED	Light-emitting diode
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MFOS camera	Camera integrating imaging and sensing functions
NFC	Near Field Communication
NRD	Noise reduction devices
OEM	Original equipment manufacturer
POS	Point of Sale
PPP	Public Private Partnership
PTW	Powered two wheeler
SEV	Small electric vehicle
TEN-T	Trans-European Transport Network
TRIP	Transport Research and Innovation Portal
TRS	Thematic Research Summary
V2X	Vehicle-to-vehicle and vehicle-to-infrastructure technology
VRU	Vulnerable road users/vapour recovery units
VVA	Variable Valve Actuation for diesel engines

ANNEX: Projects by Sub-Theme

Sub-Theme : Financing				
Acronym	Title	Funding Programme	Project Website	Duration
AVTR	Optimal Electrical Power Train via Adaptable Voltage and Transmission Ratio	European green cars initiative – FP7	www.avtr-project.eu/	2012–2015
CONVENIENT	Complete Vehicle Energy-saving Technologies for Heavy-Trucks	FP7	N/A	2012–2015
CORE	CO ₂ Reduction for long distance transport	FP7	www.co2re.eu	2012–2015
Cosivu	Compact Smart and Reliable Drive Unit for Dully Electric Vehicles	European green cars initiative – FP7	www.cosivu.eu	2012–2015
ECO-FEV	Efficient cooperative infrastructure for fully electric vehicles	European green cars Initiative – FP7	www.eco-fev.eu/	2012–2015
Emerald	Energy Management and Recharging for Efficient Electric Car Driving	European green cars initiative – FP7	www.emerald-project.eu	2012–2015
EUROLIION	High Energy Density Li-Ion Cells for Traction	European green cars initiative – FP7	www.eurolion.eu	2011–2015

FASTINCHARGE	Innovative FAST INductive CHARGing solution for Electric vehicles	FP7	N/A	2012–2015
GREEN EMOTION	Green eMotion	FP7	www.greenemotion-project.eu	2011–2015
Greenlion	Advanced Manufacturing Process for Low cost Greener Li-Ion Batteries	European green cars initiative – FP7	www.greenlionproject.eu	2011–2015
Mobility 2.0	Co-operative ITS systems for Enhanced Electric Vehicle Mobility	European green cars initiative – FP7	www.mobility2.eu/	2013–2015
NECOBAUT	New Concept of Metal Air Battery for Automotive Application	European green cars initiative – FP7	www.necobaut.eu	2012–2015
NOWASTE	Engine Waste Heat Recovery and Re-Use	FP7	N/A	2011–2015
ODIN	Optimised Electric Drivetrain by Integration	European green cars initiative – FP7	www.fp7-odin.eu	2012–2015
OPERA4FEV	OPerating Energy RAck for Full Electric Vehicle	FP7	www.opera4fev.eu	2011–2015
Stable	Stable High-Capacity Lithium Air Batteries with Long Cycle Life for Electric Cars	European green cars initiative – FP7	N/A	2012–2015
Unplugged	Wireless Charging for Electrical Vehicles	European green cars initiative – FP7	N/A	2012–2015

Amelie	Advanced Fluorinated Materials for High Safety	European green cars initiative – FP7	www.amelie-green-car-project.fr/	2011–2014
Autosupercap	Development of High Energy/ High Density Super capacitors for Automotive Applications	European green cars initiative – FP7	www.autosupercap.eps.surrey.ac.uk/	2011–2014
CAPIRE	Coordination Action on PPP Implementation for Road-Transport Electrification	FP7	www.capire.eu/public	2010–2014
e-DASH	Electricity Demand and Supply Harmonisation for EVs	European green cars initiative – FP7	www.edash.eu	2013–2014
Electrograph	Graphene-based Electrodes for Application in Super capacitors	European green cars initiative – FP7	www.electrograph.eu	2011–2014
ELIBAMA	European Li-Ion Battery Advanced Manufacturing for Electric Vehicles.	FP7	www.elibama.eu	2011–2014
ESTRELIA	Energy Storage with Lowered Cost and Improved Safety and Reliability for Electrical Vehicles	European green cars initiative – FP7	www.estrelia.eu/	2011–2014
Labohr	Lithium-Air Batteries with Split Oxygen Harvesting and Redox Processes	European green cars initiative – FP7	www.labohr.eu/team	2011–2014
Libralato	Libralato Engine Prototype	European green cars initiative – FP7	N/A	2011–2014

MotorBrain	Nanoelectronics for electric vehicle intelligent failsafe power train	European green cars initiative – FP7	www.motorbrain.eu	2011–2014
Opener	Optimised Energy Consumption and Recovery Based on System Network	European green cars initiative – FP7	www.fp7-opener.eu	2011–2014
OPTIMORE	Optimised Modular Range Extender for every day Customer Usage.	FP7	N/A	2012–2014
OSTLER	Optimised storage integration for the electric car	FP7	N/A	2011–2014
SMART-LIC	Smart and Compact Battery Management System Module for Integration into Lithium-Ion Cell for Fully Electric Vehicles	European green cars initiative – FP7	www.smart-lic.com	2011–2014
SMARTV2G	Smart Vehicle to Grid Interface, European Green Cars Initiative	European green cars initiative – FP7	www.smartv2g.eu	2011–2014
SuperLIB	Smart Battery Control System Based on a Charge-Equalisation Circuit for an Advanced Dual-Cell Battery for Electric Vehicles	European green cars initiative – FP7	www.superlib.eu	2011–2014
Apples	Advanced High Performance Polymer Lithium Batteries for Electrochemical Storage	European green cars initiative – FP7	www.applesproject.eu	2010–2013
Castor	Car Multi-Propulsion Integrated Power Train	European green cars initiative – FP7	www.castor-project.eu/	2010–2013

EASYBAT	Models and generic interfaces for easy and safe Battery insertion and removal in electric vehicles	FP7	www.easybat-project.eu	2011–2013
eLCAR	E-Mobility Life Cycle Assessment Recommendations	European green cars initiative – FP7	www.elcar-project.eu/	2012–2013
FUEREX	Multifuel Range Extender with High Efficiency and Ultra-Low Emissions	European green cars initiative – FP7	www.fuerex.eu	2011–2013
HCV	Hybrid Commercial Vehicle	FP7	www.hcv-project.eu	2010–2013
HELIOS	High Energy Lithium-Ion Storage Solutions	European green cars initiative – FP7	www.helios-project.eu	2009–2013
JOBVEHELEC	Job opportunities in vehicle electrification	FP7	N/A	2011–2013
POWERFUL	POWERtrain for FUTURE Light-duty vehicles	FP7	www.powerful-eu.org	2010–2013
PowerUp	Specification Implementation Field Trial and Standardisation of the Vehicle 2 Grid Interface	European green cars initiative – FP7	www.power-up.org	2011–2013
SMARTOP	Self powered vehicle roof for on-board comfort and energy saving	FP7	www.smartop.eu/fe	2010–2013
Somabat	Development of Novel Solid Materials for High Power Li Polymer Batteries Recyclability of Components	European green cars initiative – FP7	www.somabat.eu	2011–2013

ELVIRE	Electric Vehicle communication to Infrastructure, Road services and Electricity supply	European green cars initiative – FP7	www.elvire.eu	2010–2012
HEATRECAR	Reduced Energy Consumption by Massive Thermoelectric Waste Heat Recovery in Light Duty Trucks	FP7	www.heatrecar.com	2009–2012
SMARTBATT	Smart and Safe Integration of Batteries in Electric Vehicles	FP7	www.smartbatt.eu	2011–2012
STORAGE	Composite structural power storage for hybrid vehicles	FP7	N/A	2010–2012
TIFFE	Thermal systems integration for fuel economy	FP7	www.tiffe.eu	2009–2012
BEAUTY	Bio-ethanol Engine for Advanced Urban Transport by Light Commercial Vehicle & Heavy Duty	FP7	N/A	2009–2011
E³Car	Nanoelectronics for an Energy-Efficient Electrical Car	European green cars initiative – FP7	www.e3car.eu	2009–2011
EE-VERT	Energy-efficient vehicles for road transport	FP7	www.ee-vert.net	2009–2011
TOSCA	Technology Opportunities and Strategies towards Climate-Friendly Transport	FP7	www.toscaproject.org	2009–2011
Asterics	Ageing and Efficiency Simulation and Testing Under Real World Condition Innovative Electric Vehicle Components and Systems	European green cars initiative – FP7	www.asterics-project.eu	2012–2015

LORRY	Development of an innovative low rolling resistance truck tyre concept in combination with a full scale simulation tool box for tyre performance in function of material and road parameters	FP7	N/A	2012–2015
V-FEATHER	InnoVative Flexible Electric Transport	FP7	N/A	2012–2015
Automics	Pragmatic Solution for Parasitic-Immune Design of Electronics ICs for Automotive	European green cars initiative – FP7	www.automics.eu/	2012–2015
DELIVER	Design of Electric Light Vans for Environment-impact Reduction	FP7	www.deliver-project.org	2011–2014
E-VECTOORC	Electric Vehicle Control of Individual Wheel Torque for On- and Off-Road Conditions	European green cars initiative – FP7	www.e-vectoorc.eu/	2011–2014
FURBOT	Freight Urban RoBOTic vehicle	European green cars Initiative – FP7	www.furbot.eu/	2011–2014
ICE	Magneto-Caloric Refrigeration for Efficient Electric Air Conditioning	European green cars initiative – FP7	www.ice-mac-ev.eu	2010–2014
HI-WI	Materials and Drives for High&Wide Efficiency Electric Powertrains	European green cars initiative – FP7	www.hiwi-eu.org	2010–2014
ELVA	Advanced Electric Vehicle Architectures	European green cars initiative – FP7	www.elva-project.eu	2010–2013

E-LIGHT	Advanced Structural Light-Weight Architectures for Electric Vehicles	FP7	www.elight-project.eu	2011–2013
WIDE-MOB	Building blocks concepts for efficient and safe multiuse urban electrical vehicles	FP7	N/A	2010–2013
ECOSHELL	Development of new light high-performance environmentally benign composites made of bio-materials and bio-resins for electric car application	FP7	www.ecoshell.eu	2011–2013
Maenad	Model Based Analysis & Engineering of Novel Architectures for Dependable Electric Vehicles	European green cars initiative – FP7	N/A	2010–2013
EFuture	Safe and Efficient Electrical Vehicle	European green cars initiative - FP7	www.efuture-eu.org	2010–2013
CITY MOVE	City multi-Role Optimised Vehicle.	FP7	www.citymoveproject.eu	2010–2012
CO2NTROL	Integrated solutions for noise and vibration control in vehicles	FP7	www.fp7-co2ntrol.eu	2009–2012
ID4EV	Intelligent Dynamics for Dully Electric Vehicles	European green cars initiative – FP7	N/A	2010–2012
PICAV	Personal Intelligent City Accessible Vehicle System	European green cars initiative – FP7	www.picav.eu	2009–2012
QUIESST	Quietening the environment for a sustainable surface transport	FP7	www.quiesst.eu	2009–2012

Compare	Continuous Health Monitoring and Non-destructive Assessment of Composites and Composite Repairs on Surface Transport Applications	FP7	www.compairproject.com	2008–2011
MID-MOD	Mid-frequency Vibro-acoustic Modelling Tools/Innovative CAE Methodologies to Strengthen European Competitiveness	FP7	www.mid-mod.eu	2009–2011

Sub-Theme: Traffic and travel management and other IT systems				
Acronym	Title	Funding Programme	Project Website	Duration
79GHZ	International automotive 79 GHz frequency harmonisation initiative and worldwide operating vehicular radar frequency standardization platform	FP7	www.79ghz.eu	2011–2014
CARBOTRAF	A Decision Support System for Reducing CO ₂ and Black Carbon Emissions by Adaptive Traffic Management	FP7	http://carbotraf.com	2011–2014
DECOMOBIL	DECOMOBIL – Support action to contribute to the preparation of future community research programme in user centered Design for ECO-multimodal MOBILity	FP7	http://decomobil.humanist-vce.eu	2009–2014
FOTSIS	European Field Operational Test on Safe, Intelligent and Sustainable Road Operation	FP7	http://www.fotsis.com	2011–2014
TRIMM	Tomorrow's Road Infrastructure Monitoring and Management	FP7	http://trimm.fehrl.org	2011–2014
DRIVE C2X	DRIVE C2X DRIVING implementation and Evaluation of C2X communication technology in Europe	FP7	http://www.drive-c2x.eu	2011–2013
EUROPTIMA	European open platform for smart card ticketing, payment and multiservice in interoperable mass transit applications	FP7	http://www.europtima.teleticketing.eu	2011–2013

SARTRE	Safe road trains for the environment; Developing strategies and technologies to allow vehicle platoons to operate on normal public highways with significant environmental, safety and comfort benefits	FP7	http://www.sartre-project.eu	2009–2012
GAMMA-A	Galileo Receiver for Mass Market Applications in the Automotive Area	FP7	http://www.gamma-project.info	2009–2011
ITETRIS	An Integrated Wireless and Traffic Platform for Real-time Road Traffic Management Solutions	FP7	http://www.ict-itetris.eu	2008–2011
FOT-Net	Networking for Field Operational Tests	FP7	http://www.fot-net.eu	2008–2010
ECODRIVER	Supporting the driver in conserving energy and reducing emissions	FP7	http://www.ecodriver-project.eu	2011–2015
ECOMPASS	eCO-friendly urban Multi-modal route Planning Services for Mobile uSers	FP7	http://www.ecompass-project.eu	2011–2014
ECONAV	Ecological Aware Navigation: Usable Persuasive Trip Advisor for Reducing CO ₂	FP7	http://www.econav-project.eu	2011–2014
Enhanced WISETRIP	Enhancing Inter-modality of Content, Personalised Information and Functionality of WISETRIP Network of Journey Planning Engines	European green cars initiative – FP7	www.wisetrip-eu.org/	2011–2014
REDUCTION	Reducing Environmental Footprint based on Multi-Modal Fleet management System for Eco-Routing and Driver Behaviour Adaptation	FP7	http://www.reduction-project.eu	2011–2014

COMPASS	Optimised CO-Modal PASSenger Transport for Reducing Carbon Emissions	FP7	http://www.fp7-compass.eu	2011–2013
ECOGEM	ECOGEM (Cooperative Advanced Driver Assistance System for Green Cars)	FP7	http://www.softeco.it/ecogem	2010–2013
ECOMOVE	ECOMOVE (Cooperative Mobility Systems and Services for Energy Efficiency)	FP7	http://www.ecomove-project.eu	2010–2013

Sub-Theme: Safety and Security				
Acronym	Title	Funding Programme	Project Website	Duration
MATISSE	Modelling And Testing for Improved Safety of key composite StructurEs in alternatively powered vehicles	FP7	http://www.fka.de	2012–2015
SafeEV	Safe Small Electric Vehicles through Advanced Simulation Methodologies	FP7	http://www.vif.tugraz.at	2012–2015
ARTRAC	Advanced Radar Tracking and Classification for Enhanced Road Safety	FP7	http://artrac.org/index	2011–2014
ASPECSS	Assessment methodologies for forward looking Integrated Pedestrian and further extension to Cyclists Safety Systems	FP7	http://www.aspecss-project.eu	2011–2014
EM-SAFETY	EM safety and Hazards Mitigation by proper EV design	FP7	http://www.sintef.no/projectweb/em-safety	2011–2014
EVADER	Electric Vehicle Alert for Detection and Emergency Response	FP7	N/A	2011–2014
OPTIBODY	Optimised Structural components and add-ons to improve passive safety in new Electric Light Trucks and Vans (ELTVs)	FP7	http://optibody.unizar.es	2011–2014
ADSEAT	Adaptive seat to reduce neck injuries for female and male occupants	FP7	http://www.adseat.eu	2009–2013
SAFETRIP	Satellite application for emergency handling, traffic alerts, road safety and incident prevention	FP7	http://www.safetrip.eu	2009–2013

2WIDE_SENSE	WIDE spectral band & WIDE dynamics multifunctional imaging SENSOR Enabling safer car transportation	FP7	www.2wide-sense.eu	2010–2012
ACTIVETEST	Dissemination of Performance Testing Methods for ICT-based Safety Functions in Road Vehicles	FP7	www.activetest.eu	2011–2012
ASSES	Assessment of integrated vehicle safety systems for improved vehicle safety	FP7	http://www.assess-project.eu	2009–2012
FIMCAR	Frontal Impact and Compatibility Assessment Research	FP7	http://www.fimcar.eu	2009–2012
MINIFAROS	Low-cost Miniature Laserscanner for Environment Perception	FP7	http://www.minifaros.eu	2010–2012
MOSARIM	MOre Safety for All by Radar Interference Mitigation	FP7	N/A	2010–2012
TELEFOT	Field Operational Tests of Aftermarket and Nomadic Devices in Vehicles	FP7	http://www.telefot.eu	2008–2012
ADOSE	Reliable Application Specific Detection of Road Users with Vehicle On-board Sensors	FP7	http://www.adose-eu.org	2008–2011
ASSET-ROAD	Advanced Safety and Driver Support in Essential Road Transport	FP7	http://www.project-asset.com	2008–2011
euroFOT	European Large-Scale Field Operational Test on Active Safety Systems	FP7	http://www.eurofot-ip.eu	2008–2011
HAVE-IT	Highly automated vehicles for intelligent transport	FP7	N/A	2008–2011

HAVEit	Highly Automated Vehicles for Intelligent Transport	FP7	http://www.haveit-eu.org/	2008–2011
ATESST2	Advancing Traffic Efficiency and Safety through Software Technology Phase 2	FP7	http://www.atesst.org/	2008–2010
INROADS	INtelligent Renewable Optical ADvisory System	FP7	N/A	2011–2014
SKIDSAFE	Enhanced driver safety due to improved skid resistance	FP7	http://skidsafe.org	2009–2013
SMART RRS	Innovative concepts for smart road restraint systems to provide greater safety for vulnerable road users	FP7	http://smarrtrs.unizar.es/co	2008–2012
ROSATTE	ROad Safety ATtributes Exchange Infrastructure in Europe	FP7	N/A	2008–2010
TYROSAFE	Tyre and Road Surface Optimisation for Skid Resistance and Further Effects	FP7	http://tyrosafe.fehrl.org	2008–2010
UDRIVE	eUropean naturalistic Driving and Riding for Infrastructure & Vehicle safety and Environment	FP7	N/A	2012–2016
HEMIS	Electrical powertrain Health Monitoring for Increased Safety of FEVs	European green cars initiative – FP7	www.hemis-eu.org	2012–2014
CASPER	Child Advanced Safety Project for European Roads	FP7	http://www.casper-project.eu	2009–2012
THOMO	Development of a finite element model of the human thorax and upper extremities	FP7	http://www.thomo.eu	2009–2012

2-BE-SAFE	2-wheeler behaviour and safety	FP7	www.2besafe.eu	2009–2011
EPOCH	Enabling Protection for Older Children	FP7	http://www.epochfp7.org	2009–2011
SCVP	Smartest Cars Video Project	FP7	N/A	2008–2010
PRESERVE	Preparing Secure Vehicle-to-X Communication Systems	FP7	http://preserve-project.eu	2011–2014
OVERSEE	Open VEhicular SEcurE platform	FP7	http://https://www.oversee-project.com	2010–2012
EVITA	E-safety Vehicle Intrusion proTected Applications	FP7	http://evita-project.org	2008–2011