MINISTERIO DE CIENCIA E INNOVACIÓN

CDTI Centro para el Desarrollo Tecnológico Industrial

SPANISH CONTRIBUTIONS AND PRIORITIES TO THE EUROPEAN GREEN CARS INITIATIVE (EGCI)

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0. Preamble

The purpose of this document is to summarize the Spanish initial contributions and priorities to the European Green Cars Initiative (EGCI)[1]. Its aim is to translate the interests and needs in research and development of Spanish entities involved in this field, to help medium and long term development of sustainable transport and eco-efficient mobility solutions. It also sets out the strengths of the "value chain" of the Spanish system, in order to achieve a clear positioning within the European Green Cars Initiative framework.

The document is structured according to the three major R&D avenues proposed by the European Commission for the RTD stream of action of the EGCI:

1. **Research for heavy duty vehicles,** aimed at improving energy efficiency and primarily concentrated on advanced **internal combustion engines (ICE)**, with emphasis on new combustion, the use of alternative fuels, intelligent control systems, 'mild' hybridisation (use of recuperated electricity to power the auxiliary systems) and focused also on special tyres for low rolling resistance.
2. **Electrification of urban and road transport, i.e. research on electric and hybrid vehicles** linked to smart electricity grids with intelligent vehicle charging systems tailored to customers' needs, including the development of components for the vehicles (energy storage systems and drivetrain), vehicle integration, grid integration and integration of the vehicles in the transport system.
3. **Logistics and co-modality** combined with **intelligent transport system** technologies to optimize the overall system efficiency and sustainability.

[1] ***IMPORTANT NOTE: THE TERM "GREEN CARS" SHOULD BE UNDERSTOOD AS "GREEN VEHICLES" INCLUDING TWO-WHEEL VEHICLES AND OTHER TYPES OF VEHICLES LIKE HEAVY DUTE VEHICLES.*** *In particular powered two-wheel vehicles have an important role to play in the following areas: Integrated safety; Advanced electric vehicle concepts; Smart storage integration; Auxiliaries systems; Validation; and Demonstration*

For each research avenue, different priorities may be identified and linked to the already defined R&D areas for electrification of road and urban transport.

The core of the road transport electrification is the electric vehicle, with electric powertrain and their modules and components. Different car, truck and bus concepts are the main subject of current research and homologation activities, both for urban and road use. Key issues in the development of pure electric vehicles and hybrid vehicles include challenges for the mass production and feasibility of energy storage systems (such as the increase in energy density, capacity, safety, duration, charge-discharge cycles, a higher mechanical and electric standardization and a better communication interface, linked to a cost reduction), cell packaging (especially when dealing with safety, cost, manufacturing, diagnosis, maintenance, repair and recyclability) and the development of architectures for energy management systems and elements exchange and the definition of testing standards.

Full deployment of electric vehicles will also demand the availability of the charging infrastructure and its integration in the large scale mobility system. In this context, the concept V2G combines fast charge with and smart payment system, and ICT for data exchange between the infrastructure and the storage system using standard procedures.

For the long term, road transport will reduce its dependency on, and finally abandon fossil and other non-renewable sources of primary energy. At the same time, the protection of the environment is calling for further reductions of exhaust gas emission (particulates, CO_2, …).

Urban mobility, as specific segment of transport demand calls for specific solutions both for the development, testing and integration of new technologies in electric and hybrid vehicles and their adaptation to the mobility demand of different users, and also for the fleet management with new tools for communication vehicle-infrastructure – control centre, that require real time management of large amounts of information and its processing and distribution using optimized communication channels.

There are some technical complementary aspects between Green Cars and Factories of the Future PPPs. In fact, manufacturing and supply chain of the green cars sector could take advantage of the new concepts and technologies developed within FoF: Sustainable manufacturing, ICT enabling intelligent manufacturing, high performance manufacturing and exploiting new materials through manufacturing. All this transversal manufacturing topics could also be developed for the green cars industry. On the other hand, FoF initiative could take advantage of the optimization of the overall transport system through logistics, co-modality and ITS implementation, improving Supply Chain performance.

The EGCI, focusing as it does on electrification of road transport, is complementary to the Hydrogen and Fuel Cell Technology Initiative launched last year. This initiative will implement the EU target-oriented research and development to support the broad market introduction of these technologies. At national level, the short/medium/long-term strategy is coordinated by the Spanish Hydrogen & Fuel Cell Technology Platform (www.ptehpc.org).

This document is the result of several meetings held along the summer/autumn 2009 with the participation of the main Spanish stakeholders including representatives from industry, research centres and academia in the fields of automotive and road mobility (both light and heavy duty vehicles), energy, logistics, ICT... Apart from the meetings, the document has undergone a broader online consultation with other actors. The annexes at the end of this document detail the entities participating in the meetings and those who provided comments and input in the broadened on-line consultation.

1. Introduction: Spanish strengths

Fulfilment of the ambitious goals set in the Green Cars initiative demands collaboration among all the sectors and technology agents involved: Vehicle manufacturers and their suppliers, utilities, infrastructures and logistics operators and public and private technological centres and research teams.

All those stakeholders contribute to strengthen the Spanish position in the general goal of achieving greener road mobility as follows:

- The size of the Automotive sector: Spain is the 3rd largest European manufacturer of cars and light vehicles and the first in heavy duty and commercial vehicles in Europe, linked to a strong component suppliers sector, that includes around 1000 companies from large international groups to SMEs and manufactures all types of components and systems.
- The production of a pure electric vehicle has already been assigned to a Spanish OEM plant for 2011.
- Spain, as first EU heavy duty vehicle manufacturer, presents strong HDV power-train R&D capabilities, especially concerning natural gas engines. Moreover the 2nd largest biomethane plant worldwide is in Madrid.
- R&D capabilities of vehicle and component manufacturers is complemented by a network of technological centres and specialized research groups, with broad technical capabilities and experience in national and international RTD projects, customers' support, testing and homologation.

- The Spanish Utilities hold a leading position in the European energy market, whereas renewable energies represent a significant ratio in the generation mix in Spain (390 gCO_2/kWh). Therefore integration of renewable energy sources by means of road transport electrification is a logical strategic energy policy at national level.
- Transport activities and the logistics network represent also a key pillar of Spanish economy, which is reflected in the high Spanish participation level in the European Association Europlatforms
- The National Technology Platforms are meeting points for technological agents within each sector and have already defined their own industrial oriented vision and strategic research agendas. Those directly linked to the EGCI are M2F-SERtec for the automotive sector (www.plataformasertec.es), Futured for smart grids (www.futured.es) and Logistop for logistics (www.logistop.org). The national platforms have already established links with the related or mirror European TPs.
- The Ingenio 2010 Plan launched in June 2005 has provided a significant increase of public funding for RTD projects, specially of large integrated projects, and the set up of strategic public-private consortia, with a impact on the resources devoted to R&D (47% increase of public investment in R&D between 1999 and 2006, reaching 1.27% GDP in 2007).

The **Automotive Sector** is one of the keystones of the Spanish economy, generating, in 2008, nearly 9% of both the direct and indirect employment of the active workforce and contributing 6% to the GDP. Spanish vehicle production has dropped in 2008 by 12%, positioning itself as third largest European vehicle producer and 8th worldwide, with a volume level of a little more than 2.5 million units, accounting for 32,090 M€. By the other hand, Spain represents the 5th largest car market in Europe (1.2-1.5 Mill cars/year).

PRINCIPALES PAÍSES PRODUCTORES 2008
MAIN MANUFACTURING COUNTRIES 2008

País / Country	Turismos Cars	%08/07	Veh. Indus. Trucks	%08/07	TOTAL	%08/07
UE-15/*EU-15*	**13.027.118**	**-9,7**	**2.349.210**	**-5,8**	**15.376.328**	**-9,1**
JAPÓN/*JAPAN*	9.916.149	-0,3	1.647.480	-0,3	11.563.629	-0,3
CHINA	6.755.609	7,3	2.567.978	-0,3	9.323.587	5,1
USA	3.776.641	-3,8	4.896.450	-28,3	8.673.091	-19,3
ALEMANIA/*GERMANY*	5.532.030	-3,1	513.700	1,9	6.045.730	-2,7
COREA DEL SUR/*SOUTH KOREA*	3.450.478	-7,3	376.204	3,7	3.826.682	-6,4
BRASIL/*BRAZIL*	2.561.496	7,1	658.979	12,5	3.220.475	8,2
FRANCIA/*FRANCE*	2.145.935	-15,9	423.043	-9,0	2.568.978	-14,8
ESPAÑA/*SPAIN*	1.943.049	-11,5	598.595	-13,7	2.541.644	-12,0
INDIA	1.829.677	6,8	484.985	-10,2	2.314.662	2,7
MÉJICO/*MEXICO*	1.241.288	2,7	949.942	7,2	2.191.230	4,6
CANADÁ	1.195.436	-10,9	882.153	-28,7	2.077.589	-19,4
REINO UNIDO/*UNITED KINGDOM*	1.446.619	-5,7	202.896	-5,9	1.649.515	-5,8
ITALIA/*ITALY*	659.221	-27,6	364.553	-2,4	1.023.774	-20,3

Fuente: Elaboración ANFAC en base a datos de las Asociaciones de Fabricantes de los países considerados
Source: Prepared by ANFAC from appropiate association in each country

The automotive sector is one of the main exporters in the Spanish economy, since it represents nearly a quarter of the total goods exports. The value of the vehicle exports in terms of the total value of goods exported by the automotive sector accounts for 67%, the rest is related to motors, parts and components. Nearly 83% of the vehicle production is for exportation, mainly to the European Union. It should be highlighted, however, that the exports to the countries that have recently joined the EU is gradually increasing.

It is also remarkable that the investment levels have managed in 2008 to recover to over 1,600 million Euros, which demonstrates the high confidence that the "parent companies" have in Spanish factories. According to the information provided by the official statistic sources, the R&D investment of the Automobile Manufacturers and Trucks during 2007, was 280 M€, which represents a sharp drop from the average of the years 2003-2005, which was the order of 560 M€.

Spain, as 1st EU LCV+HDV producer, has major production facilities of HDV and presents strong HDV power-train R&D capabilities especially concerning Natural Gas (NG) engines. Regarding passenger transport vehicles, Spain holds a leading position in the multi-stage vehicle production and has significant examples of R&D projects on alternative power-train technologies (including hybrid and hydrogen) in this sector. Moreover, the advantageous position of Spanish LNG infrastructure and national operators and the biomethane national production provides increasing opportunities in this technology related R&D projects.

Finally, in regards to urban transport and services, Spain has cities (i.e. Madrid and Barcelona) which must be considered as "EU Champions" in incorporating alternative powertrain vehicles into their public transport and services systems.

The Spanish **component manufacturers' sector** holds the 6th position in the world in turnover: 29,970 M€ in 2008 after a peak of 32,873 M€ in 2007, 58% of which were exported. The component manufacturers' sector includes 1000 companies from SMEs to large international groups. They show a strong innovation capability, with an average R&D investment of 3% related to turnover. In general, 75% of the value of the car and 50% of the R&D spending comes from suppliers.

Spanish automotive suppliers are well aware of the threats and challenges that the highly demanding automotive industry requests through the whole value chain, from TIER 1 to TIER 4. Besides production plants of the main global foreign component manufacturers, there are a few large Spanish companies and a broad network of smaller suppliers, most of them SMEs, who are showing, year by year, their capability to comply with the stringent quality and technical requirements demanded by OEMs and transferred through all the value chain. As requested by OEMs, companies are not only providers to the former level, but real development suppliers.

Competitiveness of the European automotive industry at the upper level of the pyramid will be assured when all the lower levels (TIER 1 to TIER 4) can become development suppliers of the former one. To reach the goals set for a sustainable mobility, meeting the challenges of cleaner, safer and smarter vehicles and transport systems, TIER 1 suppliers must develop new products and systems. However, they cannot do it alone, they need the following levels of the chain to provide them with new components and sub-systems, materials, etc. and work of all of them must be aligned. The sector's priorities must be known and encompassed through all the value chain. For this reason it is important to establish mechanisms for an effective flow of information on both directions, upstream and downstream in the suppliers pyramid, and to support technological collaboration of suppliers from different levels.

There is a need for the development of technologies for the vehicles, but, upon that, there is also a strong need of establishing collaboration models to develop communication systems that lead to a higher efficiency in energy and resources use. Sustainable mobility must be based not only on cleaner and smarter vehicles, but on connected vehicle (V2X) strategies and energy efficiency paradigms in the whole system as well. New development opportunities and technological collaboration agreements are therefore needed, especially with those sectors that are becoming more and more linked to the vehicle in the future: the utilities, infrastructures and ITS suppliers.

The **smart integration of green cars into the electricity grid** requires the development of new coordination and standardisation schemes along all the electricity supply value chain: cars, distribution companies, resellers, and transmission system operators (TSOs), in order to assure that the infrastructure that fuels these mobility schemes is available not only nation but European-wide, with the same quality, standards and services.

Spain has the suitable electricity sector structure for contributing to meet the green car initiative. In fact, from the electricity infrastructure point of view, one single company is acting as TSO over the whole national territory while two distribution companies cover almost 80% of the area. This would assure that coordination and agreements for nationwide standards can be achieved in shorter terms than other European countries where the number of stakeholders in the sector is greater. Common projects are already ongoing for that purpose. Also, Spanish utilities are leading companies at the European level in contributing to achieve common standards for connection and management of distributed demand resources. It is also worth mentioning the Spanish TSO is the only European TSO having a special unit entirely devoted to demand-side management (DSM).

Logistics and Freight Transport represents in Spain between 9.5 and 11.5% of the GDP and employs nearly 865,000 people in 223,328 enterprises. Logistics is a transversal sector and it has been estimated that logistics costs represent 12% of the final cost in manufacturing sectors and over 20% in retail.

The development of logistics activities in Spain is high, as shown by the fact that there are more than 60 Logistics Platforms and Areas in Spain. 21 of them participate in the European Association of Logistics Platforms and Freight Villages *Europlatforms*, which means the highest representation of a Member State at the European level. Thus the national transport and logistics network gives Spain a key position as platform for international transit.

Regarding R&D, it is worthwhile highlighting the active role of the Spanish Logistics, Intermodality and Mobility Technology Platform, Logistop.

The rest of this document is structured around the following sections:

2.1.1. Heavy duty vehicles: focus on electrification and alternative technologies

2.1.2. ICEs for heavy vehicles

2.2. ELECTRIFICATION OF ROAD AND URBAN TRANSPORT

2.2.1. Materials, manufacturing and processes

2.2.2. Systems and components for electric vehicles

2.2.3. ICEs for light vehicles (range extenders)

2.2.4. Smart infrastructure and services for Green Vehicles

2.2.5. Grid integration

2.2.6. Sustainable urban mobility: vehicles and concepts

2.2.7. Demonstration and field operational tests

2.2.8. Regulation and standards, homologations, tests, validation, safety and type approval of the hybrid and electric vehicles

2.3. LOGISTICS, COMODALITY AND ITS

2.3.1. Logistics and comodality

2.3.2. Sustainable urban mobility: connected vehicle and fleets

2.3.3. ICT technologies for the improvement of the whole transport system

2. Research Priorities

2.1 Heavy Duty Vehicles

The 'European Green Cars Initiative' includes Heavy Duty Vehicles as one of the three major research and development priority pillars, addressing the key role of "traditional" medium and long distance Heavy Duty vehicles for road transportation in Europe both for passengers and goods.

Spain as the 3rd largest European manufacturer of cars and light vehicles and the first in heavy duty and commercial vehicles in Europe, presents strong HDV power-train R&D capabilities, especially concerning natural gas engines.

This fact combined with a leading position in the multi-stage vehicle R&D and national production and the advantageous position of Spanish LNG and bio-methane infrastructure and national operators, provides increasing opportunities in this technology related R&D projects.

In the other hand, some promising opportunities are seen in the evolution of traditional ICE for HDV, as well as in partial electrification of new vehicle concepts designed for specific purposes such as urban services and transportation.

In summary, RTD specific priorities in this area can be divided in two different lines:

2.1.1. Heavy Duty Vehicles: focus on electrification and alternative technologies

2.1.2. ICEs for heavy vehicles

2.1.1. Heavy Duty Vehicles: focus on electrification and alternative technologies

Objectives and scope

The shrinking availability of fossil energy sources requires, in the short to medium term, strongly increasing the energy efficiency of vehicles and of the traffic and transport system as a whole, including Medium and Heavy Duty Vehicles (MDV & HDV).

Maintaining Spanish leading industrial position and leveraging our R&D capabilities in the Medium and Heavy Duty Vehicle industry appear then as major objectives in the framework of the Green Cars initiative at national level.

Major R&D areas

1. **Renewable/alternative fuels and related drivetrains** for HDV. Further research related to the energy and environment topic is aiming at the diversification of energy sources and at finding the optimum combination of drive train and energy carrier. R&D needs include:
   - Development of CO_2-neutral fuels from renewable materials, particularly biogas/biomethane, first and second generation bioethanol, hydrogen and electricity.
   - Development of on-board storage systems for alternative fuels
   - Optimisation of powertrains for alternative fuels: diesel for 2nd generation and CNG/biomethane.
   - Development of HDV for medium and long distance transport based on LNG (Spain receives 70% of NG in liquid form and saving in running cost accounts for 50%)
   - Development of hybrid thermo-hydraulic powertrains for urban service vehicles applications.
   - Assessment of climate and energy impact:
     - Well-to-wheel analysis for various fuel options and drive trains,
     - Simulation packages for CO_2 indicators of various types of commercial vehicles and for air quality indicators in urban areas taking into account climate conditions.

2. **Technological innovations of the internal combustion engine and exhaust systems** are important short-term paths towards fuel savings. This topic is fully developed under 2.1.2. below.

3. **Electrification of the vehicle**. Due to their zero local and potentially minor greenhouse gas emissions, electric propulsion and drive trains combining alternative technologies (hybrid, plug-in, electric drive, hydrogen and fuel cell) will play a certain role in reducing the impact of transport on energy consumption, climate and environment also for HDV (although less important than in passenger car). Some R&D possibilities are seen in:
   - Development of hybrid thermo-hydraulic powertrains for urban service vehicles applications.
   - Extending hybrid thermo-electric (including plug-in) developments from passenger cars to M & HDV used in urban distribution and passenger transportation. This leads to extend to M & HDV research initiatives in the following fields: Energy storage systems, new vehicle concepts required for electric propulsion technologies, e.g. using in-wheel motors; solutions for electric vehicle integration issues, key components for hybrid, electrical drive and fuel cell systems, etc.

Expected impact

- Maintaining Spanish leading industrial position and leveraging R&D capabilities in the Medium and Heavy Duty Vehicle industry. This will help to keep actual labour force and possibly enhance technical/specialist human resources in Spain.
- Identify Spain as a UE reference in R&D projects and initiatives based on NG (particularly LNG) in the powertrain systems for M & HDV (medium and long distance transport).
- Realizing real applications of hybrid thermo-electric (including plug-in) developments from passenger cars in M & HDV used in urban distribution and passenger transportation.
- Consolidate Spanish municipalities in a leading position in Europe in incorporating alternative powertrain vehicles into their public transport and services systems. Sustainable urban transport in Spain to be a mature reality in the short term.
- Renewable/alternative fuels and related drivetrains for HDV in the multi-stage busses and trucks industry to be recognize as "European champions"
- Development of the Spanish industry of buses and trucks by specialising the existing industry which has experience in the adaptation to natural gas and GLP use.

2.1.2. ICEs for heavy vehicles

Objectives and scope

To promote Research and Development in the propulsion systems for Heavy Duty automotive vehicles in the areas in which the Spanish industry has industrial production capabilities:

- Development / adaptation of thermal – electric engines for auxiliary power units and range extenders of electric / hybrid vehicles.
- Alternative fuels: biofuels, biogas (bio-methane), natural gas, including LNG.

As a means to fulfil this objective it is necessary to establish working groups and installations specialised in Research and Development for the adaptation of the thermal and electric engine and of the additional systems required (electric energy converters, regulation and control systems, energy recovery and optimisation), as well as for performance optimisation for use with alternative fuels and Spanish manufactured biofuels.

Major R&D areas

Technological innovations of the internal combustion engine and exhaust systems are important short-term paths towards fuel savings. R&D needs are seen in:

1. **Further improvement of conventional powertrains**: High-efficient combustion engine technologies allowing significant reduction of CO_2,

2. **Optimisation of the vehicle** regarding energy management, energy recuperation, light weight structures (high-strength steel, aluminium, plastics, compound materials);

Expected impact

- Maintaining Spanish leading industrial position and leveraging R&D capabilities in ICEs for Medium and Heavy Duty Vehicles. This will help to keep actual labour force and possibly enhance technical/specialist human resources in Spain.

2.2 Electrification of road and urban transport

Transport electrification can be considered the main pillar of the GCI, due to the technology breakthroughs required and also due to its high impact on the reduction of oil dependency and urban and road transport emissions. Moreover, it involves the development of new vehicle and mobility concepts and of new business models, as well as step changes on materials and technologies for the new components in the vehicle.

The development of electric transport systems demand R&D efforts on the whole value chain from the development of components and new high performing materials (energy storage systems, their management and smart integration in the vehicles, drivetrains, energy efficient auxiliaries, energy recovery systems and ICEs for range extenders) and the development and/or adaptation of manufacturing processes to produce them; new vehicle concepts and architectures; the interaction of the vehicle with smart electrical grids and also the integration of electric vehicles in the whole transport system. Full deployment of electric vehicles will also demand taking into account the specific issues related to urban mobility, the validation of vehicles and users' acceptance studies provided by demonstration programmes and field operational tests and, finally, the definition of standards and homologation procedures and tests.

Summarising, RTD specific priorities in this area have been split into eight lines:

2.2.1. Materials, manufacturing and processes
2.2.2. Systems and components for electric vehicles
2.2.3. ICEs for light vehicles (range extenders)
2.2.4. Smart infrastructure and services for Green Vehicles
2.2.5. Grid integration
2.2.6. Sustainable urban mobility: vehicles and concepts
2.2.7. Demonstration and field operational tests
2.2.8. Regulation and standards, homologations, tests, validation, safety and type approval of the hybrid and electric vehicles

2.2.1. Materials, manufacturing and processes

Objectives and scope

Hybrid and electric vehicle components from the first generation are mostly derived from industrial equipments, such as industrial drives, static energy storage systems and so forth. These components need to be re-engineered in order to meet the stringent requirements of the road transportation sector in terms of cost,

reliability, weight, volume and safety. This means that new materials and processes must come into play, particularly when it comes to mass production of electric components under automotive sector requirements.

Technological solutions from other fields such as power electronics, renewable energies and nano-technologies (Spanish research strong fields) may offer significant improvements to the new generation of hybrid and electric vehicle components.

Major R&D areas

1. **Development and manufacturing of lighter high performance materials** for new definitions of:
   - Design and modelling of vehicle modular architecture
   - Life cycle analysis and environmental sustainability. Recycling, reusing and revalorization of materials at the end of product's useful life cycle (batteries, electric motors, ...). Develop renewable and alternative materials (i.e. biomaterials) to replace non-renewable ones (fossil origin materials).
   - High energy absorption properties to improve vehicle safety without penalizing weight.
   - Lightening and optimization of batteries and electric motors. Reduction of costs increasing motor specific power. Improvement of mechanical performance.
   - New (multi)functional performance materials and components for new vehicles (e.g. sensors, actuators, EM shielding)
   - Progress in the implementation of nanotechnologies (nanocomposites, polymeric matrixes, ...).

2. Development and implementation of **electronic systems embedded in materials** to allow informing about their behaviour in real time.

3. Development of **multifunctional materials** to allow their implementation in the vehicle surface and in key vehicle elements.

4. Development of **new joining technologies** with lower environmental costs, paying special attention to dissimilar joining and enabling easier dismantling and recycling processes.

5. **Metrology applied to manufacturing**: development of measuring and calibration methods for the quality control and manufacturing system verification. Calibration and traceability test.

6. **Mechatronics and microtechnology**: design, manufacturing and calibration systems and prototypes for manufacturing and contact - no contact high precision measurements.

7. Incorporation of **customization and vehicle adaptation concepts** to finished products, decoration and differentiating elements.

8. **Improvement of the collaboration between different agents of the suppliers' chain. Optimization from a global point of view. This means:**
   - Security and privacy of Know-how.
   - Protection of sensible information.
   - Design of platforms for information exchange.
   - Collaborative learning.

9. **Optimization of transport from a supply chain perspective.** Optimization of the entries management and the supply chain planning. Analyzing products from the design taking into account logistic requirements for favouring materials inverse flow, recycling, reusing and remanufacturing.
   - Processes of recycled materials reincorporation in production processes.

10. **Optimization of current networks of material feed-back.**

Expected impact

- **Improvement of Spanish position in materials and processes own technologies** for future green cars.
  - New quality instruments for new cars (sensors, inspection systems, digital 3D)
  - Development of own technology, technology transfer.
- **Continuous improvement of productivity and innovation**: development, optimization and automation of techniques and new inspection systems to allow competing in a global market.
- **Reduction of consumption of processing auxiliary systems** (process integration, reduction of intermediate sequences)
- **Reduction of necessary packaging** for ICE and new electric motors.
- **Favourable impact for environment regarding:**
  - Materials reuse (use of biopolymers and plastics recycling)
  - Consumption reduction
  - Emissions reduction
  - Efficient use of energy

- **Reduction of the "time to market"** with expert support for the decision taking about OEM suppliers and Tier 1 related to innovative materials performing and related processing technologies.
- Translation and use of virtual modelling instruments related to materials and processes behaviour.

2.2.2. Systems and components for electric vehicles

Objective and scope

Most of the priorities set for the development of individual components for the electrification of vehicles have been already included in the GCI 2010 calls, which were launched on July 30th 2009. However, some priorities for their further development and integration in the vehicle and dealing with specific developments of vehicle components and systems for the other areas included in the GCI have been identified.

Major R&D areas

1. **Development of advanced energy storage systems** to comply with the targeted requirements of high energy density and life, linked to low cost and raw material availability and recyclability. R&D efforts are needed at all technology levels: from fundamental electrochemistry research on new materials for batteries and supercapacitors, development of cell technologies and smart integration of battery cells into packs or modules and the final integration into the vehicle (hybrid energy/power storage systems) and the grid (fast charge, monitoring for peak and load levelling when required).

2. **Development of Drivetrain components and systems**, optimization of in-vehicle energy efficiency and energy management:
   - Standard modularization of powertrain components and flexible assembly
   - Components for achieving higher specific power and less weight -packaging
   - Increasing plastic content in underhood components and working in higher temperature environments
   - Vehicle technologies for energy efficiency optimisation: brakes, suspension and recuperation technologies, mechanical and thermal energy recovery systems. (Note: this R&D area is also included in section "2.2.3. ICEs for light vehicles, range extenders")
   - Development of electric generators for hybrid propulsion systems (Note: this R&D area is detailed in section "2.2.3. ICEs for light vehicles, range extenders").

- Integration of ICE range extenders: Energy management strategies aiming at minimizing energy consumption, including information about energy routing capabilities, availability and limitations of power, trip optimization, predicted or real time traffic situation and specific road attributes.
- Development of new concepts of auxiliary systems, such as air conditioning/heating, specially designed for electric vehicles.
- Further development of technologies and concepts related with electric in-wheel engines.

3. **Safety aspects of electric vehicles**:
   - Adaptation of passive and active safety systems to the future transport concepts and low-weight vehicles. New ADAS systems for electric vehicles: vulnerable road users, collision avoidance, intelligent vehicle dynamics and crash mitigation (Note: this R&D area is also included in section "2.3.3. ICT for the improvement of the whole transport system").
   - Functional safety and reliability of components and systems.
   - Safety issues related to new electric components and high voltage

4. **In-vehicle system integration**:
   - Development of components and systems for the new vehicle types and topologies. Microprocessors, FPGAs devices and HW/SW designs for multi-system architectures.
   - Integration of nanoelectronic technologies, devices, circuits and power electronics modules.
   - Functional architecture: position and standardization of interfaces for power and data, distributed x-by-wire systems.
   - Development of a distributed real time embedded system platform and embedded systems architectures (hardware, software, operating systems, algorithms, etc.), considering safety critical issues and designed with standardised and interoperable components.
   - Control methods and strategies related to different architectures
   - Standardisation, interoperability, and interoperability analysis and verification.

5. **Integration with the electrical network: Vehicle-to-Grid connection**
   - In-vehicle components for advanced vehicle to grid (V2G) interface. Vehicle charging systems with on-line information and interoperability and bidirectional capabilities.

6. **Integration of EVs with the transport system**:
   - Cooperative systems vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I), connected cars to improve safety and efficiency, road and traffic information, car-in traffic control systems, communications and infotainment.

Expected impact

- Work on the priorities detailed above will support the medium-long term introduction of Spanish technologies related with green cars.
- Full deployment of electric vehicles demands availability in due time and at affordable prices of technologies and components for the vehicle itself as well as for its integration with the electrical grid and with the transport system. This can be accomplished by joint work of all the levels of component suppliers, together with vehicle manufacturers, utilities and infrastructure operators.

2.2.3. ICEs for light vehicles (range extenders)

Objectives and scope

To promote Research and Development in the propulsion systems for light automotive vehicles in the areas in which the Spanish industry has industrial production capabilities:

- Development / adaptation of thermal – electric engines for auxiliary power units and range extenders of electric / hybrid vehicles.
- Alternative fuels: biofuels, biogas (bio-methane), natural gas

As a means to fulfil this objective it is necessary to establish working groups and installations specialised in Research and Development for the adaptation of the thermal and electric engine and of the additional systems required (electric energy converters, regulation and control systems, energy recovery and optimisation), as well as for performance optimisation for use with alternative fuels and Spanish manufactured biofuels.

Major R&D areas

1. **Development of small internal combustion engines** of high specific power, ecologic, efficient and quiet, specifically designed as range extenders to increase the autonomy and feed the auxiliary systems of electric vehicles. R&D needs include:
   - Engine Downsizing, Downspeeding, Turbocharging

- Reduction of energy losses in the various engine systems (heat losses, mechanical losses, …)
- Recovery of waste energy (exhaust, cooling, braking, …).
- Development of new more efficient transmissions, optimized lubrication systems, and integral cooling system for thermal-electric engine.
- Efficient management and integral control of the internal combustion engine and of its auxiliary systems and transmission.

2. **Development of electric generators** for hybrid propulsion systems:
   - Optimisation of the mechanical and thermal design
   - Control of the thermal engine – electric generator system
   - Common energy flow management

3. **Strategies for engine management and use of different fuels:**
   - Development of management strategies for engine and range extenders
   - Adaptation of thermal engines for the use of fuels with different properties
   - Development of lubricants suitable for alternative fuels

4. **Development of alternative fuels**
   - 2nd generation biofuels
   - On-board storage systems for alternative fuels

Expected impact

- Development of the Spanish industry by specialising the existing industry which is nowadays manufacturing stationary and small motorcycle engines. As the range extenders require medium range mechanical and electrical power, they are within reach of the Spanish industry. This development could be extended to hybrid vehicles with higher requirements.
- Development of the Spanish industry of electrical systems and components: generator, electric energy converters, control systems, etc…
- Development of the Spanish biofuel and lubricant manufacturing industry.
- Reduction of the impact on the environment by use of renewable fuels.

2.2.4. Smart infrastructure and services for Green Vehicles

Objectives and scope

Smart grids is a network of networks whose overall objective shall be the integration of all the stakeholders in the electricity networks and communications fields with the transport system, so that the overall use of energy is reduced considering these different stakeholders (vehicles, heavy duty, buses and motorbikes)

Spain has a great potential in the area of integrating vehicle with road infrastructure, based on the main issues:

- ***Infrastructure (road and electricity),*** improving its value creating a road network able to integrate and develop new business and adding value to the road infrastructure itself. Construction companies, with a great projection and potential at the European level, shall take a special leadership in this objective, together with generation and distribution companies, which are key issues in this new scenario in which infrastructure can take a leader role, even ahead of vehicles.
- ***Communication and Services,*** sector with great capabilities at the national level, linked to services related to electric vehicles and users. Integrating these capabilities with infrastructure developers, specific solutions could be obtained by improving services offered to final users and optimising the distribution, charging and safety and security of infrastructure linked to electric vehicles.
- ***Transport***, with R&D solutions for the OEM using different technologies permitting the communication with infrastructures and the network, guaranteeing a real time bidirectional information exchange and secure transactions. Technologies able to integrate public and freight transportation.

Major R&D areas

1. **"Smart charging":** control architectures, balancing, standardisation of operation modes, hardware and software for settlement and payment, algorithms and SW operation (network – vehicle) and integration with existing DMS.

2. **Forecast and Adaptive algorithms** (PHEV/EV)

3. **Communication services** with protocols BUS / PLC, RF and their associate technologies: SDRC, Wimax, Zigbee, Tetra or other.

4. **Standardisation of traffic prioritisation and "electric" transportation** (specific lanes, dedicated lanes, freight – last mile-, public transportation, etc.)

5. **Fast charging** and charging system integrated in the infrastructure.

6. **Integration of alternative energy sources and green vehicles** (storage, distribution)

7. **User services**: driving using dedicated lanes, quick lane or exclusive lane, payment of parking fees in blue or green zones, covered parking places, and ICT solutions for the management of these services.

8. **Safety improvement** (compatibility, crashing in junctions, etc, …), warnings of emergency vehicles approaching, emergency or support calls, driver support services, etc..).

9. **Value added services for the EV**: management of carsharing (sharing of EV) solutions (localization, metering etc.), telematics services for the EV (Location Based Services, ICT-based Insurance, use of EV as traffic probes, ICT-based parking management etc.).

10. **Launching of pilot projects** able to evaluate technologies developed in **different real life scenarios**.

11. **Bidirectionality of EV**. Technologies V2G. Study of new actors, roles, relationships, business models and cost-benefit analysis of the electricity sector integrated with EV. Management of bidirectionality of charging – discharging of EV and integration with existing DSM.

12. **Launching of pilot projects** able to evaluate technologies developed with simulation of **different network scenarios**.

Expected impact

- The impact is undoubtful in environmental terms if pollutant primary energy sources are substituted by cleaner and efficient ones. It is of special interest to fulfil the described objectives, in order to have an efficient intelligent network integrated with the sufficient capability to distribute and supply the necessary energy for charging.
- The position of Spanish companies with greater potential (construction companies, generation and distribution companies, communication and services) as main players in the transport of people and goods, such as the development of physical connections between vehicle, infrastructure (charging points) and electricity network, and the deployment and exploitation of new services based on specific technologies (V2X) and convergent technologies (advanced driver assistance systems - ADAS).

2.2.5. Grid integration

Objectives and scope

Electrical vehicles represent a new type of demand in the value chain of the electricity sector, which, in accordance with the development previsions, will constitute a considerable percentage of energy and power demands on the electrical system in the coming decades. In addition, the impact on the electricity sector is not well known as the patterns of use of electric vehicles are dependent on the technological options available and their social acceptance. It is worth mentioning that electric vehicles are mobile units which in the future will create different electrical demand scenarios from a geographical point of view.

Strategies for fostering electrical mobility lie in the search of an efficient overall energy system. Because of this, it is not only important to pay attention to the efficiency of the design of the vehicles, but also to the operability of these loads according to the needs of the electrical systems. Therefore, it is fundamental that the latter is considered in the strategic development of the infrastructures.

In this area, the objective to be covered is the search for the standardization of the physical connection of the vehicles to the grid, aiming at defining European standards for the interoperability of the vehicles in the different distribution networks. In addition, with the objective of achieving an efficient integration into the energy system, infrastructures need to allow for intelligent management of the electric vehicles (identification, charging, payment, operation services, V2G)

Major R&D Areas

Among relevant aspects to cover for an efficient integration of electric vehicles into the grid, the following can be outlined:

1. **Development of European standards for charging** electric vehicles,

2. **Implementation of new models** for planning and operating the electricity networks, taking into account the new energy demands

3. **Development of a regulatory and rating framework** which permits future users of electric vehicles to receive adequate quotes for an efficient use of vehicles, promoting charging during off-peak hours.

4. **Development of new forecast models** for predicting future electricity demand

5. **Harmonious design of monitoring and real time control and management systems,** which allow the use of the charging stations irrespectively to the distribution networks in which the electric vehicles are connected.

6. **Optimal use of the existing infrastructure** for an intelligent management of electric vehicles. Profiting from telematic netwoks for metering and customer tele-management.

7. **Identification of new services** which electric vehicles could offer to the electrical system: new operation services, support against black-outs, V2G.

8. **Identification of business models**.

9. **Integration of renewable energy into the grid**.

Expected impact

- The anticipated results are the achievement of European standards for connection, payment, monitoring and management of the charging of electrical vehicles, so that energy benefits may be achieved.

2.2.6. Sustainable urban mobility: vehicles and concepts

Objectives and scope

Urban mobility is a segment of transport demand that shows significant differences with the interurban and that calls for specific solutions in the field of the European initiative "Green Cars". Specific issues include:

- greater significance of local emissions,
- the possibility of using private vehicles with very low emissions as a result of less demanding specific performance,
- the offer of public transport, structured in vehicle fleets of different sizes, can implement strategies and technologies of exploitation and optimization that are not applicable or more difficult to apply in other domains,
- the development and field test in early stages of implementation of new concepts and technologies can be facilitated under a more professional management of fleets and companies involved
- the existing huge frame for the incorporation of new innovative solutions.

Among the principal technological objectives to achieve sustainable and accessible urban mobility of people and goods is the development, testing and integration, in electric and hybrid vehicles platforms, of a set of technologies associated with these vehicles, new fuels generation, electricity supply, energy storage systems, more efficient.

Currently, the interest of companies and public authorities, both national and international, focuses on electric and hybrid vehicles, both sharing a large number of technologies, including those relating to electrical energy storage with batteries that combine the best possible high energy density, short recharge times, reduced weight and number of charge cycles without suffering damage. These requirements are difficult to fulfil all together with existing technologies, hence the interest to tackle projects that would achieve significant progress in several of the identified areas.

The vehicles must enable greater adaptation to the demand for mobility of different users, including reduced mobility persons and goods, especially, urban logistics distribution and collection of urban solid waste.

Major R&D Areas

1. **New concepts and technologies for urban vehicles**, electric and hybrid, both for private individuals and public transportation, freight logistics distribution, solid waste and others.

2. **Advanced systems of electrical energy storage in the urban area**, refuelling points, design of the distribution network in urban areas, rapid recharging, vehicle sharing.

Expected impact

The additions of new operating systems and vehicles for urban transport offer have different effects:

- Significant reduction of local emissions, with the reduction at the same time of greenhouse gases emissions and the positive effects that such a reduction involves the health and quality of life of citizens.
- Increased use of private vehicles with ultra-low emissions.
- Increased user accessibility to transportation.
- Contribution to strengthening the leadership position of European industry in addressing future demands for sustainable urban transport and accessible.

2.2.7. Demonstration and field operational tests

Objectives and scope

The development of technologies linked to the electric vehicles requires the existence of large scale demonstrations, aimed at validating said technologies. These demonstration projects need to have a global scope so that not only are individual technologies validated in the areas of vehicles, infrastructure, communications and energy supply, but also to validate how these different technologies are integrated in order to obtain synergies that lead to better efficiencies, lower costs, CO_2 emissions…

The scenario for these demonstrations should be urban and periurban areas. The implementation of these demonstrations will be done using commercial vehicles, public transportation, delivery vehicles, etc. Also, all systems implemented should be analyzed (communications, electricity, etc.) as well as the degree of users' acceptance, with the aim of identifying appropriate policies for a better future use.

Major R&D Areas

R&D needs are related to the integration of existing technologies and new developments permitting the efficient, secure and reliable connection among the different elements integrating the system.

1. **Vehicles (private cars and freight transport)**
   - Study of different vehicle concepts, according to their use (urban, periurban, goods transport, etc…)
   - Analysis of the systems implemented in the vehicles and users' review and analysis
   - Analysis of charging systems in vehicles (fixed battery, battery change, etc…)
   - Impact of great number of information in the economy of the vehicle
2. **Infrastructure: road, electric** (generation and charging), **communications** (vehicle to infrastructure and infrastructure to vehicle)
   - Way the information is presented: location of charging points, traffic situation, road situation, etc…
   - Adequate technologies for information exchange: system – vehicle, vehicle – vehicle
   - Influence of infrastructure on information saturation.
3. **Study of new energy generation systems** implemented in vehicles as well as distributed along road infrastructures.

4. **Establishment of regulations** for the use of infrastructure

Expected impact

- Use of Spanish technology is the demonstrations, permitting Spanish companies to validate their technology and developments, both at the individual level as well as their integration in the overall system. Also, to increase the services offered by these technologies and developments.
- Analysis of the impact of introducing the different systems in terms of safety, comfort, etc… permitting establishing the regulations that shall be observed by the next generation of electric vehicles, as well as for the new infrastructures.
- Accelerate the use of transport means more environmentally friendly, as well as the rational use of energy with lower carbon emissions.
- Analysis and validation of possible business models in Spain.

2.2.8. Regulation and standards, homologations, tests, validation, safety and type approval of hybrid and electric vehicles

Objective and scope

The core of the electrification of road transport is new vehicles (EV) based on electric traction and the modules and components being part of them. Different concepts of cars, trucks and buses are in the main focus of current research activities and type approval processes to operate in both urban and interurban roads. The pure electric vehicles due to their zero local and potentially minor greenhouse gas emissions (if energy from renewable sources is used) are considered the cleanest option are the mile stones towards sustainable road transport. Hybrid vehicles (HEVs) such as micro, mild and full hybrid are a favourable entry point in this process. The increased energy density, capacity, safety, lifetime, cycle life, and greater standardization of mechanical and electrical interface and better communication, with cost reduction are the major challenges for production mass of energy storage systems and their viability in the EV and HEV. The integration of cells in the packaging of the batteries is an important issue particularly with regard to safety, cost, manufacturing, diagnostics, maintenance, repair and recyclability. It is considered necessary therefore to develop system architectures and energy management of change elements of rapid activation and the establishment of evaluation standards and testing.

The deployment of EV in the market will require the provision of support infrastructure and its integration into a complete system of large-scale mobility. The

purchase of power for EV should be as easy as today's refilling at service stations. There should be no barriers to the use of different facilities, suppliers, rates or types of charging stations. For this purpose, the concept vehicle-to-grid combines a fast power charging with a smart payment system. In this regard will require new technologies of information and communication technologies make use of standard protocols for exchanging data falls infrastructure and storage system. It will be necessary to design the technology of charging stations, the standardization of connections, the rapid charging process, the security requirements and the collection process according to different rates, depending on the origin of electricity charged.

There is now a notable lack of enforceable laws and regulations in the systems involved and in the electric and hybrid vehicles, which ensure the required safety levels and conditions of standardization to facilitate its use, international level, with zero or reduced technical barriers.

The objective is to stimulate and support pre-standardization research for both new systems and for vehicles as a whole.

Major R&D areas

1. **Identification of safety standards of components, systems and hybrid and electric vehicles** related to storage, use and supply of energy on board, as well as pollutant emissions level produced.

2. **Identification of safety standards of the facilities** of electricity supply to vehicles.

In both cases, technical requirements must be defined in international regulations and the tests necessary to verify compliance.

Expected impact

- Contribute to tests standardization both at components and vehicle-infrastructure levels.
- Contribute to safety of electric and hybrid vehicles on the road.
- Raise the level of trust of future users of such vehicles.
- Reduce the costs related with engineering and production processes of hybrid and electric vehicles.

2.3 Logistics, co-modality and ITS

The 'European Green Cars Initiative' includes Logistics and co-modality combined with intelligent transport system technologies as one of the three major research and development priority pillars.

The optimization of the overall system efficiency and sustainability avoiding sub-optimal logistics can improve performance regarding energy consumption and environmental impact. In this respect, smooth and co-operative interactions between the different transport modes will be essential as well as new and innovative concepts to improve collaboration between stakeholders aiming at CO_2 emissions reduction.

Spain has a strong potential to contribute and could be an "EU Champion" in terms of Logistics, Co-modality and ITS. The Spanish Technology Platform on Logistics, Intermodality and Mobility, Logistop, could play a key role to the deployment of innovative processes and services.

RTD specific priorities in this area can be divided in three different lines:

2.3.1 Logistics and comodality

2.3.2 Sustainable urban mobility: connected vehicle and fleets

2.3.3 ICT technologies for the improvement of the whole transport system

2.3.1. Logistics and comodality

Objectives and Scope

The main objective of this stream is the optimization of the efficiency of the transport system as a whole, taking into account both, goods and people. All transportation modes should work in a collaborative way improving sustainability. In this regard, road transport interaction with other modes is essential to avoid sub-optimal logistics and promoting the deployment of co-modality concepts.

Major R&D areas

1. **Optimization of the average load percentage in freight transportation** avoiding that empty trucks circulate on highways.
   - Pooling centres and Platforms and shared services between companies and 3PLs.
   - Improving transportation forecast to optimize planning.
   - Development of efficient technologies aiming intermodal routing optimization and co-modality.

- Empty container management.

2. **Increasing the maximum load weight and/or length in trucks** including gigaliners, road trucks, etc.
   - Infrastructural constrains.
   - Impact assessment.

3. **Improve last mile process and development of city logistics** and freight urban distribution for the benefit of cities and citizens (See section 2.3.2) and take into account possible implications in the logistic chain.

4. **Development and support of new logistic business models** related to the implementation of the Green car initiative.
   - Optimal design of supply chain networks.
   - Strategic design of the "green cars" initiative from a logistics perspective (charging points, fleets sizes, routing, etc.).
   - Identification and implementation of the use of electric freight vehicles in industrial and logistic areas.
   - Storage, handling and transportation of special materials such as lithium and magnesium salts.
   - Handling of new products (i.e. batteries) in distribution, use and end of life taking into account recycling implications.

5. **Environmental analysis** (CO_2 emissions) of **the logistics chains** from a supply chain holistic point of view including aspects beyond transportation.

6. **Promotion of co-modality/intermodality**
   - Increasing visibility of the movement of freight along the logistic chain and strategic transportation planning.
   - Integration of different stakeholders involved in intermodal chain; Information systems simplification, interoperability and reduction of bureaucracy.
   - Improvement of intermodal exchange processes and physical issues among transportation modes, freight units, freight modules, intermodal containers, etc..
   - Optimization of logistics operations in logistics platforms.

Expected Impact

- Improving efficiency of the overall transportation system in relation to energy consumption and CO_2 emissions.

- Improvement of the services for customers and citizens.

2.3.2. Sustainable urban mobility: connected vehicle and fleets

Objectives and Scope

In point 2.2.6 general objectives and scope of sustainable urban mobility are included. Here, we can find specific items regarding services in future urban mobility, i.e. fleet management and information and communication systems needed to achieve urban transport of people and goods more efficient, environmentally friendly and accessible to all users. On top of the R&D here included it is worthwhile pointing the relationships of this line with "2.2.4. Smart infrastructure and services for Green Vehicles". Interesting R&D areas mentioned there such as traffic prioritisation, dedicated lanes management, carsharing solutions, ICT-based parking management including parking slots and information for users are pretty relevant in the field of Sustainable Urban Mobility.

Fleet management, with new demands arising from the type of vehicle and type of energy, requires new tools for communication vehicle - infrastructure - control centre. All this requires real-time management of large amounts of information from different actors in the system: clients, infrastructure, vehicles and operators as well as its processing and distribution using optimized communication channels.

Major R&D areas

1. **Advanced communication systems and fleet management**, enabling efficient use of vehicles from the energetic point of view, while providing a quality service to users, with maximum accessibility.

2. **Implementation of new concepts in mobility** resulting from the introduction of electric vehicles.
   - Inclusion in the mobility patterns of new factors or modification of conditions implied by the introduction of the electric vehicle: routes, range, changes, loading and unloading of goods, vehicle sharing, parking slots, etc.
   - New concepts of urban freight distribution: distribution systems, last mile, dedicated lines for freight and their management.

3. **Improving mobility in the current scenario**:
   - Defining strategic network, transport network design considering transfers, access and waiting times.
   - Creation of industrial clusters with origins and / or destinations matching to optimize the mode of transport used.
   - Design of distribution infrastructure associated with the capillary (city-logistics) with focus on Urban Platforms at the neighbourhood level, designing urban freight distribution in cities. Infrastructure design (see line 2.2.4).
   - Modelling of distribution networks to optimize the overall cost of operations. Optimization of delivery routes based on efficiency and sustainability criteria.
   - Solutions to the operation of the distribution and delivery logistics in support of electronic commerce (B2V and B2B), especially on specialized platforms and problems of the last mile.
   - ITS Applications to convert the cities in collaborative environments with integrated management of mobility (people and goods) as developed in line 2.3.3.
   - Allocation and network optimization and dynamic urban routes from real-time information.

4. **Promoting the use of public transportation**:
   - Perceptions, motivations, attitudes and expectations and other factors that may tip the users to use public transport.
   - Actions to improve service reliability, to increase travel comfort, to select routes faster, and in general driving public transport measures.

Expected impact

Besides expected impact included in point 2.2.6, a new generation of services is expected as well as the optimization of current performances by increasing the use of public transport

2.3.3. ICT technologies for the improvement of the whole transport system

Objectives and Scope

ICT technologies will play a major role in the research and development of future generations of clean vehicles. The new developments based on ICT will broaden the range of applications and key systems for a safer, cleaner and smarter sustainable mobility. In this sense, complementarity of vehicle-to-vehicle and vehicle-to-infrastructure communication systems, along with new models of flexible traffic management are part of a global perspective that will facilitate mobility of people

and goods, where comodality plays a key role. Similarly, new electric vehicles require the development and integration of systems and advanced components based on ICT technologies applied to both the vehicle and the network, in order to ensure the required levels of safety and energy efficiency.

Major R&D areas

Following areas are considered of special interest by the Spanish entities:

1. **New Intelligent Transportation Systems (ITS) based on ICT technologies** to provide advanced solutions for sustainable mobility in urban and interurban areas, introducing the use of EV as a new element in the transportation network.

2. **Advanced HMI concepts** (Human Machine Interface) which optimize the interaction between the end-user and the eco-efficient multi-modal transport models.

3. **V2X communication technologies** (vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-grid) and cooperative systems/services applied to efficient mobility.

4. **New ADAS (Advanced Driver Assistance Systems) and active safety systems for the electric vehicle.**

5. **New concepts of autonomous driving applied to public transport vehicles**, or adapted to fleets with special characteristics.

6. **Development of data communication interfaces between the green car and the infrastructure**, including transmission of information (protocol definitions) to feed the models of demand management.

7. **Development of advanced concepts of mobility of people and goods** (Co-modality)

8. **ICT for advanced and eco-efficient logistic applications**.

9. **New control and traffic management models** oriented to energy efficiency (reliable real time traffic information accessible from anywhere, eco-routing/eco-navigation, etc.).

10. **Impact assessment**: emissions and consumption reductions, energy efficiency, transport efficiency, road safety improvement, etc.

11. **Implementation of Galileo**. Enhancement of navigation and positioning performance which can allow going a step beyond in current applications based on the use of GNSS, be an alternative to other technologies currently used for different mobility applications or facilitate the introduction of applications not possible with current GNSS technology.

Expected impact

- Introduction of new products and services based on ICT that will actively contribute to the deployment of electric cars and the implementation of new models for sustainable mobility.
- Contribution of the ICT technologies to the optimization of the logistic chains and urban mobility.
- Improving information sharing reducing bureaucracy.
- Implementation of real time decision systems in mobility.

Annex 1: List of technological domains and contributing entities

Area	*Contributors*[2] *
1. INTRODUCTION: SPANISH STRENGTHS	**SERNAUTO, ANFAC**, REE, IBERDROLA, ENDESA, IDAE, LOGISTOP
2. RESEARCH PRIORITIES	
2.1. HEAVY DUTY VEHICLES	
2.1.1. Heavy duty vehicles: focus on electrification and alternative technologies	**ANFAC**, IVECO, NISSAN, CMT-UPV
2.1.2. ICEs for heavy vehicles	**CMT-UPV**, IVECO, CIE Automotive, CIDAUT, MONDRAGÓN
2.2. ELECTRIFICATION OF ROAD AND URBAN TRANSPORT	
2.2.1. Materials, manufacturing and processes	**TECNALIA**, ANFAC, CIE, GESTAMP, SERNAUTO, ANTOLIN, UPC, CTAG, MONDRAGÓN, LOGISTOP, TecnoEbro, CIDAUT, MONDRAGÓN
2.2.2. Systems and components for electric vehicles	**SERNAUTO**, GESTAMP, UPC, TECNALIA, CTAG, Lear, MONDRAGÓN, CIE, FICOSA
2.2.3. ICEs for light vehicles (range extenders)	**CMT-UPV**, IVECO, CIE Automotive, CIDAUT, MONDRAGÓN
2.2.4. Smart infrastructure and services for Green Vehicles	**CIDAUT**, CTAG, UPC, ENDESA, IBERDROLA, REE, FICOSA, ACCIONA, LOGISTOP
2.2.5. Grid integration	**REE**, Iberdrola, ENDESA, IDAE, UPC, TECNALIA, ACCIONA
2.2.6. Sustainable urban mobility: vehicles and concepts	**INSIA-UPM**, UPC, TECNALIA, CTAG, MONDRAGÓN, LOGISTOP, CIDAUT, ACCIONA
2.2.7. Demonstration and field operational tests	**CIDAUT**, SEAT, IVECO, HISPANO, TecnoEbro, CTAG, REE, IDAE, IBERDROLA, ENDESA, ANFAC, INSIA-UPM, ACCIONA, MONDRAGÓN, LOGISTOP
2.2.8. Regulation and standards, homologations, tests, validation, safety and type approval of hybrid and electric vehicles	**INSIA-UPM**, CIDAUT, CMT-UPV, CTAG, (MITYC) , MONDRAGÓN
2.3. LOGISTICS, COMODALITY AND ITS	
2.3.1. Logistics and comodality	**LOGISTOP**, UPC, TECNALIA, ANFAC
2.3.2. Sustainable urban mobility: connected vehicle and fleets	**CTAG**, CIDAUT, UPC, TECNALIA, MONDRAGÓN, FICOSA, LOGISTOP, ANFAC
2.3.3. ICT technologies for the improvement of the whole transport system	**CTAG**, INSIA-UPM, UPC, TECNALIA, MONDRAGÓN, LOGISTOP, CIDAUT, ACCIONA

[2] *Note: bold characters indicate the contributing leader/s of each area*

Annex 2: List of contact emails of those taking part in the working group

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