Purpose of this document

Considering the number of initiatives taken worldwide by governments, the EC, vehicle manufacturers and suppliers, energy suppliers, etc., and the challenges ahead for a successful electrification of vehicles in the transport system, the aim of this document is to present a synthetic view about the potential of current and future ITS technologies and services to enable and support the introduction of Fully Electric Vehicles (FEVs), knowing that many of these solutions can also serve other type of vehicles.

Table of Contents

Purpose of this document ........................................................................................................................................ 1
Table of Contents ........................................................................................................................................................ 1
Introduction and motivation ........................................................................................................................................ 2
ITS as an enabler for the electrification of vehicles ................................................................................................. 3
ITS priorities for FEVs .............................................................................................................................................. 5
Introduction and motivation

It has been shown that transport needs and demands grow with GDP. Climate change and the continuous decrease of non-renewable energy resources are therefore key challenges for society and the mobility of people and goods. Furthermore, by 2050 urban areas will account for about 70% of the world’s population; and aging will lead to an increase of Vulnerable Road Users who will have specific mobility needs. Cities will be under pressure to find sound solutions to handle the increase of mobility demand from citizens and goods.

We need to rethink our mobility services and transport system under these new conditions in order to achieve significant CO₂ reductions to preserve our environment, as well as continuing to offer our citizens and our economy efficient and safe transport means. FEVs are definitely part of the solution and will play an important role toward these challenges in offering efficient, clean, zero-emission and -noise urban mobility.

The main challenges ahead are the use and acceptance of FEVs, as well as their integration in both the transport and the energy supply system. FEVs will lead to increased demand for ITS services which facilitate intermodal mobility (information, reservation, ticketing). There will also be a need for ITS services to facilitate the interlink between the electric vehicle and the grid.

ElectroMobility is currently given first priority in many countries: such as Germany, France, Spain, Italy as well as USA, Japan and China. In the EU the European Commission has launched the “Green Car Initiative”\(^1\) (EGCI) as part of the “European Economic Recovery Plan” to support R&D in this field. Different reference documents were published by organisations in order to present their strategic views and proposals for R&D priorities, in particular EUCAR\(^2\), CLEPA\(^3\), and ERTRAC together with EPoSS and SMARTGRIDS\(^4\).

In the EGCI context, EU-funded research projects like ELVIRE\(^5\) have already started. We also have to ensure convergence between energy efficiency R&D projects like eCoMove\(^6\) and FEVs needs as many of these developments are pertinent for FEVs. As a key step, the European Parliament adopted a resolution\(^7\) on 6.5.2010, calling on the European Commission and the European Council to promote standardisation of infrastructure and charging technologies, including smart grids, open communication standards and on-board metering technology and interoperability for cross-border electric mobility.

This working paper addresses the FEV thematic from the ITS perspective. ITS solutions for FEVs were not addressed by the eSafety WG on “ICT for Efficient Mobility”\(^8\) and are only partly handled by the iCAR Thematic Network on Energy-Efficiency\(^9\).

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1. EC - Green Car Initiative, EC communication, 05/2009
3. CLEPA-EUCAR press release, with R&D priorities for the Greening of Vehicles and Road Transport, 05/2009
5. ELVIRE - “Electric Vehicle communication to Infrastructure, Road services and Electricity supply”, FP7 project, started 01.01.2010
6. eCoMove - “Cooperative Mobility Systems and services for energy efficiency”, FP7 Integrated Project, DG-INSFO, started 01.04.2010
8. eSafety, final report on “ICT for Clean and Efficient Mobility”, Brussels, 11/2008
Regarding deployment, a new generation of FEVs are expected to be introduced on European market in 2011.

**ITS as an enabler for the electrification of vehicles**

**Individual use case example**: “A 30 km return home trip with 40 km autonomy remaining under average conditions; but, this day: the weather is very hot so Climate Control is fully on and some unusual heavy congestion is occurring ahead ...”

**What does the user/driver need?**
- Accurate real time traffic and traveller information
- Autonomy assessment (embedded or not)
- Eco driving advices
- Guidance and booking facility to available charging spots

**FEV drivers need ITS systems and services**

Today's main focus is the development of battery, engine and vehicle technologies. Innovative ITS systems and services support the widespread usage of FEVs. The key is prediction and connectivity; ITS facilitates the exchange of data and information among the different components of the transport systems and services. Furthermore, the optimisation of the whole transport system and mobility services with FEVs can only succeed with the use of innovative ITS technology.

The development of FEVs will evolve from the conventional to the revolutionary - i.e. using first conventional vehicles with new motorisation and ending in the future with a complete redefinition of the vehicle, its use, management and integration in the transport system.

Similarly, ITS solutions will evolve from the adaptation of today's existing solutions to completely new mobility service concepts. ITS will also link the user and utility providers with an effective provision of related information services enabling users to optimise their charging needs and preventing the network from becoming overloaded. **So the ultimate aim of a zero-carbon transport system will require multiple innovative steps in vehicle, infrastructure and associated mobility services.**

An **evolution phase** will adapt existing ITS applications and services to FEVs requirements. For example eco-driving systems currently introduced on the market will evolve to change driver behaviour in the long term. Other supporting systems or services to be further developed are:

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10 “ITS and Vehicle Electrification”, presentation by Ch. Rousseau (Renault) to the ERTICO 2nd workshop with the European Parliament about “Bringing intelligence into Urban Mobility” on 4.2.2010
• navigation and associated maps for prediction with ADAS\textsuperscript{11} horizon for FEVs, taking into account new data needs for the management and control of FEVs
• battery management with information on location of battery charging or exchange stations. On-board navigation systems to calculate optimised routes based on the energy capacities of the vehicle and provide information about the nearest battery exchange or charging stations
• vehicle-to-driver interaction to optimise FEV trips, e.g. range, battery life and management
• cooperative systems from V2I to V2G\textsuperscript{12} for standardised data exchange between FEVs and the Smart Grid
• FEV fleet management/vehicle sharing, e.g. global mobility management services integrating FEVs

A revolution phase will lead to completely new developments, in particular by accessing predictive information and data provided by ITS to:

• solve safe interaction between FEVs and Vulnerable Road Users, as FEVs produce little noise while moving. It is also a safety issue for which current solutions still need to be accepted and certified
• develop new ADAS for FEVs (safety, comfort), as new FEVs may completely change with respect to their design around the electric propulsion system, and therefore vehicle systems and interfaces will have to be revised or redefined based on specific vehicle performance and handling characteristics
• develop simulation models optimising deterministic traffic management with respect to mobility demand and mobility impact integrating the Smart Grid
• integrate FEVs into the Smart Grid as a component of the energy distribution network. Such a novel development will bring the ITS and Energy sectors together\textsuperscript{13}; in particular:
  o creating utilities for vehicle charging that will not only be optimised for the single vehicle profile and need of the user, but also for the entire charging network
  o creating a kind of dynamic billing profile that will enable the network not to have peaks in certain locations and at certain times of the day
• develop new urban mobility services; this concept should consider the evolution of current vehicle sharing to a more general mobility sharing i.e. FEVs being part of a fully integrated multimodal transport system. The success and acceptance of such a concept depends on the quality of service associated with it
• develop Cooperative Deterministic Urban Traffic Management, e.g. offering dynamic routing for all connected vehicles based on their destination information, including FEVs, which will accelerate the penetration rate of connected vehicles. Real-time navigation directions will be provided to drivers increasing energy use performance and time reliability thanks to microscopic traffic management;
• promote societal benefits and raise awareness for these new ITS systems and services offering individual and collective mobility with at least the quality level achieved for today’s mobility.

\textsuperscript{11} ADAS: Advanced Driver Assistance Systems \textsuperscript{12} V2I: Vehicle to Infrastructure; V2G: Vehicle to Grid \textsuperscript{13} First development started, e.g. in Denmark with the EDISON project (http://www.edison-net.dk/).
ITS priorities for FEVs

For the first time, the use of ITS technologies and services are mandatory and not only nice to have. Knowing that many of the proposed solutions can also serve other type of vehicles, the following priorities are proposed to pave the way for the full introduction of FEVs within the transport system:

ITS relevant technologies and services

FEVs autonomy and eco-driving

- Eco-predictive navigation using suitable maps with dedicated data (e.g. choosing the best eco-route)
- Driving advice based on battery management and contextual data (e.g. using navigation data, former trips, traffic situation, weather conditions, actual/predictive in-vehicle power consumption)
- Guidance to available and booked charging spots
- Real-time Traffic Information (RTTI) based on accurate data and models

Electricity supply management and Smart Grid

- Smart Grid and system architecture (how ITS and Electricity Supply network interface together)
- Smart charging system
- Optimised transfer of electricity and data, based on Vehicle to Grid and Website communication
- Smart metering and forecast capabilities to operate the electricity Grid networks
- Integration of renewable electricity into the Grid
- Cooperative systems V2I and V2G (energy storage and management according to mobility demand and management)
- Billing and accounting

Cheaper and greener urban mobility services based on FEVs

- Mobility services and demand / accessibility management
- Dynamic vehicle sharing and pooling with zero emissions, low running costs and shared investments
- Inter-modality enhanced capability due to FEVs connectivity in a cooperative service system

New Business models:

- New business impact, new client / value chain
- Electricity storage service (vehicle consumes electricity, Vehicle provide electricity)

ITS specific framework conditions

Standardisation

- High level architecture and interfaces
- Interface between predictive / contextual data
- Communication protocols
- Billing facilities
- Performance criteria
- Open platform capabilities
- European-wide services

**Consistent and balanced involvement from public and private sectors**

- Development or adaptation of the legal framework offering investment security for the industry
- Relevant incentives from Member States to launch the market, take part in the learning curve effect and show their commitment to their citizens.
  - Both incentives and legislative development / adaptations will underline that policymakers opt for the “zero emission individual” and the completion of collective transport in urban and peri-urban areas.
- Public sector leading the process, by acquiring FEV fleets, defining FEV accessible areas, deciding infrastructure investments etc.
- Deployment platform and instruments ensuring phasing consistency to accelerate the roll out plan of systems and services, regulation, etc.
- Coordination of collaboration between the key stakeholders, e.g. public & private mobility operators
- Encourage companies to develop FEV mobility plans and aid with fleet acquisition
- Research and development investments for the next generation of systems and associated mobility services.

**Other relevant actions**

- Build user awareness by promoting the use of FEVs and associated services to the general public
- Set-up technology and services showcases
- Set-up of European FOT projects bringing together local/regional experimentation projects, enabling local authorities to realise local trials in a European context, sharing and learning experience with other European cities or regions. This will also be a key step towards FEVs deployment and acceptance in Europe.

While a new generation of FEVs will be introduced in 2011 and could engender some changes in mobility demand from the users in the short term, it is **time to develop the ITS research agenda** for forthcoming generations of FEVs and future mobility services.