Task 26 Workshop
Versailles 25-26th April 2017

European Commission projects
for Green Vehicles charging
in EGCI-EGVI

Maurizio Maggiore - DG RTD H2
Sustainable Surface Transport
WHY

ELECTRIC?
What is at stake?

Electro-mobility is one of the largest opportunities to radically change the transport system & make a quantum leap into the next generation of sustainable mobility

- Reduce emissions - sustainable growth, comply with COP21 and health targets
- Energy independence (less reliance on fossil energy, reduction of imports)
- Competitiveness of EU automotive sector
- Competitiveness/innovation of EU supply industry:

  Millions of EU jobs!
Pollutant emissions

Stricter and stricter emissions regulations for light and heavy duty over the years
PM Number standard introduced
Enhanced durability

Yet...

Global warming progresses
Oil might get cheaper or get back to higher prices ... but it will be dirtier and dirtier

Source: Prometheus, NTUA (E3MLab)
The press discovered consumption discrepancies long ago.
Consumers are getting angry: class actions in US, Canada and EU
THE NEW CHALLENGE IS
REALITY!
Reality for electrified vehicles?

Real life performance is even more important due to:
- Realistic range in real conditions is critical
- Battery life expectations vs fast charge
- Temperature effects
- Auxiliaries energy consumption

all reduce the vehicle performance and its attractiveness

Same flexibilities as for ICEs probably used on EVs to increase advertised range? Never again use NEDC values, WLTP is there

A conventional car might have even bigger discrepancies, but it's enough to fill her up to get to destination
Reality for electrified vehicles? (2)

Customers are not used to this type of vehicle and need education and reassurance, information MUST be correct.

First hand experience might be disturbing (Top Gear, France TV report).

New vehicle generation has 300km+ range, stop mentioning range anxiety, convenience for long distance travel is the new key parameter: time to drive 1000km a possible comparison key.

Charging is the new frontier, fast and easy charging is needed.

Alternatively, continuous charging to stop the race to bigger and bigger batteries and allow long range HD transport.
What customers want?

Technology must improve:

- From derivative to clean sheet of paper
- Better energy density for batteries
- Cheaper components (economy of scale the main driver here)

Give alternatives to customers:

- Multiple battery sizes -> Model S, Leaf, Zoe
- Pure HEV - EV – PHEV – REV versions of same vehicle BMW, TOYOTA
- Mobility solutions BMW, FIAT, PSA
- Real fast charging in occasional long trips, not baseline case

PHEV/EREV an important bridging technology but with current battery sizes, EREVs with small specialised engine or FC could make more sense

....

All this unless electric roads become feasible
WHAT ABOUT EU RESEARCH?
EU Research and innovation invest in the future of sustainable transport

FP7 and Horizon 2020 funded heavily clean automotive propulsion

EGCI launched 95 electrification projects, EGVI on track to surpass it

EC contribution in € million

- Vehicle System Integration & Demo: 140
- Energy Storage: 86
- Drive Train & Auxiliaries: 65
- ICT and infrastructure: 32
- Trucks: 35
- Logistic: 32
- Grid Integration: 25
- Range extenders: 24
- other: 16
- EGVI: 7
- other: 16

Research and Innovation
WIDE-MOB

Mission:
Building blocks concepts for efficient and safe multiuse urban electrical vehicles

Focus:
- Development of state-of-the-art building blocks critical systems
- Demonstrate and validate the integration of the developed systems into a next generation low weight and safe Electrical Vehicles for urban mobility

Research Topics and results:
- Exceptional crashworthy performance for such small vehicle demonstrated
- Improved aerodynamics
- Embedded solar panels distributed on both horizontal and vertical surfaces with adaptive electronics ensuring ~20 km/d free
- Modular and reconfigurable design addressing the WIDEst needs with ergonomic on board space
- Distributed fail safe propulsion (before Tesla) with symmetric powered axles

Coordinator: Fiat Research Center
Total budget: 3,9M€
EC contribution: 2,6M€
Start date: 1/12/2010
Duration: 36 months

http://eeepro.shef.ac.uk/wide-mob/index.html
Mission:
Eco-design and Validation of a new generation of motor in-Wheel Concept for Electric Vehicles

Focus:
• New “motor in wheel” solution for “B segment” electric vehicles
• Robustness and safety, with high power density for equivalent ICE performance (52kW continuous operation, 100kW peak)
• Compatible with existing platforms with minimum changes

Research Topics and results:
• Functional requirement definition:
  • Interfaces between partners being defined
  • Torque- Speed characteristic for high performance & drivability
  • Definition of vehicle dynamics targets
• Integration on a McPherson suspension type:
  • Research in highly integrated topologies
  • Thermo mechanical constraints definition
• First feasibility go-no go milestone to be assessed soon
Mission: “Next Generation High Efficiency Motors and Power Trains”

Focus:
- Innovative Technologies for Integrated FEV/HEV platforms
- Innovative magnetic machine technologies
- Safety first adaptive electronic controllers
- New standards and guidelines for uptake of FEV/HEV

Research Topics:
- Novel Magnetic Materials
  - Nanoscale modelling & simulation
  - New nano-macro production methods
  - Excellent results, better magnetic performance with just 10% of Dy
- Innovative Motor Designs
  - New topologies for high efficiency
  - New controller systems and technology
  - Multi-physics modelling and simulation
- Power Controllers
  - Fault-tolerant adaptive electronic controllers
  - Efficient bidirectional power coupling between the drive and accumulator pack

Coordinator: University of Cambridge
Total costs: ± 3.5m€
EC contribution: 2.4m€
Start date: 1/12/2010
Duration: 36 months
GREENLION

Mission:
Manufacturing processes for greener and cheaper Li-Ion batteries (electrodes, cells & modules)

Focus:
• More environmentally friendly production of battery components
• Substantial shortening of the battery assembly procedures: automated module assembly
• Easier and more effective disassembly and end-of-life recycling

Research Topics and results:
• Aqueous processing of ELECTRODES using natural binders
  • 0.5 m² Graphite & NMC with CMC
• CELL assembly
  • GEN0 (C/LFP) and GEN1 (C/NMC; 1.5Ah)
  • GEN2 power cell design
• Lighter MODULE design for automated assembly & easier disassembly coupled to GEN2 (ongoing)
SMARTOP

Mission:
To develop an autonomous smart roof for EVs integrating solar cells, storage systems and auxiliaries such as thermoelectric climatic control, electrochromic glazing, and courtesy LED lighting to increase comfort and fuel economy

Focus:
- New flexible lightweight solar panels (DSSC, back contact c-Si)
- Peltier modules based on high efficiency thermoelectric materials
- Smart integration of Li-batteries, EC glasses, LED lights and electronic management

Research Topics and results:
- Design of a modular roof component with energy generation and storage up to 1200 Wh per day
- Development of innovative and high performances sub-systems for power management
- Development of low cost, compact, low power consumption and robust electrified comfort auxiliaries

Coordinator: Fiat Research Center
Total costs: 3,9M€
EC contribution: 2,6M€
Start date: 1/12/2010
Duration: 36 months
ENLIGHT

Mission:
Development of highly innovative lightweight material technologies for structural parts of electric vehicles

Focus:
- highly innovative lightweight / low embedded CO$_2$ materials such as thermoplastics or bio-based materials,
- Manufacturing and joining capabilities for affordable medium-volume lightweight EVs.
- Design capabilities for affordable medium-volume lightweight EVs.

Research Topics and results:
- Conceptual lightweight design of defined modules of an advanced electric vehicle architecture with respect to weight and CO$_2$ balance over life-time
- Development of highly advanced materials to a stage that they are applicable at least in medium volume production; considered are thermoplastic and fibre reinforced composites, advanced hybrid (Al/CFRP) and sandwich materials, bio-materials.
- Manufacturing processes for these materials for medium-scale production.

Coordinator: Fraunhofer LBF
Total costs: 10,9M€
EC contribution: 7,1M€
Start date: 1/10/2012
Duration: 48 months

www.seam-cluster.eu & www.project-enlight.eu
Over 30 EGCI projects @ DG CONNECT (+ 4 CIP projects)

Electric Powertrains
Source: ODIN

Battery Management
Source: ESTRELIA

Vehicle-to-Grid
Source: e-DASH

Vehicle Dynamics
Source: E-VECTOORC

E/E Architectures
Source: OpEneR

Coordination & Support
Source: Smart EV-VC
EGVI Roadmap

Resources
- Alternative / lightweight materials
- Alternative fuels and energies
- Advanced materials, Equipment, Nano- / Microtechnologies
- Advancement and adaption of resources for green vehicles

Integration
- Processing, integrating advanced (lightweight) materials & technologies
- Electrification & hybridization; Components for sensing & control
- Energy Storage, functional integration; design for manufacturing
- Power electronics

Modules
- Drivetrain for alternative / renewable fuels;
- Reliability and robustness
- Advanced ICE and ICE in context of electrification & hybridization
- PT systems design, optimization, modularization and integration

Systems
- PT integration, E/E architecture, thermal management, weight reduction
- Simulation, prototyping, testing, recycling
- Safety & security of data
- Novel vehicle concepts; tailored trucks

Vehicles
- Interfaces and interaction to infrastructure outside vehicles,
  e.g. smart grid integration, IST for energy efficiency

Integration
- Grid and road infrastructures
- Data networks
- Intermodal hubs
Charging Scenarios

**STATIC charging**
- The vehicle is not moving for a medium/long period of time ( >5 minutes)
- The driver does not intend to use the vehicle soon
- Scenarios: Parking at home / the office / the supermarket etc.

**STATIONARY charging**
- The vehicle is not moving for a short period of time (<5 minutes)
- The driver is likely still on the vehicle, on the way to his/her target location or intends to use the vehicle again very soon
- Scenarios: Traffic light, Bus stop, Taxi stand, Delivery truck

**DYNAMIC charging**
- The vehicle is moving
- The driver is on the way to his/her target location
- Scenarios: Highway, Strategically chosen roads
Static and dynamic en-route inductive charging study

Technical feasibility of en-route charging
Power grid power request and grid management strategies
Economic feasibility of en-route charging
Social impact of en-route charging technical
Dynamic charging feasibility
Test sites

**Aachen**

*Research only*

- Positioning
- Communication
- EMI shielding
- Low power transfer (3.7 kW)
- Test vehicle: Fiat 500

**Zaragoza**

*Research & Demonstration*

- Interoperability
- Billing
- Integration into public environment
- High power transfer (50 kW)
- Test vehicle: Iveco Daily (Distribution truck)

Different focuses

[Image of Fiat 500 and Iveco Daily]
Passenger Car System @ 3.7kW

Vehicle Pickup

Primary coil
Commercial vehicle system @ 50kW
Positioning System
Final Demo in Zaragoza successfully performed on March 25\textsuperscript{th}-26\textsuperscript{th} 2015
unplugged-project.eu
INNOVATIVE FAST INDUCTIVE CHARGING SOLUTIONS FOR ELECTRIC VEHICLES
# System specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated output power</td>
<td>30kW</td>
</tr>
<tr>
<td>Air gap</td>
<td>80 mm ± 10mm</td>
</tr>
<tr>
<td>Misalignment</td>
<td>In direction X(L): ± 15cm</td>
</tr>
<tr>
<td></td>
<td>In direction Y(W): ± 10cm</td>
</tr>
<tr>
<td>Rated efficiency</td>
<td>Above 90% (80% misaligned)</td>
</tr>
<tr>
<td>Dimensions of the primary coil</td>
<td>800x700x90mm</td>
</tr>
<tr>
<td>Dimensions of the secondary coil</td>
<td>800x700x60mm – 20/25Kg</td>
</tr>
</tbody>
</table>

*FastInCharge inductive charging main objectives*
Component Bench testing

Battery test bench and secondary IPTM test bench

Mock up for static and on-route inductive charging performance test and analysis

Electro-mechanical unit to keep constant Coil distance
Final prototype installation

In the city of Douai (dismantled after testing)

On an Iveco Daily vehicle

Installation of the black box on the vehicle’s chassis

Non-magnetic polymer concrete covers

Ongoing installation work and view of the finalized installation
### Static test results

<table>
<thead>
<tr>
<th>Static charging</th>
<th>Active load</th>
<th>Battery load</th>
<th>Battery load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No misalignment</td>
<td>No misalignment</td>
<td>15cm misalignment</td>
</tr>
<tr>
<td>Station Input power (W)</td>
<td>34428</td>
<td>27749</td>
<td>26089</td>
</tr>
<tr>
<td>Output DC voltage (V)</td>
<td>392.3</td>
<td>353.9</td>
<td>348</td>
</tr>
<tr>
<td>Output DC current (A)</td>
<td>80.3</td>
<td>70.9</td>
<td>62</td>
</tr>
<tr>
<td>Output DC power (W)</td>
<td>31501</td>
<td>25113</td>
<td>21576</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>91.5</td>
<td>90.5</td>
<td>82.7</td>
</tr>
</tbody>
</table>

FastinCharge static inductive charging main results

Compatible with ICNIRP requirements, less than 27µT

>30kW continuous output demonstrated
Semi-dynamic test results

<table>
<thead>
<tr>
<th>On-route charging</th>
<th>Coil #1 Min misalign.</th>
<th>Coil #2 Min misalign.</th>
<th>Coil #3 Min misalign.</th>
<th>Coil #4 Min misalign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station Input power (W)</td>
<td>26179</td>
<td>26719</td>
<td>26179</td>
<td>26179</td>
</tr>
<tr>
<td>Output DC voltage (V)</td>
<td>349</td>
<td>352</td>
<td>352</td>
<td>349</td>
</tr>
<tr>
<td>Output DC current (A)</td>
<td>68</td>
<td>69</td>
<td>69</td>
<td>68</td>
</tr>
<tr>
<td>Output DC power (W)</td>
<td>23732</td>
<td>24288</td>
<td>24288</td>
<td>23732</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>90.65</td>
<td>90.9</td>
<td>90.9</td>
<td>90.65</td>
</tr>
</tbody>
</table>

Installed at a crossroad, for charging while the vehicle is standing or moving slowly
40% peak overload capacity, suitable for en-route charging
2017 CALL ‘GREEN VEHICLES’ included topic GV8 with significant charging content

Challenge: Assessing and comparing different options for range extension of medium/heavy electric commercial vehicles

Scope: Development of vehicle drive-train concepts, rapid charging and energy storage delivering the required performances integrated in the global system

Expected impact:

- Vehicles: energy efficiency improvements, low noise operation, reducing polluting emissions and costs
- Infrastructure: Power transfer capability above 100 kW; transfer efficiencies above 90% for static contactless systems
Thank you for your attention

More information:

HORIZON 2020:

Contractual Public-Private Partnerships in research and innovation: