Feasibility analysis and development of on-road charging solutions for future electric vehicles

Dynamic Wireless Power Transfer

Denis Naberezhnykh
Head of Low Carbon Vehicle and ITS Technology
TRL

CERV 2015, 9/02/2015
Project facts

Integrated Programme

1. Duration:
   – 1 January 2014 - 31 December 2017

2. Total cost:
   – 9.000.580,64€

3. EC contribution:
   – 6.495.000,00€.

4. Coordinator:
   – Institute of Communication and Computer Systems
Project partners

23 Partners

9 EU countries

Large stakeholder group of international industrial and research organisations
Project objectives

1. Development and testing of advanced ICT and charging solutions

2. Sustainable integration with road and grid infrastructure / development of specifications

3. Long-term socioeconomic impact and feasibility studies for large scale electromobility implementation
Achievements to date

- SotA and technical benchmarking of ICT and dynamic charging solutions
- Definition of FABRIC use cases
- Definition of requirements
- Existing dynamic charging solution market readiness study.
Development of solutions

- Improved prototypes
- Specifications
- Requirements

- Road Operator
- Distribution System Operator
- City and Local Authority
- Vehicle Manufacturer
- EM and Safety

Date 9/2/2015  FABRIC,CERV 2015, Utah
Requirements for misalignment tolerance

1. In total, 36 drives were complete
2. Aged between 25 and 45 years old

Table 1: Summary of the analysis of lateral position

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>36</td>
</tr>
<tr>
<td>Mean duration (seconds)</td>
<td>145.3</td>
</tr>
<tr>
<td>Mean lateral position relative to lane centre (m)</td>
<td>-0.108</td>
</tr>
<tr>
<td>Mean standard deviation of lateral position (m)</td>
<td>0.181</td>
</tr>
<tr>
<td>Mean 25th percentile of lateral position (m)</td>
<td>-0.230</td>
</tr>
<tr>
<td>Mean 75th percentile of lateral position (m)</td>
<td>0.020</td>
</tr>
<tr>
<td>Mean driving time within ±0.05m from lane centre (%)</td>
<td>13.9</td>
</tr>
<tr>
<td>Mean driving time within ±0.15m from lane centre (%)</td>
<td>37.9</td>
</tr>
</tbody>
</table>

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Considerations of segment lengths and spacing

1. Most common gap between vehicles at 80.5km/h (50mph) to a gap between vehicles of 20m.

2. In motorway queues with stop-start driving, vehicles typically occupy 10m each, this equates to a 4m gap between vehicles on average.

3. 1% of drivers are travelling within 4m of the vehicle in front.
Electric grid requirements

Effect of power transfer design

- Separated Power transfer pads: large fast fluctuations
- Contiguous Power transfer pads: reduced fluctuations

![Diagram showing separated and contiguous power transfer pads]
Electric grid requirements

Effect of traffic conditions

- Different densities at low speed (urban traffic, 36 km/h)
  - Higher demand
  - Larger fluctuations

- Different densities at high speed (inter-urban traffic, 108 km/h)
  - Lower demand
  - Less fluctuations
Road infrastructure requirements

- Requires a considerable amount of further research to optimise installation method
- Examples of key requirements and considerations:
  - Load and temperature limits (10—13.5 tonnes per axel, 120-200°C, temperature gradient of around 60°C in 3 minutes)
  - Function at motorway speeds (up to 65mph)
  - Must function through at least 4cm of wearing course of road surface (plus air gap surface and secondary coil)
  - Road side power supply must be at least 2m from safety barrier
  - Must be able to remain in the road without degrading the structure for at least 20 years
  - Should be able to cope with resurfacing works every 10-12 years
  - Number of new interfaces between road structure materials (joints) should be minimised
  - Must have same coefficient of friction as the surrounding surface.
Conclusions so far

- Dynamic WPT segments must:
  - Be of appropriate length to accommodate expected vehicle densities (20m at highways speeds)
  - Cope with driver misalignment of at least 15cm
  - Allow for a depth of installation of at least 4cm
  - Cope with high temperatures (up to 200°C and high loads up to 13.5 tonne per axle)
  - Not require maintenance for at least 10 to 12 years

- Dynamic WPT solutions can be made grid friendly by
  - Adequate design
  - Additional infrastructure: energy storage
  - Additional systems: traffic control
Next steps

1. Vehicle and test site installation architectures defined – August 2015
2. Complete prototypes and begin test track installations – February 2016
Dynamic WPT research in the UK

- TRL commissioned to do the feasibility study
- Expected to be completed by April 2015
- Followed by off-road and on-road trials of multiple technologies
- Prepare the SRN for future EV take up and facilitate their adoption
- Contribute to reducing GHG emissions and air pollution
Dynamic WPT in highways concept
UK feasibility for dynamic WPT – project team
UK feasibility for dynamic WPT – Plan

Q1 2014
Feasibility Study

Q2 2016
Off road Trail

Q4 2016
On road Trail

2016 2017

Functional requirements
- Cost per mile to install
- Cost of maintenance
- Resilience of system to weather, salt, vibration
- Lifespan of equipment
- Impact on road surface
- Impact of speed of vehicles
- Future proofing against obsolescence of technology

System requirements
- Civil Engineering requirements
- Standards
- Energy requirements
- Vehicle adaptation

Process requirements
- Link to National Grid
- Billing road users for energy consumed
- Energy management

Draft plan – details are being finalised
Thank you!

Denis Naberezhnykh
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