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

The Slide-in project, On-road charging as FABRIC benchmark

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FABRIC Final demo, 21st of June 2018
Agenda

1. The Slide-in project

2. Hällered Test Track

3. Project result Slide-in phase 2
   - Alstom ERS
   - Volvo Vehicle integration

4. FABRIC theoretical feasibility study
Joint FFI project to develop and evaluate 2 different ERS, with a design intended for Swedish highway traffic, capable of delivering power for heavy-duty traffic.

Inductive power transfer (Scania, Bombardier)

Conductive power transfer (Volvo, Alstom)
Slide-in project organisation

Inductive Power Transfer

Sponsor

Conductive Power Transfer

Infrastructure

Reference
Hällered Test track – Conductive solution

- Based on Alstom APS for trams
- The conductive powered section: 12 segments, 22m each
Conductive (ERS) power transfer

- Power switched on when truck pass segment at > 60km/h
- Switching power capability: 1 MW (power requirement ~125 kW)
Hällered Test track Infrastructure Installation (2012)

- Switching units in manholes every 44m
- Design to withstand heavy traffic
Slide-in, phase 2

Project result, Alstom:
ERS track updated at Volvo Hällered test track:

• Steel tracks updated to stainless steel
• Some track segments engraved to increase friction
• New rubber with better adhesion to asphalt
• Integrated wire loops for communication with the vehicle
• Mechanical switch used for APS (trams) upgraded to IGBT switches
Slide-in, phase 2

Project result, Volvo GTT:
• New pickup design
• New road/track sensor integrated in pickup
• DC/DCs (2 x 40kW double isolated)
• Interfacing power electronics and SW
• All HW integrated in hybrid truck
• Complete system testing ongoing

40kW DC/DC (double isolated)
Slide-in, phase 2

Project result, Volvo Group Trucks Technology

Slide-in power electronics integrated in Volvo FH hybrid truck

Pickup integrated in truck

Pickup with additional test HW (in grey box)
In a FABRIC theoretical feasibility study it was advocated that:

- There are no fundamental impediments to using conductive on-road charging in all FABRIC use cases.

- All defined power requirements (3 – 200 kW) could be fulfilled with the same conductive ERS solution.

- Total efficiency, including friction on pickup shoes typically > 93 % (Electric efficiency have been calculated and measured to 97 %).

- With adaptations e.g. shorter track segments and touch barriers, Static, Stationary en-route and Dynamic charging may be supported.
Thank you!

Contact
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### Extra Slide. Summary data for Slide-in

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRL Level</td>
<td>3-4</td>
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<tr>
<td>Costs</td>
<td>800000 €/km (single track), this does not include installation and commissioning costs.</td>
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<tr>
<td>Foreign object detection</td>
<td>No</td>
</tr>
<tr>
<td>Voltage</td>
<td>690V (limitation of the substation)</td>
</tr>
<tr>
<td>Current</td>
<td>180A</td>
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<tr>
<td>Power rating and Power Range</td>
<td>126kW</td>
</tr>
<tr>
<td>Power Factor</td>
<td>Not measured (expected to meet minimum grid requirements)</td>
</tr>
<tr>
<td>Quality Factor</td>
<td>N/A</td>
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<tr>
<td>Overall System Efficiency</td>
<td>97%</td>
</tr>
<tr>
<td>Note: Contact friction use case not included</td>
<td></td>
</tr>
<tr>
<td>Operating Frequency</td>
<td>N/A</td>
</tr>
<tr>
<td>Effective misalignment tolerance (x,y,z)</td>
<td>0.5 metre</td>
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<tr>
<td>Communication protocol (IEC 61851)</td>
<td>Not yet approved</td>
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<tr>
<td>EMC, EMF</td>
<td>Expected to be within the limits of specified standards. There could possibly be a problem with arcs.</td>
</tr>
<tr>
<td>EM Exposure</td>
<td>expected to be within the limits of specified standards</td>
</tr>
<tr>
<td>Harmonics (THD % V &amp; I)</td>
<td>Not measured (expected to meet IEC 61000-3-4</td>
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<tr>
<td>On-vehicle equipment Dimensions</td>
<td>0.5 x 1,5 x 0,5m</td>
</tr>
<tr>
<td>On-vehicle equipment weight</td>
<td>Estimated for first prototype:</td>
</tr>
<tr>
<td></td>
<td>• Pickup (+80kg)</td>
</tr>
<tr>
<td></td>
<td>• Power converter (+40kg)</td>
</tr>
<tr>
<td>Distance between feeder points</td>
<td>Grid connection every 968 m, Power boxes (switches) in manhole every 44 m</td>
</tr>
</tbody>
</table>