



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

Slide-in project description

FFI

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



BOMBARDIER



ROYAL INSTITUTE OF TECHNOLOGY

Sponsor



FFI

Infrastructure



Reference



Conductive Power Transfer

VOLVO

ALSTOM



LUND INSTITUTE OF TECHNOLOGY
Lund University

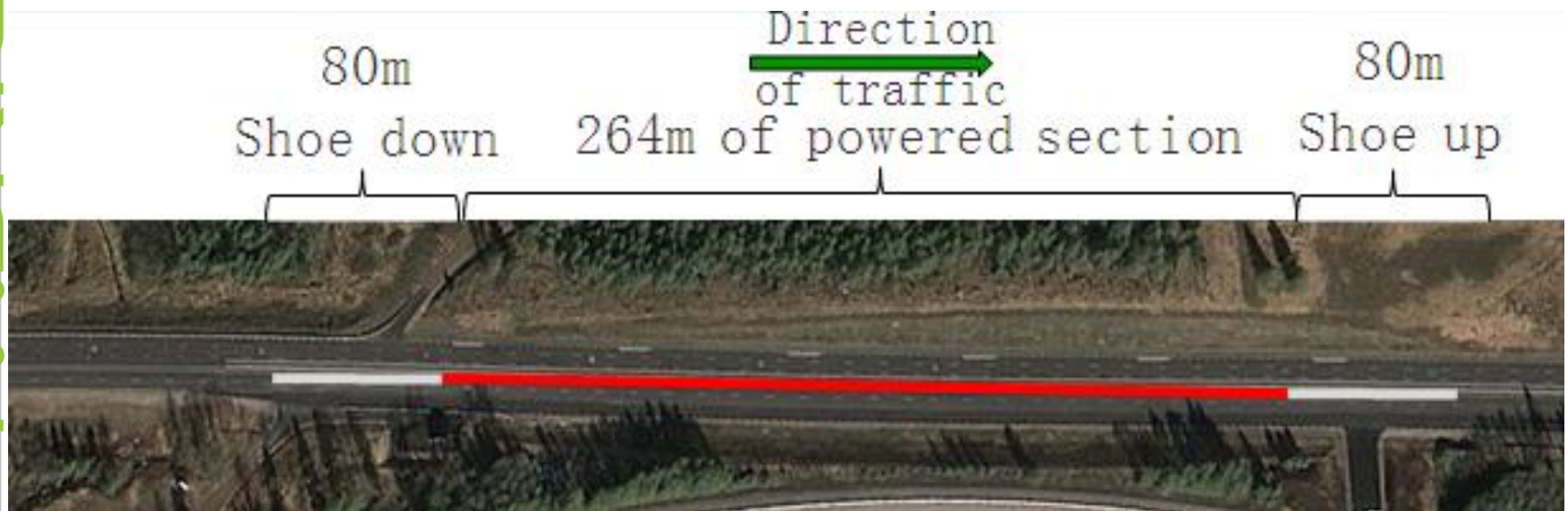


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CHALMERS

Hällered Test track – Conductive solution FFI

- Based on Alstom APS for trams
- The conductive powered section: 12 segments, 22m each

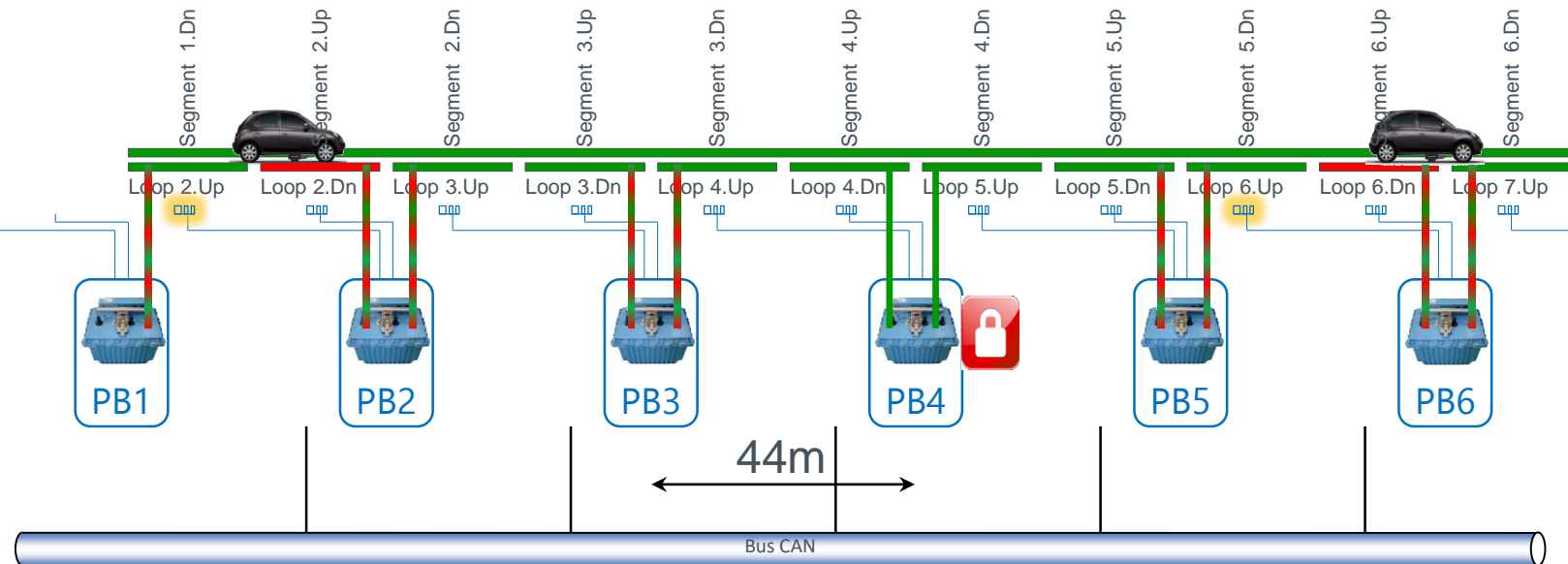


Hällered ERS Test track

Conductive (ERS) power transfer

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- Power switched on when truck pass segment at $> 60\text{km/h}$
- Switching power capability : 1 MW
(power requirement $\sim 125\text{ kW}$)



Hällered Test track Infrastructure Installation (2012)

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- Switching units in manholes every 44m
- Design to withstand heavy traffic



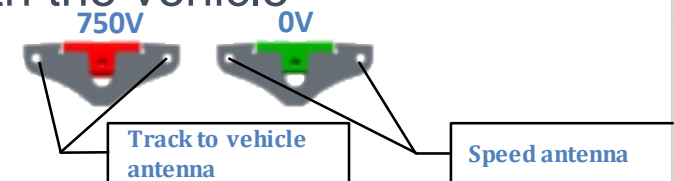
Slide-in, phase 2

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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

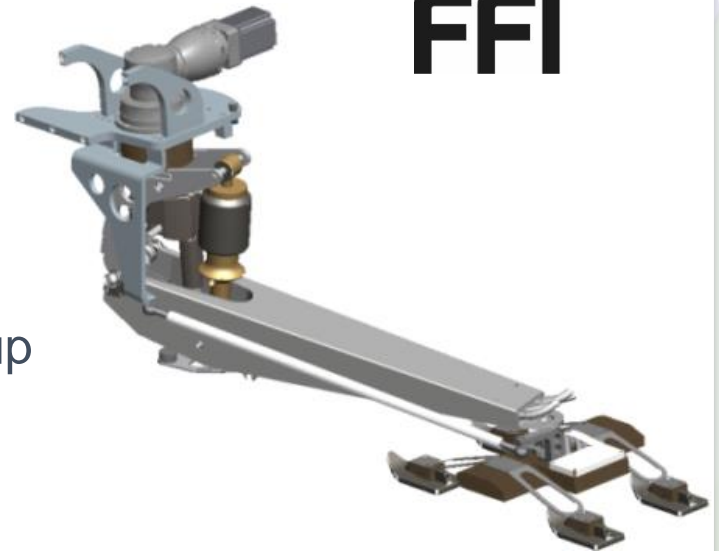


Slide-in, phase 2

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

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40kW DC/DC (double isolated)

Slide-in, phase 2

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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



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

Thank you!



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Extra Slide. Summary data for Slide-in

Parameter	Value
TRL Level	3-4
Costs	800000 €/km (single track), this does not include installation and commissioning costs.
Foreign object detection	No
Voltage	690V (limitation of the substation)
Current	180A
Power rating and Power Range	126kW
Power Factor	Not measured (expected to meet minimum grid requirements)
Quality Factor	N/A
Overall System Efficiency	97%
Note: Contact friction use case not included	
Operating Frequency	N/A
Effective misalignment tolerance (x,y,z)	0.5 metre
Communication protocol (IEC 61851)	Not yet approved
EMC, EMF	Expected to be within the limits of specified standards. There could possibly be a problem with arcs.
EM Exposure	expected to be within the limits of specified standards
Harmonics (THD % V & I)	Not measured (expected to meet IEC 61000-3-4
On-vehicle equipment Dimensions	0.5 x 1,5 x 0,5m
On-vehicle equipment weight	Estimated for first prototype: <ul style="list-style-type: none"> • Pickup (+80kg) • Power converter (+40kg)
Distance between feeder points	Grid connection every 968 m, Power boxes (switches) in manhole every 44 m