Goal

Develop and improve two different electric road systems for heavy-duty traffic on Swedish highways.
Project partners and roles

General items
Volvo/Scania – Project prerequisites
KTH - Business models investigation
LTH – ERS power load simulations
Vattenfall - Power load and grid infrastructure proposal for ERS (Helsingborg-Jönköping)
Trafikverket – Road and traffic, environmental information

Inductive road system, project A
Scania – Vehicle design
Bombardier – Inductive ERS design

Conductive road system, project B
Volvo – Vehicle design
Alstom – Conductive ERS design
Chalmers – Pick-up dynamical studies and simulations
Project prerequisites

Inductive vehicle test results
- Weight reduction
- Need of new components
- Vehicle packaging
- Static charging station for development
- Road segment development

Conductive vehicle test results
- Need of new components
- Vehicle packaging
- Improved pick-up design
- Road segment development

General result of phase 1
- High efficiency of dynamical charging for both systems
  - 90% for inductive and 97.3% for conductive
  - 1st defined, detailed cost estimate stated by both ERS suppliers
  - Energy cost estimates made by Vattenfall together with ERS suppliers

Request for:
- Cost estimate for route Helsingborg - Jönköping
- Simulations for segmented road structure
- Simulations for pick-up development
- Case study for power-stations, route Göteborg-Borås

Phase 2 - Content and plan

FFI – FORDONSSTRATEGISK FORSKNING OCH INNOVATION VINNOVA.SE/FFI
Ref. Volvo Scania
Power system estimations

Vattenfall participates with *ERS System Analyses and Cost Evaluations*.

- Vattenfall focus in Phase 2 on a proposed ERS electric supply system for the E4 route Helsingborg – Jönköping. *This work includes cooperation with EON Elnät regarding the regional network (up to 130 kV) analyses for parts of this route.*
- Vattenfall also participates in joint analyses regarding “partial ERS solutions” (on RV40) within this project.
Traffic data available, more detailed data can be delivered.

For more reliable cost estimation; needs deeper analyze, in cooperation with e.g. Vattenfall and other partners.

Accessibility for maintenance work and repairs etc.
Project power simulations

Phase 1 - Done
- Dynamic simulation of traffic flow
- Simulation of currents, voltages and component temperatures in the power system along the ERS
- Uses a 20 km idealized fictive road as an example

Phase 2
- Use RV 40 Göteborg – Borås as a real world example of e.g. traffic patterns and slopes
- Suggested placement of transformer stations along the road based on satellite photos - Done
- Improved modeling of vehicles - planned
- System optimization, battery size vs amount of ERS installed - Planned

Ref. LTH, Lars Lindgren
Slide-in results

- Improved efficiency measurement during dynamic behavior
- Validation of shielding concept
- Improved segment switching control
Inductive project, test track and static installation

Static installation
- Delayed due to purchasing process and clarification of conformation of Swedish regulations
- Ready for testing in November

Dynamic installation
- 75% ready
- Ready for testing in November

Electrical drawing
Civil drawing (sketch)
Status in May
Inductive project, vehicle 2

Slide-in results
- Test and define control interfaces
- Packaging study of a real BEV installation
  - Battery and DCDC installation
Inductive project, vehicle 3
(Synergies from inductive static charging project)

Slide-in results
- Packaging study on a real bus PHEV installation
- Comparable to dynamic installation
Conductive project pick-up simulations

Actuator forces

SimMechanics Model

Actuator positions & velocities

Pick-up prototype

Prototype Modelled

Actuator forces & velocities

SimMechanics Model

Prototype

Pick-up prototype

Conductive project pick-up simulations

Actuator forces

SimMechanics Model

Actuator positions & velocities

Pick-up prototype

Prototype Modelled

Actuator forces & velocities

SimMechanics Model

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SimMechanics Model

Prototype

Pick-up prototype

Prototype Modelled
Conductive project vehicle

- Alstom APS-ERS conductive system to be tested on Volvo hybrid vehicle
- Slide-in new charging components, installed on Volvo hybrid
- 80kW (DCDC) charging HW capability
Conductive project vehicle

- Pick-up installed under vehicle
- New Volvo pick-up prototype
- New Volvo control system
Conductive test track

Adaptation of APS to ERS

New third rail beam adapted for road

Static switches Power box

Adherence improvement

Engraved conductive bars

<table>
<thead>
<tr>
<th></th>
<th>Tramway</th>
<th>ERS</th>
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</thead>
<tbody>
<tr>
<td>Nb vehicles per day</td>
<td>200</td>
<td>20 000</td>
</tr>
<tr>
<td>Nb switchings per 5 years</td>
<td>365 000</td>
<td>36 500 000</td>
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Ref. Alstom, Jean-Luc Hourtane
Conductive test track result

- Measured road/rail friction by SAAB friction meter

General rules to apply to:

- Friction number > 0.5 in average
- Friction number > 0.4 in certain rare areas/zones
- Friction number difference between 2 wheels, in a pair, not to exceed 0.2

Test result, friction surface

- Road friction with new beam has been measured by VTI, with an average of 0.66 (friction coefficient)
- New beam is above limits for road surface approval

Test result, power transfer

- No interruptions, in connection
- Noise is in reality (source) power station

Ref. VTI (Anna Arvidsson, Carl Södergren)
Slide-in, Fas 2

Richard Sebestyen
Volvo Group Trucks Technology

Questions ?