eHighway
Electrified heavy duty road transport, Patrik Akerman
Road freight emissions trends make it clear: Solutions for decarbonization are needed.

Transport will increasingly be the biggest challenge for decarbonization in **Europe**.

If current trends continue, surface freight will become the largest source of **global** transport emissions by 2030.
Measures to reduce road freight CO$_2$ emissions

- **Without action**: 99 Mio. t
- **With rail expansion**: 87 Mio. t
- **With biodiesel-blending**: 73 Mio. t
- **With logistic optimization**: 65 Mio. t
- **With improved efficiency**: 61 Mio. t
- **Target level -80% of 2005**: 8 Mio. t

Source: German Ministry of Environment (BMU), March 2013
Alternative concepts

Investigated concepts comprise external power supply and on-board storage systems.

**On-board storage**

- Alternative fuel
- Electricity
  - Battery
  - Capacitors
  - Fuel cell

**External power supply**

- Contactless
  - Inductive power supply
  - Linear s. motor concepts
- Conductive
  - Ground-based contact line
  - Overhead contact line
Zero emission trucks are possible with renewable energy, but efficiency varies greatly.

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Range</th>
<th>Efficiency</th>
<th>Example vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Road Systems</td>
<td>60 km 19 ct/km</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>Battery</td>
<td>48 km 20 ct/km</td>
<td>62%</td>
<td></td>
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<tr>
<td>Hydrogen</td>
<td>24 km 55 ct/km</td>
<td>29%</td>
<td></td>
</tr>
<tr>
<td>Power-to-Gas</td>
<td>17 km 70 ct/km</td>
<td>20%</td>
<td></td>
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1) Including storage
Source: German Ministry of Environment
Infrastructure built on the heavily trafficked roads can address significant part of heavy duty emissions

60% of the HDV emissions occur on 2% of the road network (BAB = 12,394 km)

The most intensely used 3,966 km handle 60% of all ton-km on the BAB

Image: HDV density on BAB-network ; Source: Verkehr in Zahlen 2012; TREMOD 2012

IO = Urban roads
AO = Non-urban roads
BAB = Federal freeways

BAB = Federal freeways (12,594 km)
BS = Federal roads (40,400 km)
LS = State roads (86,600 km)
KS = District roads (91,600 km)
GS = Municipal roads (>420,000 km)
Alternative concepts

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What an Electric Road System could look like
Siemens’ Electric Road System: eHighway

Electrification of hybrid trucks via an overhead catenary system

Advantages

- High energy efficiency
- Reduced operating costs
- Swift integration into existing infrastructure
- Safe, reliable and open technology
How it could work

Film

https://www.youtube.com/watch?v=Z8l9ieolazc
Electric Road Systems are able to integrate a wide range of technologies without operational limitations.

**Hybrid concepts**
- Parallel hybrid
- Serial hybrid
- Diesel or gas combustion engines

**Full electric concepts**
- On-board energy storage by batteries or capacitors
- Recharging schemes
- Fuel cell technology

**No concessions on truck availability and performance**
- Full electric operation up to 90 km/h

**Operability in all situations**
- Passing
- Cutting in / out of lanes
- Full electric idling

**Compatible with and complementary to alternative fuel technologies**

Technological alternatives of Electric Road Systems: Overhead or ground-based transmission technologies (Wiberg and Rådahl, 2012).
But is it realistic?

Videos from demonstration project on Swedish highway near Gävle

https://www.youtube.com/watch?v=s2Q2Tk2lL0o&list=PLPlRtfVZufNyU5npEu-dEPPbW9
https://www.youtube.com/watch?v=fmcMmYdF6iA&list=PLPlRtfVZufNyU5npEu-dEPPbW9
https://www.youtube.com/watch?v=VGe2u8PQ-10&list=PLPlRtfVZufNyU5npEu-dEPPbW9
eHighway is developing quickly and is ready for commercial use in near future

**Development project**

- Test track of 2.1 km with realistic highway conditions outside of Berlin
- Cooperation with e.g. Scania and Volvo
- Technical assessment of complete system by TU Dresden & BASf (the German Federal Highway Research Institute)
- Analysis of the economic and ecological impacts by German federal ministries lead to approval of field trial plan by 2017
- Public reports found positive results for applications considered with German transport volumes and energy costs (SRU, UBA (Sept 2015) and Öko-Institute (forth-coming in 2016))
- Studies from outside of Germany (e.g. Sweden and California) confirm potential economic benefits
The German Federal Environment Agency (UBA) commissioned the independent German Öko-Institute to make a comprehensive strategy for traffic energy supply until 2050:

- final version to be published in 2016
- covers all modes of transport
- refers to following options for long haul road freight transport
  - Carbon neutral fuels (sustainable biofuels, synthetic fuels from renewables)
  - Fuel cell electric vehicle (hydrogen from renewables)
  - Direct use of electricity (electric road systems)

Example: costs of carbon neutral long haul road freight transport (see next slide)
External assessment ... ecologically and economically beneficial

 Accumulated costs (2020 – 2050) in billion € (compared to fossil fuels)

Key assumptions:
- Length of electric network: 4,000 km; Infrastructure costs: 2.2 million €/km; Maintenance 2.5% of investment per year
- Additional vehicle costs: per today 50,000 € / truck; per 2050 19,000 € per truck; share of direct electric traction: 60% in 2050

Öko-Institut e. V.: Decarbonisation of road transport; Comparison of technical options including electric road systems. Webinar, June 08, 2016.

study to be published
Where are we now?

**Sweden – Operation started**
- Innovation Procurement Process for demo projects by Trafikverket
- Field trial (2 years) started **June 22**
- **Overall aim:** evaluate ERS-options prior to introduction on road network
- **Scania as truck OEM**, second truck will join operation next year

**USA – trucks ready**
- **eHighway** to reduce emissions of port links on 1-mile infrastructure near ports in L.A. and Long Beach
- **Cooperation with Volvo Trucks** and local truck converters
- **Contract with South Coast Air Quality Management District** testing throughout 2017.

**Germany – field trial planned**
- **R&D Projects** (ENUBA) incl. test track
- **Federal Ministries for Economy (BMWi) and Environment (BMUB)** – decided on field trial of eHighway ERS in call 10/2015
- Presently project ideas are being evaluated and will be decided on soon
- **Construction** approx. 2017 // **field project** approx. 2017-2019
The path forward focuses on the electrification of highly frequented routes.

**eHighway application fields**

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<th>Near term</th>
<th>Long term</th>
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<tr>
<td>Shuttle transport</td>
<td>Long haul traffic</td>
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<tr>
<td>Mine transport</td>
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The development path of road electrification can echo that of rail electrification a century ago.
Thank you for your attention

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