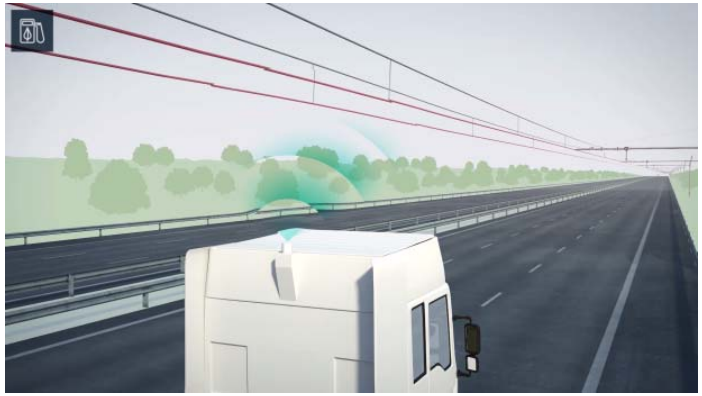
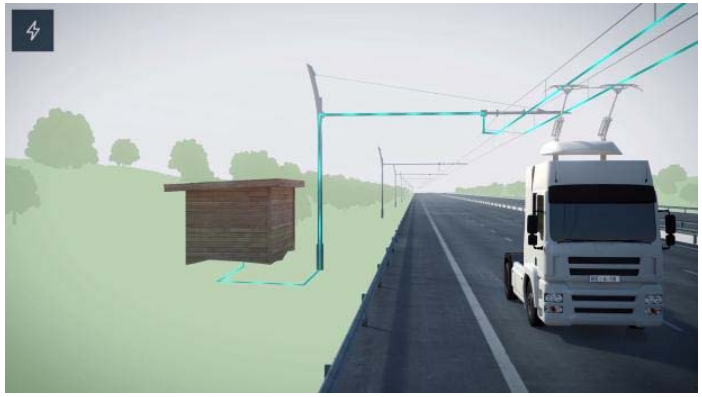
eHighway

Designing and demonstrating an electric road system for efficient and sustainable road freightransport

siemens.tld/keyword

How the eHighway system works





https://www.youtube.com/watch?v=zV2yZkRFBK0

Funded research projects supplement the currently executed projects on public roads in Los Angeles and Sweden

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Research Projects

- **ENUBA (Germany)**
  - First research project with BMUB
  - Duration: 05/2010 – 09/2011
- **ENUBA 2 (Germany)**
  - Second research project with BMUB
  - Duration: 05/2012 – 12/2015
- **ELANO (Germany)**
  - Third research project with BMUB
  - Duration: 01/2016 – 09/2019

Projects on Public Roads

Los Angeles – Port Application

- One mile demonstration as connection to near-dock rail terminals for cargo vehicles for 6 months
- Primary goal is to promote the implementation of zero emission goods movement technologies
- Cooperation with Volvo trucks and local truck converter

Sweden – Highway Application

- Two kilometer demonstration on a public road between industrial area and port for 2,5 years
- Overall aim is to evaluate Electric Road System options prior to introduction on road network
- Cooperation with Scania trucks

How it works in Reality

https://www.youtube.com/watch?v=wuMVHA27QZw

ICCT* sees electrification with contact lines as crucial for reaching deep decarbonization of HDVs

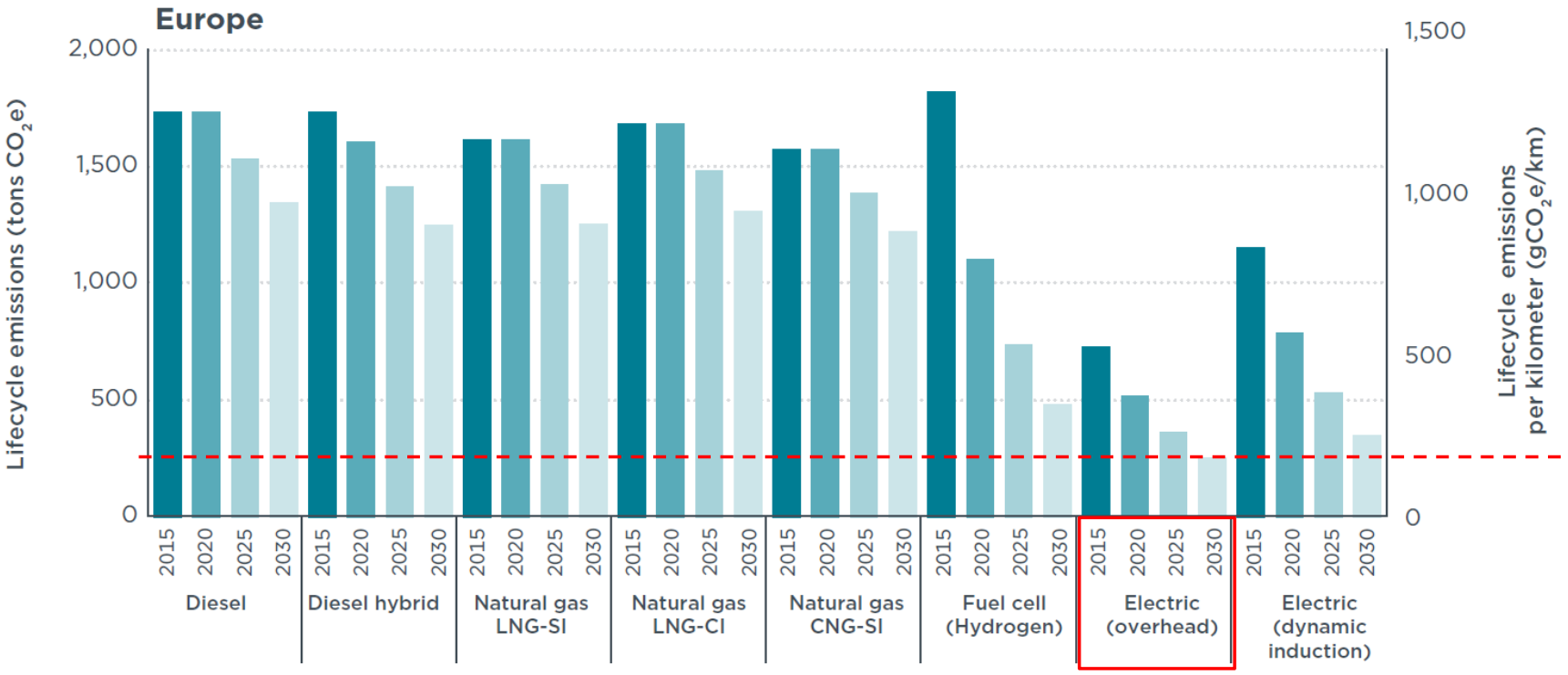

Figure 6. China, Europe, and U.S. lifecycle CO_2 emissions over vehicle lifetime (left axis) and per kilometer (right axis) by vehicle technology type.

- Greatest reductions in GHG emissions in all time periods

Source: ICCT - Transitioning to zero-emission heavy-duty freight vehicles (2017) page 26

* ICCT = International Council of Clean Transportation

German industry association (BDI) recommends 4.000 to 8.000 km of overhead catenary lines as a cost-effective climate action for HDVs

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Background

- BDI commissioned an independent BCG and Prognos report looking at **all sectors of the economy**
- Investigated the most **cost effective ways** to reach German climate goals: **-80% and -95% GHG**
- Involved 68 BDI-member associations and companies, 200 industry experts and 40 workshops

Major findings

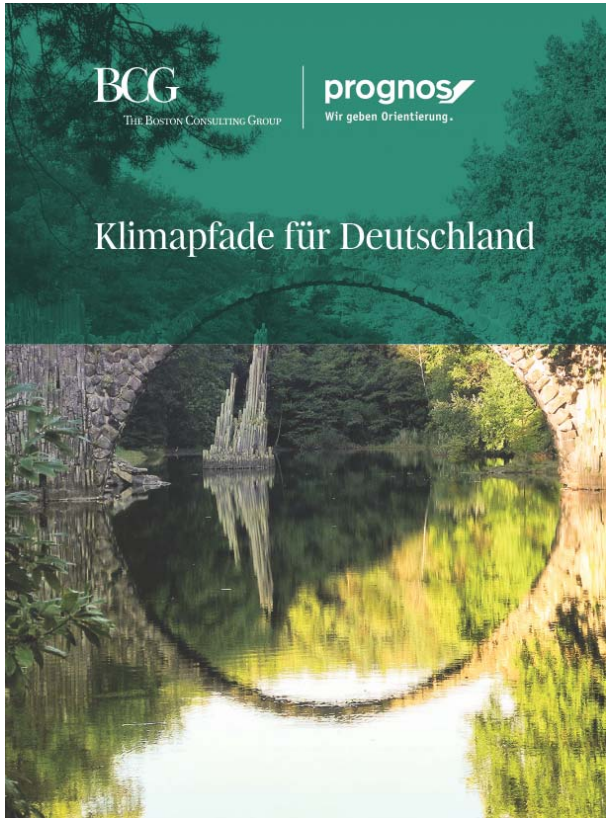
- Reaching **the 80% reduction is possible** by pushing existing technologies to the max. Has economically **positive effects, even if Germany acts alone**.
- Reaching the **95% reduction goal** touches the limit of what can be expected from technology and citizens. **Only in joint action with G20 economies** would this be economically manageable

Transport highlights

- Shift to rail leads to an i**ncrease by 88% of ton-km of freight activity** on rail by 2050
- **No additional biofuels for transport** (other sectors will need biomass more and out-bid transport)
- **PtX only in 95% scenario** (due to high expected costs of fuel)

eHighway

- Building **overhead catenary is the cheapest solution** for HDVs, despite high infrastructure costs.
- Recommends building **4.000 km** overhead contact line in the 80% scenario and **8.000 km** in 95%
- Based on DE perspective. **EU solution** brings **large synergies** and is even more cost-effective
- Investment decision needs to be made by 2025, leading to first 400 km in operation by 2028.



Source: https://bdi.eu/publikation/news/klimapfade-fuer-deutschland/

Zero emission trucks are possible with renewable energy, but efficiency varies greatly

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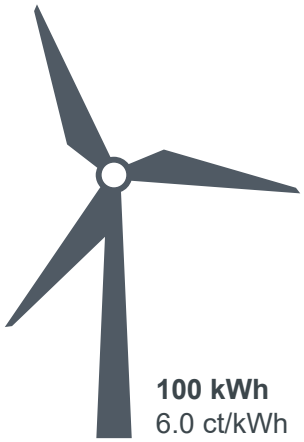

Pathway	Range Cost per km	Efficiency WTW	Example vehicle
Electric Road Systems e⁻ → Grid (incl. catenary) → e⁻ → eTruck (Catenary-Hybrid) 96 kWh, 12 ct/kWh; 1,6 kWh/km	**60 km** 19 ct/km	77%	
Battery e⁻ → Grid → e⁻ → eTruck (Battery) 96 kWh, 10 ct/kWh; 2 kWh/km	**48 km** 20 ct/km	62%	
Hydrogen e⁻ → Electrolysis η = 70% → H_2 → H_2-network[1)] → H_2 → CH_2- fuel station → CH_2 → Fuel cell truck 2 kWh, 5 kWh 93 kWh; 65 kWh, 15 ct/kWh; 65 kWh, 18 ct/kWh; 65 kWh, 20 ct/kWh; 2.7 kWh/km	**24 km** 55 ct/km	29%	
Power-to-Gas e⁻ → Electrolysis η = 70% → H_2 → Methanation η = 80% → CH_4 → NG-network[1)] → NG → CNG-fuel station → CNG → Gas-truck 2 kWh 98 kWh; 69 kWh, 15 ct/kWh; 55 kWh, 19 ct/kWh; 55 kWh, 20 ct/kWh; 55 kWh, 22 ct/kWh; 3.2 kWh/km	**17 km** 70 ct/km	20%	

1) Including storage
Source: German Ministry of Environment

Pilot projects proving that zero-emission heavy road freight is both economical and practical is the next step

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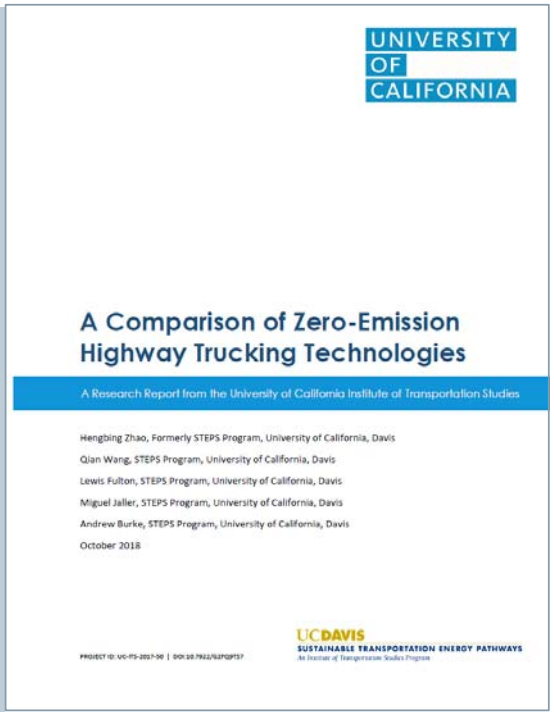
CEO of Scania, CTO Volvo Group & Johan Rockström

Argued in an Op-Ed in Sweden's main business daily that **Sweden should conduct pilot projects where whole fleets of trucks can show how the transition to sustainable road transport can happen**. They also gave five examples of possible projects, with the **first one on the list being a scaling up of the existing eHighway demonstration** project in Gävle.

Source: https://www.di.se/debatt/volvo-scania-mfl-sverige-ska-bli-en-fossilfri-varldsutstallning/ (April 2018)

UC Davis

„Considering technology readiness, energy efficiency, and capital cost, the most feasible approach for the zero-emission technologies for long-haul trucks may be to deploy local or regional catenary systems. "
- Executive Summary


UNIVERSITY OF CALIFORNIA

A Comparison of Zero-Emission Highway Trucking Technologies

A Research Report from the University of California Institute of Transportation Studies

Hengbing Zhao, Formerly STEPS Program, University of California, Davis
Qian Wang, STEPS Program, University of California, Davis
Lewis Fulton, STEPS Program, University of California, Davis
Miguel Jaller, STEPS Program, University of California, Davis
Andrew Burke, STEPS Program, University of California, Davis
October 2018

UCDAVIS
SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS

Source: A Comparison of Zero-Emission Highway Trucking Technologies (Oct 2018)

Hybrids make fast and broad infrastructure roll out possible, which in turn accelerates the uptake of zero-emission vehicles

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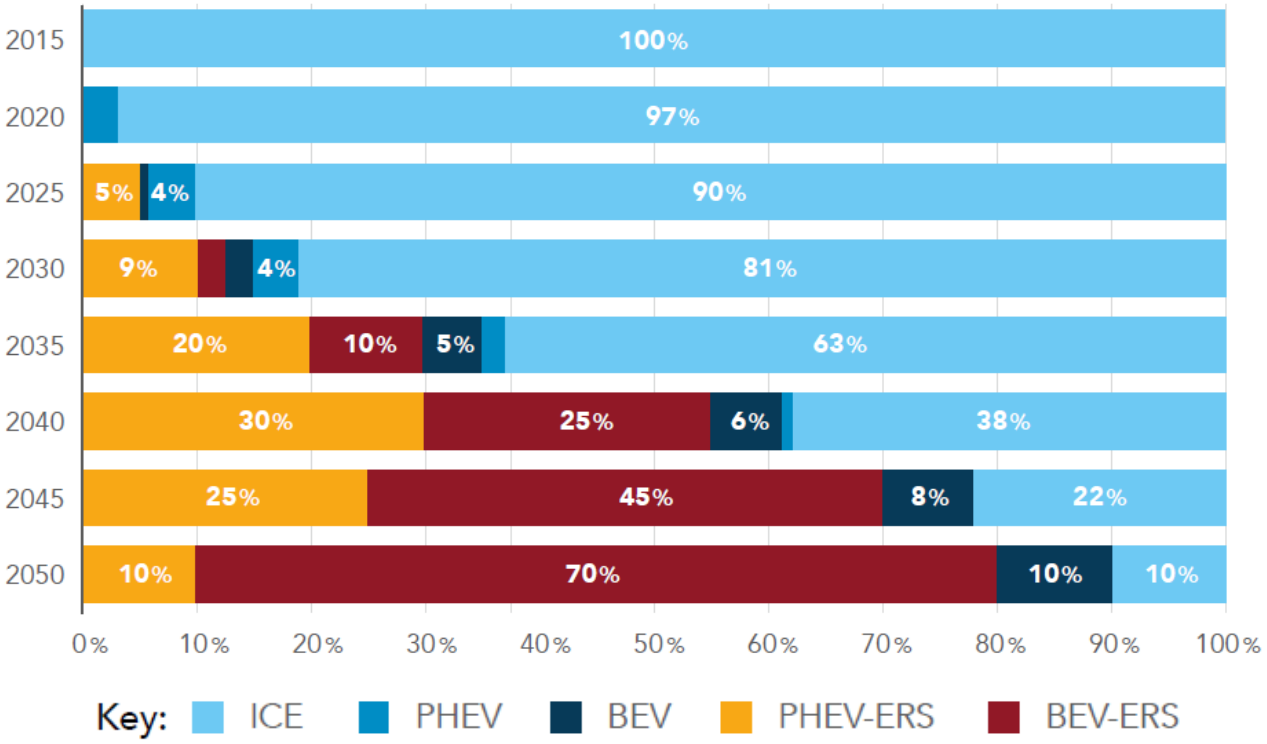
New vehicles sales by technology type in an Electric Road Systems scenario



ERS is a back-bone that enables economical emission reductions with known technology

ERS can accelerate the uptake of zero-emission solutions (e.g. would enable full-electric trucks with much less batteries, proven charging concept and no time-cost)

Source: European Climate Foundation – Trucking into a Greener Future (2018) page 9

Infrastructure on heavily use roads addresses significant part of heavy duty vehicle (HDV) emissions

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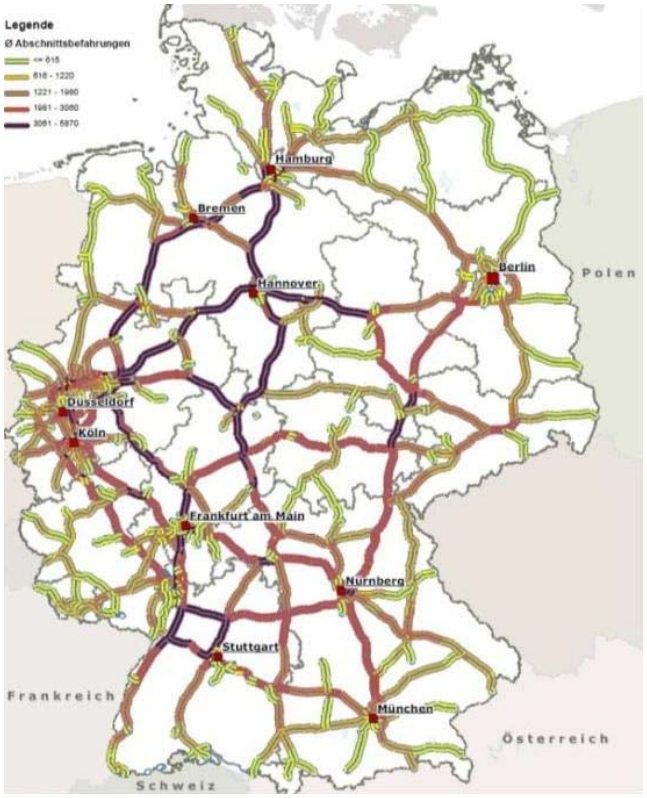
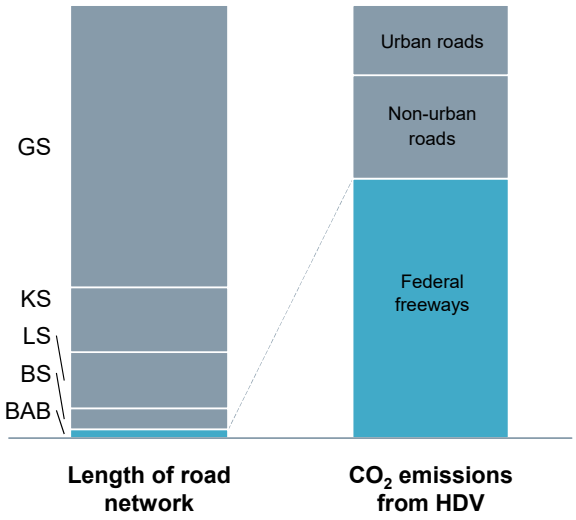




BAB = Federal freeways (12,394 km)
BS = Federal roads (40,400 km)
LS = State roads (86,600 km)
KS = District roads (91,600 km)
GS = Municipal roads (>420,000 km)

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

The analysis of the German road network leads to the following key messages:

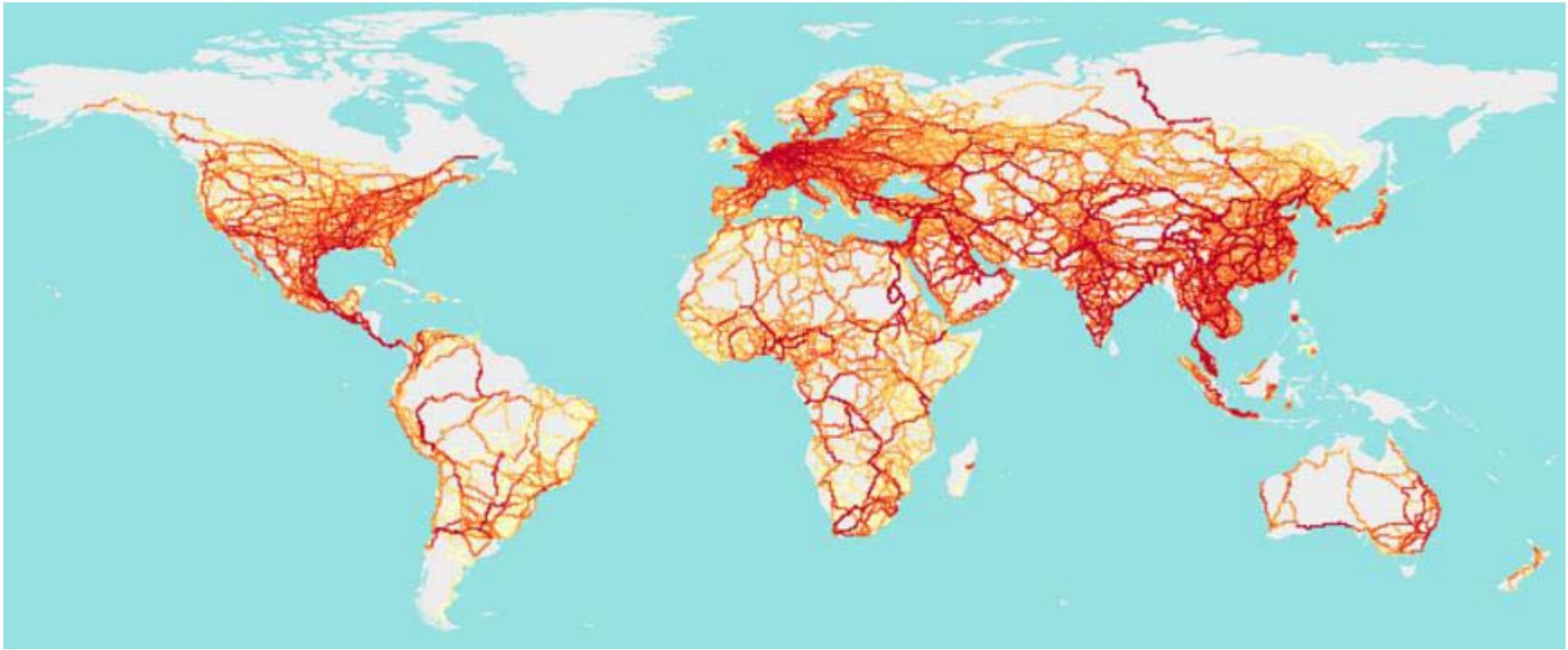
1. **60%** of the HDV emissions occur on 2% of the road network (BAB = 12,394 km)

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

Focusing first on the main freight transport routes, a significant decarbonization step can be achieved.

This approach can be applied all over the world.

Surface freight density: 2010, 2030 and 2050



Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016)

The potential of the eHighway technology ranges from closed shuttle applications to open highways solutions

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eHighway application cases

Shuttle transport

- Solution for high frequency shuttle transport over short and medium distances (<50km), i.e. in ports or industrial areas
- Lower fuel consumption and longer lifetime
- Reduction of air and noise pollution

Electrified mine transport

- Connection of pits and mines to storage or transit locations
- Minimization of harmful emissions
- Sustainable, clean and economical mine operation

Electrified long-haul traffic

- Economical and sustainable alternative for road freight transport
- Significant reduction of CO_2 emissions
- Substantial cost savings for freight carriers

The development path of road electrification can echo that of rail electrification a century ago

Field Trials in Germany are a necessary next step for the development of the system

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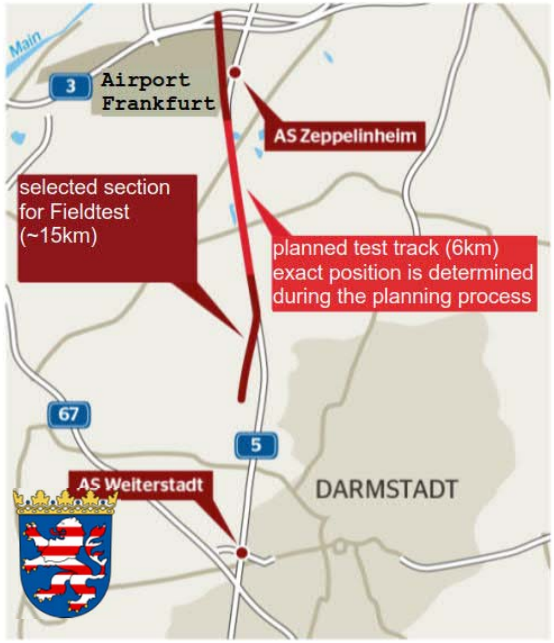
Information and routing

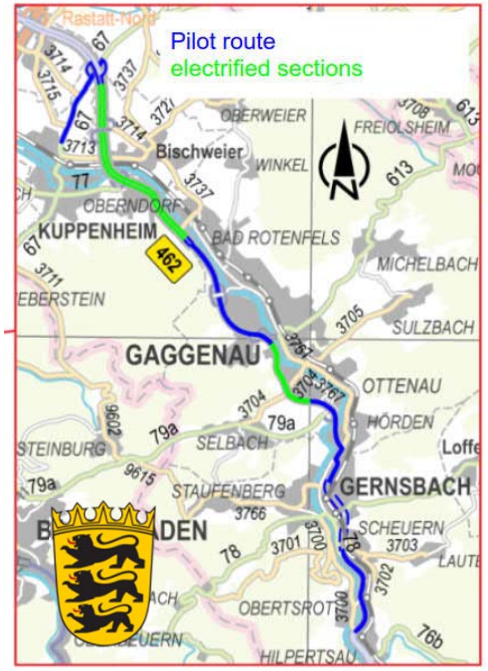
Federal State of Schleswig Holstein
Project awarded to Siemens and SPL Powerlines
Track length / Amount of trucks: 5-6km / 5
Start of Construction 10.2018
Opening: 05.2019

Quelle: Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit / Grafik: DVZ

Federal State of Hessen
Project awarded to Siemens
Track length / Amount of trucks: 5km / 5
Start of Construction: 03.2018
Opening: 12/2018



Federal State of Baden-Wuerttemberg
Tender: 11/2018
Track length / Amount of trucks: 5-6km / 5
Start of Construction: 2019



Copyright: Straßenbauverwaltung Baden-Württemberg, 2017

First German eHighway Field Trial takes shape – Motorway A5 near Frankfurt Airport

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Thank you for your attention

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Gerrit Stumpe
Business Developer eHighway
Siemens Mobility GmbH
Mobility
Technology & Innovation
eHighway
Erlangen, Germany
Mobile: +49 (173) 702 7740
E-mail: gerrit.stumpe@siemens.com

www.siemens.com/ehighway
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