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Electric Roads for HDVs

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A European perspective on Barriers & Solutions for future market successes

December 3rd 2015

CEC & UC Davis Workshop

siemens.com/answers

Outline

Agenda

What problem are we solving?

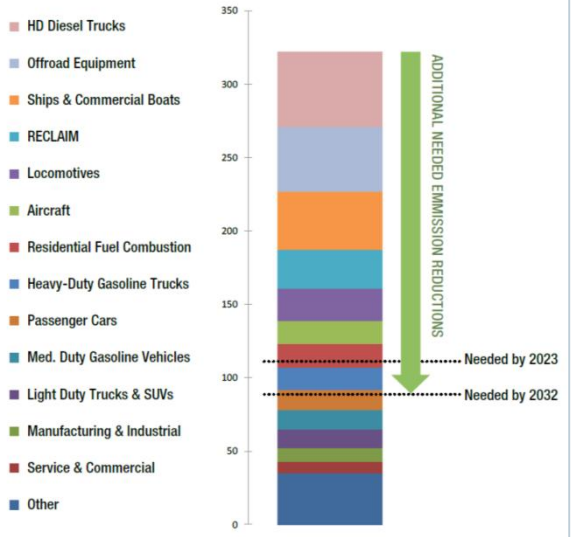
What are Electric Road Systems?

Critical barriers and Opportunities

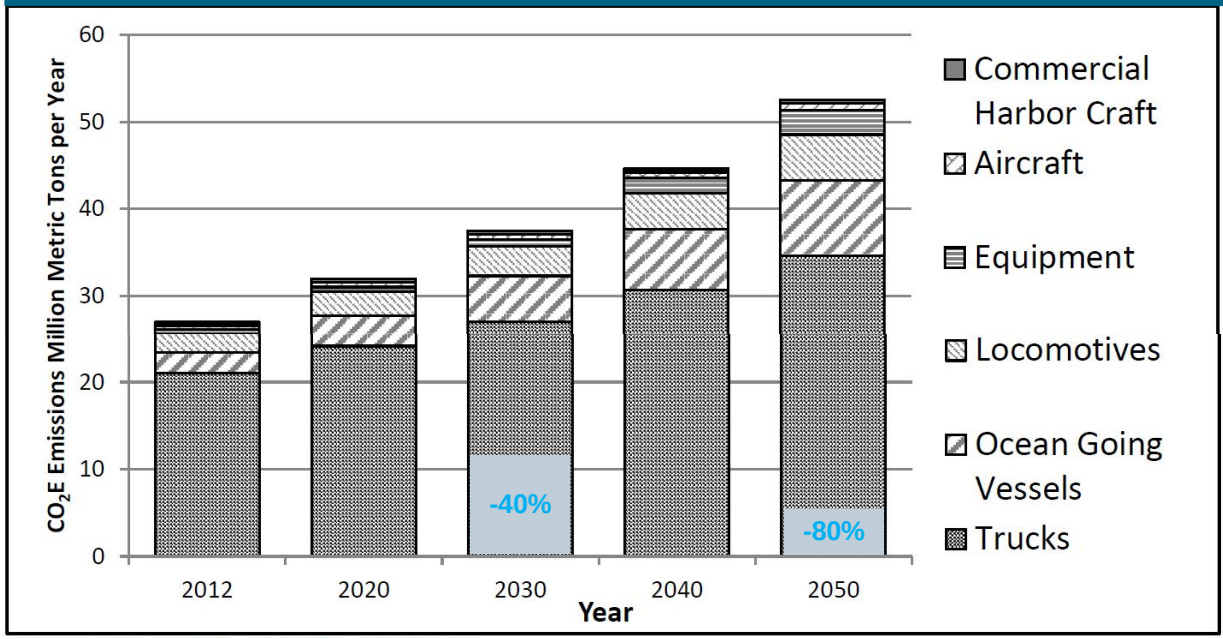
Focus on zero-emission trucks is necessary

Air Quality

Figure 2: Nitrogen Oxides Emissions in 2023 With Adopted Standards in the South Coast Air Quality Management District



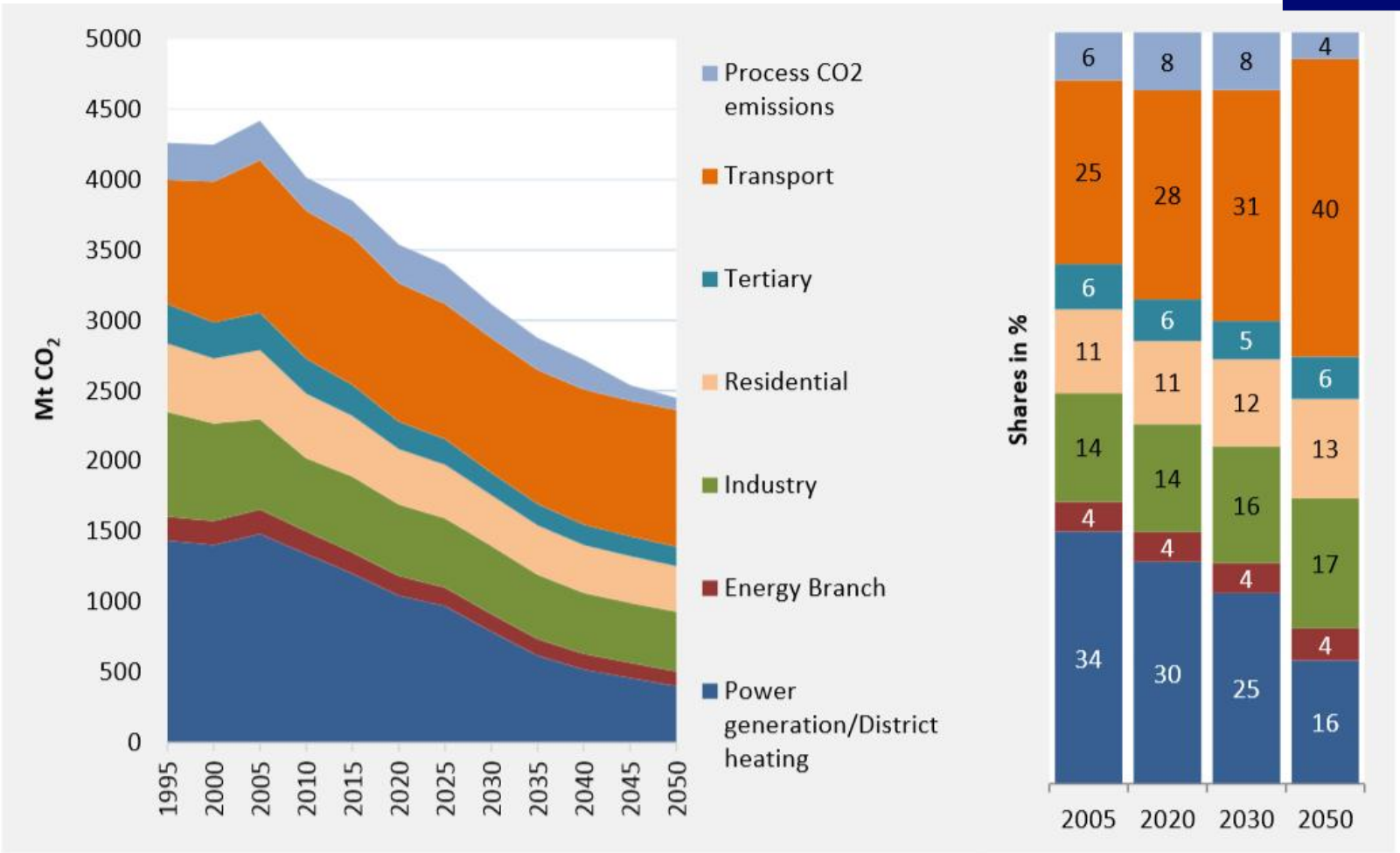
California GHG emissions and targets



*Ocean-going vessels out to 24 nautical miles.

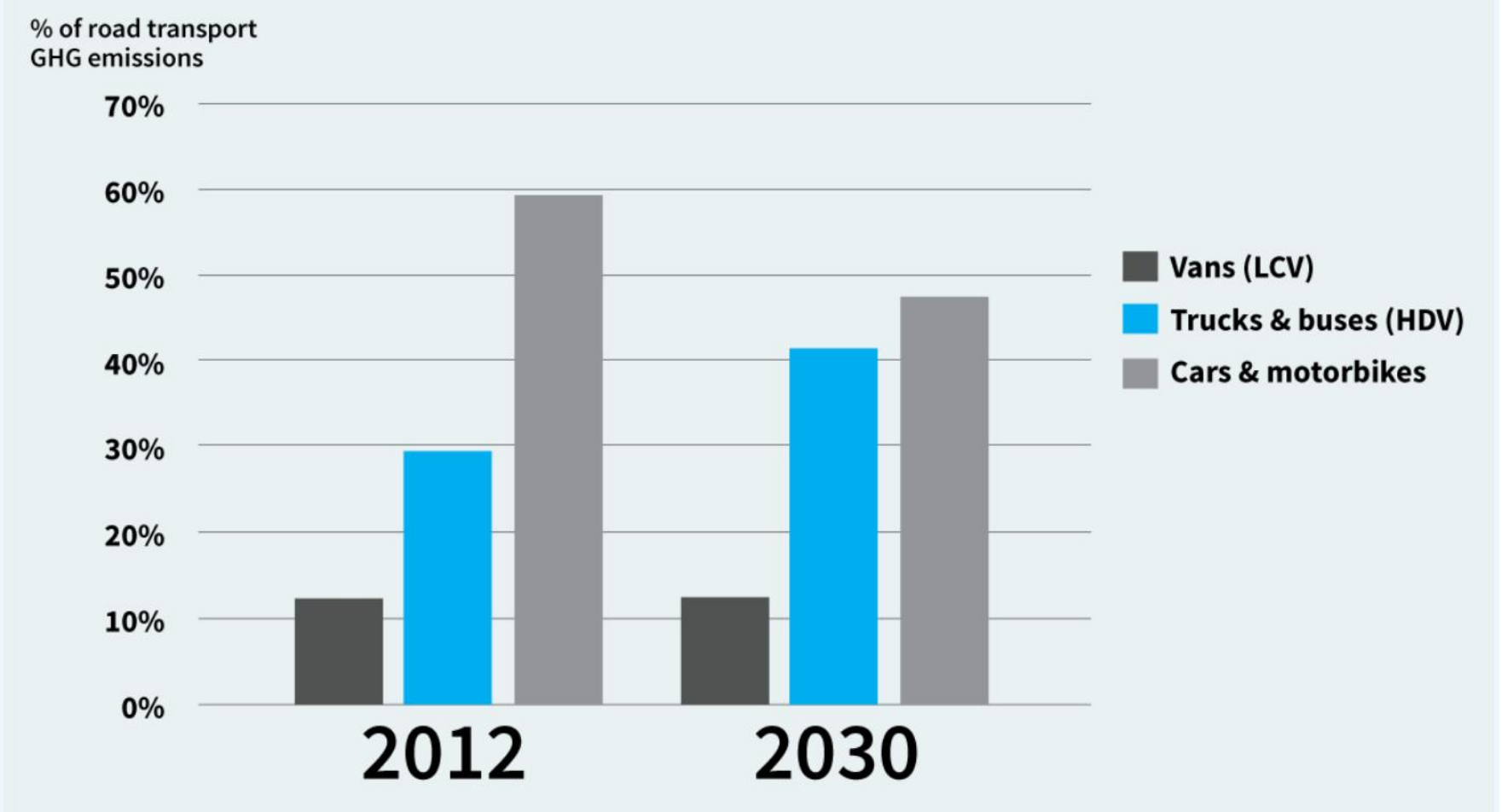
"By focusing on the ultimate technology endpoint (zero emissions) that satisfies all of our air quality goals and supporting needed engineering advances, we can provide the certainty businesses need for long-term planning" – CARB

Transport will increasingly be the biggest challenge for decarbonization



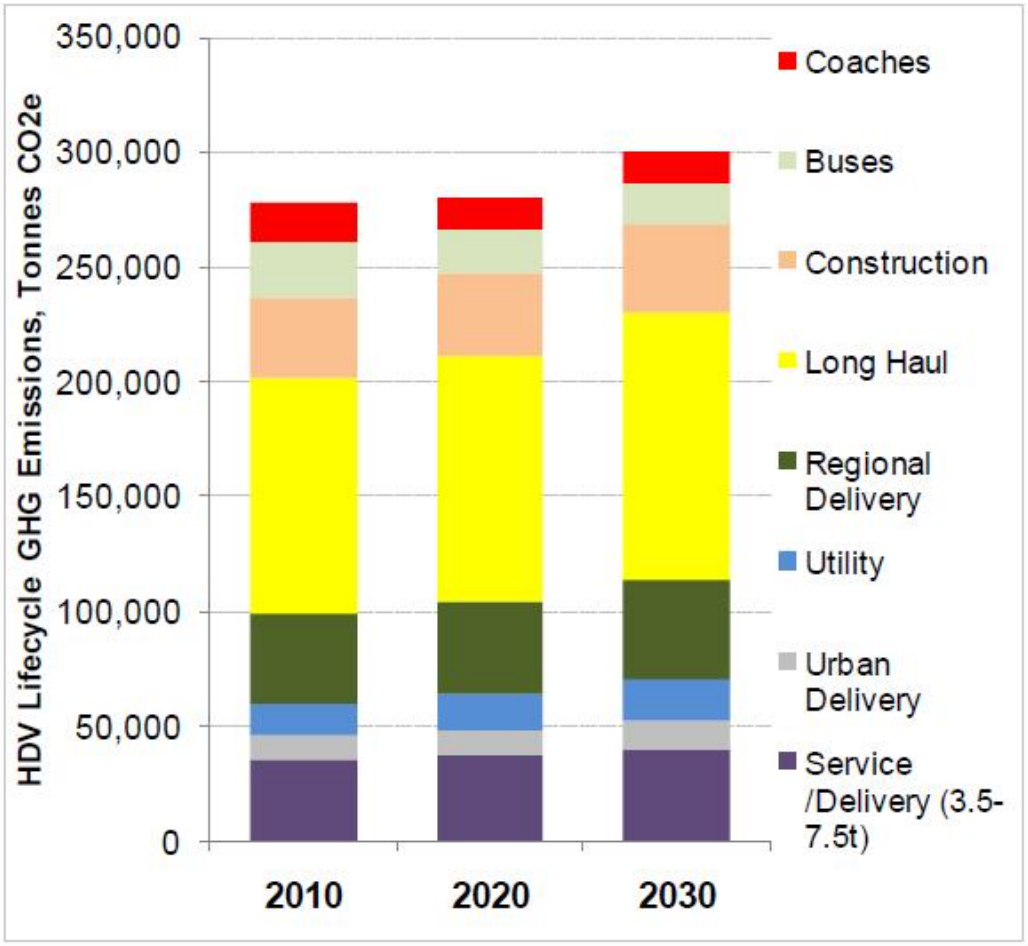
Source: European Commission reference scenario for 2050 (2013)

Freight emissions will replace passenger traffic as main source of CO_2 already by 2030



Source: Transport & Environment – Briefing: Too big to ignore – truck CO2 emissions in 2030 (2015)

Long haul is by far the biggest segment of HDV in terms of fuel consumption and GHG-emissions



Lifecycle GHG Emissions

Infrastructure built on the heavily trafficked roads can address significant part of heavy duty emissions

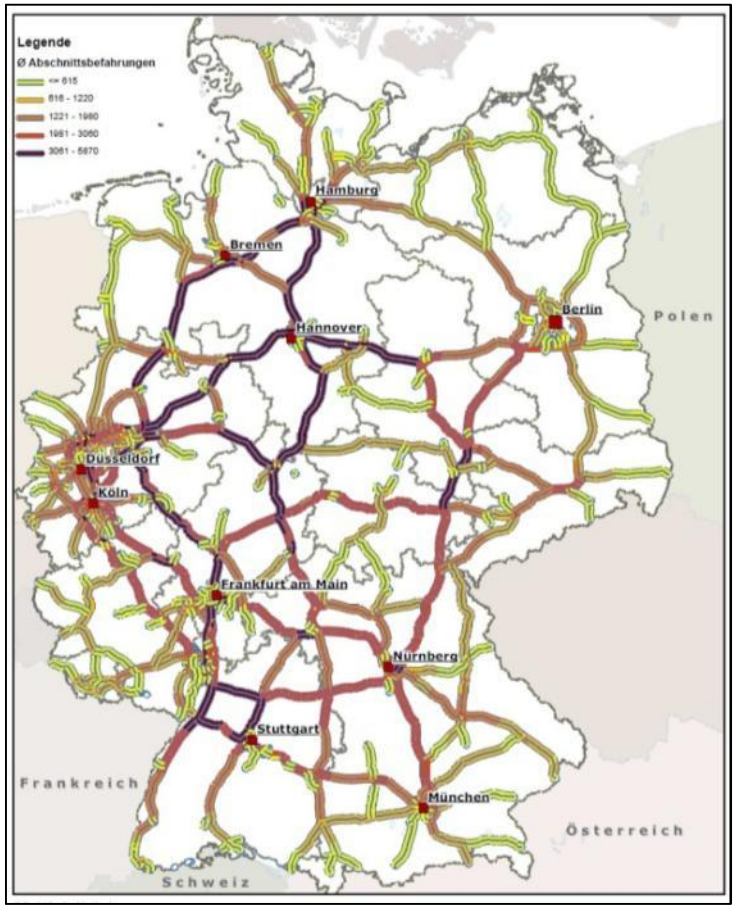
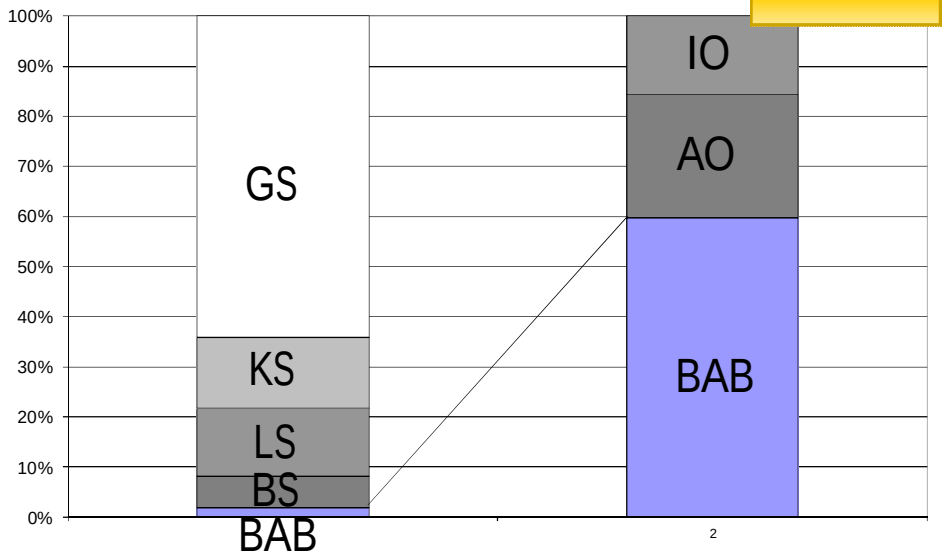


Image: HDV density on BAB-Network

BAB = Bundesautobahnen (12.594 km)
BS = Bundesstraßen (40.400 km)
LS = Landesstraßen (86.600 km)
KS = Kreisstraßen (91.600 km)
GS = Gemeindestraßen (>420.000 km)

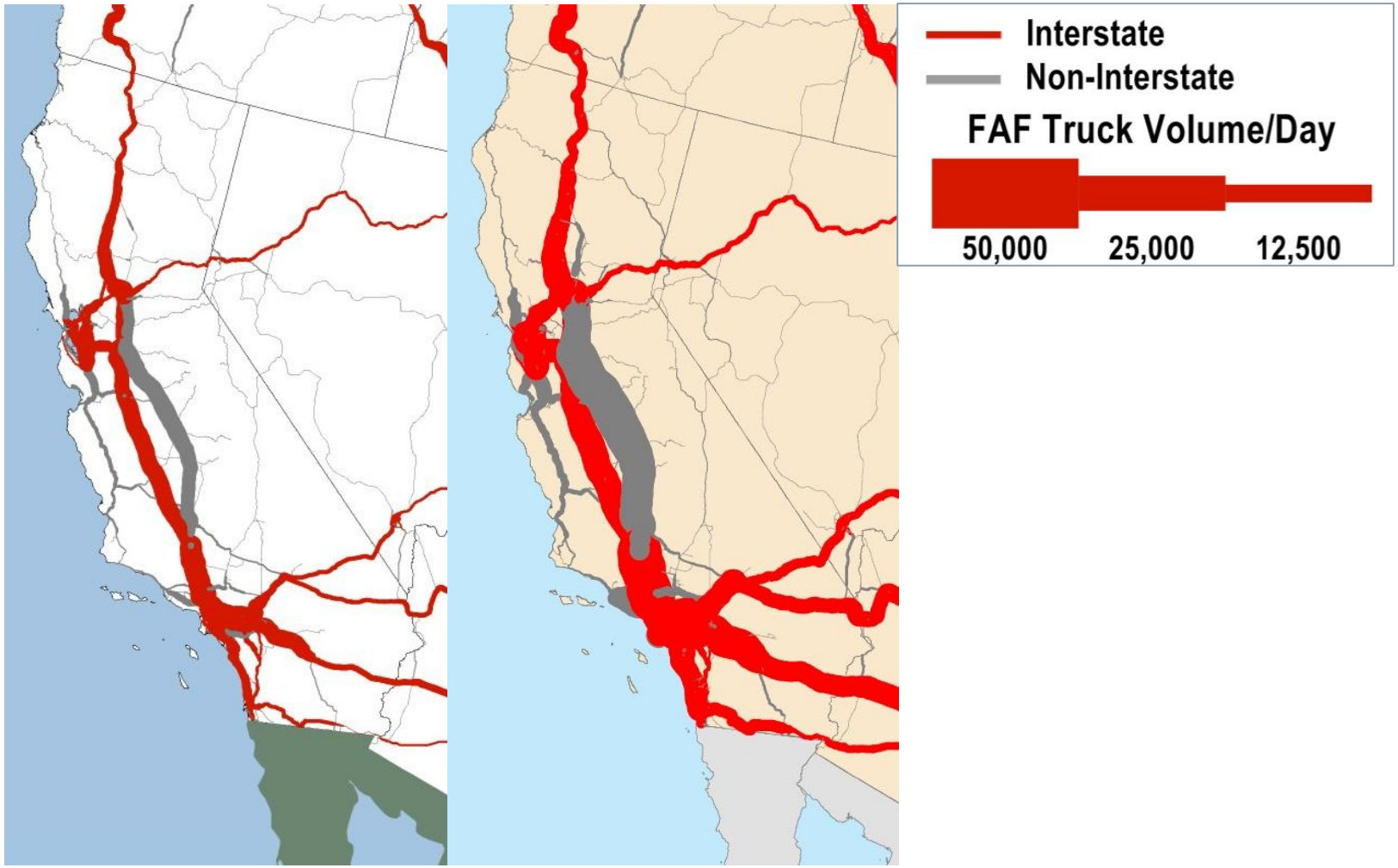
Source: Verkehr in Zahlen 2012



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

California's need for solutions to address long distance road freight will only grow from 2007 to 2040



Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, *Freight Analysis Framework*

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Critical barriers and Opportunities

Electric Road Systems are gaining attention and different technology options are being explored

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ERS definition: *Electric road systems (ERS) can be described as electrified roads that support continuous or dynamic power transfer to vehicles from the roads on which they are driving* – Tongur & Engwall (2014)

Examples of ERS investigations and development

Road authorities and research agencies

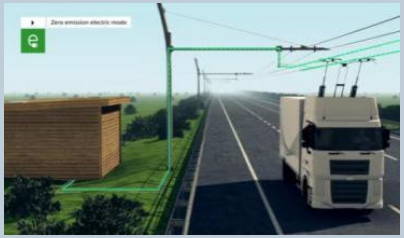
- Swedish Transport Administration pre-commercial procurement
- Highways England & TRL conducting off-road trials
- EU-funded FABRIC program for feasibility analysis and development
- KAIST developed solution and started pilots, e.g. on city bus route
- Utah State University test facility for Electric Vehicle and Roadway

Corporate sector

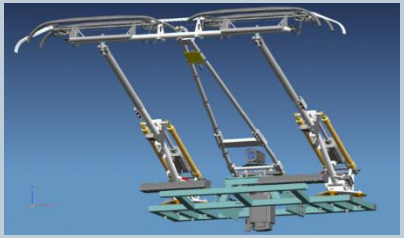
- Bombardier Primove: Inductive ground-based solution
- Alstom APS: Conductive ground-based solution
- Elways: Conductive ground-based solution
- Qualcomm Halo: Inductive ground-based solution
- OLEV Tech: Shaped Magnetic Fields in Resonance, ground-based solution

Siemens ERS solution: eHighway

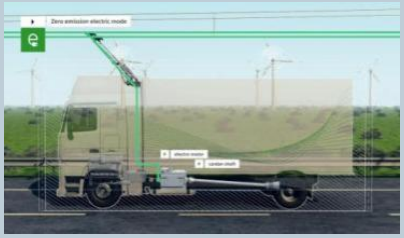
Electrification infrastructure



Active current collector



Hybrid-electric drive train



Advantages

- High **energy efficiency**
- **Reduced** operating **costs**
- **Swift integration** into existing infrastructure
- **Safe, reliable & open** technology

Electrification of hybrid trucks via an overhead catenary system

eHighway built up and in operation

See: http://www.mobility.siemens.com/mobility/global/en/interurban-mobility/road-solutions/electric-powered-hgv-traffic-eHighway/electric-mobility-in-commercial-vehicles/Pages/electric-mobility-in-commercial-vehicles.aspx

eHighway is developing quickly and is ready for commercial use in near future

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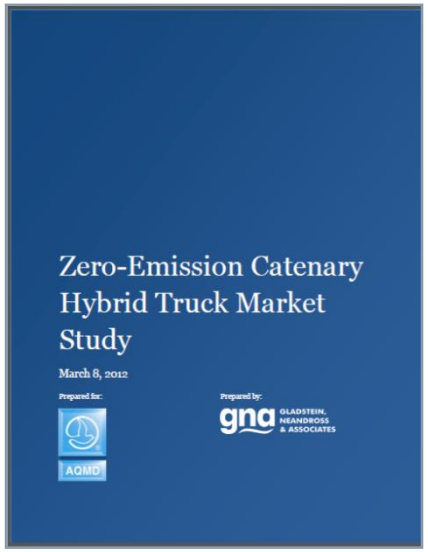
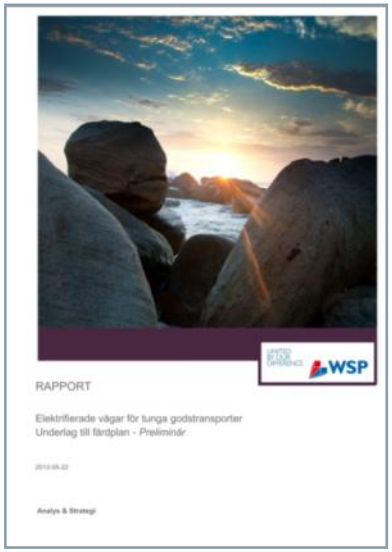
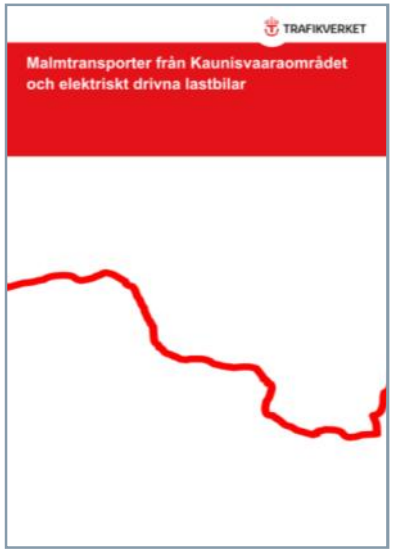
Development project

- Test track of 1.3 miles with realistic highway conditions
- Technical assessment of complete system by TU Dresden & BASt (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
- Cooperation with e.g. Scania and Volvo

Further independent reports confirm economic and ecological benefits of system







- Gladstein, Neandros and Associates report, commissioned by AQMD, confirmed economic attractiveness of Catenary Hybrid truck solution and showed market potential
- Swedish Transport Authority (TRV) has investigated eHighway with great interest. Several reports on the topic have been published (regulation, first application, impact on national transport goals)
- Application for harbour links to industrial centers as well as mining connections are being considered

Electrification is especially attractive on highly frequented routes

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eHighway application fields

near term

Shuttle transport

Mine transport

long term

Long-haul traffic

The development path of road electrification is likely to echo that of rail electrification a century ago

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Challenge

„Chicken and egg“

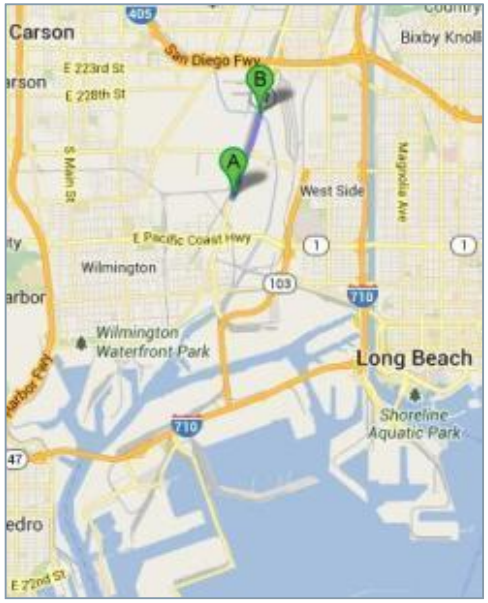
→„Many different chickens and eggs“?

Public road demonstration in the U.S.

Background

- Trucks are a key link between the ports and rail yards
- Air quality and GHG concerns
- **AQMD** (Air Quality Management District) is pursuing environmental relief for the LA metropolitan area

- **Goal:** To promote the implementation of zero emission goods movement technologies, and to demonstrate the most viable technology to be adopted for a future, regional zero-emissions corridor



Scope

- One mile of infrastructure on Alameda St. next to the near-dock rail terminals.
- Integration on different hybrid and zero-emission trucks supplied by Volvo Trucks and local truck manufacturers
- Construction work has started
- Demonstration period of 12 months for data collection and evaluation

Public road demonstration in Sweden in early 2016

Background

- **Trafikverket** (the Swedish Transport Administration) initiated an **Pre-Commercial Procurement Process** (PCP) for demonstration projects with **electric road systems (ERS)** for heavy transport (>16 tons) with a budget of app. **11,5 M€**
- Aim of the call: Realization of demonstration projects to evaluate **different ERS-technologies** prior to a potential introduction on the Swedish road network

Scope

- 2 km of infrastructure, in one direction, on highway E16
- Main transport road between the industry region Dalarna (steel, paper, mining) and the port of Gävle.
- Alternative rail road congested
- Hybrid trucks supplied in cooperation with SCANIA
- Construction starting early 2016. Demonstration period of 24 months for data collection and evaluation

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