

Designing and Demonstrating a System for Efficient and Sustainable Road Freight based on Dynamic Power Supply

EVS29 Montreal – Patrik Akerman, Siemens AG

Celebrating - 134th anniversary of ERS (Electric Road Systems)



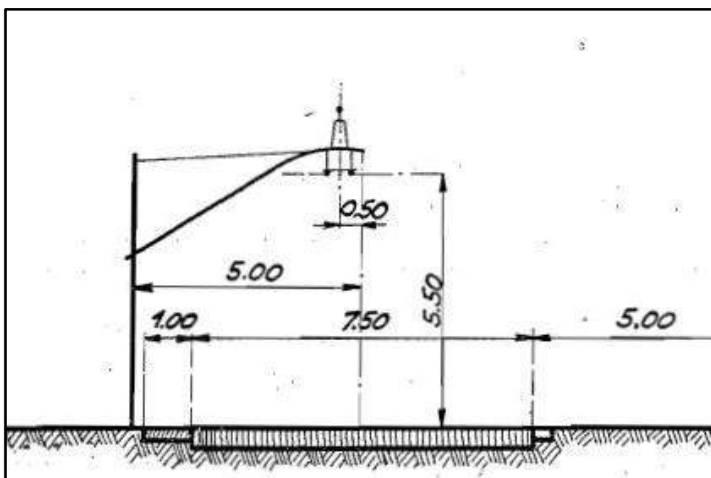
Siemens Elektromote (1882)

- road applications date back more than 130 years
- about 300 trolleybus systems (incl. long-distance up to 100 km for inter-city traffic) operative world-wide
- road applications demand early standardization to allow for common interfaces to base vehicles

Trolleybus in Germany



Foto: Lars Brüggemann www.larsbrueggemann.de



German Highway Concept (1936)

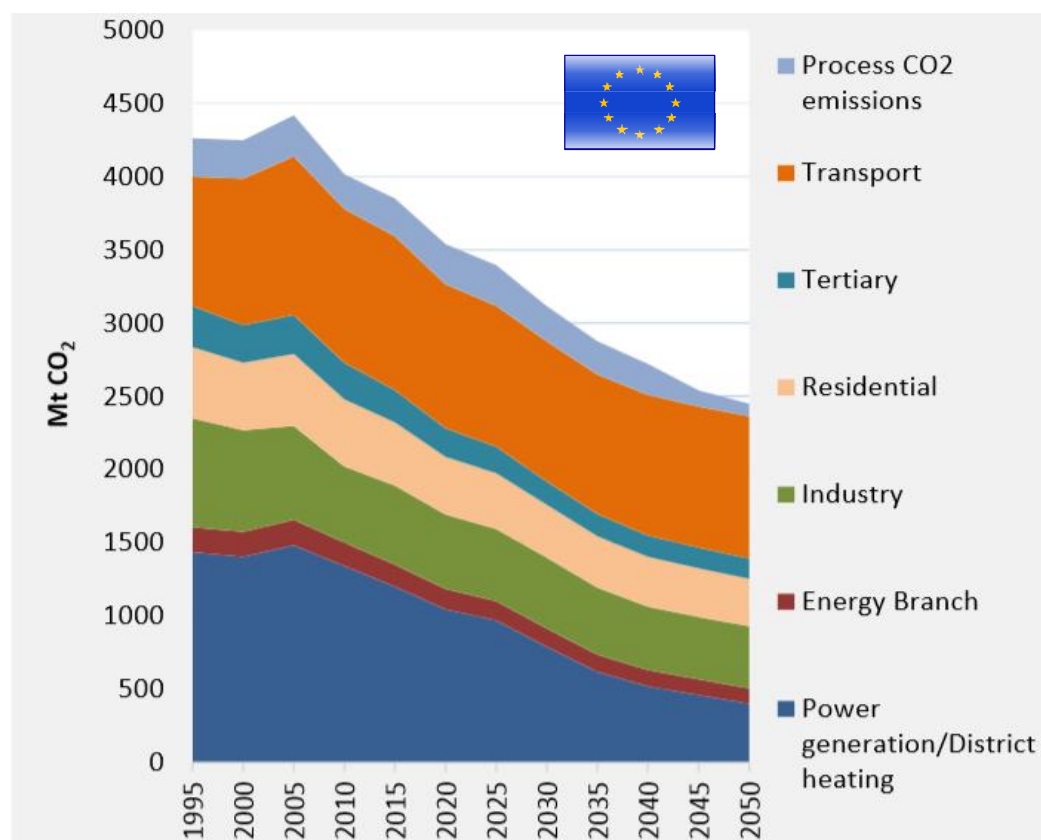
- electric traction systems can be beneficially used on highways as well
- applicable to trucks/long-distance busses
- may be combined with energy storages
- DC power supply (600 ... 750 V nominal), catenary type contact lines

Electric mining truck



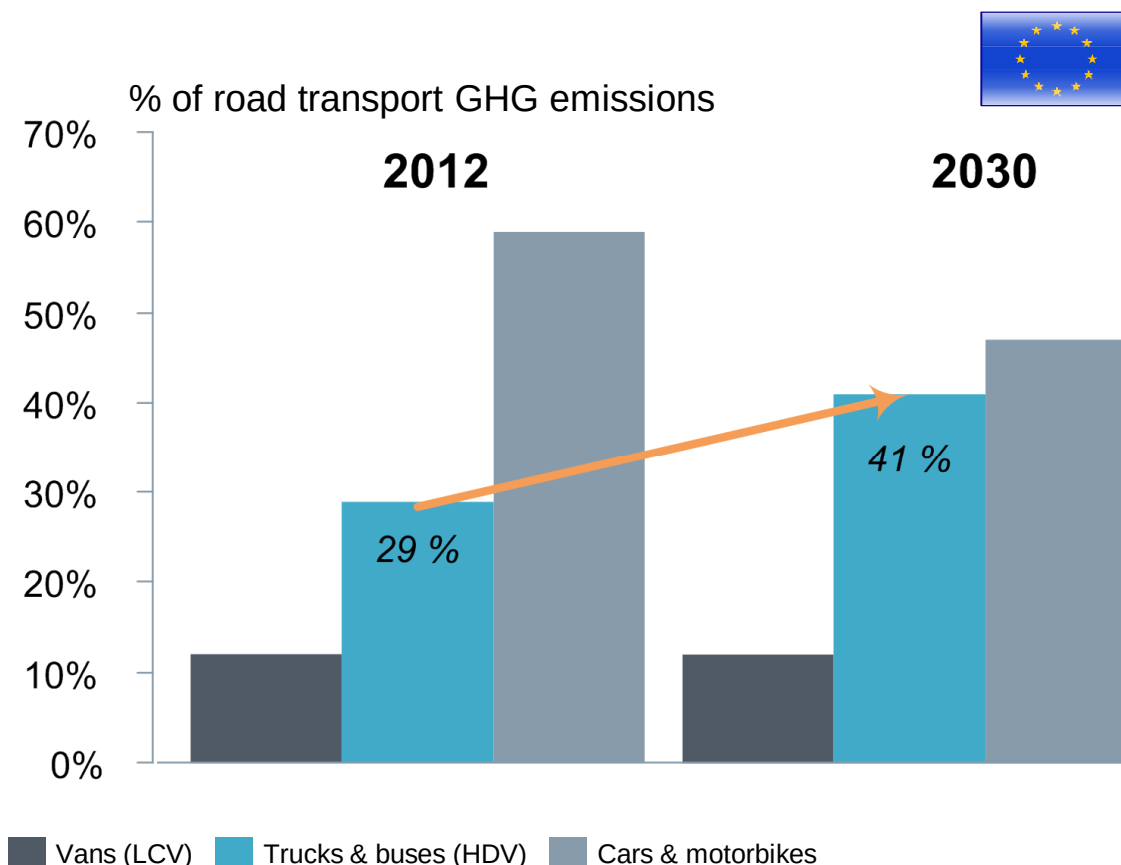
Reasons, Alternatives & Benefits - Need to act

Transport will increasingly be the biggest challenge for decarbonization.



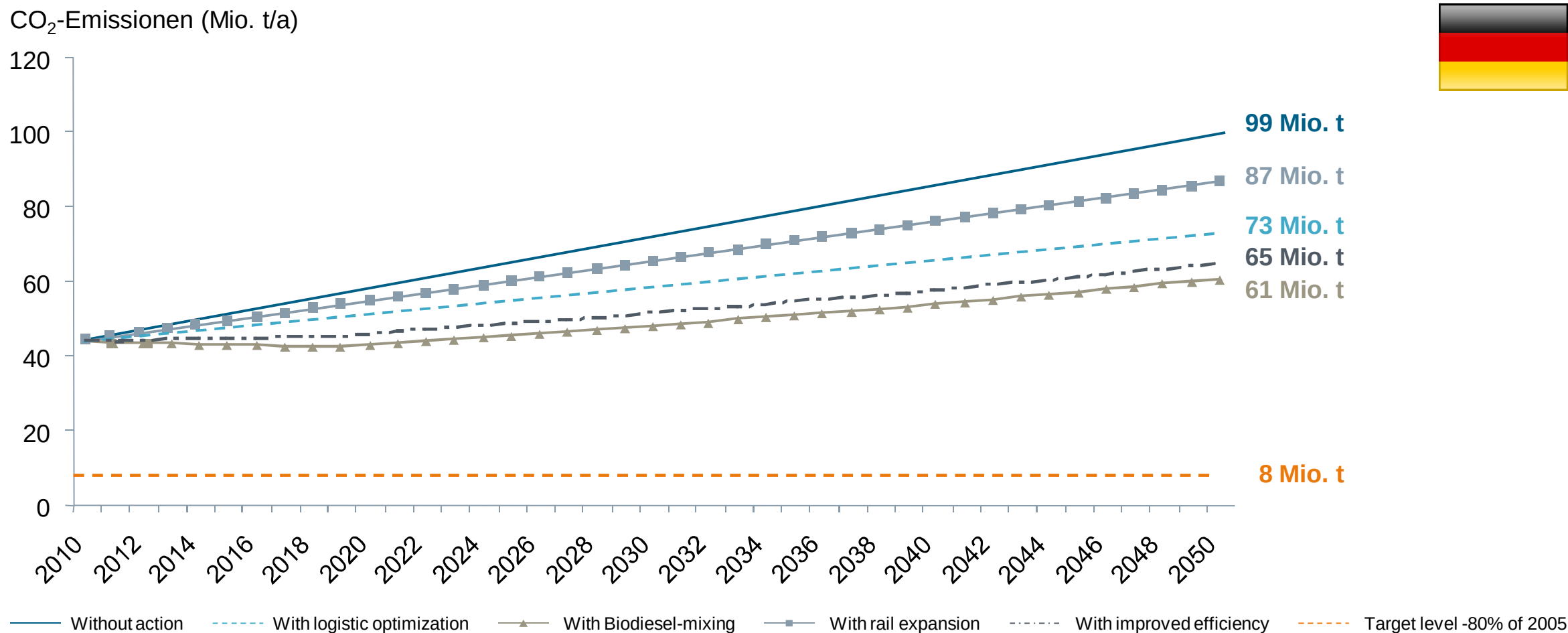
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If current trends continue, road freight will become the largest source of transport emissions after 2030.



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

Measures to reduce road freight CO₂ emissions



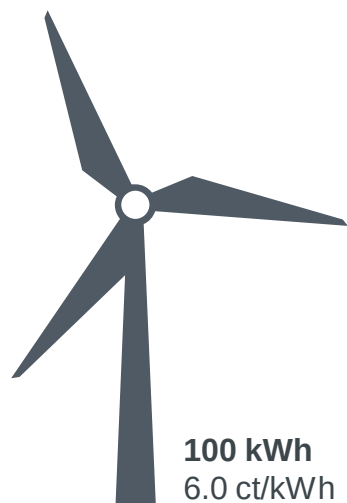
Source: German Ministry of Environment (BMU), March 2013

Alternative concepts

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



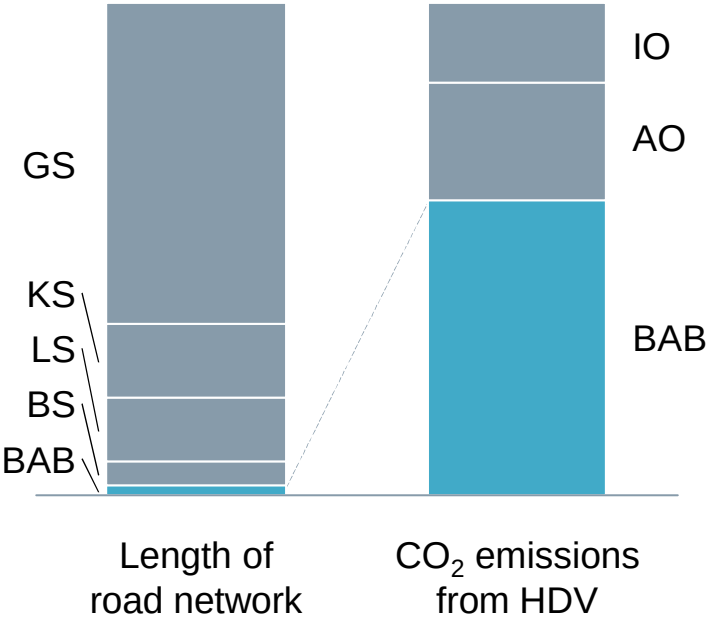
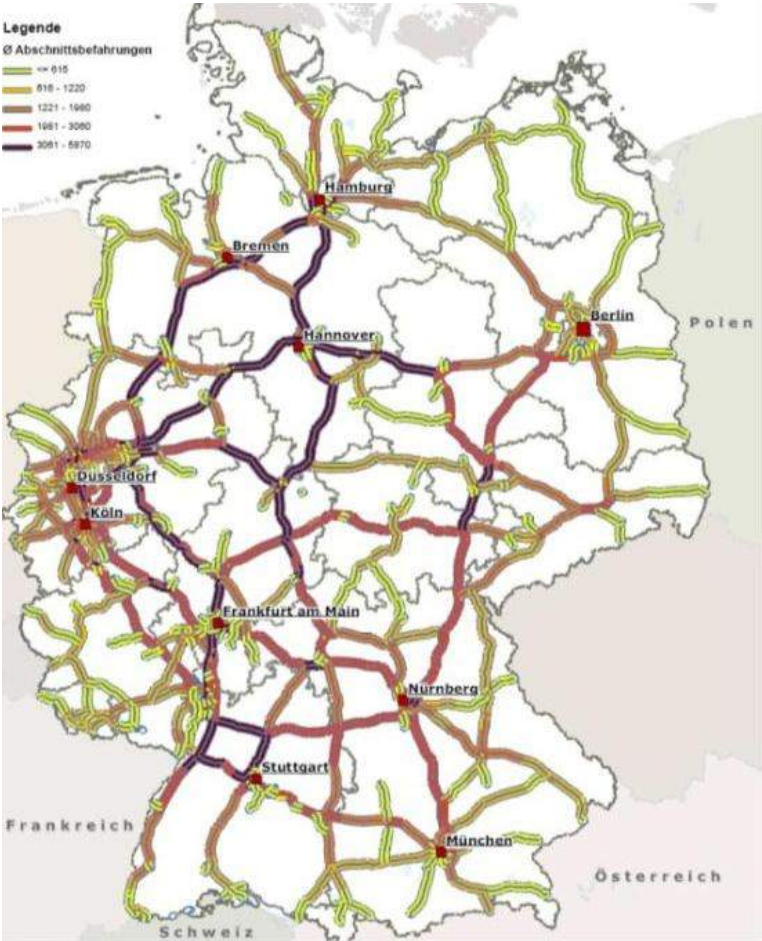
Reasons, Alternatives & Benefits - Traction Options



Pathway	Range Cost per km	Efficiency WTW	Example vehicle
Electric Road Systems 	60 km 19 ct/km	77%	
Battery 	48 km 20 ct/km	62%	
Hydrogen 	24 km 55 ct/km	29%	
Power-to-Gas 	17 km 70 ct/km	20%	

1) Inklusive Speicher
Source: German Ministry of Environment

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



IO = Innerorts
AO = Außerorts
BAB = Bundesautobahn

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)



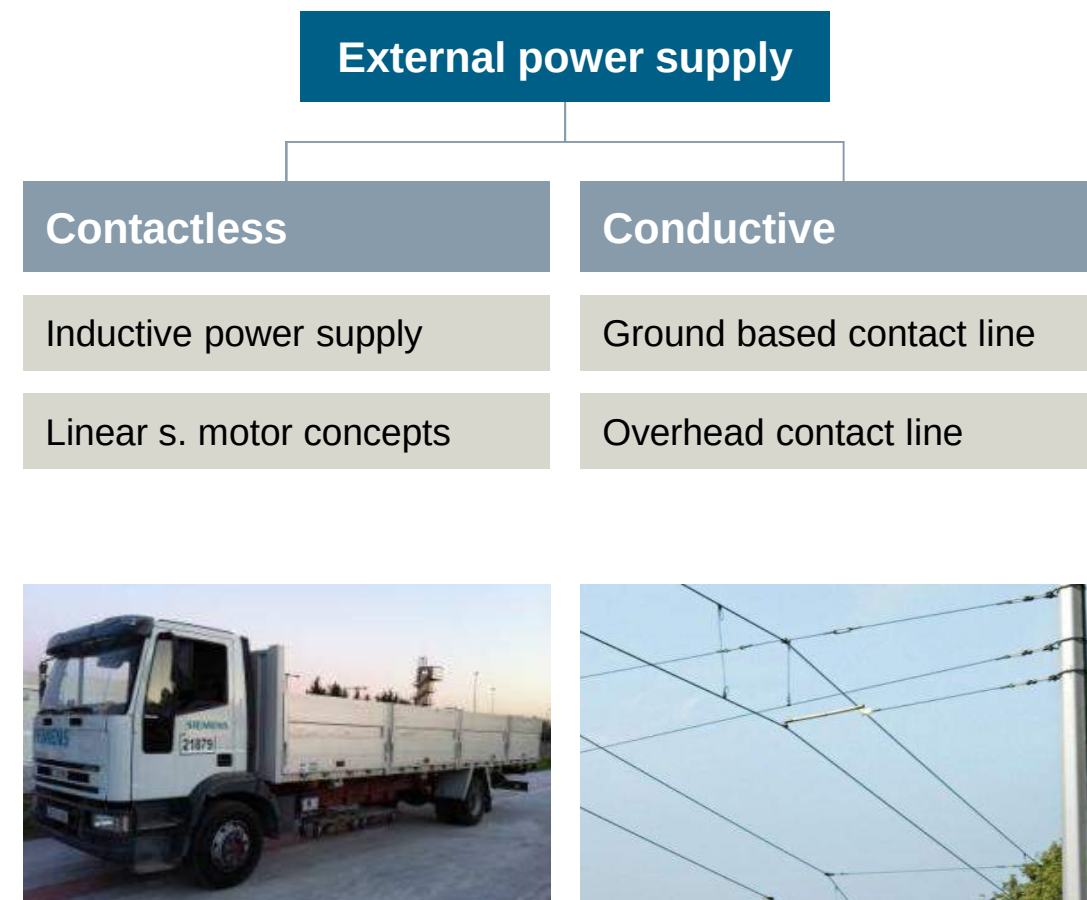
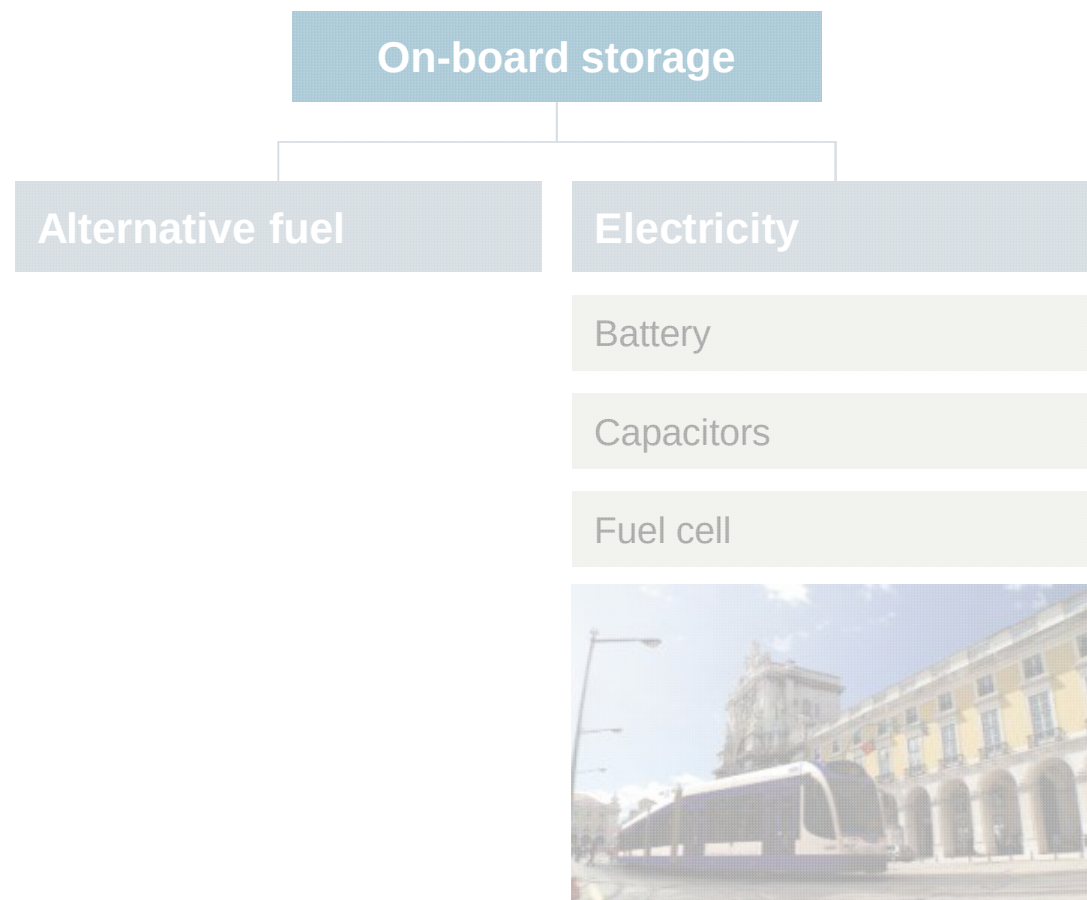
60% of the HDV emissions occur on 2% of the road network (BAB = 12,394 km)

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

Alternative concepts

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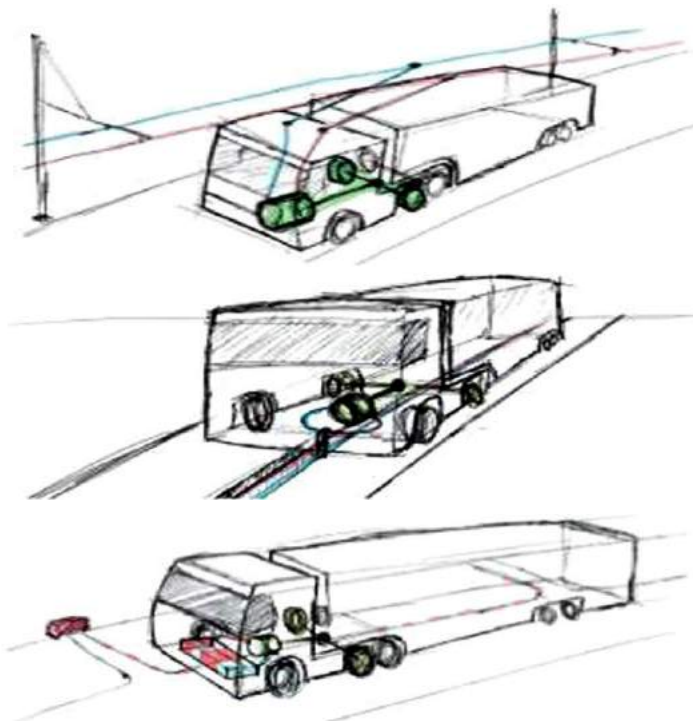
Reasons, Alternatives & Benefits - First Choice => ERS

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



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

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

What an Electric Road System could look like



Film

But is it realistic?



But is it realistic?

SIEMENS

Film

Where are we now?

Sweden - Operation starting



- **Innovation Procurement Process for demo projects by Trafikverket**
- **Field trial (2 years) starting 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, start 2016



- **eHighway** to reduce emissions of port links on **3 km** infrastructure at of ports in L.A. & 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**

External assessment ... ecologically and economically beneficial

Umweltforschungsplan des
Bundesministeriums für Umwelt,
Naturschutz, Bau und Reaktorsicherheit

Forschungskennzahl 3713 45 103
UBA-FB-00 [trägt die UBA-Bibliothek ein]

Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050

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Im Auftrag des Umweltbundesamtes

08/2015

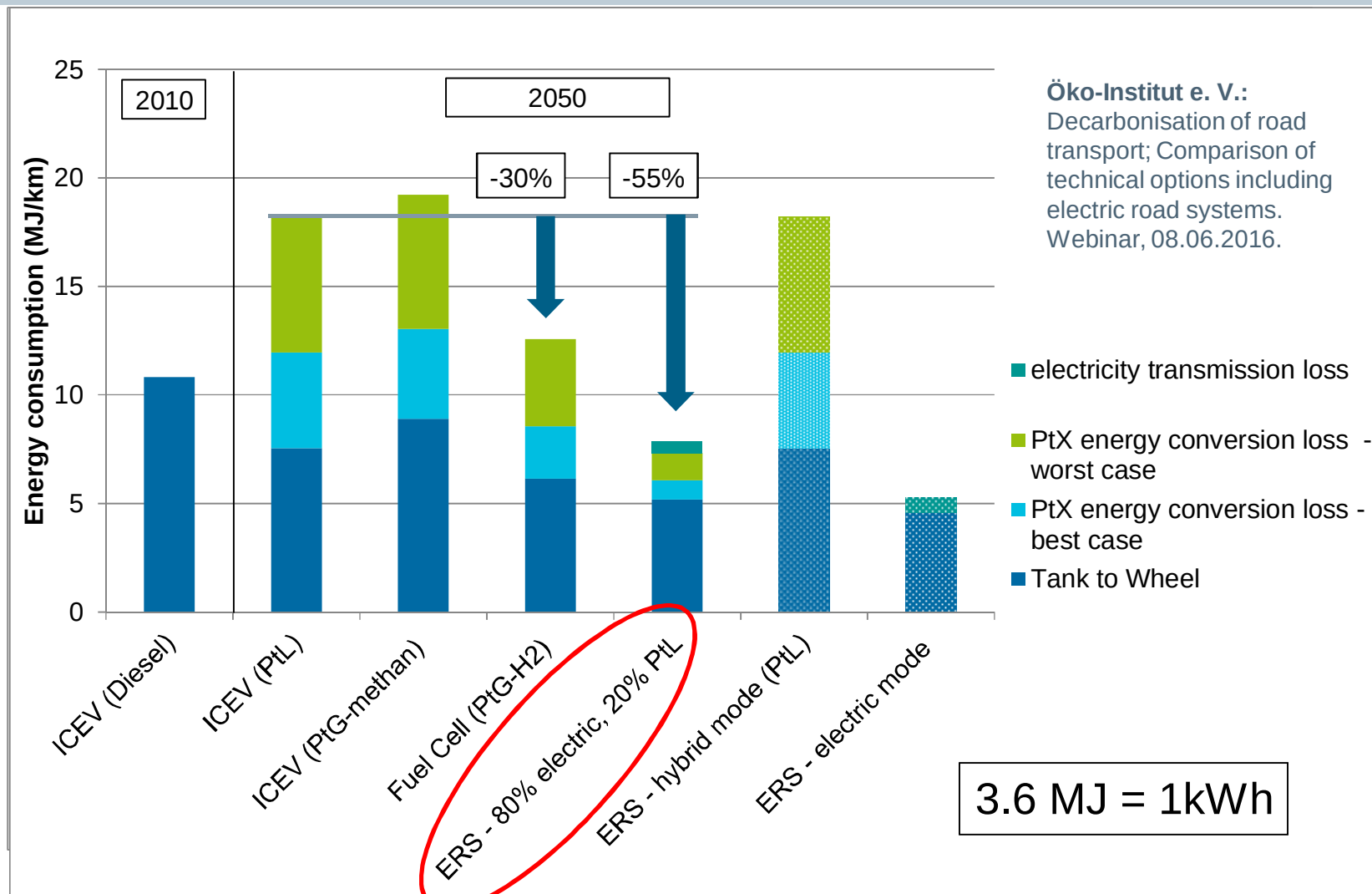
German UBA - Umweltbundesamt ordered & published a comprehensive strategy for traffic energy supply until 2050:

- final version to be published XX-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 1: energy efficiency of trucks by concept and type of fuel

Example 2: costs of carbon neutral long haul road freight transport

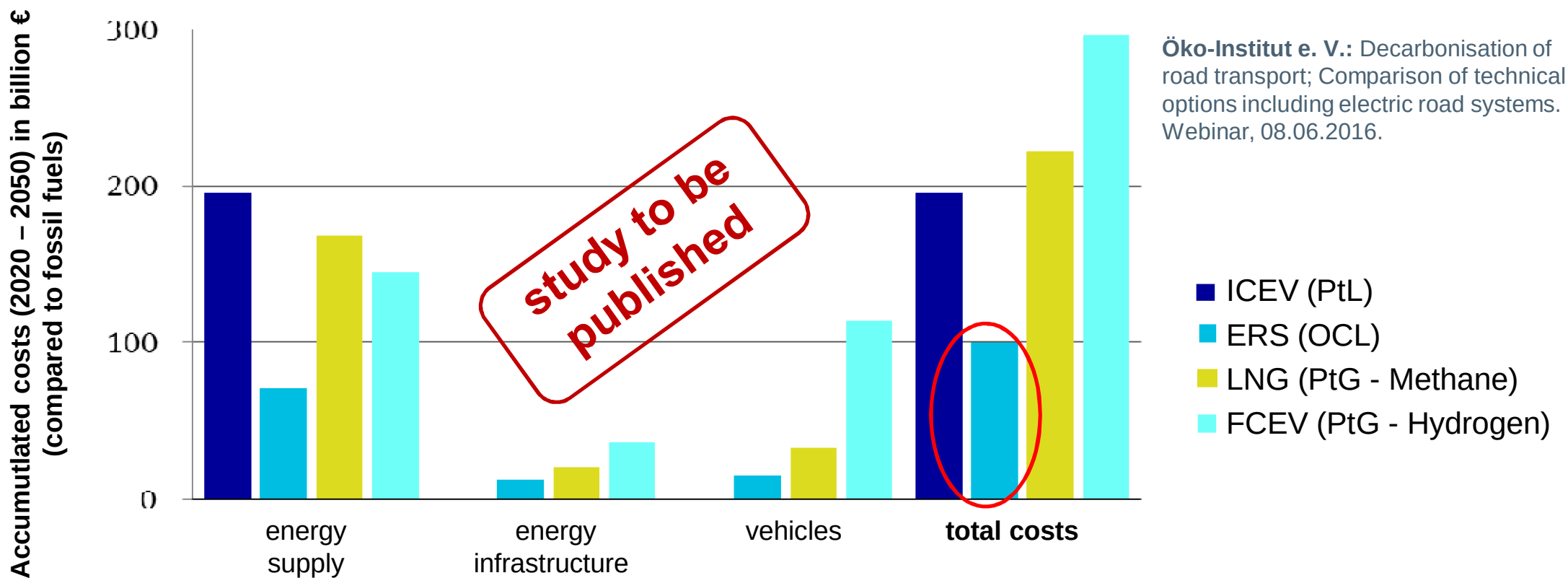
External assessment ... ecologically and economically beneficial



Öko-Institut e. V.:
Decarbonisation of road
transport; Comparison of
technical options including
electric road systems.
Webinar, 08.06.2016.

study to be
published

External assessment ... ecologically and economically beneficial



Öko-Institut e. V.: Decarbonisation of road transport; Comparison of technical options including electric road systems. Webinar, 08.06.2016.

Key assumptions:

- Length of electric network: 4,000km; 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

Electrification is especially attractive on highly frequented routes

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

The Road ahead ...

... summary and main conclusions

- The decarbonisation of the transport sector is necessary and possible.
- The total costs of an overhead-line-ERS are below any other options of decarbonisation.
- Advantages of conductive electric road systems
 - high energy efficiency & reduction of air pollutant emissions
- Compatible with and complementary to alternative fuel technologies

Thank you for your attention



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