eHighway
Sustainable road freight transport
Climate action is urgent, because waiting makes the necessary transition to zero carbon emissions much shorter and disruptive.

We need to put emissions, including those from road freight,
• on a path towards zero
• with minimum total emissions getting there

Source: Figueres et al, *Nature* June 2017
Road freight decarbonization is particularly a challenge for the few vehicles that emit the majority of CO₂

Source: Oeko Institute, Fraunhofer ISI & IFEU – Alternative drive trains and fuels in road freight transport – recommendations for action in Germany
Road freight emissions trends make it clear: Solutions for decarbonization are needed

Based on latest policy announcements, global heavy road freight is forecast to emit 3 Gt CO₂ by 2050.

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

Source: European Commission reference scenario for 2050 (2013) page 53

Source: IEA - The Future of Trucks (2017) page 117
Surface freight density: 2010
Shows high density of freight on European corridors

Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016) page 31
Surface freight density: 2050
Shows global need for road freight solutions suitable for corridors

Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016) page 31
Long haul road transport is highly concentrated to the highway network

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. **89%** of German truck trips after leaving the highway are **50 km or less**

**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

Source: [BMVI website](https://bmvi.bund.de). Study available [here](https://www.bmvig.de/menue/1/38/35330.html).
ICCT assesses that electrification with contact lines can contribute the most to deep decarbonization of HDVs

- Greatest reductions in GHG emissions in all time periods


Figure 12. Long-haul tractor-trailer lifecycle CO₂ emissions over vehicle lifetime (left axis) and per kilometer (right axis) by vehicle technology type.²⁹
German industry association BDI recommends 4,000 to 8,000 km of overhead catenary lines as a cost-effective climate action for HDVs

Background

- BDI published in 2018 an independent report looking at all sectors of the economy
- It 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 increase by 88% of ton-km of freight activity on rail by 2050
- No additional biofuels for transport, because other sectors will be prepared to pay more
- PtX only in 95% scenario. Imported from Middle East & North Africa, and it will still be very pricey

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 GER 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.

Catenary electrification is compatible with and complementary to other alternative fuel technologies.

The eHighway hybrid truck can be configured to suit specific applications.

<table>
<thead>
<tr>
<th>Truck types</th>
<th>Drive system</th>
<th>On-board source of electricity</th>
<th>Combustion engine</th>
<th>Non-electrical source of energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor truck (2 axles)</td>
<td>Parallel-hybrid</td>
<td>Battery (small)</td>
<td>Engine (small)</td>
<td>Diesel</td>
</tr>
<tr>
<td>Tractor truck (3 axles)</td>
<td>Serial-hybrid</td>
<td>Battery (medium)</td>
<td>Engine (medium)</td>
<td>Bio-fuel</td>
</tr>
<tr>
<td>Rigid truck (2 axles)</td>
<td>Full electric</td>
<td>Battery (large)</td>
<td>Engine (large)</td>
<td>CNG/LNG</td>
</tr>
<tr>
<td>Rigid truck (3 axles)</td>
<td></td>
<td>Fuel cell</td>
<td></td>
<td>H₂</td>
</tr>
<tr>
<td>Rigid truck (4 axles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
eHighway Trucks – from Proof-of-Concept to Field trials

Development of the eHighway vehicle technology

- **2010**
  - 1. Generation
    - Proof of concept
- **2019**
  - 3. Generation
    - Field trials
  - 2. Generation
    - Demonstration projects

- Operations up to 100 km/h possible
- Connection and disconnection to catenary in motion
- Recharging of onboard energy storage while driving
- No limitations for first and last mile
German field trials in 2019 are a necessary near term step for the development of the system.

### Information and routing

**Federal State of Hesse**
- Infrastructure project awarded to Siemens
- Track length / Amount of trucks: 5km / 5
- Construction: April-Nov 2018
- Demonstration: Official start **May 7 2019**

**Federal State of Schleswig Holstein**
- Infrastructure project awarded to Siemens
- Track length / Amount of trucks: 5-6km / 5
- Construction: Started Oct 2018
- Demonstration: Start in 2019

**Federal State of Baden-Wuerttemberg**
- Tender published Nov 2018
- Track length / Amount of trucks: 5-6km / 5
- Customer's targeted start of Demonstration: 2019

Project homepage: ELISA  
Project homepage: FESH  
Project homepage: eWayBW
Scenes from the construction

Many pictures available at: https://mobil.hessen.de/verkehr/elisa/baustellen-news
eHighway is being trialed on public highways in Germany and Sweden
Start of German field trial on A5 motorway just outside Frankfurt

May 7th, 2019: Official Opening of Germany's 1st eHighway near Frankfurt Airport

SCANIA will deliver 15 hybrid trucks for all three field trials in Germany (Press release)
Independent institutes in Germany have identified early shuttle applications and how to scale up to a full system

Selected recommendations

- Suitable first applications are on routes around Hamburg, in Ruhr area and southern Germany
- With a comprehensive network of catenaries it is possible that 65% of the vkm by heavy duty trucks could be commercially viable to switch to catenary-trucks
- Using electricity with a carbon footprint of 412 g/ kWh this would help reduce the total GHG emissions from heavy duty trucks in Germany by 17%
- Without a transparent development plan for the infrastructure the risks of faced by OEMs and trucking companies during the transitions are too big

Identified routes based on freight goods flow suitable for catenary systems usage

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>BAB</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Essen/Gladbeck – Dreieck Heumark</td>
<td>A3/A2</td>
<td>85 km</td>
</tr>
<tr>
<td>2</td>
<td>Düsseldorf – Kreuz Kamen</td>
<td>A46/A1</td>
<td>81 km</td>
</tr>
<tr>
<td>3</td>
<td>Neckarsulm - Stuttgart</td>
<td>A81/A6</td>
<td>57 km</td>
</tr>
<tr>
<td>4</td>
<td>Hamburg – Lübeck</td>
<td>A1</td>
<td>49 km</td>
</tr>
<tr>
<td>5</td>
<td>Krefeld – Köln</td>
<td>A57</td>
<td>45 km</td>
</tr>
<tr>
<td>6</td>
<td>Schwerte – Lüdenscheid-Süd</td>
<td>A45</td>
<td>32 km</td>
</tr>
<tr>
<td>7</td>
<td>Essen – Dortmund</td>
<td>A40</td>
<td>26 km</td>
</tr>
<tr>
<td>8</td>
<td>Kreuz Kamen – Hamm-Uentrop</td>
<td>A2</td>
<td>23 km</td>
</tr>
<tr>
<td>9</td>
<td>Pfaffenhofen – München</td>
<td>A9</td>
<td>20 km</td>
</tr>
<tr>
<td>10</td>
<td>Bremen – Hamburg</td>
<td>A1/A261</td>
<td>81 km</td>
</tr>
</tbody>
</table>

Source: IFEU, PTV – Roadmap OH-Lkw Potentialanalyse 2020-2030 page 22 and 30
Field Trial FeSH on Motorway A1 between Luebeck and Hamburg
Questions?
Your point of contact for eHighway at Siemens Mobility Germany

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www.siemens.com/ehighway
#eHighway
The systemic transition to zero emission road freight requires breaking out from early shuttles to large scale network

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

- Possible important role of hybrids (driving a very high share on electricity) as users of partial infrastructure network
- Nearly completed network will facilitate transition to fully zero-emission mobility

Providing the right infrastructure is a necessary precondition for zero emission long-haul trucking

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