Transitioning to zero-emission heavy-duty freight vehicles

A system perspective on zero-emission heavy-duty road freight transport and challenges for a successful market entry

Florian Hacker
Brussels, 04.12.2018
Decarbonisation of road freight transport: Long-haul transport of particular importance

- Light & heavy-duty vehicles responsible for about 35 % of EU transport GHG emissions
- Long-distance trucks particularly relevant in terms of GHG emissions due to high annual mileage and high fuel consumption

The challenge of zero emissions freight transport has a number of dimensions

- GHG emissions from road freight transport continue to rise in the EU
- In regional freight transport the battery electric drive is emerging as a possible solution
- Among the possible powertrain alternatives in long-haul transport, there is no clear favourite yet
- In particular long-distance transport requires cross-border solutions
- New propulsion technologies must enable zero-emission road freight transport in the long term – at the lowest possible economic cost
Electric propulsion systems in long-haul transport offer near-term cost advantages

- Lower operating costs compensate for higher vehicle costs
- **BUT:** uncertainties remain regarding the development of technology costs, energy prices and regulatory / fiscal framework

### Case study: TCO of long-haul truck in Germany

<table>
<thead>
<tr>
<th>Year</th>
<th>Diesel</th>
<th>FCEV</th>
<th>OC-HEV</th>
<th>OC-BEV 100</th>
<th>BEV 800</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2030</td>
<td></td>
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</tbody>
</table>

**Assumptions of TCO:** operation of a long-haul truck in Germany, user costs excl. VAT, 3,5% discount rate, 5 years of vehicle operation, annual mileage of 120,000 km

FCEV – fuel cell electric vehicle, OC – overhead catenary, HEV – hybrid electric vehicle, BEV 100 – battery electric vehicle 100 km electric range


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Transitioning to ZE HDV | Florian Hacker | Brussels | 4.05.2018
The roll-out of alternative energy supply infrastructure needs to be pre-financed

Assumptions of TCO: operation of a long-haul truck in Germany, user costs excl. VAT, 3.5% discount rate, 5 years of vehicle operation, annual mileage of 120,000 km

*Energy supply infrastructure: hydrogen filling station, overhead line system or station-based charging infrastructure

The roll-out of alternative energy supply infrastructure needs to be pre-financed

- Availability of energy supply infrastructure is key to market ramp-up of alternative drives
- If early users fully carry infrastructure cost, this will hinder economic operation

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Example of overhead catenary core network (4.000 km) in Germany: relatively low investment required

- All alternative propulsion systems require a reliable energy supply infrastructure
- In road freight transport, a relatively low network density along corridors could already be attractive for a variety of applications
- Investment needed is moderate compared to other expenditures for future technologies

*Average annual toll revenues or infrastructure investments during the indicated period

Overall costs of carbon neutral road freight transport until 2050: energy costs of particular importance

- Decarbonisation of freight transport is related with considerable economic costs
- Total costs are determined by the energy costs
- Costs of infrastructure and vehicles are less important from this perspective
- Direct use of electricity shows economic cost advantages

Case study: Decarbonisation of German long-haul freight transport

Updated version of the study will be published soon.

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

- ICEV (PtL)
- OC-EV
- ICEV (PtG)
- FCEV (PtG)
Decarbonisation of the freight transport sector by 2050:
Demand of renewable energy depends on propulsion system

- Decarbonisation of long-haul freight transport requires high amount of renewable energy
- Highest energy efficiency for direct use of electricity results in lowest additional demand
- Use of synthetic fuels (PtL, H₂) requires energy imports
- Use of synthetic fuels must be combined with sustainability criteria at an early stage

Case study: Decarbonisation of German long-haul freight transport

<table>
<thead>
<tr>
<th>Propulsion type scenarios</th>
<th>2010</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICEV - Diesel</td>
<td>109</td>
<td>4</td>
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<tr>
<td>ICEV - PtL</td>
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<td>193</td>
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<tr>
<td>FCEV</td>
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<td>47</td>
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<tr>
<td>EV (catenary)</td>
<td></td>
<td>46</td>
</tr>
</tbody>
</table>

Net electricity generation from renewable energies in Germany 2017: **210 TWh**

Scenario assumptions:
- All scenarios: complete decarbonisation of long-haul freight transport
- ICEV – PtL: Diesel replaced by imported synthetic fuel based on renewable energy → WTT efficiency: 49%
- FCEV: imported hydrogen (electrolysis, liquefaction and transport) → WTT efficiency: 48%
- EV (catenary): OC-vehicles with 75% electric mode and 25% conventional mode (PtL); WTT efficiency of electricity: 85%
Long-term framework conditions are needed to encourage the deployment of zero emission HDV in Europe

- Pressure to decarbonise road freight transport is high
- Direct use of electricity, as in passenger transport, also has advantages in road freight transport
- Depending on the application, synergies and various combinations of different drive technologies are also conceivable
- Parties involved need planning security, therefore strong state incentives for alternative drives and infrastructure development are necessary
  - e.g. CO$_2$-based truck toll, ambitious efficiency standards
Infrastructure development requires government action and pre-financing

- Competitive alternatives to diesel propulsion require a reliable basic energy supply network
- In the early market phase, the costs can neither be passed on to the (few) users, nor does a privately financed implementation appear realistic
- State initiative and takeover of investment risks related to infrastructure deployment is therefore necessary in this early stage
Large demonstration projects are necessary to gain practical experience and create acceptance

- New drive technologies create numerous practical challenges for all the players involved
- Near-market technologies should therefore be tested on a larger scale as soon as possible
- The aim of the pilot tests should be to develop a long-term strategy for road freight transport on the basis of experience gained including an infrastructure development strategy for HDV
- Cross-border projects should be taken into account at an early stage
Further reading – recent publications of Oeko-Institut

StratON project report (09/2018)
on overhead catenary heavy-duty vehicles

Policy paper (10/2018)
on alternative drive trains and fuels for HDV

Available on our website: www.oeko.de
Thank you for your attention!

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