The Future of Zero Emission Long-Haul Trucking

Dr. Manfred Schuckert
19 February, 2020
Brussels
Introduction

Commitment to Paris Agreement

Climate action already established as a global mission of cities, companies, countries and governments worldwide

Worldwide commitments with action plans

going to distance itself from fossil fuels

Rockefeller Family Fund hits Exxon, dives from fossil fuels

...and accelerates CO₂ regulations

Regulator Excellence Hub: Experts for CO₂ Emissions

Initial situation

European Union

Trucks in category 5.2 count the most:
very costly to build CO₂ compliance strategy on several categories.
OEM specific target value 2025 for each sub-group

Vehicle sub-group | Annual mileage [km] | Average payload [t] | MPW factor
--- | --- | --- | ---
4.2-RD | 78,000 | 3.2 | 15% seven trucks in 4.2 equal
5.2-LH | 116,000 | 13.8 | 100% one truck in 5.2
10.1-RD | 68,000 | 10.3 | 43% two trucks in 10.1 equal

Rockefeller fund eliminates holdings of Exxon Mobil


Baseline 2019/2020 -15% 2025/2026 -30% 2030/2031

Volvo To Vehlow 20 EYs by 2020: A Dieselgate Turns Into Tesla’s Taralby

\*Unprecedented support of „Paris“ \( \rightarrow \) 1,000 mayors, governors and CEOs

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Initial situation
## Available technologies to comply with regulation and customer needs

### Relevant for 2025 vs. 2030

<table>
<thead>
<tr>
<th>Technology</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>Diesel</td>
<td>Electric</td>
</tr>
<tr>
<td>BEV</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Plug-in hybrid</td>
<td>Yes (limited)</td>
<td>No</td>
</tr>
<tr>
<td>Catenary</td>
<td>? (not covered in reg.)</td>
<td>No</td>
</tr>
<tr>
<td>HPDI</td>
<td>Limited fleet potential</td>
<td>Limited fleet potential</td>
</tr>
<tr>
<td>SI</td>
<td>Customer acceptance</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Fuel Cell/ICE</td>
<td>Infrastructure</td>
<td>Finance, timeframe, technology limitations</td>
</tr>
</tbody>
</table>

### Technology Assessment (fleet, customer)

- **Zero Emission**
  - Conventional: No
  - Electric: Yes (limited)
  - Gas: No
  - Electric (H₂): Yes

- **Base Technology**
- **Limited fleet potential**
- **Customer acceptance**
- **Infrastructure**
- **‘VECTO’ unclear**

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* Tank-to-Wheel
SI = Stoichiometric injection (λ=1)
ICE = Internal Combustion Engine
Conventional potential very limited – Former NGO FC reduction projections more than questionable, but new challenges at the horizon.

**Fuel consumption savings**

<table>
<thead>
<tr>
<th>conventional engine</th>
<th>tyres</th>
<th>aerodynamics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>

**Development timeframe**

- **today**
- **ramp-up**
- **7 years**
- **2020**
- **2025**
- **2030**

**But:**

- **Euro VII**
- **Direct vision:**
  - cost
  - complexity
  - timeframe
- **Noise**
  - cost (€), time ...?
  - ?

! **Decisions need to be made today to achieve 2030 reduction target**

! **Long lead times to be reflected in today’s regulatory activities**

! **Industry, infrastructure companies (oil/gas & utilities) and government need to work together**
Conventional measures are not sufficient to achieve 2030 target.

Zero/low emission technologies are required to reach challenging targets.

Regulatory outlook

- Target level 2025: 15%
- Target level 2030: 30%
- Diesel: <10 - 15%
- Hybrid / Gas / BEV / FCV
The road to CO$_2$-neutral transportation – Daimler Trucks and Buses
CO$_2$-neutral commercial vehicle fleet by 2039

Climate protection – our vision:
We shape the future of CO$_2$-neutral road transportation

For our new commercial vehicles, it is our ambition to become tank-to-wheel CO$_2$-neutral in 2039 in the triad

By 2022, the product portfolio in the core regions will also include battery electric series production vehicles
BEV and H$_2$-FC/ICE powertrains can perfectly complement one another: customers can choose most cost-efficient solution for mission requirements.

**But ... infrastructure key:**

- We need a powerful charging infrastructure
- Electric power and eTrucks must become much cheaper
- Long term investment stability required
- Euro-Vignette with a clear benefit for Zero Emission Trucks

### Charging stations (industry) (on top of 100,000 charging stations with 100kW)

<table>
<thead>
<tr>
<th></th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC 350 kW</td>
<td>11,000 public</td>
<td>20,000 public</td>
</tr>
<tr>
<td>DC &gt; 500 kW</td>
<td>2,000 public</td>
<td>20,000 public</td>
</tr>
</tbody>
</table>

### H$_2$ (Daimler)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>LH$_2$</td>
<td>&gt; 50</td>
<td>&gt; 400</td>
</tr>
</tbody>
</table>

CO$_2$ reduction/a

BEV truck
- medium mileage
- medium payload

H$_2$-FC/ICE truck
- high mileage
- high payload

mission
route profile
payload
**Technical data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perm gross weight</td>
<td>18 t/25 t</td>
</tr>
<tr>
<td>Vehicle application</td>
<td>heavy distribution traffic</td>
</tr>
<tr>
<td>Drivetrain</td>
<td>electric</td>
</tr>
<tr>
<td>Output</td>
<td>252kW (2x126kW)</td>
</tr>
<tr>
<td>Chassis</td>
<td>4x2, 6x2 (current version)</td>
</tr>
<tr>
<td>Operation range</td>
<td>Up to 200 km</td>
</tr>
<tr>
<td>Torque</td>
<td>torque per drive motor 485 Nm (2 pieces)</td>
</tr>
<tr>
<td>Batteries</td>
<td>270 kWh installed battery capacity, thereof 240 kWh usable battery voltage 750 V</td>
</tr>
</tbody>
</table>

- presently 12 vehicles running -

**In series**
- Mercedes-Benz eCitaro
- FUSO eCanter

**Prototypes running**
- Thomas Built Buses Jouley
- Freightliner eCascadia & eM2

**Strong investment in emission free trucks & busses world-wide**

Today: our Gen1 projects

Daimler Trucks commitment

Getting zero-emission trucks on the road: 'The Future of Zero Emission Long-Haul Trucking'  
Dr. Manfred Schuckert  
Brussels, February 19, 2020
Daimler Trucks runs several trials in the world to achieve steep learning curve in technology, suppliers, charging & customers: Example USA

- **Testing**: >150 test completed
- **Truck**: >10 vehicles delivered
- **Charging**: 36 chargers installed
- **Training**: >25 training workshops done
LH₂ enables high performance trucks with a range > 600 km/day at affordable costs

<table>
<thead>
<tr>
<th>Use of H₂ in HDV</th>
<th>H₂ options</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGH₂</td>
<td>• 35 MPa (buses)</td>
<td>• Vehicle range</td>
</tr>
<tr>
<td></td>
<td>• 70 MPa (passenger vehicles)</td>
<td>• High cost for H₂ storage system</td>
</tr>
<tr>
<td>LH₂</td>
<td>• Use of cryogenic liquid hydrogen</td>
<td>• Large scale distribution</td>
</tr>
</tbody>
</table>

- Liquid Hydrogen in HD trucks would be ideal to satisfy customer long range requirements
- LH₂ supply chain to decouple local demand with regional supply deficits
H₂ could become the energy carrier of the future especially in the HDV sector, but international liquefaction chain key to reach low cost

**Supply chain**

- Water → Electrolysis → Electricity → Liquefaction → Shipping to Europe → LH₂ trailer transport → LH₂ filling station

**International H₂ production and shipping**

- MENA-EU: 9000 km
- AUS-EU: 18000 km
- Distance: 600 km

* battery needed for enabling 24/7 liquefaction of hydrogen

- International sunbelt regions provide a cost-efficient way to produce hydrogen with abundant solar energy resources
Key take-aways: CO₂ regulation and business environment

Ambition Level
• Green wave in EU politics led to an ambition level of at least 30%, impact assessment completely mismatching regulatory and customer requirements

Energy Politics
• From an OEMs perspective medium and long-term future will be electrified using electric power and hydrogen
• Natural gas (NG) and Bio-LNG gaining political momentum in Brussels heavily supported by the oil and gas industry, but outlook within the HDV sector remains very uncertain
• We expect a significant reduction of oil consumption in the EU transport sector around 2030, natural gas will not reach a significant level, significant use of elec. power in the HDV sector for BEVs, H2 consumption in EU-transport in the x00 kt p.a. around 2030

Robust Strategy
• High uncertainties in upcoming years require a robust technology strategy resistant to external shocks