DAIMLER TRUCK

Hydrogen in the Mobility Sector

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Hydrogen in the mobility sector – activities since decades

Hydrogen infrastructure

35 MPa | 70 MPa | Liquid H_2

Shell, TotalEnergies, bp, Air Liquide, Linde, Air Products, Exxon

and many more

H2MOBILITY, GP JOULE, OMV, infraserv höchst, cellcentric, Cryoshelter, LIFE H2, clean logistics, CRYOMOTIVE, faurecia, JET H2energy, EWE

Vehicles

Passenger Cars | Vans | Buses | Trucks

Fuel Cells

H_2 ICE

- **The Automotive Industry as well as the Oil/Gas industry active since decades achieving a robust technology progress as basis for the large scale introduction of hydrogen/fuel cell vehicles and the related infrastructure**

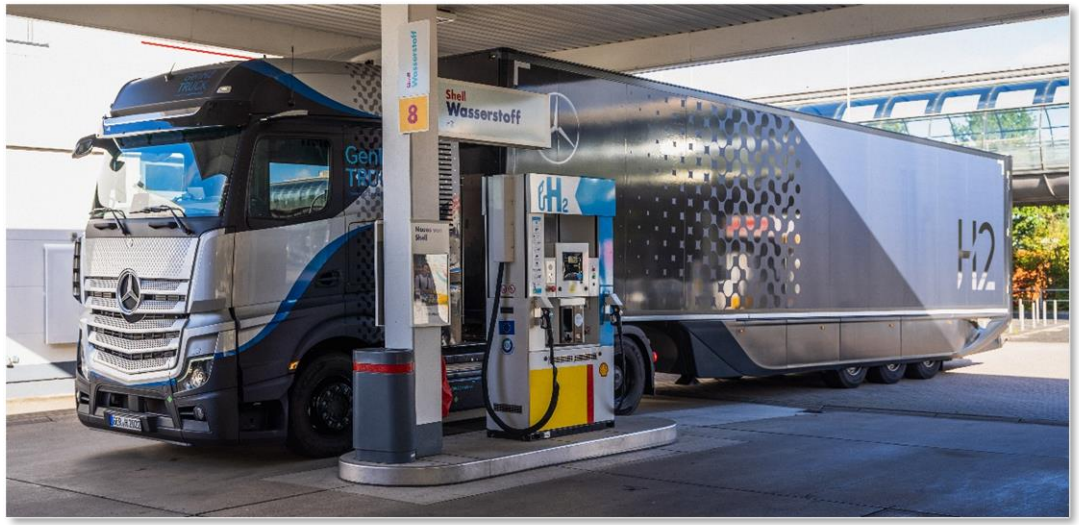
Why Hydrogen will be necessary for the Mobility Sector, beyond all decarbonization needs - some arguments -

Vehicles

- Vehicles allow a much larger range, especially with LH_2
- Better efficiency compared to diesel and gasoline engines
- Refueling times equal to diesel/gasoline, but much better than battery vehicles
- Technical properties similar in summer/winter
- Compared to battery electric vehicles much less dependent on critical raw materials
- .....

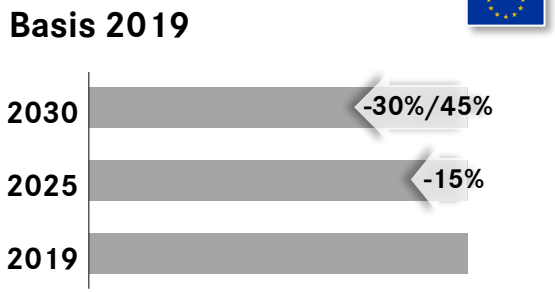
Infrastructure

- Refueling infrastructure could be built similar to existing diesel/gasoline system
- Hydrogen as global energy carrier allows local/regional independent energy supply
- Large scale production and global trade will bring costs down to existing systems
- .....



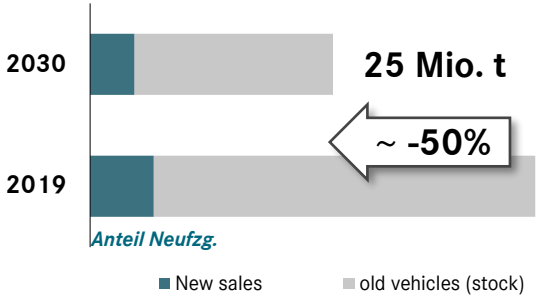
Disruptive Decade: To achieve the German CO_2 targets, by 2030 ~80% of newly registered trucks and buses would need to become Zero Emission.

EU fleet targets (new sales)

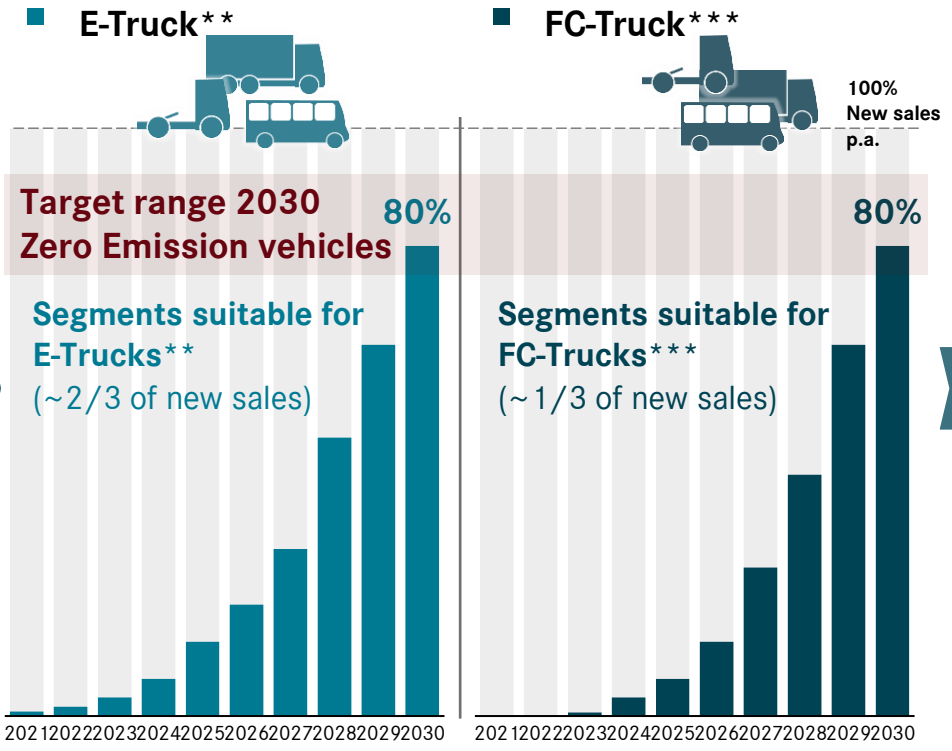


DE Climate Action Law (veh.-fleet)

CO_2 emission target by 2030 p.a. (share HDV)



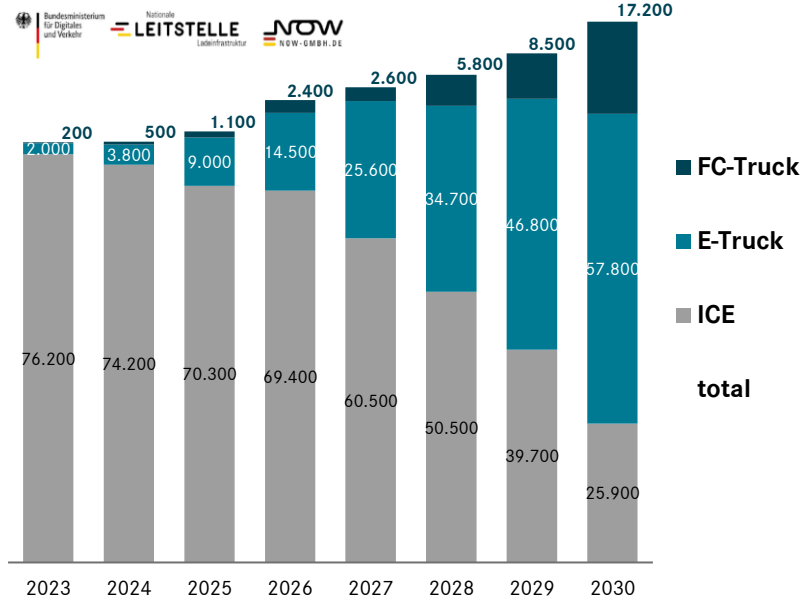
Required uptake ZEV in % of new sales 2021 – 2030*



** 2019 new sales ~95,000 units*
*** HD comm. vehicles, battery-electric*
**** HD comm. Vehicles with fuel cell*

Green H_2-Demand ca. **400.000to p.a. by 2030!**

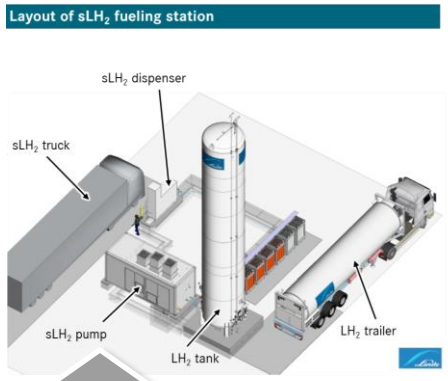
Forecast new sales per year of heavy trucks in Germany
(results of bilateral talks between OEM and Ministry of Transport in 2022)



- **A massive ramp-up of Zero Emission Trucks would be necessary to achieve the German CO_2 reduction ambition !**

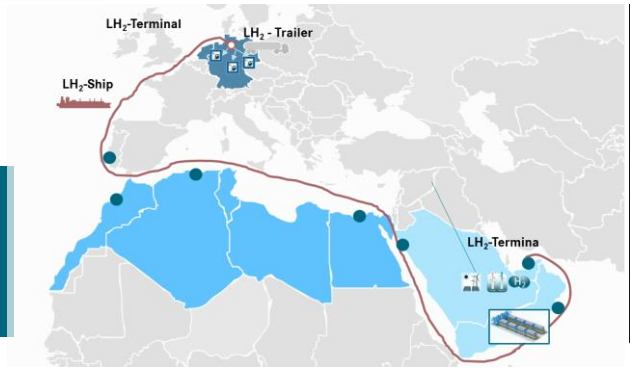
DAIMLER TRUCK is working on all aspects of the new transportation system

Hydrogen infrastructure



collaboration

Lighthouse-projects & Standards
H2MOBILITY
Shell
TOTAL
bp
H2Accelerate

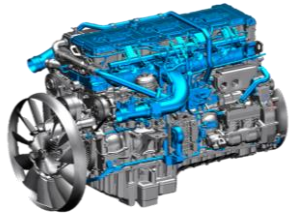


Green Hydrogen Supply

Fuel Cell System

cellcentric
A Daimler Truck & Volvo Group Company

Hydrogen engine



- Changing with H_2-ICE

Standardization

ISO/TC 197
Hydrogen Technologies

and others

Fuel Cell and H_2-ICE trucks

MB GenH2

H_2-ICE Unimog

Mercedes-Benz Actros

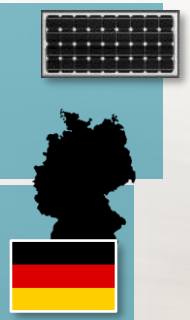
Ready for Battery and Fuel Cell

Many components identical for BEV and H_2/FC !

The **energy efficiency** story: BEV and FC/H_2 not far away and still a lot of optimization potential on the FC/H_2 side …

Comparison of energy demand

Size of PV (Germany) 170 m²



grid loss

charging station

charging vehicle

vehicle (85%)

110 kWh/100 km @wheel

BE trucks
long-haul

Size of PV field (Middle East) 210 m²

H_2 electrolysis

liquefaction

transport)

station

vehicle (46%)

110 kWh/100 km @wheel

FC electric trucks
long-haul

FC electric truck: Range >1000km w/o refueling

Mercedes-Benz GenH2 Truck, presented already in 2020:
Fully dedicated to heavy-duty long-haul transportation

Performance

Fuel-cell system	→	**2x150 kW**
HV battery	→	**400 kW** (time limited) **70 kWh**
H_2 storage	→	**80 kg (LH_2)**
Voltage level	→	**800V**
eMotor power	→	**2 x 230 kW** (cont.) **2 x 330 kW** (peak)
eMotor torque	→	**2 x 1,577 Nm** (cont.) **2 x 2,071 Nm** (peak)

CO_2 Impact: Locally emission free

Refueling time: ~ 10 minutes

Fuel Cell Technology: 30 years fuel cell know-how evolve in a tailor-made truck system Partnership with Volvo Group provides scale and industry leadership

Creating Customer Value

- Purpose-built fuel cell design, optimized for efficiency, longevity and high-volume production
- First vehicle tests running in Europe – more than1,000km w/o refueling
- First prototype vehicle for US in build-up

Creating Scale

Commonality

- One global platform for all Daimler Truck brands
- Same electric drivetrain between BEV and FCEV

Partnership

- cellcentric as 50:50 JV with Volvo - open for other customers

DAIMLER TRUCK cellcentric VOLVO VOLVO GROUP

H_2 combustion engine as complementary technology: Depending on transportation task it can be an attractive choice, but limit should be 1 to 2g CO_2/tkm

KEY: Regulatory Framework nearly given for the EU27:

(3) Article 3 is amended as follows:
(g) point (11) is replaced by the following: '(11) 'zero-emission vehicle' means the following vehicles:
(a) **a heavy-duty motor vehicle with not more than 5 g/(t·km) or 5 g/(p·km) of CO_2 emissions** as determined in accordance with Article 9 of Regulation (EU) 2017/2400;
(b) ...

Creating Customer Value

Advantages

- Similar vehicle packaging as Diesel
- Higher payload than BEV & FCEV
- Lower vehicle price than BEV & FCEV

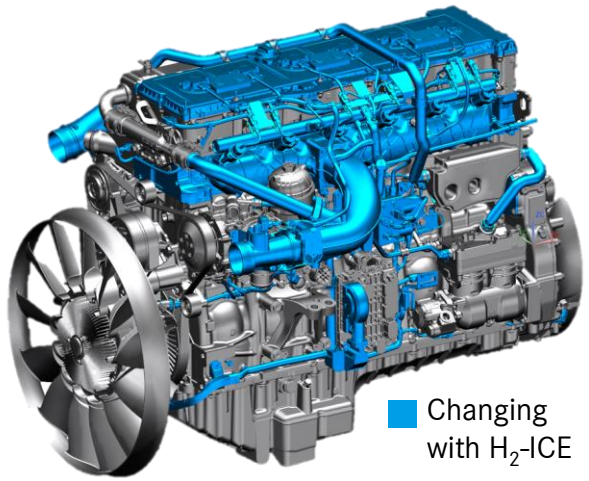
Disadvantages

- Higher energy consumption

Creating Scale

Commonality

- Relevant core engine parts and assets stay the same
- Established supplier landscape can be leveraged
- Same refueling infrastructure and vehicle tank as FCEV possible



Changing with H_2-ICE

Infrastructure must fit to vehicle technology: Liquid hydrogen as additional solution especially for large scale demand (e.g. 8 to H_2 per station and day)

AFIR on EU-level disappointing,
but Germany with encouraging announcements

!

Translating AFIR requirements
into numbers of chargers and H_2 stations

	AFIR 2030	ACEA 2030
Charging points		
TEN-T		
800 kW	-	**30,000**
350 kW	**17,000***	**15,000**
Urban node⁺		
150 kW	5,000	5,000
Parking Areas⁺⁺		
100 kW	3,800	*not quantified****
H_2	**cH_2 only**	
TEN-T	200*	2,000**
Urban node⁺	424	

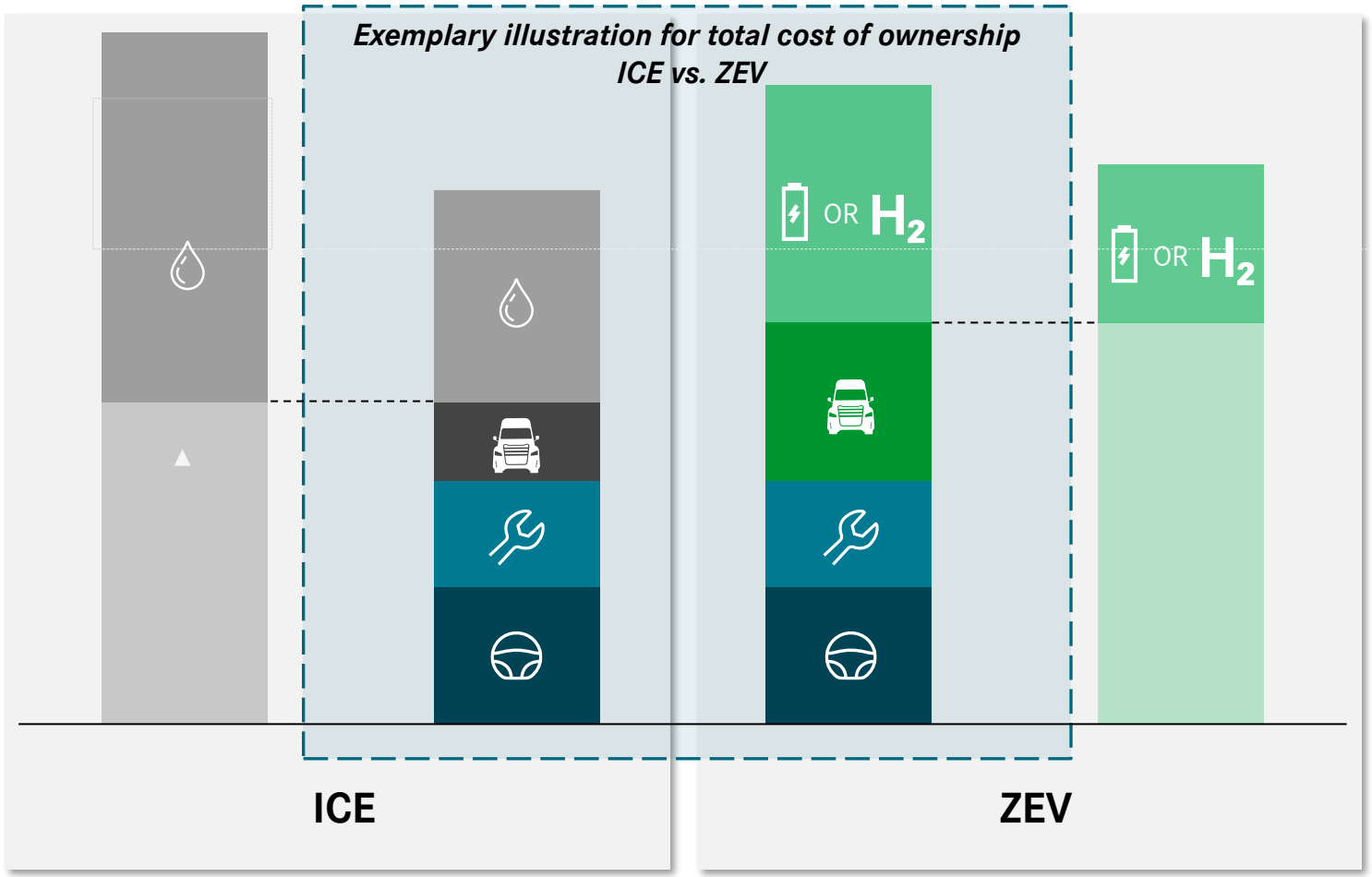
Targets way to low to achieve -45% CO_2 fleet target in 2030

TCO: Energy prices are crucial for TCO and thus decarbonization speed

External policy support needed to make green hydrogen cheaper than diesel

Strongly depending on **"CO_2 price"**

Strongly depending on: **"Green Energy Price" - Target: 5€/kg @ HRS**



There is a long way to go and a lot of investments necessary… Development and built up of the H2 infrastructure will need time! Does this all fit into a 2030 timeline?

Factor 1
Product Offering

Products are there
- but remain costly!
3 times more expensive
(KsNI-insight)

X

Factor 2
Infra-structure

Infrastructure is lacking
Targets are 3 times too low

X

Factor 3
Cost Parity

CO_2 pricing/CO_2 tolls too modest
Level is 6 - 8 times too low!

H_2

Smaller stations — Around 2024/25 starting initial activities

Larger stations — Supply of green H_2 2026-28 ramping up

CO_2 tax (ETS II) — Minor support

CO_2 toll — Germany / Europe — CO2 implemented on right level only until 2032!

Energy Costs — Hydrogen, expensive during ramp up
H2-Global could be quite helpful