Zero emission logistics with hydrogen heavy duty trucks

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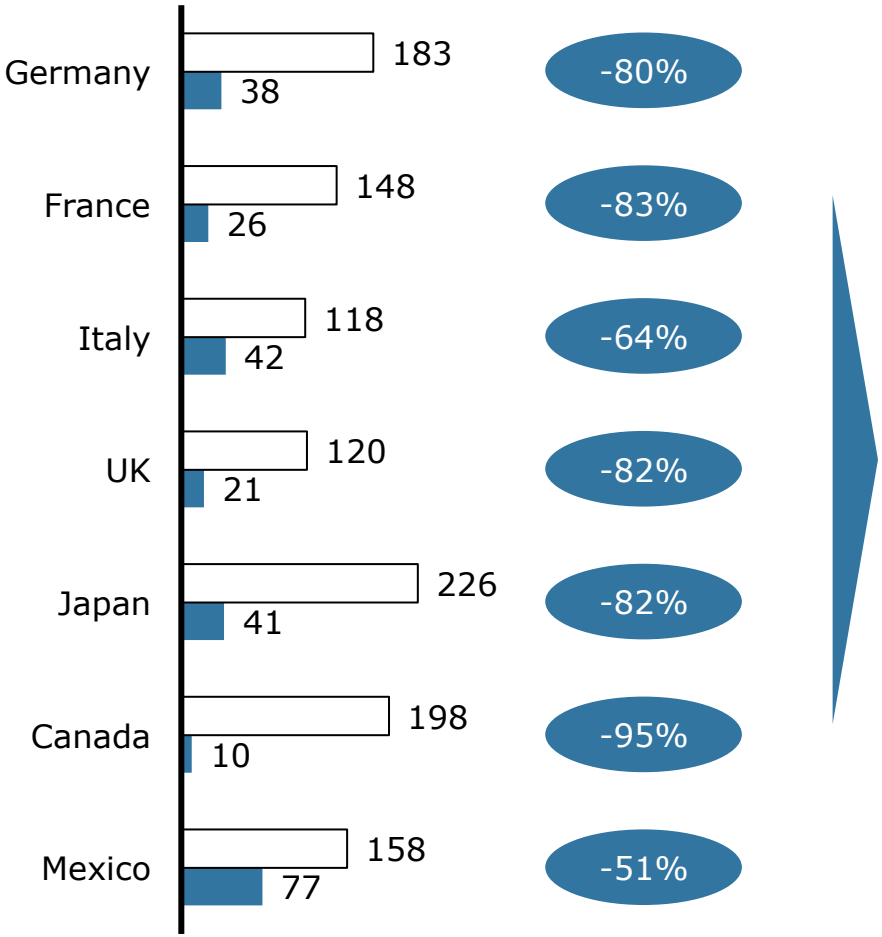
Decarbonization is a worldwide initiative and will happen

Actual and planned greenhouse gas emissions for transportation segment

In $MtCO_2$



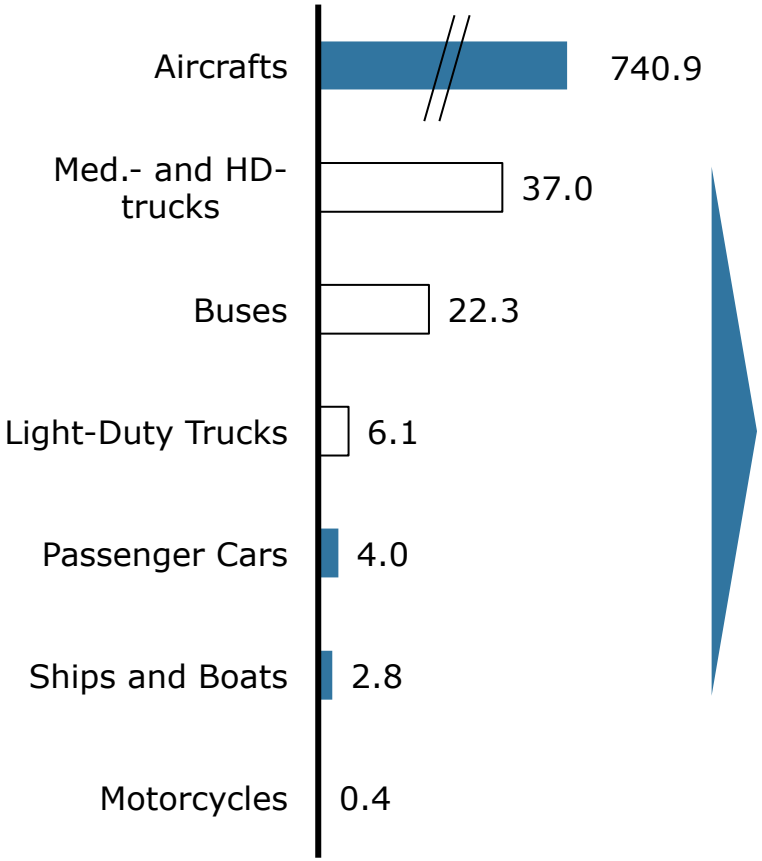
- Average projected greenhouse gas savings of more than 77% by 2050
- World-wide initiative
- Primary focus on heavy consumers necessary
- Are these objectives realistic?
- Implementation plan?

Source: DDPP, Pathways to deep decarbonization for several countries, 2015 reports

Trucks and buses emitting more CO_2 than cars
Example USA

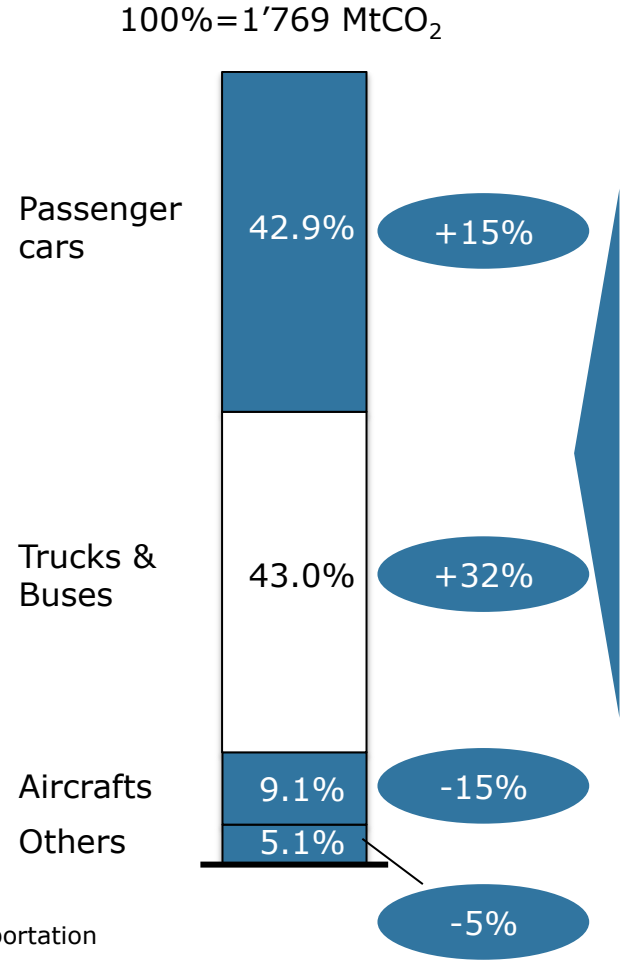
US greenhouse gas emissions per unit and transportation category

In tCO_2 per unit/vehicle



US split of CO_2 emission by transportation category

In $MtCO_2$



Diff. 1990 vs. 2015

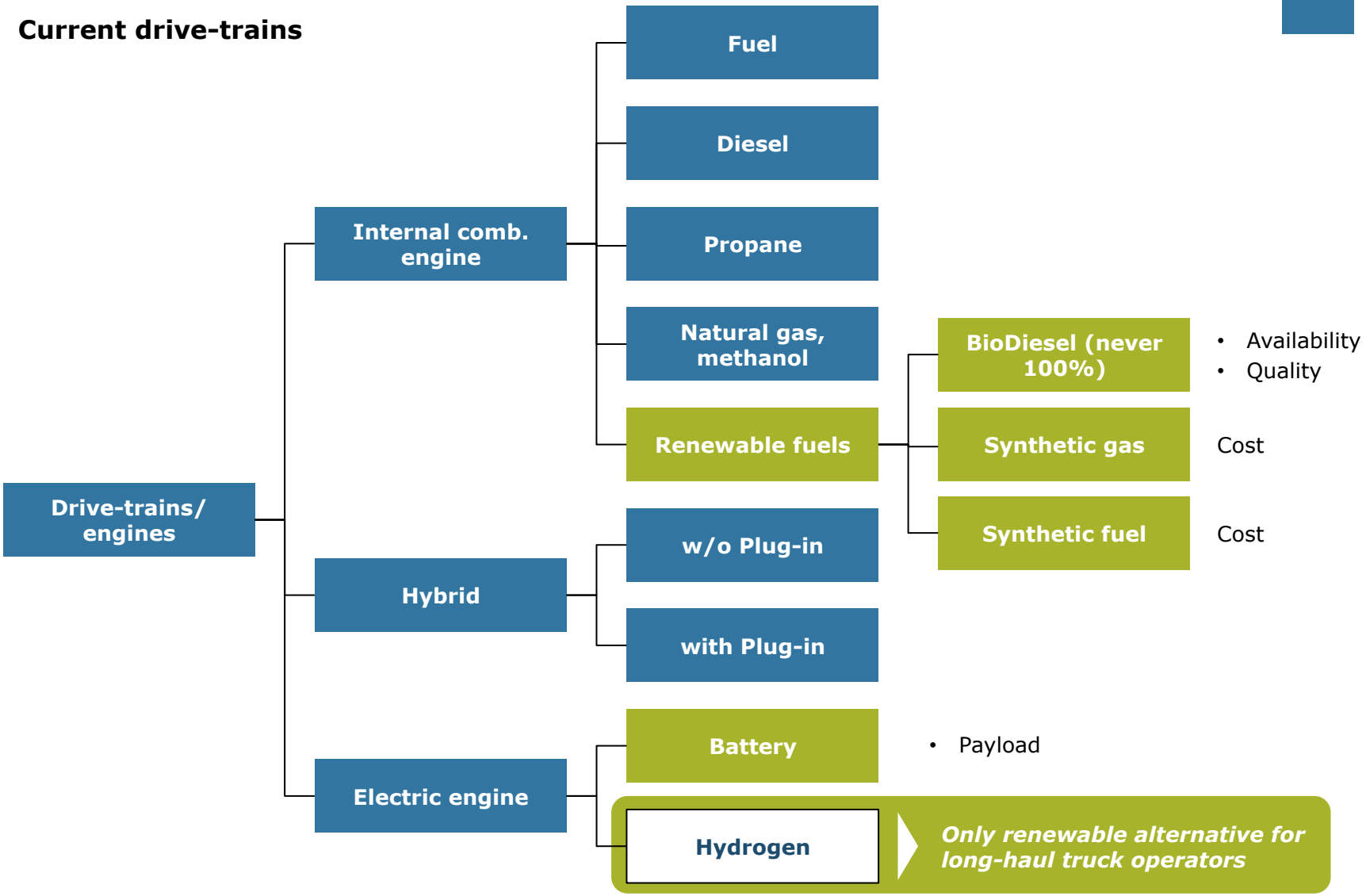
- Replacing fossils for aircrafts is a challenge
- Second biggest categories to focus on are trucks and buses
- 'Tesla' will not safe the planet: trucks & buses account for an equivalent amount of CO_2 emissions

Source: US Environmental Protection Agency, Office of Transportation and Air Quality, EPA-420-F-17-013, July 2017

Hydrogen is only viable non fossil alternative for long-haul trucks

Fossil

Current drive-trains

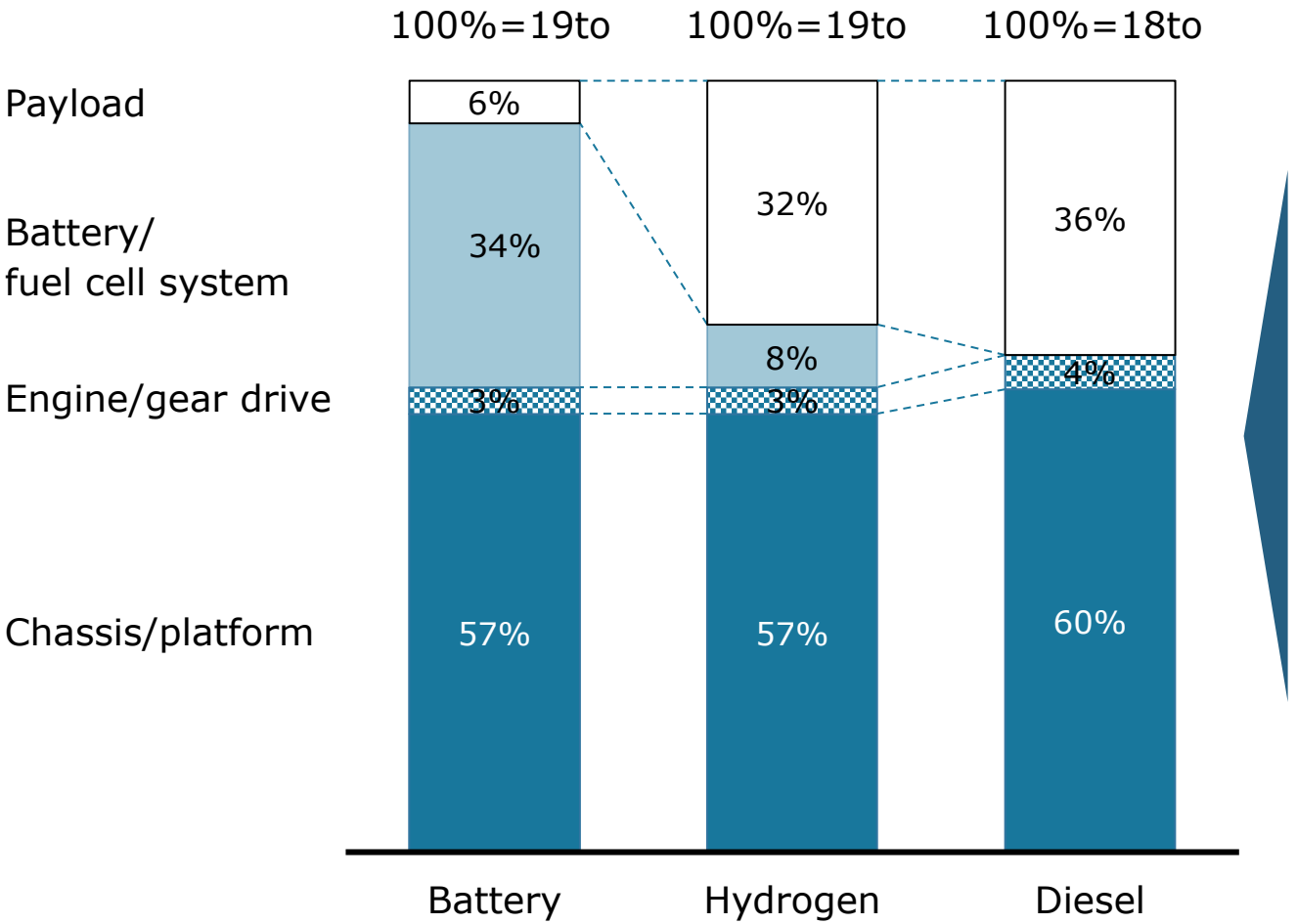


Payload of only one ton for 400km battery electric truck

Calculation Coop H2 truck

Weight calculation for 18/19 ton heavy duty rigid vehicle with standard platform and drive train

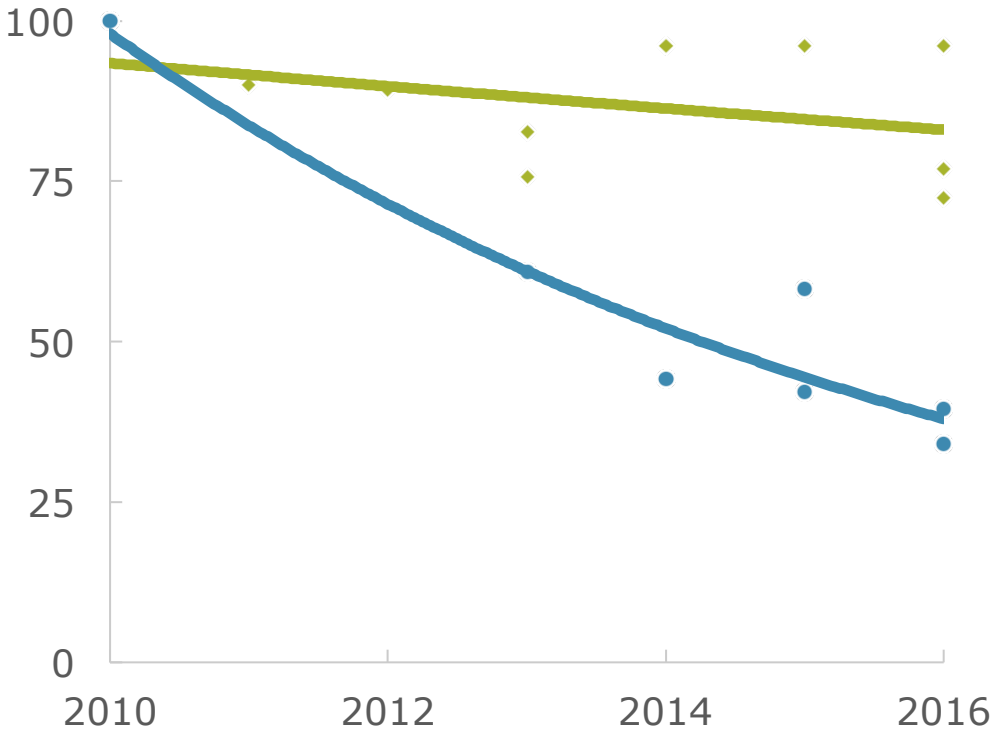
In Percent



- On May 7, 2017 federal council of Switzerland allows one additional ton of payload for electrified trucks
- Without this decision the battery truck would have zero payload left
- Hydrogen with comparable payload

Despite improvement of gravimetric weight for cells total weight of battery pack not reduced sufficiently

Battery weight per watt hour
Development since 2010, in percent
(starting point approx. 100Wh/Kg)



Quelle: emvalley.com

Main reasons for additional weight of battery packs:

- Cooling
- Holder
- Controlling & monitoring systems
- etc.

No serial OEM production of H2 trucks, despite the fact hydrogen being the only solution for decarbonizing trucks

Truck OEMs	Brands	Inhouse fuel cell technology	Perceived interest in hydrogen (status 2017)
VOLVO	Volvo Trucks, Mack Trucks, DU Trucks, Renault Trucks	Not available	High
DAIMLER	Mercedes-Benz, Sterling Trucks, Western Star, Freightliner Trucks, Unimog, Mitsubishi Fuso	Available	Unclear
DONGFENG Trucks	Dongfeng (JVs mit Kia, Honda, Nissan)	Not available	Very high
VOLKSWAGEN TRUCK & BUS / MAN / SCANIA / Caminhões Ônibus / RIO	Scania, MAN, Volkswagen	Not available	Unclear
IVECO	Iveco	Not available	Very high
TATA	Tata, Daewoo	Not available	Very high

World wide innovation: Coop 34t truck with trailer

Potential to fully substitute diesel drive trains

Fuel cell system 100kW

H2 dispenser
350 bar high flow
Left to cabin

Chassis
MAN TGS

H2 refilling system
7 x 4.93 = 34.5 kgH2 gross ➔ pay load 31 kg H2

Electric engine
Synchronic engine 250KW constant, Allison 4 gear automatic

Electric plug-in
Left side, 2 x 22kW charging performance, plug: 63A, 400VAC, only on weekends

Battery
Total 120kWh (2x60 kWh), left and right in front of back axes

Cooling system
Underneath, right, electric supply of trailer cooling system

Composition
Load volume: 30 transport units (normally 33)

Coop hydrogen system – closing the energy cycle

Hydrogen Coop trucks
convert hydrogen into electricity and water vapor; on board electricity then feeds electric engine; water vapor transitions into rain and feeds the run-of-the-river-plant

Run-of-the-river-plant
delivers renewable energy

Coop hydrogen refueling station
offers hydrogen to it's customers

H_2 Energy's **electrolyzer**
transforms water and renewable energy into hydrogen

H_2 Energy's **hydrogen trailer**
stores and delivers hydrogen

Functioning H_2 Energy hydrogen production plant, Coop HRS and fuel cell truck

Coop HRS with H_2 Energy Trailer in the background

H_2 Energy electrolyzer and trailer refilling station

Coop fuel cell truck

Key findings

- Hydrogen technology works, is safe and ready
- Fuel cell technology underrated (especially for trucks & buses)
- Compared with passenger cars, trucks and buses produce equivalent or even higher amounts of CO_2
- Coop truck able to fully replace diesel trucks with no restrictions on payload, range, refueling time and external energy consumption (cooling, etc.)
- Truck OEM's needed to make chance happen, extremely high interest from Asian truck OEM's for hydrogen
- Further advantages of technology
  - Fuel cell trucks boosting H2 infrastructure for passenger cars
  - Hydrogen could help boosting image for truck industry

Thank you for your attention

www.h2energy.ch