

# Getting zero emission trucks on the road

## From regional to long-haul

**Comparing the costs and benefits of different technologies: A case study for Germany**

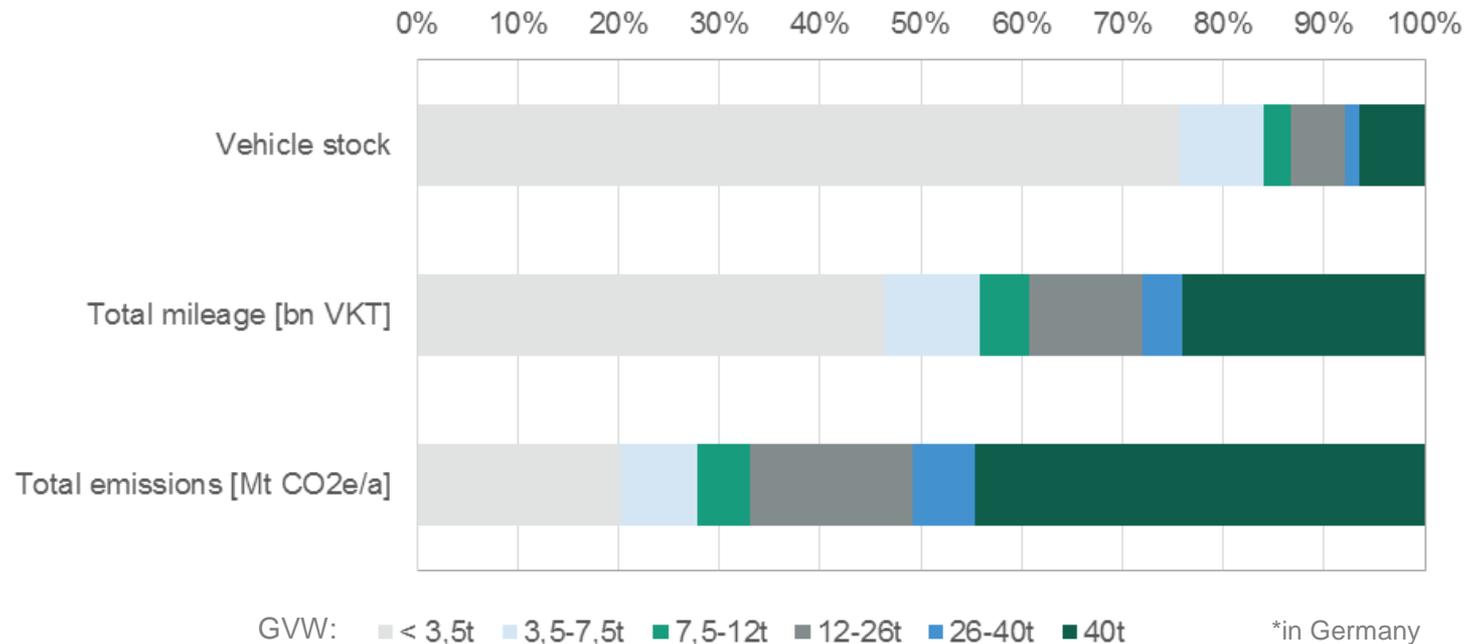
Florian Hacker

Brussels, 19.02.2020

# 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

Vehicle stock, total mileage and CO<sub>2</sub> emissions of commercial vehicles\*



# 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
- In long-haul transport there is **no clear favourite** powertrain alternative to the diesel engine yet
- 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

# What are the propulsion and fuel options for zero emission long-haul transport?

## Direct use of electricity



**Battery-electric (BEV):** electric drive; large battery in combination with ultra fast charger



**Overhead catenary electric (OC):** electric drive; electricity uptake from overhead catenary line, second drive / energy supply via hybrid powertrain (**HEV**) or smaller battery (**BEV**)

## Indirect use of electricity



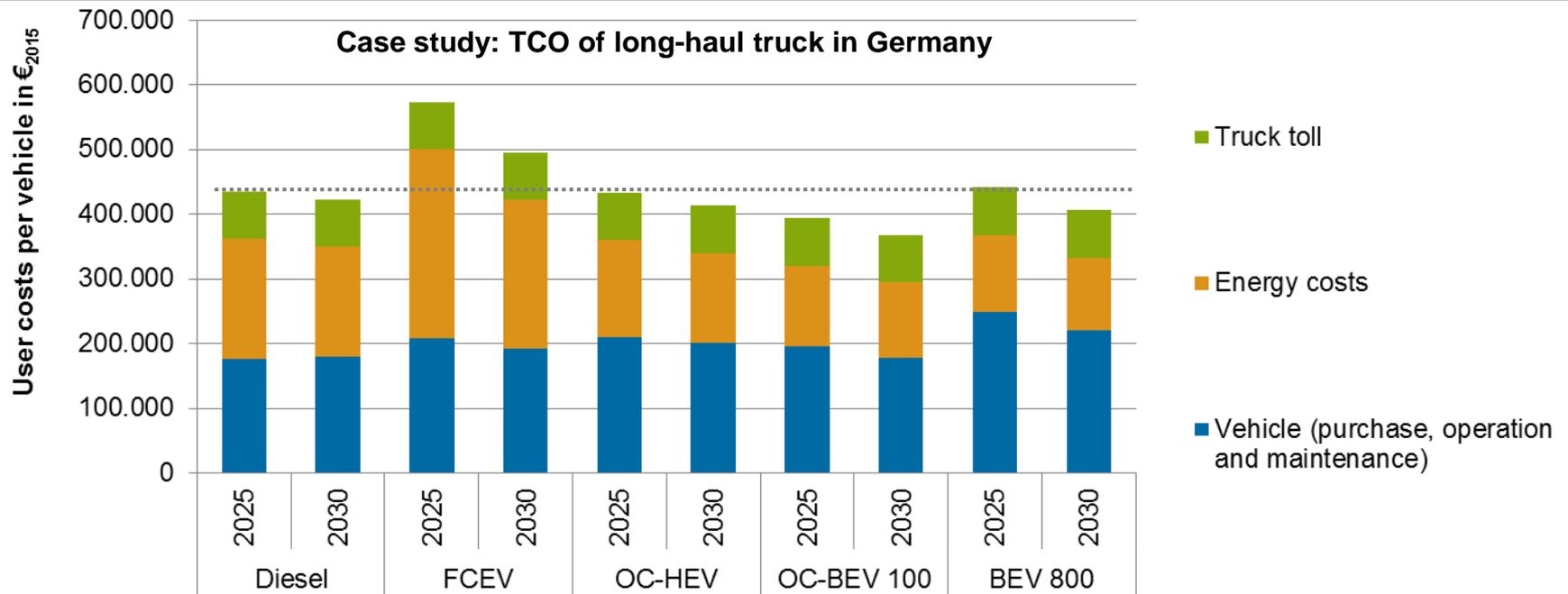
**Fuel cell electric (FCEV):** electric drive; electricity is generated in an on-board fuel cell based on hydrogen



**Internal combustion engine (ICEV):** conventional propulsion with hydrocarbon synthetic fuel (so-called efuel)

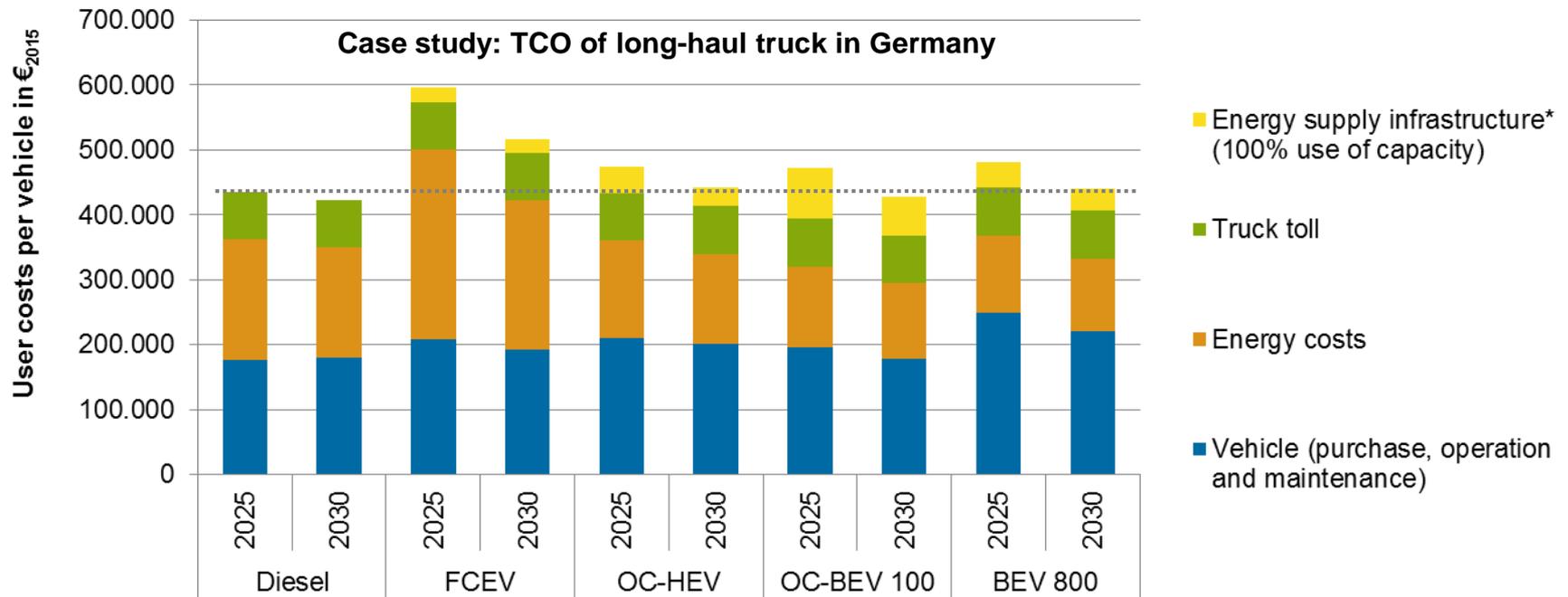
# Electric propulsion systems in long-haul transport offer near-term cost advantages

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



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

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

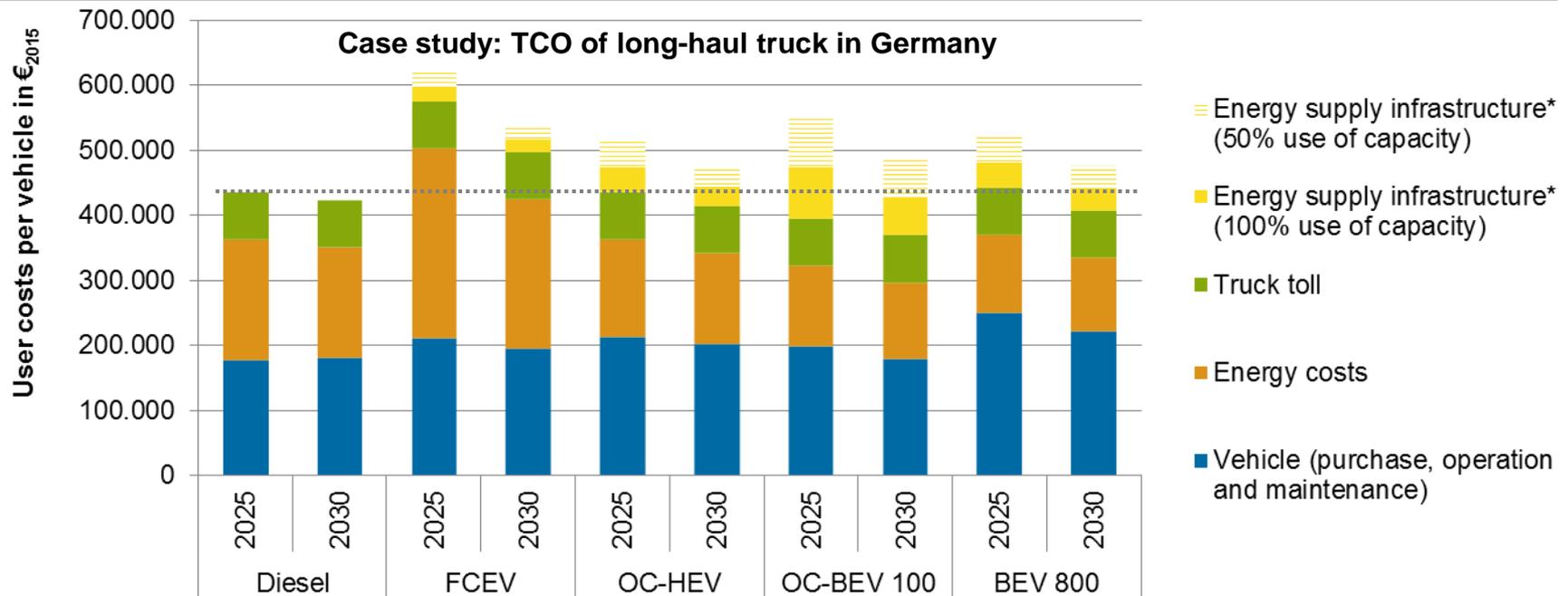


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\*Energy supply infrastructure: hydrogen filling station, overhead line system or station-based charging infrastructure

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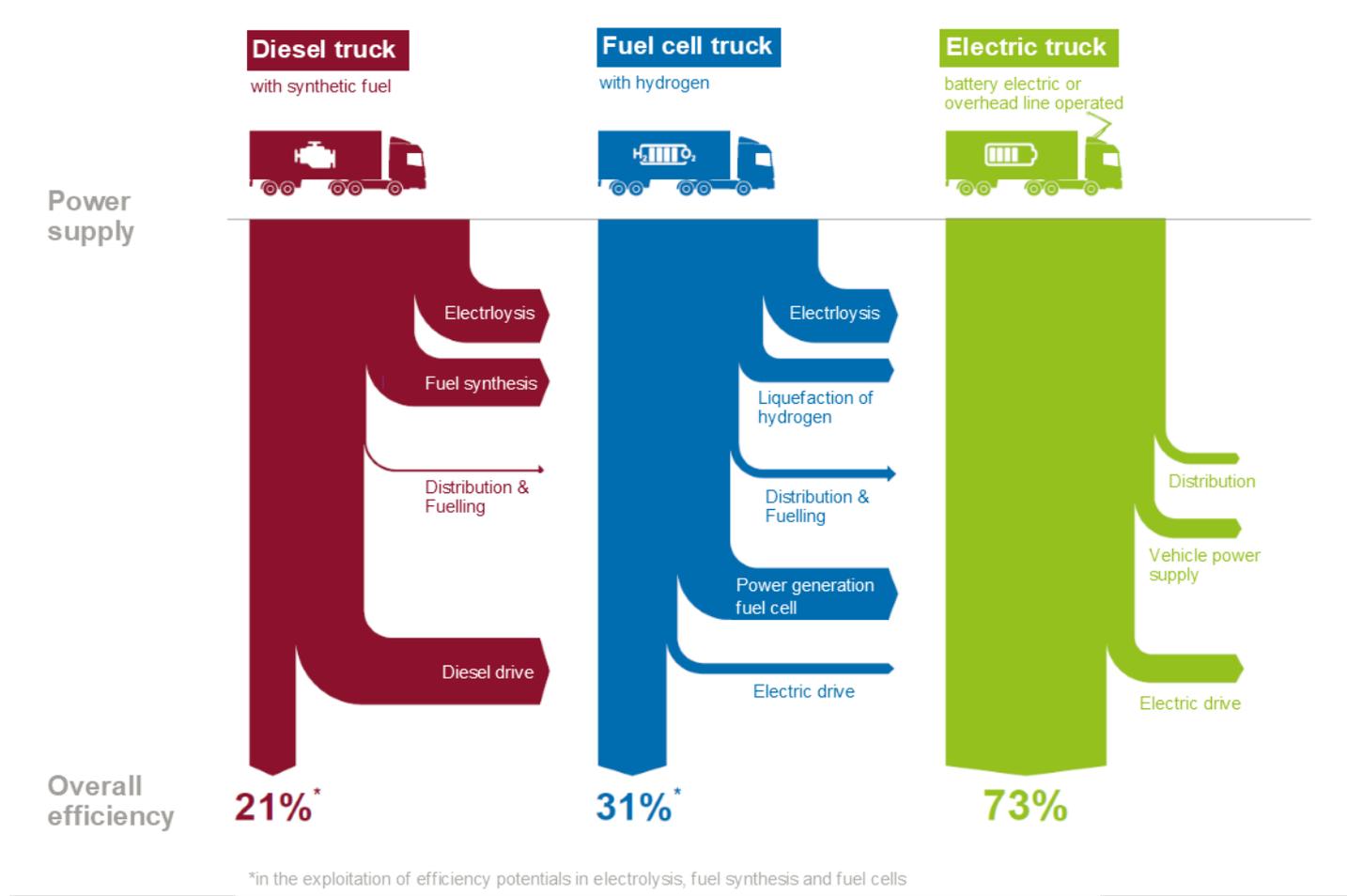
- Availability of energy supply infrastructure is key to market ramp-up of alternative drives
- If early users fully carry infrastructure cost, this will hinder economic operation



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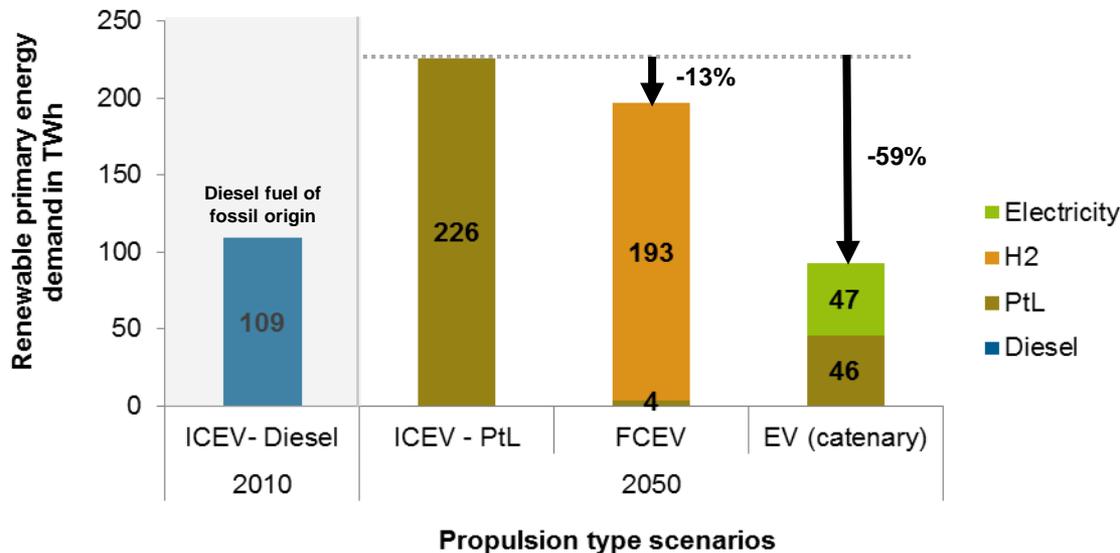
# Direct use of electricity is by far the most energy efficient option for climate-neutral long-haul HDV operation



# 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, H<sub>2</sub>) 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



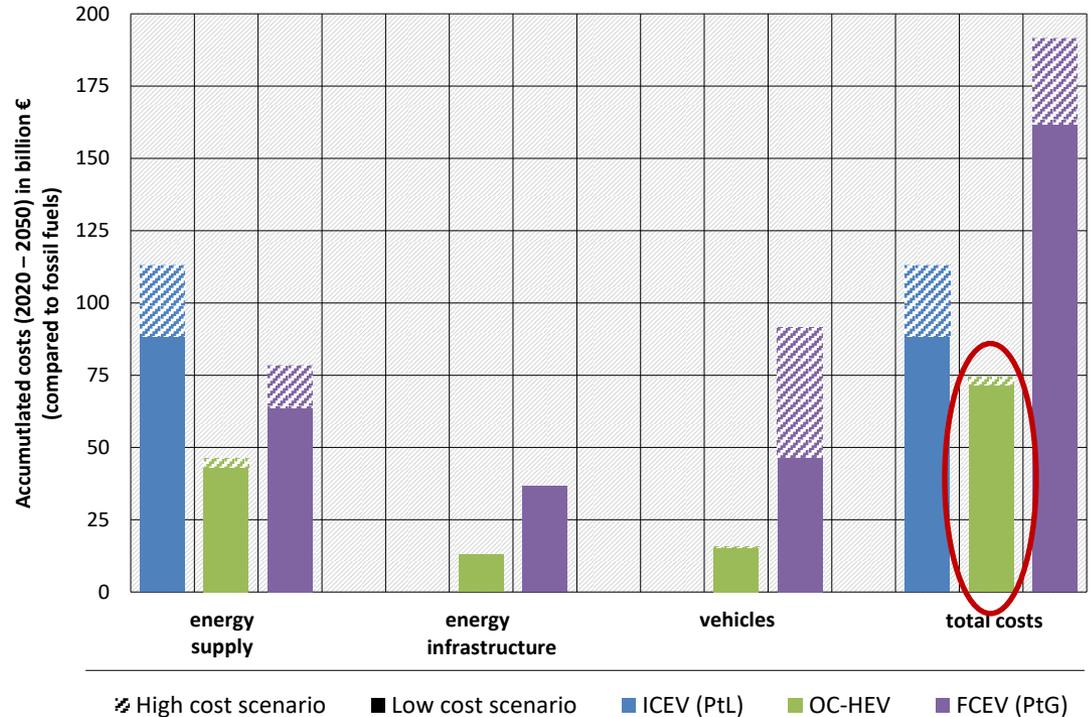
Net electricity generation from renewable energies in Germany 2017: **210 TWh**

### 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 %

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

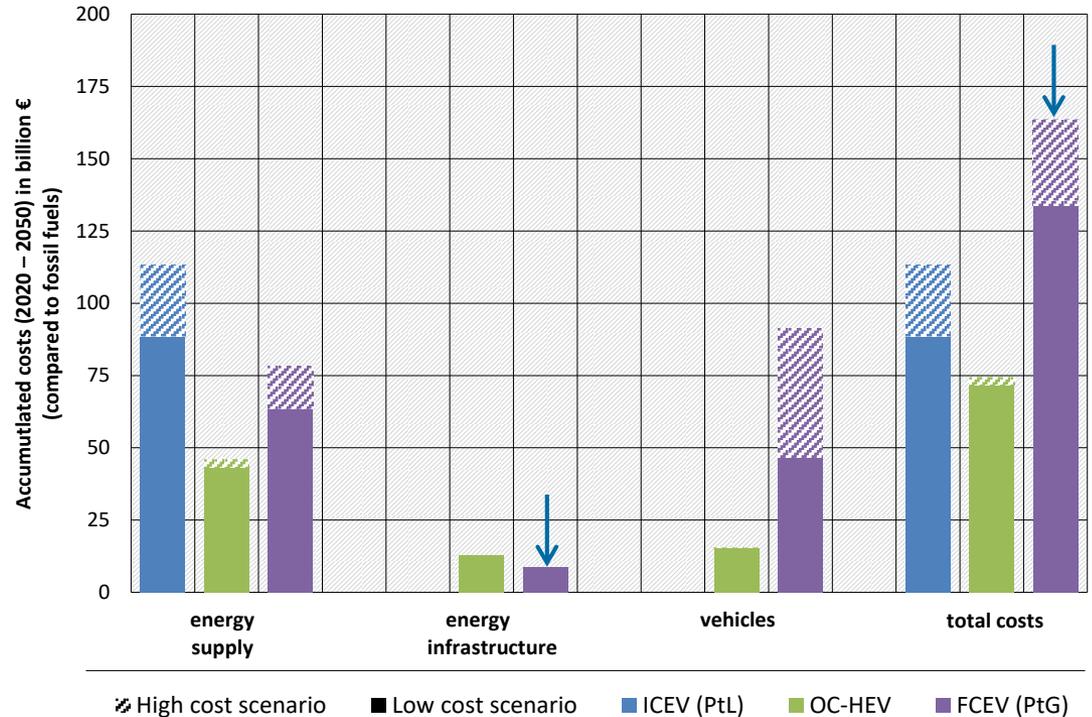
## Case study: Decarbonisation of German long-haul freight transport



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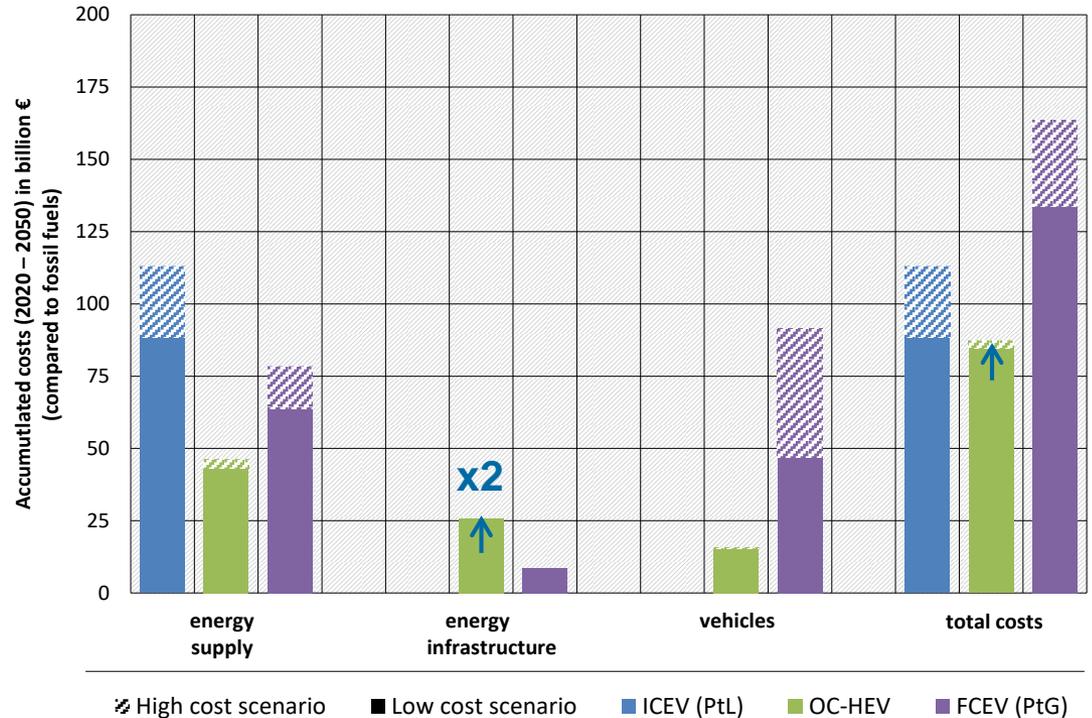
**Sensitivity:**  
 Low investment costs for H<sub>2</sub> infrastructure



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

**Case study:  
Decarbonisation of German  
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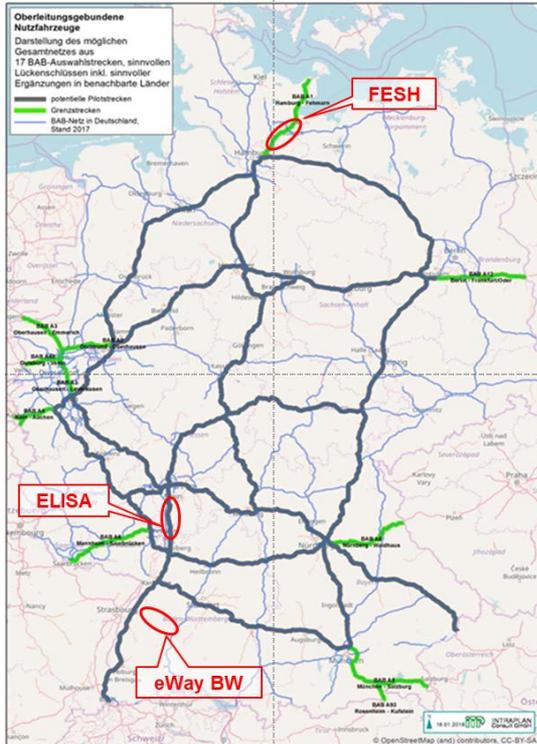
**Sensitivity:  
High investment costs for  
overhead catenary network**



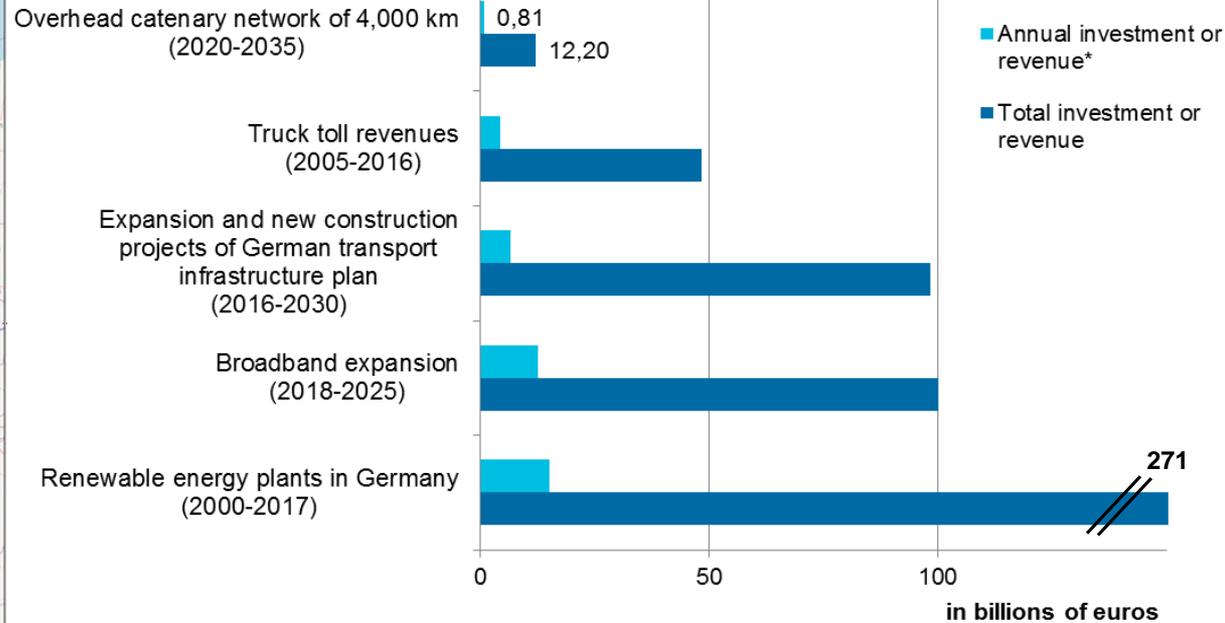
- Decarbonisation of freight transport is related to considerable economic costs
- Total costs are determined by the energy costs
- Costs of infrastructure and vehicles are less important from this perspective
- Direct use of electricity shows **robust** economic cost advantages

# 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

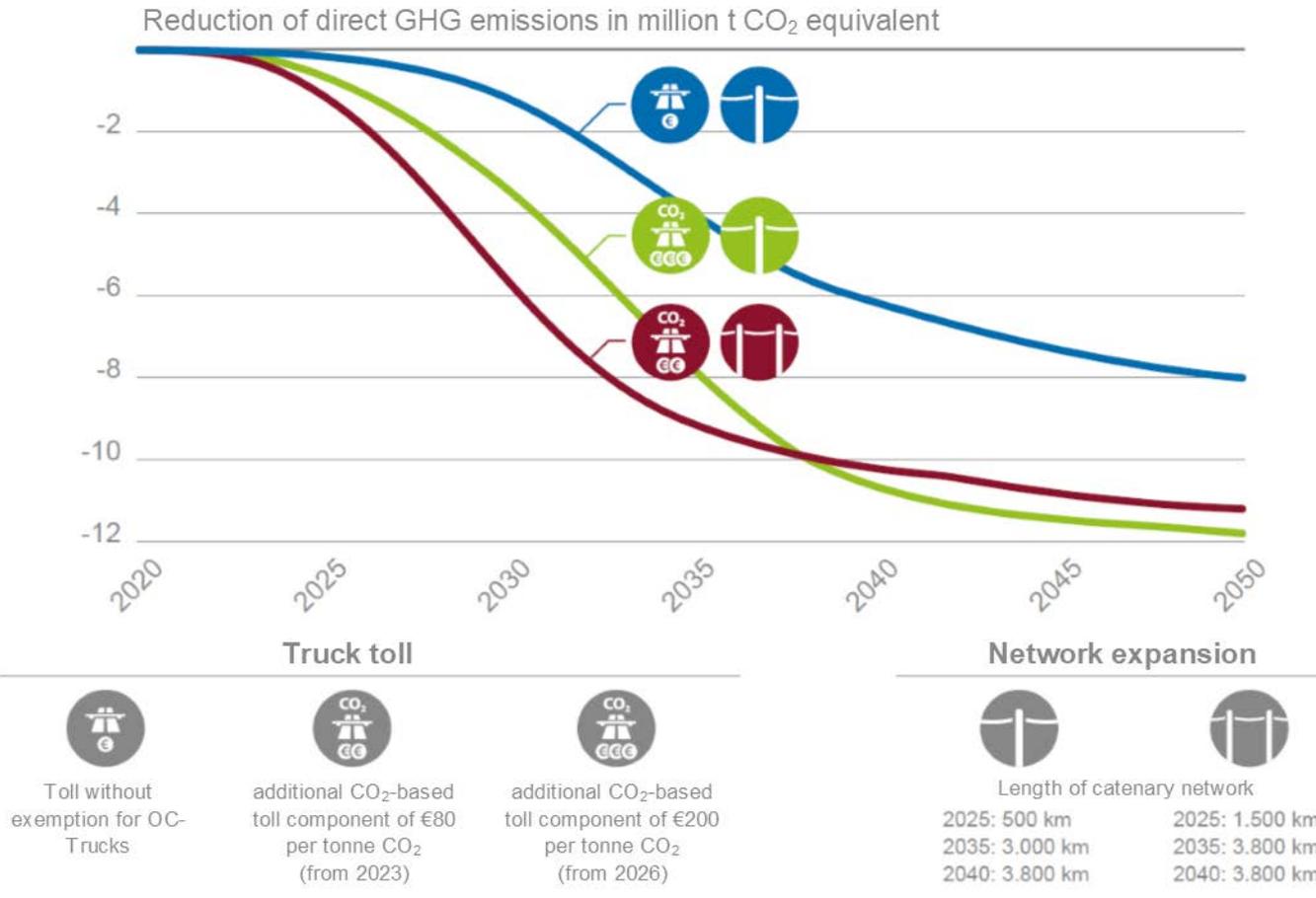


Overhead catenary network of 4,000 km (2020-2035)



# Speed of infrastructure development and CO<sub>2</sub> pricing decisive for GHG reduction of ZE trucks – the example of OC-HDV

## Three scenarios with different toll designs and network expansion rates



- Rapid infrastructure development is a key requirement for relevant GHG reduction
- CO<sub>2</sub>-based truck toll system: establishes a **polluter pays relationship**, creates a **robust user cost advantage**, enables **infrastructure financing**

# Electrification of long-haul road transport: Conclusions

- **Electrification enables climate neutrality** of road freight transport
- Electric trucks **can already be operated economically** in the near future
- The **direct use of electricity is the most efficient** and requires the least expansion of renewable energies
- **Infrastructure costs** are particularly relevant in the start-up phase, but are **of secondary importance in the long term**
- The **GHG mitigation** potential is highly **dependent on** the speed of **infrastructure development**

# What should happen now?

## Plan of action

- **Planning security for market players:** Align freight transport policies with GHG emissions
- **Guarantee infrastructure expansion:** Develop a reliable infrastructure expansion plan and public financing of infrastructure
- **Framework conditions for the supply side:** Set minimum quota for new electric truck registrations
- **Framework conditions for the demand side:** Base truck tolls on CO<sub>2</sub> emissions
- **Practical experience:** Enable and promote larger implementation projects in public road space
- **International cooperation:** Initiate cross-border technology development and start standardization at an early stage

A challenging journey from today's situation to the set targets – decisive action is required!

**Targets set in the German government's climate package (09/2019) for the year 2030:**

**One third** of road freight transport performance **on the basis of electricity**

**Number of electric trucks (>12 t payload) registered in Germany in 2019:**

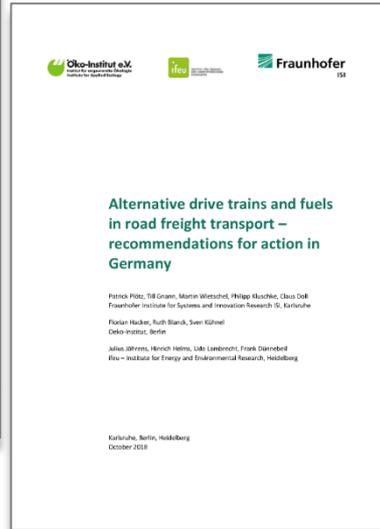
**8** out of 120.000

# Further reading: Recent and forthcoming 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



**Final report (02/2019)**  
energy supply options of the transport sector



**StratON final report (02/2020)**  
assessment of overhead catenary trucks



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# Thank you for your attention!

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