Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

# 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**

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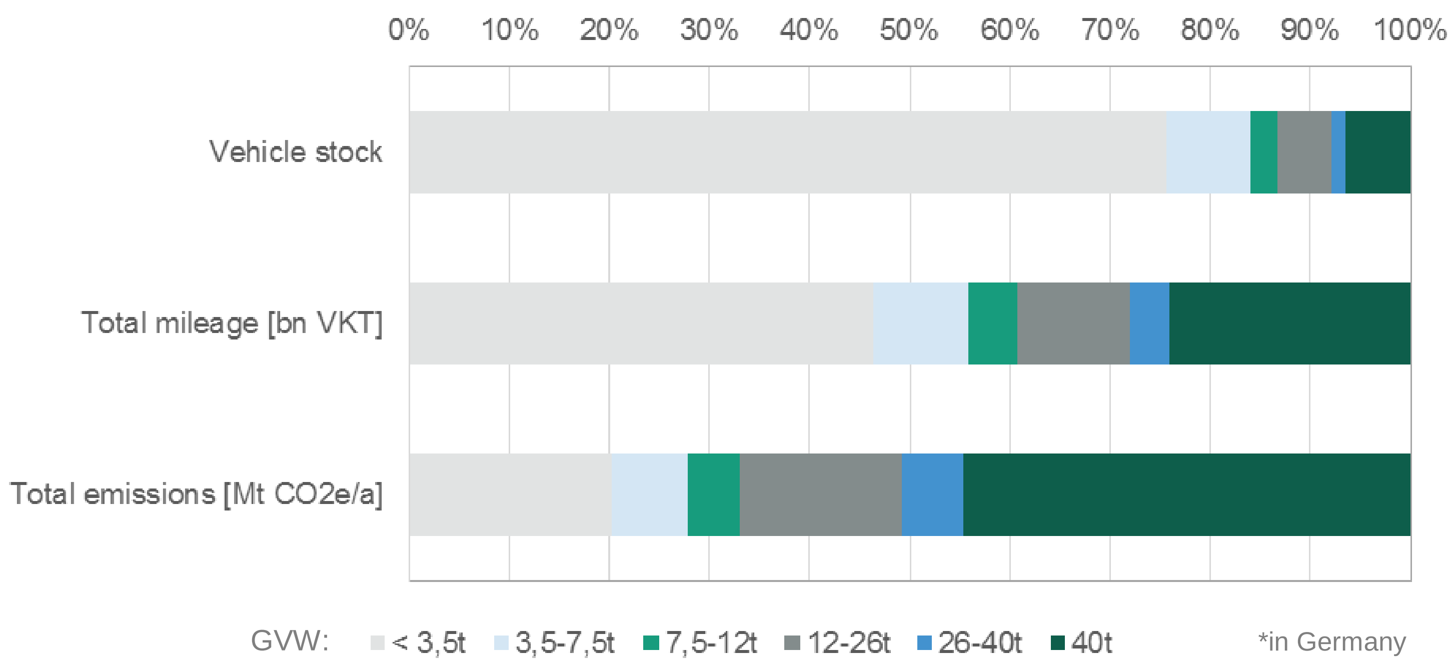
Brussels, 04.12.2018

# 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

**Vehicle stock, total mileage and $CO_2$ emissions of commercial vehicles***




*in Germany



**Source:** Fraunhofer-ISI, Öko-Institut, ifeu (2018): Alternative Drives and Fuels in the Road Freight Transport – Recommendations for Action for Germany

# 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

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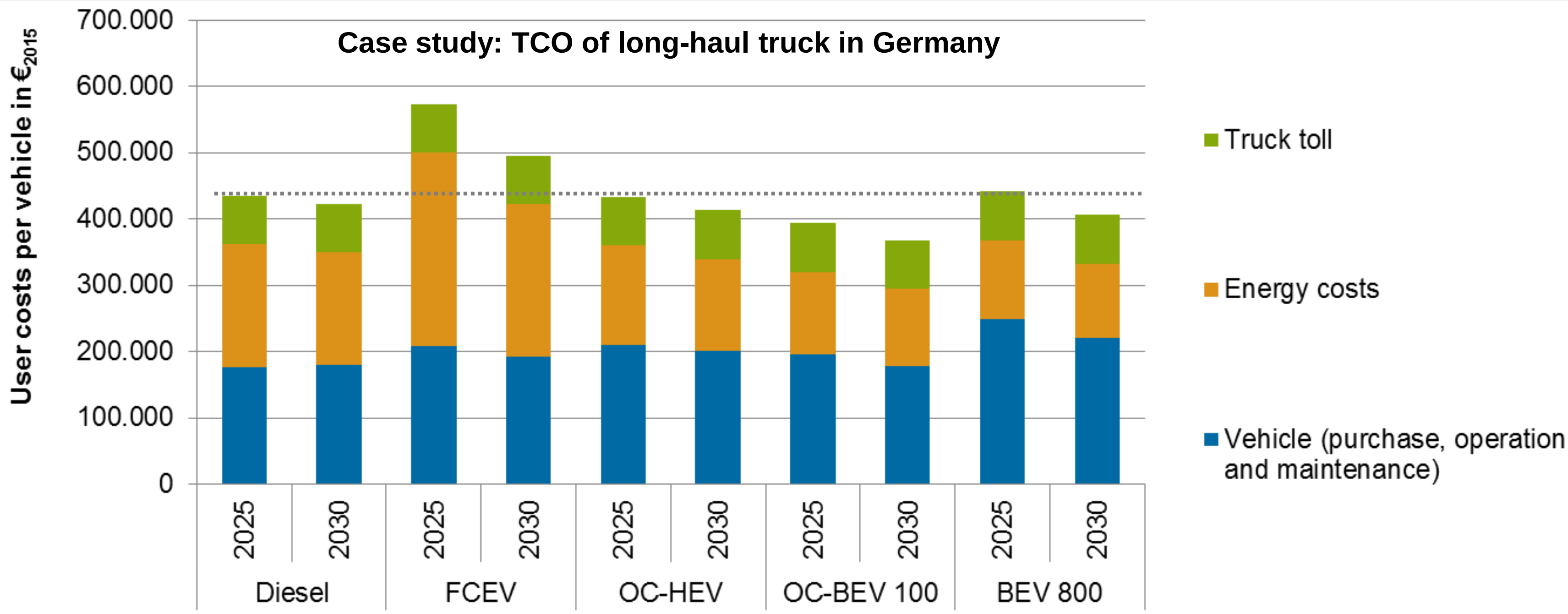
# Electric propulsion systems in long-haul transport offer near-term cost advantages

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



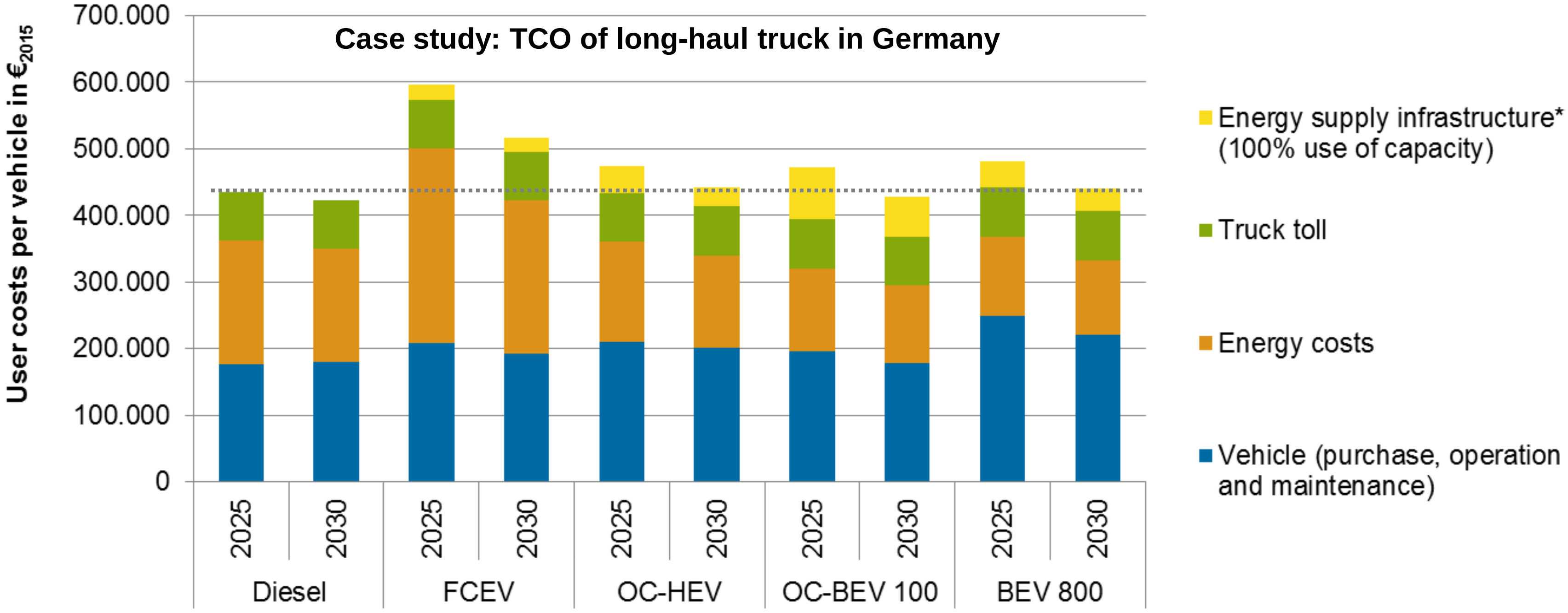

Assumptions of TCO: operation of a long-haul truck in Germany, user costs excl. VAT, 3,5% discount rate, 5 years of vehicle operation, annual mileage of 120.000 km

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



**Source:** Öko-Institut (2018): Oberleitungs-Lkw im Kontext weiterer Antriebs- und Energieversorgungsoptionen für den Straßengüterfernverkehr. Ein Technologie- und Wirtschaftlichkeitsvergleich. Subreport of StratON project

# 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

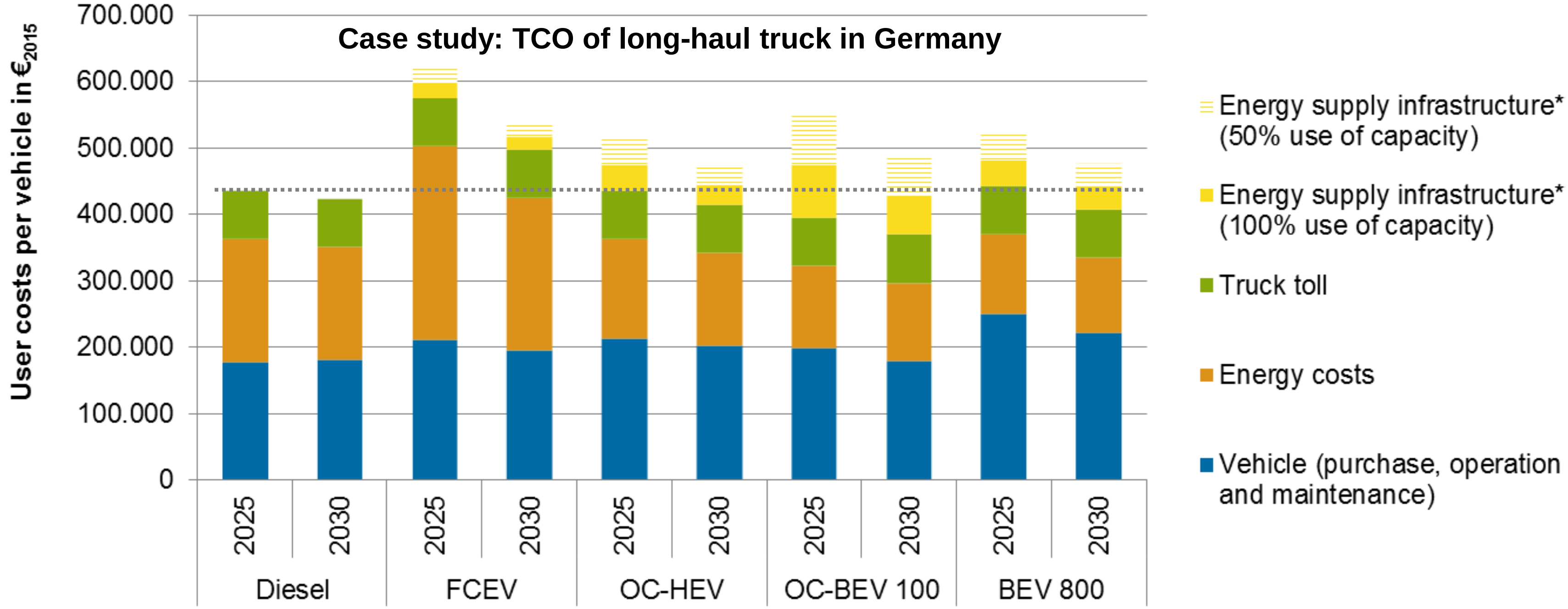
*Energy supply infrastructure: hydrogen filling station, overhead line system or station-based charging infrastructure



**Source:** Öko-Institut (2018): Oberleitungs-Lkw im Kontext weiterer Antriebs- und Energieversorgungsoptionen für den Straßengüterfernverkehr. Ein Technologie- und Wirtschaftlichkeitsvergleich. Subreport of StratON project

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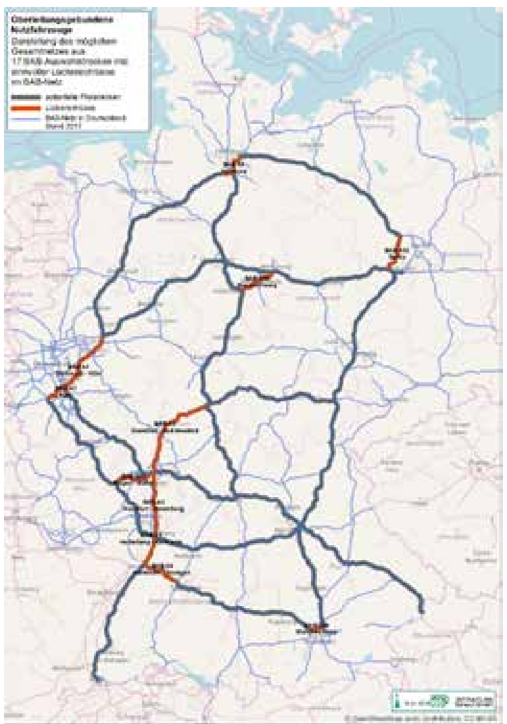
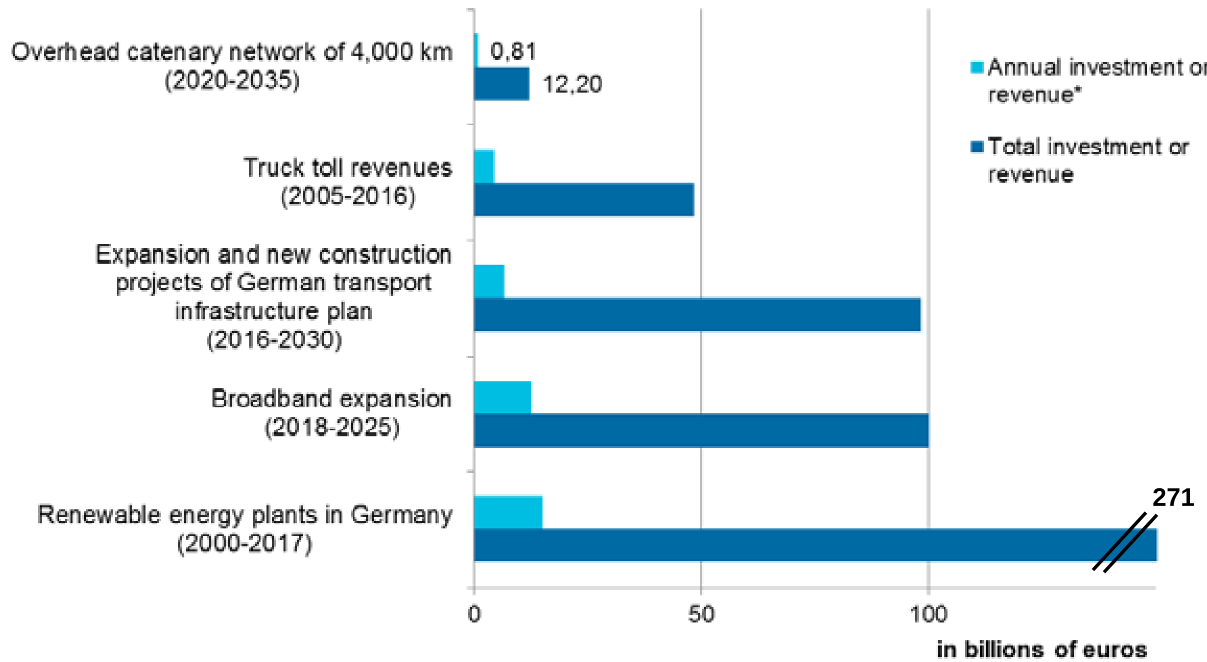
# Example of overhead catenary core network (4.000 km) in Germany: relatively low investment required

- 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





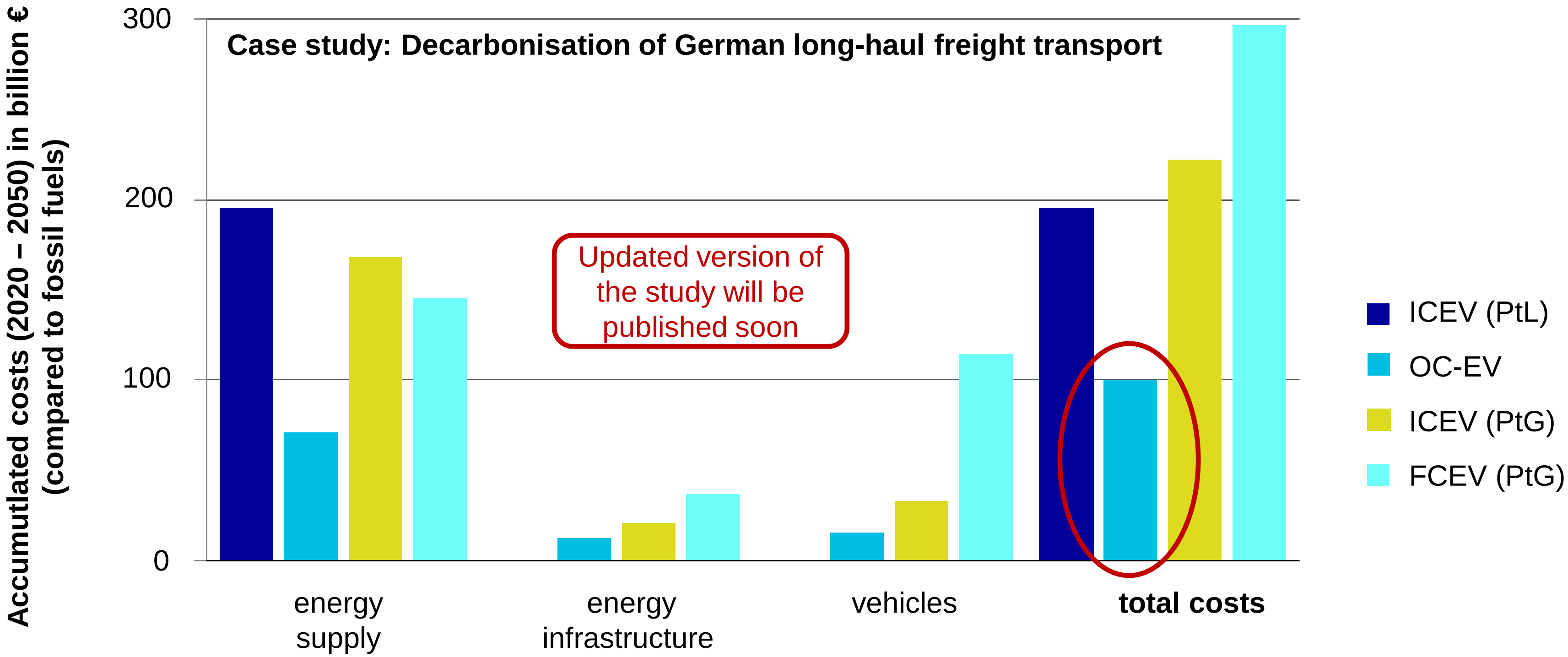

*Average annual toll revenues or infrastructure investments during the indicated period



**Source:** Öko-Institut (2018): Oberleitungs-Lkw im Kontext weiterer Antriebs- und Energieversorgungsoptionen für den Straßengüterfernverkehr. Ein Technologie- und Wirtschaftlichkeitsvergleich. Subreport of StratON project

# 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



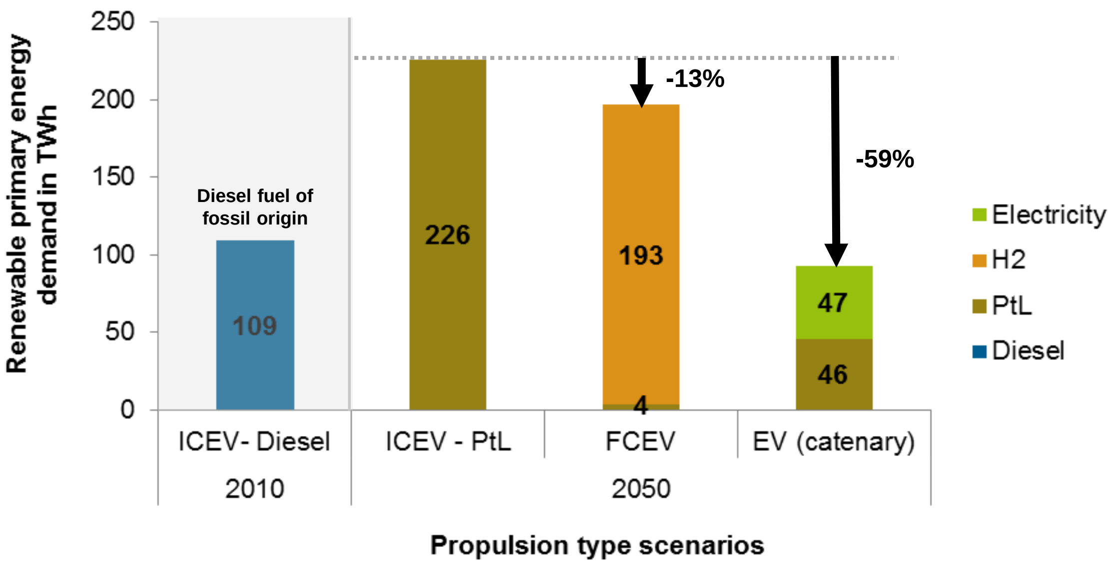



**Source:** Öko-Institut et al. (2016): Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050. Study commissioned by the Federal Environment Agency (UBA)

# 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, $H_2$) 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) à WTT efficiency: 48%
- **EV (catenary):** OC-vehicles with 75% electric mode and 25 % conventional mode (PtL); WTT erfficiency of electricity: 85 %



**Source**: Own illustration based on Öko-Institut et al. (2016): Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050. Study commissioned by the Federal Environment Agency (UBA)

# 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
  - Ø 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
  - Ø 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


Oberleitungs-Lkw im Kontext weiterer Antriebs- und Energieversorgungsoptionen für den Straßengüterfernverkehr

Ein Technologie- und Wirtschaftlichkeitsvergleich

Berlin, 13.09.2018

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


Alternative drive trains and fuels in road freight transport – recommendations for action in Germany

Ø **Available on our website: www.oeko.de**

# Thank you for your attention!

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