Costs of the energy supply infrastructure for trucks with alternative driving system from a user and macroeconomic perspective in Germany

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Motivation and research questions

- Among possible powertrain alternatives in long-haul transport, there is no clear favourite yet.

- All alternative propulsion options require investments in energy supply infrastructure and significantly change the cost structure of freight transport.

- The question of the economic viability of alternative propulsion systems in freight transport is relevant from both a user and a macroeconomic perspective.

**Research questions:**

- How economically competitive is ERS in the comparison of propulsion options from a user and macroeconomic perspective?

- How relevant are the necessary infrastructure investments in relation to the total costs in the short or long term?
### Methodological approach: Total cost of ownership and macroeconomic costs

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<thead>
<tr>
<th><strong>TCO:</strong></th>
<th><strong>Macroeconomic costs:</strong></th>
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<tbody>
<tr>
<td>- Cost perspective of truck operator</td>
<td>- Cost perspective of society as a whole</td>
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<td>- Comparison of different acquisition years (2025 and 2030)</td>
<td>- Total costs of carbon neutral road freight transport until 2050</td>
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<td>- Include vehicle costs (purchase, operation, maintenance), energy costs, toll &amp; energy supply infrastructure</td>
<td>- Include costs of energy supply, energy infrastructure and additional vehicle costs</td>
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<td>- GHG-emissions of different propulsion options are different</td>
<td>- Excludes taxes, toll</td>
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<td>- All technology scenarios achieve the same GHG reduction</td>
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Main assumptions for cost comparison from a user perspective (TCO)

- **Vehicle costs and efficiency (2025):**
  - Diesel: 107,000 €, 27 l/100 km;
  - FCEV: 154,000 €, 2.3 kWh/km;
  - OC-HEV: 155,000 €, 25 l/100 km or 1.6 kWh/km;
  - OC-BEV: 133,000 €, 1.6 kWh/km
  - BEV 800: 231,000 €, 1.5 kWh/km

- **Fuel costs (2025):** Diesel 1.11 €/l; electricity 0.14 €/kWh; H₂ 0.23 €/kWh

- **Taxes and levies:** no VAT; truck toll 0.19 €/km;

- **Infrastructure (costs, performance, occupancy rate):**
  - H₂-Station: 6.3 million €, 110 trucks per day
  - OC-System: 2.6 million €/km, 1 MW/km, up to 8 vehicles per km
  - Charging point: 420,000€ (1.2 MW) and 80,000€ (150 kW)
TCO of ERS depends highly on infrastructure utilisation

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
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Sensitivity: Exemption of truck toll and pricing of CO$_2$ on diesel

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First findings – TCO perspective of ERS

- OC-ERS already competitive in the near term -> lower operating costs compensate for higher vehicle costs
- FCEV with highest TCO-cost of the alternative propulsion options
- BUT: uncertainties remain regarding the development of technology costs, energy prices and regulatory / fiscal framework
- 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
- In the long term, the costs for the overhead catenary infrastructure (operation and replacement) can be financed by the users
Main assumptions regarding economic costs of different long-term decarbonisation pathways

- Technologies: ICEV, OC-HEV, FCEV
- Requirement: zero GHG emissions of all options in 2050, comparable reduction of emissions among technologies in interim years
- Vehicle costs and efficiency:
  - The additional vehicle costs for the drive options compared to the ICEV are similar to those in the TCO except FCEV. Energy consumption slightly below the TCO-assumptions
- Fuel costs: High and low energy cost scenario, efuels are significantly more expensive than fossil fuels (diesel 0.58 €/l vs. PtL-diesel 1.75€/l in 2030)
- Infrastructure:
  - Investment costs: OC-System 2.4 million €/km, a total of 4,000 km is build between 2023 and 2040,
  - the utilization rate increases from 10% (2030) to 54% (2040) and 100% in 2050;
Overall costs of carbon neutral road freight transport until 2050

Accumulated costs (2020 – 2050) in billion € (compared to fossil fuels)

- High cost scenario
- Low cost scenario
- ICEV (PtL)
- OC-HEV
- FCEV (PtG)

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Sensitivity:
FCEV infrastructure: low costs

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Sensitivity: 
ERS infrastructure: high costs

Accumulated costs (2020–2050) in billion € (compared to fossil fuels)

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<th>Energy infrastructure</th>
<th>Vehicles</th>
<th>Total costs</th>
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<td>OC-HEV</td>
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- **ICEV (PtL)**
- **OC-HEV**
- **FCEV (PtG)**

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First findings – macroeconomic perspective

- Total additional cost of transition to carbon neutral road freight transport until 2050: direct use of electricity in OC-HEV leads to the lowest costs.

- PtL-ICEV leads to 20% - 50% higher additional costs compared to OC-HEV, the costs for FCEV are more than twice as high as for OC-HEV.

- Robust results regarding FCEV with variation of energy supply costs, vehicle manufacturing and infrastructure costs.

- The costs of energy supply dominate the total costs, the costs of energy infrastructure are relatively low.
Conclusions & open questions

- The investment costs for the overhead catenary infrastructure are moderate from a macroeconomic perspective, but cannot be passed on to the first users.
- In the market ramp-up phase with low capacity utilisation, the allocation of infrastructure costs risks the economic operation of overhead catenary trucks.
- In the long term, the costs for the overhead catenary infrastructure (operation and replacement) can be covered by the users. This requires a medium to high utilisation of the overhead system.
- How can this critical period be bridged to finance the infrastructure?
- What contribution should conventional trucks make to the financing of OC-infrastructure?
Further reading


will be published soon
Thank you for your attention!

Do you have any questions?
Let's get in contact

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