Decarbonisation of road transport

Comparison of technical options including electric road systems

Moritz Mottschall/
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Our Profile

Oeko-Institut is a leading European research and consultancy institute working for a sustainable future.

- A non-profit association founded in 1977
- Offices in Freiburg, Darmstadt and Berlin
- Clients: European Union, national and state-level ministries, companies, foundations and non-governmental organizations
Background

- Ambitious climate protection goals: Reduction of GHG-emissions in Germany (80% to 95% until 2050)
  - Emission “budget” is used in agriculture and industrial processes.
    - Full decarbonisation of the transport sector is needed.

- Long term forecasts show increasing demand of road freight transport

- Limited potential of energy efficiency of conventional trucks
  - Technical measures: e.g. improved aerodynamics, increased engine efficiency, hybridization
  - Management: e.g. speed reduction, reduction of empty trips, increased utilization
CO₂-emissions of the transport sector until 2050

Source: Scenario results of the TEMPS-Modell. Transport demand based on „Verkehrsprognose 2030“, -30 % fuel consumption of new Trucks in 2050
Alternatives to fossil fuels in road transport: Carbon neutral fuels (Biofuels/ PtL)

● **Advantages:**
  - well known vehicle technology and use of existing infrastructure
  - safety

● **Disadvantages:**
  - air pollutant emissions
  - low engine efficiency, energy losses in fuel production
  - limited potential of biomass and competition with food production (biofuels)
  - CO₂-source needed
  - competition with other modes of transport: high demand for liquid fuels in aviation and navigation
Alternatives to fossil fuels in road transport: Hydrogen (PtG) in fuel cell vehicle

- **Advantages:**
  - No air pollutant emissions
  - Efficiency above ICEV
  - No CO₂-source is needed

- **Disadvantages:**
  - High vehicle costs (fuel cell stack and H₂-storage)
  - Energy losses due to electrolysis and liquefaction
  - Safety might be an issue
Alternatives to fossil fuels in road transport: Direct use of electricity

- **Advantages:**
  - high engine efficiency
  - Direct use of renewable energy possible
  - No air pollutant emissions

- **Disadvantages:**

  **Battery only electric vehicles:**
  - not feasible for long haul transport (Electric driving range of 500 km requires an 8t battery)

  **Electric Road Systems (e.g. overhead catenary):**
  - Increased vehicle costs (pantograph, hybrid drivetrain) and infrastructure costs
  - New infrastructure components might increase the vulnerability
Energy efficiency of trucks in 2050 by vehicle concepts and type of fuel

![Diagram showing energy consumption (MJ/km) for different vehicle concepts and fuel types in 2010 and 2050. The graph indicates a decrease in energy consumption from 2010 to 2050, with a notable reduction in PtX energy conversion loss.]

-30% - 55%

3.6 MJ = 1kWh
Study: “Determining an expert strategy for the energy supply of the transport sector up to 2050”

- Comparison of the costs of different energy scenarios and options for a greenhouse-gas-neutral transport sector in 2050.
- Scope: Road- and rail transport, navigation and aviation
- 4 different energy scenarios
- Calculation of the economic costs of:
  - energy supply
  - energy infrastructure
  - vehicles
Economic costs of carbon neutral long haul road freight transport in Germany until 2050

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

- ICEV (PtL)
- OH-ERS
- LNG (PtG)
- FCEV (PtG)

Source: “Determining an expert strategy for the energy supply of the transport sector up to 2050”; work in progress!
Summary

- The decarbonisation of the transport sector is necessary.
- Possible options include the use of carbon neutral fuels (biofuels, PtX) and the direct use of electricity in electric road systems.
- The total economic costs of an overhead-line-ERS are below other options of decarbonisation.
- Advantages of conductive electric road systems:
  - High energy efficiency
  - (local) reduction of air pollutant emissions
- Challenges of electric road systems:
  - International solutions are necessary.
  - New infrastructure components may increase the vulnerability of the road system.
Contact

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Vielen Dank für Ihre Aufmerksamkeit!
Thank you for your attention!

Haben Sie noch Fragen?
Do you have any questions?