INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH HEIDELBERG

Climate-friendly road freight transport – putting catenary trucking in context

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Virtual Tour of Frankfurt eHighway Site – September 10th, 2020

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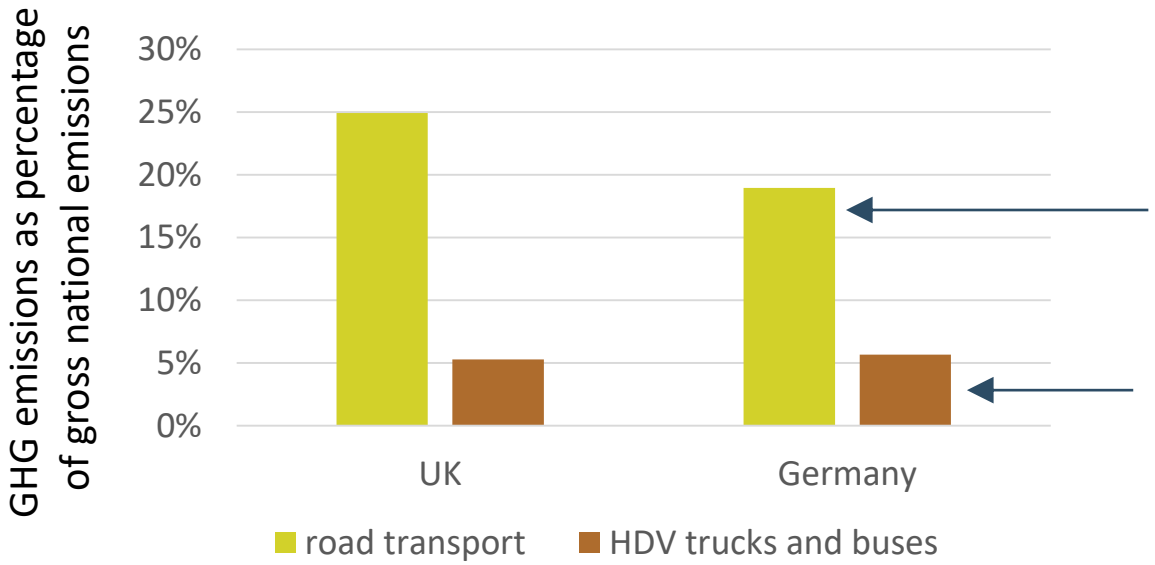
Outline

- Technology options for HDV decarbonization
  - Efficiency and GHG emissions
  - Transition pathways and costs
- Policy implications

Climate targets and the role of HDV transport



German Targets 2030

- 40 %

- 33 %

→ „1/3 on electricity!“

Similar GHG contribution of HDV transport in UK and Germany.

→ **Rapid and consistent action is required**

Data: Eurostat (https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do) , data for 2018

Technology options for decarbonizing HDV Candidates

Direct usage of electricity (Battery, catenary vehicles or a combination of both)

Hydrogen / fuel cell

Synthetic eFuels / combustion engine

- All of these options rely on renewable electricity as primary energy
- Multiple hybridisation options exist

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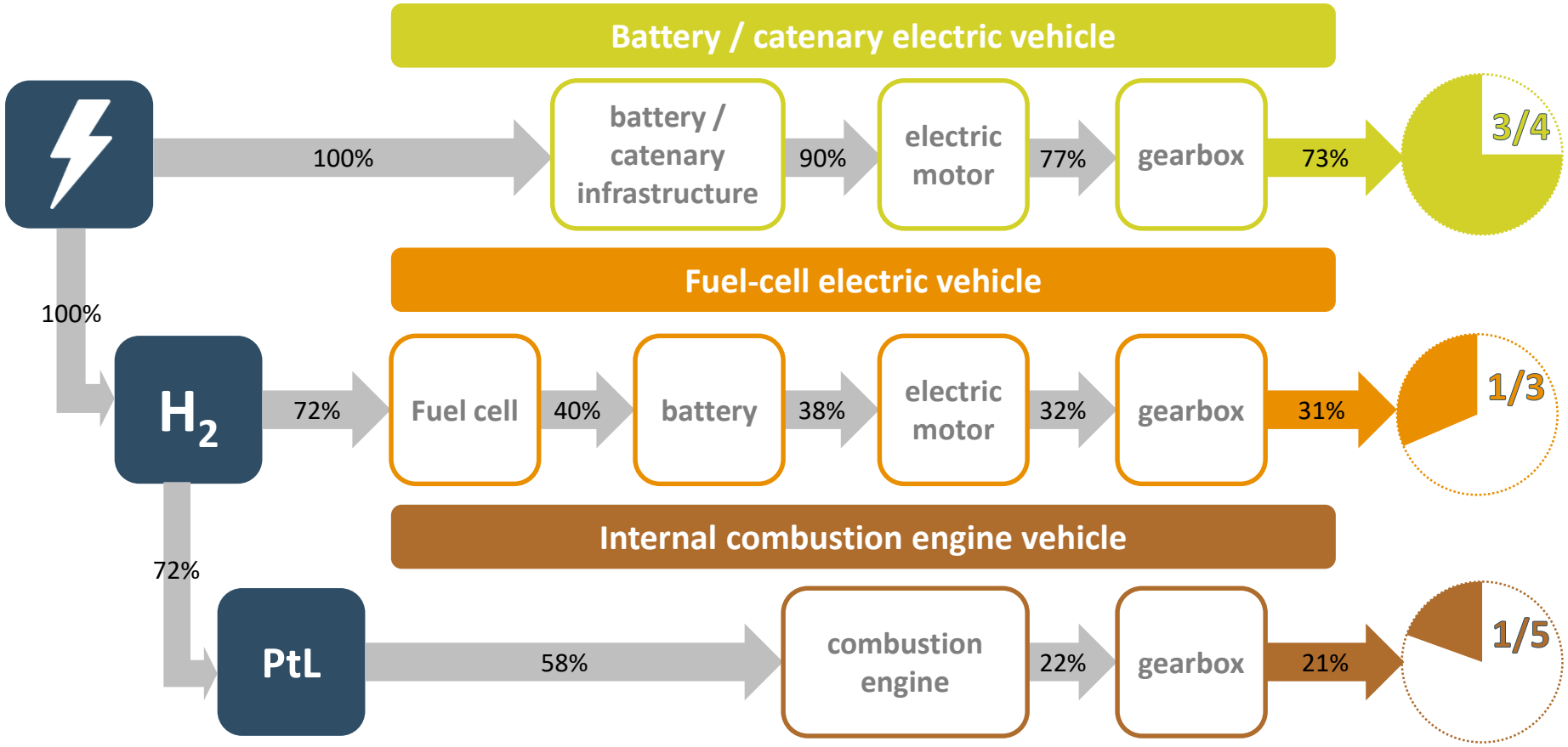
Efficiency and GHG emissions

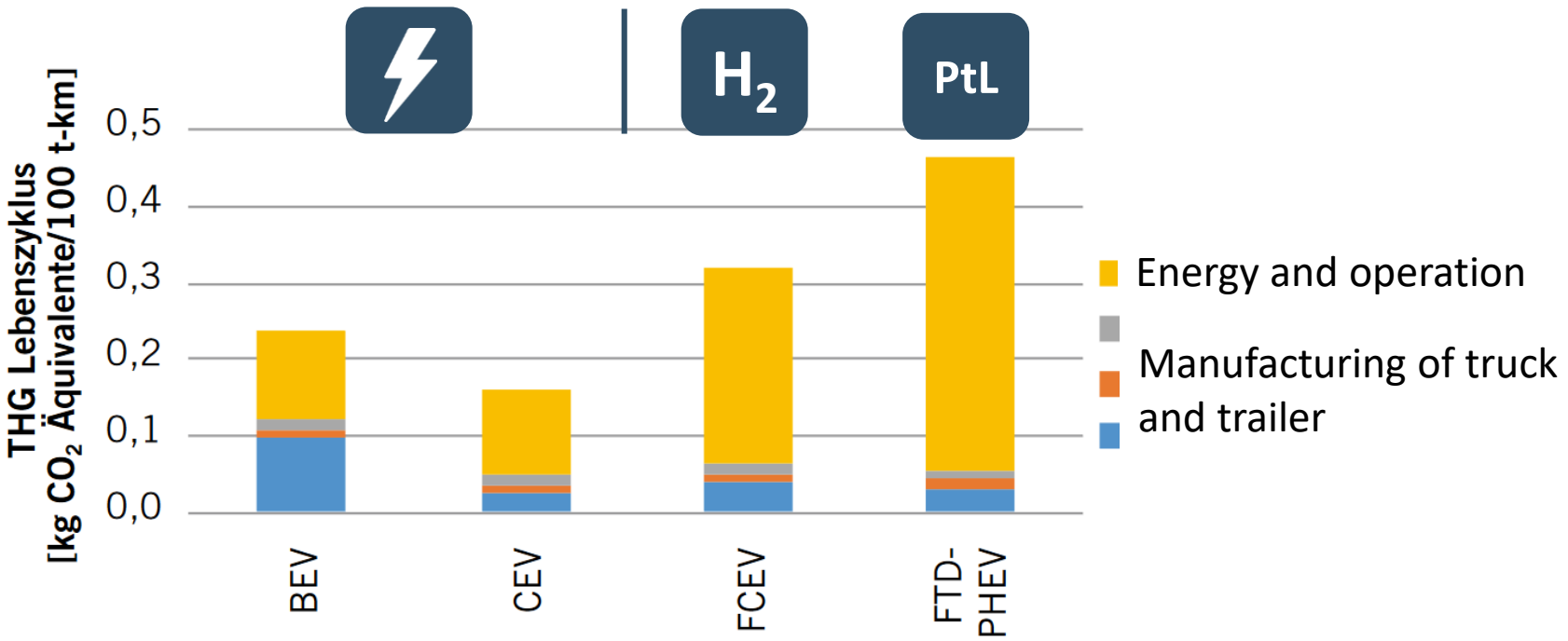
Comparing technology options
Energy efficiency



Schematic view which aims to show a rough average case. Figure and efficiency estimations: ifeu based on https://www.oeko.de/fileadmin/oekodoc/StratON-Zentrale-Ergebnisse-O-Lkw.pdf (slide 4)

Comparing technology options
Life-cycle CO_2 emissions

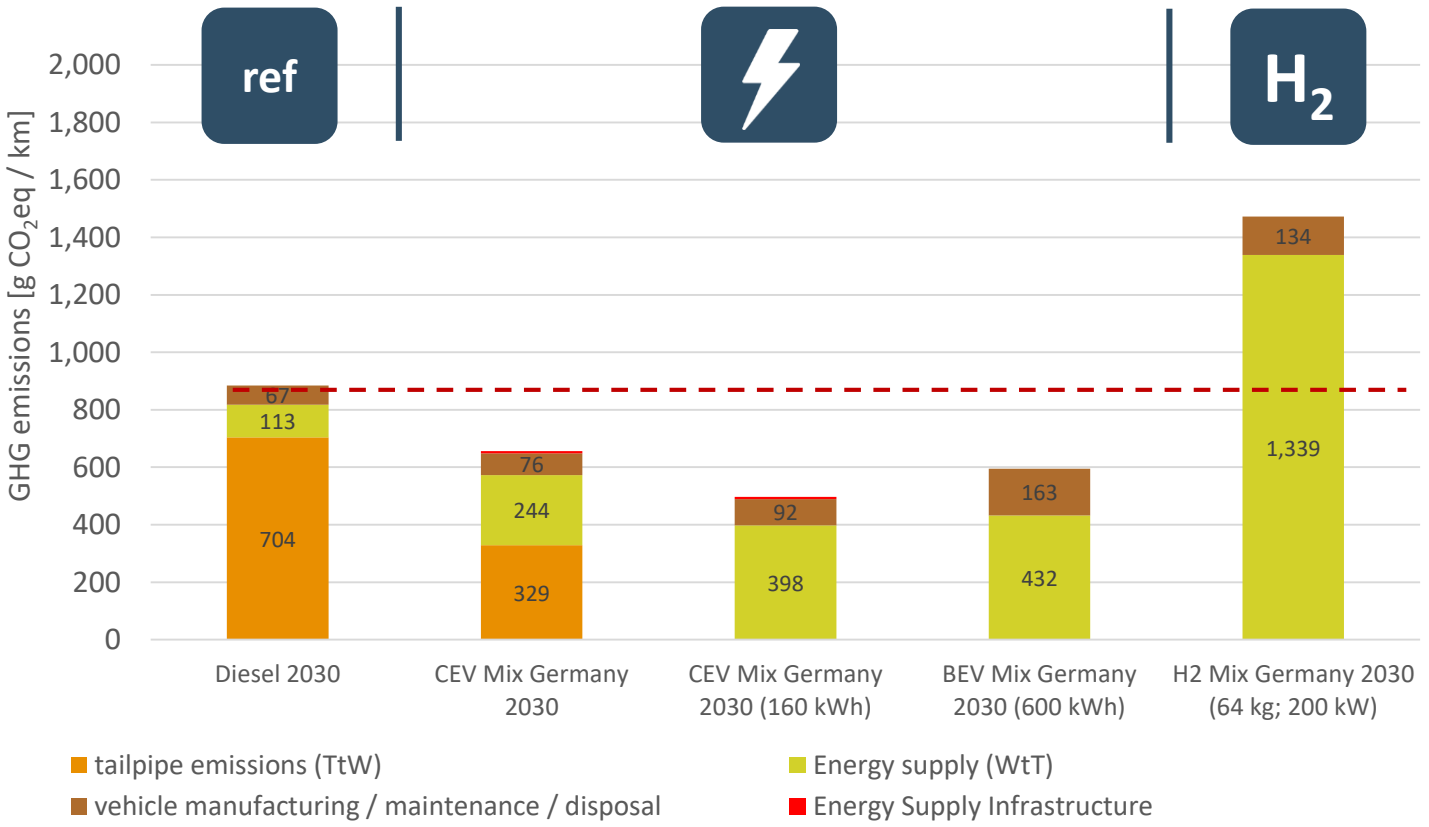
Long-term perspective 2050, 100% renewable electricity



- Vehicle (and battery) manufacturing becomes more important
- Also renewable electricity production is expected to have non-zero life-cycle GHG impact

Lozanowski, A.; Dingel, O.; Semper, T.; Geß, A. (2020): Technische und ökobilanzielle Analyse von Langstrecken-Lastkraftwagen für das Jahr 2050. In: *ATZ heavy duty*. Vol. 13, No.1, S. 56–60.

But what about the transition phase, if energy supply is not 100 % renewable?



Catenary electric vehicles can reduce CO_2 emissions significantly also for near future operation with partly grey electricity – H_2 and PtX fuels will yield increased LCA emissions in this case!

Ifeu calculations as part of the BOLD project.
https://www.ifeu.de/en/project/bold-catenary-truck-research-in-germany/

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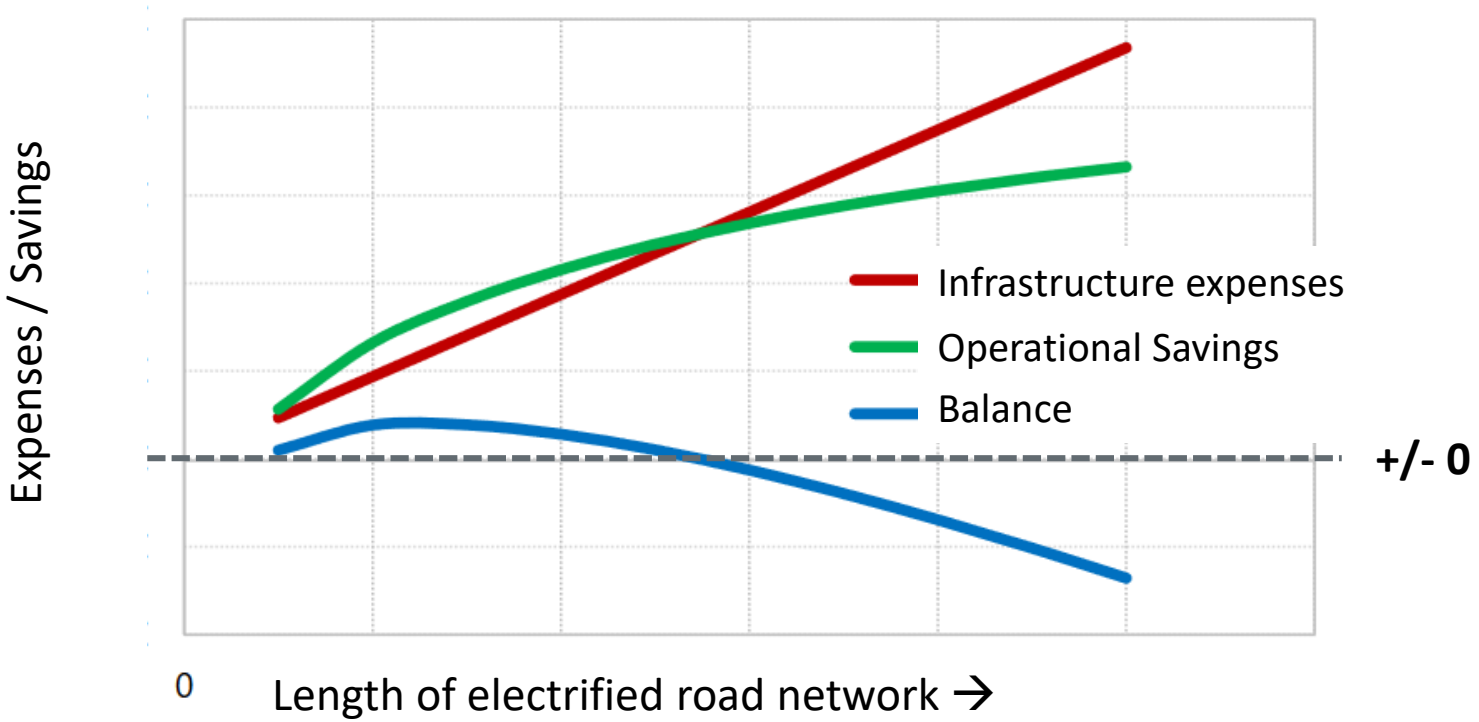
Transition pathways and costs

Cost characteristics of a catenary truck system

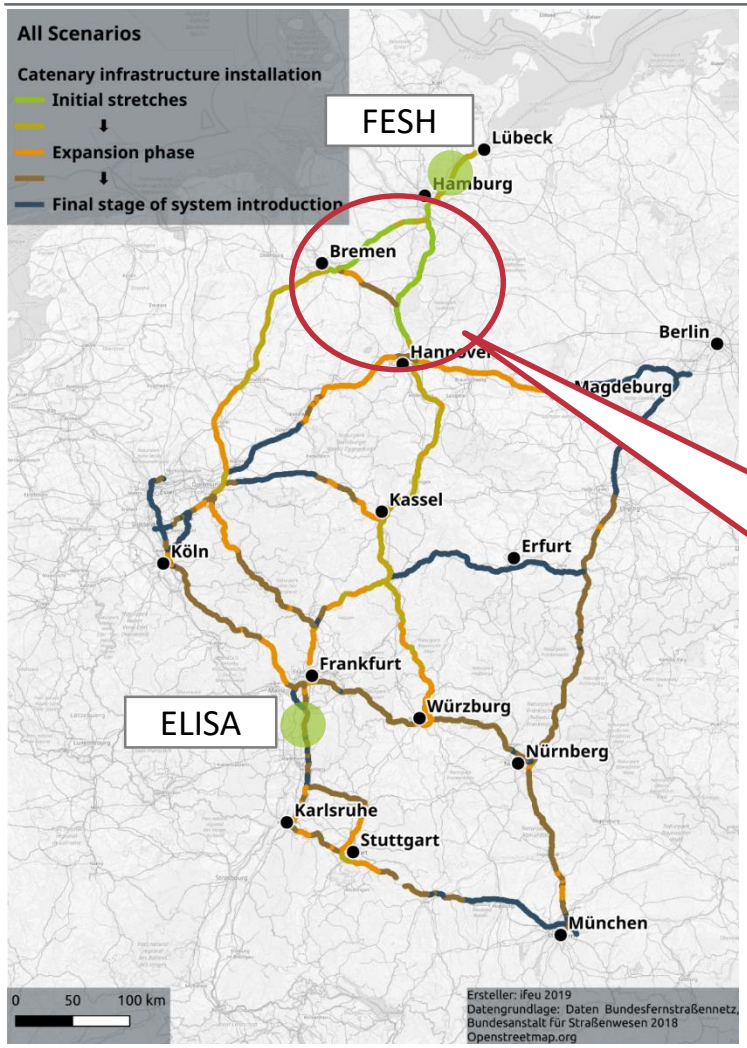
Schematic, first-order approximation



→ **Makes sense as a backbone for highly trafficked roads.**

Wietschel, M.; Gnann, T.; Kühn, A.; (...); TU Hamburg-Harburg (2017): Machbarkeitsstudie zur Ermittlung der Potentiale des Hybrid-Oberleitungs-Lkw. Fraunhofer ISI, Fraunhofer IML, PTV Transport Consult GmbH, TU Hamburg-Harburg – IUE, M-Five, Karlsruhe.

Model results for infrastructure roll-out: Basic electric roads network and prioritization



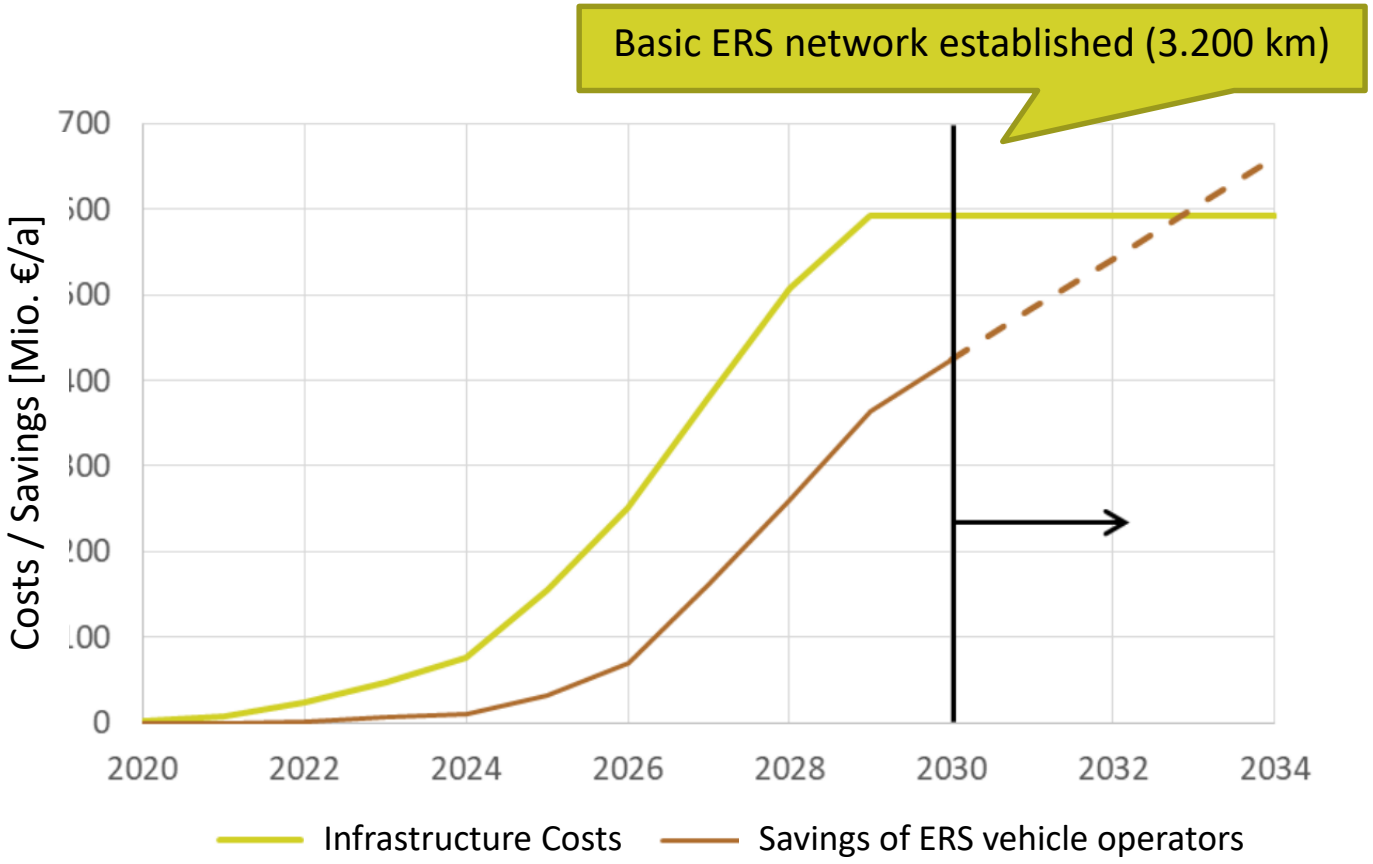
Two thirds of long-haul truck traffic in Germany takes place on only one third of the motorway network.

3.000 … 4.000 km of German motorways appear suitable as a basic ERS network.

particularly high suitability as starting points for network expansion in the area Hamburg – Hannover - Bremen

Jöhrens, J.; Rücker, J.; Kräck, J.; Allekotte, M.; Helms, H.; Biemann, K.; Schillinger, M.; Waßmuth, V.; Paufler-Mann, D. (2020): Roadmap OH-Lkw: Einführungsszenarien 2020-2030. Heidelberg. https://www.ifeu.de/wp-content/uploads/Roadmap-OH-Lkw-Bericht-Einfuehrungsszenarien-web.pdf .

Infrastructure is likely to pay off soon after establishment of basic electric roads network.

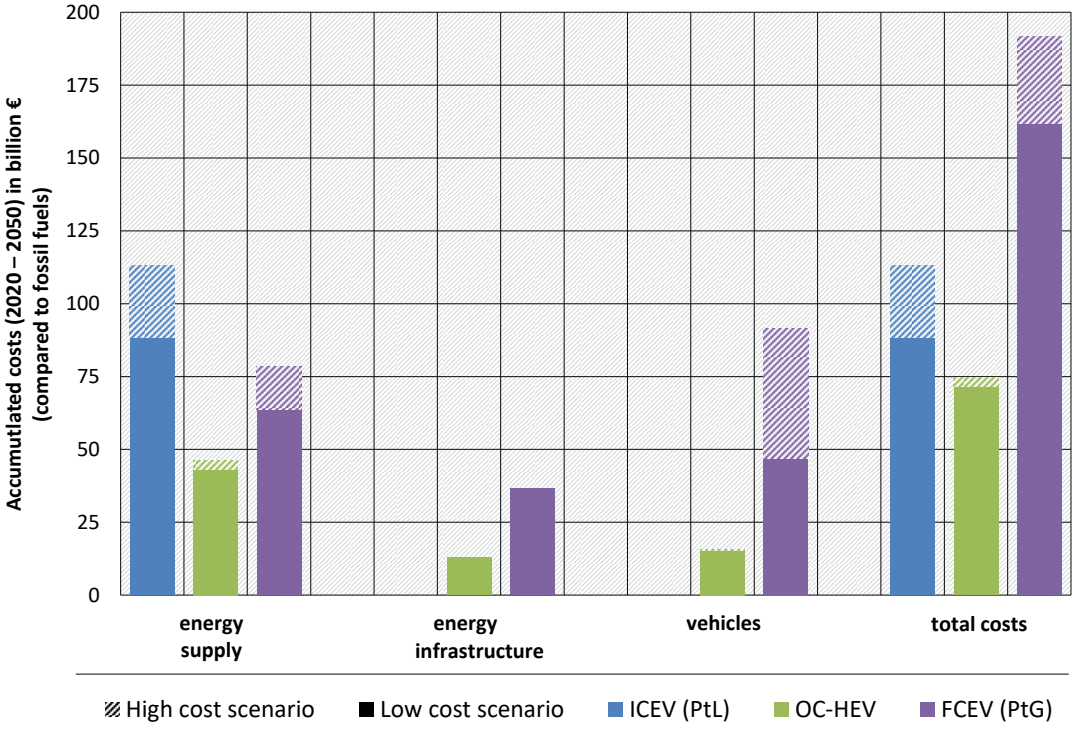


Annuity of infrastructure cost, compared to the operational savings due to the electric roads system.

Jöhrens, J.; Rücker, J.; Kräck, J.; Allekotte, M.; Helms, H.; Biemann, K.; Schillinger, M.; Waßmuth, V.; Paufler-Mann, D. (2020): Roadmap OH-Lkw: Einführungsszenarien 2020-2030. Heidelberg. https://www.ifeu.de/wp-content/uploads/Roadmap-OH-Lkw-Bericht-Einfuehrungsszenarien-web.pdf .

Overall costs of carbon neutral road freight transport until 2050

Case study: Decarbonisation of German long-haul freight transport



- 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

Öko-Institut et al. (2016/2019): Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050. Study commissioned by the Federal Environment Agency (UBA)

Conclusions regarding suitability of OC trucks

- OC trucks make most efficient use of renewable electricity compared to other options.
- OC trucks allow for deep GHG reductions, while base emissions by vehicle and infrastructure manufacturing are comparably low.
- OC trucks can realize significant GHG savings already in the transition phase.
- Total costs of all decarbonization options are driven by energy costs in the long run. Thus, an OC truck system is most cost-effective for highly trafficked roads in spite of considerable infrastructure costs.
- Initial costs for a basic catenary infrastructure roll-out in Germany could likely be relayed to the vehicle operators once a basic network is established.

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Policy implications

Fields of action for tapping CO_2 mitigation potential of catenary trucks

Pilot phase

- Define a possible **role for catenary truck technology** in a sustainable transport system
- Create a **major pilot** as a nucleus for future network expansion
- Initiate a **business ecosystem** for catenary trucks (supply and operation of vehicles / infrastructure)

Network phase

- Push on **network expansion in a predictable way**
- Align **fiscal framing conditions** with network expansion to ensure a high network utilization

ifeu (2020): Roadmap für die Einführung eines Oberleitungs-Lkw-Systems in Deutschland. Heidelberg.

Fields of action for tapping CO_2 mitigation potential of catenary trucks

Pilot phase

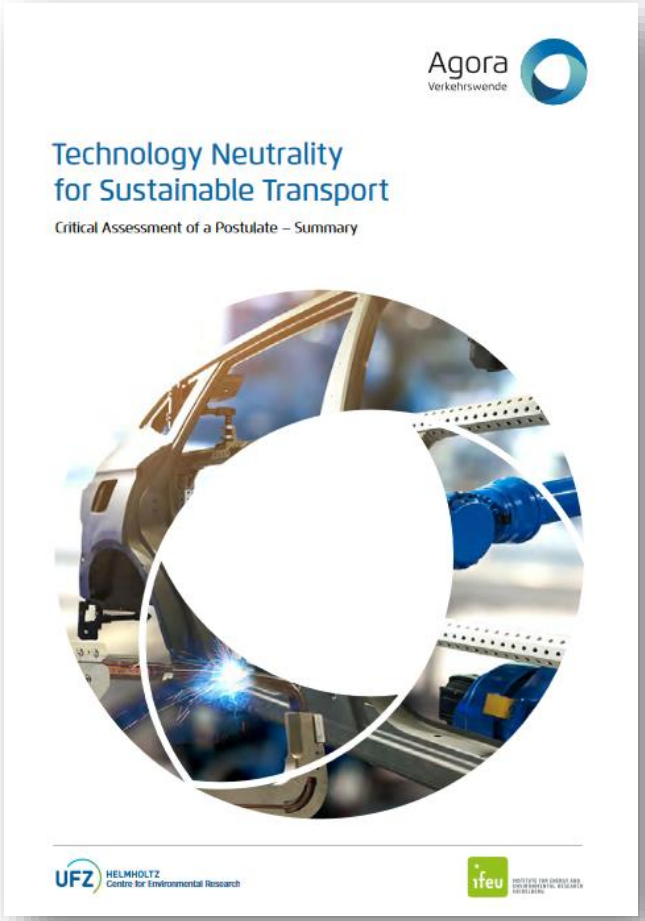
Network phase

Coordinate technology and network development

- across borders
- across energy carriers
  (e.g. battery / hydrogen solutions)
- across sectors
  (energy sector integration of catenary network will be crucial)

ifeu (2020): Roadmap für die Einführung eines Oberleitungs-Lkw-Systems in Deutschland. Heidelberg.

But shouldn‘t we be technology-neutral?



Some **technology-specifity** in terms of climate action is inevitable to **ensure economic efficiency** of technology transition!

Particularly in case of

- Imperfect market coordination
- Path dependencies (e.g. in terms of infrastructure)
- Multiple policy objectives (e.g. geostrategical concerns, resource demand, non-GHG environmental impacts)

Helmholtz Centre for Environmental Research; ifeu-Institute (2020): Technology Neutrality for Sustainable Transport Critical Assessment of a Postulate – Summary. AGORA Verkehrswende. https://www.agora-verkehrswende.de/fileadmin/Projekte/2019/Technologieneutralitaet/Agora-Verkehrswende_Technology-Neutrality-for-Sustainable-Transport.pdf (09.09.2020).

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Thanks for your attention!

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