Does the Money Match the Targets? - Aligning EU Investment in Transport Infrastructure with EU Climate Targets

Carbon Neutral Transport in Germany: Scenarios to 2050 and infrastructure requirements

7th of December 2016 – Brussels, Belgium

Martin Lange
German Environment Agency, Section I 3.2 „Pollution Abatement and Energy Saving in Transport“
Goal: Reducing GHG emissions across all sectors by 95% until 2050 compared to 1990.
Ambitious climate protection targets in transport require a general transition in the sector.

Final energy demand (relative to: 2005)

- Avoid transport + Shift transport + Improve efficiency

Electric vehicles (incl. OC-hybrid trucks)

-50%

GHG-emissions (relative to: 1990)

- Avoid transport + Shift transport + Improve efficiency

- Alternative drives and GHG-neutral energy supply options

- General transition in transport

- Energy transition in transport

Example: GHG-neutral Germany in 2050
Post-fossil energy supply options: various suitable pathways

Conventional drives (Internal Combustion engine)
- Gaseous and liquid biofuels

Alternative drives
- Electric vehicles and renewable electricity (incl. off-vehicle charging hybrids and overhead catenary trucks)
- Fuel cell vehicles that use electricity-based hydrogen
- Gaseous and liquid electricity-based hydrocarbons

Energy transition in transport
Working principle of Power to Gas/Liquid (PtG/PtL)

2 H₂O ↔ 2 H₂ + O₂ \[ \Delta H = +571.8 \text{ kJ/mol} \]

4 H₂ + CO₂ ↔ CH₄ + 2 H₂O \[ \Delta H = -164.9 \text{ kJ/mol} \]

nCO + (2n+1)H₂ ↔ CₙH₂ₙ₊₁ + nH₂O [Alkanes]

nCO + (2n)H₂ ↔ CₙH₂ₙ + nH₂O [Alkenes]

nCO + (2n)H₂ ↔ C₉H₁₈ + (n-1)H₂O [Alcohols]

Source: Umweltbundesamt 2016
On the study: items included and some main assumptions

STUDIED ITEMS:
- Adaptation at vehicles & energy-supply infrastructure
- Costs for energy carrier are also approximated
- Final energy demands of sector and economic costs for transition to 2050 in Germany

THINGS THAT ARE THE SAME IN THE SCENARIOS:
- Transport performance for different means of transport
- Overall number vehicles
- Improvements of efficiency and production costs of vehicles and energy carriers

AGGREGATION FOR MEANS OF ROAD-TRANSPORT
- Short haul transport (2-wheeler, light vehicles, trucks in short-haul traffic)
- Long haul transport (trucks and busses in long-haul traffic)
Four energy supply scenarios that span a wide solution space and are carbon neutral in 2050

- **Partial electrification of LDV and short haul trucks**
  - **E+**
    - Further electrification (LDV, trucks)
    - Electric busses
    - Overhead catenary hybrid trucks
  - **Liq+**
    - Further use of liquid hydrocarbons
  - **CH₄+**
    - Change to gaseous hydrocarbons when possible
  - **H₂+**
    - Change to hydrogen when possible
  - Substitution of fossil fuels by electricity-based ones: PtG/PtL

* LNG/PtG-CH₄ partially substitutes heavy oil in shipping

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
Road: short haul transport (LDV, short haul trucks)

![Energy supply and infrastructure costs chart]

- Strong electrification
- Liquid fuels (PtL)
- Gaseous hydrocarbons (PtG-CH₄)
- Hydrogen (PtG-H₂)

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
Carbon Neutral Transport in Germany: Scenarios to 2050 and infrastructure requirements

Road: short haul transport (LDV, short haul trucks)

Differential economic costs (bill. €2010)

- Strong electrification
- Liquid fuels (PtL)
- Gaseous hydrocarbons (PtG-CH₄)
- Hydrogen (PtG-H₂)

(Source: Oeko-Institut / INFRAS/DVGW-EBI 2016)

2016/12/07 T&E: Aligning EU Investment in Transport Infrastructure with EU Climate Targets
Road: long haul transport (trucks/busses)

- Strong electrification
- Liquid fuels (PtL)
- Gaseous hydrocarbons (PtG-CH₄)
- Hydrogen (PtG-H₂)

Differential economic costs (bill. €₂₀₁₀)

Energy supply
Gas stations & caternary
Vehicles
Sum

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
#1: Costs of energy supply infrastructure are often much smaller than costs for vehicles and for the supply of energy.

**Energy supply**
- **E+**: Sum: 243,2 billion €\textsubscript{2010}
- **Liq+**: Sum: 334,7 billion €\textsubscript{2010}
- **H\textsubscript{2}+**: Sum: 738,3 billion €\textsubscript{2010}

**Gas stations & charging points**

**Vehicles**

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
#2: Costs of energy supply structures are significant but even larger blocks of infrastructure costs are „hidden“ in production/supply of fuels and electricity.

Costs are for:
1) RE generation
2) productions sites for carbon neutral fuels from electricity
3) preparation of products for transport, transport to and distribution in Germany
#3: Overhead catenary trucks are energy and cost efficient but there are barriers to a market entry. Decision whether to build the system should be made as soon as possible and in accordance with climate targets.

(Catenary and trucks) vs. Energy supply

To benefit from potential savings:
- a **positive decision is necessary soon**
- lead time to build up infrastructure should be taken into account
- delayed phase-in of trucks should also be considered

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
Road – short haul transport: Infrastructure for electrification

#4: Charging infrastructure for battery-electric and off-vehicle charging hybrid-electric vehicles has to be build up, as the electrification in short haul transport is an efficient and effective way to achieve a carbon neutral transport.

(Source: Oeko-Institut/INFRAS/ DVGW-EBI 2016)
#4: Charging infrastructure for battery-electric and off-vehicle charging hybrid-electric vehicles has to be build up soon. Electrification in short haul transport is an efficient and effective way to achieve a carbon neutral transport and a reasonable first step.

- In short haul transport a significant financial barrier with additional costs exists
- In comparison to caterinary system a less pronounced chicken-egg-dilemma
- Battery electric vehicles are ready for the market and can contribute to 2030 climate targets (e.g. 40% in Germany)

(Source: Oeko-Institut/INFRAS/DVGW-EBI 2016)
Summary and Outlook

A COMPREHENSIVE STRATEGY FOR ENERGY SUPPLY OF TRANSPORT...

- Contains of a general transition and an energy transition in transport
- Is in line with long-term climate targets and therefore allows a shift to carbon neutral transport
- Builds where technically feasible on electric vehicles as they use renewable electricity efficiently and are therefore cost efficient -> infrastructure is crucial!
- Takes into account, that parts of long haul transport, and (international) aviation & shipping require huge amounts of PtG/PtL fuels to align with climate targets
- Considers, that costs for energy supply structures are often much smaller than for energy supply itself
Thank you for your attention

Dr. Martin Lange

Martin.Lange@uba.de
Phone: +49 340 2103 2310

www.umweltbundesamt.de/verkehr
www.umweltbundesamt.de/en/topics/traffic-noise