INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

Life cycle assessments (LCA) of electric cars - study for Agora Verkehrswende

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Motivation for LCA of electric cars

- Background
  - Electric cars are supposed to play a key role for transport decarbonisation
  - Their environmental assessment greatly depends on energy production and the vehicle manufacturing (incl. batteries)
  - Big need for answers to media response to the question: "How ecological are electric cars really?“
- Contents of Agora Study*
  - Meta study of existing LCAs of e-cars
  - Sensitivity analysis for GHG balance of e-cars in Germany
  - Scenarios for 2030

Helms et al., 2019: „Klimabilanz von Elektroautos - Einflussfaktoren und Verbesserungspotenzial“. Commissioned by Agora Verkehrswende

Meta study - Key Parameters for GHG emissions

Use phase:

- Electricity charging mix (country, year, energy production type)
- Specific energy demand (vehicle segment, driving pattern)
- Usage intensity (annual mileage)

Production:

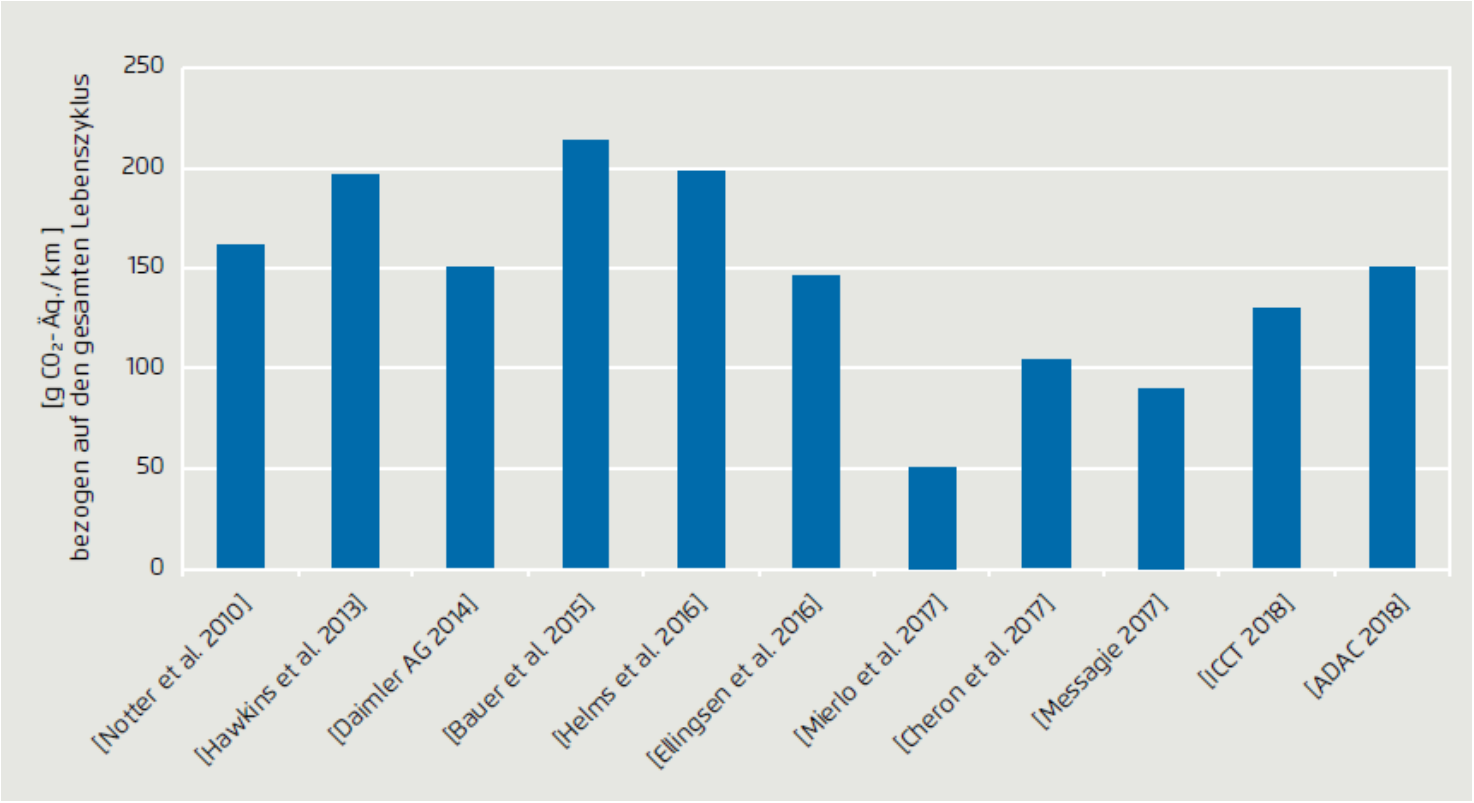
- Battery size
- Energy density
- Cell chemistry

→ **Type and quantity of materials**

- Energy intensity for production
- Energy mix for production

Meta Study – normalized GHG emissions per km for different studies

Results diverge greatly , but underlying assumptions have to be considered …



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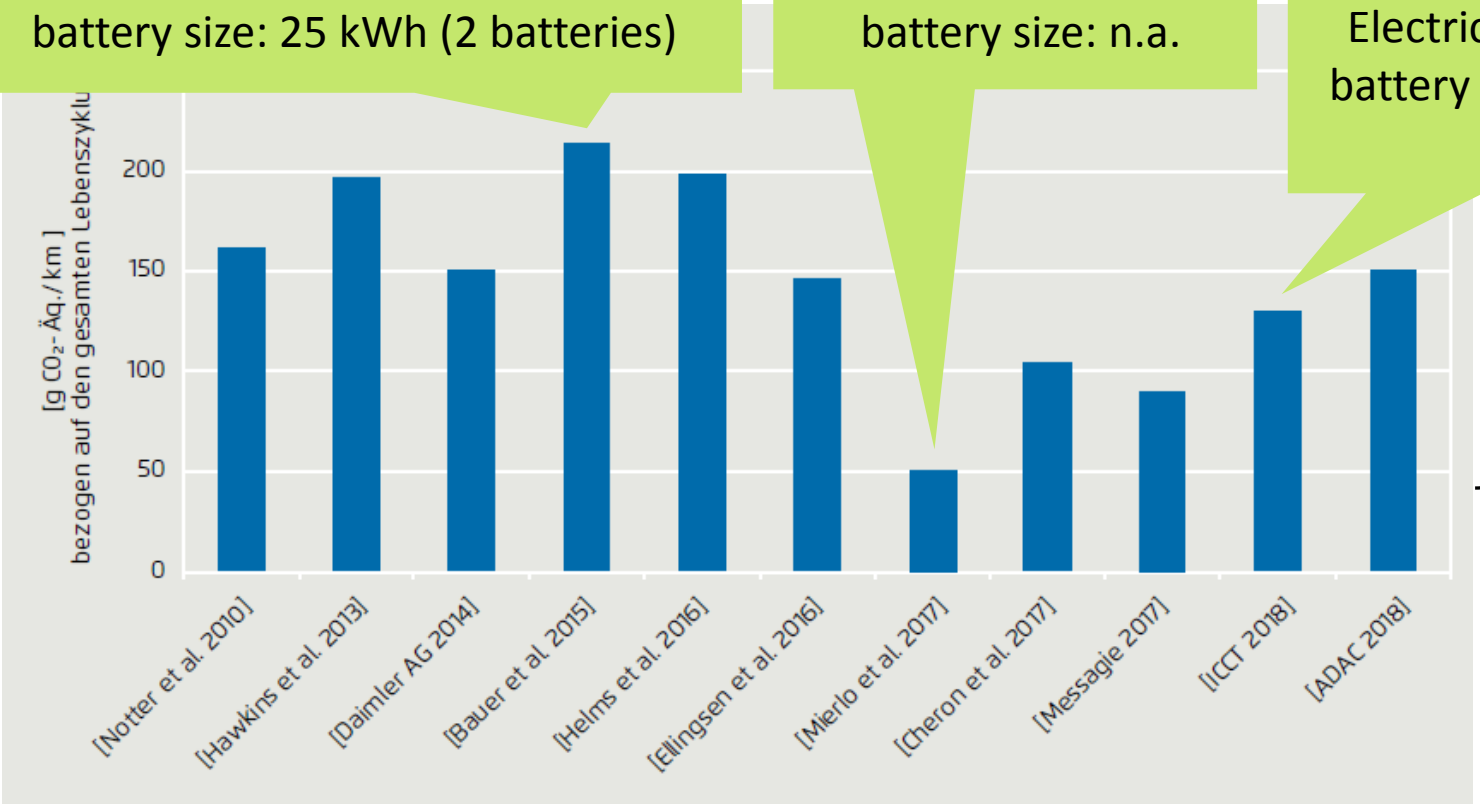
Meta Study – normalized GHG emissions per km for different studies

Bauer et al 2015
Car: D-Segment
EC: 21,4 kW/100km (Real-World)
Electricity mix: CH/EU
battery size: 25 kWh (2 batteries)

Mierlo et al 2017
Car: n.a.
EC: n.a.
Electricity mix: BE
battery size: n.a.

ICCT 2018
Car: C-Segment
EC: 20,5 (Real-World)
Electricity mix: EU
battery size: 30 kWh



50-220 g CO_2-eq per km

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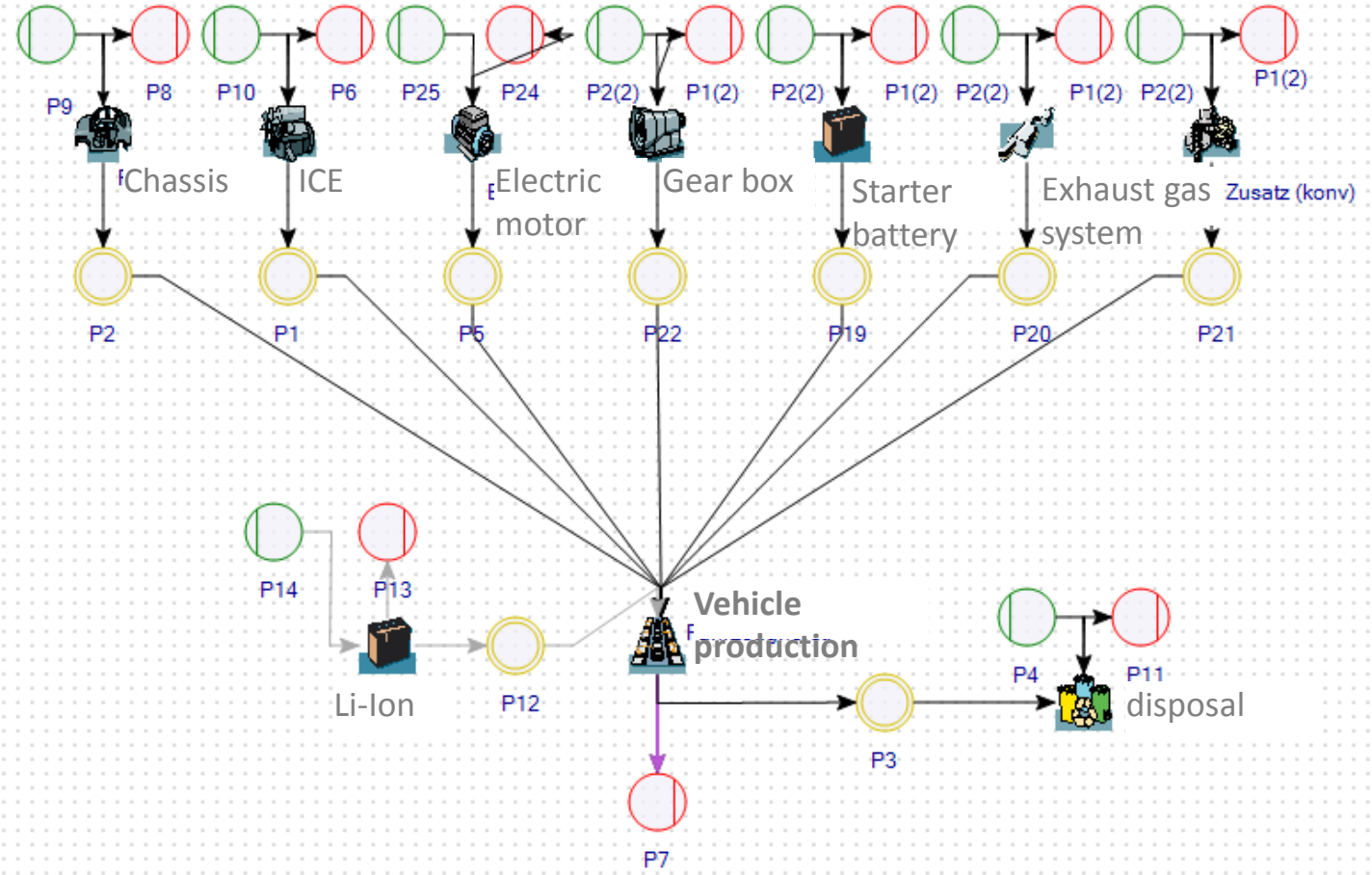
Vehicle production: Process modelling in the eLCAr model

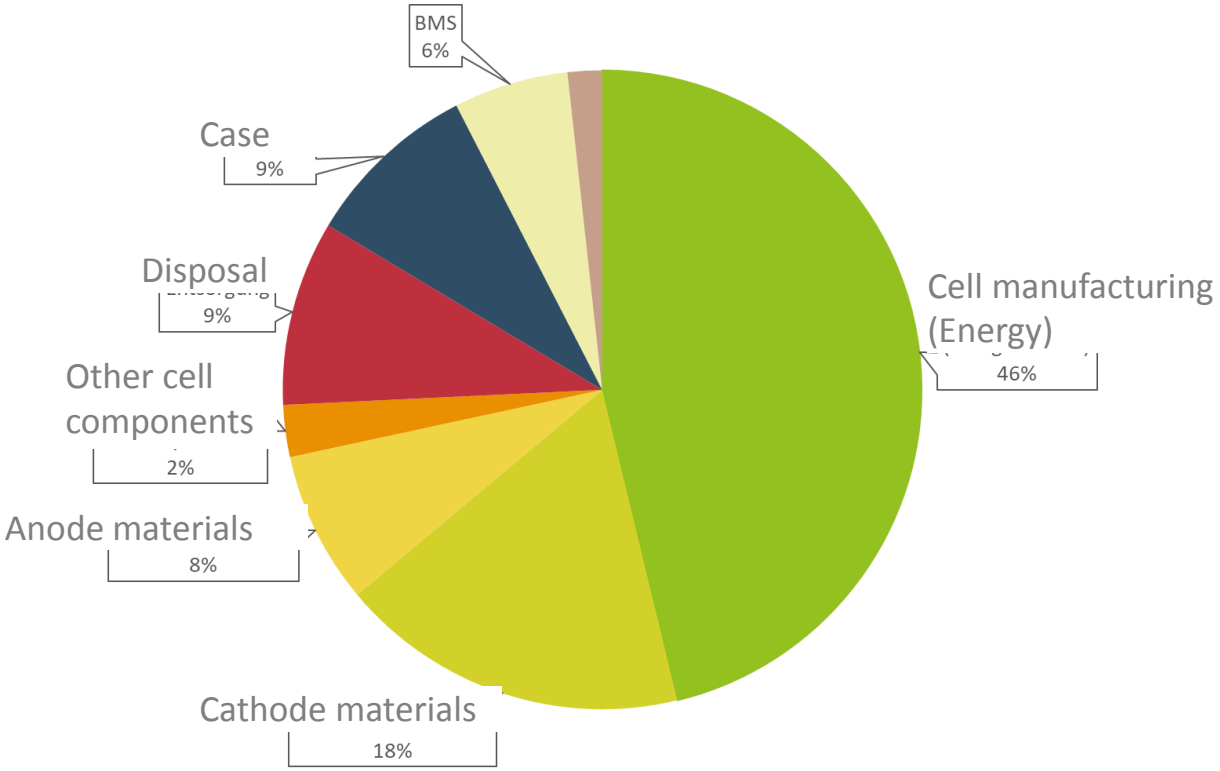


Data inputs from ecoinvent 3

Source: ifeu

Vehicle production: GHG balance of Li-Ion-Battery

- In total 145 kg CO_{2eq}/ kWh for battery production
- Cell production dominates GHG emissions (46%)



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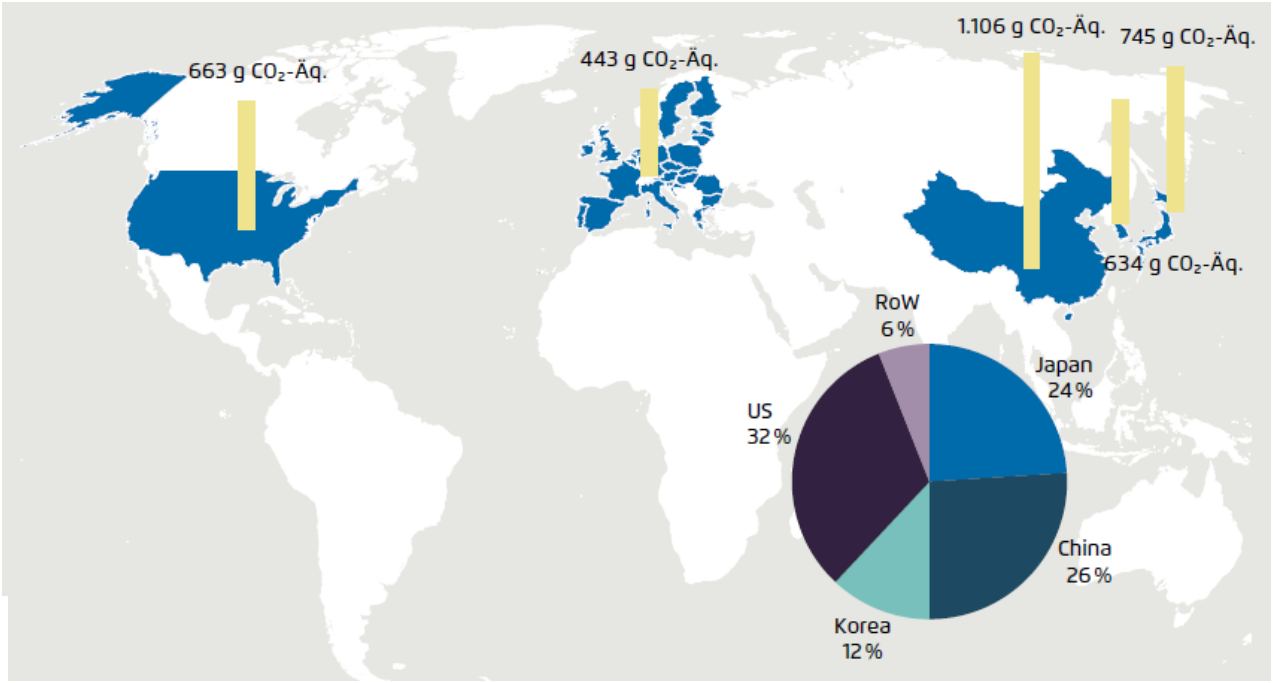
Vehicle production:
Influence of energy mix in cell production

Today‘s manufacturing countries (US, China, Japan, Korea) have high share of fossil energy for electricity production



Ø 800 g CO_2-eq/kWh

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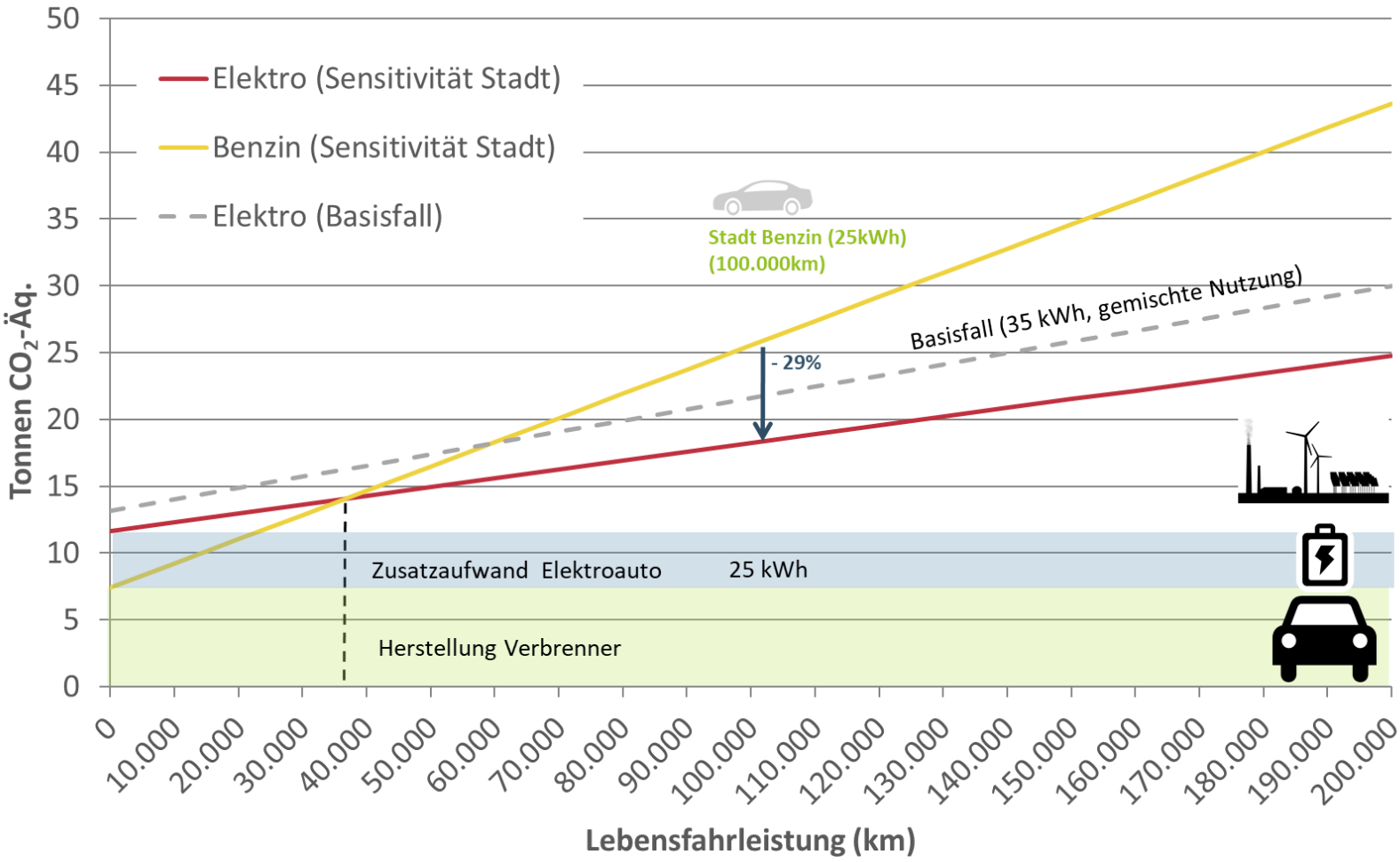
Example use phase: GHG balance of a city car



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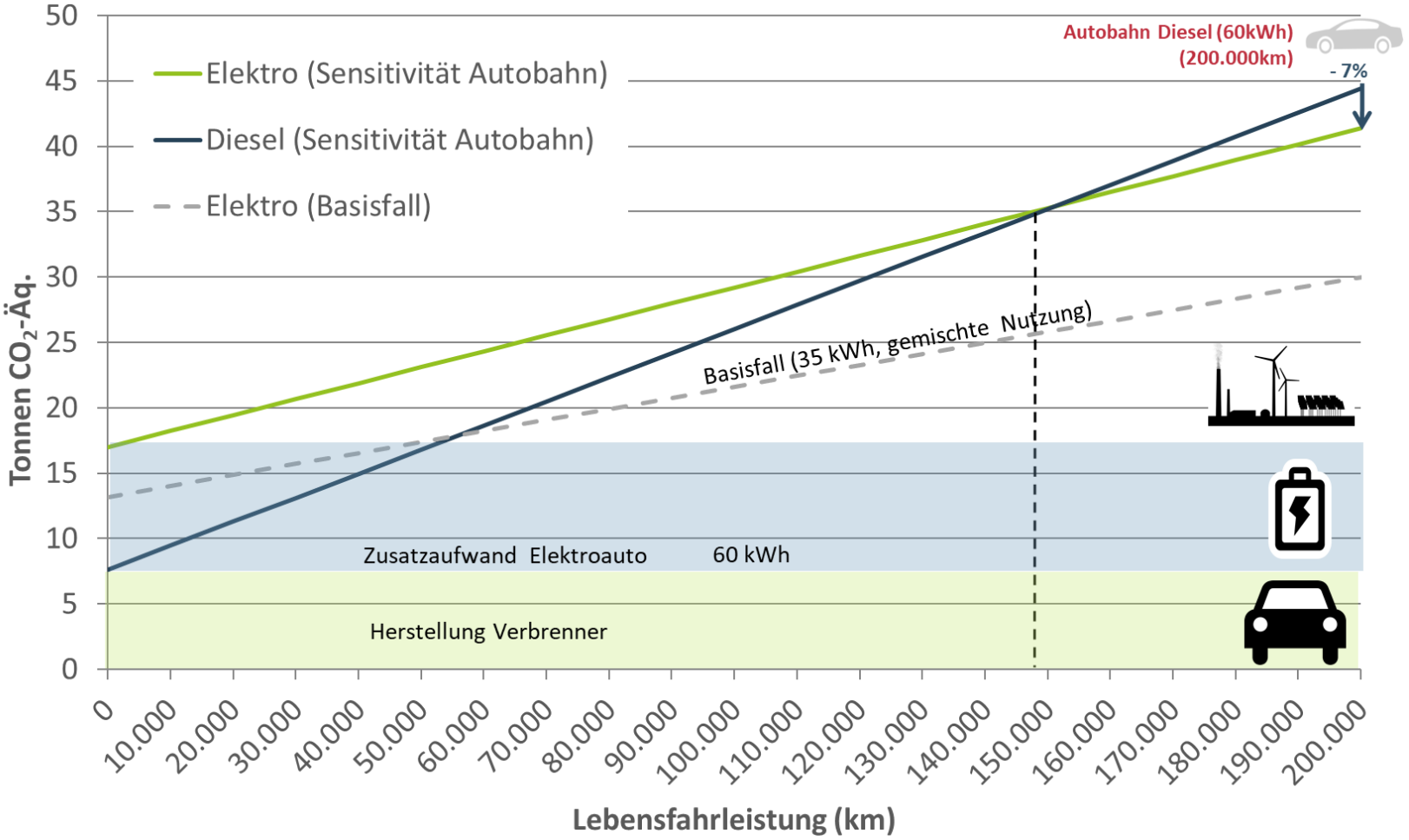
Example use phase: GHG balance of a „long-distance car“



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Conclusion and outlook

- E-Cars can already have a **positive GHG balance today** in Europe
- **Environmental opportunities** for the future due increasing shares of renewable electricity production and progress in battery production (increasing energy density, production in countries with „cleaner“ power mix)
- **Environmental risks** due to increase in battery size and range, heavier vehicles and higher energy consumption
- **Further LCAs will be needed** with increasing market share of e-vehicles, new technologies and materials
- Pressure on decision makers for **providing transparent LCA data** will increase -> inclusion of LCA criteria in vehicle regulations?

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