University of Stuttgart
Chair of Building Physics (LBP)
Life Cycle Engineering (GaBi)

ENVIRONMENTAL IMPACTS OF ELECTRIC VEHICLES WITH RANGE EXTENDER ON THE BASIS OF EUROPEAN VEHICLE USE PROFILES

Michael Baumann, Laura Brethauer

OVERVIEW

- European project EVREST: Electric Vehicle with Range Extender as a Sustainable Technology
  - → How could extended range electric vehicles (EREVs) match different usage patterns?
  - → Acceptance and impacts of such solutions
- Range autonomy one of the main barriers to commercial success of battery electric vehicles (BEVs)
- Statistics show that large proportion of daily trips are far below maximum range of BEVs
  - → BEV with range extender
  - → satisfy majority of needs, zero emissions in limited area, enable over range trips
- Analyses of users' profiles and expectations based on databases from different European countries
- Development of EREV specifications which show an optimized design from a technical, economic and environmental perspective

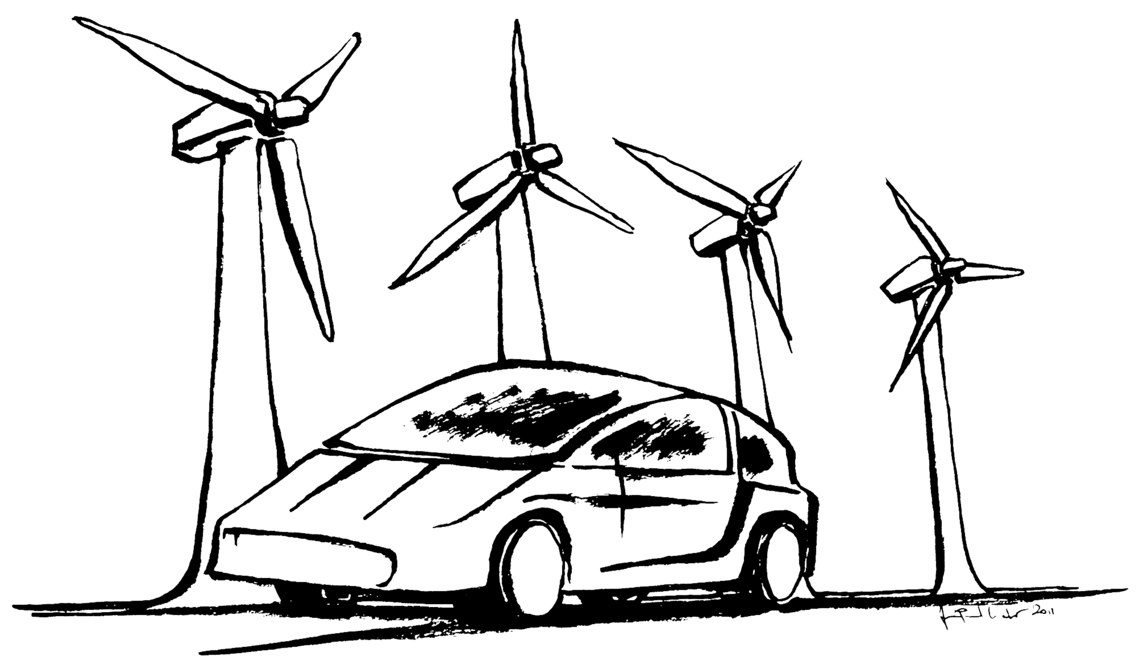

Fig. 1. Electric vehicle and wind power plants

→ Comparison of the environmental impacts of developed EREVs with BEVs and conventional vehicles with internal combustion engines (gasoline and diesel) on the basis of Life Cycle Assessment (LCA)

METHODS

Framework conditions

- Range extender with gasoline engine
- Flexible and parameterized LCA models created within GaBi Software
- LCA models consider production (incl. all vehicle components) and use phase (incl. mileage, electricity, fuel consumption)
- Small vehicles; EREV and BEV, modelled with German 2010 electricity grid mix
- Compact vehicles: EREVs modelled with 2010 electricity grid mixes for Germany, France and Austria and Euro 3 exhaust emission standard (Euro 3 engine also used for emission measurements)
- LCA models of compact gasoline and diesel vehicle´s based on Euro 5
- Focus on Global Warming Potential (GWP) influenced by emissions from combustion (e. g. CO_2, CH_4)

Conclusions & further tasks in EVREST

- High potential for EREVs for low environmental impacts using electricity from renewable energy
- Assessment of range extender with diesel engine and fuel cell
- Future scenarios with same exhaust emission standard (Euro 6)
- Assessment of further impact categories

Results

Small vehicles (European cluster 2: yearly mileage 4877 km, 12 years operation)

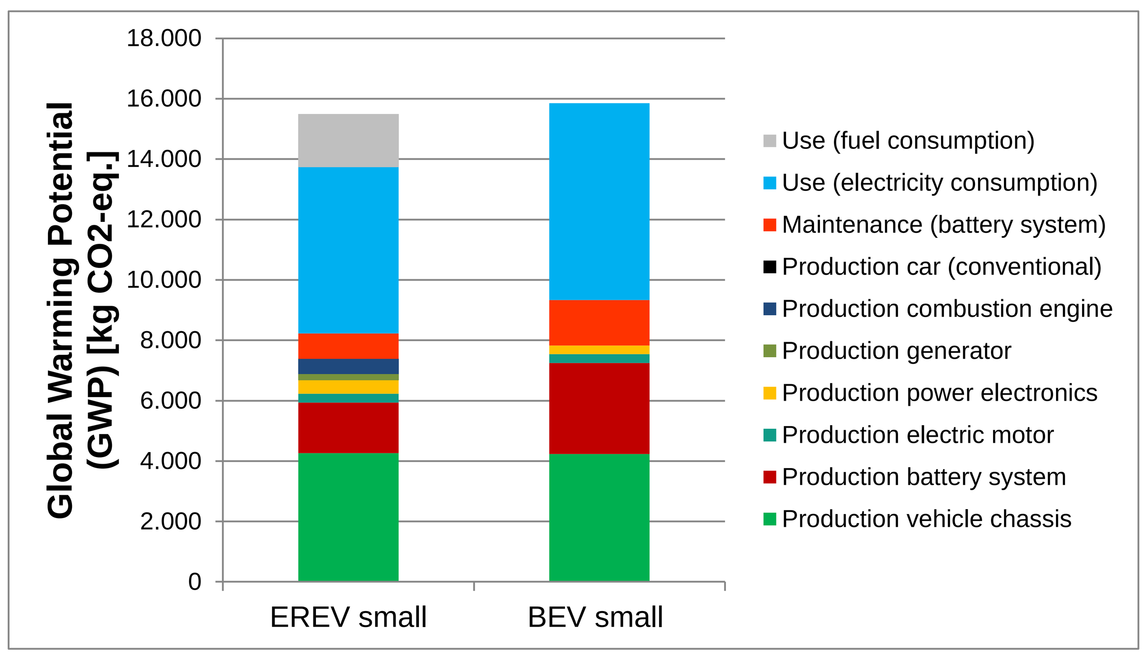

Fig. 2. Global Warming Potential of small vehicles (European cluster 2), modelled with German electricity grid mix of 2010

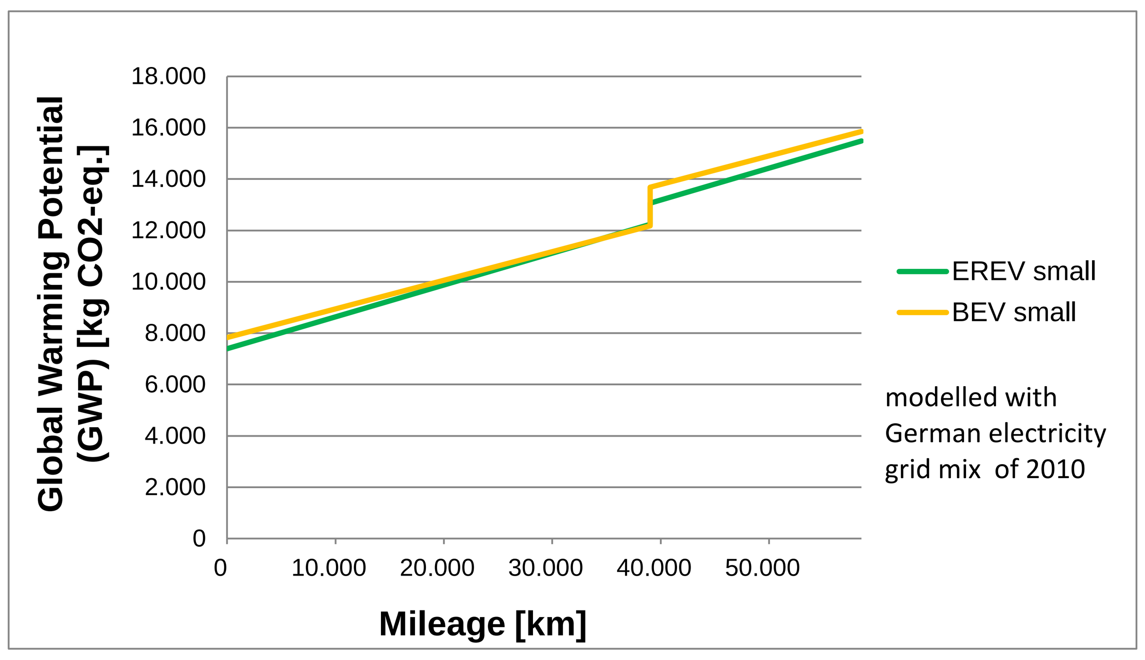

Fig. 3. LCA function showing increasing Global Warming Potential of small vehicles during use phase

- Break-even points define mileage on which alternatives show environmental advantages
- Battery maintenance after 8 years (assumption from literature research) causes gap in curves

Compact vehicles (European cluster 3: yearly mileage 12001 km, 12 years operation)

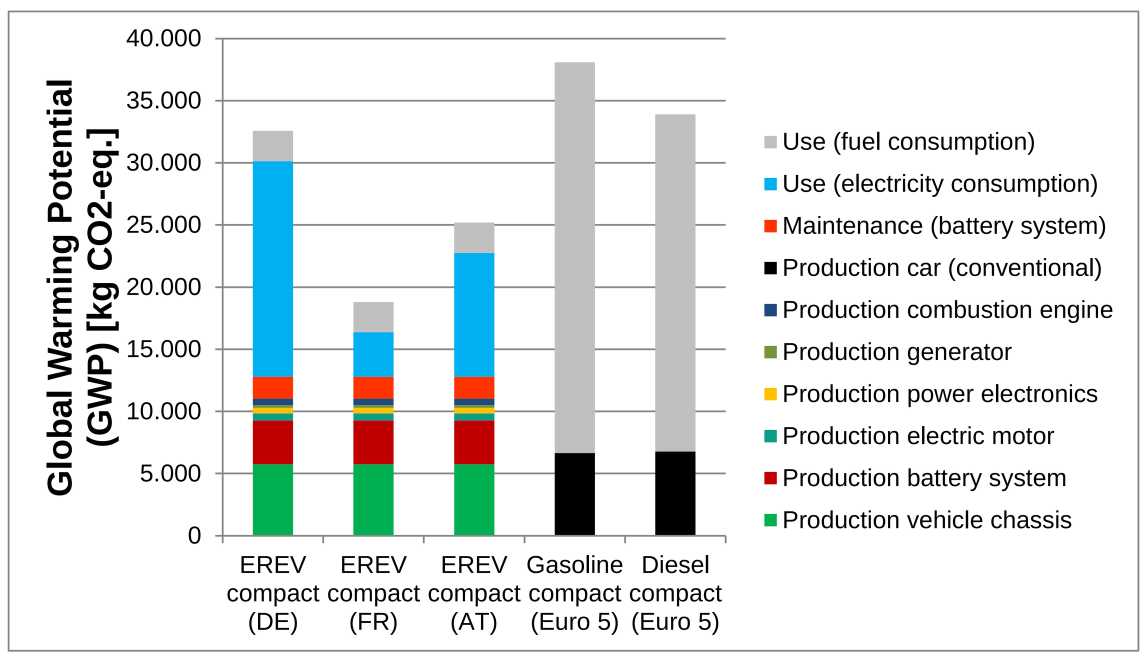

Fig. 4. Global Warming Potential of compact vehicles (European cluster 3) modelled with various electricity grid mixes from 2010

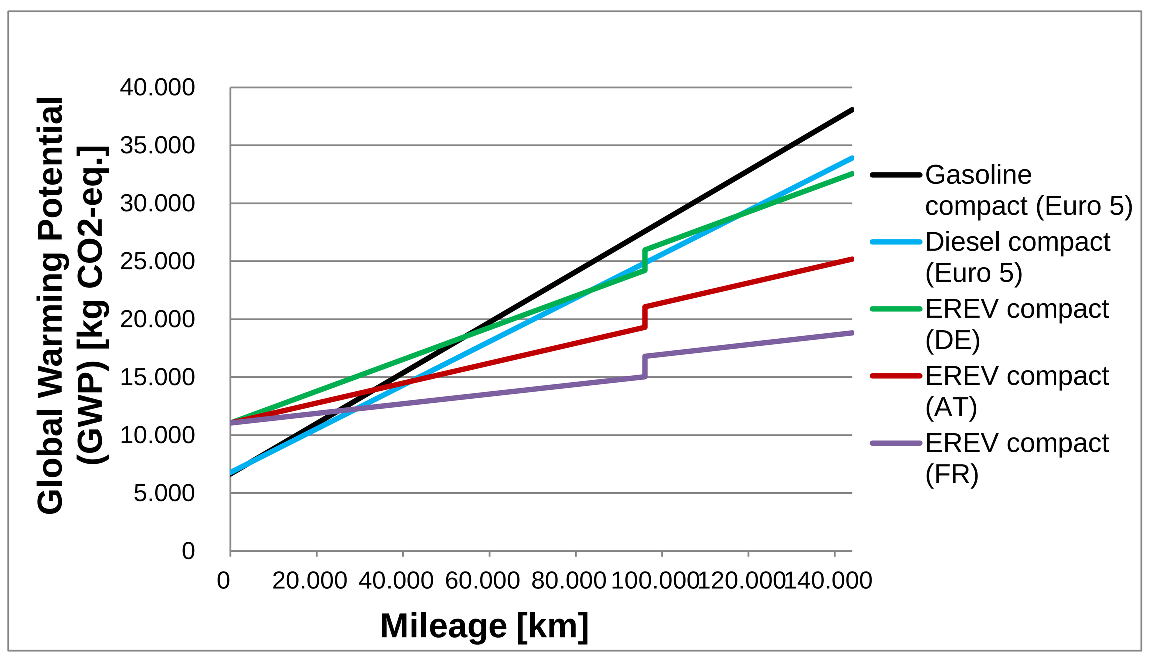

Fig. 5. LCA function showing increasing Global Warming Potential of compact vehicles during use phase

- EREVs are assessed adversely (Euro 3) in comparison to conventional vehicles (Euro 5)
- Electricity grid mix influences share of use phase electricity consumption
- French grid mix: low impacts due to high share of nuclear power with low impact on GWP
- Austrian grid mix: lower impact than German mix due to a high share of hydropower

CONTACT

Michael Baumann: michael.baumann@lbp.uni-stuttgart.de
Laura Brethauer: laura.brethauer@lbp.uni-stuttgart.de
www.lbp-gabi.de

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