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EVALUATING INDIVIDUAL MOBILITY TECHNOLOGIES: AN EXPERIMENTAL FIELD STUDY AND LIFE CYCLE ASSESSMENT

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MOTIVATION

- The transportation sector represents the largest contributor to the energy consumption (38%) and CO_2 emissions (32%) in Switzerland.
- Alternative technologies and fuels are pushed into the market to achieve the CO_2 targets set for new passenger vehicles.
- For some technologies, major discrepancies have been observed between the approval values vs. real world energy demand.
- Real world tests and complete life cycle assessments are required to evaluate the energy and environmental impacts of the new technologies.

OBJECTIVES

Evaluated powertrains: NGV  FCV  HEV  PHEV  BEV 

ESMOBIL-RED (CA A2/A3):

(1) Field study of the real world energy carrier consumption of alternative propulsion systems (Empa, APT)

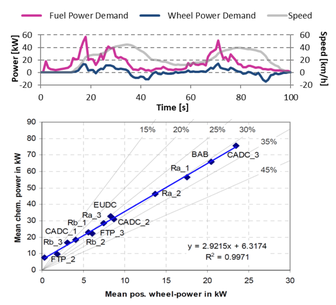
(2) Energy systemic model for the evaluation of sustainability measures in the Swiss mobility sector (ETHZ, LAV)

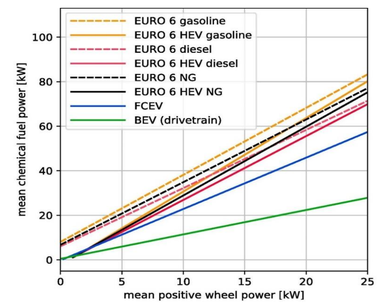
Carculator (CA B2):

(3) Life cycle assessment of the environmental impacts of different powertrains today and in the future (PSI, LEA)

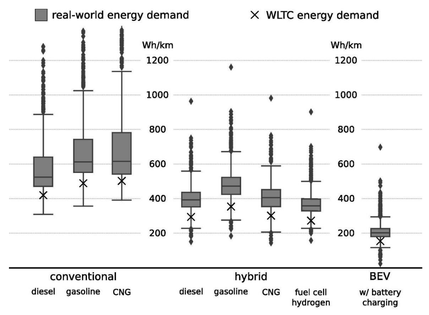
METHODS

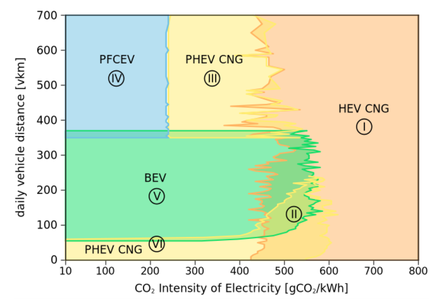
(1) Willans approach and real world energy consumption:



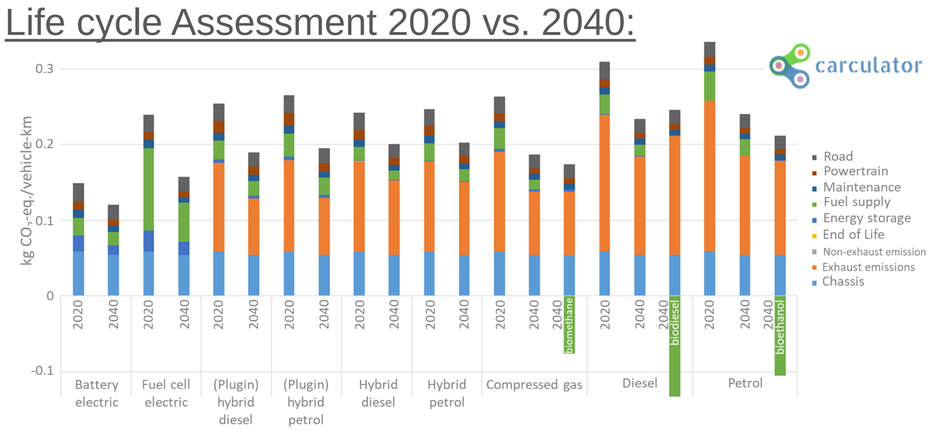


(2) Swiss Energy Systemic Model:





(3) Life cycle Assessment 2020 vs. 2040:



KEY RESULTS

(1) Willans approach and real world energy consumption:

- Simple model for real world energy demand of alternative technologies based on Willans approach and real world tests. The model can be used widely with only little input data (average velocity and mean slope of a trip) needed.

(2) Swiss Energy Systemic Model:

- For all technologies, the real-world energy demand is 20-30% higher than the reported WLTC values.
- Depending on the CO_2 intensity of the electricity mix, different vehicle propulsion technologies (I-VI) are CO_2-optimal:
  - Above 600gCO_2/kWh, the optimal passenger car fleet only operates on fossil fuels in the form of compressed natural gas.
  - Between 600 and 235 gCO_2/kWh, electricity is used as energy carrier but the long daily distances still utilize natural gas.
  - Below 235 gCO_2/kWh the entire fleet is powered through electricity, directly or by hydrogen electrolysis.

(3) Life cycle Assessment 2020 vs. 2040:

- BEVs have a strong potential for reducing GHG emissions in the future passenger car fleet. However, future carbon intensity of electricity grid remains complicated to forecast.
- While FCVs do not perform as well as BEVs, they offer a much larger range autonomy (600 km, against 350 km), which increases its utility.
- ICEVs remain a viable option in the future if associated with 2G biofuels or low carbon electricity-based synthetic fuels.

Empa Materials Science and Technology

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