

Effect of fast charging on the efficiency of energy storage system and on-going research

Low Temp Task force, 16th meeting
Empa Dübendorf, 12.+13. of December 2017

Thomas Büttler
Empa Dübendorf, Switzerland
Automotive Powertrain Technologies Laboratory

Agenda

- Effects of fast charging on BEV
- Calculation method for the energy demand of BEV
- Fuel consumption results of a fuel cell vehicle

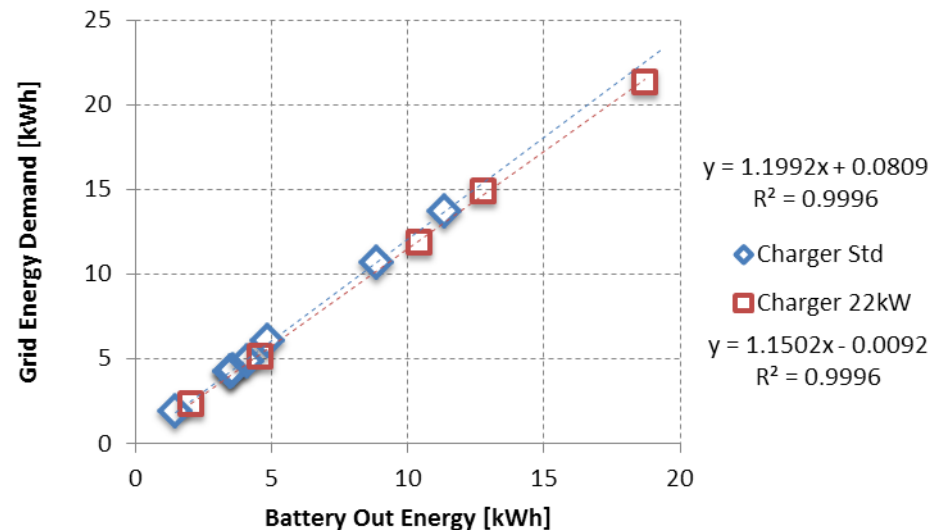
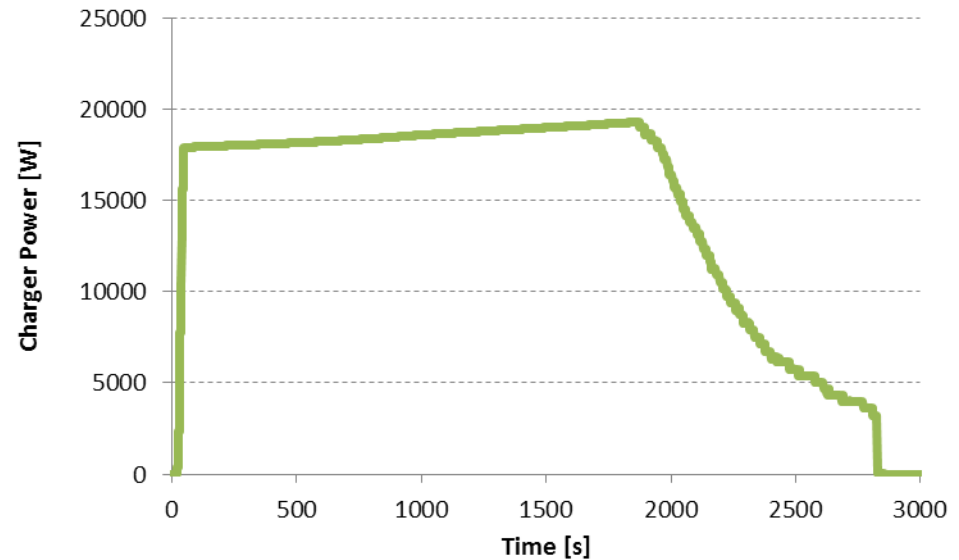
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Energy demand of BEV

Effects of fast charging (preliminary results)

- Av. Charging power std. charger: 1.8kW
- Av. Charging power fast. Charger (max22kW) : 15kW

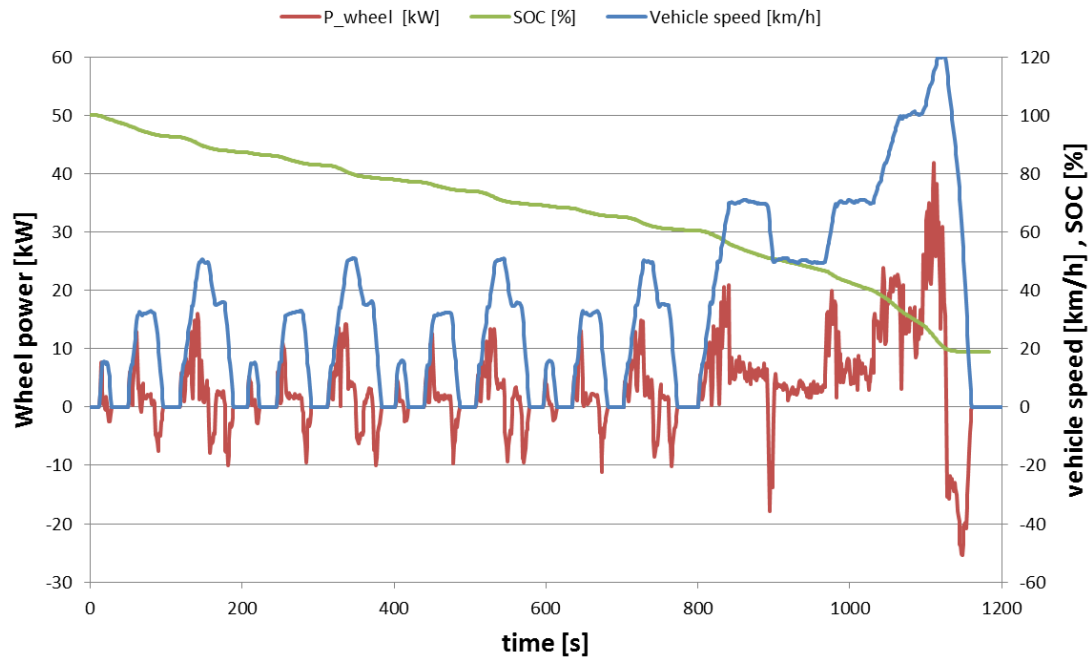


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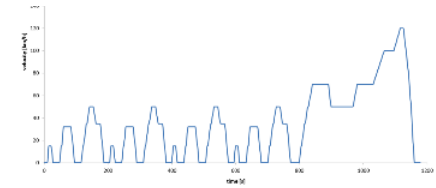
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Energy demand of BEV

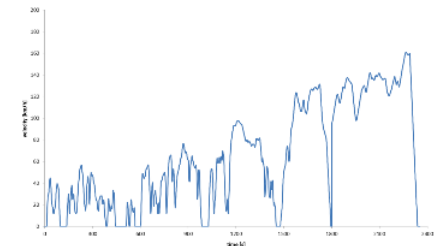
Drive train efficiency 23°C



NEDC



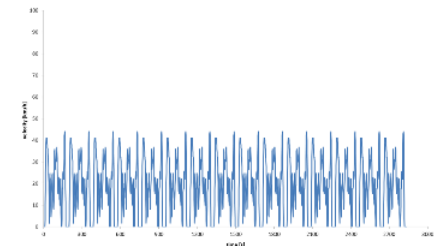
WLTC



CADC



IUFC15

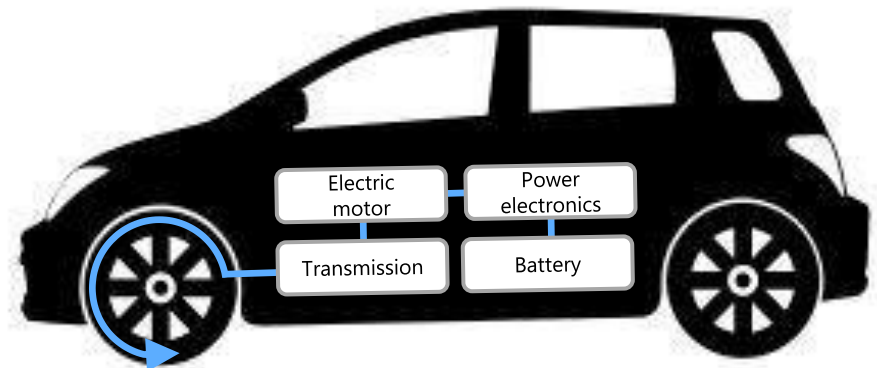
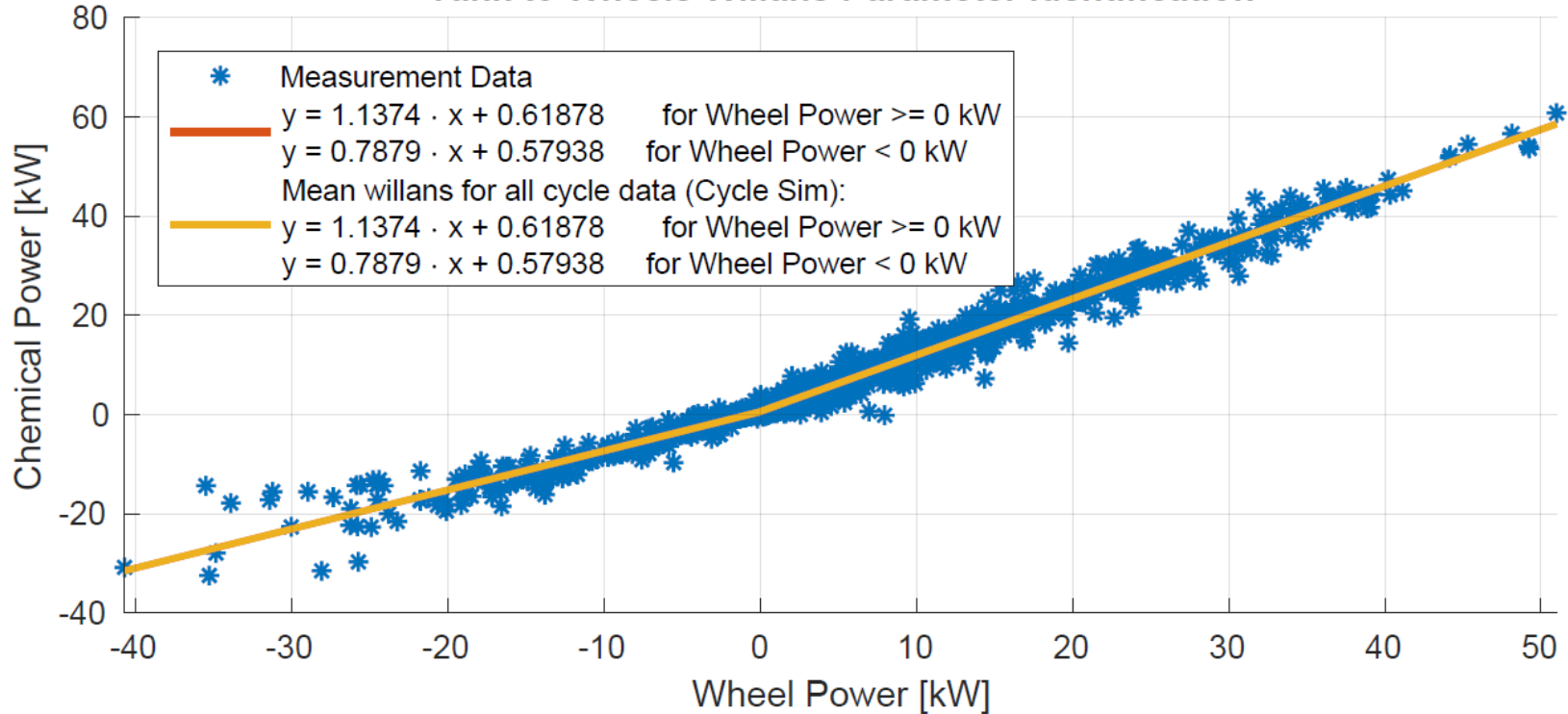


$$P_{Wheel} = m \cdot \frac{dv}{dt} \cdot v + \frac{1}{2} \cdot c_w \cdot \rho \cdot A \cdot v^3 + \mu \cdot m \cdot g \cdot v$$

Energy demand of BEV

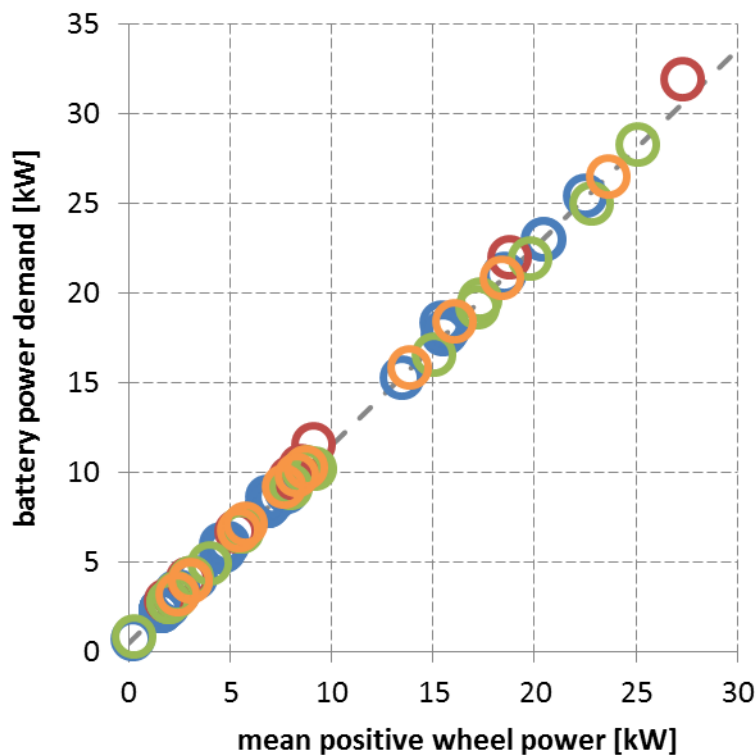
Drive train efficiency 23°C

Tank to Wheels Willans Parameter Identification



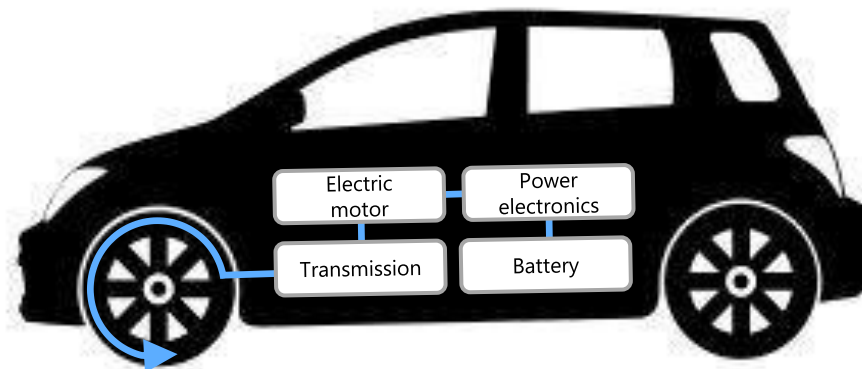
Energy demand of BEV

Drive train efficiency 23°C



- drivetrain veh. 1
 - drivetrain veh. 2
 - drivetrain veh. 4
 - drivetrain veh. 5
 - linear correlation
- $R^2 = 0.9988$

- Mean efficiency: 90%
- Baseload: ca. 500 W
 - Electronics
 - Multimedia
 - Lights
 - ...

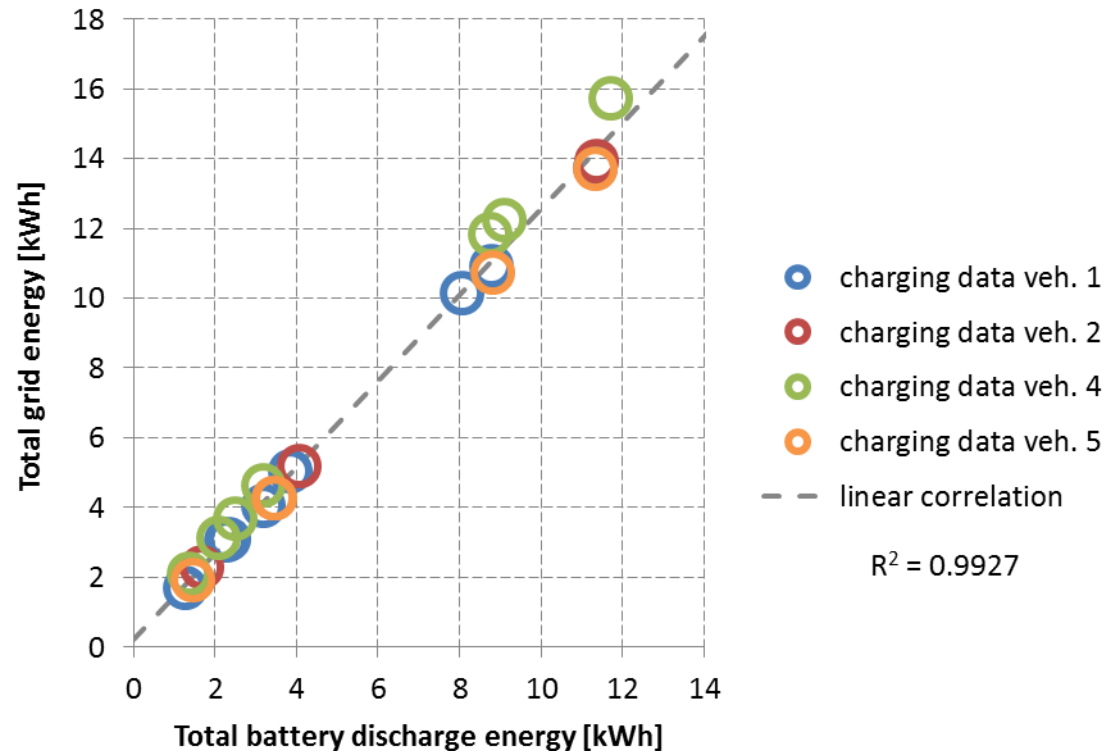


Energy demand of BEV

Battery system and charging efficiency, 23°C

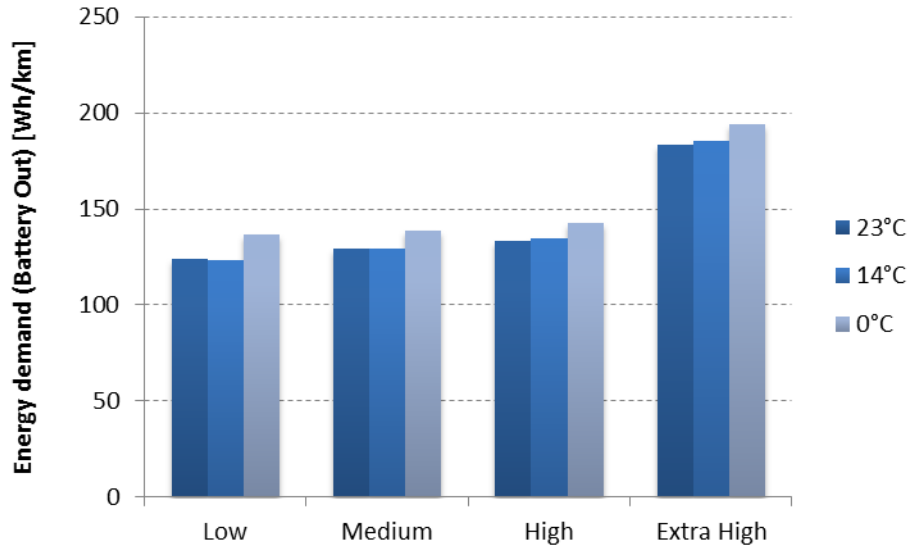
Standard charging

- Mean efficiency: 77%
- Minimum: 66%
- Maximum: 83%
- Vehicle 04 with complete thermal management and therefore lower efficiency



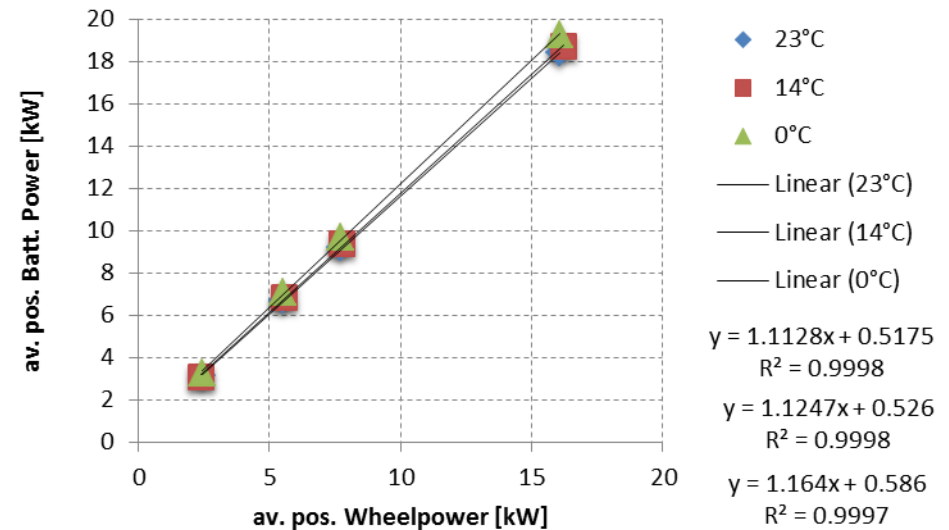
Energy demand of BEV

WLTC



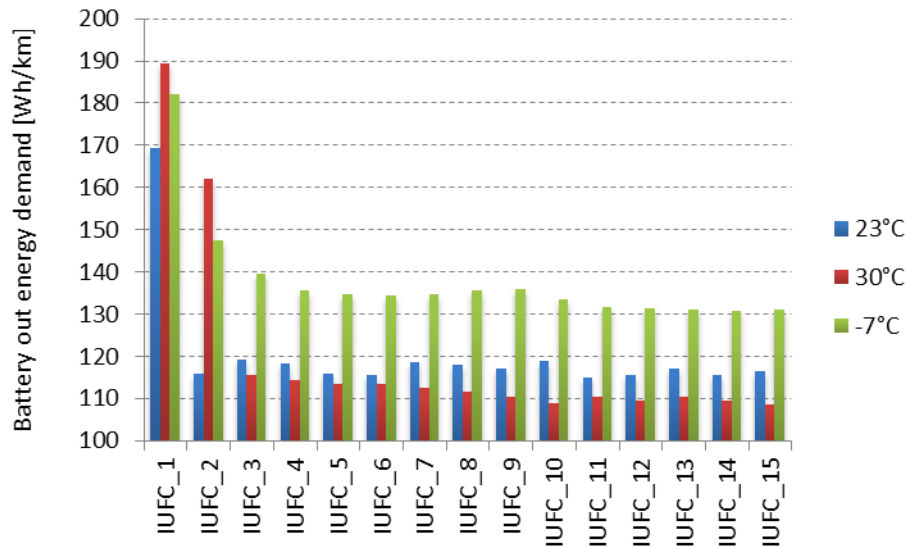
Observed drive train efficiency decrease (cold start)

- 23°C: ~89%
- 14°C: ~89%
- 0°C: ~86%



Energy demand of BEV

BEV at different temperatures, without auxiliaries

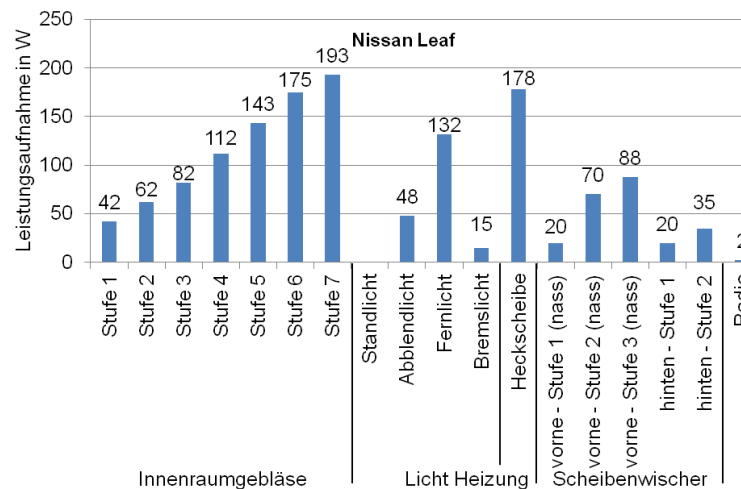
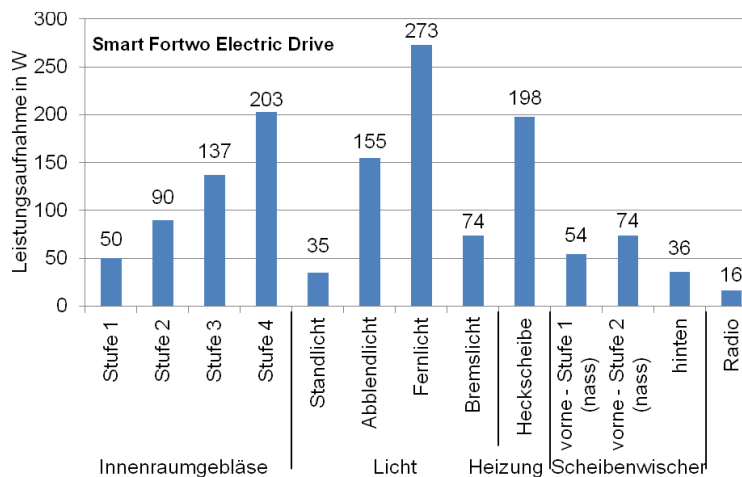
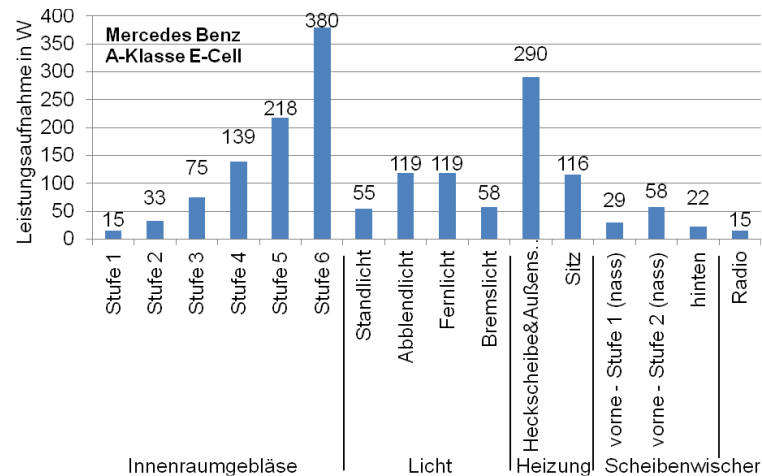
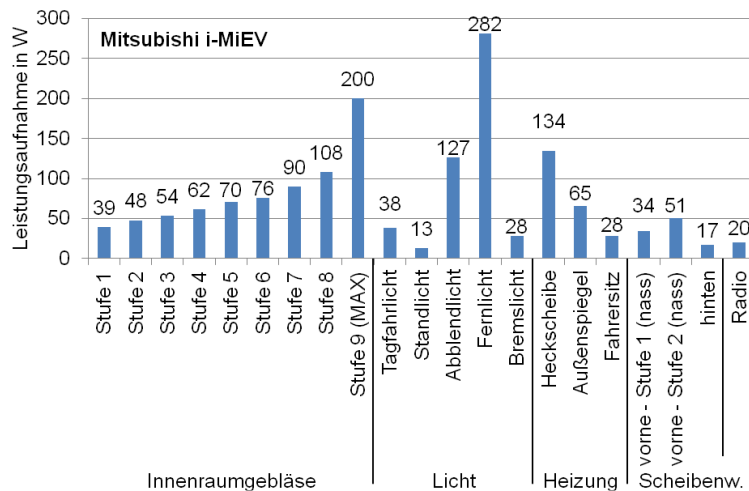


IUFC sub cycle results
(battery out energy)

- Thermal management of the battery influences overall consumption
- active heating at low temperatures
- active cooling with AC at high temperatures

Energy demand of BEV

Energy demand due to auxiliaries



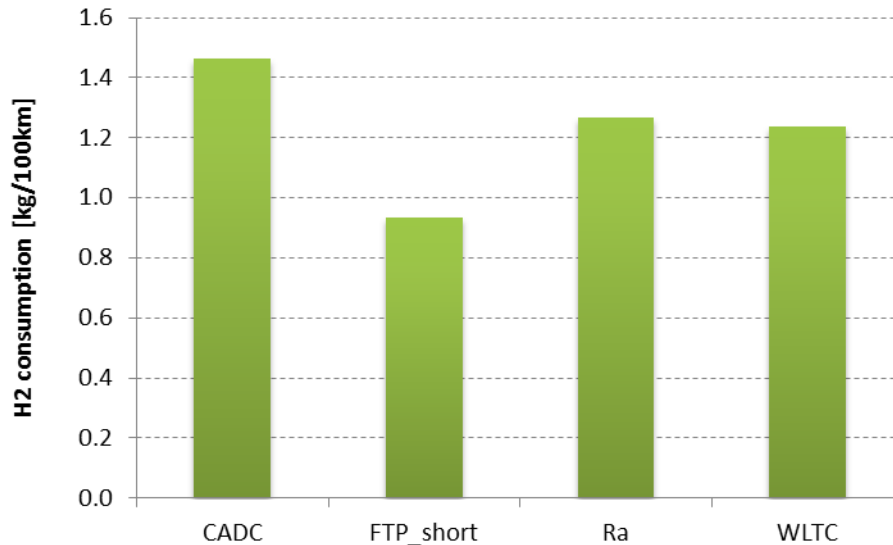
ÖVK, Batterieelektrische Fahrzeuge in der Praxis, 2012

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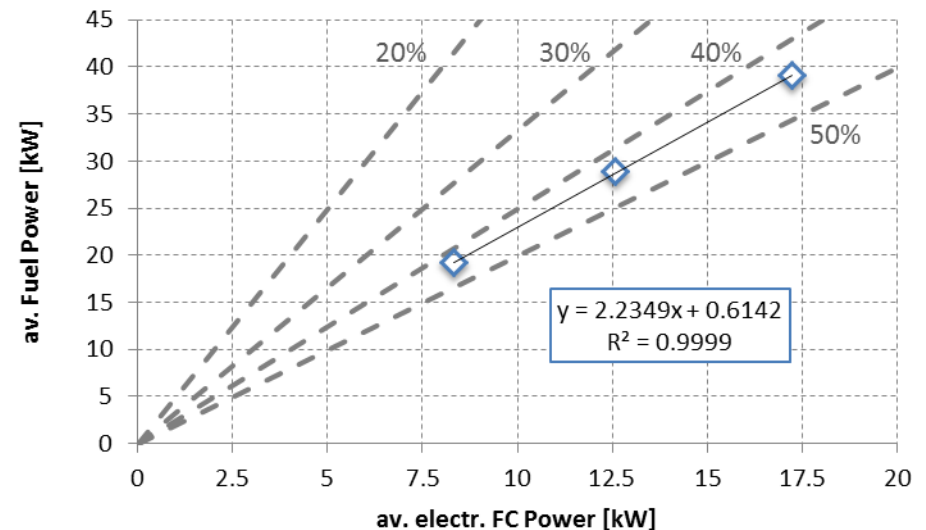
Fuel Cell vehicle chassis dyno tests

Fuel consumption @ 23°C



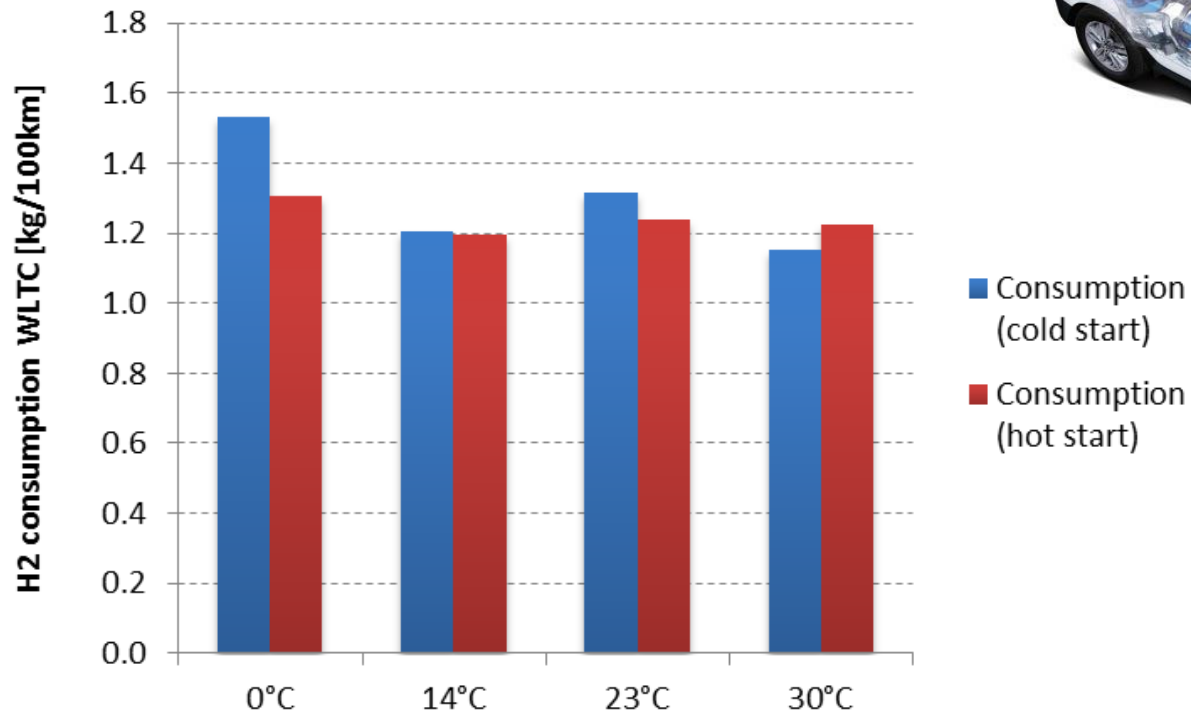
Preliminary results

- Av. vehicle efficiency: 44%
- Av. fuel cell efficiency: 48% - 50%



Fuel Cell vehicle chassis dyno tests

Fuel consumption comparison cold start vs. hot start (Preliminary results)



Thank you for your attention!

With a sincere vote of thanks to:

Swiss Federal Office for the Environment FOEN, Air Pollution Control and Chemicals Division, Traffic Section

Dr. Brigitte Buchmann, Head of Department Mobility Energy and Environment, Empa

Christian Bach, Head of the Automotive Powertrain Technologies Laboratory, Empa

Team of the Automotive Powertrain Technologies Laboratory, Empa

Contact:

thomas.buetler@empa.ch