11. A3PS-Conference – “Eco-Mobility 2016”
"Feasible Propulsion and Vehicle Technologies versus Political Visions"
17th – 18th October 2016, Vienna

Research on Automotive Propulsion Systems for Future Mobility Needs

Institute for Powertrains & Automotive Technology

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TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Institute for Powertrains & Automotive Technology

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Organization of Vienna University of Technology

University Council

Senate

Rectorate

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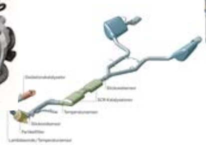
- Architecture and Planning
- Civil Engineering
- Electrical Engineering and Information Technology
- Informatics
- Mechanical and Industrial Engineering
- Mathematics and Geoinformation
- Physics
- Technical Chemistry

Research competences


- Combustion and Flame Propagation
- Exhaust Gas Aftertreatment
- Alternative Fuels
- Alternative Propulsion
- Component Development

- Exhaust gas measurement instrumentation
- Engine measurement instrumentation
- Hardware-in-the-Loop
- Numerical Simulation
- Trend Analysis
- Measurement instrumentation of E-Cars
- Thermal management & heat storage

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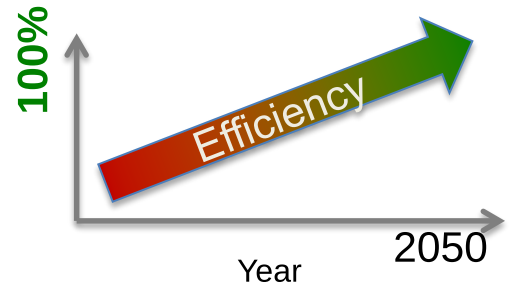
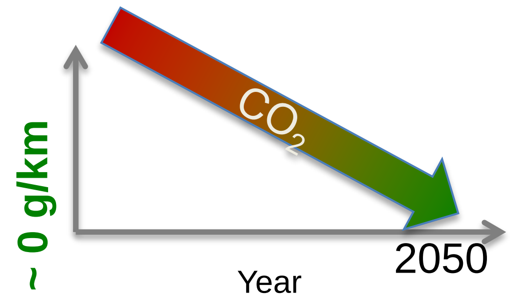
Requirement for future vehicle

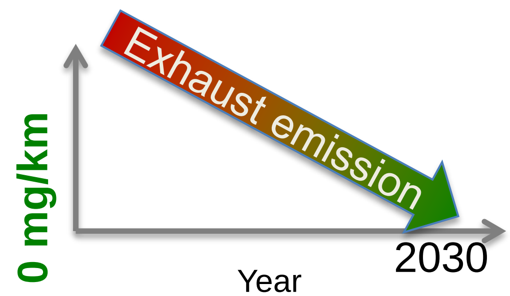
- ☐ **Efficiency increase** ↑



- ☐ **CO_2 reduction** ↓

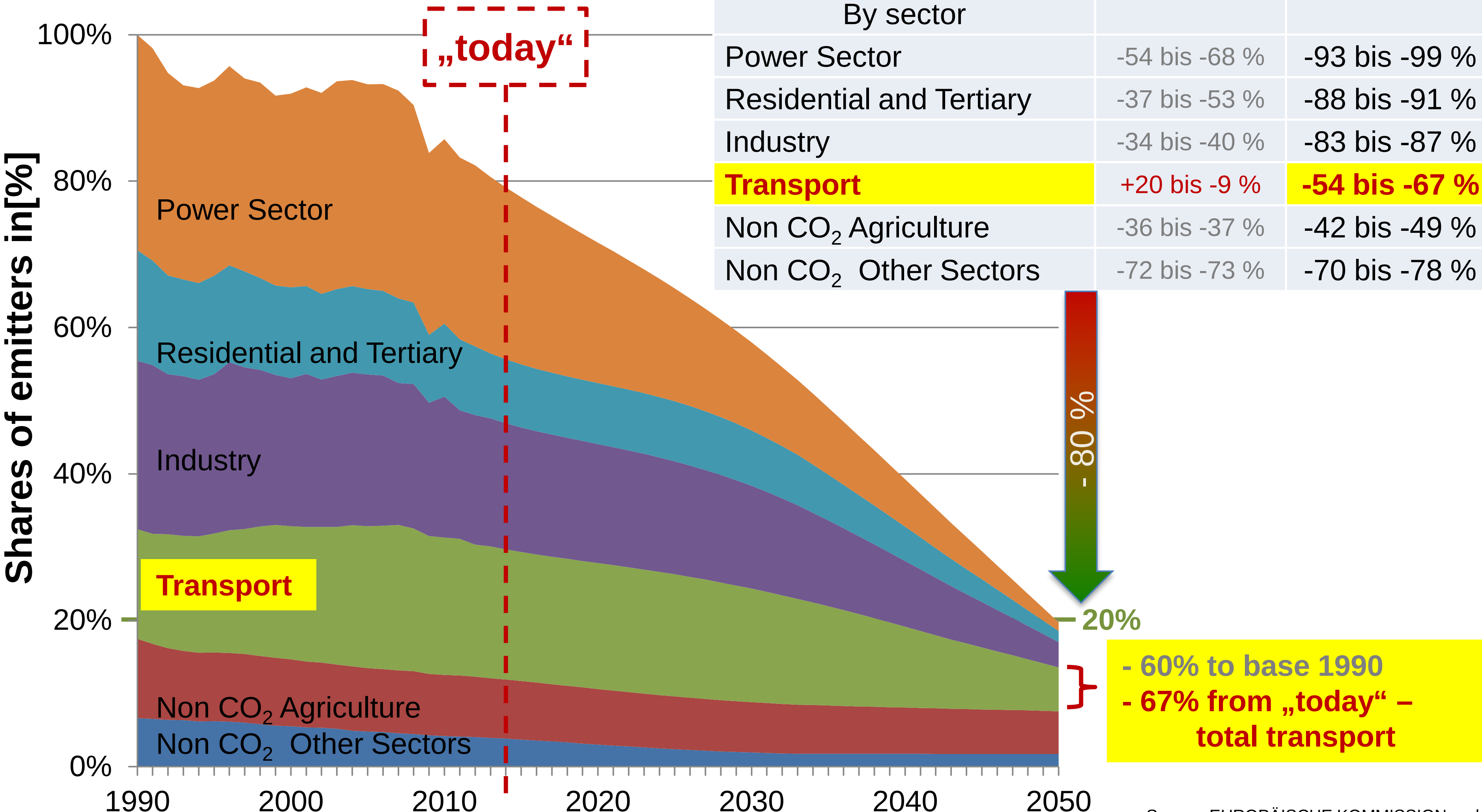


- ☐ **Exhaust emission reduction** ↓



EU roadmap: 80% cut in greenhouse gas emissions by 2050 to base 1990

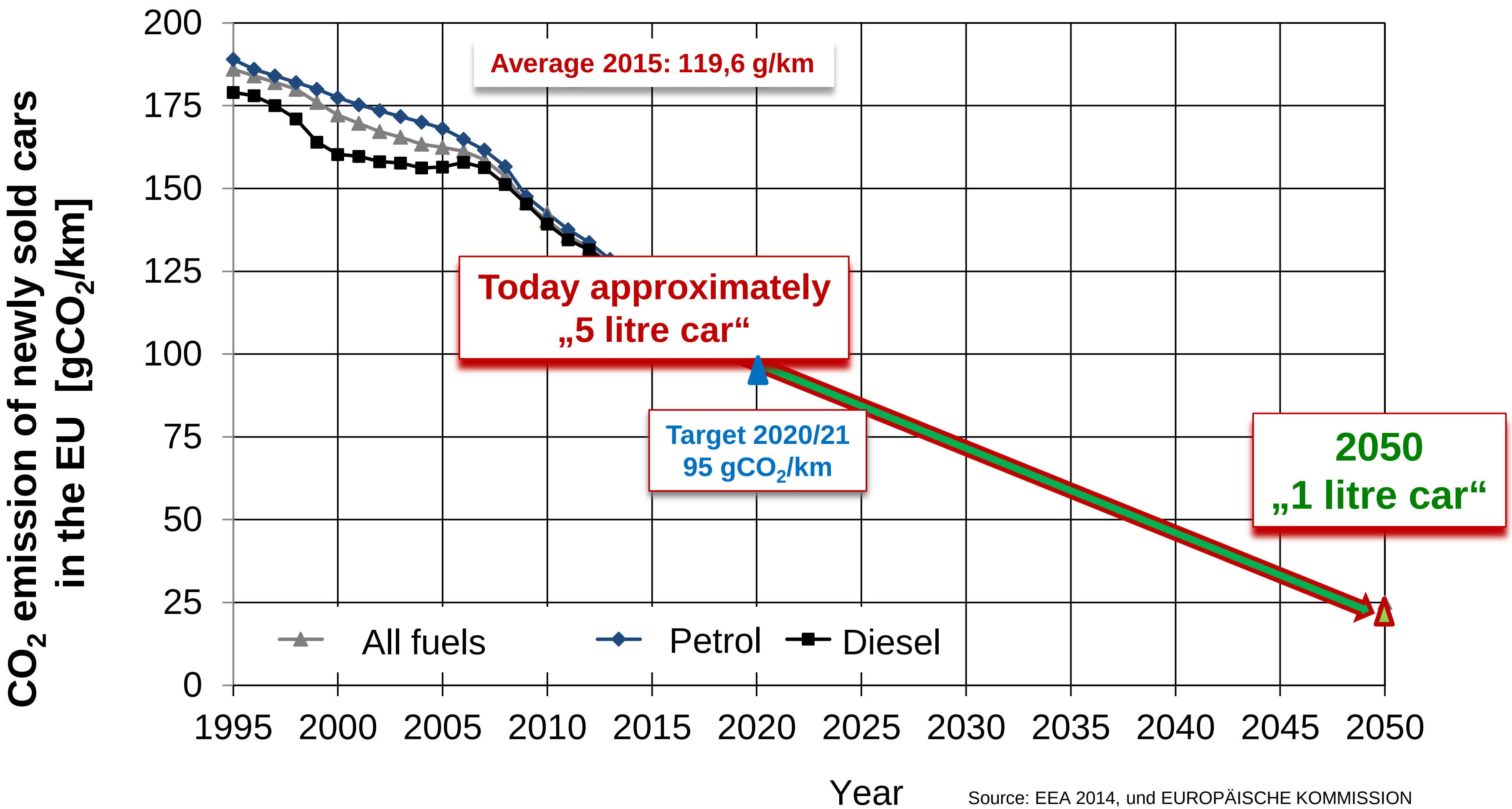
GHG – Target Basis 1990	2030	2050
Total	-40 bis -44 %	-79 bis -82 %
By sector		
Power Sector	-54 bis -68 %	-93 bis -99 %
Residential and Tertiary	-37 bis -53 %	-88 bis -91 %
Industry	-34 bis -40 %	-83 bis -87 %
Transport	+20 bis -9 %	**-54 bis -67 %**
Non CO_2 Agriculture	-36 bis -37 %	-42 bis -49 %
Non CO_2 Other Sectors	-72 bis -73 %	-70 bis -78 %



Source: EUROPÄISCHE KOMMISSION und
© 2014 United Nations Framework Convention on Climate Change

From “5 litre car” to „1 litre car“

80% cut in greenhouse gas emissions by cars requires the „1 litre car“



Source: EEA 2014, und EUROPÄISCHE KOMMISSION

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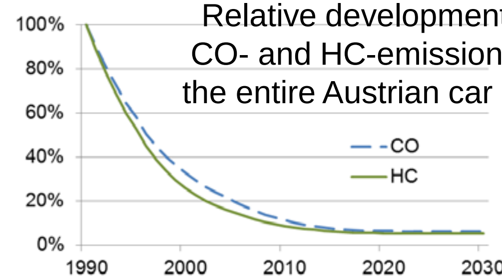
Short term solutions

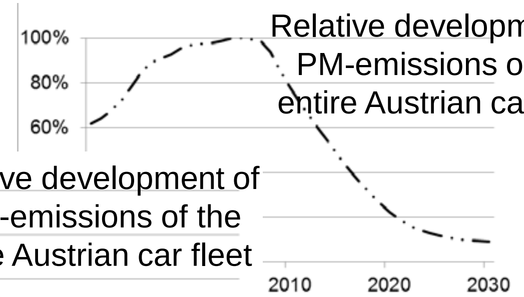
Combustion Engine improvement:

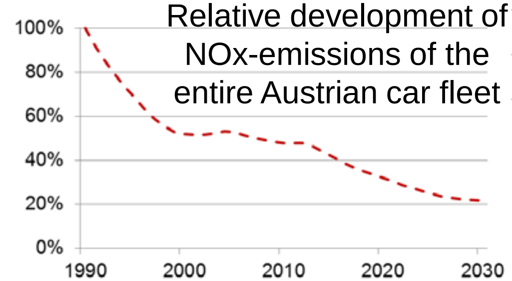
- η today 40% in future 45 ÷ 50%



Exhaust aftertreatment:

- CO- and HC- Emissions → approach zero
- PM-Emission due to filter systems → problem solved
- NOx-Emissions → on the path towards 0





Regenerative fuels:

- Biofuels 1st generation → 1st try – historically important
- Biofuels 2nd and 3rd generation → promising solutions
- Synthetic CNG → promising solution

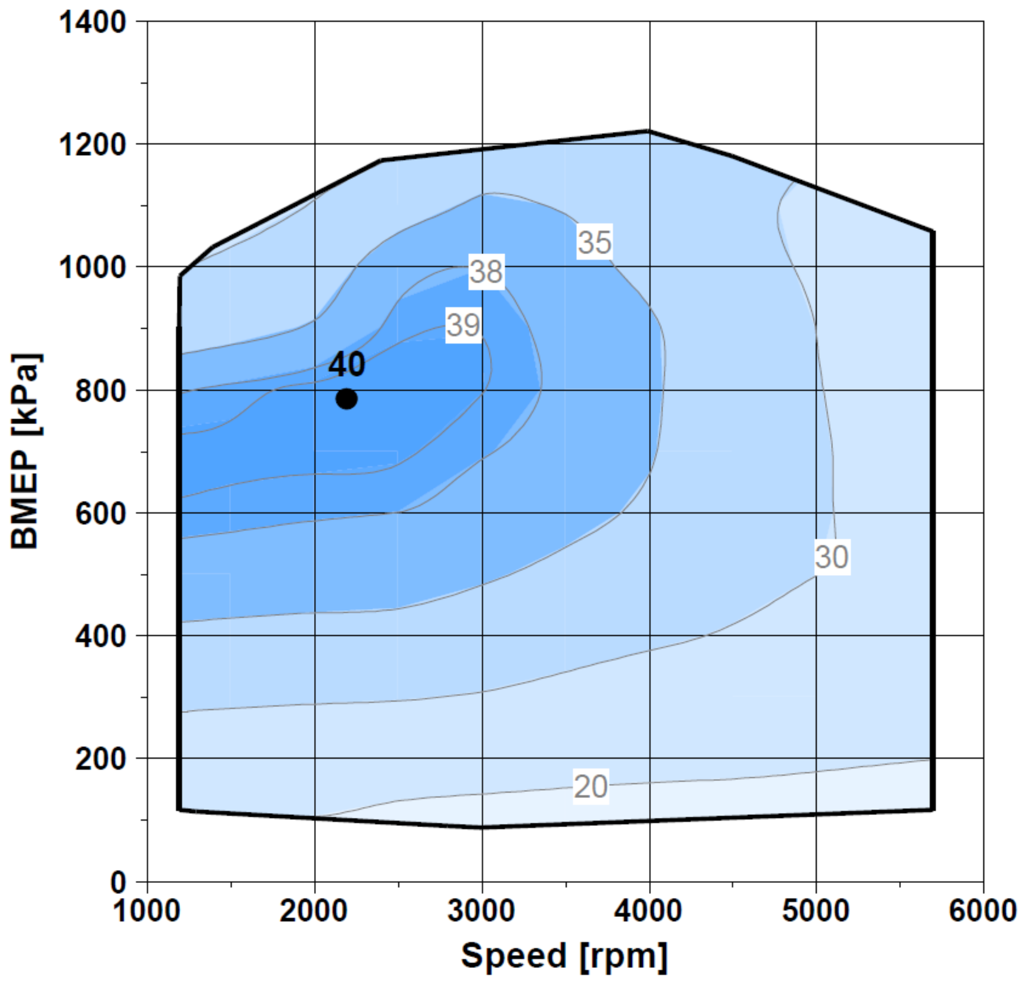
Electrification of the powertrain:

- Start/stop and hybrid
- Range extender and pure BEV

Thermal efficiency improvement – Gasoline engine

Gasoline direct injection engine dedicated for hybrid vehicles:

- 1,35 stroke-bore ratio
- Atkinson cycle with high compression ratio
- Cooled exhaust gas recirculation
- High tumble intake ports
- Continuous variable valve timing
- Minimized friction
- …



Source: Hwang, I et al.: WMS 37, 2016

Midterm solutions

Vehicle improvement to the extreme:

- Including modified combustion cycles
- Variabilities (valve timing, charging, compression ratio)
- Lightweight,
- Aerodynamics
- ….

Alternative fuels → increasing the production:

- Synthetic fuels
- Biogenic fuels 3rd generation (e.g. algae)
- E-fuels
- ….

Electric vehicles → increasing the production:

- Battery-electric-vehicles
- Fuel-cell-vehicles

Long-term solutions

Combustion engine:
- Only with regenerative energies

Choice of electrified powertrain depending on the transport task:

Battery-electric-vehicles:
- Urban and regional transport
- Cars, light duty truck, city buses

Fuel-cell-vehicles:
- For long distance
- Coaches, heavy duty trucks

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Exhaust gas after treatment | RDE – Real Driving Emissions
Research Project

- Development of a methodology to simulate on road driving on a chassis dynamometer
  - Aim: reproducibility of measurements by performing RDE-tests on a chassis dynamometer

- Boundary conditions and contents
  - Verification of the comparability of results from tests on road and on the chassis dynamometer
  - Logging and analysis of real-world on road driving
  - Extensive recording of vehicle and environmental parameters within RDE-tests on road
  - Deduction of relevant environmental parameters, which need to be simulated on the chassis dynamometer

Publications:

Szikora, M.: Ermittlung und Bewertung der Abbildungsgüte von Realfahrteinflüssen zur Darstellung von Real-Driving-Emissions-Messungen auf Rollenprüfständen, Technische Universität Wien, Institut für Fahrzeugantriebe und Automobiltechnik, Diplomarbeit, Wien, 2015

Szikora, M.; Tober W.: Enabling Real Driving Emissions Measurements on a smart modified chassis dynamometer; EAEC European Automotive Congress 2015; Bukarest

Alternative Propulsion Systems | E-cars

Measurement technology requirements

- Currents up until 500 A.
- Voltage up until 600 V.
- Current sensors need to have
  - high linearity
  - low offset
  - high band width
  - small phase error
  - temperature stability

- No interaction of the current measurement system with the car electronics
- High sampling rate (up until 400 kHz necessary, depends on the inverter).
- Variable sampling rate (e.g. temperature at 1 Hz)
- High processing power for high calculation rates (up until 200 kHz, in real time)

Publication:
Geringer, B., Tober, W.: Batterieelektrische Fahrzeuge in der Praxis – Kosten, Reichweite, Umwelt, Komfort, Studie des Österreichischen Vereins für Kraftfahrzeugtechnik (ÖVK) und des Österreichischen Automobil-, Motorrad und Touring Clubs (ÖAMTC), 2012, (Durchgeführt durch das IFA)

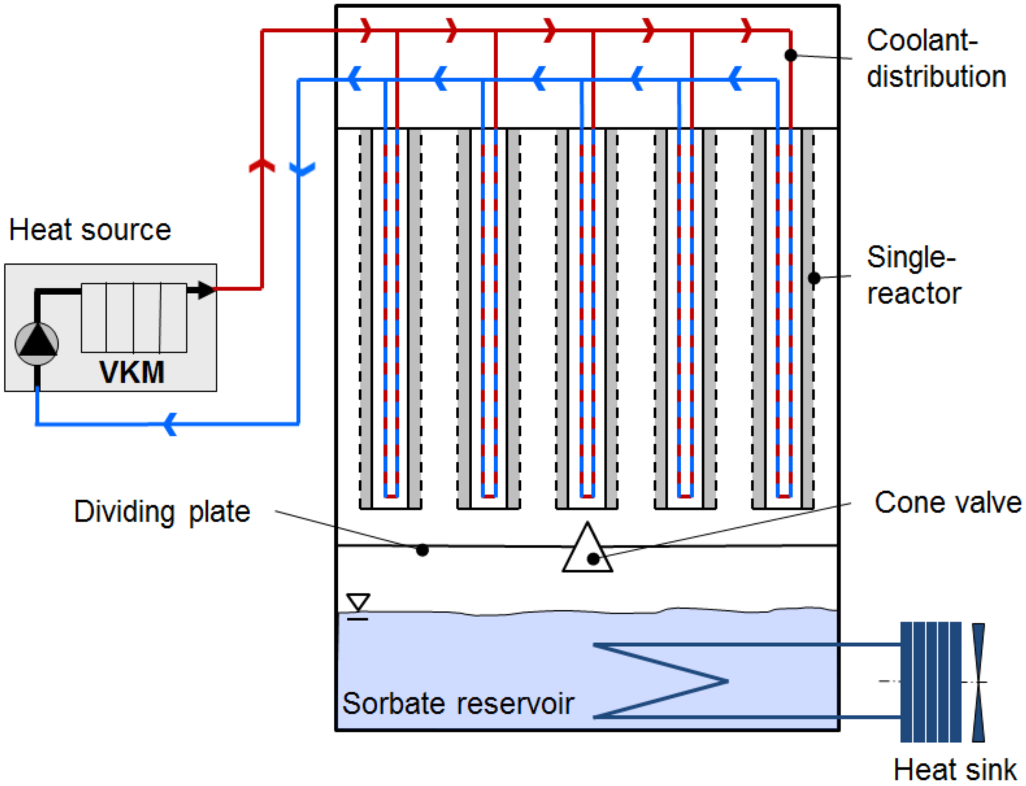
- Analysis of Hyundai ix35 FCEV on the chassis dynamometer
- Analysis based on selected driving cycles in changing environmental conditions
- Detection of:
  - Mass flow of hydrogen and air
  - Coolant flow
  - Temperature and Pressures of fluents
  - Current and voltage of the fuel cell and battery
  - Electrical power of consumers

- Results:
  - Fuel consumption during heating and cooling requirements
  - Efficiencies, energy management, strategies and operating parameters
  - Parameter determination for concept and vehicle evaluation

Heat storage | Prototyping

FVV CO_2-Special research programme: „Utilisation of residual heat“

- Chemiclal heat storage - Analysis at test bench
  - Determination of temperature- and pressure profiles at low vacuum (10 - 100 mbar)
  - Low temperature tests
  - Recording of the discharging power of several materials
  - Optimising the heat conduction
  - Reduction of desorption-duration and -temperature



Publications:

Geringer, B.; Hofmann, P.; Jakobi, M.: Neue Wärmespeichertechnologien für den Einsatz in zukünftigen Fahrzeugen, 32. Wiener Motorensymposium, Mai 2011

Geringer, B.; Hofmann, P.; Jakobi, M.: Restwärmenutzung durch intelligente Speicher- und Verteilungssysteme, FVV Frühjahrstagung, März 2011

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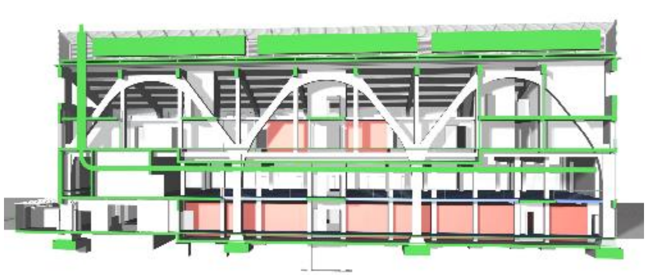
- ☐ Short-term to long-term solutions
- ☐ Variety of research portfolio – with emphasis “simulation”
- ☐ **Conclusion**

IFA | New test facility at Science Center Arsenal (2017)

- New test facility at the Arsenal area
- Part of the infrastructure project of the TU Vienna „**TU Univercity 2015**“



Conclusion

Furthermore, the mobility will provide interesting challenges

→ and the TU-Wien will be at the forefront with highly competences & advanced research facilities

Thank you for your attention!