

INNOVATIVE ANTRIEBE MIT BRENNSTOFFZELLE – POTENZIAL UND BEISPIELE

15. Symposium Energieinnovation

Dr. Alexander Trattner, DI Frank Mair, Dr. Patrick Pertl,
Assoc. Prof. Dr. Manfred Klell

Graz, 15. Februar 2018

**First Austrian research institute for hydrogen
with test stands and filling facility since 2005**



**More than 13 years expertise in the fields of
production, storage and application of hydrogen.**



**HyCentA is a non-university research institution located at
facilities of Graz University of Technology**

- Team consists of experts from: physics, chemistry, mechanical engineering, electrical engineering and economics
- R&D of electrolysis, hydrogen storage systems, H₂-ICE and fuel cells
- Highly sophisticated research infrastructure
 - High pressure test stand up to 1000 bar
 - H₂-refueling for busses, trucks and passenger cars (350 bar)
 - Two flexible test cells with modern measurement techniques
 - Fuel cell system test bench up to 160 kW (HIFAI-RSA)



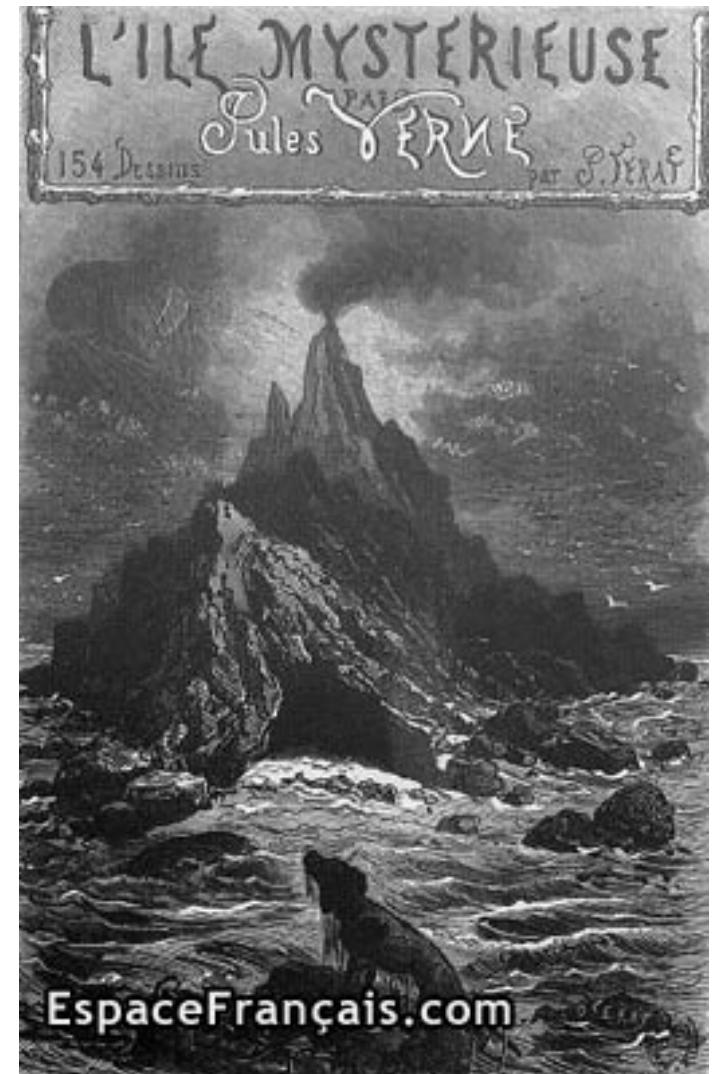
Vision: Jules Verne

«L'eau, décomposée en ses éléments par l'électricité [...] sera un jour employée comme combustible [...] L'hydrogène et l'oxygène qui la constituent [...] fourniront une source de chaleur et de lumière inépuisables. »

Jules Verne, 1874, dans « L'île mystérieuse»

«Wasser, aufgespaltet in seine Elemente durch Strom [...] wird eines Tages als Brennstoff eingesetzt werden [...] Der Wasserstoff und der Sauerstoff, die es bilden, [...] werden eine unerschöpfliche Quelle für Wärme und Licht darstellen. »

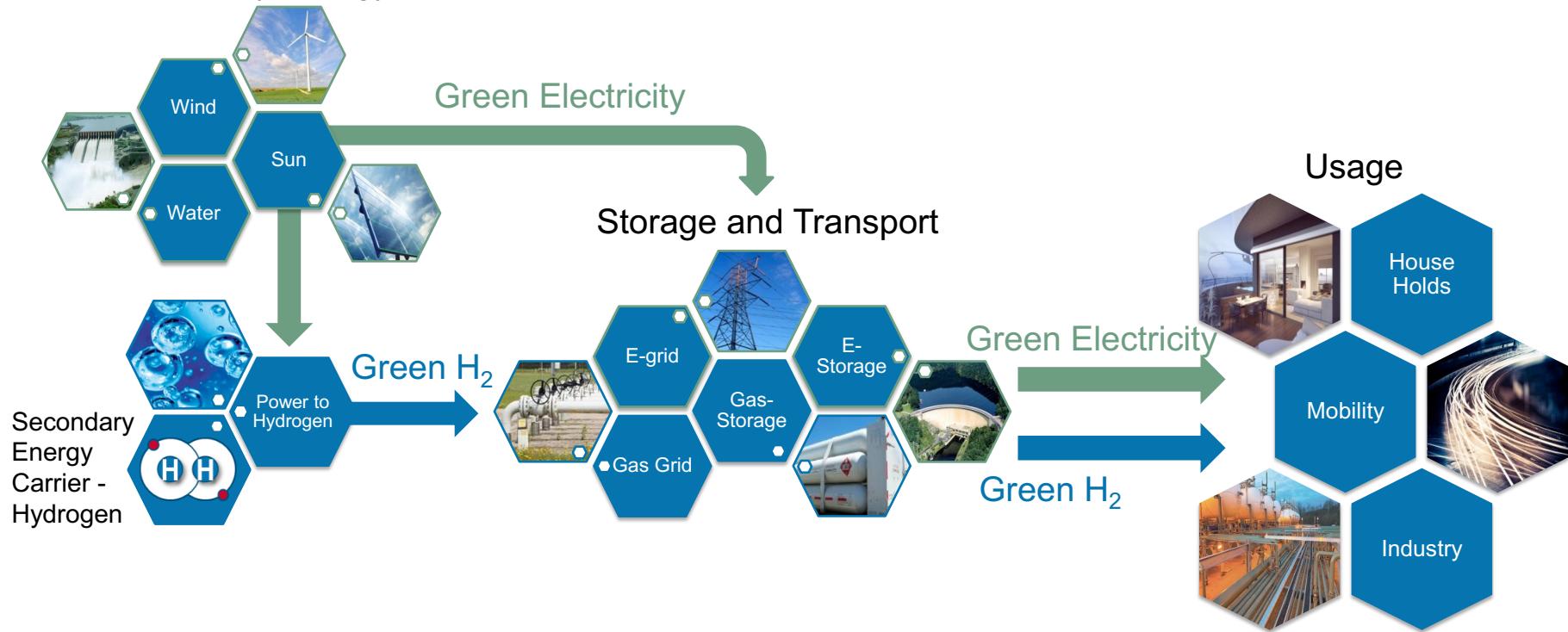
Jules Verne, 1874,
in « Die geheimnisvolle Insel ».



Realization of the Vision

Hydrogen enables a renewable and **emission-free energy cycle**

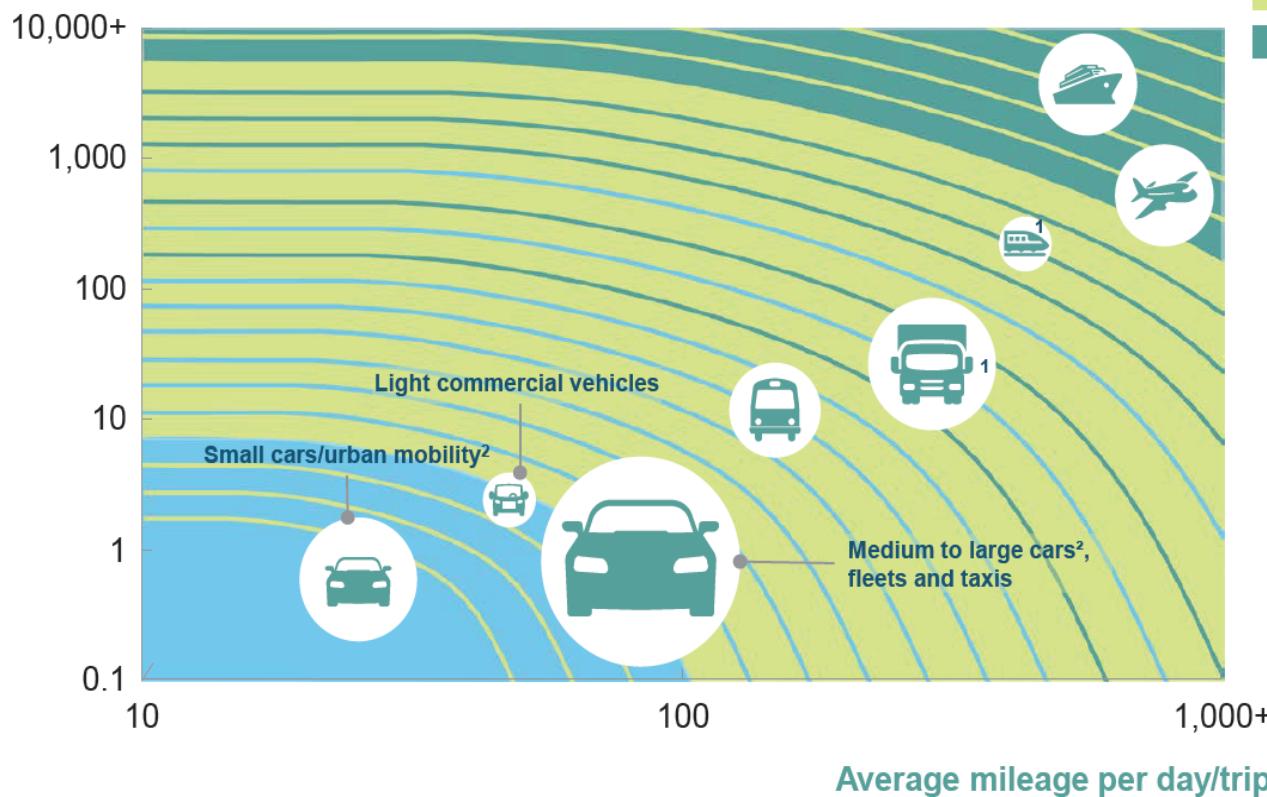
Renewable Primary Energy



- Fluctuating electrical energy production requires hydrogen as energy storage
- For energy distribution electricity and gas grid is required
- Hydrogen can be used in all segments: mobility, industry and households

Role of Fuel Cell Electric Vehicles - FCEVs

Weight
Tons



Bubble size representing the relative annual energy consumption of this vehicle type in 2013

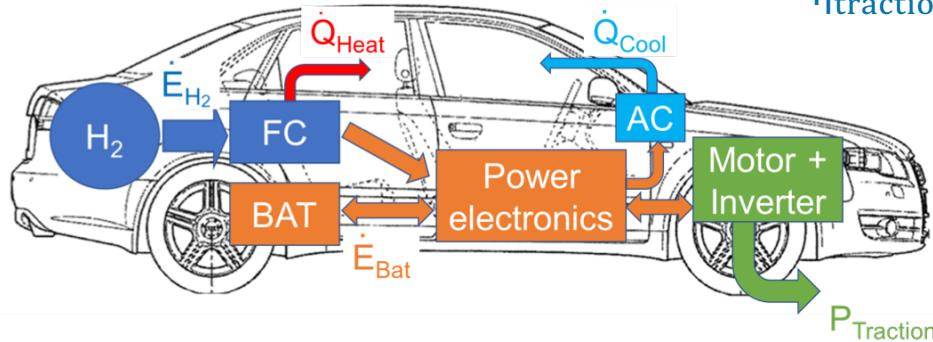
- BEV
- FCEV
- Bio- and (H₂-based) synthetic fuels



Source: Hydrogen Council 2017

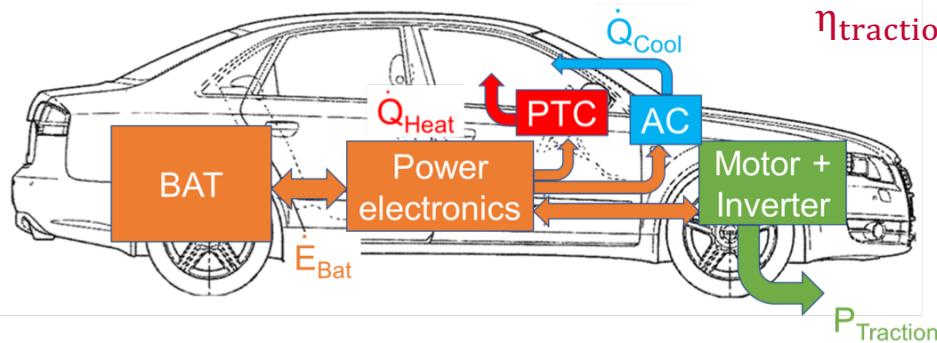
Tank-to-Wheel Efficiency

FCEV



$$\eta_{\text{traction}} = \frac{\text{Traction energy}}{\text{used chem. energy (H}_2\text{) for traction}} \approx 55\%$$

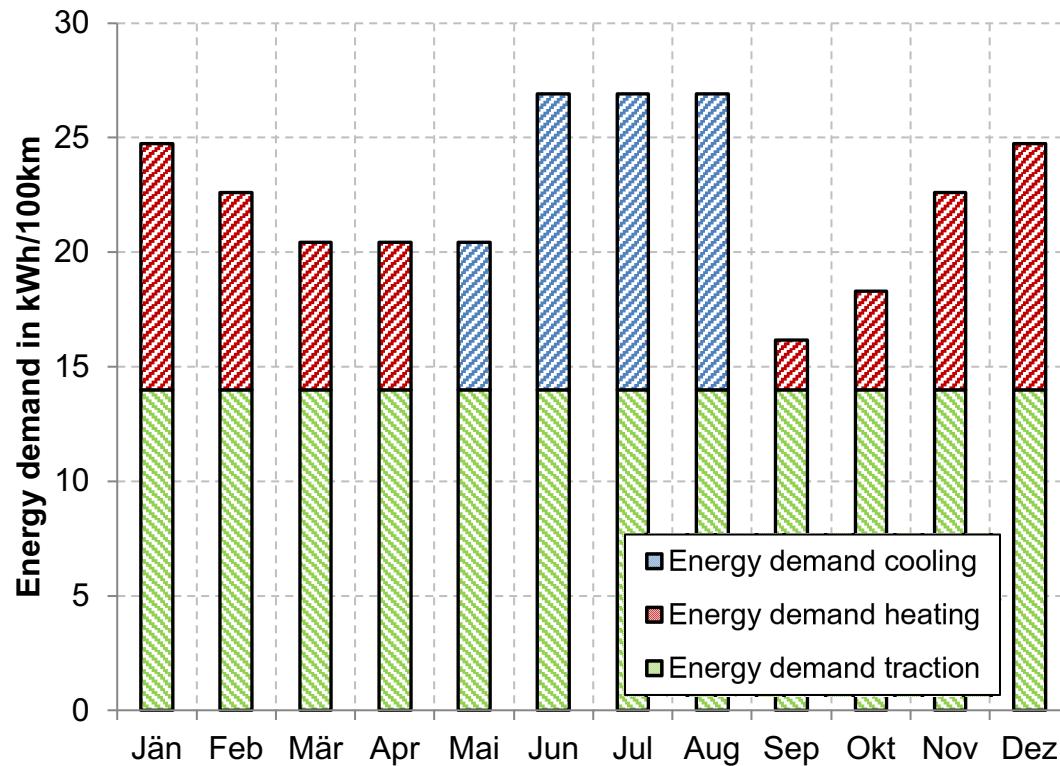
BEV



$$\eta_{\text{traction}} = \frac{\text{Traction energy}}{\text{used el. energy for traction}} \approx 85\%$$

In real operation additional energy is needed for heating and cooling of the cabin!

Tank-to-Wheel Efficiency



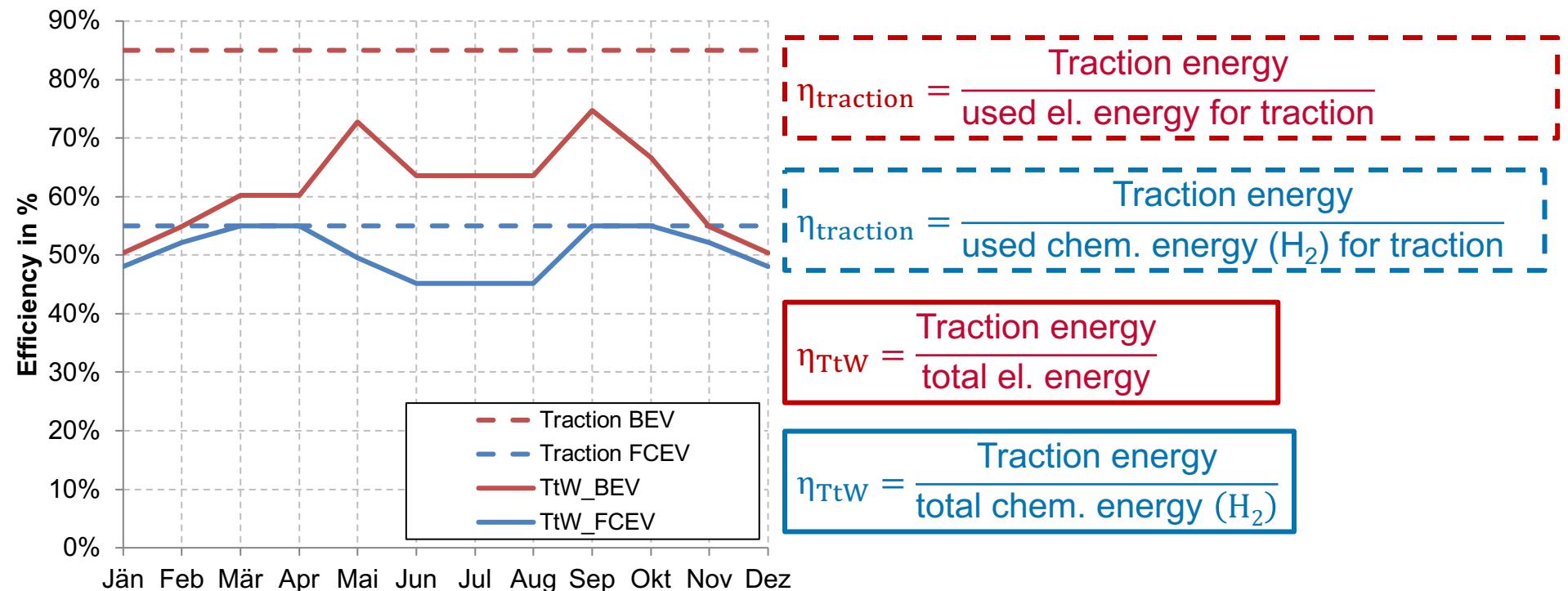
Energy demand for traction for a medium-sized vehicle in the WLTP-cycle

- Independent of drivetrain technology

Energy demand for cooling and heating based on annual temperature data of ZAMG AUT

- Energy demand for warm up during cold start procedure not considered

Tank-to-Wheel Efficiency

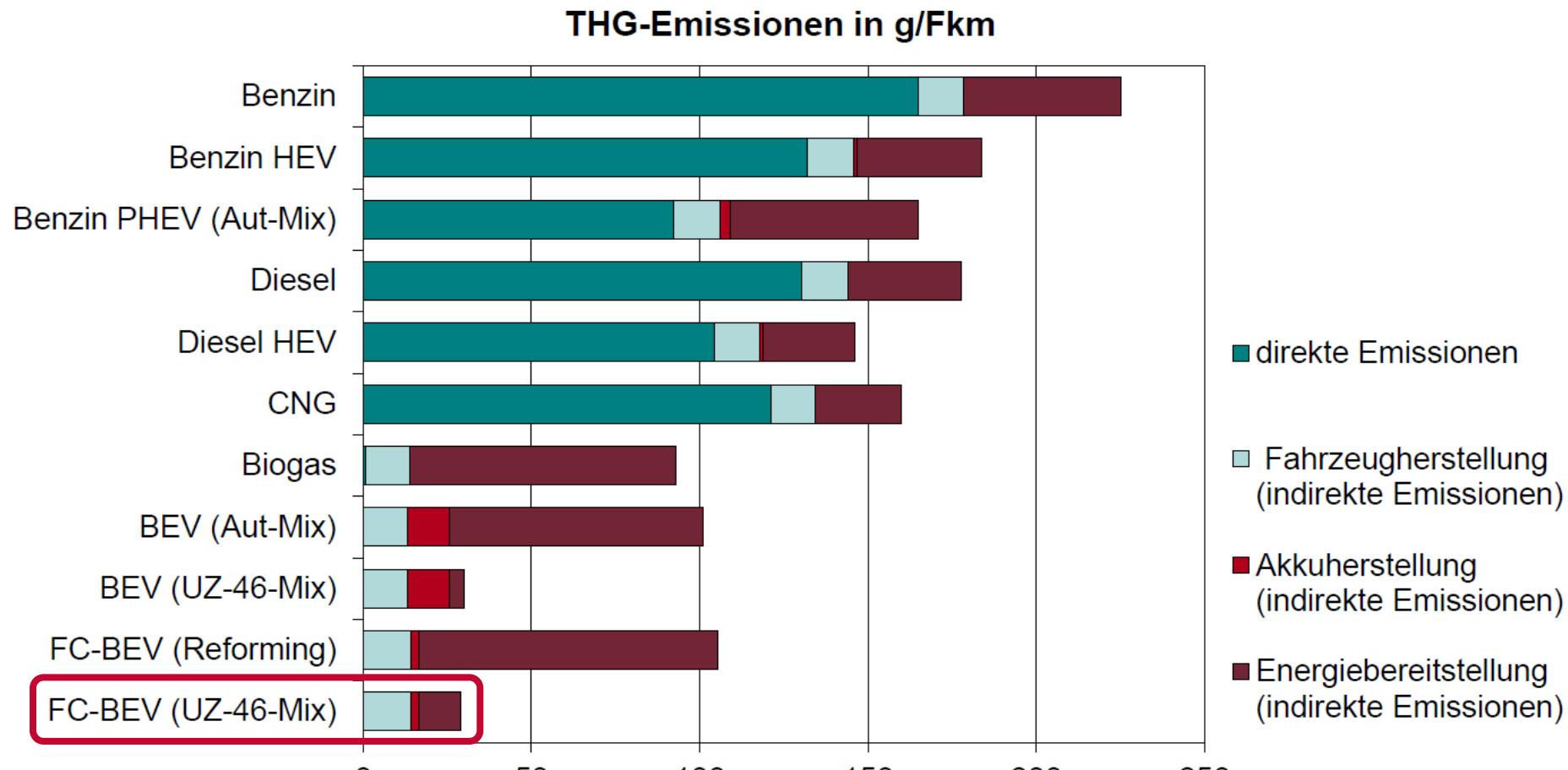


Annual average Tank-to-Wheel efficiency:

- **BEV $\approx 61\%$**
- **FCEV $\approx 50\%$**

Less impact on TtW-Efficiency of FCEV due to the useable waste heat!

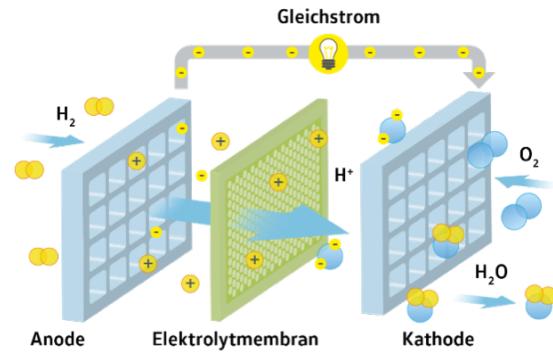
LCA CO₂ Emissions of FCEVs



Quelle: UMWELTBUNDESAMT (2017c)

FCEV vs. BEV - Costs

Fuel Cell Electric Vehicle - FCEV



Battery Electric Vehicle - BEV

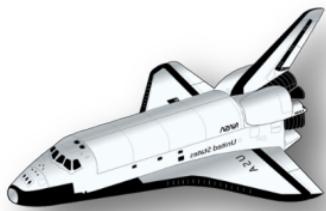


Cost Comparison

Data of DOE for high volume series production

BEV ← →

A Technology of Today!



Passenger Cars



Hyundai ix35 FCEV



Mercedes GLC F-Cell

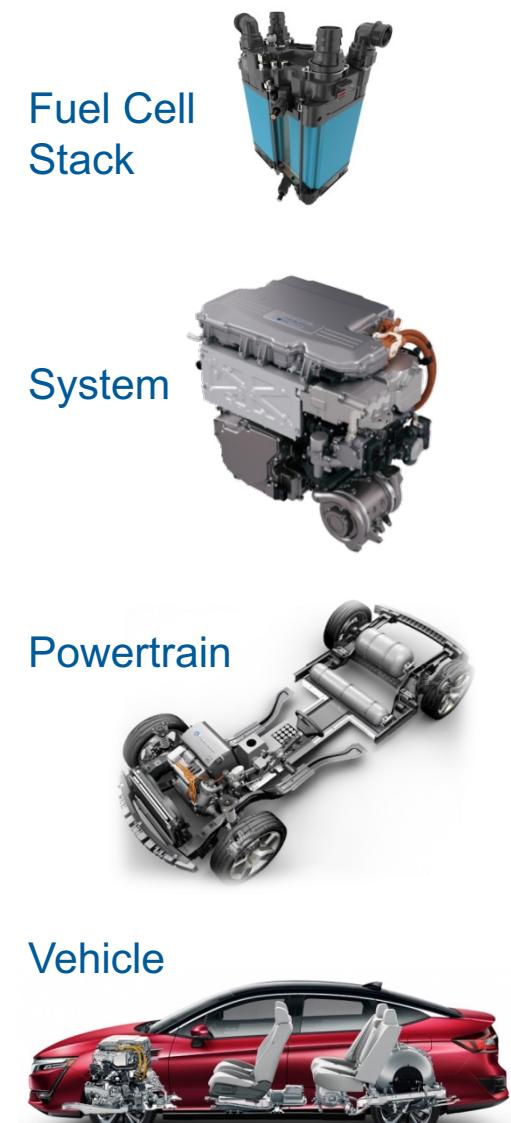
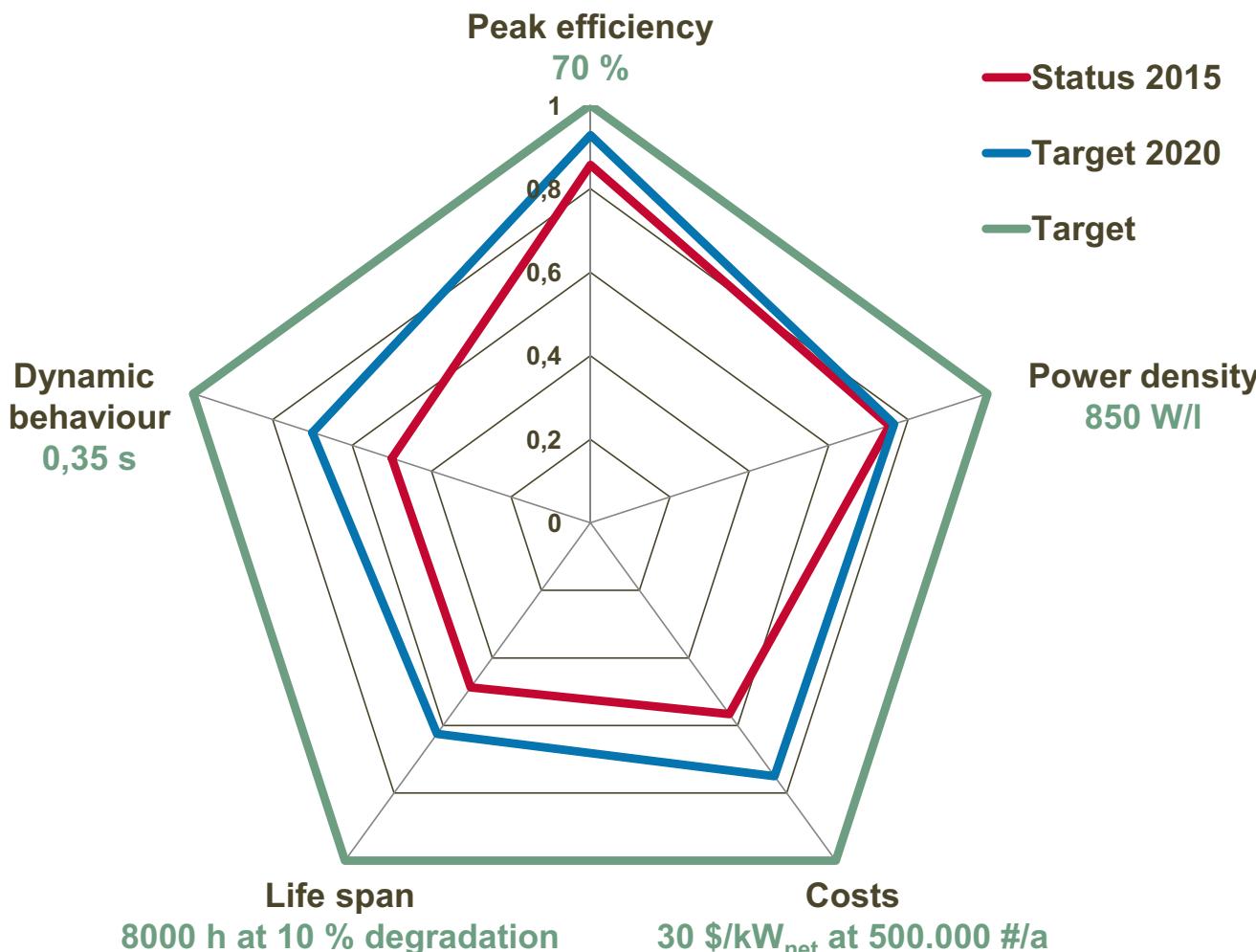


Honda Clarity



Toyota Mirai

Status of FCEV Technology



Source: Honda

KEYTEC4EV – Passenger Car

Key Technologies for Low-cost Electric Vehicle Platforms

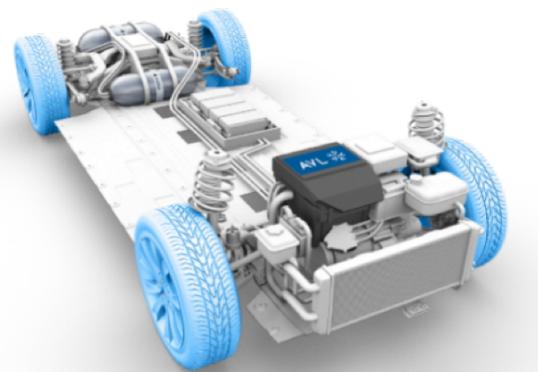


PROJECT IDEA

Battery
Reasonable size



Fuel Cell
Right size

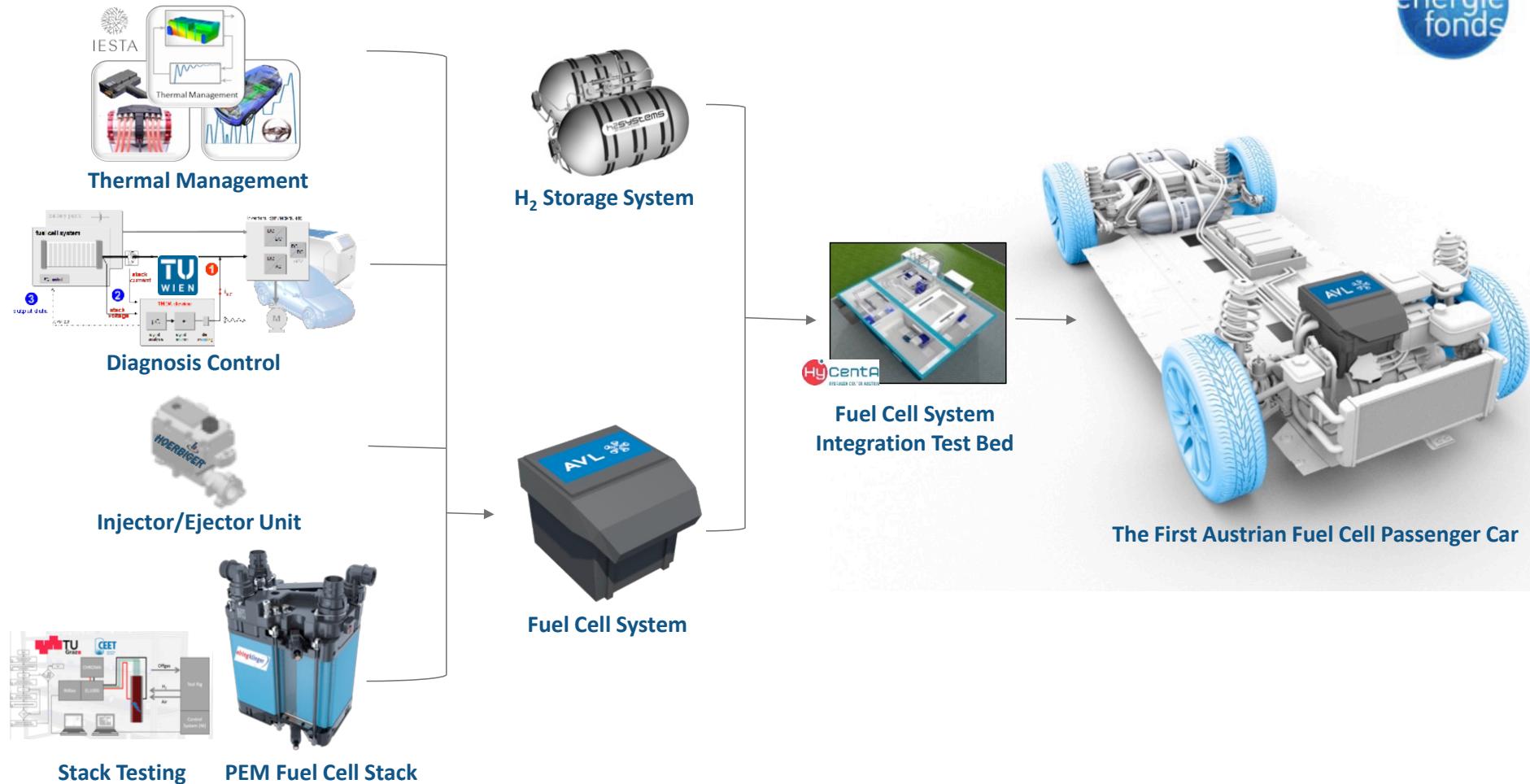


First Austrian Fuel Cell Passenger Car

Vehicle platform	VW Passat GTE
Battery capacity / power	9.9 kWh / 85 kW
Fuel cell system power	~ 60-70 kW
e-drive power	110 kW
Hydrogen tank capacity	5.3 kg
Hydrogen consumption	0.85 kg /100 km
Driving range	>600 km (NEDC, 5 kg H ₂ incl. battery-only range)

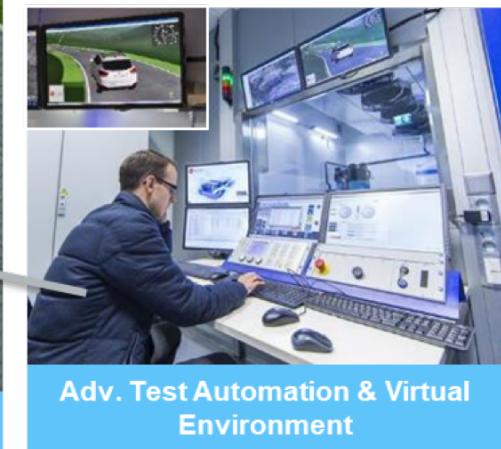
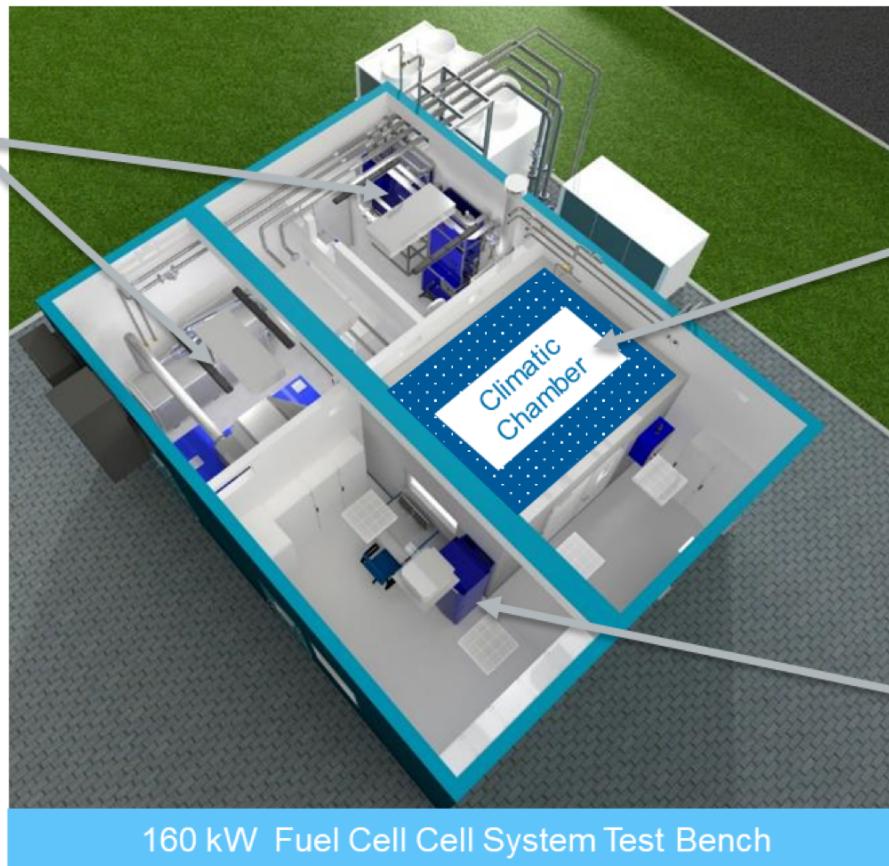
KEYTEC4EV – Passenger Car

Key Technologies for Low-cost Electric Vehicle Platforms



FC System Test Infrastructure - Overview

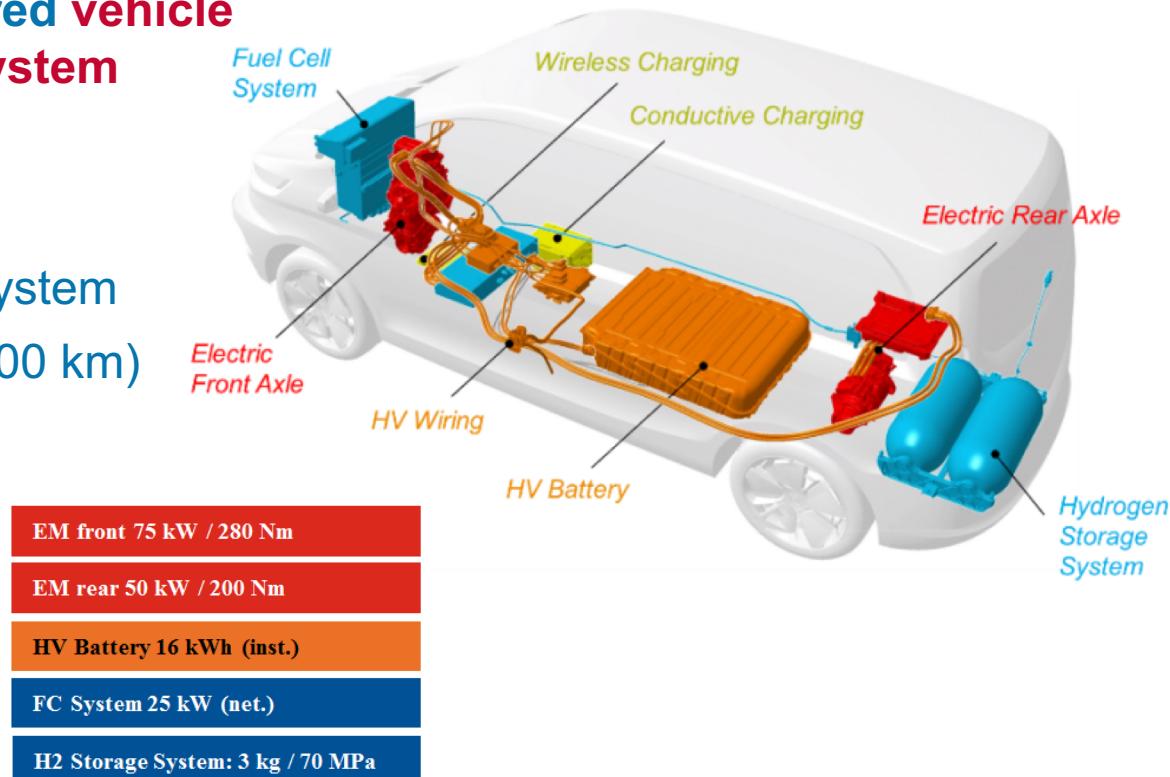
HIFAI-RSA - Highly Integrated Fuel Cell Analysis Infrastructure First Austrian Research- und Development Infrastructure for FC systems, sub systems and BoP components



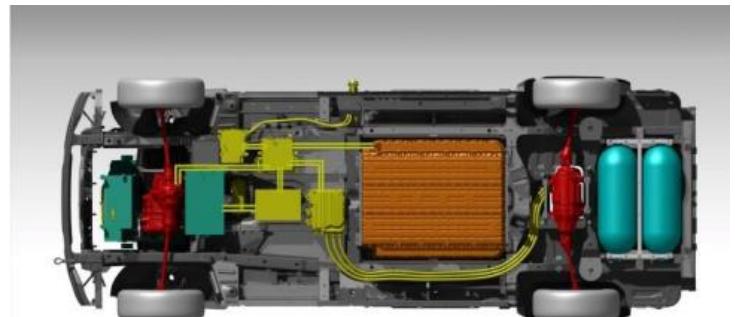
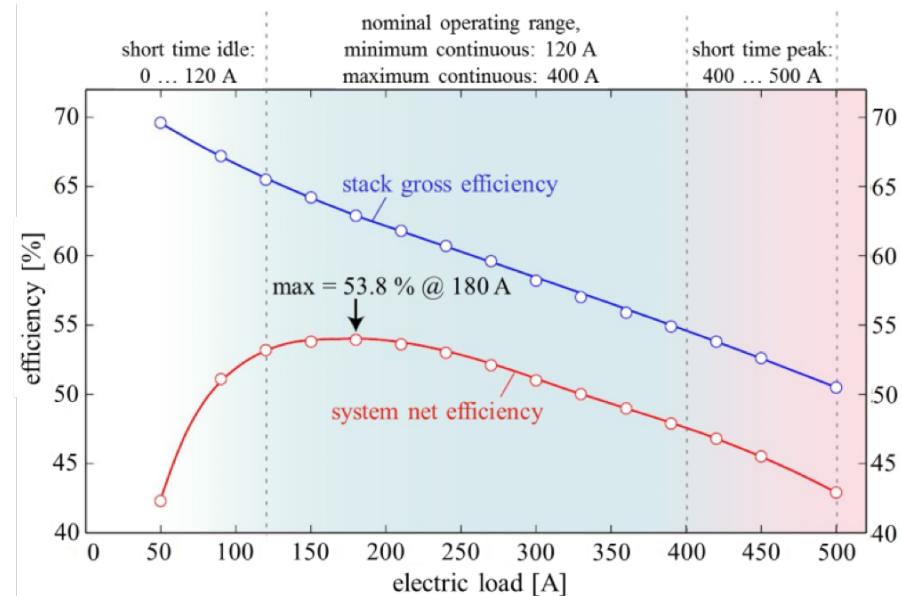
Fuel Cell Range Extended Electrical Vehicle

Extension of a battery-powered vehicle
with a 25 kW PEM fuel cell system

- AWD
- Fast refueling time ~ 3 min
700 bar hydrogen storage system
- Extended driving range (> 400 km)



- Concepts for operating strategy, energy management and thermal management
- Setup and integration 700 bar hydrogen storage system
- Fuel cell range extender system
- Vehicle integration and validation



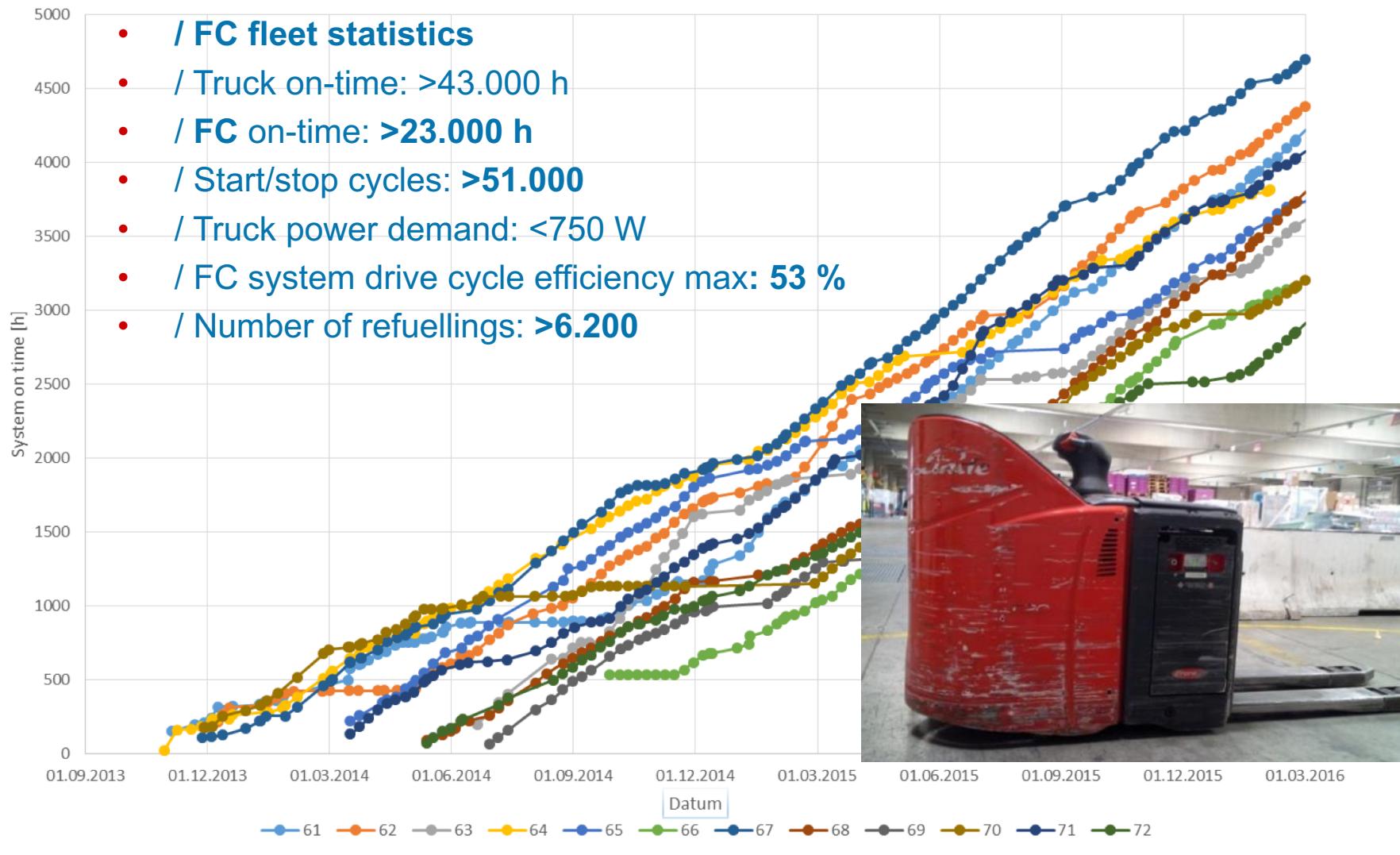
Austrian flagship project

- Replacement of industrial truck batteries by fuel cell-range extender and H₂-high pressure tank
- H₂ is produced onsite by decentralized reforming of bio-methane
- European's first hydrogen-indoor refueling
- Energy Globe Award Fire 2014



Project E-LOG BioFleet I & II 2010 – 2016

System on time



Heavy-Duty Fuel Cell Applications



Van Hool



COOP / H2energy



Alstom



Toyota



Toyota



CSR



Mercedes-Benz



Scania / ASKO

Energy Model Region WIVA P&G



WIVA – Wasserstoffinitiative Vorzeigeregion Energie Austria Power and Gas

- Funding of Austrian Climate and Energy Fund
- Overall budget WIVA P&G 125 M€ - 2018 till 2025
- Increase of renewable energy production
- Hydrogen as energy storage
- All segments: Green Mobility / Green Industry / Green Energy
- Chance for entering new markets and business models



Verbund



voestalpine

EVN



(fen)systems

KT MET
metallurgical competence center

ENERGIE AG
Oberösterreich
Wir denken an morgen



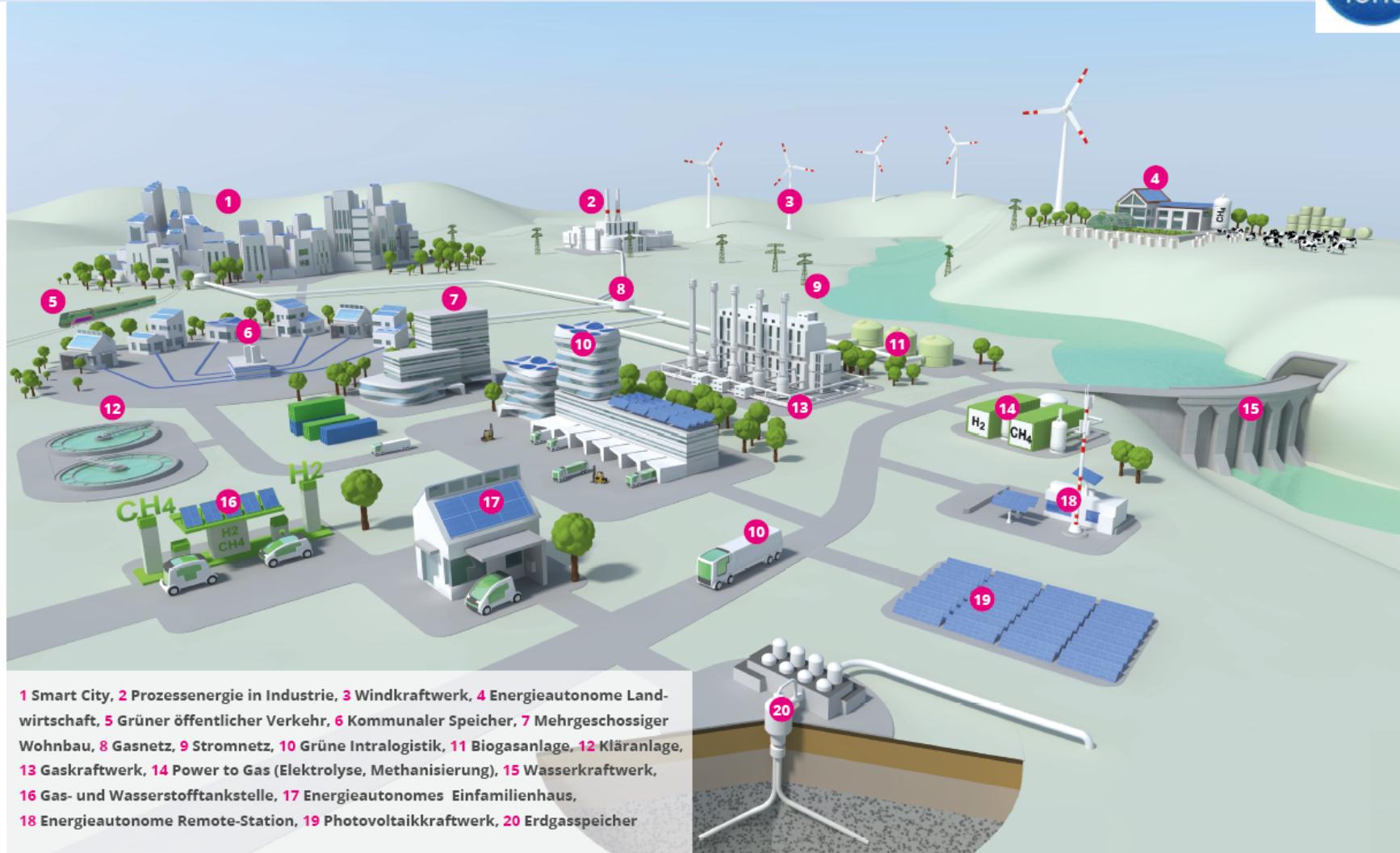
JOHANNES KEPLER
UNIVERSITÄT LINZ | JKU

TU
Graz

HyCenta
HYDROGEN CENTER AUSTRIA

Energy Model Region WIVA P&G

Vision: a **hydrogen based energy system** based on renewable sources for all economic sectors



1 Smart City, 2 Prozessenergie in Industrie, 3 Windkraftwerk, 4 Energieautonome Landwirtschaft, 5 Grüner öffentlicher Verkehr, 6 Kommunaler Speicher, 7 Mehrgeschoßiger Wohnbau, 8 Gasnetz, 9 Stromnetz, 10 Grüne Intralogistik, 11 Biogasanlage, 12 Kläranlage, 13 Gaskraftwerk, 14 Power to Gas (Elektrolyse, Methanisierung), 15 Wasserkraftwerk, 16 Gas- und Wasserstofftankstelle, 17 Energieautonomes Einfamilienhaus, 18 Energieautonome Remote-Station, 19 Photovoltaikkraftwerk, 20 Erdgasspeicher

Thank you for your attention!

YES
WE
CAN



Contact:

HyCentA Research GmbH

Manfred Klell (CEO)
Assoc.Prof. DI Dr.
+43 316 873 9500
klell@hycenta.at

Alexander Trattner,
DI Dr. (CTO)
+43 316 873 9502
trattner@hycenta.at

Inffeldgasse 15
A-8010 Graz



MOTIVATION STANDORT PROJEKTE ▾ WASSERSTOFF ORGANISATION ▾ DE ▾

Wasserstoff –
das Zauberwort für Energiespeicher



Vision

Das HyCentA (Hydrogen Center Austria) fördert die Nutzung der von Wasserstoff als regenerativem Energieträger. Mit einem Wasserstoffprüfzentrum und der ersten österreichischen Wasserstoffabgabestelle fungiert das HyCentA als Kristallisierungspunkt und Informationsplattform für wasserstoffbezogene Forschungs- und Entwicklungsaktivitäten.