European Committee of the Regions

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AUTOMOTIVE INTERGROUP

The Hydrogen Challenge

DI Dr. Marie Macherhammer

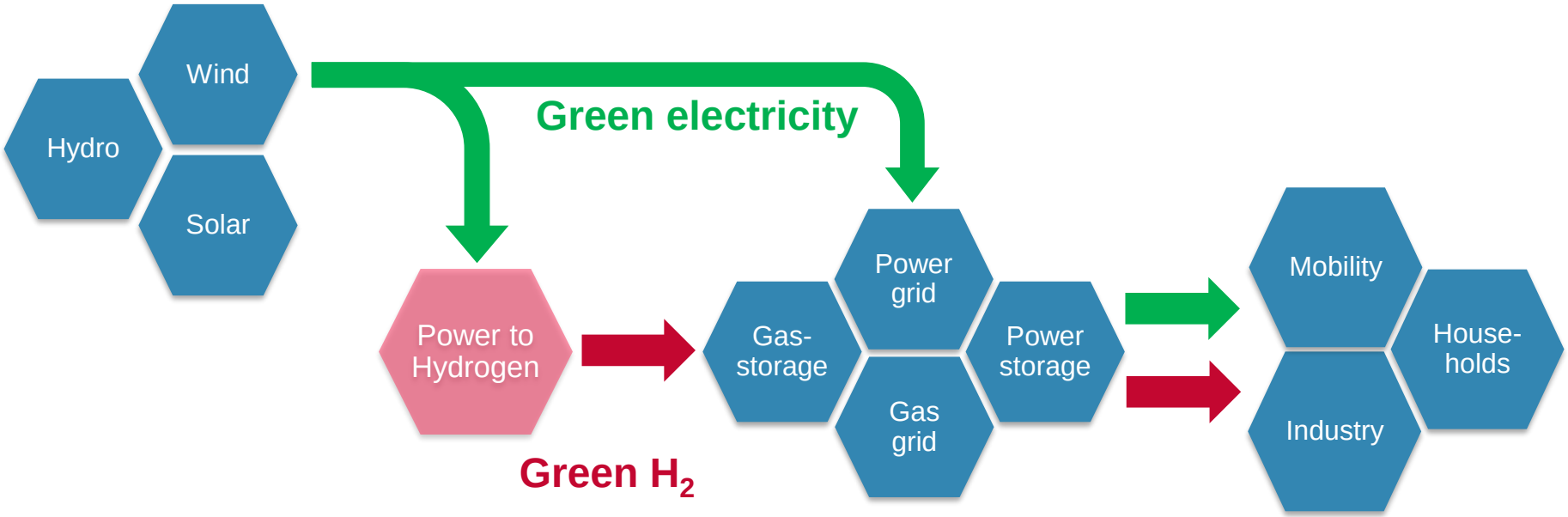
Online, May 2021

HyCentA
HYDROGEN CENTER AUSTRIA

TU Graz

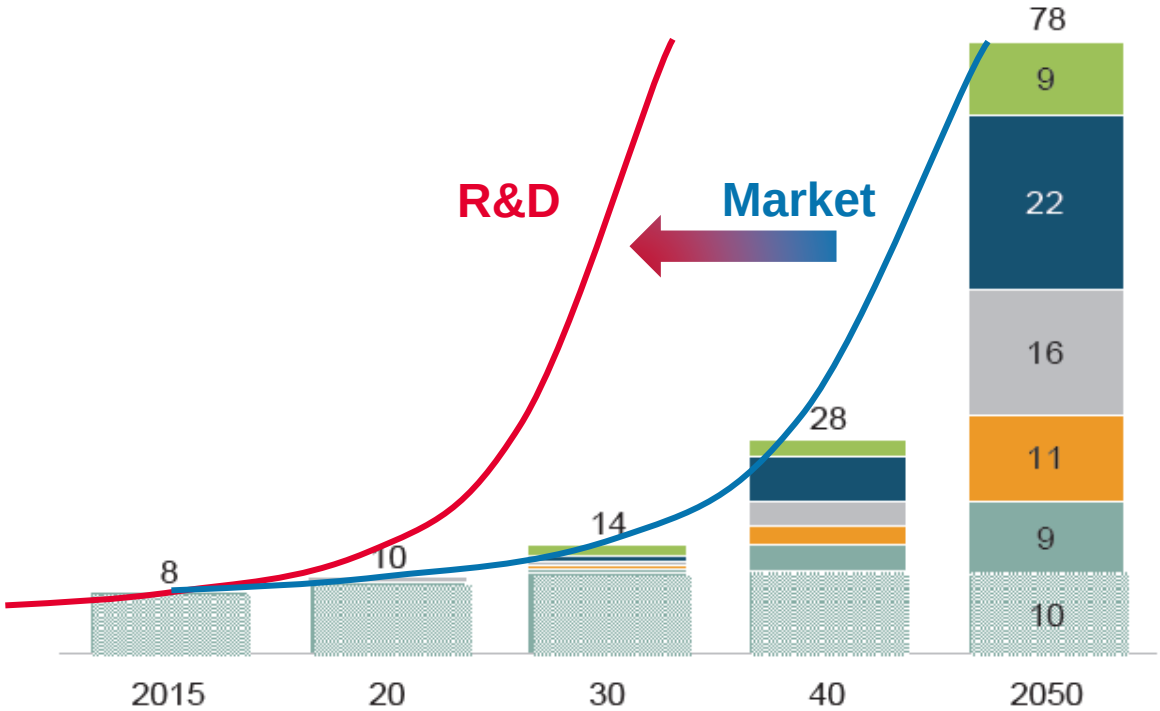
Vision Hydrogen Economy

Hydrogen economy as a solution for renewable energy systems



Marktprognose Wasserstoff

"H_2 potential with 20-30 % share of all energy sources in 2050"



Global energy demand supplied with hydrogen, EJ

1 Power generation, buffering

4 Transportation

5 Industrial energy

6 Building heat and power

7 New feedstock (CCU, DRI)

Existing feedstock uses

Source: Market prediction, Hydrogen Council, https://hydrogencouncil.com/en/

Zero-Emission E-Mobility

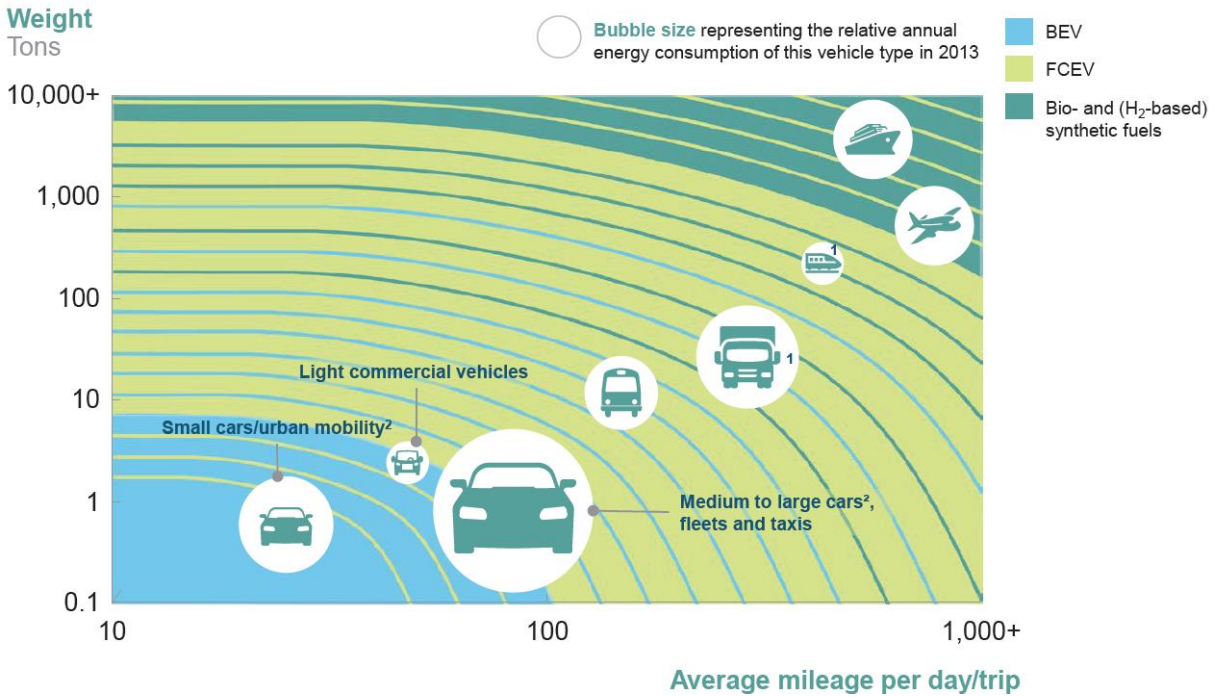
BEV - Battery Electric Vehicle

FCEV – Fuel Cell Electric Vehicle, powered by Hydrogen

Highest efficiencies

Short range

Long charging times



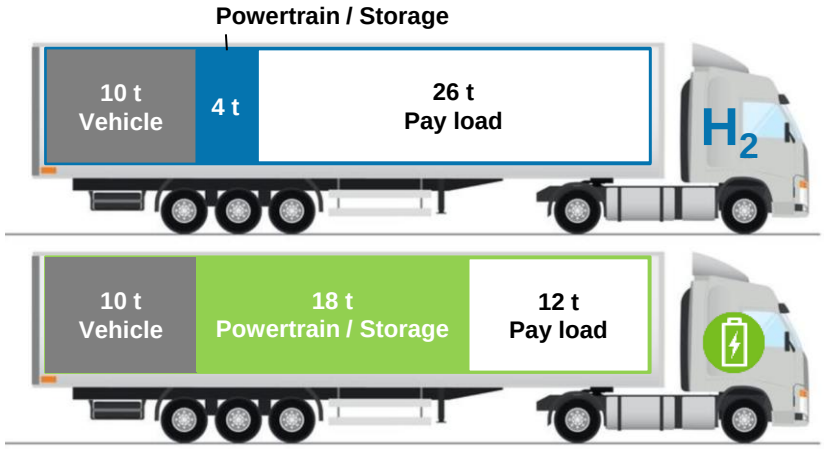
High efficiency

Long range

Short refuelling time

Source: Hydrogen Council

Heavy Duty 40 t Truck - 1000 km Range



Hydrogen Fuel Cell

Battery > 2x more traffic

Refuelling / Charging Duration

	Power in MW	Duration in h
H2 - TK 16 HF	15	0,2
BEV - 500 kW	0,5	4,2
BEV - 1 MW	1	2,1

2x

Hydrogen Fuel Cell

TtW Energy

3 kWh/km

Battery > 2x more traffic

2,1 x 2,1= 4,2 kWh/km

Recommendations

Hydrogen is essential to transform our energy system into a zero-emission power generation.

- **Investments need to start now – the earlier hydrogen production is scaling up, the earlier hydrogen is also available for transportation and mobility!**

- **Activities for hydrogen implementation have to be combined to increase impact – resources have to be bundled!**

- **Research and development has to be strengthened to ensure smooth and fast market introduction!**

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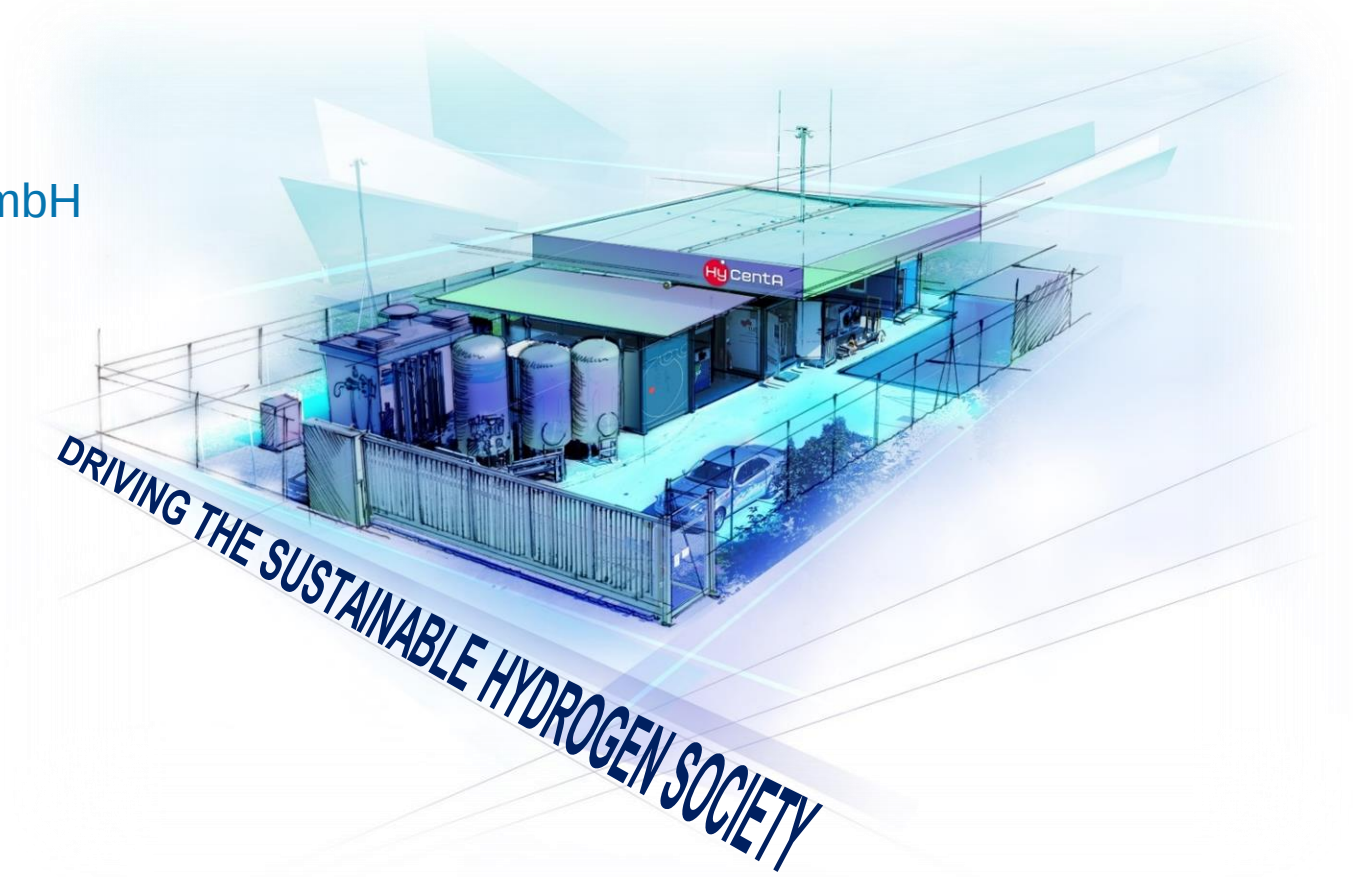


HyCentA Research GmbH

Austria's Research Centre for Hydrogen Technologies since 2005

- **44 Researchers**
  Mechanical Engineering, Physics, Chemistry, Process Engineering, Electrical Engineering
- More than **70 projects** successfully finished
- More than **16 years** of expertise
- Modern testing infrastructure and HRS
- Covering all fields of hydrogen R&D

Extra-University Public Research Organization at the Graz University of Technology (50 % owned by public bodies)

Activities

- Research & Development
- Simulation
- Testing
- Teaching

- **Electrolysis and H_2-Infrastructures**
  - Design, testing and certification: cell, stack, system und overall facilities
  - Concept development, testing, e.g.: GH_2 compression systems
- **Storage and Distribution**
  - Concept development and testing of GH2 storage systems
  - Alternative technologies: hydride storage und LH2 systems
- **Fuel Cells – Mobility and Stationary Power Systems**
  - Design & testing: stacks, BoP, systems & controls
  - R&D and testing of advanced fuel cell systems
- **Measurement Systems and Test Center**
  - Mass and gas quality measurements
  - Advanced R&D infrastructure – customer specific tasks

H_2-Refueling 350 & 700 bar

GH2 test stand up to 1000 bar with climate chamber

Two test cells for components, stacks & systems

Fuel cell system test stand 160 kW with climate chamber

Single-cell electrolysis lab and short-stack testing

H_2 gas quality laboratory

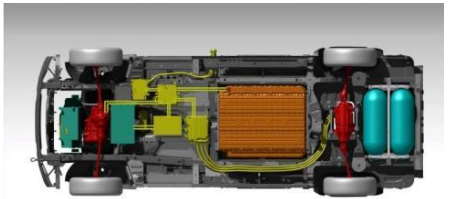
Activities – Research and Development

Electrolysers (PEM, AEM, AEL, SOEC), Hydrogen Production and Infrastructures

- Design and testing: cell, stack, system and overall facilities
- Layout and testing of GH_2 compressor systems
- Purification of hydrogen up to 8.0

Hydrogen Storage and Distribution Systems

- GH_2 layout and testing of GH_2 storage systems
- Alternatives: hydride storage systems and LH_2 systems
- Comprehensive know-how of H_2-distribution by bundles, trailer, ships and pipelines

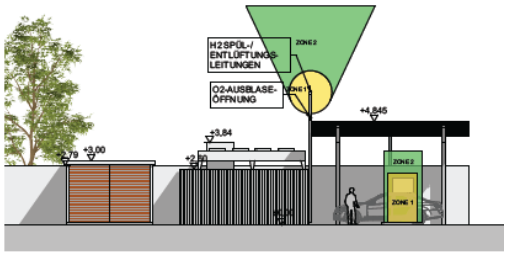


Fuel Cells (PEM) – Mobility and Stationary Power Systems

- Design and testing: stacks, BoP (auxiliaries), fuel cell systems and control strategies
- Development of overall powertrains and vehicles (PC, busses, trucks etc.)

Measurement Techniques and Test Systems

- Mass measurement techniques & gas quality measurement 6.0 and higher
- Customer specific test systems; e.g. fuel cells, components …



NORDOSTANSICHT

Activities - Simulation

HYDROLYSE (HYDROgen faciLitY Simulation modEl)
Refueling station, electrolysis …

CAD Design and FEM Simulation
Stacks, components, systems …

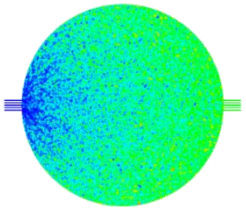
Multi-Phase Flow Simulation
Stack layout, hydrogen storage system, injector/ejector …

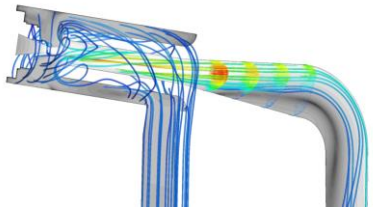
Real Time Fuel Cell System Simulation and Control Design
Automotive PEM System …

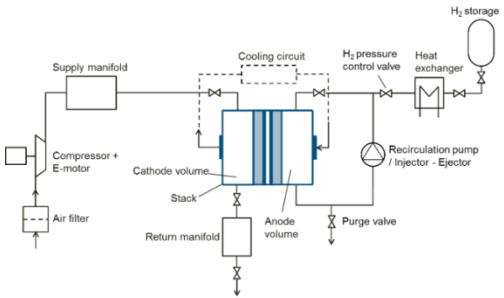
Vehicle Simulation and HiL
Passenger cars, busses, trucks, trains, snowmobiles …

DOE and Automated Calibration
Fuel cell system, electrolysis facilities …

Tools: Ansys Fluent, AVL Fire, AVL Cruise, AVL CAMEO, Dspace, Matlab, Matlab Simulink, PTC Creo …







Activities - Testing

Highly Dynamic Fuel Cell System Test Bench up to 160 kW

- HiL fuel cell-systems tests, BoP components, climate chamber
- Fully automated test cycles and DoE ability
- Certification tests

High pressure test stand up to 1000 bar

- Testing of hydrogen storage systems, high pressure components
- Durability testing and certification tests
- Climate chamber, cold fill, filling protocol parameter

H_2-Refueling for 350 and 700 bar with cold fill

- Refueling of passenger cars, busses and trucks

Two test cells for component and subsystem testing

- Modern measurement equipment
- Electrolyzers up to 20 kW
- Cathode and anode subsystems, BoP components, fuel cells up to 20 kW

Hydrogen Quality Laboratory

- Gas quality laboratory (FTIR and MS)
- Sampling Equipment and Analysis Devices

Activities - Teaching

- **Lectures at Graz University of Technology**
  - Advanced Thermodynamics
  - Hydrogen in Energy and Vehicle Technology
  - Innovative Propulsion Systems
  - E-Mobility
  - Energy Storage Systems
- **Mentoring of Bachelor, Master and PhD Theses**
- **Book 4th Edition 2018**
  - Wasserstoff in der Fahrzeugtechnik
  - Erzeugung, Speicherung, Anwendung
  - Springer Vieweg
- **Conferences, Networking and Consulting**