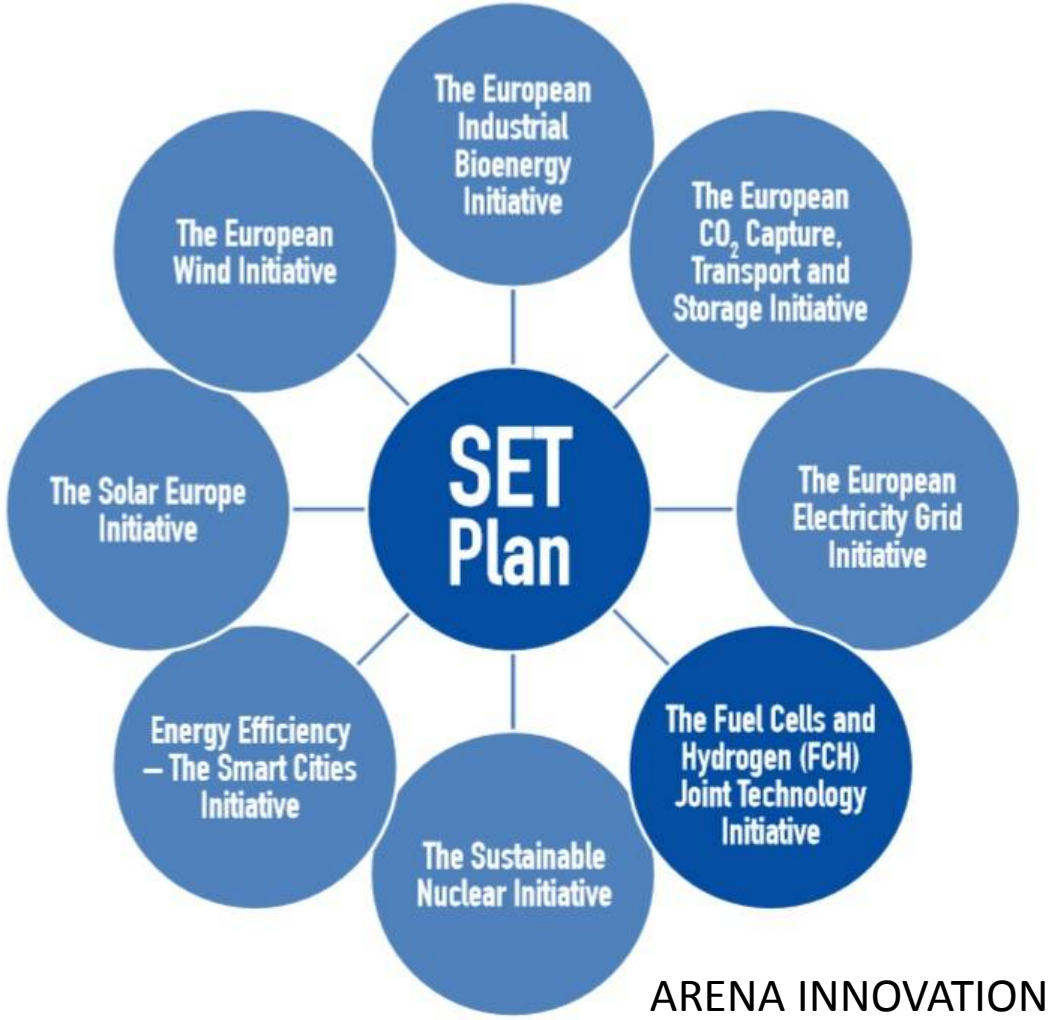
ARENA INNOVATION

4th Int'l Conference on Renewable Electrical Power Sources
Belgrade, Serbia

„New Pathways to a Hydrogen Society“

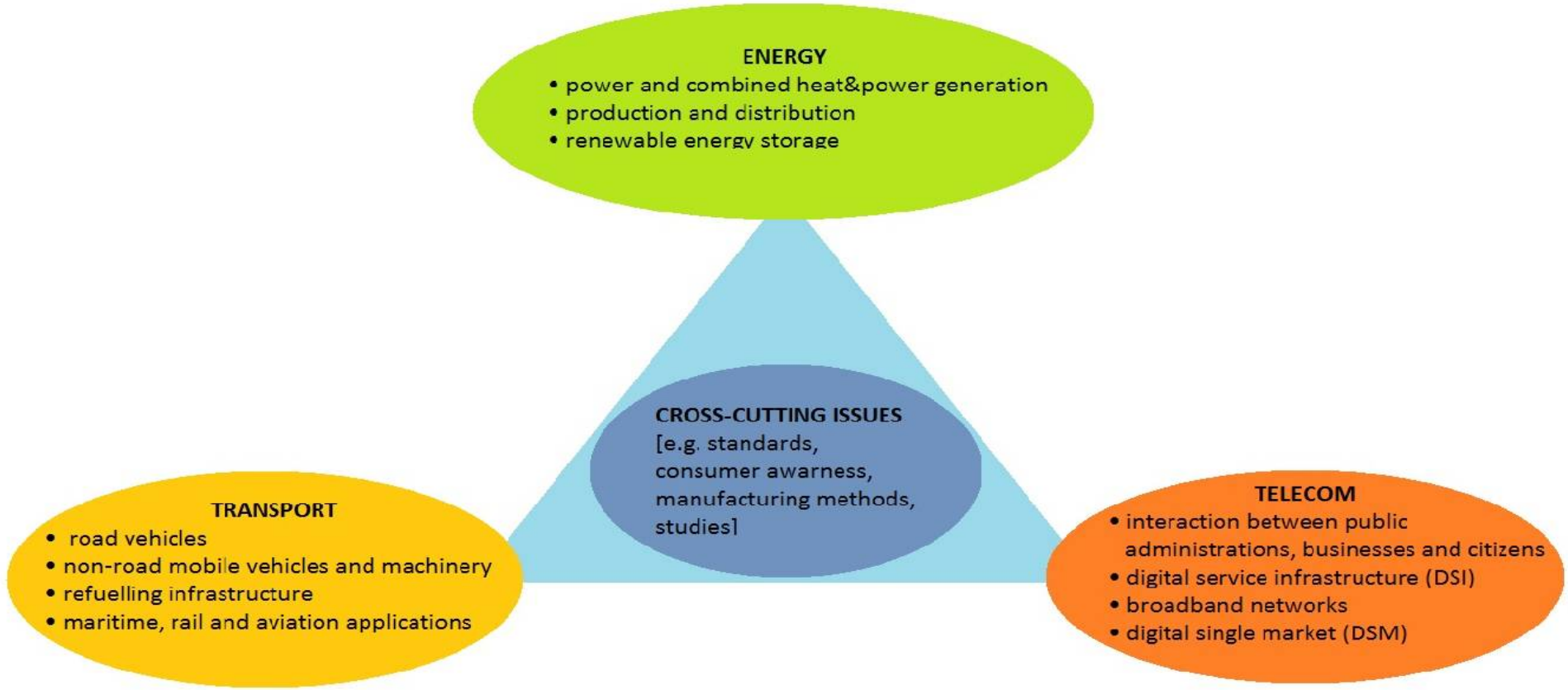
October 17-18, 2016

Core Competence – FCH (Fuel Cell & Hydrogen)



SET Plan = The European **S**trategic **E**nergy **T**echnology **Plan**

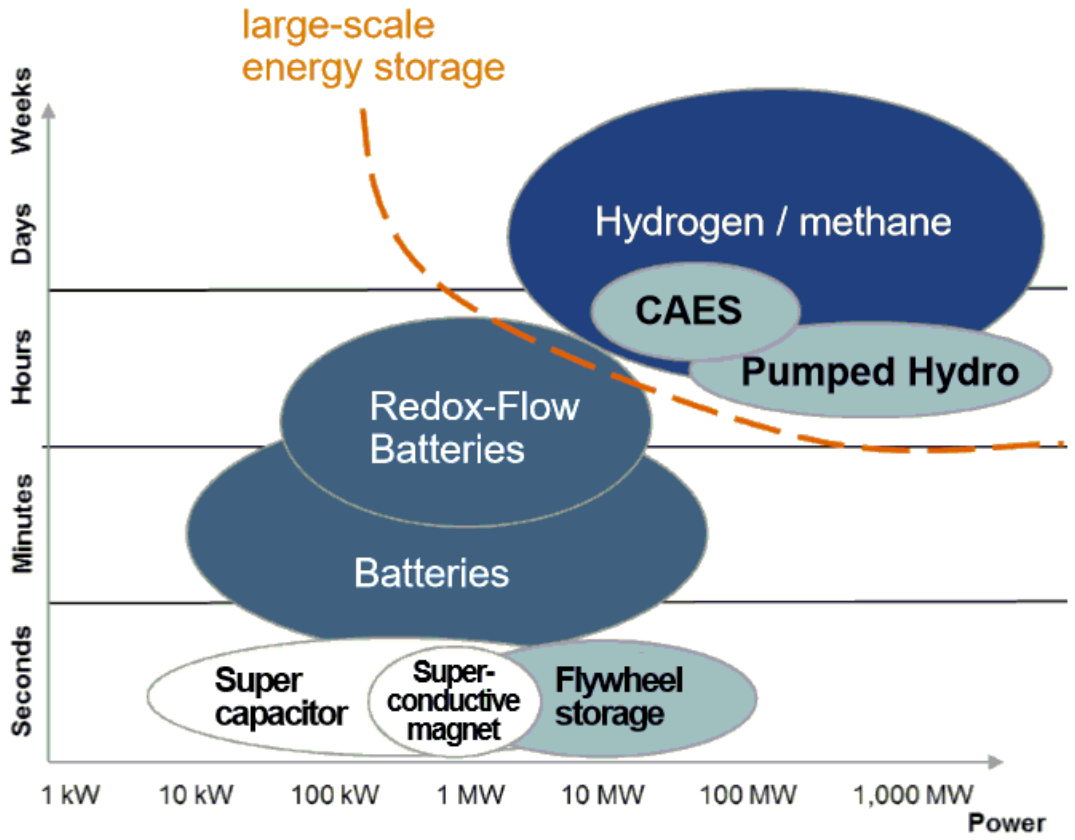
Core Competence – The 3 Pillars



ARENA-INNOVATION is structured around three research and innovation pillars dedicated to Energy, Transportation and Telecommunications Systems

Pathway towards a: HYDROGEN-SOCIETY

Segmentation of electrical energy storage



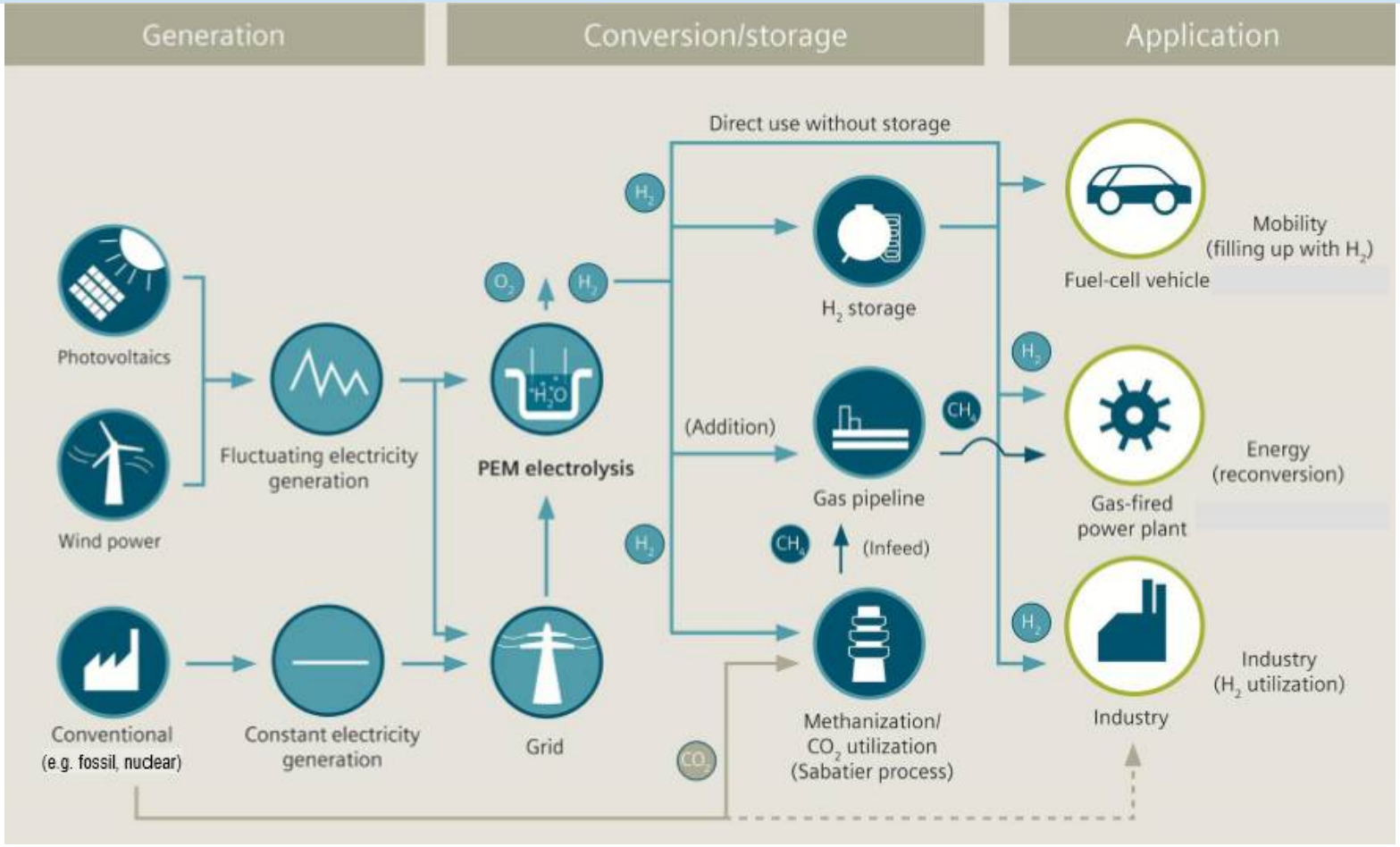
Source: Siemens Hydrogen Solutions

Key statements

- There is no universal solution for electrical storage
- Large scale storage can only be addressed by pumped hydro, compressed air (CAES) and chemical storage media like hydrogen and methane
- The potential to extend pumped hydro capacities is very limited
- CAES has limitations in operational flexibility and capacity

Hydrogen is the only option to implement energy capacities > 10 GWh

Power to Gas (P2G sau PTG)



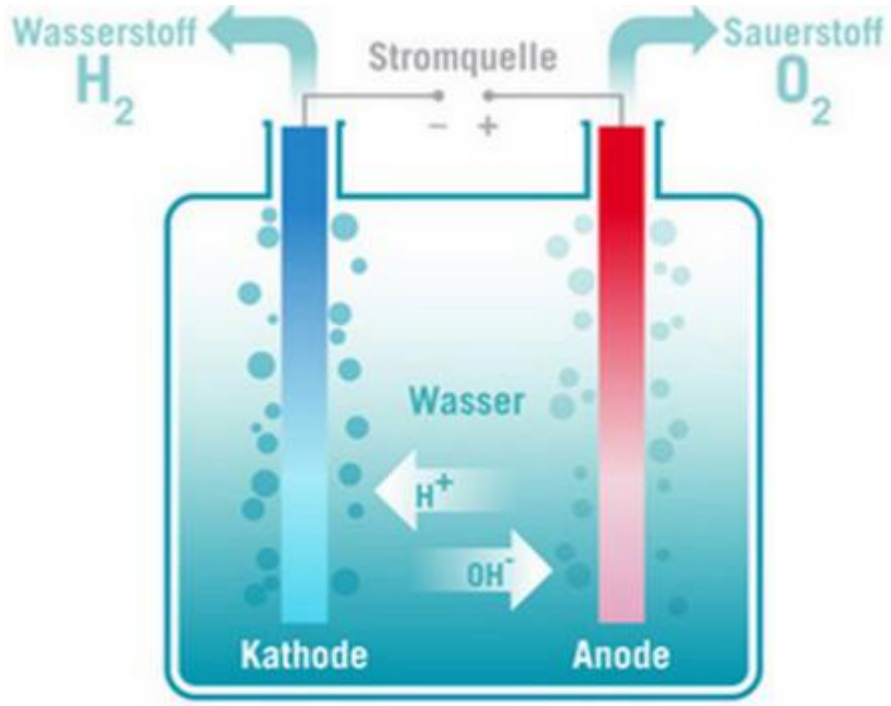
Key statements

- **Electrolysis (or other methods) enables conversion from electrical into chemical energy**
- **H2 drives the convergence between electrical and industrial markets**
- **Different applications require a more or less dens H2 supply infrastructure**

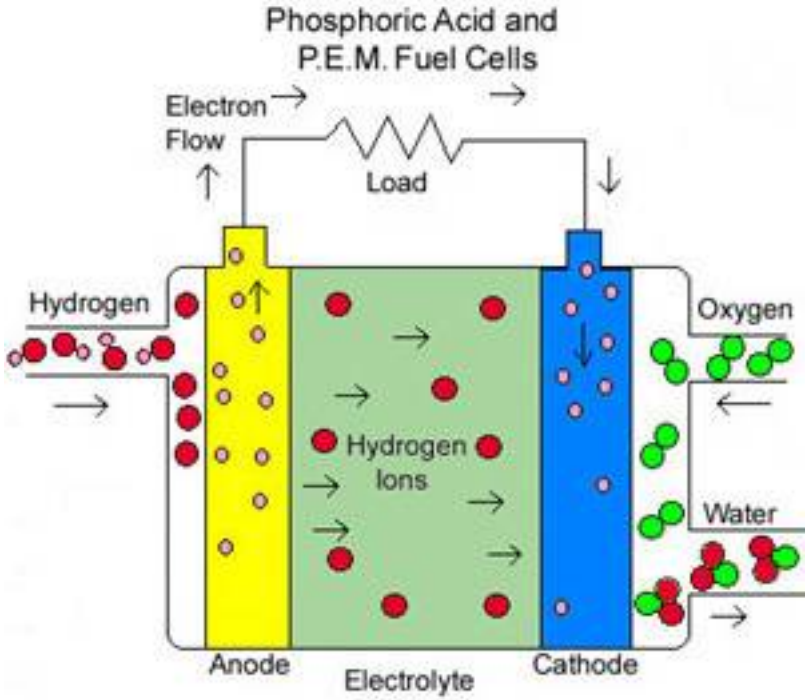
Source: Siemens Hydrogen Solutions

Clean H2 Production and Consumption

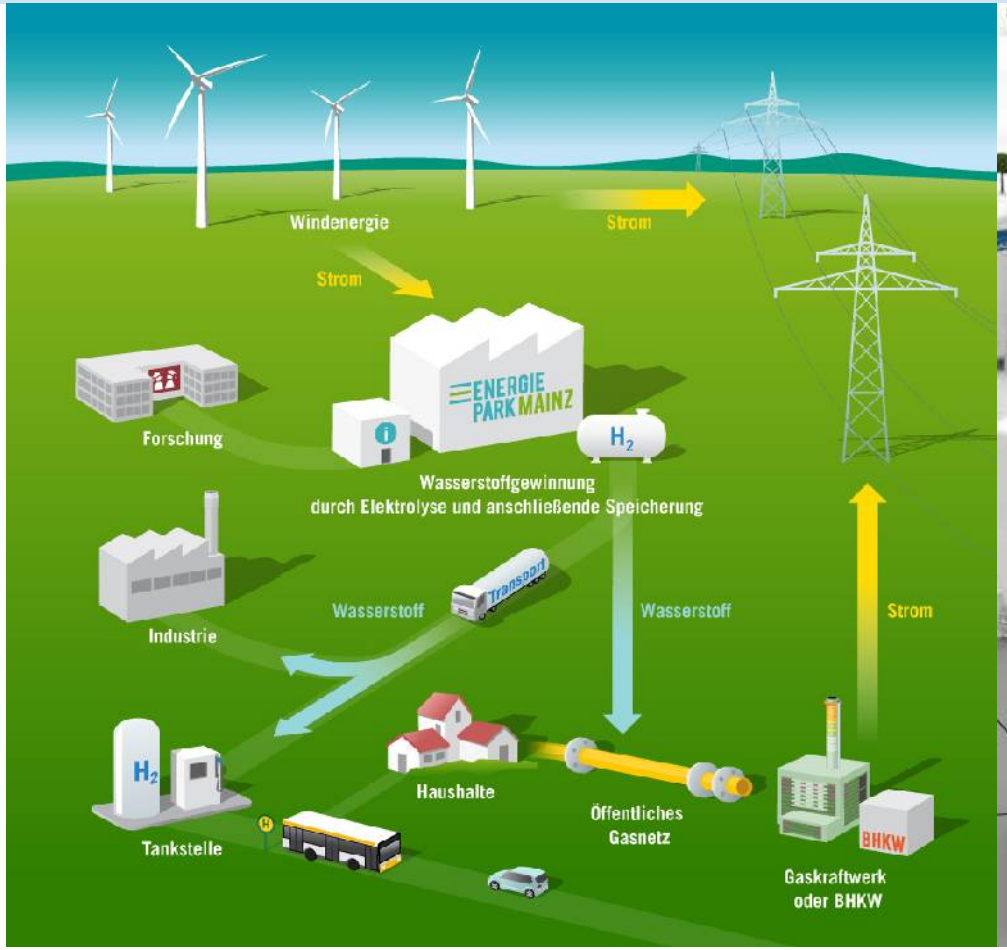
Elektrolysis (P2G)



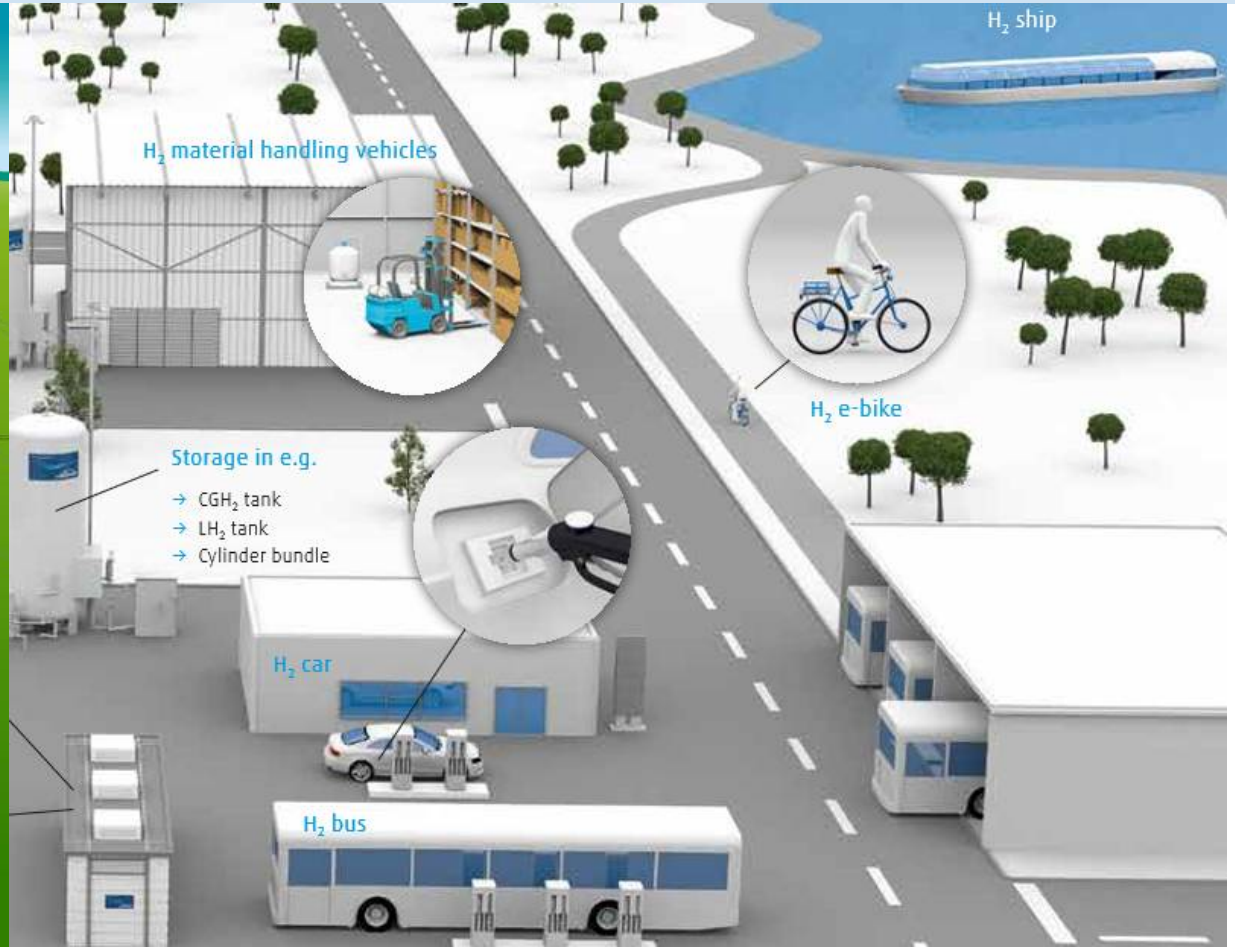
Fuel Cell (simplified)



Energiepark Mainz Vision



Source: Energiepark Mainz

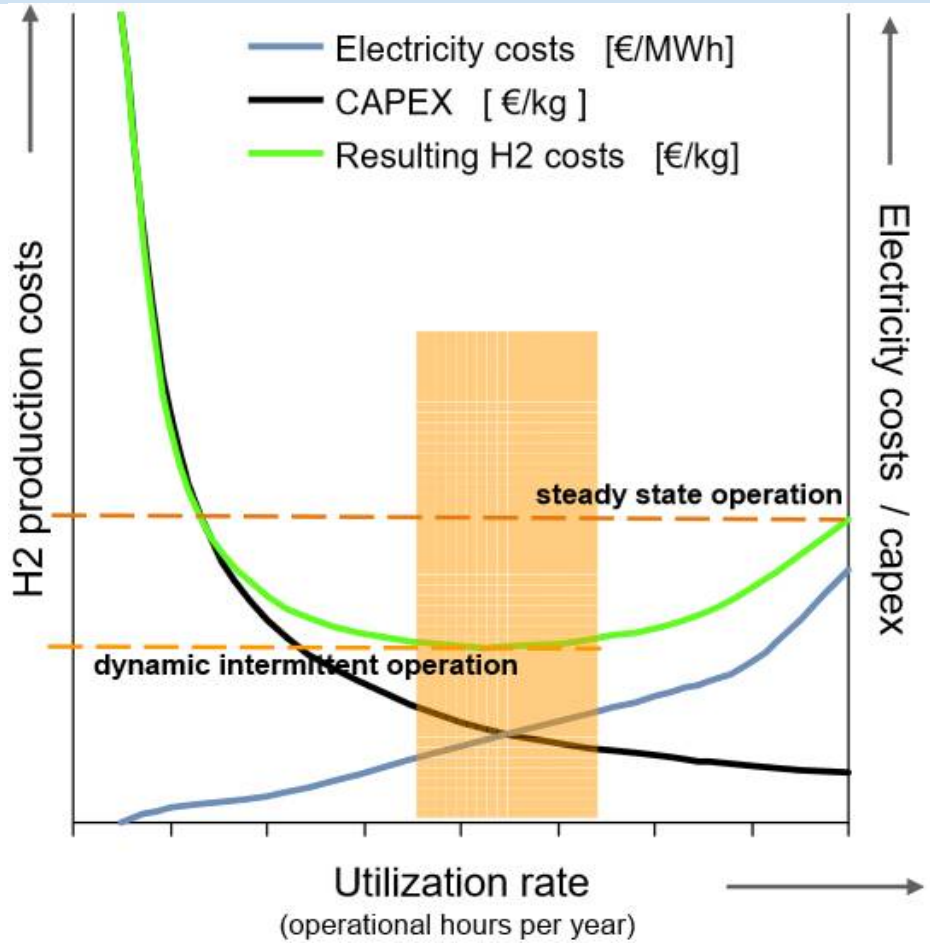


Source: Linde Hydrogen Solutions

Energiepark Mainz – Current Picture

Source: Energiepark Mainz

Economics: Intermittent Operation Compensates Higher Capex



Key statements

- The H2 production costs are mainly dependent from electricity costs, operational hours and capex.
- Alkaline Electrolyzers have attractive low capex but are made for steady state operation (high utilization rate).
- dynamic operation of PEM can yield incentives from "Regelenergie" and further select attractive low price periods for intermittent operation. This leads to reduced H2 production costs compared to a pure capex comparison.

Source: Siemens Hydrogen Solutions

Security: Simulated Fire Hazard – H2 vs. Gasoline Car

Photo 1 - Time: 0 min, 0 sec - Hydrogen powered vehicle on the left. Gasoline powered vehicle on the right.

Photo 2 - Time 0 min, 3 seconds - Ignition of both fuels occur. Hydrogen flow rate 2100 SCFM. Gasoline flow rate 680 cc/min.

Source: DWV

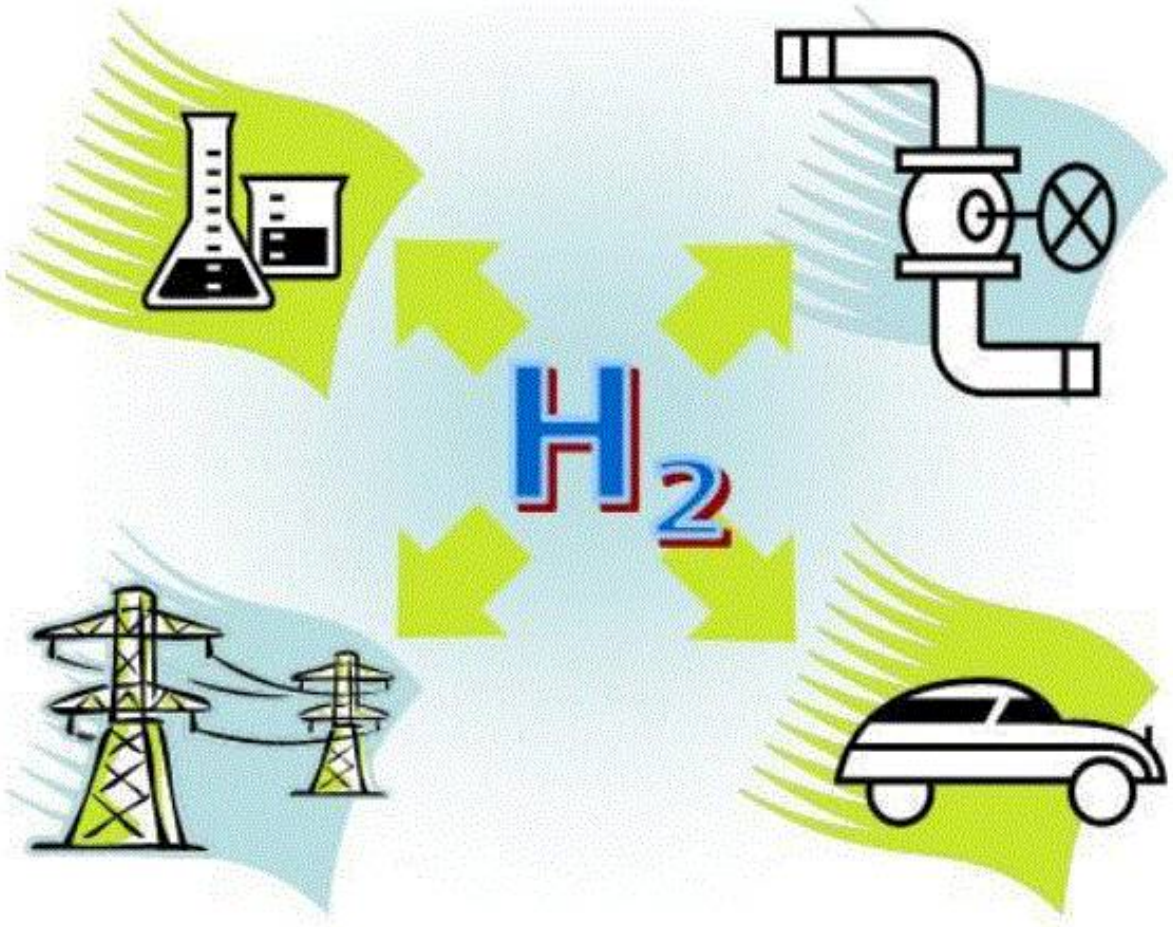
Security: Simulated Fire Hazard – H2 vs. Gasoline Car

Photo 3 - Time: 1 min, 0 sec - Hydrogen flow is subsiding, view of gasoline vehicle begins to enlarge

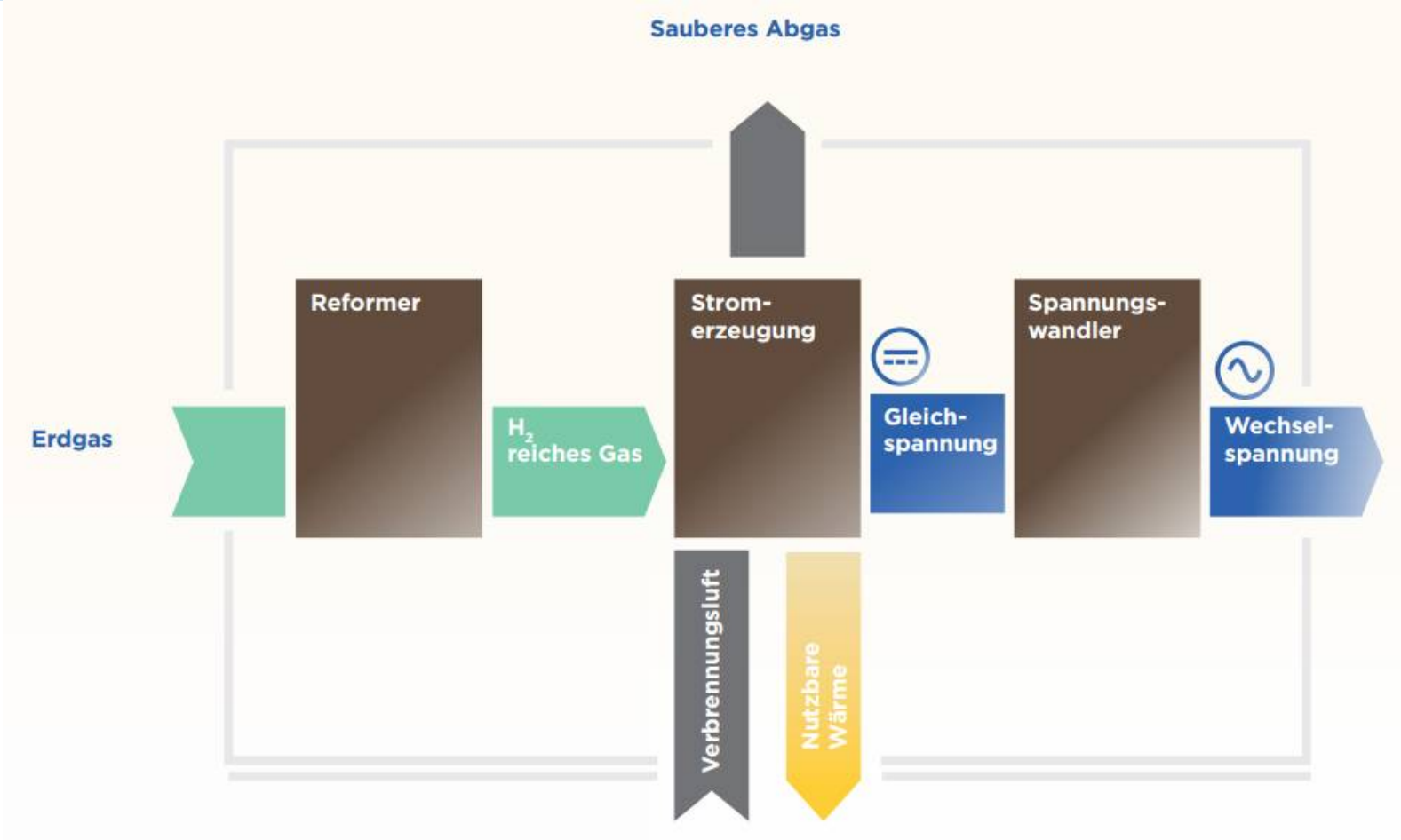
Photo 4 - Time: 1 min, 30 sec - Hydrogen flow almost finished. View of gasoline powered vehicle has been expanded to nearly full screen

Source: DWV

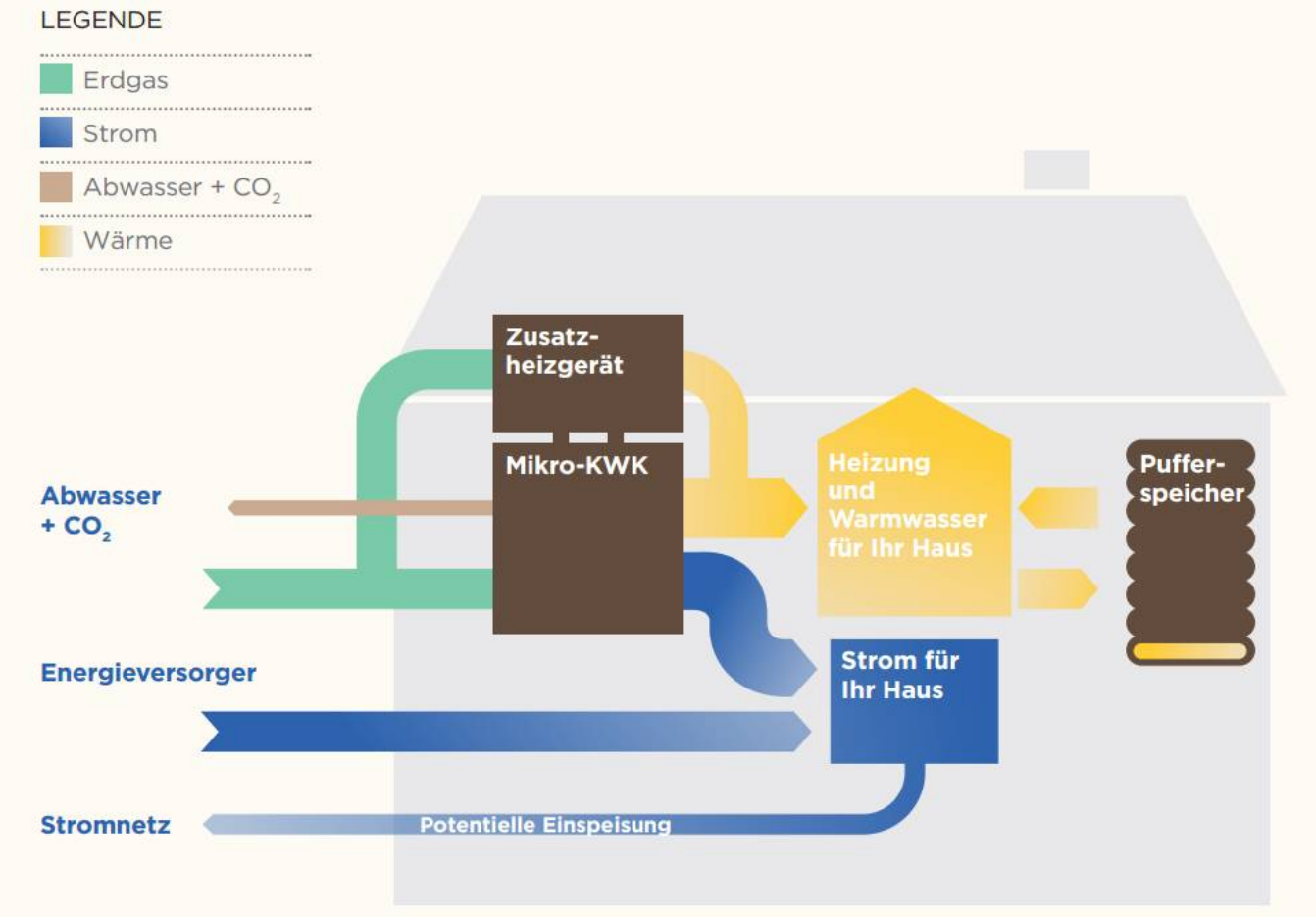
Hydrogen Applications



Micro-CHP with Fuel Cell on Natural Gas (CH_4)



Principal Diagram of a Micro-CHP-System with FC



Technical Data as a reference (for example):

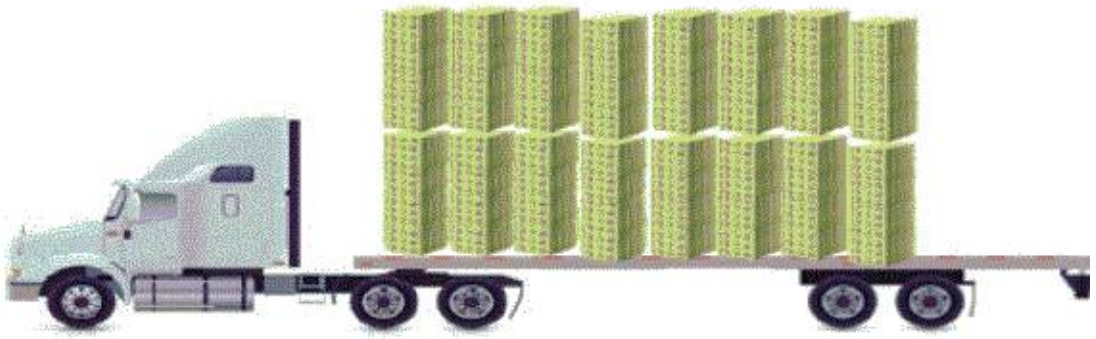
- Type: **SOFC**, HAT-PEM, NT-PEM, RSOC,..
- Power el/th: 2,5/2 kW
- Th. Power of additional burner.: individual
- Buffer storage: 300 l, optional
- Electrical Efficiency: 50 %
- **Total Efficiency: 90 %**
- Size in mm: 630 x 830 x 1700
- Weight in kg: 350
- Price in EUR ca.: ..10, ..20, ..30.000,-,..

A pathway to hundreds of FC buses in Europe

- The FCH JU has published its 2016 call, which includes the topic **"Large scale validation of fuel cell bus fleets"** (Topic ID: FCH-01-9-2016)
- Main criteria defined in the call:
- **Minimum of 100 buses**, including at least three locations with 20+ buses, other locations with minimum 10 buses
- Target **max.** on the **cost of buses: €650,000 (12m / 13.5m) / €1m (articulated)** (baseline specifications)
- **Max.** FCH JU **funding per 12m / 13.5m bus: €200,000; per articulated bus: €250,000**
- **Max**. FCH JU **funding per hydrogen refueling stations (HRS): €0.6m per 10 bus HRS / €1.2m per 20 bus HRS.**
- Total funding available for the topic: €32million
- Duration of the project: 4 to 6 years
- Once this new trial will be awarded, it will represent a major breakthrough for the sector
- On the infrastructure side: The 18-month EU project **NewBusFuel** has started in Summer 2015 to look at engineering solutions for depots integrating a larger fuel cell bus fleet **(50-200 buses – 1,000-5000kg hydrogen per day in 12 locations across Europe)**

Hydrogen (FCV's) vs BEV's

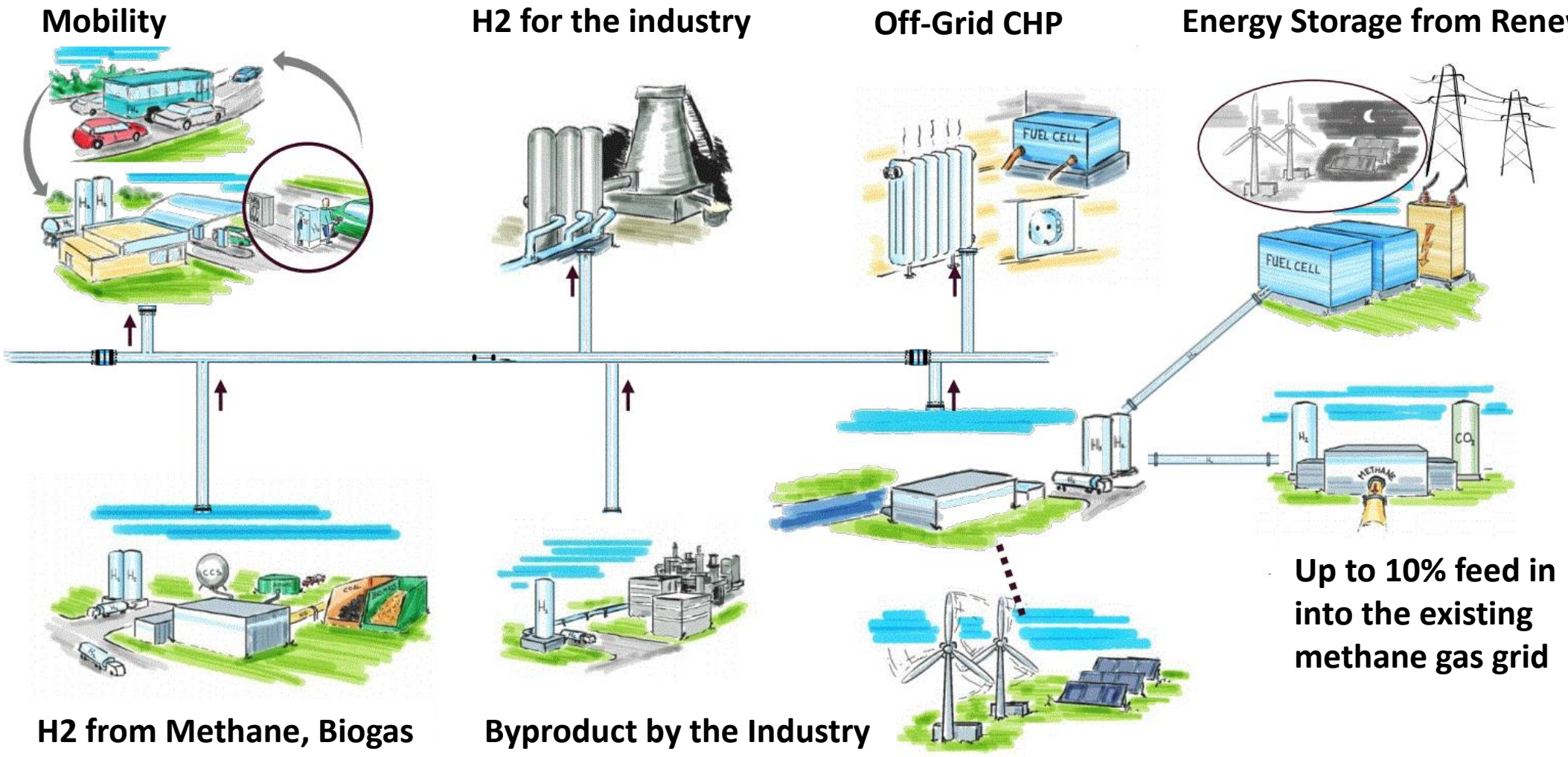
Hydrogen Fuel Tanks	Batteries (Li^+)
1 Kg H_2 ➔ 33 kWh 20 Kg H_2 ➔ 660 kWh	One (1) Battery: 3.2 V x 200 Amps ➔ 650 Watts Weighs 7.5 kg or 16.54 lbs. ...therefore to get the equivalent output 1,000 batteries ➔ 16,543 lbs. (or 8.2 tons) ➔ 650 kWh



Core Competence – Worldwide

- Worldwide **market introduction of the most innovative German and Japanese FCH technologies**
- **Technical Consulting** and **Training** in the FCH domain
- **Financial Consulting** in the FCH domain (**Horizon2020, FCH-JU, CEF, Interreg**,.)
- **Developing and tailoring** of innovative projects in the FCH domain
- Seamless Know-How transfer in the FCH domain and propagating a so called **„Hydrogen-Society“** worldwide
- Coordinating and controlling of FCH projects according to a defined **„Master-plan“**

HYDROGEN SOCIETY Vision via Interreg-Danube



Implementation Model based on the German NIP II

Reference projects and -activities

- Building up of the first CNG (Compressed Natural Gas) refueling infrastructure in Romania with Antares-Group (up to 85% funding from CEF 2015)
- Active member of the German Hydrogen Association **„H2BZ Initiative Hessen e.V.“ (Energiepark-Mainz)**
- University Certificate „European Research and Innovation Funding Programmes Professional (Steinbeis Hochschule Berlin)“
- Certified Partner der „German Energy Export Initiative – made in Germany“
- Official participation in the „hydrogen, fuel cells and electric mobility – made in Germany“ activities in Japan und Deutschland

Infrastructure in Ro.
(Project volume 4.757 mio. Euro -> EU: 4.043 mio. Euro)

Motivation

- What is the goal of ARENA-INNOVATION in Romania?
  - Position HYDROGEN SOCIETY S.R.L. as H2-activities coorinating company for the Romanian government and ministries, similar to NOW GmbH for the German NIP II
  - Deployment of FCH Best Practice (Demo) Projects in collaboration via Interreg-Danube, H2020/FCH-JU, CEF,..
  - Introduction of (Micro)-CHP technologies with FC (high volume -> low price)
  - Introduction of the electro mobility (public transport) with FC (H2-Infrastructure -> FC Buses)
  - Founding and propagating of a so called „HYDROGEN SOCIETY“ (www.hydrogen-society.com)
- What kind of partners are we looking for?
  - INVESTORS, consultants for supporting (writing) the application process for European/National/Local financing programs
  - Energy producers and-providers, public transportation companies, municipalities, chemical industry
- What are we expecting from our potential business partners?
  - IDENTIFICATION AND EXPLOITATION of (national/local) financing programs/possibilities

ARENA INNOVATION

Thank you for your attention!

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