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 Strategic Energy Technology Plan

ARENA INNOVATION Hans Marius Schuster, Koestlinstr. 150, 70499 Stuttgart, Germany, Mob.: +49-1573-82 16 727, germany@arena-innovation.com, www.arena-innovation.com
Core Competence – The 3 Pillars

ENERGY
- power and combined heat & power generation
- production and distribution
- renewable energy storage

CROSS-CUTTING ISSUES
[eg. standards, consumer awareness, manufacturing methods, studies]

TRANSPORT
- road vehicles
- non-road mobile vehicles and machinery
- refuelling infrastructure
- maritime, rail and aviation applications

TELECOM
- interaction between public administrations, businesses and citizens
- digital service infrastructure (DSI)
- broadband networks
- digital single market (DSM)

ARENA INNOVATION is structured around three research and innovation pillars dedicated to Energy, Transportation and Telecommunications Systems
Pathway towards a: HYDROGEN-SOCIETY

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.

Source: Siemens Hydrogen Solutions
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 dense H2 supply infrastructure

Source: Siemens Hydrogen Solutions
Clean H2 Production and Consumption

Elektrolysis (P2G)

Fuel Cell (simplified)
Energiepark Mainz Vision

Source: Energiepark Mainz

Storage in e.g.
- CNG tank
- LH2 tank
- Cylinder bundle

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

<table>
<thead>
<tr>
<th>Hydrogen Fuel Tanks</th>
<th>Batteries (Li⁺)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Kg H₂ ➔ 33 kWh</td>
<td>One (1) Battery:</td>
</tr>
<tr>
<td>20 Kg H₂ ➔ 660 kWh</td>
<td>3.2 V x 200 Amps ➔ 650 Watts</td>
</tr>
</tbody>
</table>

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

Mobility

H2 for the industry

Off-Grid CHP

Energy Storage from Renewables

H2 from Methane, Biogas

Byproduct by the Industry

Up to 10% feed in into the existing methane gas grid
Implementation Model based on the German NIP II

Water electrolysis
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.
Motivation

What is the goal of ARENA-INNOVATION in Romania?

- Position HYDROGEN SOCIETY S.R.L. as H2-activities coordinating 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
Thank you for your attention!

Dipl.-Ing. IT (FH) Hans Marius Schuster

Koestlinstr. 150, 70499 Stuttgart,