HYDROGEN INNOVATIONS – DRIVERS OF SUSTAINABLE VALUE CREATION

Prof. Ralf B. Wehrspohn

3rd Conference: Sustainable Chemical Conversion in Industry, 27th October 2020



Fraunhofer Hydrogen Strategy Fraunhofer Hydrogen Network – roadmap and portfolio

🖉 Fraunhofer KOMPETENZ FÜRS WASSERSTOFF-ZEITALTER

Fraunhofe Brochure »Competencies for the hydrogen era«

Fraunhofer as a broad strategic partner for tech transfer to the industry

Contains

- Status quo of Fraunhofer hydrogen **Competencies**
- **Competence Map** with contact persons
- Portfolio view
- Political and industrial target group
- → https://wasserstoff.fraunhofer.de

Fraunhofer **Position paper** »A hydrogen roadmap for Germany«

> Strategic options for political actions in Germany: supporting the development of the National Hydrogen Strategy

- Presentation of opportunities and demands
- **Requests** for technology openness and regulatory frame

Eine Wasserstoff-Roadmap

M Ramwitz T Fleiter LI Groos D Härle A Held M Jal

für Deutschland

Karlsruhe und Freibur Oktober 2019

- **International** aspects/ export opportunities
- Participating institutes: ISE, ISI, IMWS, IKTS
- Handed over to German ministries in Oct. 2019



Fraunhofer Hydrogen Strategy **The Fraunhofer Hydrogen Network** IWES, Bremerhaven Materials Systems **IST**, Braunschweig IFF, Magdeburg IEG. Cottbus 29 IMS, Duisburg Institutes UMSICHT, **IMWS**, Halle Production technology Oberhausen IEE, Kassel ILT, IPT, FEP, IFAM, **Energy Sector and** Aachen IWU, Chemnitz IKTS, IWS Grid Dresden IMM, Mainz **Applications in Industry Profile sharpening** IZFP, Saarbrücken **IISB**, Erlangen within the H₂ value chain ISI, Karlsruhe ICT, Pfinztal, **Applications in Exchange** and cooperation IAO, IPA, IBP Mobility and Transport platform Stuttgart EMI, IPM, ISE, IWM Management: Prof. C. Hebling Geschäftsstelle, Freiburg Safety and Life Cycle München (ISE), Prof. M. Ragwitz (IEG)



Fraunhofer Hydrogen Strategy Focus topics



Fraunhofer Competencies

- Security, reliability and standardisation
- Upscaling of plants and production numbers
- Digitization
- Analysis of potential, infrastructure and system modelling
- Living labs / model regions

Industry

→ Climate neutrality in steel, cement and chemical industry

Mobility

→ Mainly heavy duty and long distance (trucks, cars, rail, ships, aerospace)

Infrastructure/ Energy system

→ Energy storage, sector coupling, H₂ transport and reconversion



Fraunhofer Roadmap Expected demand for green hydrogen in Germany

Scenario A: Efficiency-optimized world with low share of synthetic fuels

Scenario B: World with higher share of synthetic fuels or barrier in electric energy coupling





Fraunhofer Roadmap R&D, Market und Technology Roadmap

		2020	203	0	longterm
R&D	Steel Chemicals and Refinery PtG/e-fuels	Kinetics of H ₂ direct reduction Load management Steel and slag quality. Methane pyrolysis Flexibilisation of chlorine-alkali electrolysis Further development Fischer-Tropsch synthesis and methanol syntheses Large-scale storage Modularization and flexibilizat Reallocation of natural gas network & connecting production Development of logistics solutions for the import of hydrogen		nt paration CO ₂ is hanol syntheses ilarization and flexibilization c & connecting production and large st Ammonia as fuel in motors	torage facilities
Market	Steel Chemicals and Refinery PtG/e-fuels	High MW H ₂ g	eneration capacity Green H ₂ insert for hydrocr Green H ₂ 1	6 Mt DRI crude steel (6 TWh H ₂) GW H ₂ generation capacity acking Meth or ammonia PtG/L C and indu	20-30 Mt DRI crude steel (38-56 TWh H ₂) anol-to-olefins O ₂ neutral ustrial scale
Technology	Steel Chemicals and Refinery	Promotion of modular demonstration plants	DRI with natural gas Upscaling of der Electrically heated reforma Methane pyrolysis Reallocation of	DRI with natural gas/ H ₂ mixture no projects to living labs tion of CO ₂ and H ₂ O from natural gas Construction of industrial pro Large-scale im Electrochemical supply of synthesi natural gas network and linking produ	DRI with regenerative H ₂ duction plants plementation, replacement of existing processes is gas from CO ₂ and H ₂ O uction and large storage facilities



Technology options

Alternative strategies to carbon neutrality in industrial processes

Carbon Capture and Storage (CCS)	Carbon Capture and Usage (CCU)	Carbon Direct Avoidance (CDA)				
Lowest Investment	 Flue gases have a value -> Circular Carbon Economy 	Highest efficiency				
Steel mill coupled with underwater storage	Steel mill coupled chemically with chemical company	Stand alone steel mill				
Use Cases						
Underwater cavern	Carbon2Chem	Stand alone steel mill				



Technologies for carbon emission valorization SALCOS – Salzgitter Low CO₂ Steelmaking

Technical approach: avoidance of CO₂ formation in the reduction steps of the steelmaking process by partial replacement of carbon by hydrogen

- → Industrial scale installation basically feasible (high TRL)
- → Transistion path via mixtures of natural gas or biogas possible
- \rightarrow Hydrogen grid for resilience necessary





Fraunhofer Roadmap **Expected hydrogen demands in the German primary industry**

	2020	2050
Steel Industry	~0 Mt	1,8 Mt H ₂ *
Chemical Industry	~ 1 Mt H ₂	7 Mt H ₂ **

* Concept steel, BMWI

** VCI



Future Perspective Transition to a Green Hydrogen Economy



Current activities on the European level EU-IPCEI "Green Octopus"

Support and accompanying research for a hydrogen IPCEI* "Green Octopus": association of various partners from the Netherlands, Belgium and Germany

Goals:

- Support of the industrial partners in application and execution
- → Reduction of the concept by means of studies
- Accompanying research

Key points:

- \rightarrow H₂ production off-/onshore as well as import via ports
- \rightarrow H₂ transport to the users via trans-European pipeline
- H₂ utilization: Large consumers in industry (steel, chemicals, refineries)



* Important Project of Common European Interest: Possibility to override state aid guidelines for projects with a European dimension.



Transition to a Green hydrogen economy **Conclusion**



- Hydrogen is the key element to keep technology souverenity and thus innovation souverenity on raw materials in Germany
- Fraunhofer is your innovation partner for a hydrogen economy in Germany and Europe on the basis of our roadmap and a broad portfolio of competencies
- Hydrogen demands are significant in German key raw materials industries – expectations for 2050:
 - Steel industry: 1,8 Mt hydrogen
 - Chemical industry: 7 Mt hydrogen
- Fraunhofer is working technology-open to meet the future H₂ demands based on renewable feedstocks.



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