//EU HYDROGEN RESEARCH DAYS 15-16 NOVEMBER

Hydrogen Storage and Distribution

Dionisis Tsimis

Claudiu Pavel, Nikos Lymperopoulos, Pietro Caloprisco

Project Officers

Clean Hydrogen Partnership

European Hydrogen Week

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Session on Hydrogen Storage and Distribution

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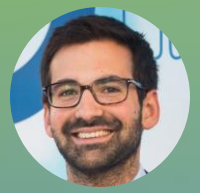
RESEARCH DAYS
15-16 NOVEMBER

16th Nov. 11:30 - 13:00



Hydrogen Distribution and Storage

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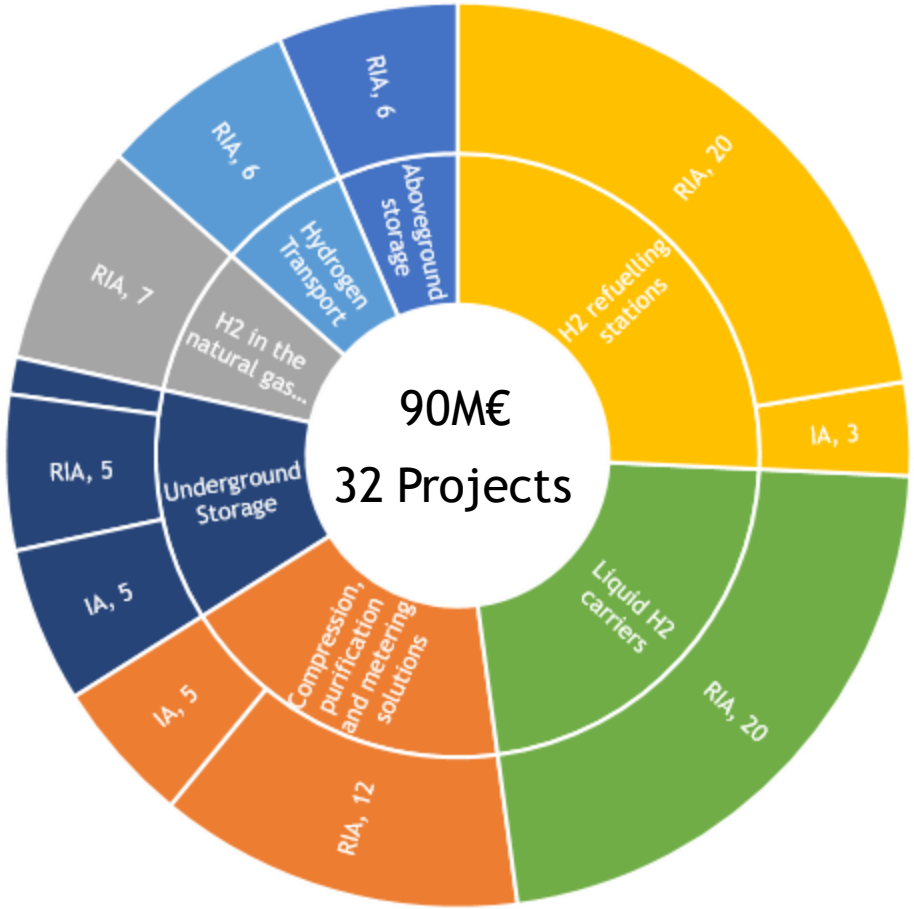
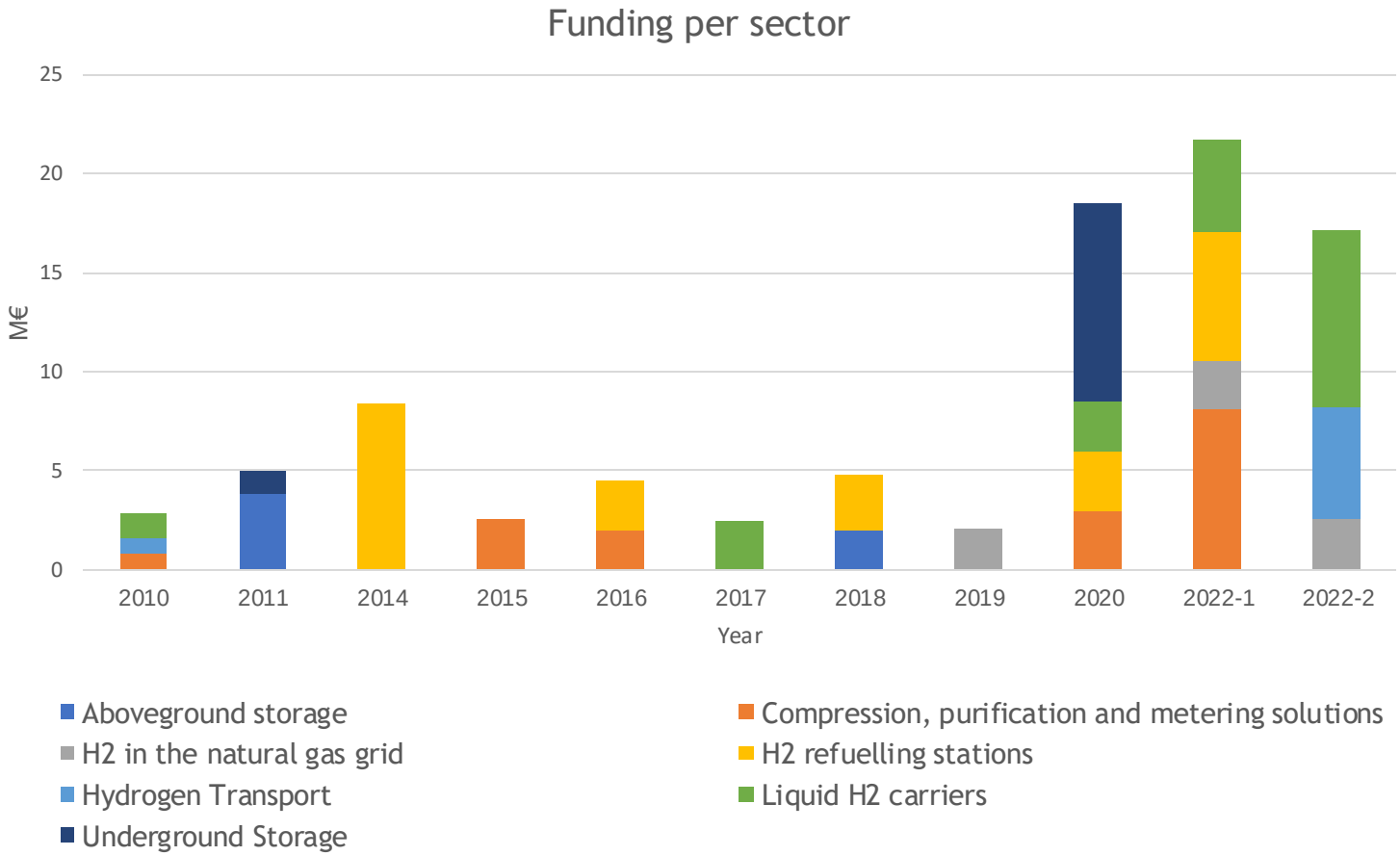
Hydrogen Storage and Distribution

Gaining traction within the program





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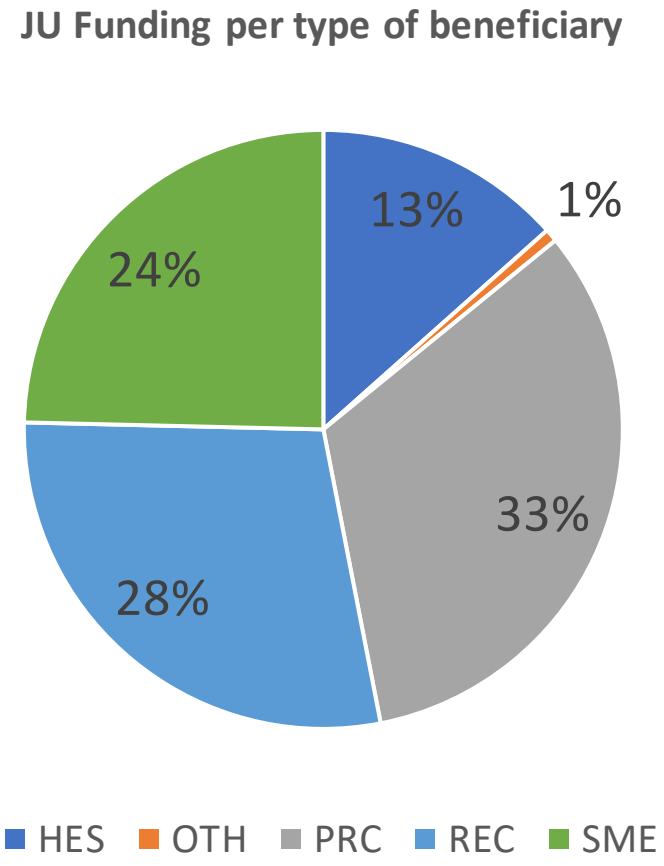
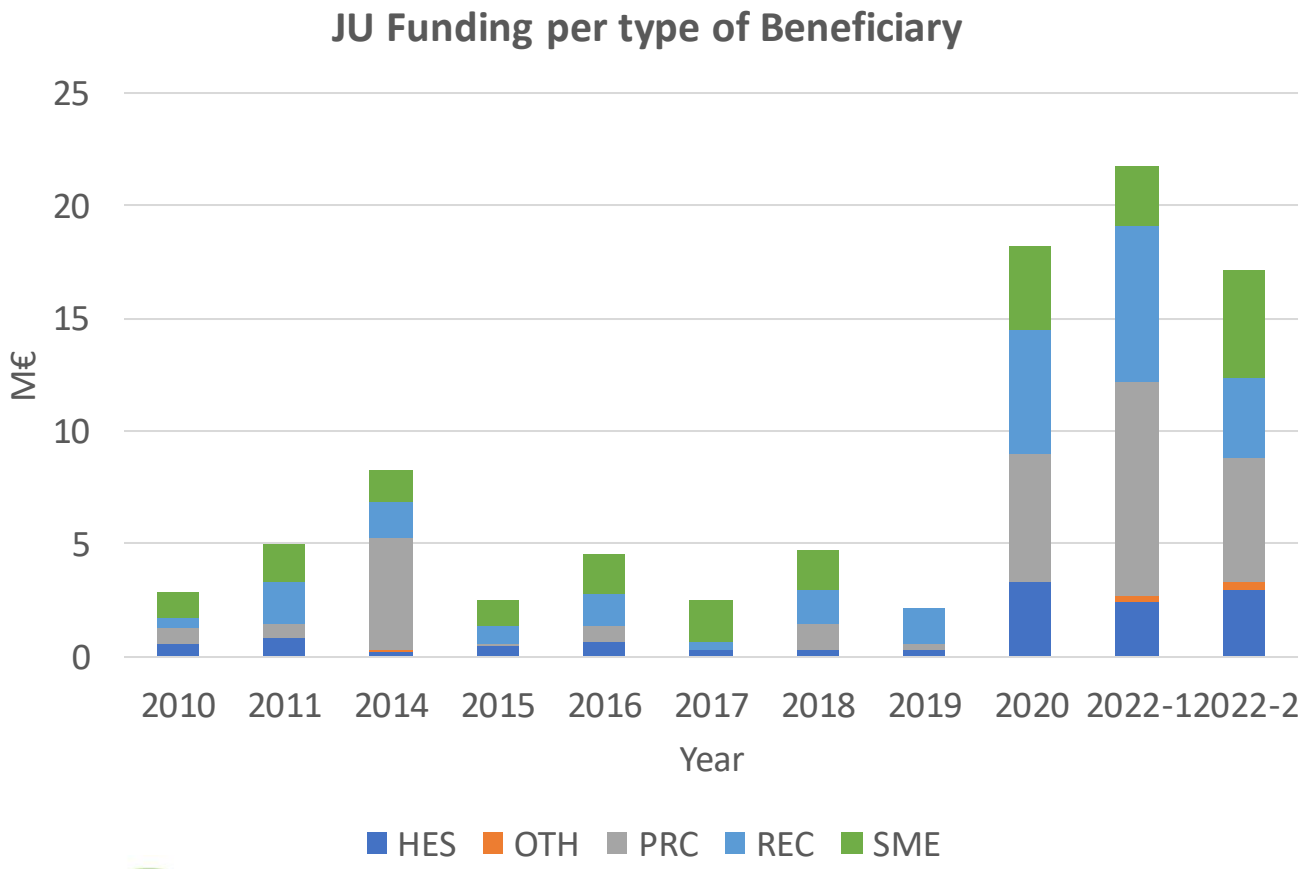
Hydrogen Storage and Distribution

Balanced support to SMEs, Industry and research members





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H_2 Underground Storage

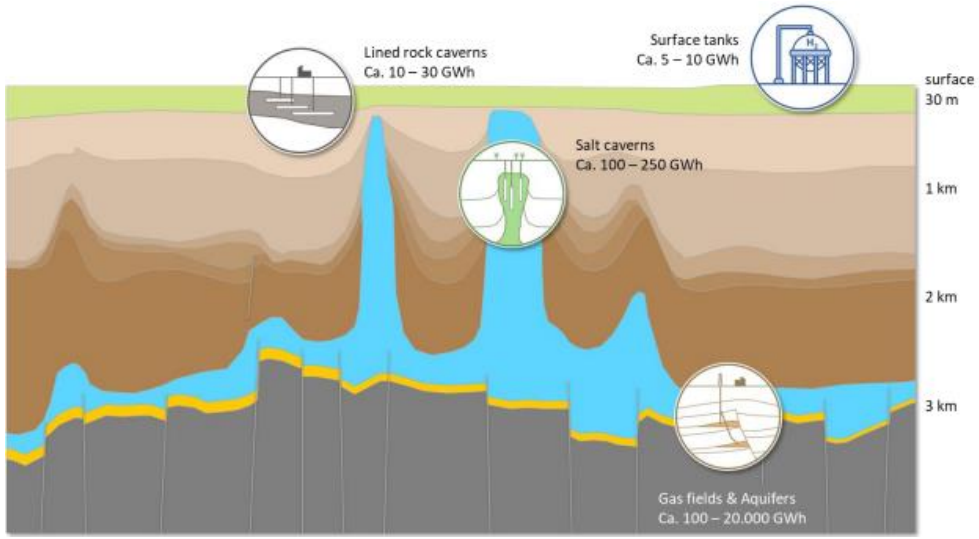
Salt Caverns and Porous Media

Salt Caverns – EU Potential

Up to 50 TWh H_2

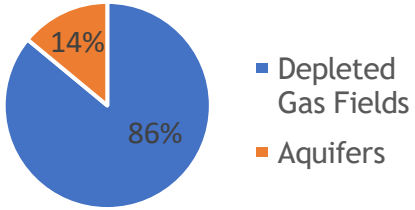
Hydrogen already stored in UK and US sites

Technical challenges remain with respect to cyclability and higher injection/withdrawal rates



Source: IEA Task 42 UHS Technology monitoring report

Porous Media – Known EU Reserve



HyUSPRe

Up to 415 TWh H_2
12 million tonnes H_2

- 17% of the estimated annual demand (2,500TWh)
- Most sites 1-5 TWh at depths of 500-2,500m
- Few large sites of 10-20 TWh at larger depths
- LCOS very site specific

Source: https://www.hyuspre.com

Challenges

- Geochemical and Microbial
- Storage Integrity
- Storage Performance
- Facilities and wells
- Economics and Social Embeddedness

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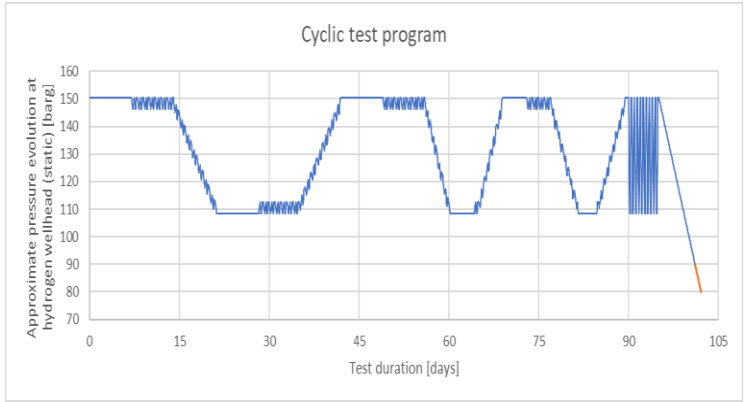
H_2 Underground Storage

Cycling testing of Salt cavern storing hydrogen

hypster Hydrogen Storage

2020

- Research cavern located in Etrez, France
- 1MW PEMEL installation being finalised
- H_2-ready wellhead in place. Testing of cavern with N_2, H_2 to be injected end Nov. 2023
- Storage of 3 tn hydrogen. Cyclic testing of cavern for 100 days between 150 and 110 bar using brine



2023

- Project Planned (Signature preparation) Demonstration in a salt cavern site of at least 1,000 tn H_2

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Underground Hydrogen Storage in porous reservoirs

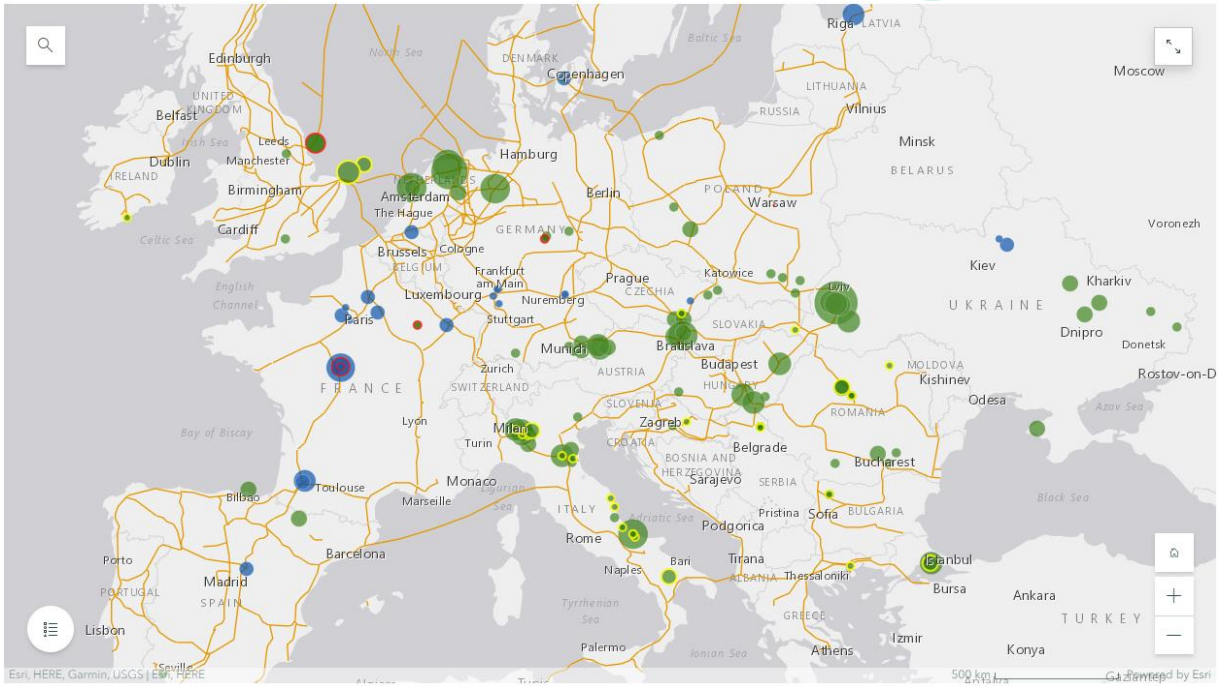
Feasibility and techno-economic assessment

hystories Hydrogen Storage in European Subsurface

HyUSPRe

2021

- Mapping H_2 storage sites and characteristics of reservoirs (geochemistry, flow transport, etc.)
- Extensive sampling and microbiological lab experiments
- Techno-economic feasibility, environmental and societal impacts studies
- Ranking of sites based on “suitability mark” and LCOS



2023

Project Planned (Signature preparation) Demonstration in a depleted gas field of at least 1,000 tn H_2

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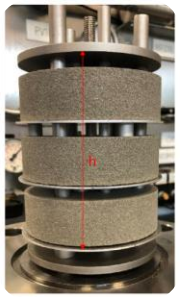
Aboveground Storage

Focused so far on the development of metal hydride solutions

2018

HyCARE



- System Capable of storing 44kg H_2 @ 1.1%$_w$
- TiFe-based intermetallic alloys coupled to phase change materials
- Energy for storing/releasing H2 reduced by 66%
- Low pressure storage 40bar
- <2% gravimetric capacity loss in 250 cycles

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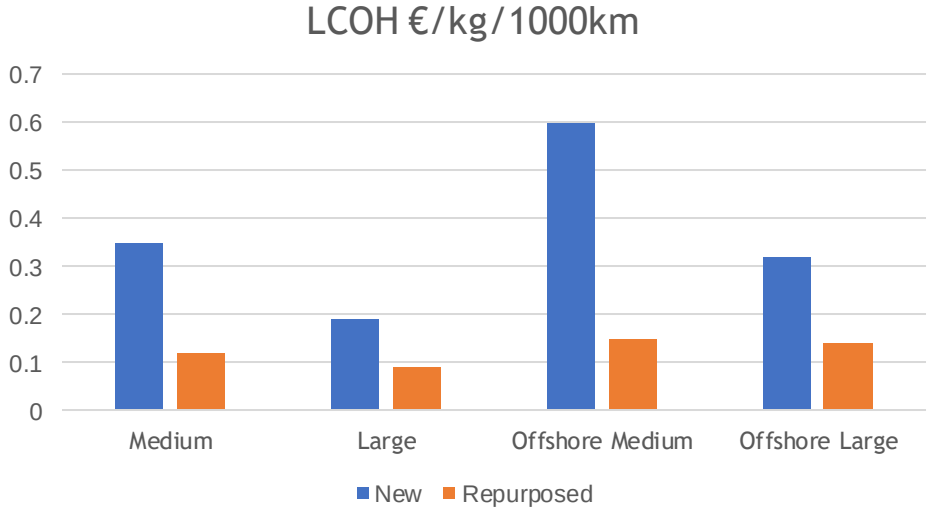
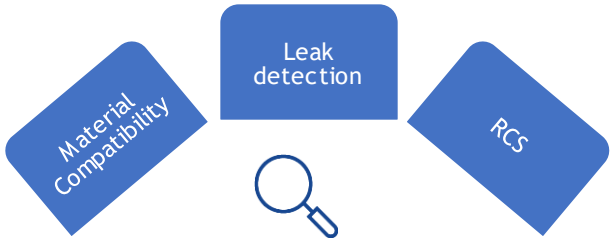
Hydrogen in the Natural Gas grid

Connecting low-cost hydrogen production to demand centers across Europe

Source: EHB vision for 2030

July 2023 Update: At 2030 – 32,000 km of pipelines foreseen
52% of which are going to be repurposed NG pipelines





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Hydrogen in the gas grid

Facilitating the formation of the backbone of a pan-European grid where the existing gas grid could be partially re-purposed

2019 HIGGS Hydrogen in Gas Grids

- 2 experimental campaigns run
- Effects of hydrogen on API 5L steels, valves etc
- High pressure testing platform
- Blends up to 20%H_2,30% and 100% H_2

2022 OPTHYCS

New sensor to be tested in:
- Pure and blended H_2
- Pipelines
- HRS
- Natural gas wells

2022

- Impact of 100% H_2 on non-steel metallic
- Focusing on low pressure distribution <16 bar
- Results will be fed to a publicly available database

2023

- Select steel specimens that cover >70% of the EU grid
- Impact of 100% H_2 on these components
- Harmonized testing protocols
- Results will be fed to a publicly available database

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Liquid Hydrogen Carriers

Enabling the liquid hydrogen supply chain infrastructure

2020-2023 Globally Planned & completed pilots

Source: IEA – Global Hydrogen Review 2023

LIQUID HYDROGEN

- LH2 not a one-size fits all solution
- Ideal for heavy-duty applications
- And long-distance distribution

2022

LH2 CRAFT

- Next gen tank for shipping of LH2
- To be demonstrated in 180m³
- Scalable design to 200,000m³
- Achieve AiP for cargo containment system (CCS) concept

2022

LH2 HyLICAL

- Magnetocaloric Hydrogen Liquefaction
- 8kWh/kg H2 liquefaction efficiency target
- 1€/kg H2 liquefaction cost target
- Prototype of 100kg/day

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Hydrogen Carriers

Exploring both LOHCs and Ammonia for long distance transport

2020

WINNER

- Cracking of Ammonia
- New materials, cells architecture
- Tubular cells tested

2022

2 projects for ~ 6 million Euro

TRL3 → TRL 5

10kg H2/day prototypes

SINGLE

AndreaH

2017

HySTOC

- 1,200kg release over 2,000h of testing
- Purity>99.7%

24kg H_2/day storage

24kg H_2/day release

2020

SHERLOHCK

- Catalyst development and testing
- Catalytic System architecture improvements
- Small scale demo testing for >200h

2022

UNLOHCKED

10kg H2/day prototype

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Hydrogen Refuelling Stations

Comprehensive approach to accommodate HD applications

Enabling Faster Refuelling

- High flow refuelling components
- Implement and test new protocols to allow refuelling of 700 bar H2 trucks at 100 kg within 10 minutes.
- Building on PRHYDE recommendations

Gaseous Supply Chain

2022

- Tube trailer payload to 1.5 tonnes (700 bar)

2023

- Compression for filling centres; (2 tonnes/day)
- a complete logistic scheme;
- Demonstration of deliveries of at least 2 tons/day;

Compression

- Broad scope of compression technologies to ensure HRS are fit for purpose
- Scaling up the hybrid compression concept for lab to demonstration (TRL7)
- Validate its ability to operate from 200kg/day to 1,400kg/day

Liquid H2

2023

- Develop and demonstrate a large LH2 HRS
- Delivery flowrates (>5 TPH);
- Boil-off management

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Conclusions

Diverse research activities for the support of a logistical infrastructure for hydrogen

- Underground storage gaining a prominent role in the partnership. First demonstrations starting now in Salt Caverns. Soon to be scaled-up
- Facilitating the creation of the European Hydrogen Backbone with targeted research
- First proof-of-concepts tested on LOHCs. Opening the scope of research to both liquid H2 and ammonia
- Addressing the high demands that will come from heavy-duty vehicle refuelling

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