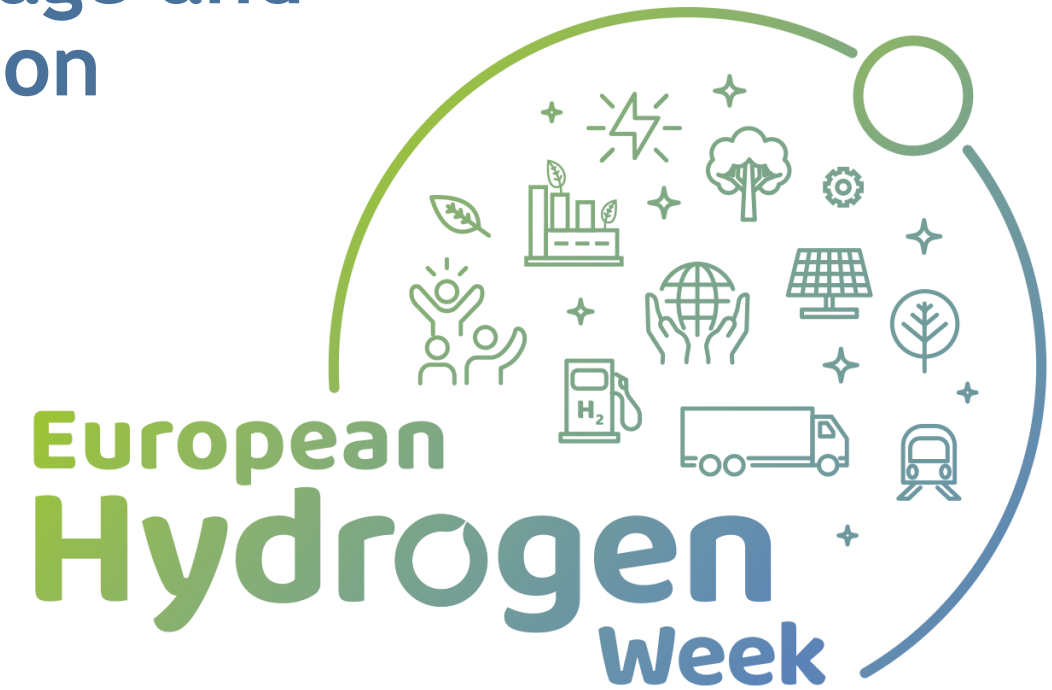
Hydrogen Storage and Distribution



D.Tsimis

Project Officer

#EUResearchDays
#PRD2022
#CleanHydrogen

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European Hydrogen Week

Sessions on H_2 Storage Distribution

28th Oct. 11:45 - 13:00

Hydrogen Distribution and Storage

Revamped objectives under the new Partnership

European Hydrogen Week

Large-Scale Storage	Injection in the NG grid	Compression and Purification	LOHCs / Other Transport means / Gaseous Trucked
• Underground Storage in Salt Caverns and Depleted Gas fields • Aboveground storage • Dedicated KPIs	• Support repurposing to 100% H2 • Assess compatibility of existing NG network with varying hydrogen content and conditions	• Compression for HRS/Pipelines • Development of metering and sensor equipment • Dedicated KPIs	• Hydrogen Liquefaction • Liquid H2 logistics infrastructure • Dedicated KPIs

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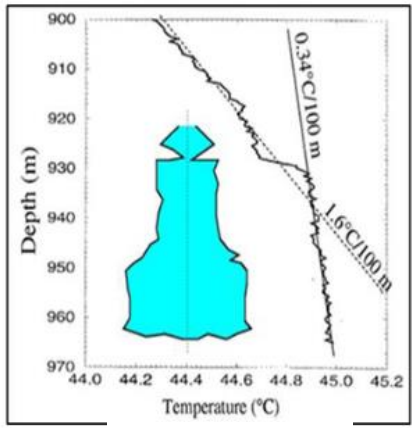
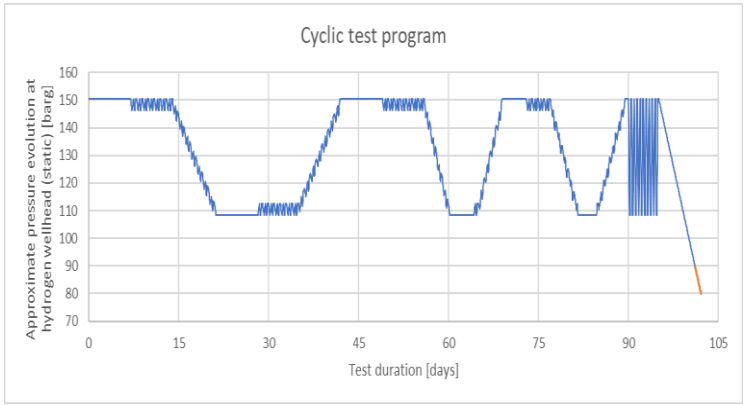
H_2 Underground Storage

Cycling testing of Salt cavern storing hydrogen





Research cavern located in Etrez, France

Production of 400kg/d through 1MW PEMEL

Storage of 3 tn hydrogen. Cyclic testing of cavern for 100 days between 150 and 110 bar using brine

Studying tightness, thermodynamic behaviour, chemical and bacteriological reaction, software modelling

2020

hypster Hydrogen Storage

	SoA	2024
Capital Cost(€/kgH_2)	35	32

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Underground Hydrogen Storage in porous reservoirs

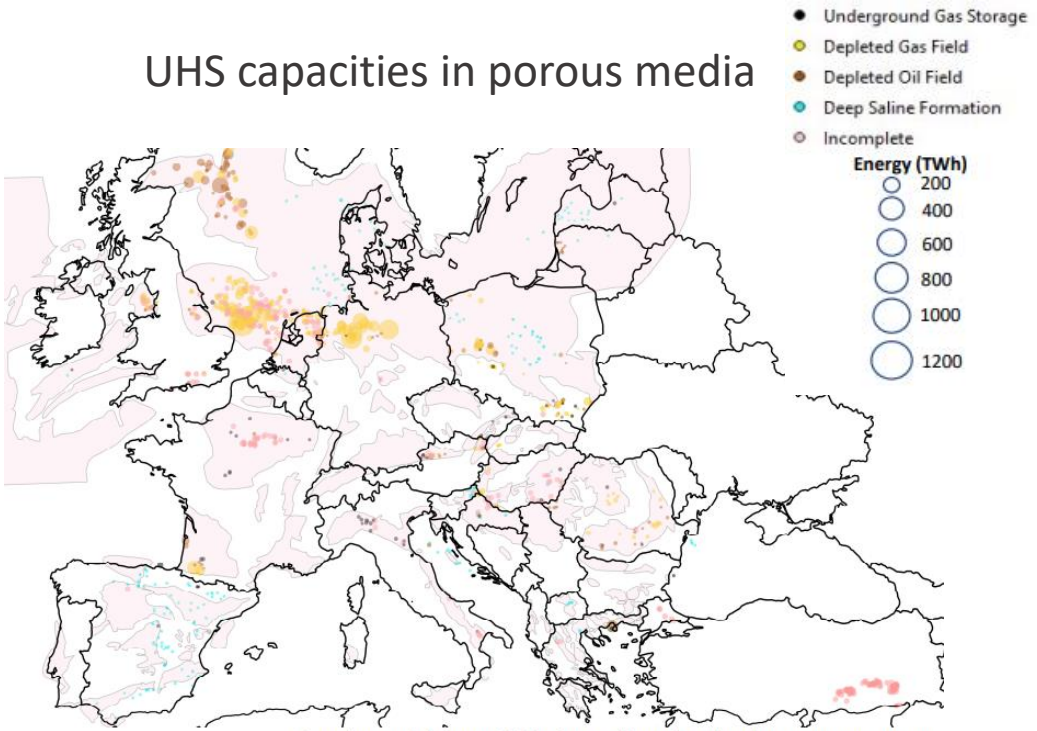
Feasibility and techno-economic assessment

hystories Hydrogen Storage in European Subsurface

HyUSPRe H_2 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
- Cost estimates and identification of business case

UHS capacities in porous media



based **on publicly available data** collected within the Hystories project

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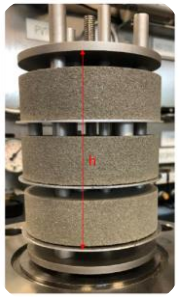
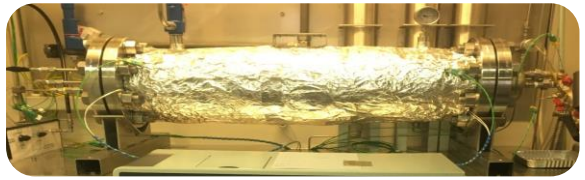
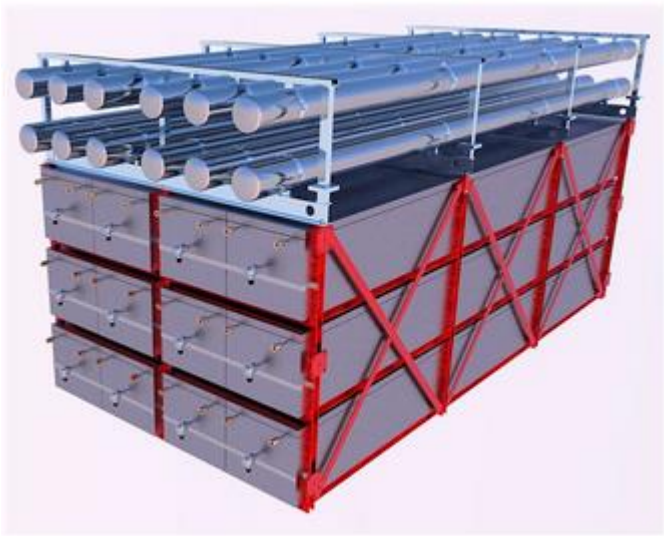
Aboveground Storage

Focused so far on the development of metal hydride solutions

HyCARE







4 projects

7.4 M€ funding

- System Capable of storing 50kg H_2
- **70%** round-trip efficiency
- Low pressure storage <50bar
- TiFe-based intermetallic alloys
- Coupled to phase change materials that store heat for the release of H_2

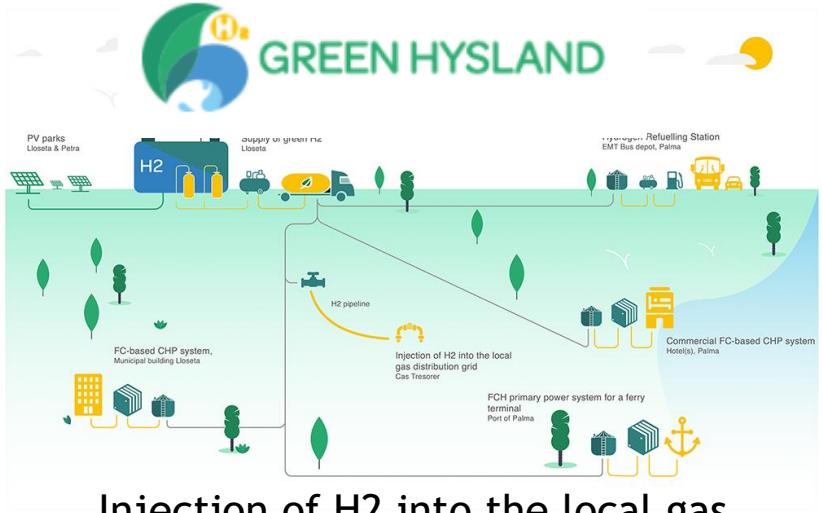
Aboveground Storage	Unit	SoA	2024
Storage Size	ton	1.1	5
Capex	€/kgH2	750	700

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

- Focuses on high pressure natural gas grid
- Development of a R&D platform for testing mixtures (20, 30 and 100%H_2)
- Innovations needed to make the existing HPN compatible with H_2 /CH_4 admixtures

Demos



Injection of H2 into the local gas distribution grid (2%), Mallorca

2 New topics in Call 2022:

- Compatibility of non-steel materials in distribution grid
- Sensor development for leak detection of ad-mixtures

HEAVENN

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Efficient separation / purification of H_2

Electrochemical separation/purification technologies showing first results

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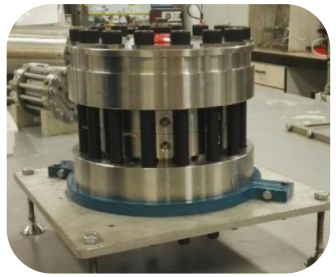
HyGrid


Focus on "low H_2 content" (e.g. 2-10 %)

Targets:
< 5 kWh/kg H_2
< 1.5 €/kg H_2
@30bar

MEMPHYS

Focus on a high concentration (> 50 %) H_2

Targets: < 3 kWh/kg H_2 @ 200bar

	Unit	Achieved	2024-SRIA
Energy Consumption - Separation	kWh/kgH_2	**4**	**3.5**
Energy Consumption - Purification	kWh/kgH_2	**4**	**3**
Hydrogen recovery Factor	%	**83**	**90**
LCOH	€/kgH_2	**1.5**	**1**

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Compression technologies

Developing the building blocks

COSMHYC INNOVATIVE H2 COMPRESSION → Achievements → COSMHYC XL

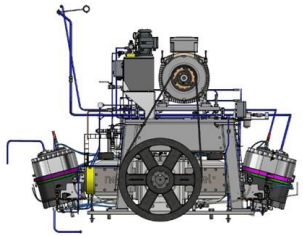
Compressor	Unit	SoA	2024
Capex	€/kW	7,700	5,600
Energy Consumption	kWh/kgH_2	6	4

Metal Hydrides

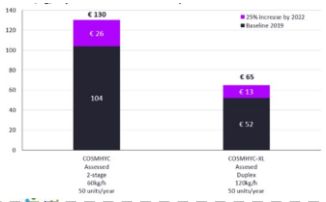
+ 100%
Absorption capacity

X 12
Compression ratio

Mechanical compressor



From 30kg/h To 60kg/h



- 50% CAPEX

Hybrid compressor

Fully containerized solution

Solution ready to be CE certified in follow-up project

COSMHYC DEMO INNOVATIVE H2 COMPRESSION

2 tonnes/day

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Hydrogen Carriers

One of the most promising solutions for the distribution of hydrogen across very long distances

24kg H_2/day storage

24kg H_2/day release

Hydrogen Carriers	Unit	SoA	2024
Delivery Cost 3,000km	€/kgH_2	4	2.5
Energy Consumption	kWh/kgH_2	20	17

- Up to 5x higher transport capacity per 40-tonne truck compared to 200 bar tube trailers
- 1,200kg release over 2,000h of testing
- Purity>99.7%

2 New topics in Call 2022 on dehydrogenation

- LOHCs
- Ammonia

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Other means of hydrogen transport

Strong focus on liquid hydrogen

Gaseous Tube trailers

- Existing solution uses working pressure

of 200bar – 300bar
- **New topic** in 2022:
- Reduce transport cost to 450€/kgH2 in 2024;
- Increase H2 payload up to 1.2 tons;
- Operating pressure above 500 bar;

LH2 Infrastructure

- **Large scale LH2 tank for shipping**

Targets for 2024

i. 350t LH2 ship tank capacity
ii. Capex<50 €/kg;
iii. Boil-off <0.5%/day

New topic in 2022: Development of a scaled down prototype of 10 tonnes

Hydrogen Liquefaction

- Targets for 2024:

i. Liquefaction Cost: <1.5€/kgH2
ii. Liquefaction Energy: 8-10kWh/kgH2

New topic in 2022: Validation of a high-performance hydrogen liquefier prototype

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Conclusions

Enabling the creation of a logistical infrastructure of hydrogen through research on:

- Underground storage gaining a prominent role in the partnership. First demonstrations starting now
- Small scale demonstrations already taking place for H_2 injection in the gas grid. Upcoming research on on compatibility and leak detection
- Innovative hybrid compressors scaling-up. Next step real-life testing
- First proof-of-concepts being tested on LOHCs. Next priority on scaling up LH2 infrastructure

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