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H2 storage: challenges from a European perspective

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OF THE EUROPEAN NATURAL GAS INDUSTRY

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H2 storage: challenges from a European perspective

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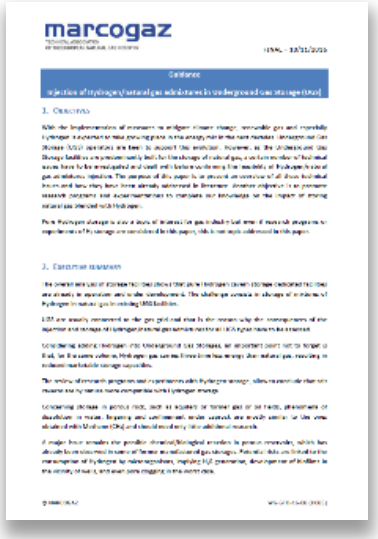
Context

Expected impacts of H2 and H2NG in UGS

Next steps



"Guidance on Injection of Hydrogen/natural gas admixtures in Underground Gas Storage (UGS)"
WG-STO-16-08

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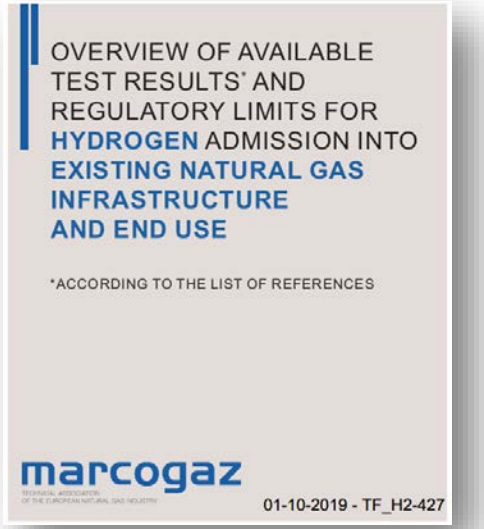

"Overview of available test results and regulatory limits for hydrogen admission into existing natural gas infrastructure and end use"
01-10-2019 – TF_H2-427

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Context

Rise of renewable H2 production
Decarbonization of Natural gas

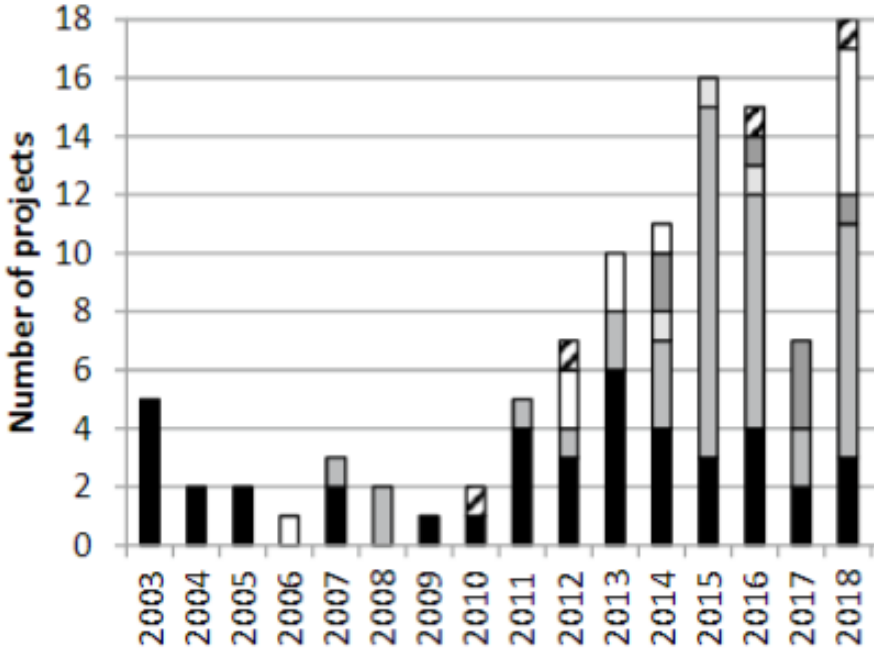
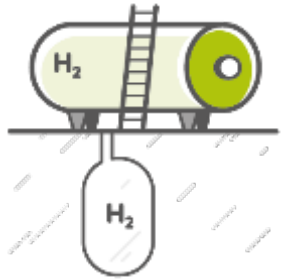


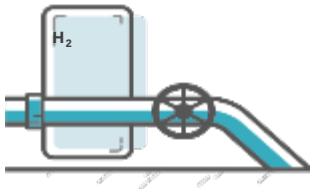
Fig. 5 Temporal development of further processing of hydrogen in Power-to-X

Source: Christina Wulf et al. / Energy Procedia 155 (2018) 367–378

Pure H2 networks
Need for H2 storage



Blend with natural gas (H2NG)
Up to which %?



Underground Gas Storage (UGS) capacity in Europe

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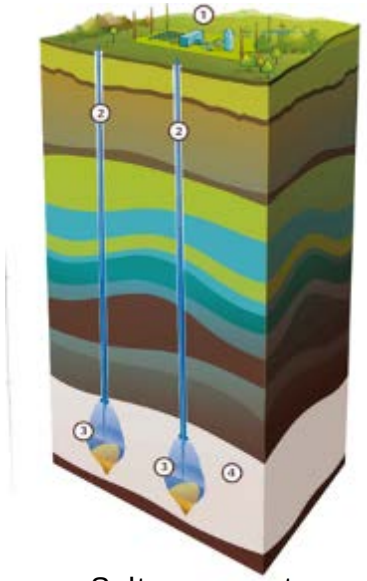
Storage of huge energy capacity

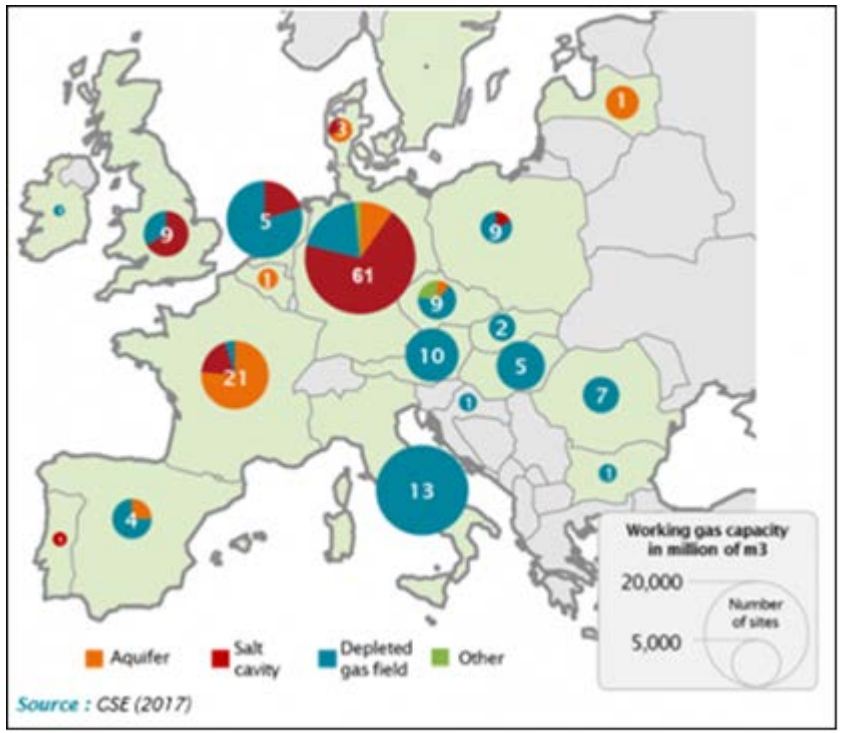
- Working gas volume (natural gas storage capacity) = 180 Bcm = 1978 TWh
  (= 150,000,000,000 Tesla Powerwall or 38,000,000,000 Renault Zoé)

Different storage types

- Depleted oil and gas fields
- Aquifers
- Salt caverns



Salt cavern storage
Source: Storengy



Source: GIE-GSE, 2017

Experience and knowledge available

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- **Some European UGS have stored manufactured gas, containing more than 40 % H_2, between 1950 and 1980.**

- **Existing H2 storage in salt caverns for the chemical industry**

- **Literature review, lab and pilot projects have already provided valuable results:**
  - HyUnder (EU)
  - DGMK research report (Germany)
  - Underground Sun Storage (Austria)
  - H2STORE (Germany)
  - Other fields of interest (native H2, deep nuclear wastes storages…)

Expected impact on UGS: surface facilities

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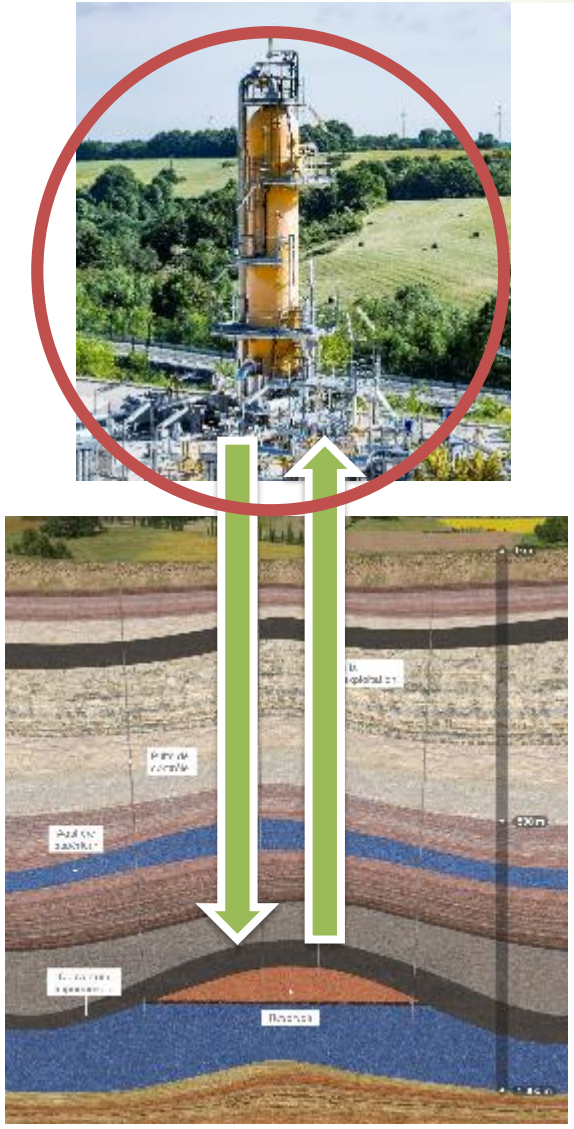


UGS specificity: Gas quality (H_2O, H_2S), high pressure, pressure cycling

Steel embrittlement and corrosion: to assess with wet and/or sour gas

Compression unit: impact on efficiency, strongly depending on technology

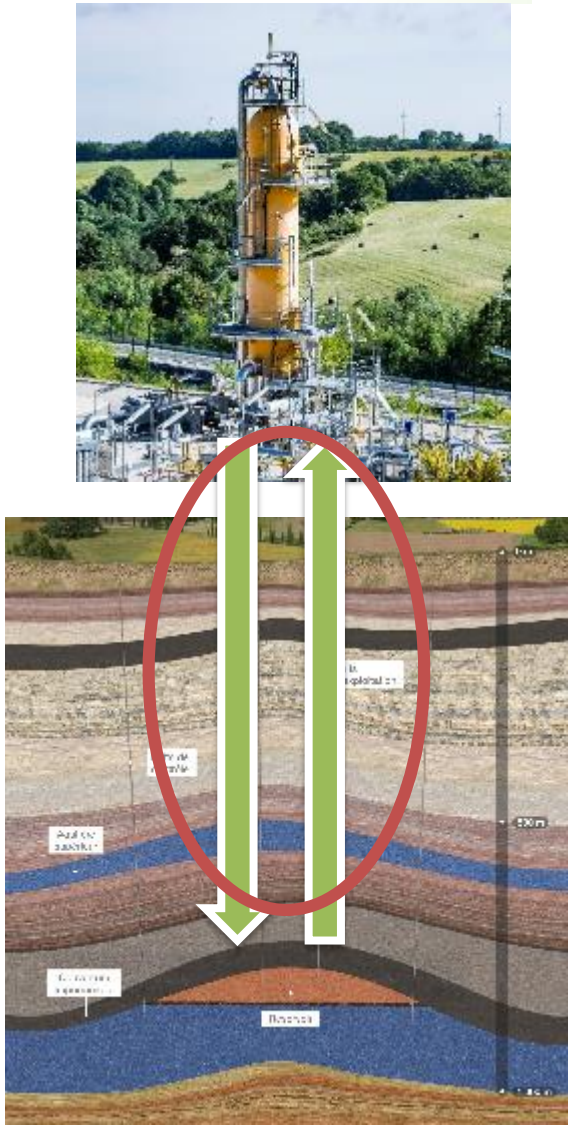
Dehydration and desulfurization unit: impact on efficiency, depending on technology (especially for Joule-Thompson)

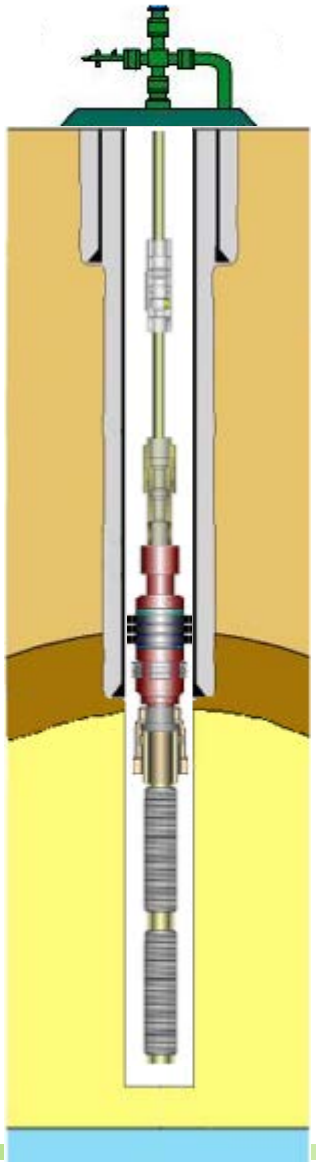
Gas metering: similar to gas transport grid

=>manageable impact, cost to be assessed

=>tests with specific steel grades to be made

Expected impact on UGS: wells





Steel embrittlement and corrosion: to assess with wet and/or sour gas, H2NG should be compatible with O&G standards

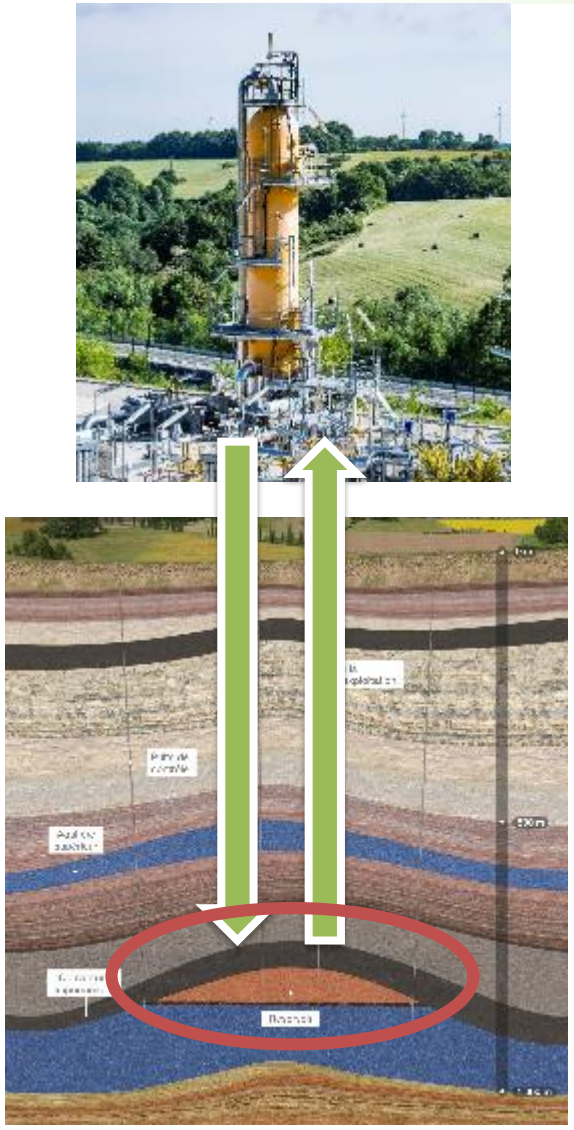
Elastomer sealing elements: mainly chemically compatible

Cement: no issues in term of containment and integrity

=>manageable impact, cost to be assessed

=>proper tests with specific steel grades and elastomers to be made

Expected impact on UGS: reservoirs



Containment: not much different than for natural gas, but must be checked for each caprock

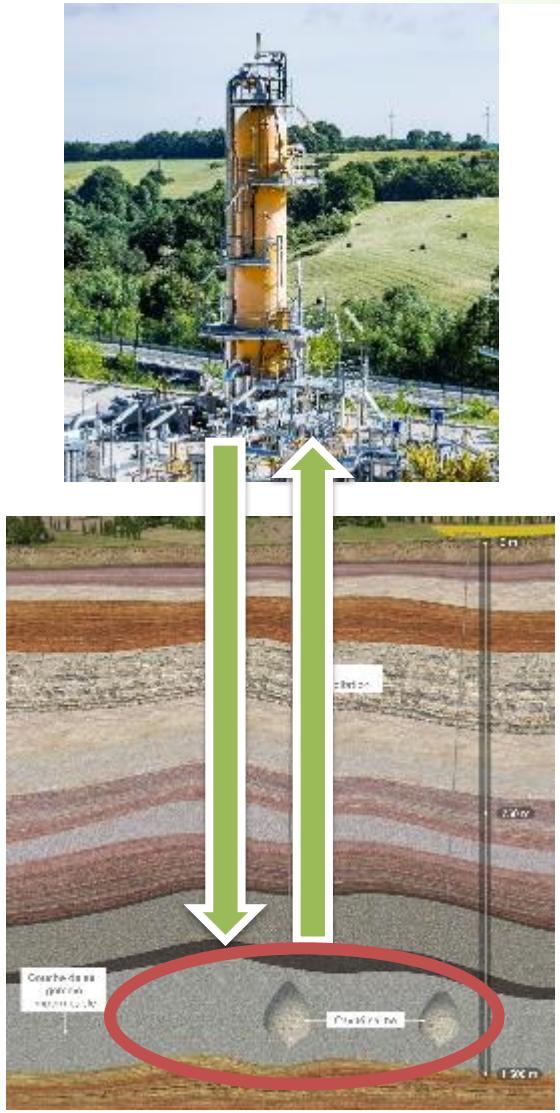
Transport mechanisms: not much different than for natural gas

Biogeochemical reactions: storage depending

Sulfate reduction to H_2S	$5\ H_2 + SO_4^{2-} = H_2S + 4\ H_2O$
Iron reduction	$H_2 + Fe_2O_3 = 2\ FeO + H_2O$
Acetogenesis	$4\ H_2 + 2\ CO_2 = CH_3COOH + 2\ H_2O$
Methanogenesis	$4\ H_2 + CO_2 = CH_4 + 2\ H_2O$ or $3\ H_2 + CO = CH_4 + H_2O$

=>to be checked case by case for each reservoir, possible blocking point

Expected impact on UGS: salt caverns



Containment: not much different than for natural gas

Thermodynamical behavior: not much different than for natural gas

Biogeochemical reactions: very limited

=>existing solution for pure H2 storage with adapted well completion

Result of Marcogaz Task-Force

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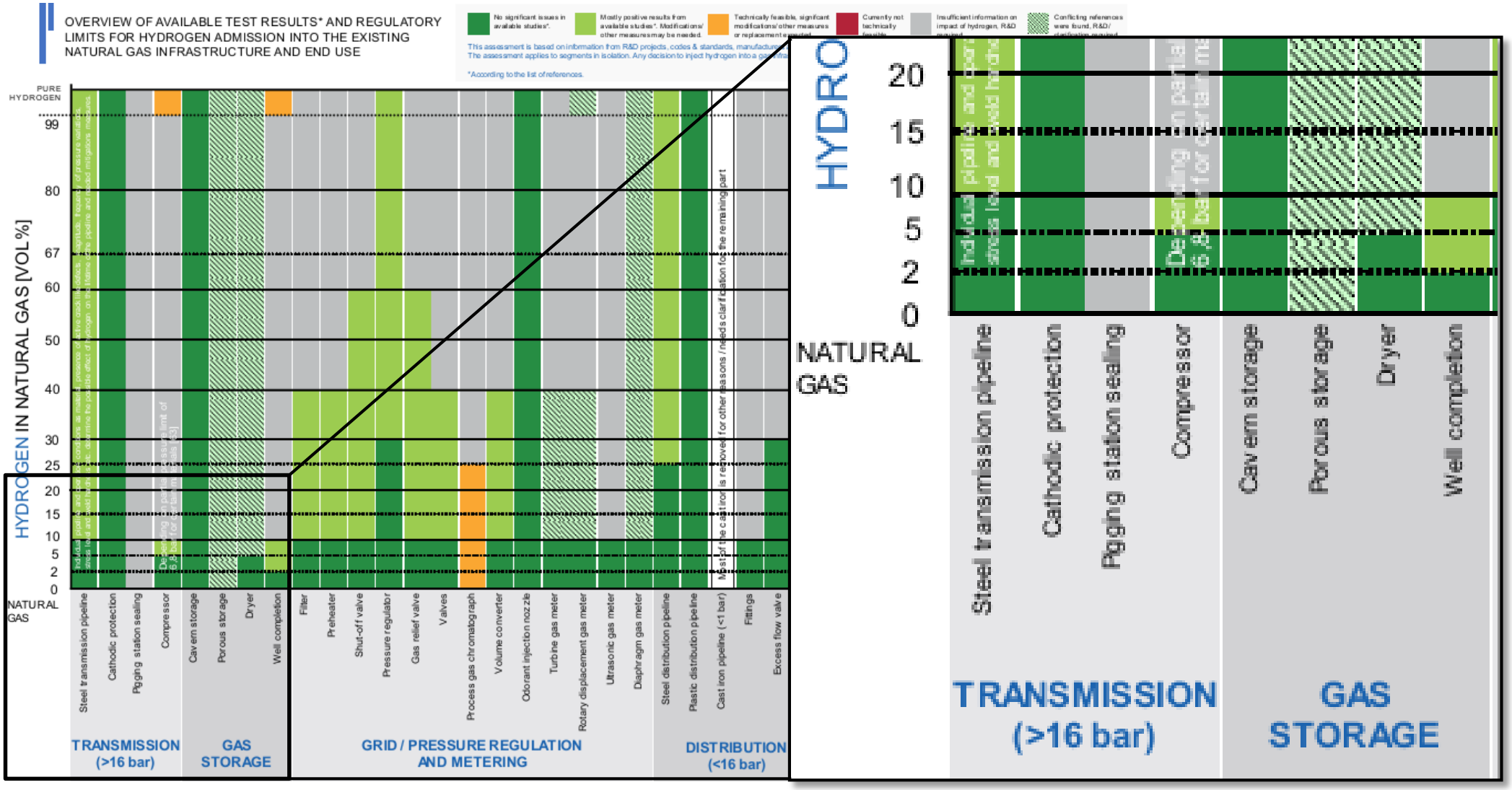

What is left to investigate

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- **Marcogaz recommendations:**
  - Reinterpretation of previous observations on the former manufactured gas storages
  - Laboratory:
    - tests and monitoring on microbiological reactivity of subsurface Hydrogen with different water/gas compositions and at reservoir conditions.
    - tests on material (valves, well completion…)
  - Pilot storage in a porous reservoir which formation water contains sulfates.
  - Pilot storage in a salt cavern to get technological information about operating issues.

- **Check list and analysis for each existing facility to review the compatibility of wells and surface facility equipment for a given H_2 content in Natural Gas.**

CEN / GERG H2NG project

CEN TCs established a shortlist of priority subjects for H2NG in gas grid, for DG energy, with the help of GERG and Marcogaz. GERG would be the coordinator.

Underground storage is listed Priority No 3.

⇒ Works program should begin in early 2020, led by DBI-Gut, literature and knowledge review, and proposition of required actions

⇒ Funded by EU as pre-standardization research

⇒ Opportunity to reach a European common position

Expected outcomes and benefits

- Updated information for the storage formations and equipment, with Identification of mitigation options, bottlenecks (need for replacement of sensitive equipment) and suitability of storage reservoirs, as well as its verification and monitoring
- Proposal of a future Work Program for PNR actions including numerical simulations, research work, experimental testing and demonstration

Priority No 3

Underground Storage

Impact of storing H2 and H2NG blends in underground gas storages (UGS) on integrity and performance of reservoirs, materials, processes.

Partners: DBI, DNVGL, Storengy, Terega, RISE, ENGIE, Imperial College, TNO, Gasunie, Kiwa, Snam

Proposed Aggregated Budget: 100 k€

Selection of on going projects

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UNDERGROUND SUN.CONVERSION

NORTHERN NETHERLANDS HYDROGEN VALLEY

HyINTEGER

HYCHICO

Project Centurion (UK)

HYPOS

RINGS (Fr)

Next Steps

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- **Current Research projects, supported by UGS operators are going on. Others are to be launched.**
- **Start soon of CEN project on H2NG, would be funded by EU. First step: Litterature review.**
- **Storage operators have to analyse facility integrity for different H_2-admixtures.**
- **The results should provide information to update Underground Gas Storage Standard (EN1918).**

Thank you !

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