hypster Hydrogen Storage

The regulatory framework of geological storage of hydrogen in salt cavern

Benno Weinberger (Ineris), Hippolyte Djizanne (Ineris),
Sylvaine Pique (Ineris), Franz Lahaie (Ineris), Andreas Bannach (ESK),
Torsten Wagler (ESK), Richard Stevenson (Inovyn),
Richard Applewhite (Inovyn)

20th September 2023

Co-funded by the European Union

Clean Hydrogen Partnership

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101006751. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

HyPSTER stands for **Hy**drogen **P**ilot **ST**orage for large **E**cosystem **R**eplication

- Project start date: January 2021
- Location : Etrez (Ain 01) | France
- H_2 Production: Electrolyzer (1 MW)
- Storing capacity: 3 tons H_2 (exp. phase)
- Total budget: 13 M€ (5M€ funding)
- End of the Pilot Phase: 2024
- Perspective Phase II: 44 tons H2 (2025)

Description: Test industrial-scale renewable hydrogen production and storage in salt caverns supported by technical and economic reproducibility of the process to other sites throughout Europe.

9 partners, 4 countries

Consortium Partners

H2 & Subsurface expertise

storengy, ARMINES, BROUARD CONSULTING, ESK

Regulation & Safety

INERIS

Storage replication potential

inovyn, storengy

Technical and economic assessments

elementenergy

Bacteriology Purification

equinor

Communication

axelera

Coordination

storengy, elementenergy

2 Strategic partnerships

Schneider Electric, TechnipFMC

Hypster is a project funded by the European Commission - Project Number : 101006751

Situation map: Etrez UGS

Etrez NG Storage facilities

Planned H_2 Production Platform

EZ53 Cavern Platform

Hypster is a project funded by the European Commission - Project Number : 101006751

HyPSTER project is divided into two parts

Renewable Hydrogen Production

- Electrolyzer 1MW
- Water
- Electricity
- Hydrogen transportation by tubes trailers

Pilot of Hydrogen Storage in salt cavern

- Use of an existing cavern
- Tightness tests
- Pressure variation cycles

Hypster is a project funded by the European Commission - Project Number : 101006751

Hypster Project Schedule overview

2021 2022 2023 2024

- **Hydrogen production**

- **Hydrogen Storage in salt cavern**

H2 Production Platform

- *Start of the construction 18th July 2022*
- *Packages deliveries:* ***end-February 2023 - Stacks July 2023***
- *Commissioning from April to August 2023*
- *Start of H2 production August 2023*

UHS EZ 53

- *Start of construction work: 22nd August 2022*
- *Cavern Workover March - April 2023*
- *Tightness Test August – October 2023*
- *Cycling Test October to February 2024*

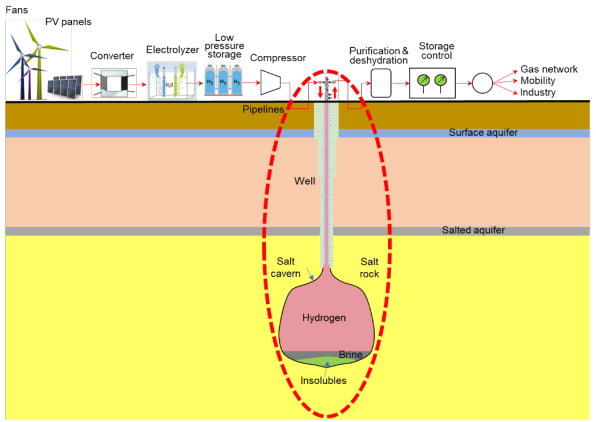
Hypster is a project funded by the European Commission - Project Number : 101006751

THE REGULATORY FRAMEWORK OF GEOLOGICAL STORAGE OF HYDROGEN IN SALT CAVERNS

This work aims to establish the current state of the art regarding regulations and standards relevant to the safety of hydrogen salt cavern storage in Europe, both at the Commission and national levels.

The purpose is to identify the legal obstacles encountered by operators and competent authorities and the legal and normative adaptations needed to favor a safe and large-scale development of this technology in Europe.

Work is focused on the regulations and standards for managing risks relevant to the cavern and the well (including the wellhead).



H2 SALT CAVERNS IN EUROPE UNTIL 2030

New salt cavern

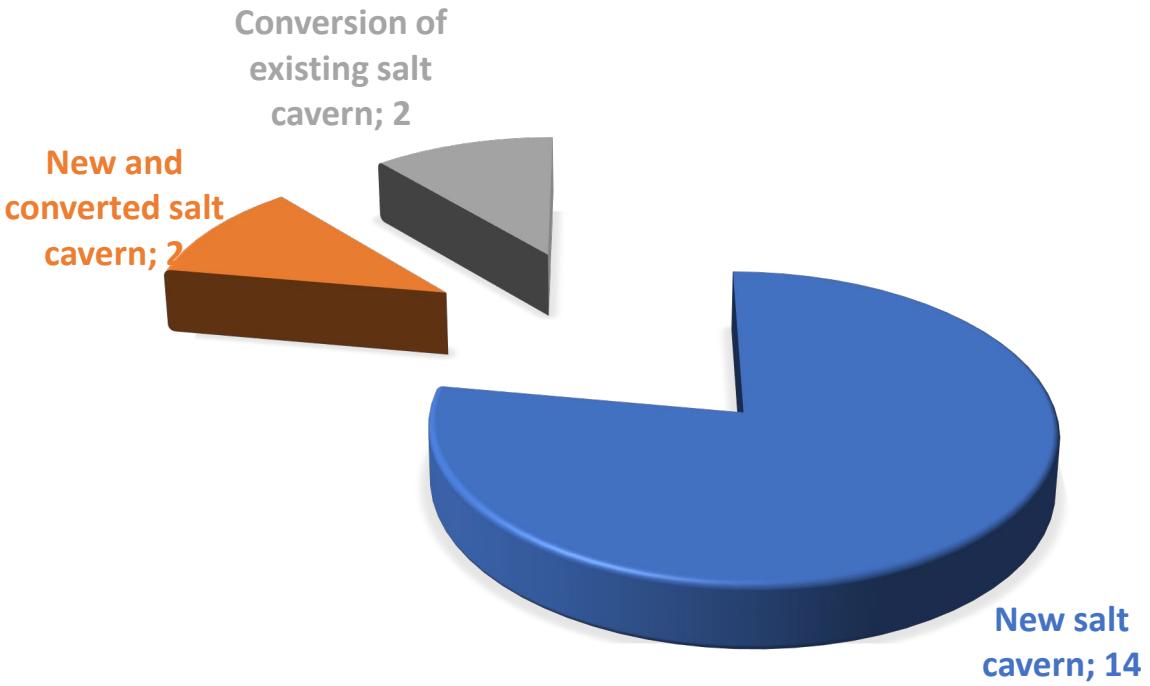
New and converted salt cavern

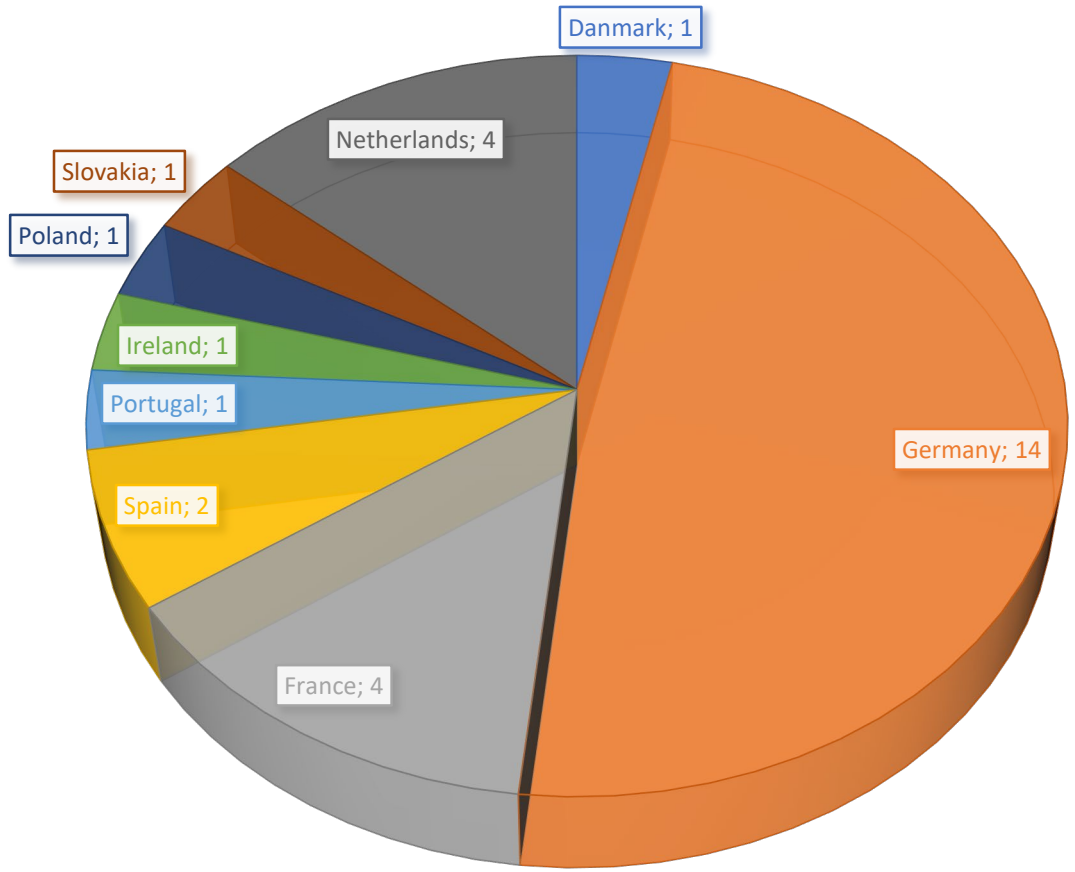
Conversion of existing salt cavern

Source: H2 Infrastructure Map Europe (h2inframap.eu)

Hypster is a project funded by the European Commission - Project Number : 101006751

H2 SALT CAVERNS IN EUROPE UNTIL 2030

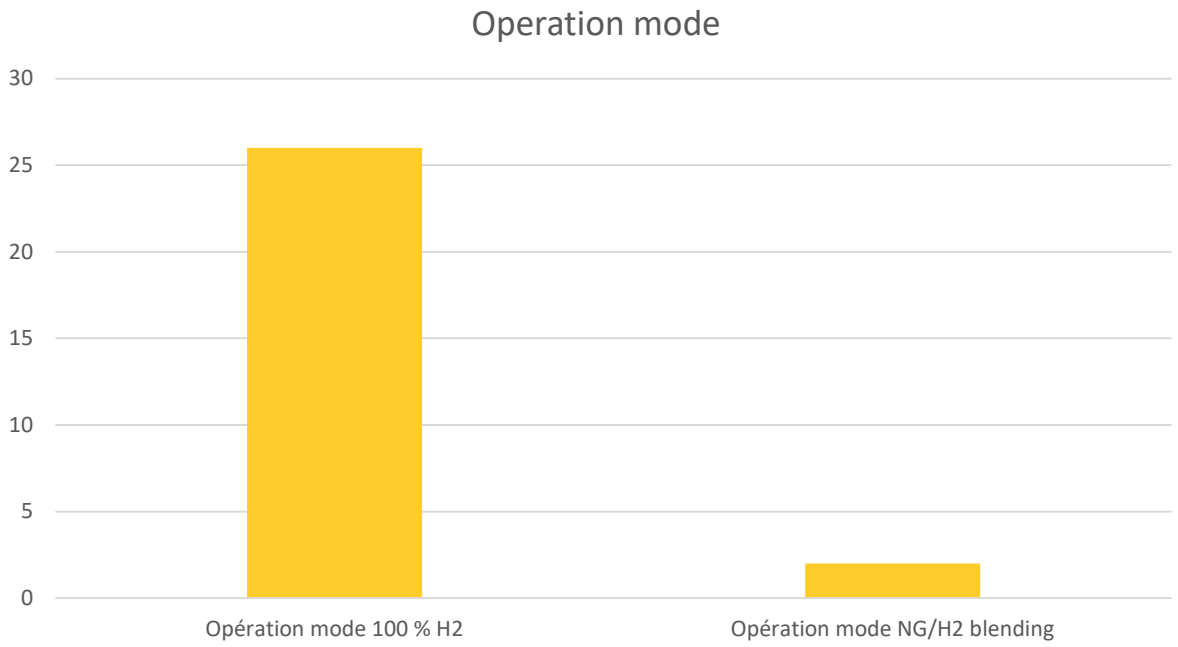


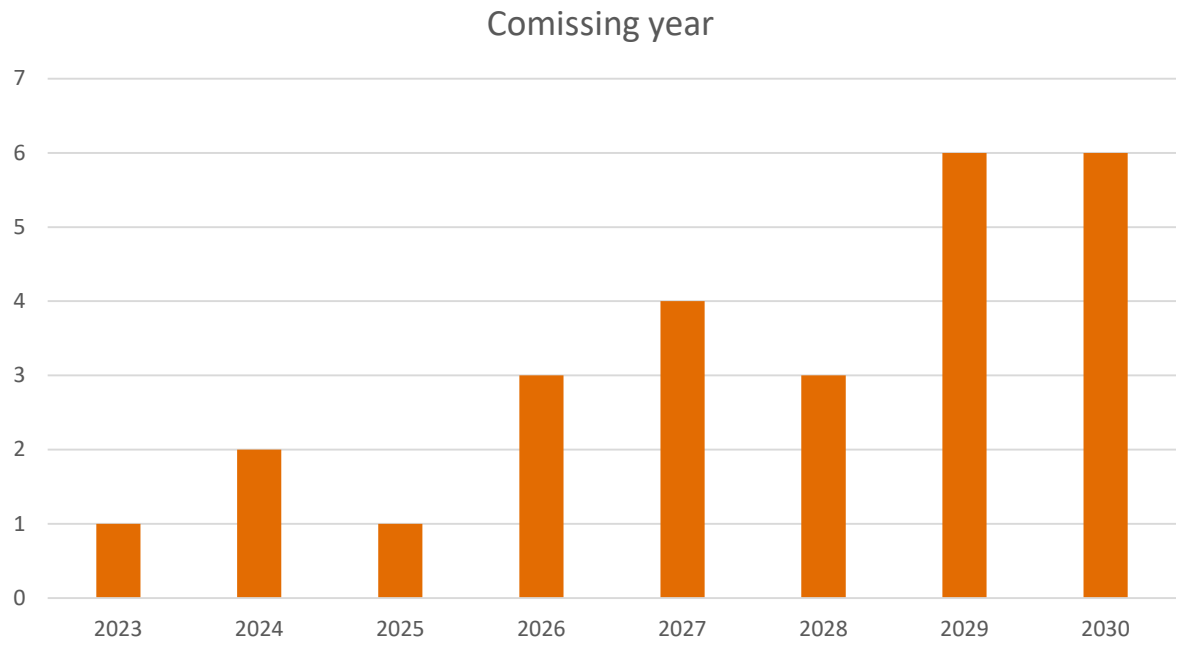


Source: H2 Infrastructure Map Europe (h2inframap.eu)

Hypster is a project funded by the European Commission - Project Number : 101006751

H2 SALT CAVERNS IN EUROPE UNTIL 2030





Source: H2 Infrastructure Map Europe (h2inframap.eu)

Hypster is a project funded by the European Commission - Project Number : 101006751

EUROPEAN REGULATION AND STANDARDS

Underground hydrogen storage in salt caverns is subject to various European regulations and norms that aim to ensure security, safety and environmental protection.

Most emblematic one is the **Directive 2012/18/EU of 4 July 2012**, known as the "Seveso III Directive".

Up to now, there is **no specific regulation or standard for underground hydrogen storage** in salt caverns at European level.

The European standard **EN 1918-3:2016** provides practical recommendations for storage in solution-mined salt caverns for underground gas storage.

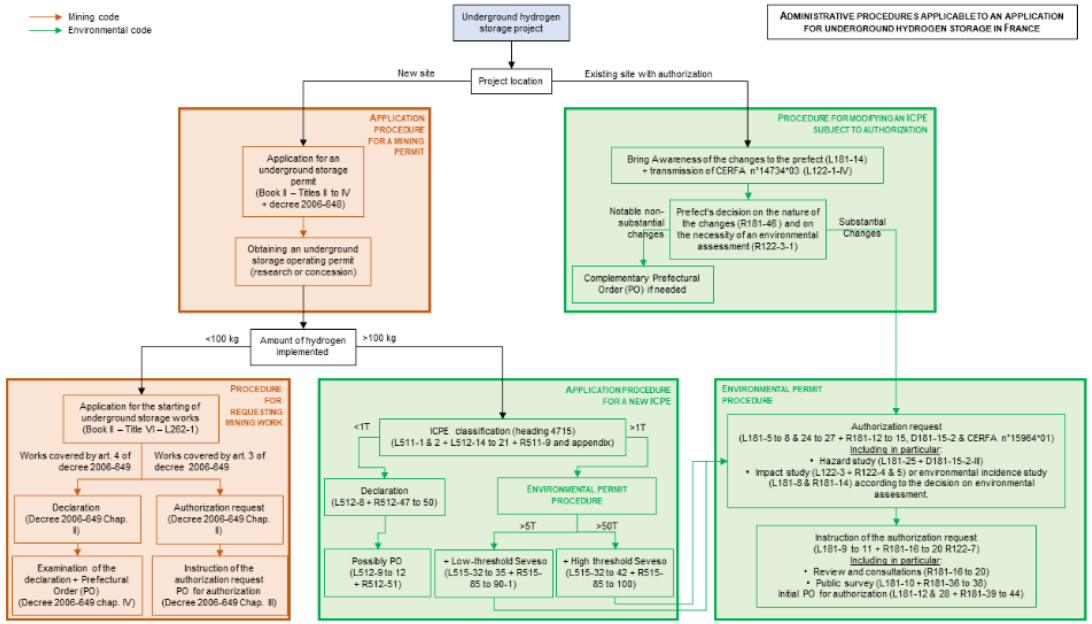
The standard applies to the solution-mined salt caverns that currently store natural gas or liquefied petroleum gas (LPG), not hydrogen.

Working group **CEN/TC 234/WG 4 - Gas underground storage** is undergoing work to adapt this standard to hydrogen. It gives practical recommendations for such ***storage facilities for design, construction, operation, maintenance, and abandonment***.

REGULATION IN FRANCE

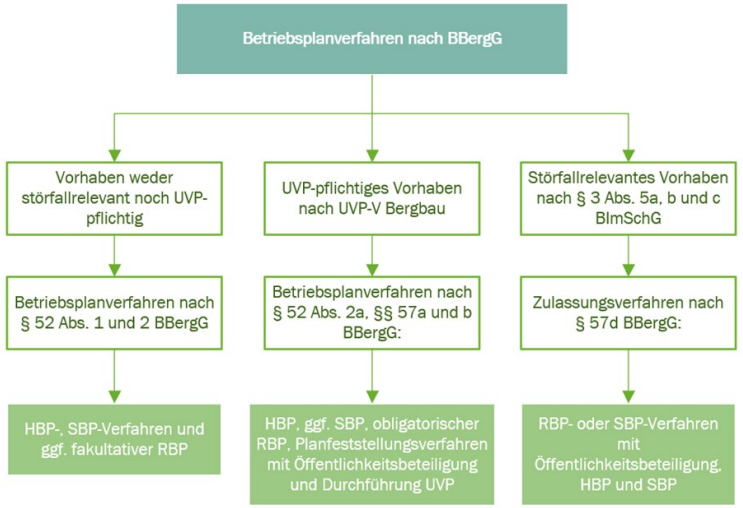
In France, the regulatory framework for hydrogen storage in salt caverns is governed by the Mining Code and the Environmental Code.

- The process involves obtaining a mining title through the Mining Code, which includes a specific procedure for granting concessions for hydrogen storage projects.
- Environmental authorization is required, emphasizing the need for an environmental impact assessment and measures to mitigate potential risks.
- The French regulations emphasize risk assessment, emergency plans, and monitoring systems to ensure the safe operation of salt cavern storage facilities.



Hypster is a project funded by the European Commission - Project Number : 101006751

REGULATION IN GERMANY



In Germany, the regulatory framework for hydrogen storage in salt caverns is based on the Federal Mining Act and state-specific ordinances.

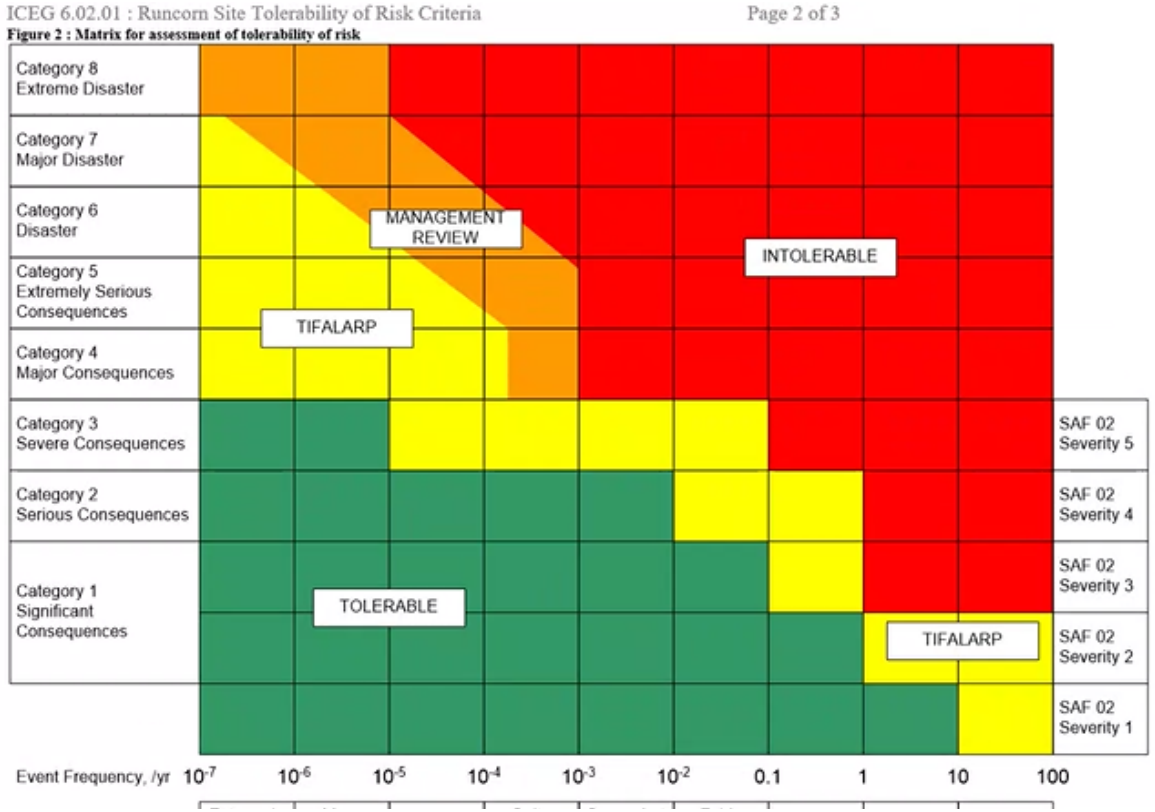
- The existing legal provisions are adapted for hydrogen storage, as there are no specific thresholds or regulations dedicated solely to hydrogen storage in salt caverns.
- The Federal Mining Authority oversees the process and ensures compliance with safety and technical standards.
- Risk assessments and safety measures are crucial in the planning and operation of salt cavern storage projects.

Hypster is a project funded by the European Commission - Project Number : 101006751

REGULATION IN GREAT BRITAIN

In Great Britain, the regulatory framework for hydrogen storage in salt caverns involves several existing legislations related to land use planning, hazardous substances, and major accident hazard control.

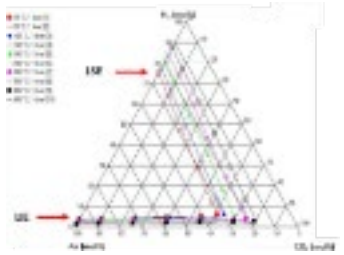
- Consent for dangerous substances, such as hydrogen, is required under the Control of Major Accident Hazards (COMAH) Regulations.
- The Health and Safety Executive (HSE) oversees safety measures and risk assessments for salt cavern storage projects.
- Borehole safety regulations are also relevant to ensure the integrity of the caverns and prevent any leakage or accidents.



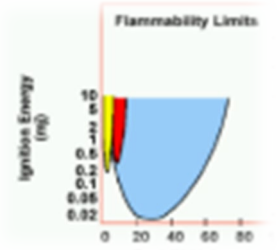
Hypster is a project funded by the European Commission - Project Number : 101006751

Specificities of hydrogen, hazardous properties

	Explosive range	Minimum ignition energy	Burning rate	Characteristics of the flame	Embrittlement	Energy density volume at atmospheric pressure
Hydrogène	**4 à 75 %**	**17 µJ**	**3,3 m/s**	**Flamme peu visible**	**Cracking/blistering/hydride formation with non-compatible steels**	10,8 MJ/m³
Hydrocarbons	**1 à 15 %**	**200 µJ**	**0,5 m/s**	**Flamme visible**	**-**	**Diesel 38680 MJ/m³** **Methane** 39,77 MJ/m³



Explosive clouds larger

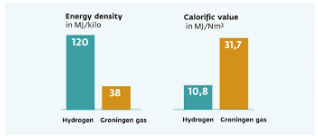


Inflammation Easier

Explosions more violent

Hardware specific Intervention

Steels Adapted



High-pressure bulky needed

CONCLUSION

While the French regulations emphasize obtaining mining titles and environmental authorization, Germany adapts its existing legal framework, and Great Britain incorporates multiple legislations to ensure safety and risk management.

Each country's regulatory approach reflects its unique legal system and priorities for hydrogen storage in salt caverns.

Underground hydrogen storage in salt caverns has the potential to play a significant role in European energy transition towards a decarbonized energy system.

However, as with any new technology, it is essential to carefully assess its potential risks and benefits to ensure that it can be safely and effectively deployed at scale. Although salt caverns have been operating for a long time, little information is available regarding subsurface equipment design and material selection versus the specific issues to be addressed with hydrogen and lessons learned.

Currently, there is no specific standard or regulation for underground hydrogen storage in salt caverns in Europe.

Hypster is a project funded by the European Commission - Project Number : 101006751


Thank you for your attention.
Institut national de l'environnement industriel et des risques
INERIS
controlling risks
for sustainable development

ACKNOWLEDGMENT

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101006751. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.