



WE MAKE THE EARTH THE BEST PLACE
FOR STORING ALL ENERGIES

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H₂ to achieve net zero: Why & how to store on a large- scale?





Content

- 1- Introduction of Geostock
- 2- What is the potential market ?
- 3- Underground storage techniques
- 4- Different ways to store H₂

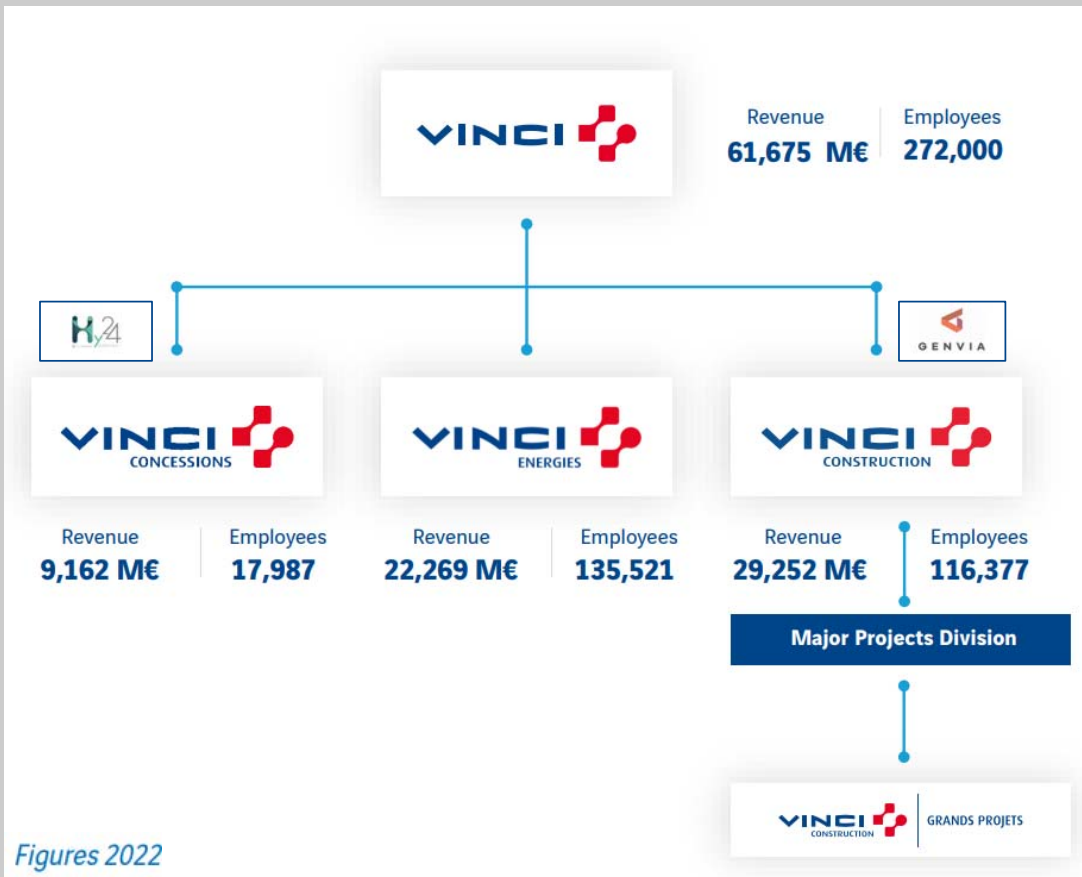




1- GEOSTOCK Introduction



VINCI Group organization

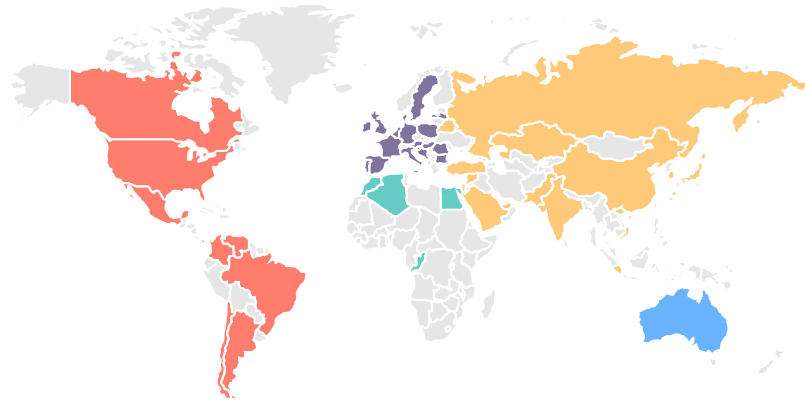


VINCI Construction Grands Projets (VCGP) is a subsidiary of VINCI group, global player in concessions, energy and construction

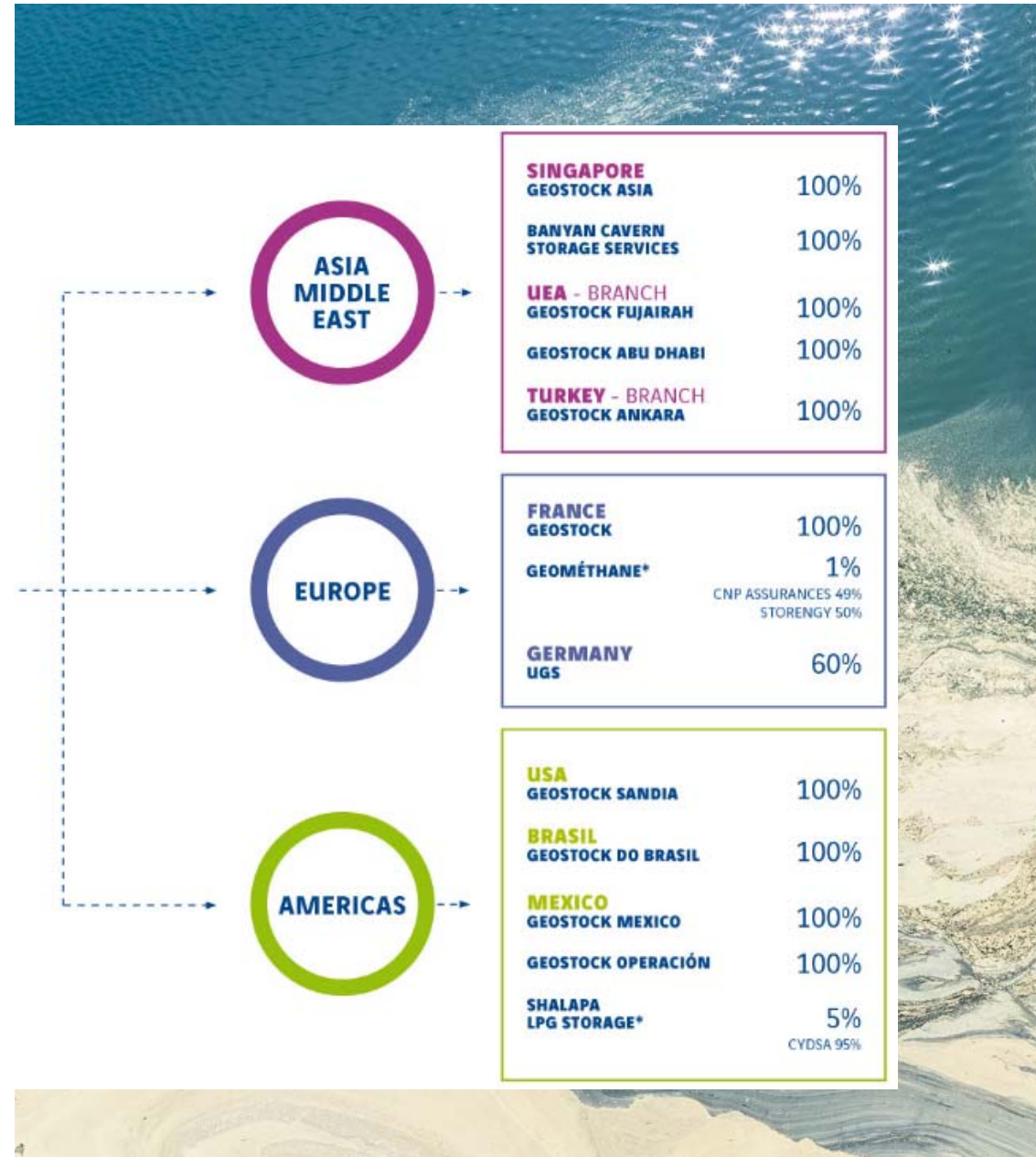
GEOSTOCK belongs to VCGP

Geostock group organization

A global presence



* Geostock owns minority shareholdings in underground storage assets operated by or in association with us.



Our Fundamental Commitments (QHSE)

Our SAFETY Objectives

0 **ZERO**
Severe Accident

0 **ZERO**
HIPO 1 or 2

Certification

ISO 9001 (QMS),
14001 Environmental
& 45001 (OH&S MS)

GEOSTOCK Green Storage Transformation Plan in 3 parts



OUR COMMITMENT

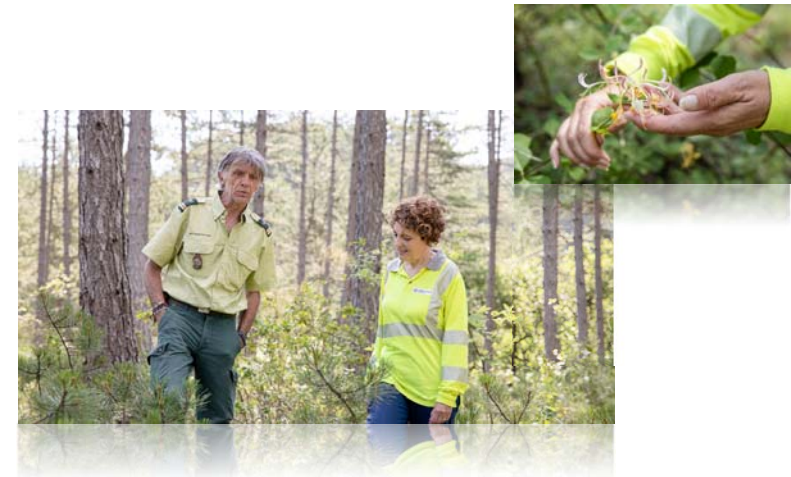
reduce by 40% our direct CO₂ emissions in 2030

SUSTAINABLE SOLUTIONS

Support our customers improving their Environmental Footprint

NET-ZERO SOLUTIONS

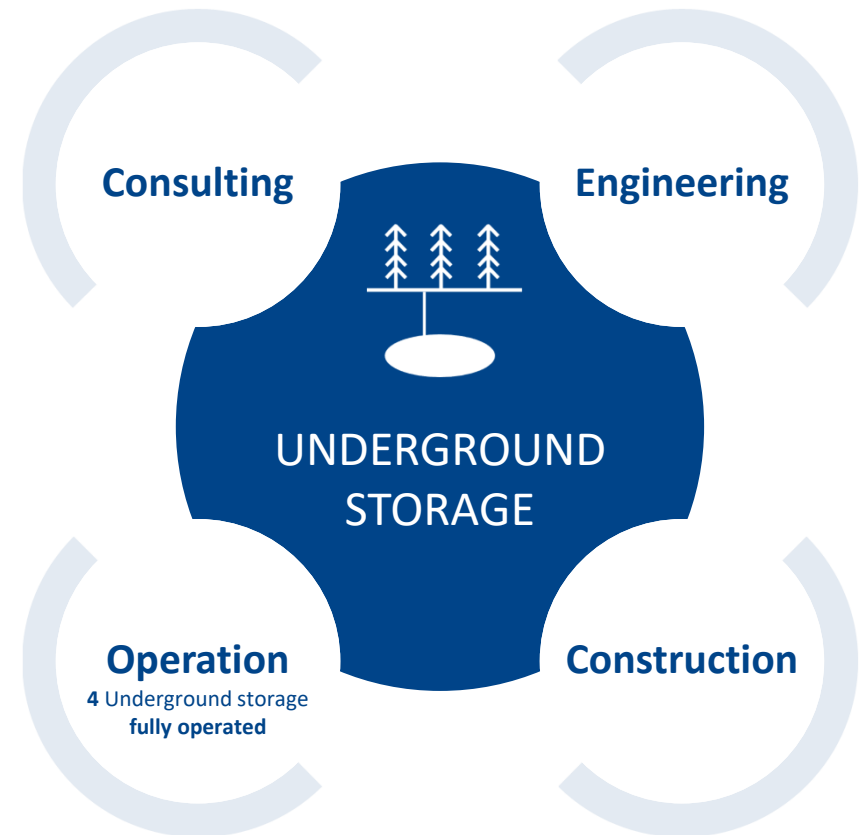
Promote Energy Transition through Decarbonized Energy Storage & CCUS



Underground Storage Excellence

- An **international Group**, more than 55 years of experience, nearly 500 employees
- We do: **Consulting, Engineering, Construction management, Operation & Maintenance**
- On **all Underground Storage Techniques** (Porous reservoir, Salt & Mined rock caverns)
- **For all energies** (Liquid, Liquefied and Gaseous Hydrocarbons, H₂, NH₃, Compressed air and CO₂)

A key player for **Underground Storages** for all energies



...BY RELYING

on the synergies between our services





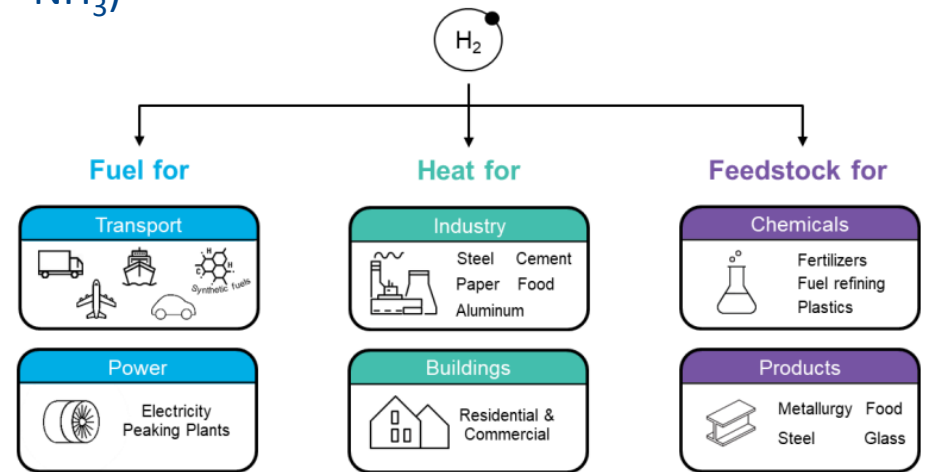
2- Different drivers for storage H₂ & H₂ market



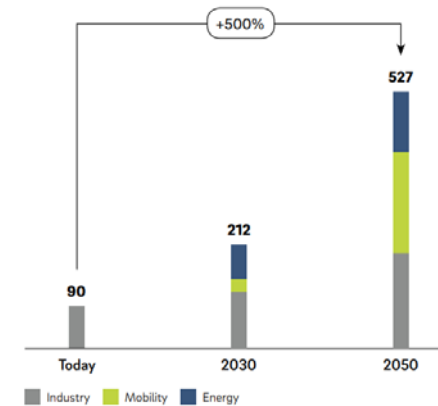
Today, The uses of many sources of Energy



Tomorrow, the many uses of H₂ (and its derivatives NH₃)



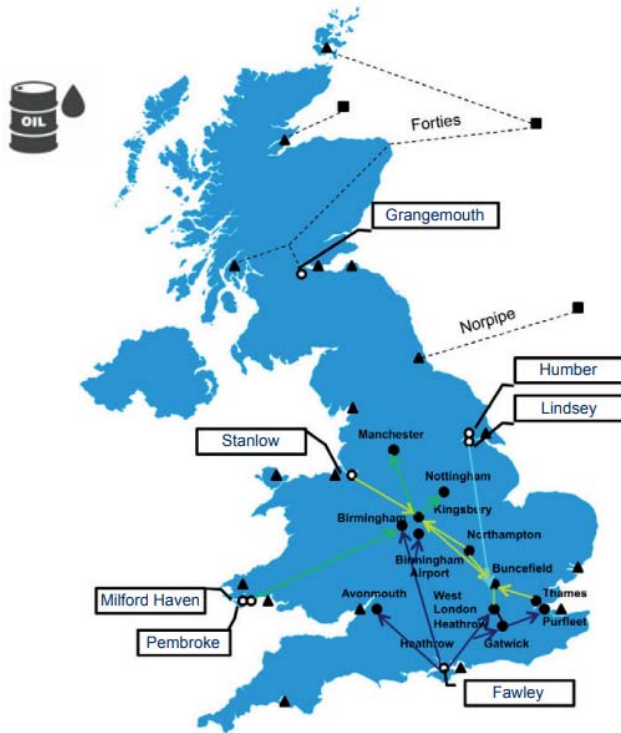
Source: BloombergNEF



Source: IEA, Roland Berber
H₂ consumption in the IEA's Net Zero Emission Scenario [Mt]

Other solutions to support the net zero transition : biofuels, e-fuels, green electricity, etc.
⇒ Focus on H₂ in the presentation

UK: Location of the current storages (Oil & Gas)



TODAY
Underground storage
and above ground
storage provide
comprehensive national
coverage

TOMORROW with H₂ ?



Underground storage

- Privately owned oil product pipelines**
- UK Oil Pipeline (Shell, BP, Valero, Total)
 - Mainline Pipeline System (Esso, Valero, Total, Shell)
 - Walton-Gatwick Pipeline (BP, Shell, Valero)
 - West London Pipeline (BP, Shell, Valero, Total)
 - Esso Pipeline
 - Fina-line (Total)
- Crude oil pipeline**
- Crude oil pipeline
 - ▲ Tanker terminal
 - Oil rig
 - Refinery
 - Distribution terminals

Source: Deloitte based on UK PIA Statistical Review 2012 (p. 9) and Finding an unusual suspect (p. 34) by BP



Different drivers for hydrogen storage

Robust supply chain	Continuity of supply in the event of failure/maintenance of H ₂ production equipment – especially for sales to industries
Balance energy supply	To meet the daily & seasonal fluctuating needs (domestic - heating, industry, etc..)
Energy resilience	Strategic stocks to provide national energy security & resilience
Energy security	To balance H ₂ produced with intermittent renewables Vital in a world of ever-increasing EnR capacity
Power generation	Renewable electricity generation is intermittent. During low generation supplied maintain by CCGT with the use of H ₂ instead of NG
Arbitrage	Optimisation of production according to the cost and availability of electricity (erasure or resale surplus)
Efficiency of CCUS	With H ₂ storage, CCUS enabled H ₂ plants can operate at a constant high load capacity



Massive storage infrastructure will be needed to deliver H₂ at scale VISION by 2030

Assumption : **5%** Storage Capacity

PRODUCTION CAPACITY

10 GW of Electrolyzers

(British Energy Security Strategy, 2022)

STORAGE CAPACITY

20 to 40 Caverns



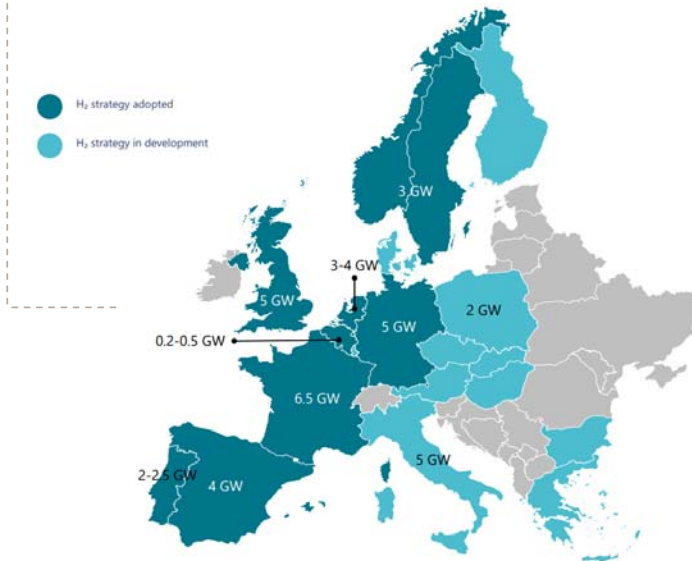
PRODUCTION CAPACITY

40 GW of Electrolyzers

(European Commission, 2020)

STORAGE CAPACITY

125 to 250 Caverns



PRODUCTION CAPACITY

(Hydrogen Council, 2021)

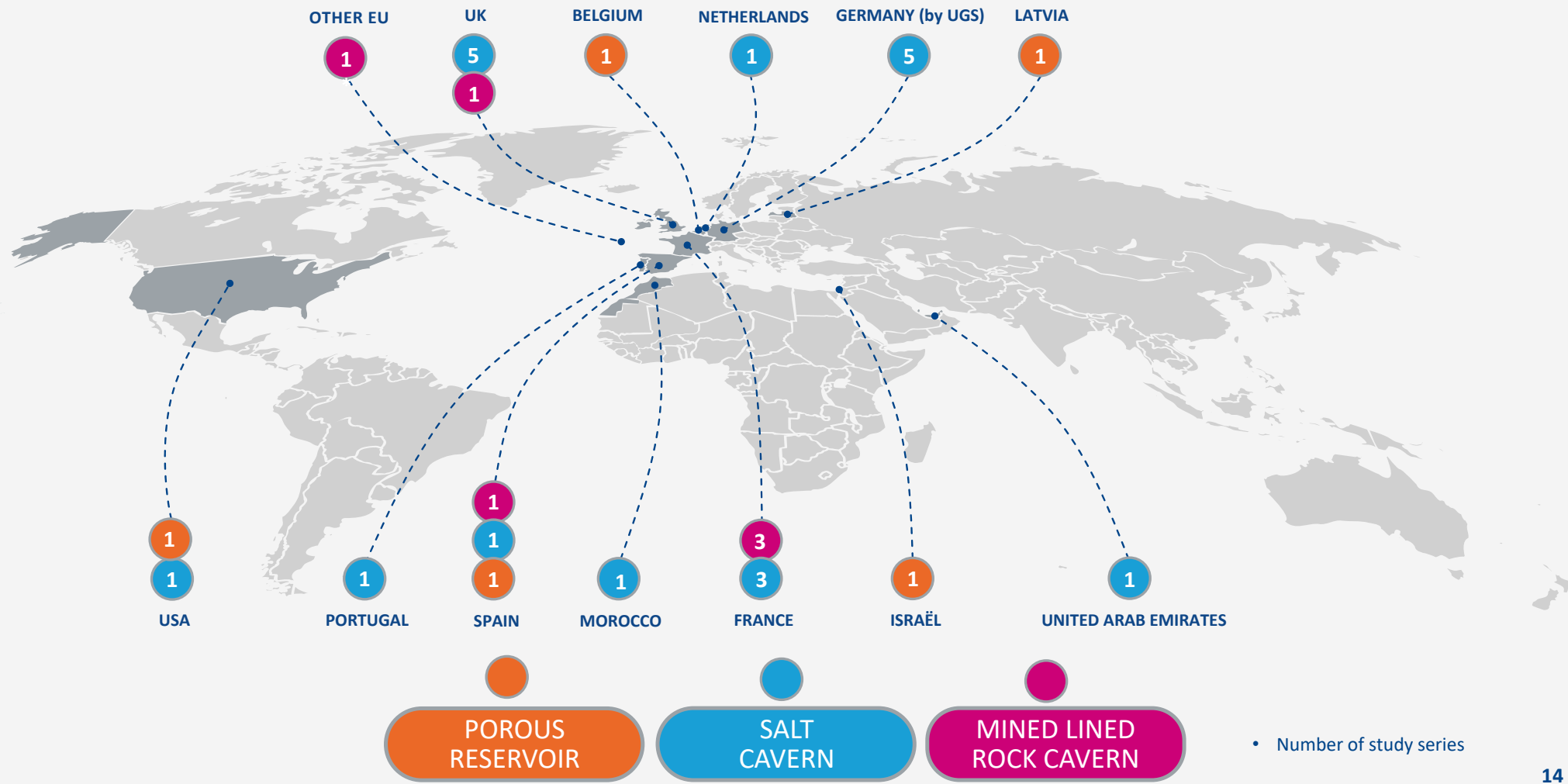
STORAGE CAPACITY

> 400 Caverns



Acceleration in demand for H₂ underground storage

REFERENCES IN HYDROGEN STORAGE (2020- March 2024)

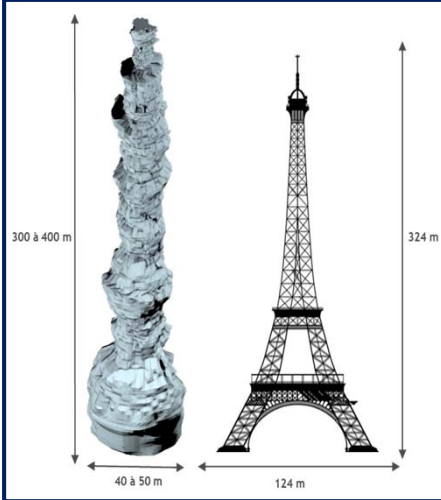
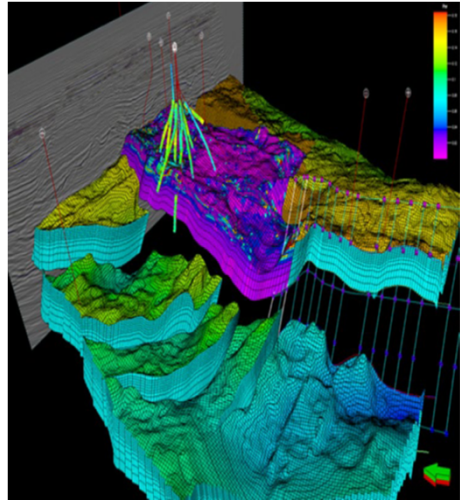




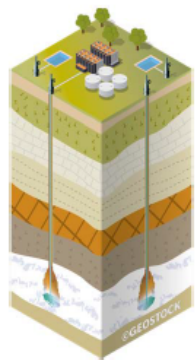
3- Underground storage techniques



Underground Storage Techniques

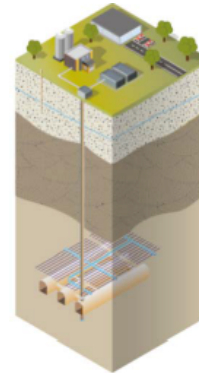


Underground Storage Techniques



SALT CAVERNS

Natural Gas
Liquid Hydrocarbons
Liquefied Hydrocarbons
Compressed Air
Hydrogen



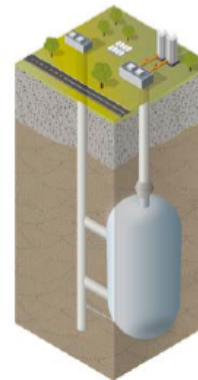
MINED ROCK CAVERNS

Liquid Hydrocarbons
Liquefied Hydrocarbons
Ammonia
Compressed Air



DEPLETED FIELDS & AQUIFERS

Natural Gas
Compressed Air
Hydrogen
CO₂ (sequestration)



LINED MINED ROCK CAVERNS

Natural Gas
Hydrogen
Compressed Air
Ammonia
CO₂ (buffer)

GEOSTOCK is the only Underground Storage Engineering addressing all the underground storage techniques



Underground storage advantages



- Cost effective (CAPEX & OPEX)
- Almost ever-lasting
- Low maintenance

- Environmentally friendly
- Reduced footprint
- No visual impact
- Social impact reduced

- Secure
- Safe
- Earthquake resistant

Geostock expertises in house: from design to operation

Consulting & Engineering

- Preliminary studies
- Site selection
- Prefeasibility
- Site investigation
- Feasibility
- Basic Design / Front-End Engineering Design

Construction Management

- Project management
- Permitting engineering
- Supervision of detailed design
- Selection of contractors and suppliers
- Construction supervision
- Tests, commissioning and start-up
- Training of operators
- Preparation of operating documents

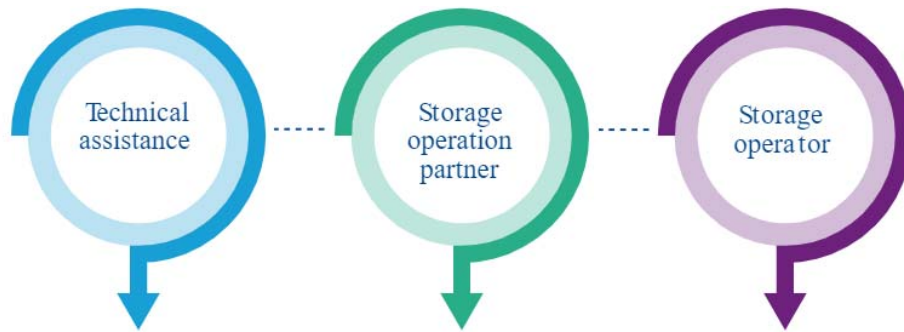
Operation & Maintenance

- Operation
- Maintenance of facilities
- Subsurface monitoring
- Subsurface Integrity Management
- Decommissioning



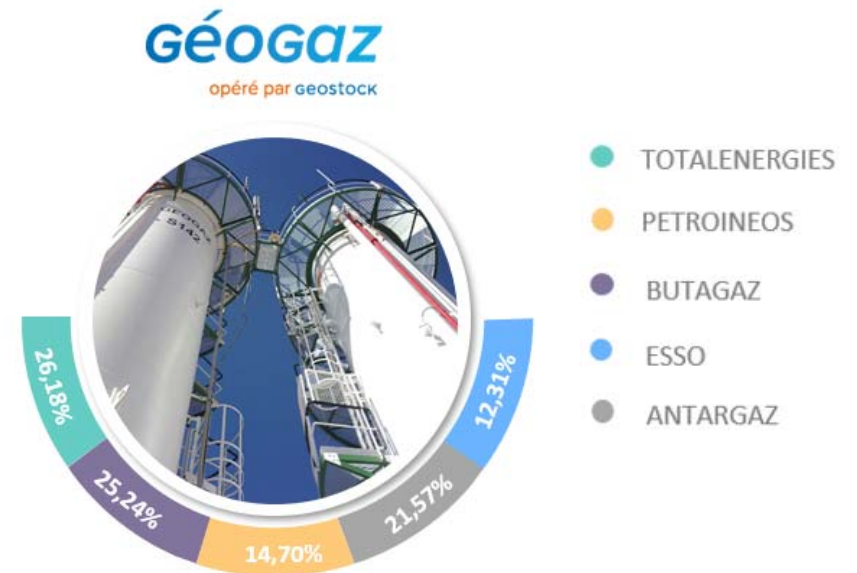
Operation of underground storage

A complete range off services



Geostock operates several storages & provides technical assistance and consultancy services worldwide

Example of an operated & managed site since more than 50 years (LPG mined cavern)





4- Different ways to store massive quantities of H₂



How to Store H₂? and why go underground?

■ Storage capacity (tons)

■ Cost / m³



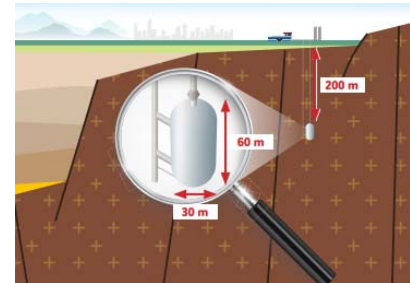
■ 4 t

■ High



■ 200 t

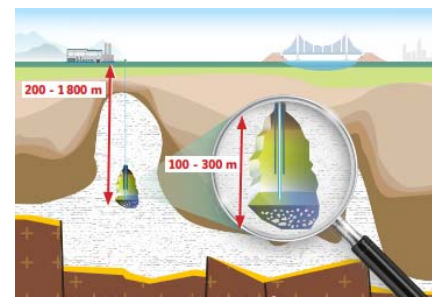
■ Medium



Lined Mined Rock Cavern

■ 500 – 1000 t

■ Medium



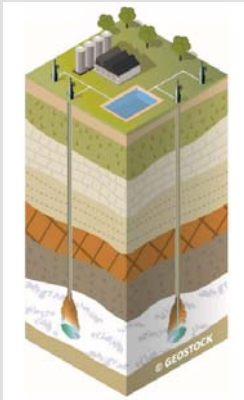
Salt Cavern

■ > 3 000 t

■ Low



Solution 1: Salt cavern – Existing H₂ storage



SALT CAVERNS

- Liquid & Liquefied Hydrocarbons
- Natural Gas
- **HYDROGEN**
- Compressed Air & Effluents

MOST COMMON TECHNIC FOR H₂ UNDERGROUND STORAGE

- No Technical Show Stopper
- Nearly 2 000 existing storage Salt Caverns Worldwide
- 50 years industrial experience with up to 6 Hydrogen Caverns (incl. 3 in the UK)



- Large volume, up to 1 000 000 m³
- Working gas up to 10 000t
- High flowrate
- Cost
- Conversion of existing salt cavern storage can be studied case by case



- Required geology not available everywhere
- Water for salt leaching
- Brine disposal
- Cushion gas (but potentially recoverable)

Solution 2: Porous media for hydrogen storage



DEPLETED FIELD & AQUIFERS

- Natural Gas
- Compressed Air, CO₂
- **HYDROGEN**

SOLUTION TO STORE MASSIVE VOLUME OF HYDROGENE

- Very common technique for Natural Gas storage
- Could be in depleted Oil/Gas fields or in saline aquifers
- Operated between 60 bar and 200 bar

 **hystories** Geostock, as the Project Leader



- Very large volume, average 500 millions Sm³
- Working gas capacity around 45 000t
- Cost



- Required geology not available everywhere
- High cushion gas, not recoverable
- Integrity of product quality (microbiological activity) to be checked on case by case basis



Solution 3: Lined Rock Caverns for hydrogen storage



LINED ROCK CAVERN

- Natural Gas
- Liquid & Liquefied Hydrocarbons
- **HYDROGEN**

UNDERGROUND STORAGE IN THE HEART OF THE INDUSTRIAL CLUSTER

- More flexible from a geological point of view to be located in the heart of industrial clusters
- Agile, highly responsive and accurate

A unique know how in Rock Cavern : For more than 50 years, Geostock has been involved in 30% caverns commissioned or under construction, worldwide.



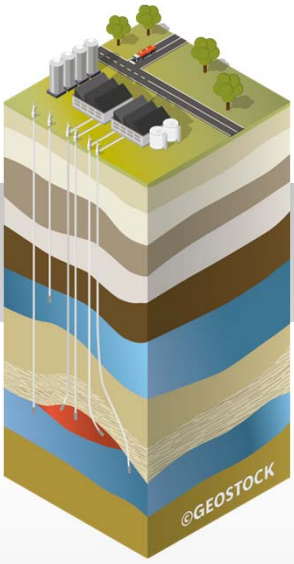
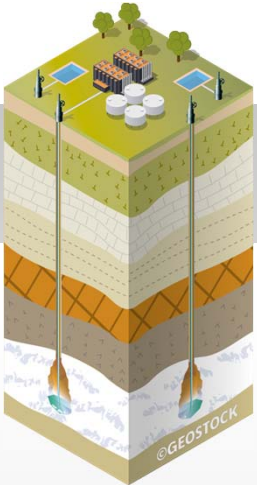
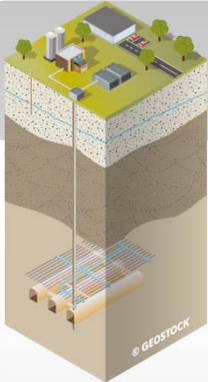
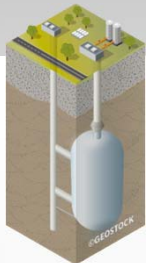
- Can be done almost everywhere
- High flowrate & Flexible storage
- Low volume of cushion gas
- Suitable for NH_3 , CO_2



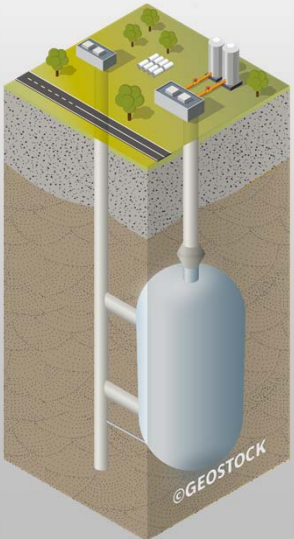
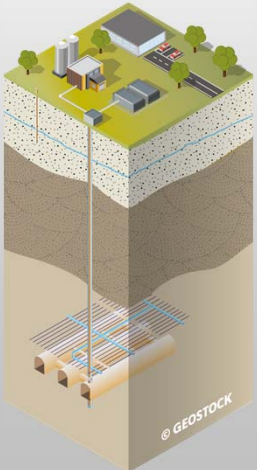
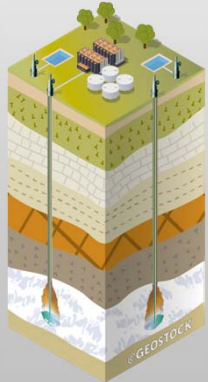
- Cost
- Liner choice to be optimised

Key takeaway

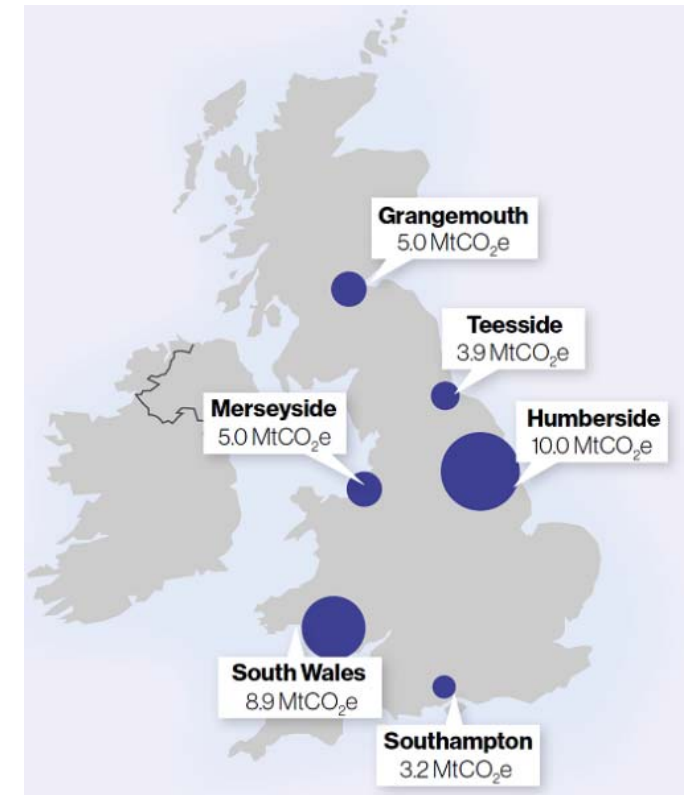
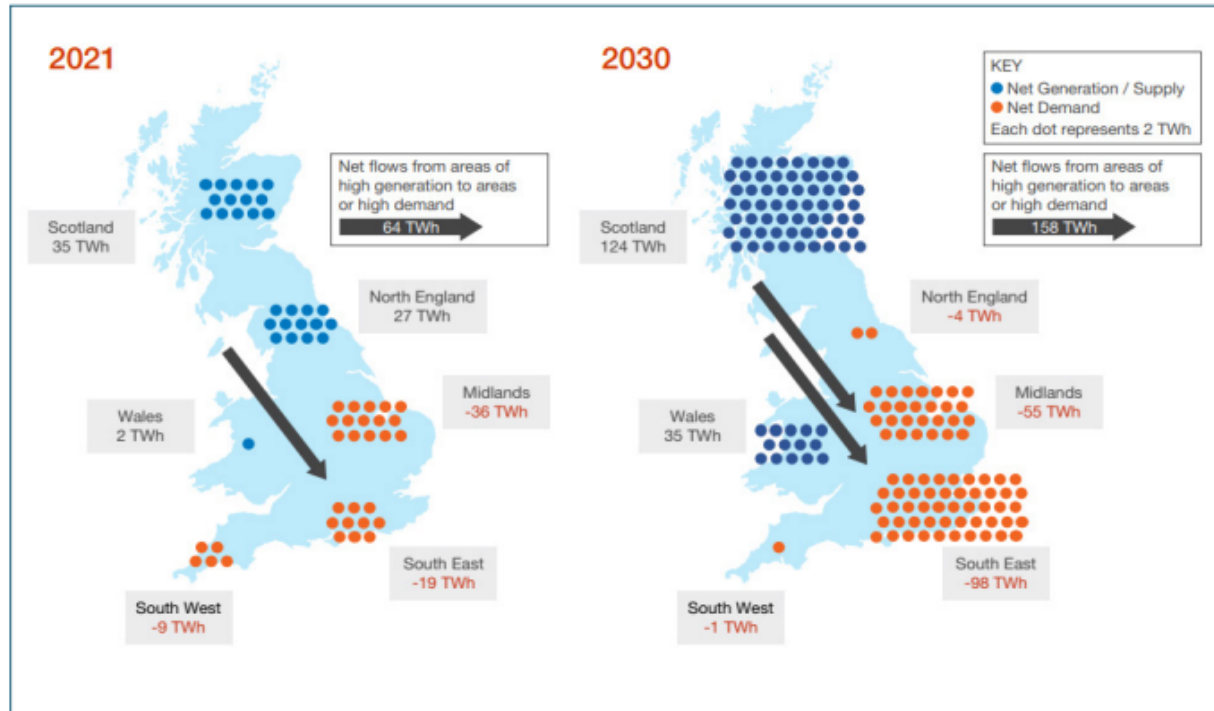
VOLUMES



CAPEX



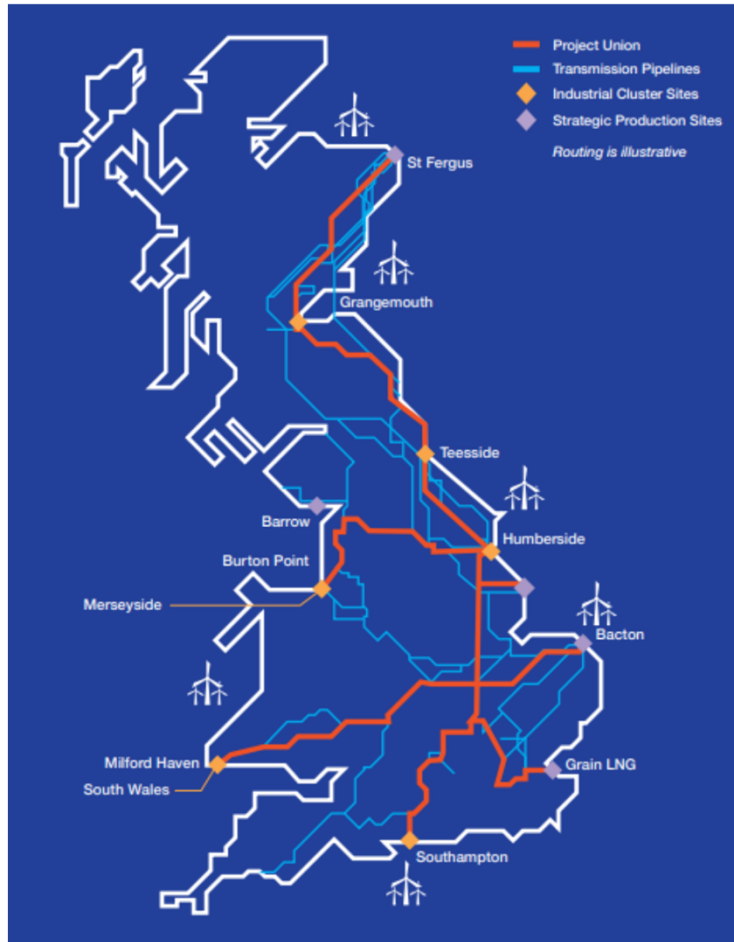
Geographical disparity between H2 production and industrial emissions



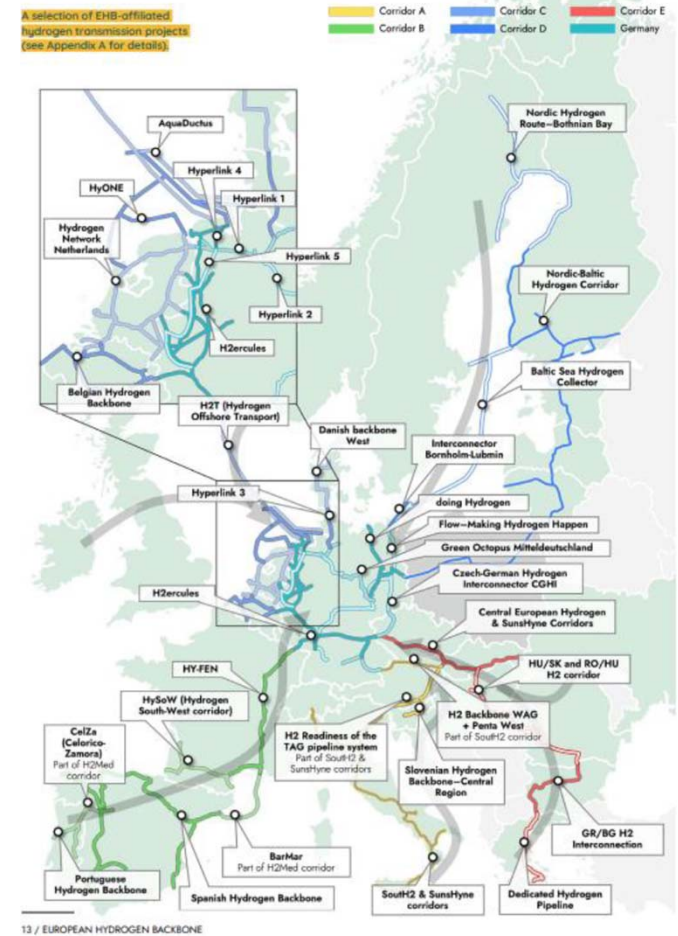
[Hydrogen Networks Recommendations from Hydrogen UK 1675337272.pdf](#)



Geographical disparity: role of the H2 backbone



<https://www.nationalgas.com/document/>



<https://ehb.eu/files/downloads/EHB-2023-20-Nov-FINAL-design.pdf>



Thank you



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