

Storage and the development of global hydrogen markets.

New ties - Deep dive into the technical challenges and the required legal framework

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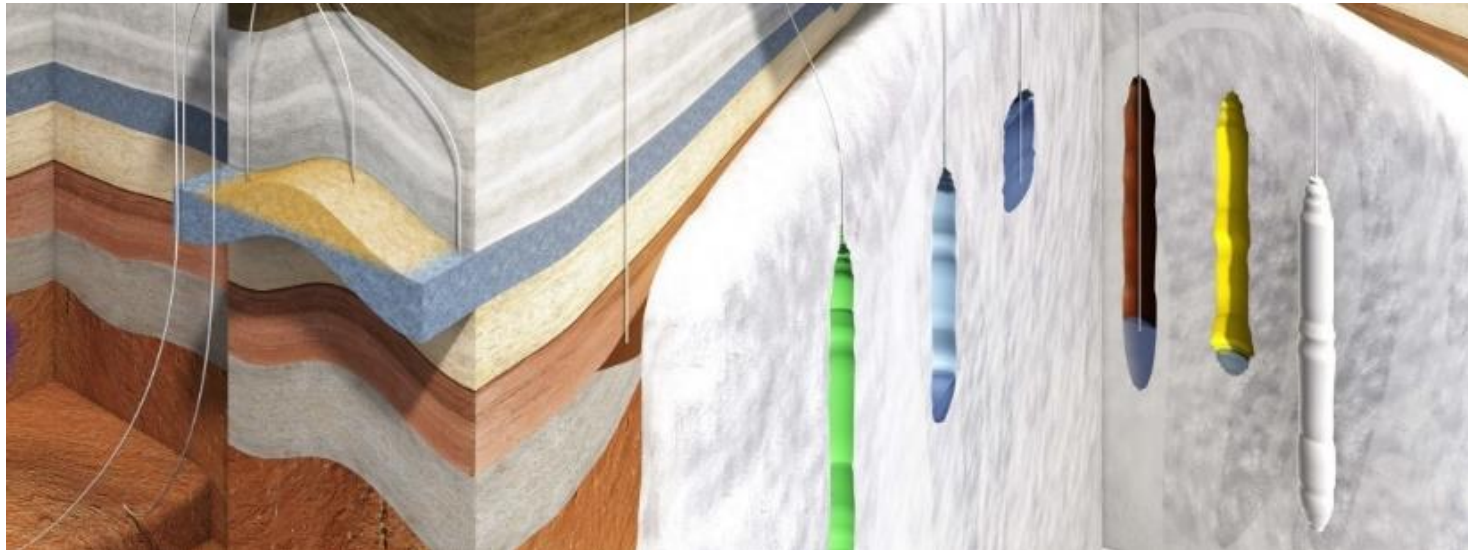
World Hydrogen Congress | Amsterdam, Netherlands |
04 - 06 October 2021

 GreenbergTraurig

 **DEEP.KBB**

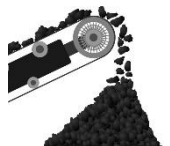
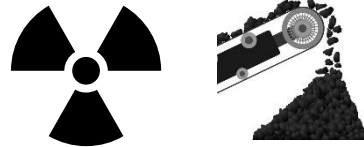
- Change of energy system
- Technical and Legal Implementation
- New Ties for a Global Hydrogen Network

CHANGE OF ENERGY SYSTEM



Change of Energy System

Different Sectors



Energy demand extends to **various sectors**

Use of **various energy carriers**

Mostly **independent** of each other

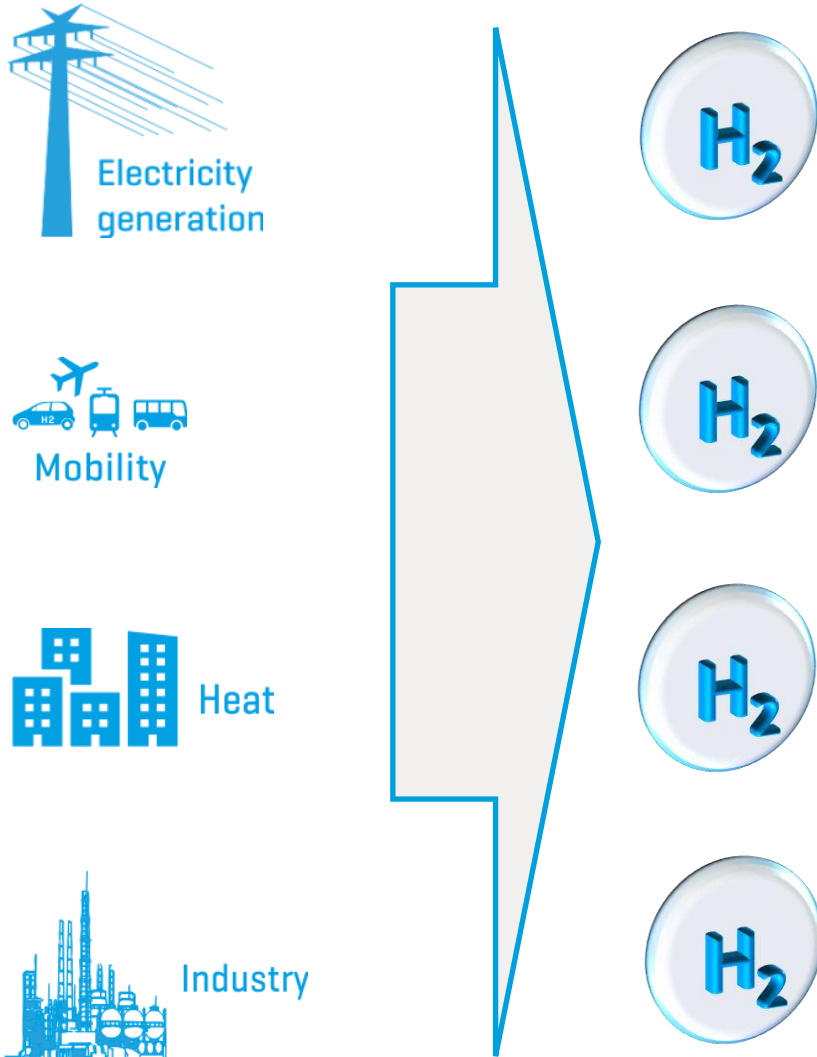
Conventional energy carriers are responsible for **90% of CO₂ emissions**

Legal requirements for **CO₂ reduction**

Decrease of conventional energy carrier leads to a **need for a replacement**

Hydrogen as renewable energy carrier

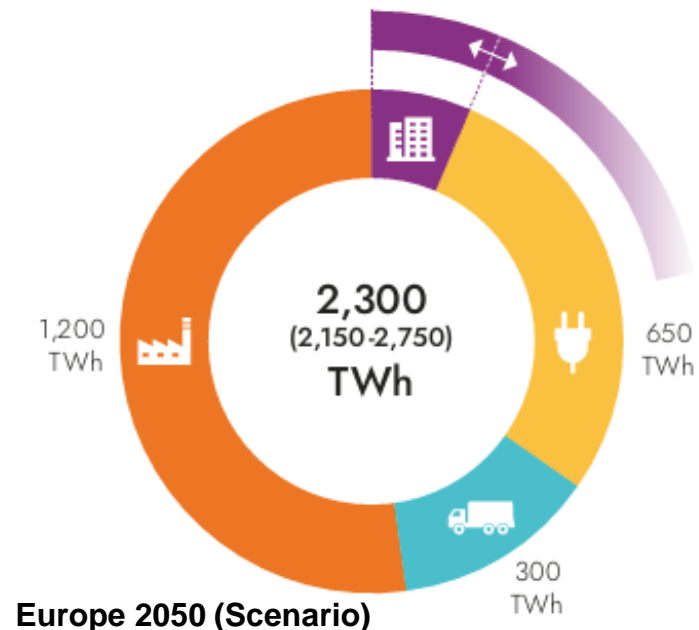
Hydrogen Use(r) Different Sectors



Use of **hydrogen as only energy carrier**

Interdependencies to be expected

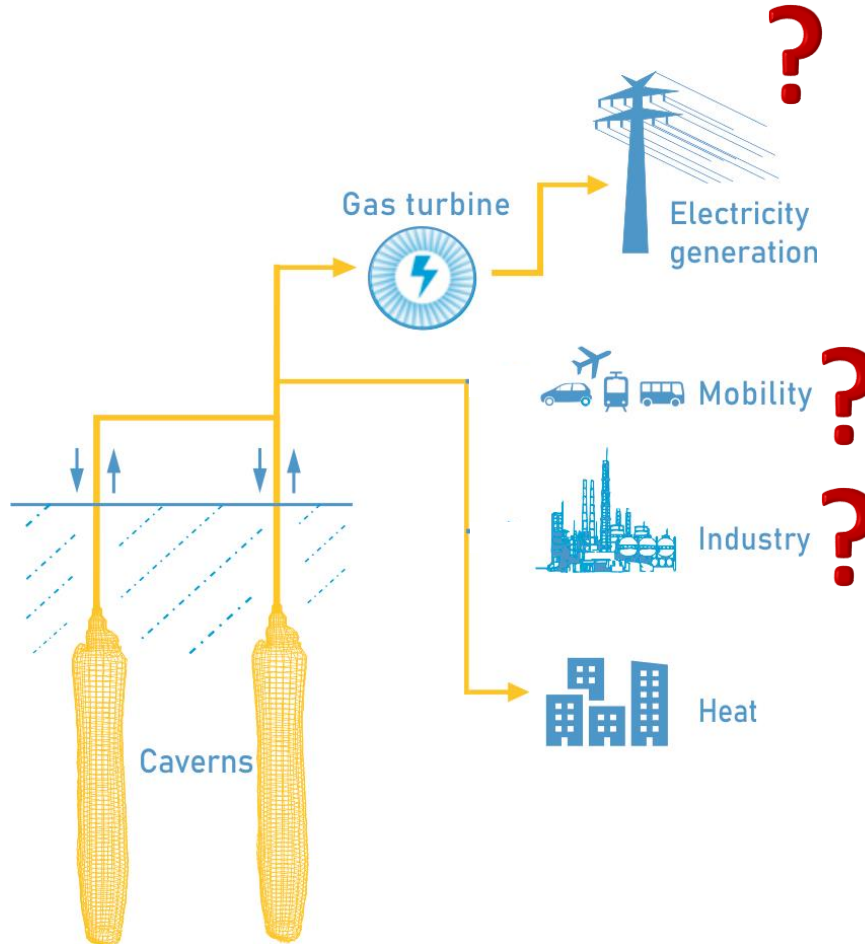
High demand for hydrogen



Source: European Hydrogen Backbone, Analysing future demand, supply, and transport of hydrogen, June 2021

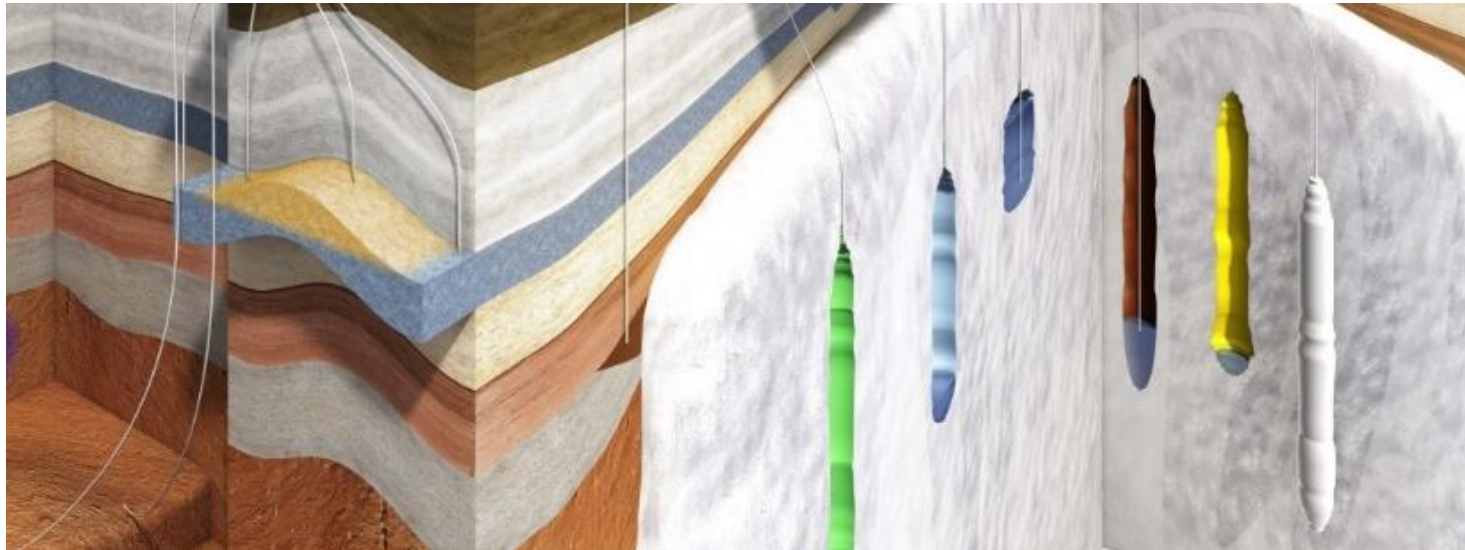
Current Gas Network

Possible Use of Existing Infrastructure

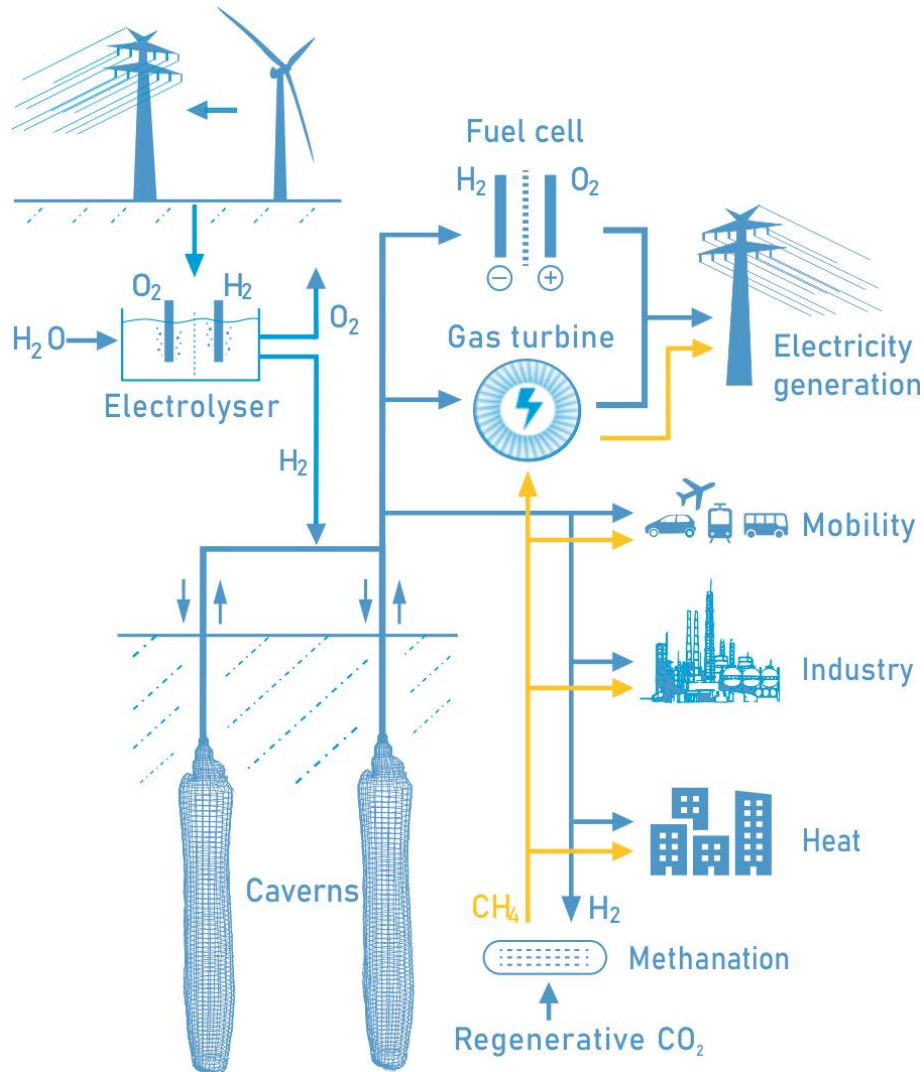


- Transmission and distribution via pipelines and existing local infrastructure
 - Technical retrofitting?
- Transition phase
 - Blending of natural gas and hydrogen?
 - Methanation?
 - All kinds of hydrogen production methods?
- Balancing of supply and demand
- Sector coupling

TECHNICAL AND LEGAL IMPLEMENTATION



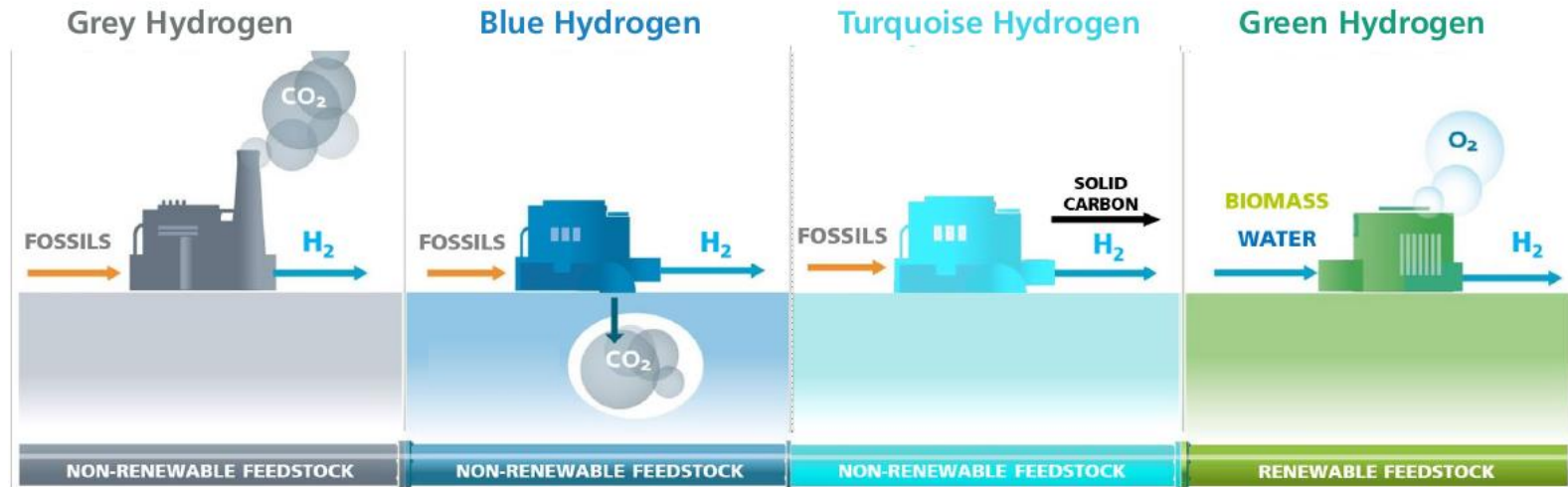
Sector Coupling Via Hydrogen



- Development of a complex hydrogen network via sector coupling
- No specific sector-related user chain, but a cross-sectoral user network with different requirement profiles of the users
- Increasing number of consumers and user agglomeration

Hydrogen Production and Demand

Categorization of different production methods:



Input from:



Output to:



Varying volatility in production and demand

Hydrogen Storage and Distribution

- Production, storage, distribution and use of hydrogen

- Volatility requires grids and storage

Country	Hydrogen demand 2030 ⁶²	Hydrogen demand 2050	Hydrogen storage need 2030 ⁶³	Hydrogen storage need 2050	Potential hydrogen storage capacity—salt caverns	Potential hydrogen storage capacity—all types
Germany	66.9	470.0	15.9	111.4	39.5	61.4
Netherlands	26.6	133.4	6.3	31.6	0.9	34.6
Total	304.5	1,968.1	72.2	466.4	50.0	264.7

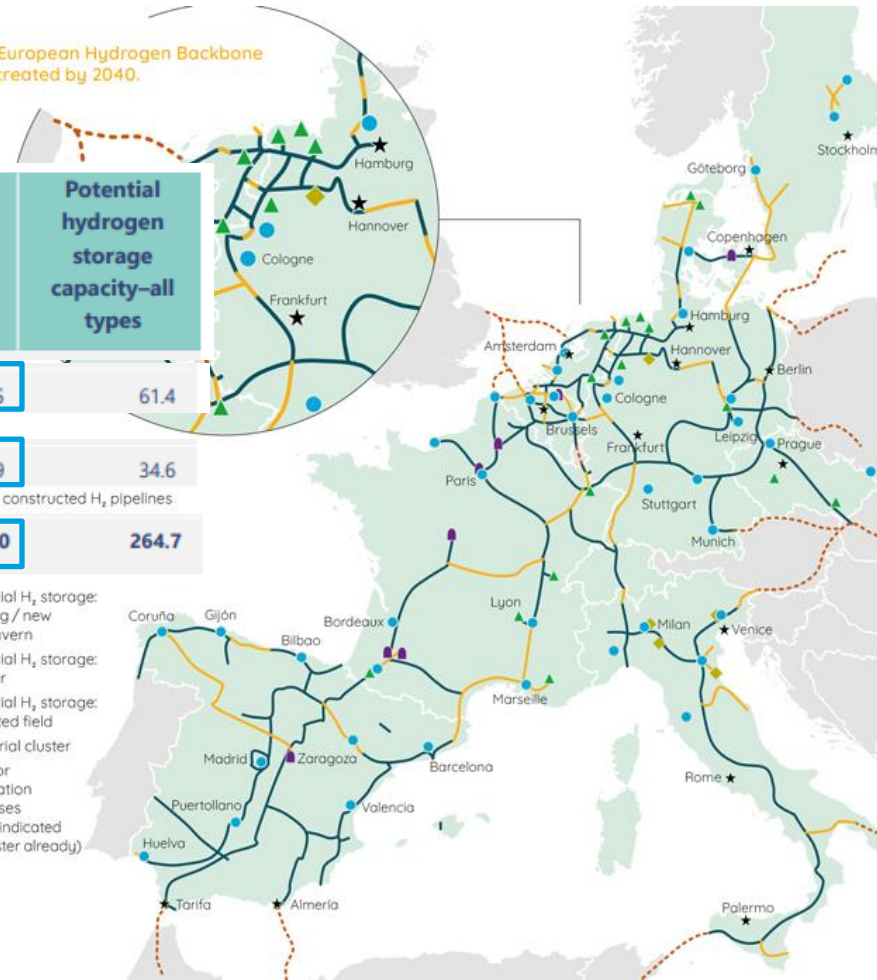
Reference: gie, June 2021, in TWh

- Expected storage need requires large-scale energy storage
- Hydrogen storage in the geological underground?

Mature European Hydrogen Backbone can be created by 2040.

Newly constructed H₂ pipelines

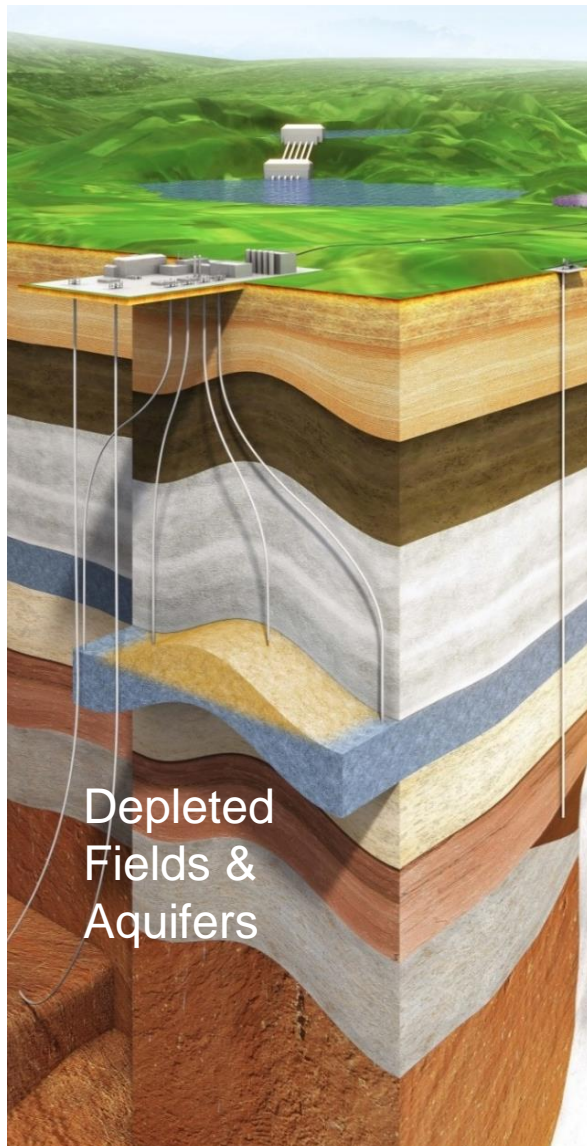
- ▲ Potential H₂ storage: existing / new salt cavern
- Potential H₂ storage: Aquifer
- ◆ Potential H₂ storage: Depleted field
- Industrial cluster
- ★ City, for orientation purposes (if not indicated as cluster already)



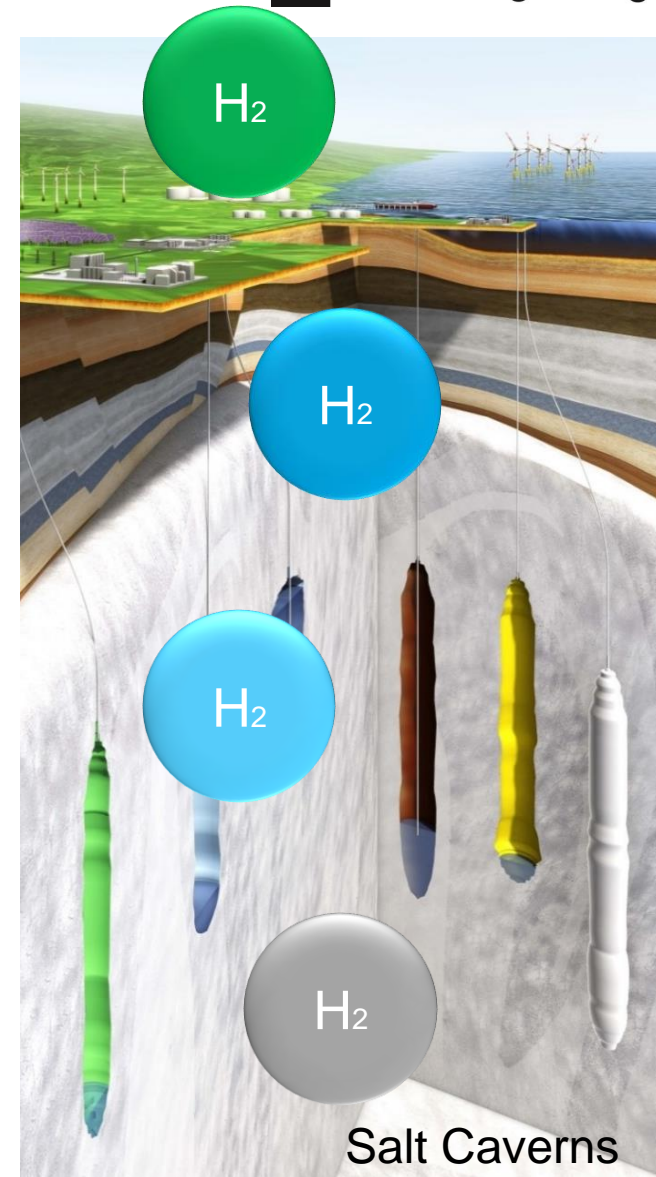
Source: European Hydrogen Backbone, July 2020

Hydrogen Storage

Advantages Large-Scale Underground Storage

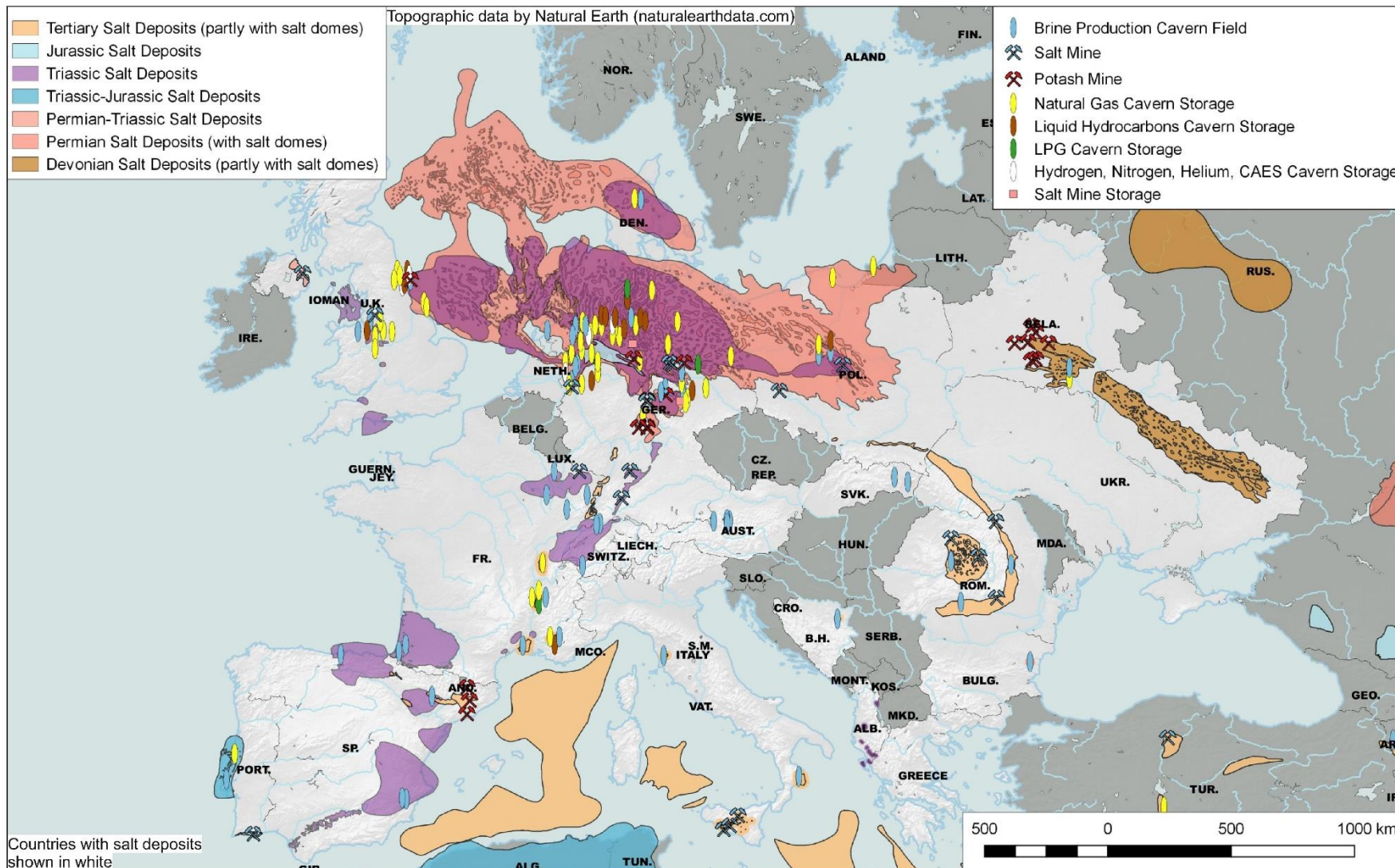


- Safety
- Extremely large storage volume
- Very high pressures possible
- Little land consumption
- Low specific invest costs (€ / m³)
- Already existent
- Longtime experience with large-scale gas storage
- Proven technical feasibility for salt caverns
- ...and colorblind



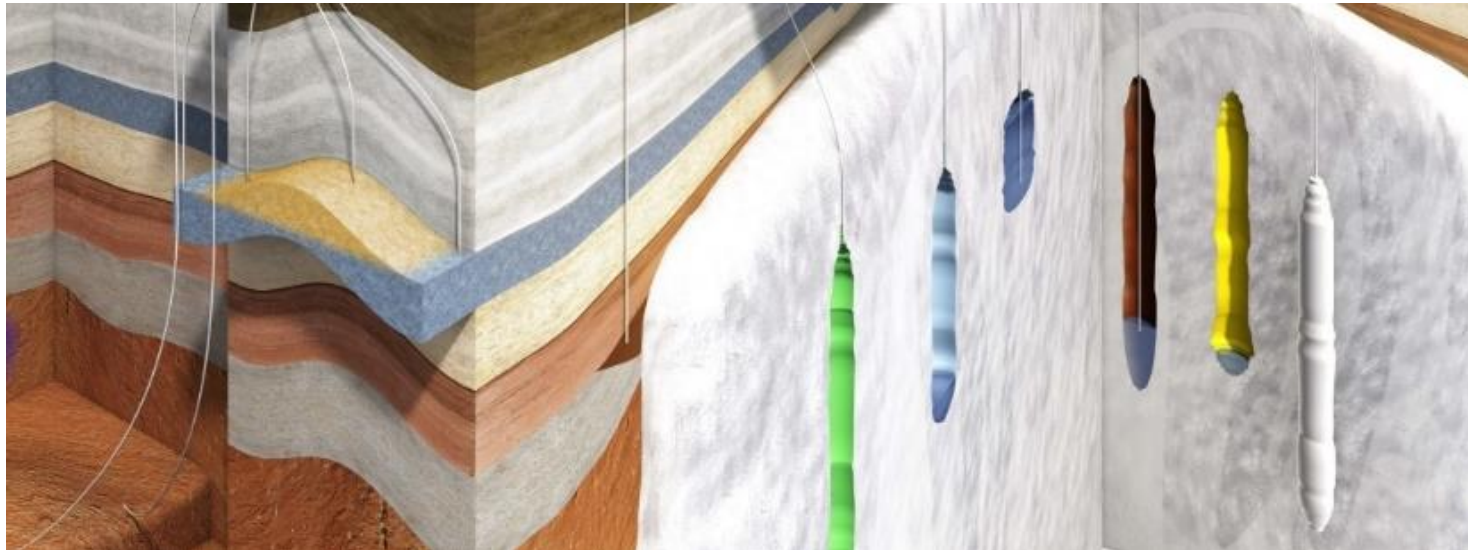
Hydrogen Storage

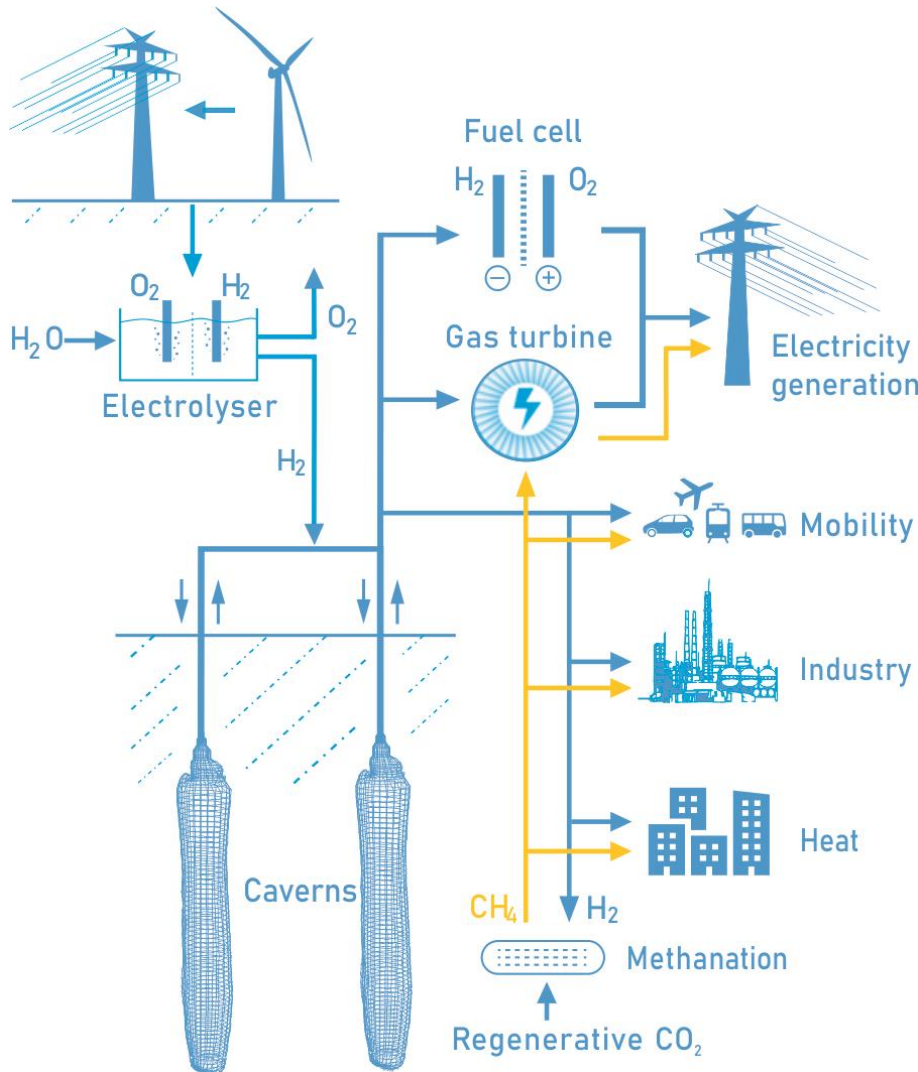
Salt in Europe: Hydrogen storage hubs of tomorrow!



Source: Solution Mining Research Institute (SMRI)

NEW TIES FOR A GLOBAL HYDROGEN NETWORK





- Porous storage uncertain due to possible chemical and microbiological reactions and processes

But

- Injection of 100% hydrogen /methanised hydrogen (CH_4) in existing natural gas grid
- Transmission and distribution via pipelines and existing infrastructure
- Large-scale hydrogen storage in existing salt caverns to balance fluctuations in supply and demand

=> **Technically possible**

=> **Legal framework!?**

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