Underground Sun Storage

Methane Electrolysis

Siegfried Kiss
Head of BD,
Authorized Representative

AUSTRIA AG
Renewables and Gas

RAG´s Underground Gas Storages are key for security of supply in Europe

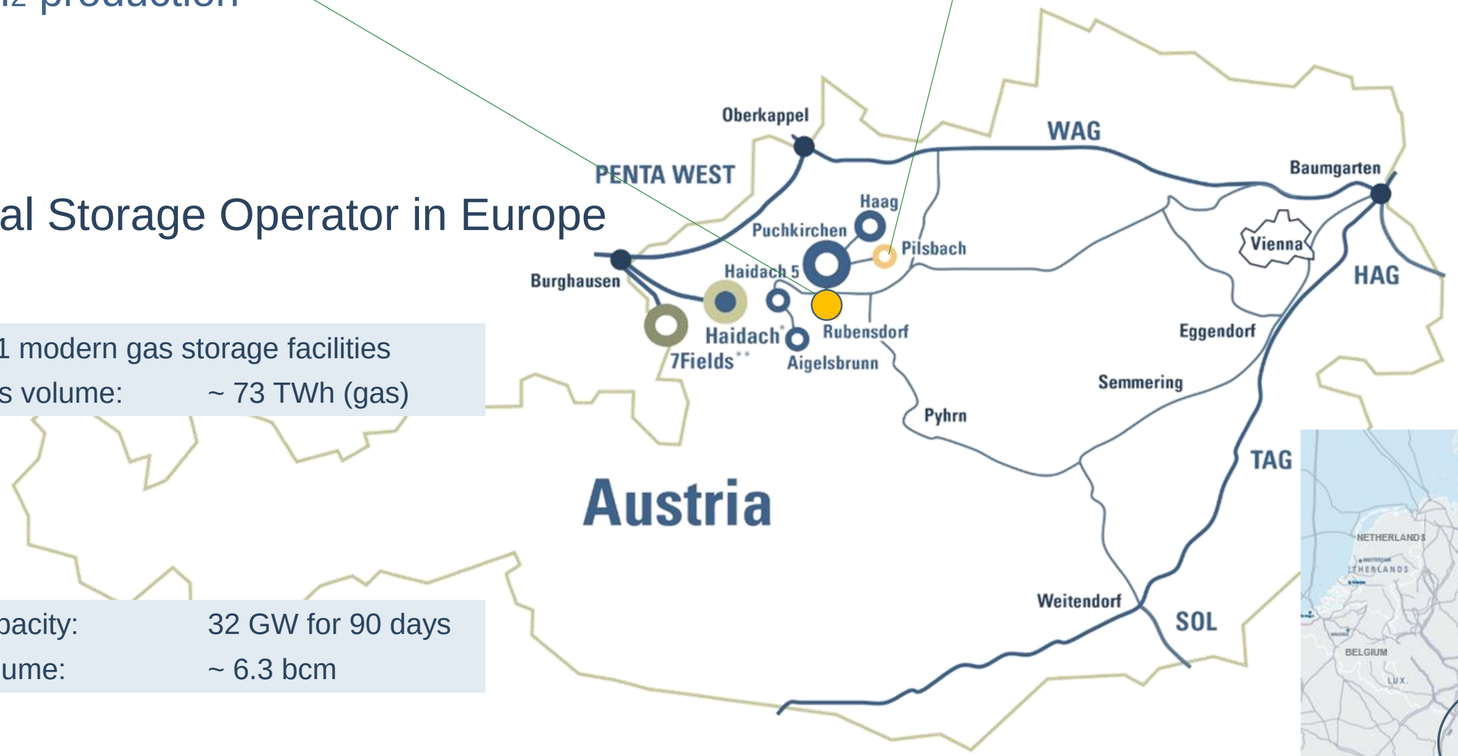
UHS Rubensdorf 2023

2 MW H_2 production

CH_4/H_2 Storage (since 2015)

0.5 MW H_2 production

4th largest technical Storage Operator in Europe



- RAG operates 11 modern gas storage facilities
- Total working gas volume: ~ 73 TWh (gas)

- RAG storage capacity: 32 GW for 90 days
- RAG storage volume: ~ 6.3 bcm

History:

1935 Mobil & Shell Oil EP
(since 2007 out)

1970.. Gas production

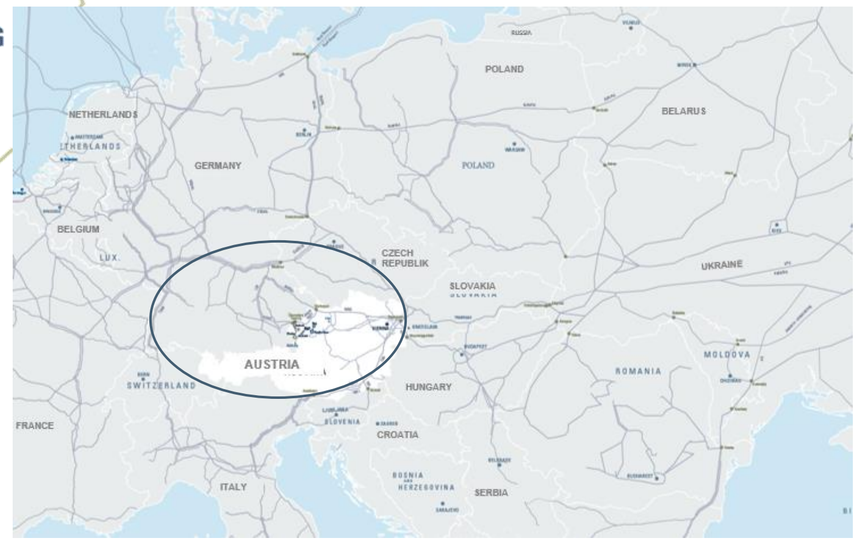
1992 UGS for market
(50% of all reservoirs volumes converted)

2015 UH/GS field test

2023 UHS 100% H_2

2024 Methane Plasmalysis

2025 H2EU+store



Gas storage volume in EU ~100 bcm (~80% porous, ~20% caverns)
~500 GW capacity in NG

Siegfried Kiss

- PORR Group - Special civil engineering and site remediation
- RAG Austria since 2005 (**R**enewables **A**nd **G**as)
  - Authorized Representative and
  - Head of Business Development – Underground Gas Storage

Mining University of Leoben (Austria) – Petroleum Engineering

K – Keep
I – It
S – Short
S – Simple

RAG UGS I UHS

UGS Puchkirchen

UGS Haag

UHS Pilsbach

UGS Aigelsbrunn

UGS Haidach 5

UHS Rubensdorf

RAG Joint Venture UGS

Haidach (RAG I SEFE)

UGS Haidach

7 Fields (RAG I Uniper)

UGS Nussdorf

UGS Oberkling

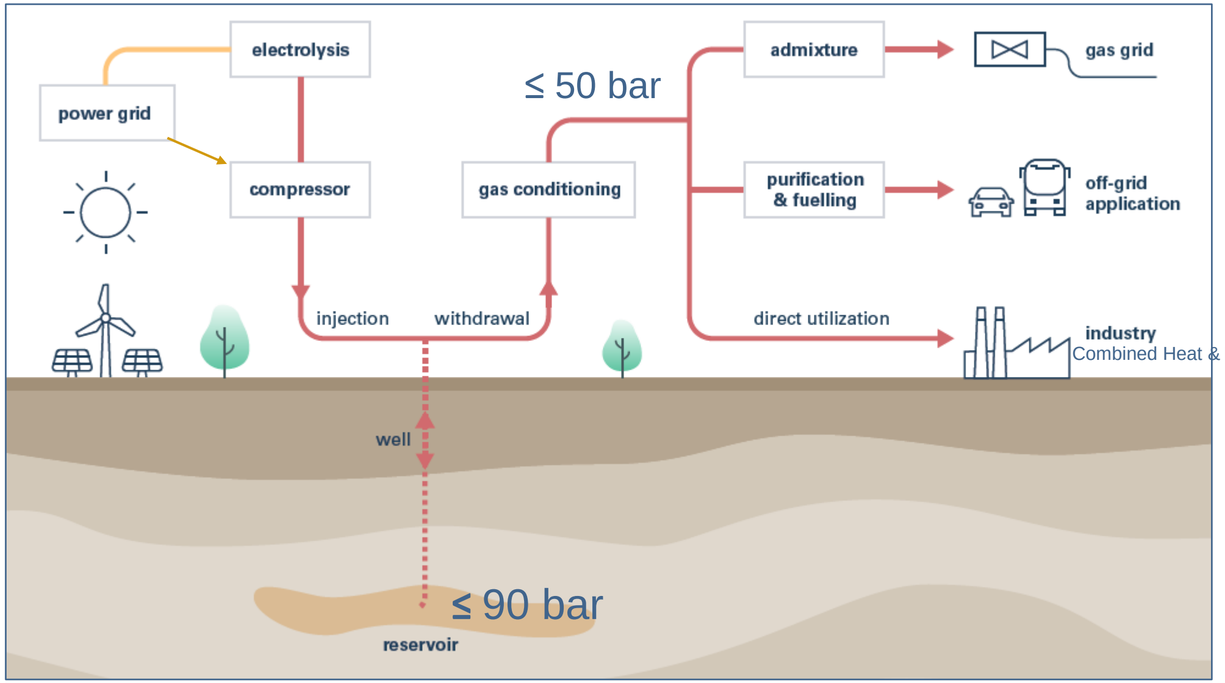
UGS Pfaffstätt

UGS Zagling

UNDERGROUND SUN.STORAGE 2030

Demonstration Project

RAG AUSTRIA AG



- Depleted natural gas reservoir
  - TOV: 1.2 mn Nm³
  - ~1000 m depth, sandstone
  - 90 bar hydrogen pressure
- 2 MW water-electrolysis (PEM)
- Integration into RAG plants in 2023
  - newly built 8 km Hydrogen Pipeline (PN70 operating pressure ≤ 50 bar)
  - Hydrogen CHP
  - Green Heat & Power for RAG winter demand

Partner: axiom, BOKU Universität für Bodenkultur Wien, ENERGIE AG Oberösterreich, ENERGIE INSTITUT an der Johannes Kepler Universität Linz, EVN, HyCentA Hydrogen Center Austria, K1 MET metallurgical competence center, TU WIEN Technische Universität Wien Vienna University of Technology, Verbund, voestalpine EINEN SCHRITT VORAUS., WIVA P&G Energy Model Region

powered by klima+ energie fonds

RAG Austria is a global pioneer in H_2 storage projects

UNDERGROUND SUN.STORAGE

10% H_2 (2013/17)

UNDERGROUND SUN.CONVERSION

$H_2 + CO_2 => CH_4$ (2017/21)

Function in the energy market:

- H_2 Production Storage
- H_2 Saisonal Storage

H_2 production technology:

- Water-Electrolysis

UNDERGROUND SUN.STORAGE 2030

100% H_2 (2021/25)

Hydrogen storage technology innovation:

- Development of underground H2 storage facilities since 2013
- Milestone in 2023 with the opening of the world's first 100% hydrogen storage facility in a porous subsurface reservoir
- RAG Austria has a clear transformation plan for the storage portfolio
- 3.2 TWh of H2 storage capacity to be realized for AT and DE by 2030

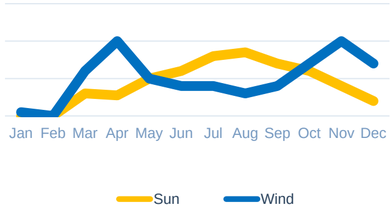
Necessary framework conditions:

- Establishment of an H_2 Valley for seasonal storage as a best practice case for Europe
- Rapid development of an H_2 infrastructure in AT (H_2-Startnetz Mitte)

Hydrogen production “UPSTREAM":
renewable “harvest”: weather-dependent/seasonal => value chain longer and more complex

UPSTREAM

Renewables Production



NOT 365 days

Water electrolysis

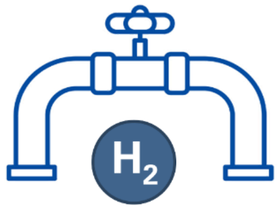
Compressor 90 bar

Production Storage

MIDSTREAM / LOGISTICS

Pipeline 50 bar

365 days



etc.

STORAGES = THE BACKBONE OF THE FUTURE H2 ECONOMY

!

DOWNSTREAM

Hydrogen consumer

Customer/Market Storage

Remark: Volume for H_2 => 3x CH_4

RAG intensifies its European outreach

- **EUH2STARS project**: Winner of recent Clean Hydrogen Partnership **funding** call.
- Goal is to demonstrate a competitive, complete and qualified **underground hydrogen storage (UHS) in depleted porous natural gas reservoirs by 2030**.
- The project consortium aims to **develop and scale-up H2-technology** along the **full value chain**
- The results of this research should be **used to develop further hydrogen storage projects** in Europe and to ensure the **integration** of UHS into the **transnational energy systems**.

EU STARS H2

European **U**nderground **H**ydrogen **ST**or**A**ge **R**eference **S**ystem

UHS costs and prices

- Assuming a new fictitious (comparable to NG) medium-depth, onshore reservoir, 100 Mio Nm³ TOV, …..

=> storage fee 30 to 40 €/MWh/year

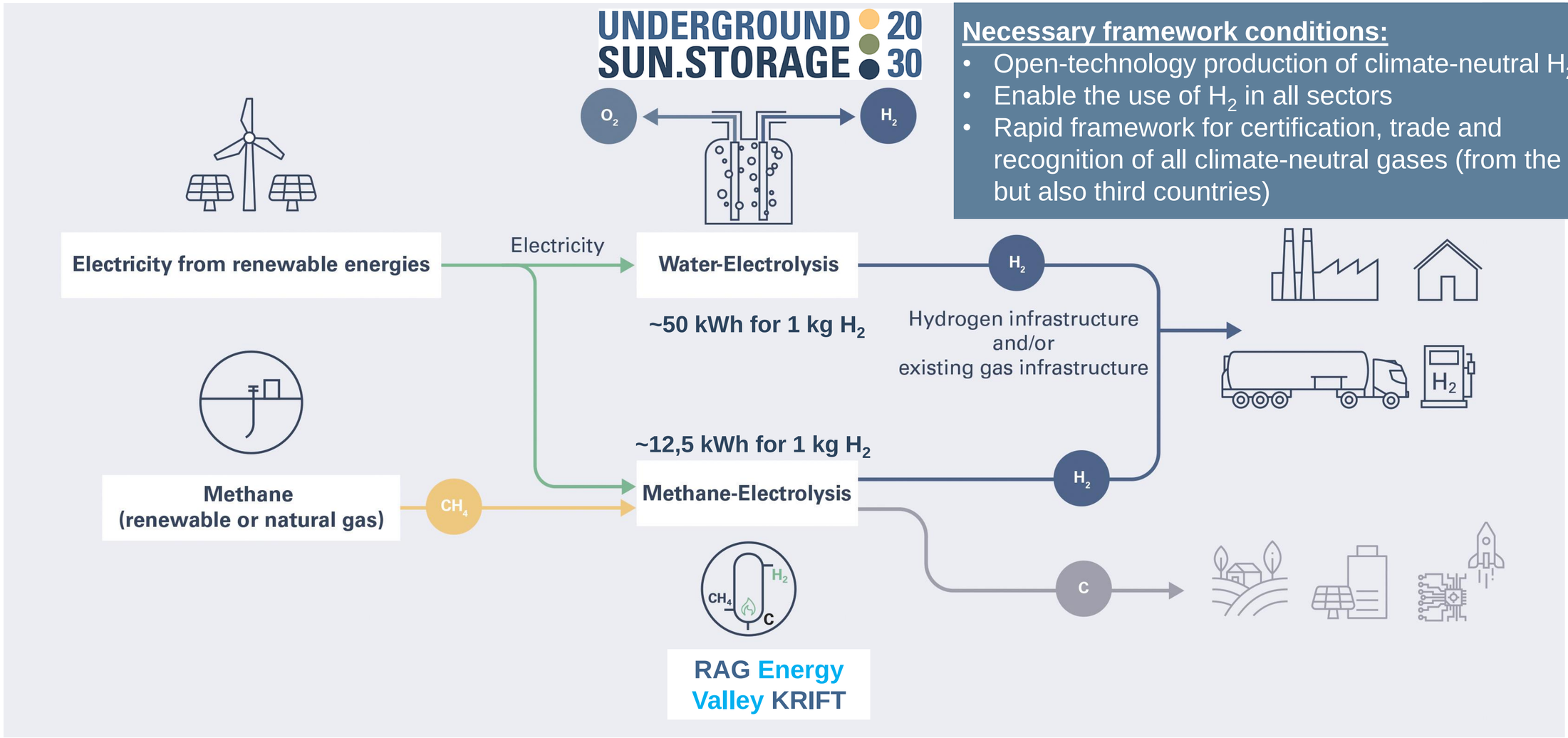
=> CAPEX (incl. cushion gas) 600-700 €/MWh installed capacity

⇒~20 €ct/kg H_2 consumed (20-25% fraction of storage)

Note: 1m³: CH_4 - 11 kWh vs H_2 – 3,54 kWh;

H_2-Purity: Grade A

H_2 production paths - RAG Austria focuses on technological openness



Methane electrolysis at the heart of *RAG Energy Valley* in Krift nearby Kremsmünster

C – in Agriculture

H_2 production technology:
- Methane electrolysis

CH_4 electrolysis

plasmalyser

Technology innovation *Methane electrolysis*:
- Immediately available H_2 production technology
- Base-load capable H_2 production possible
- Natural gas as the basis for hydrogen (ramp-up) with double added value (H_2 and C)
- Carbon as a valuable raw material for agriculture and raw material application, etc.

H_2 CHP

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OFFICIAL PARTICIPANT


AUSTRIA AG

You can´t spell Sto 

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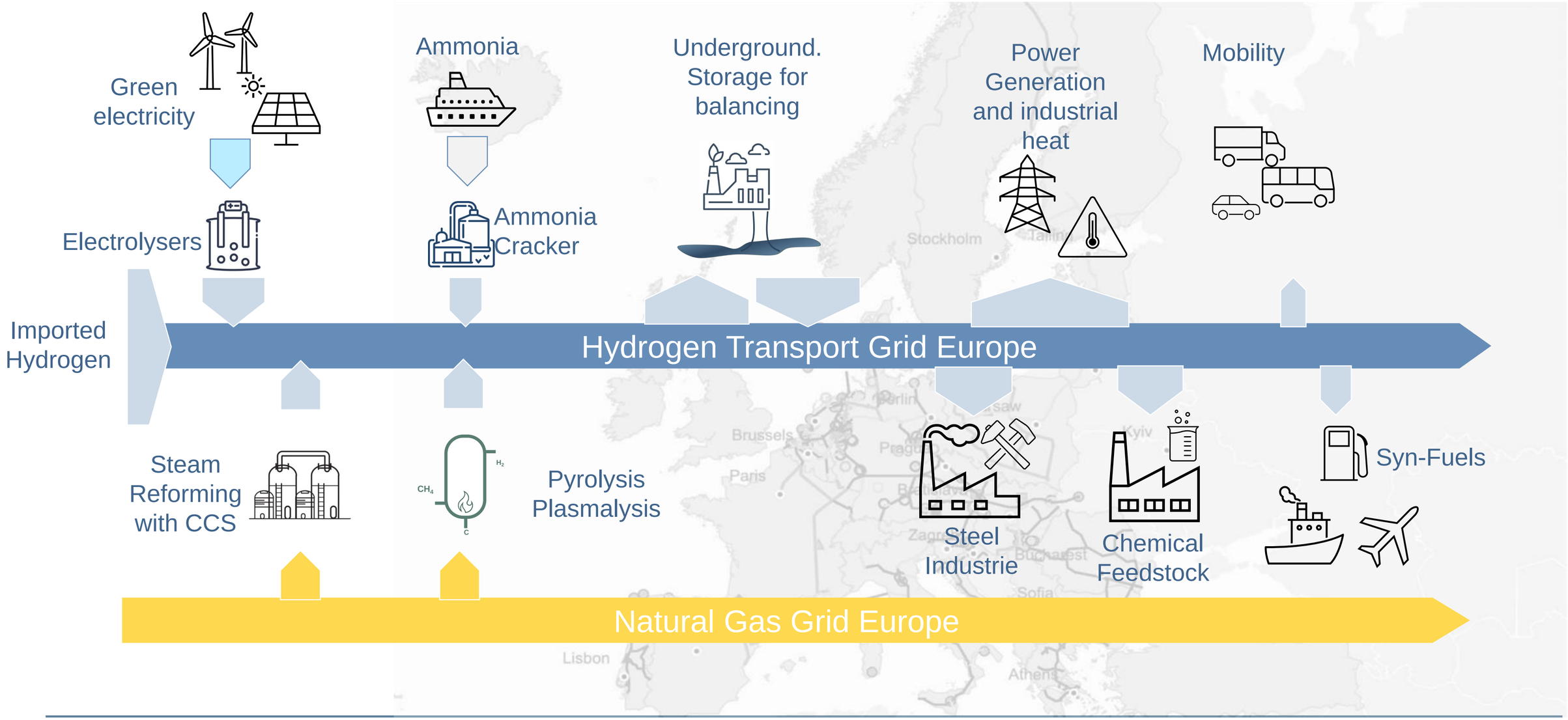
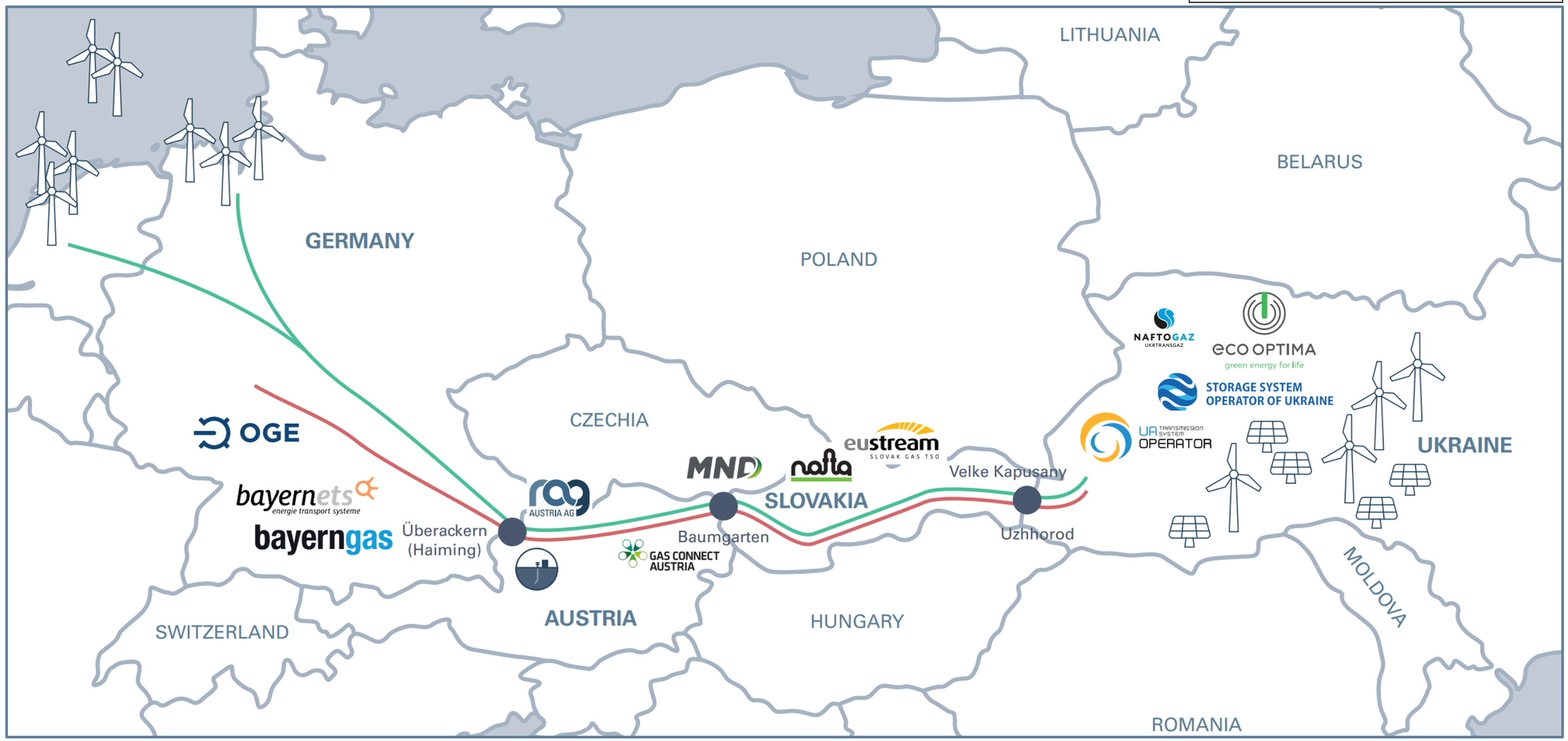
In 2050 Hydrogen will be produced locally or be imported via pipeline and will be predominantly used for power generation and industrial heat.



Map from https://ceenergynews.com/hydrogen/new-infrastructure-map-visualises-potential-of-european-hydrogen-market/

«H2EU+Store»: an integrated project along the entire H_2 value chain
Start November 2021

www.h2euplusstore.com



- **Production** in Western Ukraine
- **Transport & Storage**
- **For customers** in Austria I Bavaria

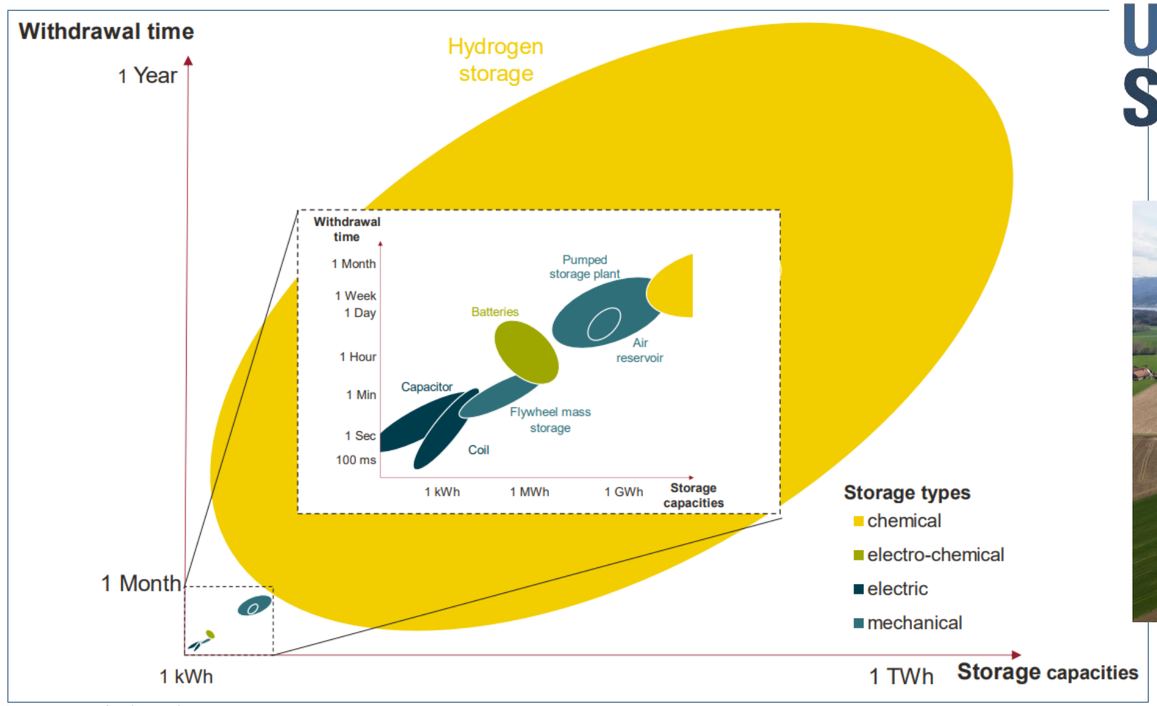
Stage 1 (60,000 t/a) — *2030*

Stage 2 (500,000 t/a) — *2030 – 2040*

Stage 3 (1 mn t/a) — *2040 – 2050*

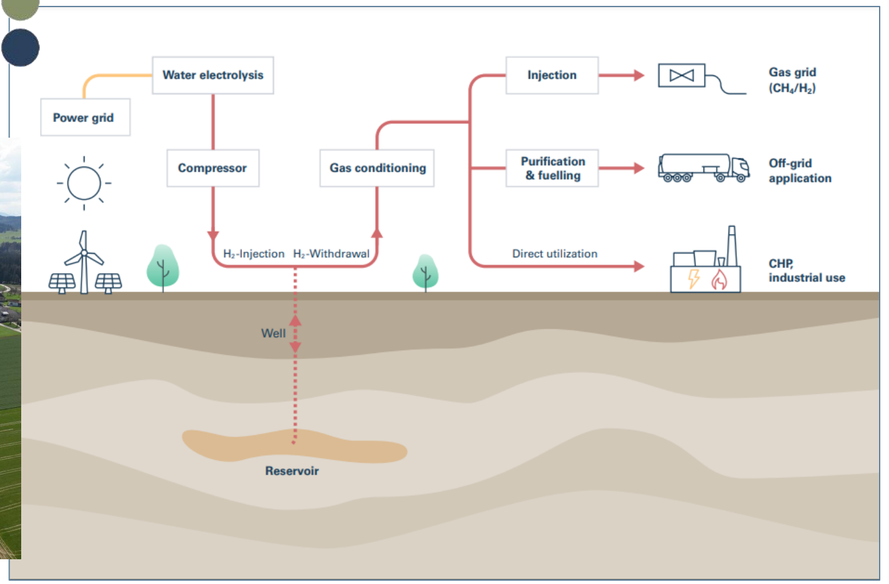
- Existing gas pipelines*
- Pipelines converted to H_2 transport*

RAG Austria´s Energy Transition Lighthouse Projects



Source: Artelys/Frontier

UNDERGROUND SUN.STORAGE



H2 EU Store

Methane - Electrolysis