Underground Storage of Hydrogen and Conversion to Methane

Highlights of Energy Research 2021
Energy Storage
23rd November 2021

RAG AUSTRIA AG

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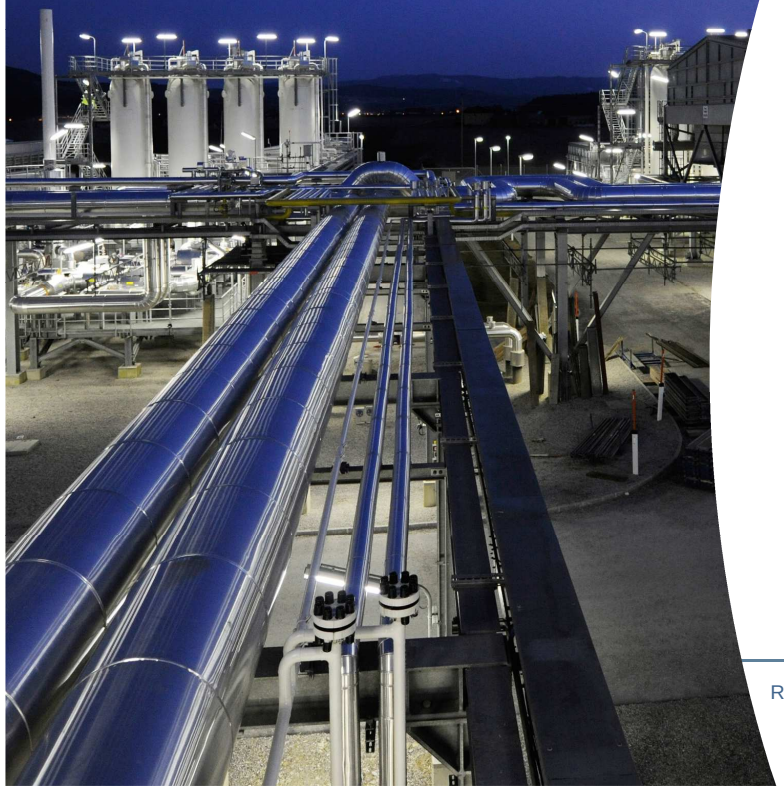
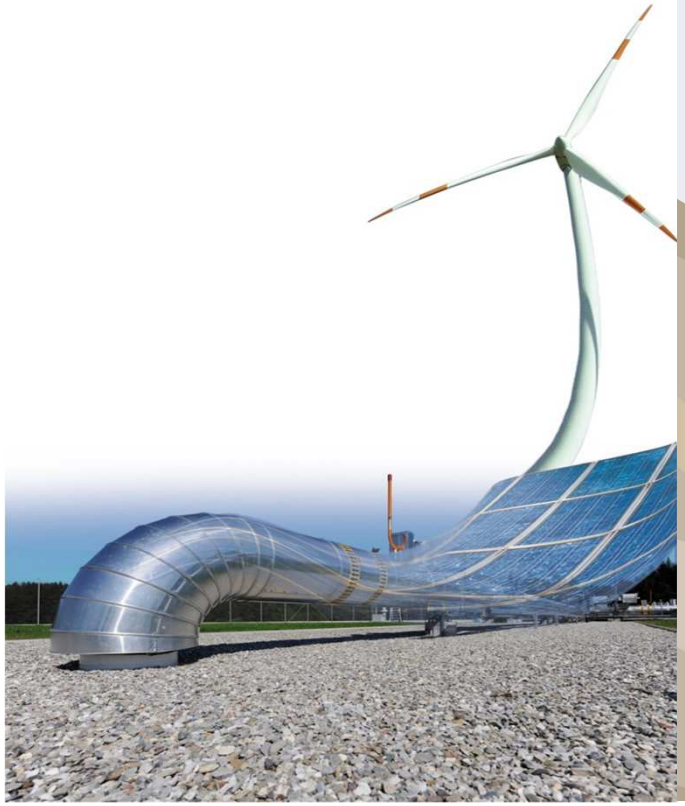
Company Profile and Vision

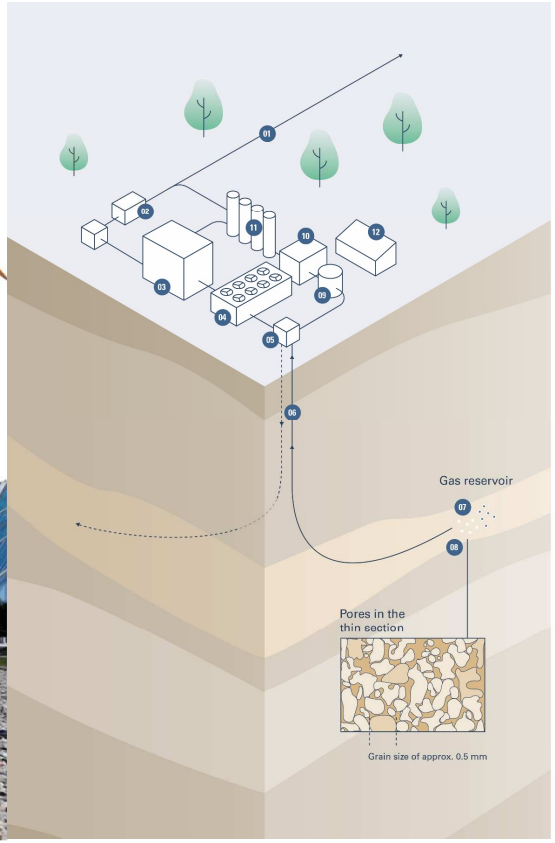


- Among leading technical Underground Gas Storage operators
- State of the art facilities
- Innovation in energy storage
- Storage volume 66 TWh (6bcm)
- Unload capacity 30 GW

- Follow the vision to serve the renewables with our existing assets

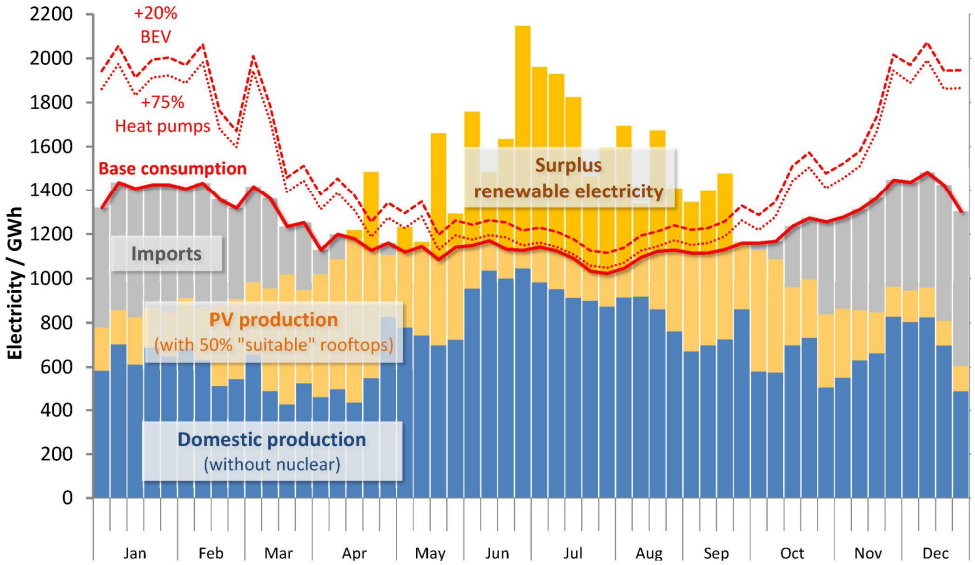
Working principle of Underground Gas Storage (UGS)





01 Public grid
02 Metering station
03 Compressor station
04 Cooling units
05 Wellhead
06 Well
07 Reservoir
08 Working or cushion gas
09 Preheater
10 Pressure reduction station
11 Drying unit
12 Control room and stores

Demand in seasonal energy storage

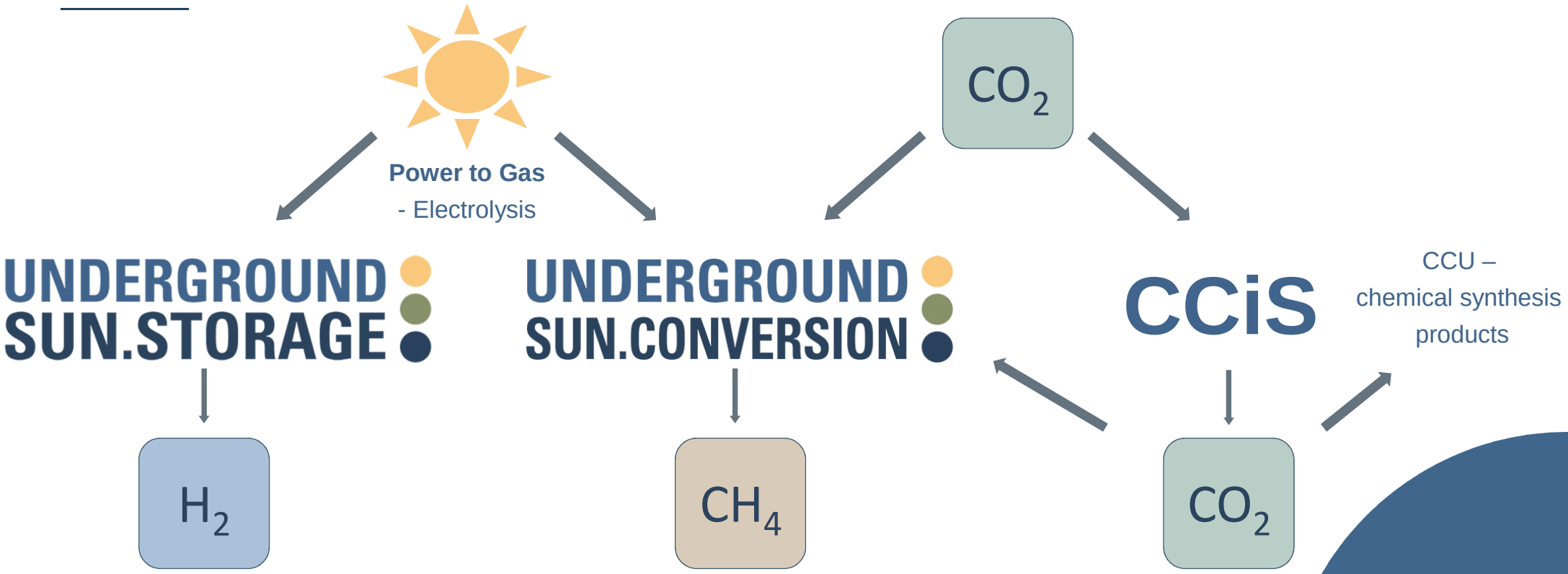


Source: M.Rüdisüli et al. (2019)

Weekly total values of a modified Swiss electricity system (basis 2010) displaying generation (columns) and demand (red lines)

- How can we assure a reliable power supply during winter months?
- Energy storage for inter-seasonal balancing is essential
- Power and Gas!

Seasonal Storage Concepts



RAG – Project overview

Abb.	Full titel	timeframe
USS	Underground Sun Storage	07/2013 – 06/2017
USS2030	Underground Sun Storage 2030	03/2021 – 02/2025
USC	Underground Sun Conversion	03/2017 – 02/2021
USC-FlexStore	Underground Sun Conversion – Flexible Storage	12/2020 – 05/2023
C-CED	Carbon – Cycle Economy Demonstration	07/2021 – 06/2025
HyStorIES	Hydrogen Storage in European Subsurface	01/2021 – 12/2022
HyUsPRe	Hydrogen Underground Storage in Porous Reservoirs	10/2021 – 01/2023

Underground Sun Storage
2013-2017

- Seasonal storage of renewable energy
- First of its kind, globally
- Hydrogen compatibility of geological reservoir structures up to 10%
- Assessment of typical UGS materials
- Laboratory and field experiments
- Final report available here: www.underground-sun-storage.at

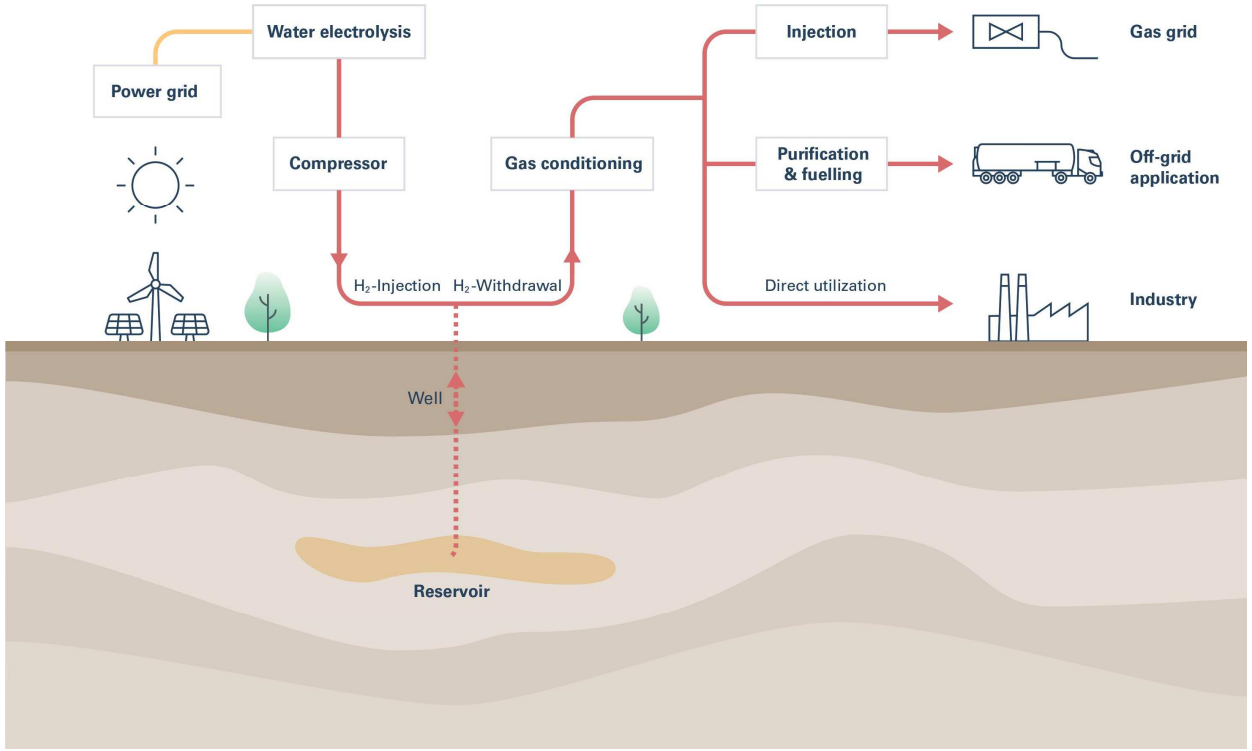
Results relevant for follow up projects

- Studies on storage integrity (reservoir, cap rock, cementation) executed with 75-100% H_2
- Steel grades tested at 100 % / 100 bar H_2 partial pressure (wet gas system)
- No curtailment of integrity detected so far
- Field experiments without any anomalies

-> even 100 % / 100 bar H_2 partial pressure technically feasible

-> Evidence for Geo-Methanation – Basis for USC-Projects

Demo project – 100% H_2 storage



- 2 MW Electrolysis
- 1.6 Mio Nm³ working gas volume
- 400 – 600 Nm³/h
- 56 -76 bar

Objectives

- Interseasonal energy storage solution
- Proof of technical feasibility
- Alignment between results from lab experiments and field test
- Development and demonstration of hydrogen purification
- Modelling of the Austrian energy system – storage demand
- Use case consideration and development of associated services

WIVA P&G Energy Model Region USS 2030

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UNDERGROUND SUN.STORAGE 2030

VORZEIGEREGION ENERGIE

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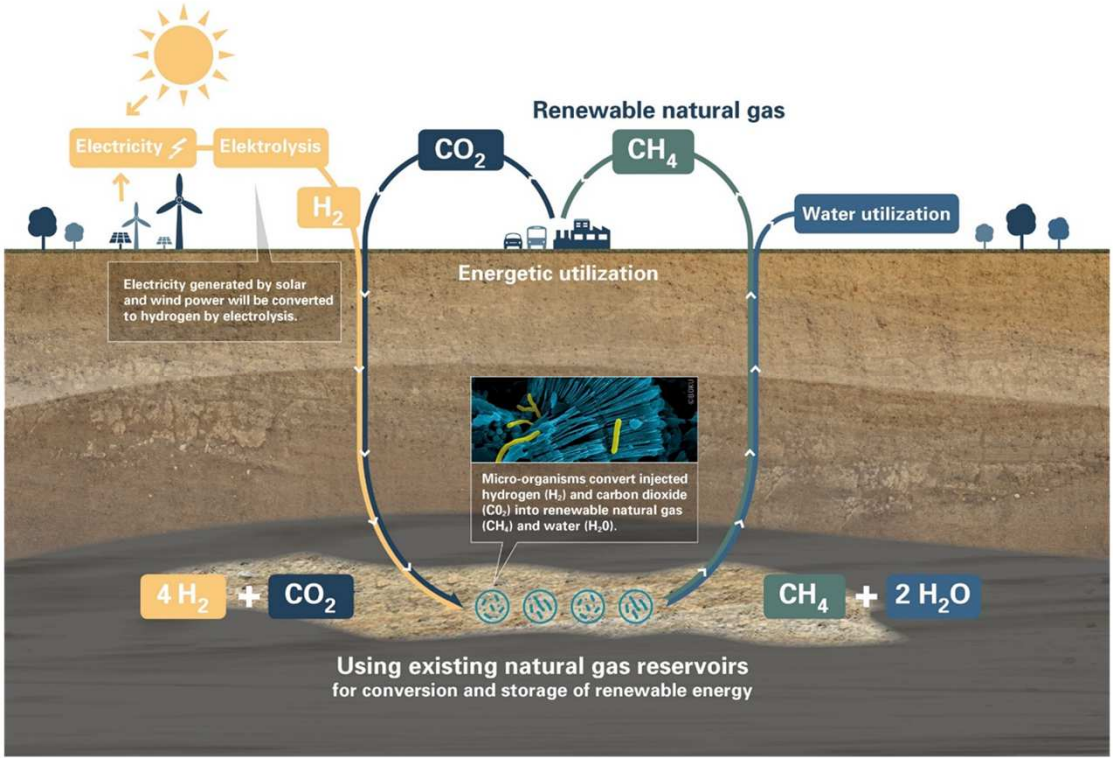
FFG Forschung wirkt.

Underground Sun Conversion



- 03/2017 – 03/2021
- Field tests at a specific reservoir
- Final report in Q4/2021 available
  www.underground-sun-conversion.at

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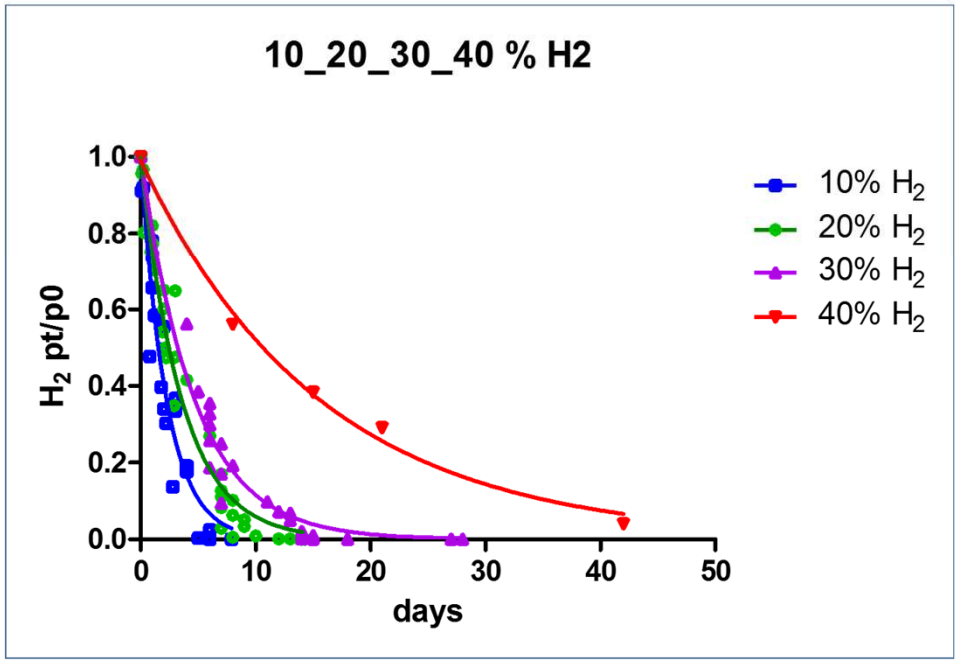
Underground Sun Conversion

Microbiology - Batch Reactors – Results

conversion process at increasing H_2 initial pp



Gasmix 3: 2.5% CO_2 + 10% H_2 + 87.5% CH_4

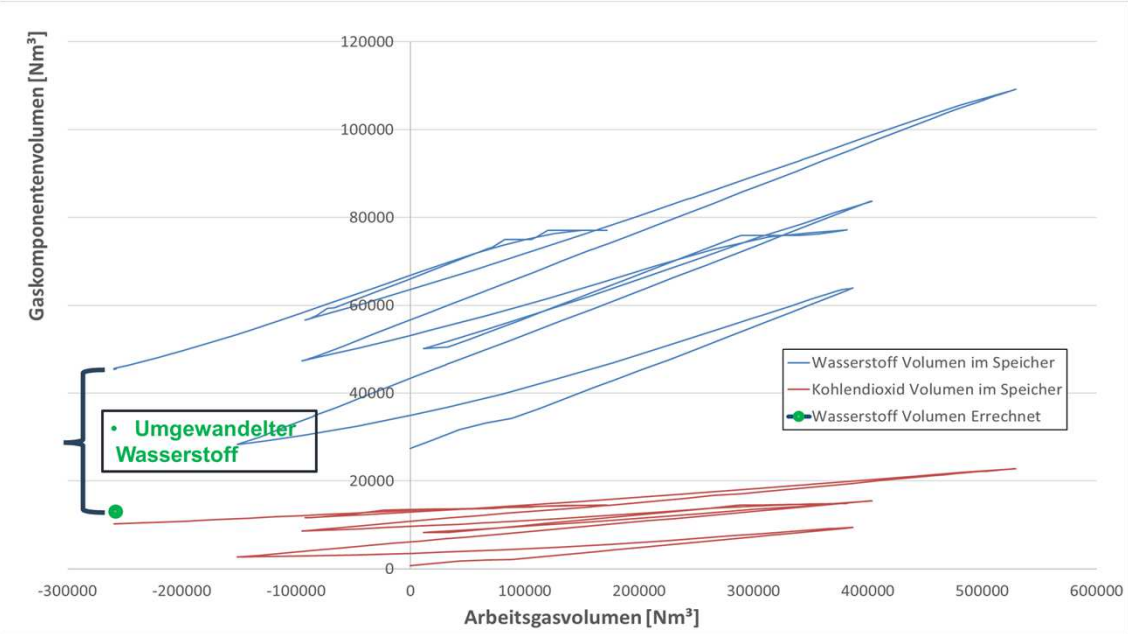
Gasmix 4: 5% CO_2 + 20% H_2 + 75% CH_4

Gasmix 5: 7.5% CO_2 + 30% H_2 + 62.5% CH_4

Gasmix 7: 10% CO_2 + 40% H_2 + 50% CH_4

High-pressure bioreactors

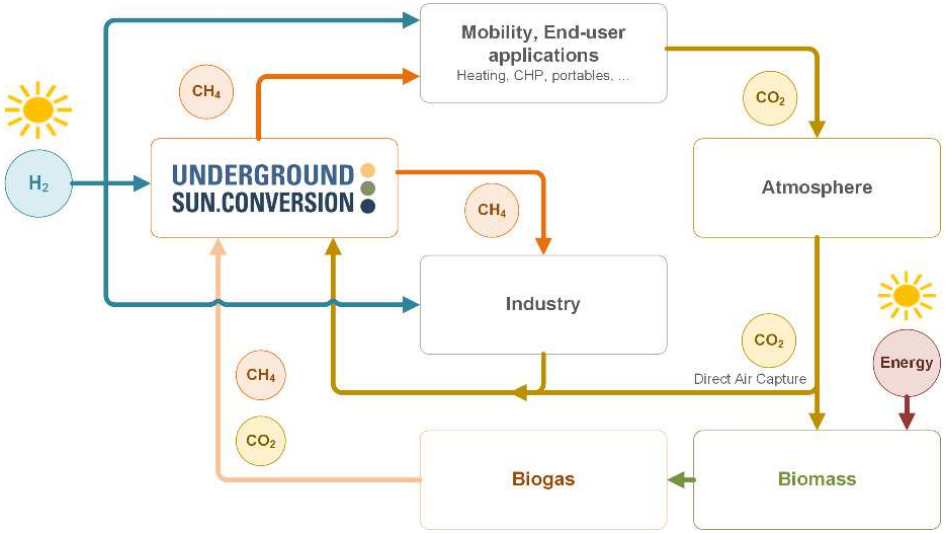
Underground Sun Conversion – Field Experiments



- Conversion process perfectly established in laboratory experiments
- Geo-methanation also works in field experiments
- Several lines of evidence
  - Course of the gas composition
  - Genetic proof of methanogenic metabolism
  - Shifts in the microbiological consortium
  - Changes in the composition of C-isotopes

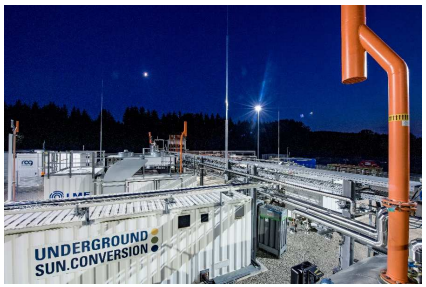
Carbon – Cycle Economy Demonstration

Underground Sun Conversion as part of a sustainable and closed carbon cycle



- Integration of different CO_2 sources
- Demonstration of a closed Carbon cycle
- Flagship project within WIVA P&G
- Project duration: 07/2021 – 06/2025

Conclusion



- State of the art **underground gas storage** facilities are essential for Europe´s **security of energy supply**
- Increase of erratic **renewable energy** generation and the integration of gas and electricity markets in turn will generate **additional demand in seasonal** and high-capacity **large scale storage options**
- **Underground Sun Storage** as well as **Underground Sun Conversion** technology can solve the problem of inter-seasonal energy storage

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