hypster Hydrogen Storage

HyPSTER Project

"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 Hydrogen Pilot STorage for large Ecosystem Replication

- 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: 2023
- 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, ESK, ARMINES, BROUARD CONSULTING

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 co-funded by the European Union's Horizon 2020 Programme through the Fuel Cells Hydrogen Joint Undertaking (FCH-JU), now Clean Hydrogen P... agrement number 101006751

01 | Scope

Storengy, a leading player in underground gas storage

4th

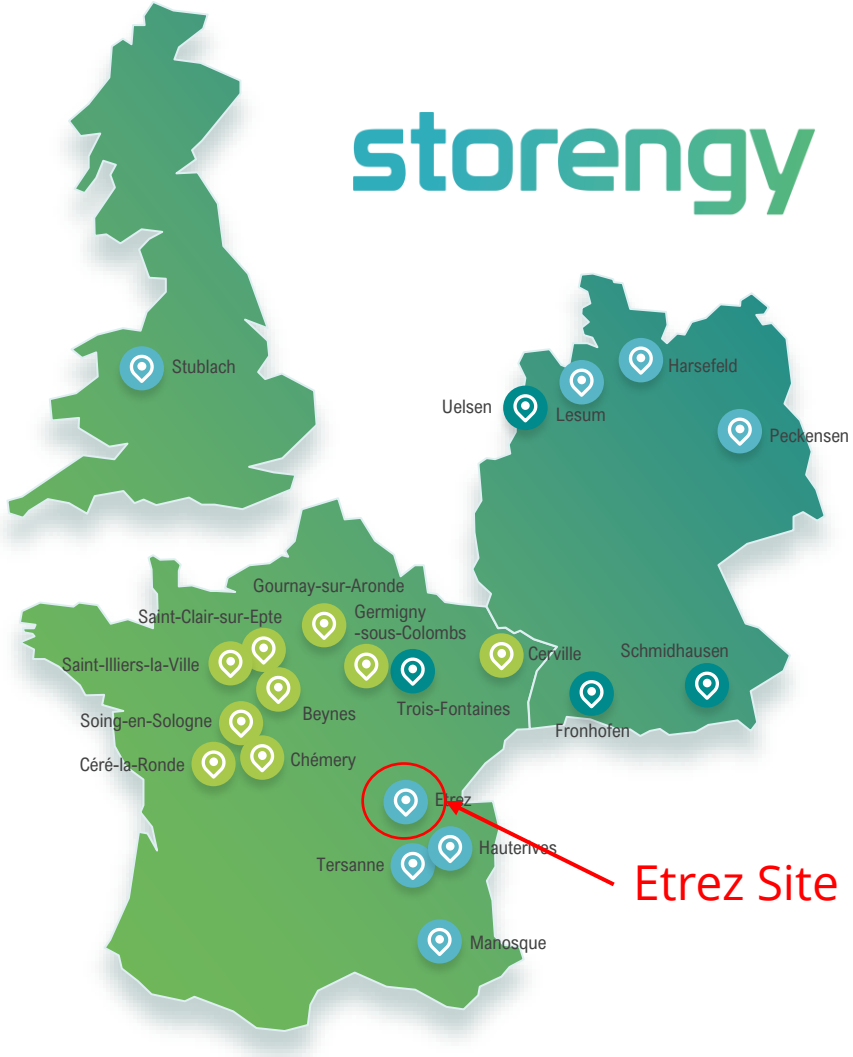
LARGEST UNDERGROUND GAS STORAGE OPERATOR IN THE WORLD

21

UNDERGROUND STORAGE SITES IN FRANCE, GERMANY & UNITED KINGDOM

12 *

BILLION CUBIC METRES OF NATURAL GAS STORAGE CAPACITY



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Etrez – Salt Cavern Gas Storage Site

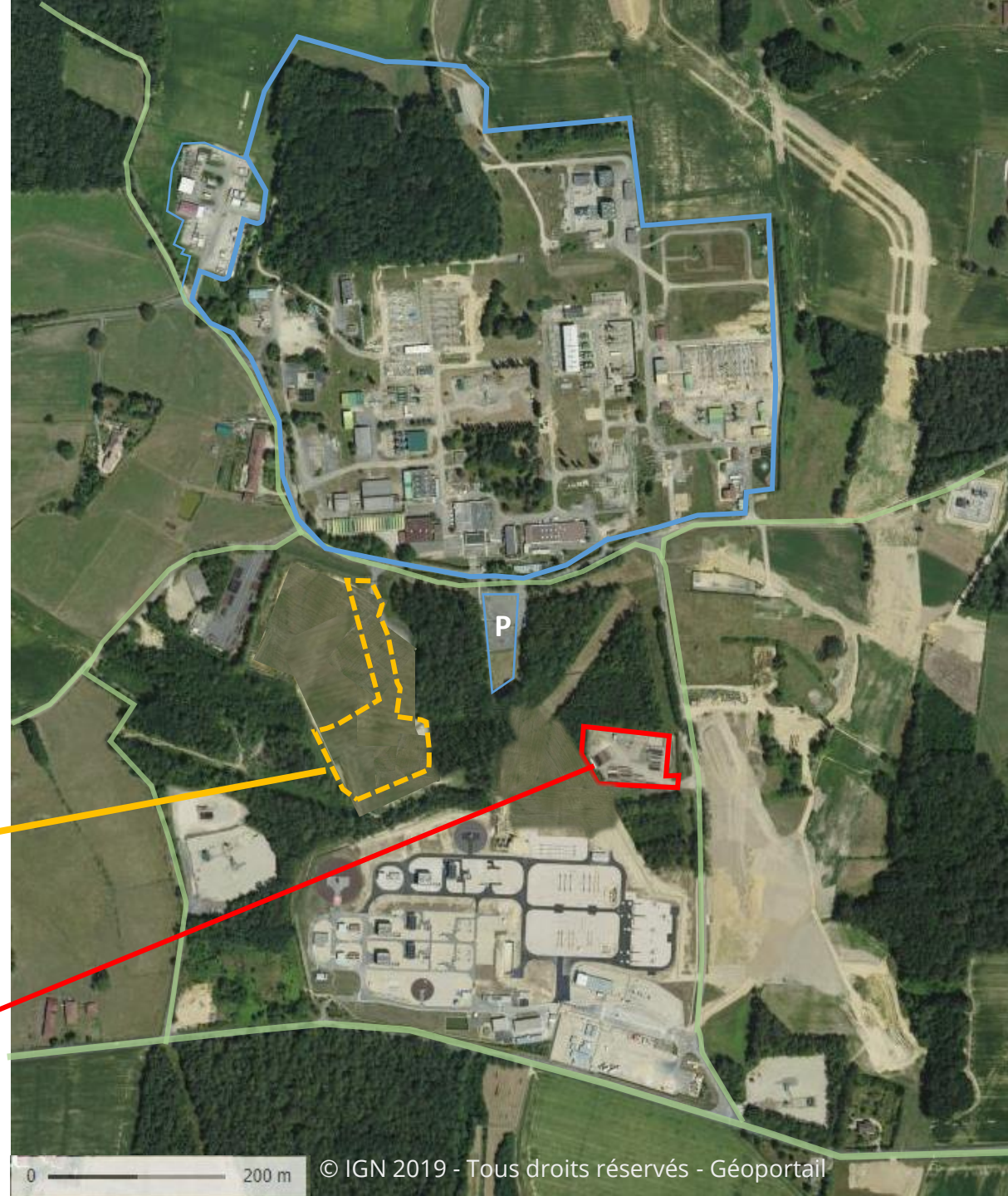
Etrez commissioned its first gas cavern in 1980.

There are at present 20 Salt Caverns storing natural gas.

The caverns have an operating pressure range from 80 to 240 bar.

Etrez site stores over 800 mcm of natural gas.

Brine produced during caverns development is supplied to Inovyn for Chlorine and Caustic Soda Production.



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HyPSTER project is divided into two parts

Green Hydrogen Production

- Electrolyzer 1MW
- Buffer Storage
- Compression
- Hydrogen tubes trailers

Salt Cavern Storage

- Use an existing salt cavern
- Hydrogen Completion
- Hydrogen Wellhead
- Brine pump / tanks

Hydrogen will be supplied to EZ53, Mobility and Industry decarbonisation projects

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Project Schedule overview – Pilot Phase

Hydrogen Production Platform

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

Underground Hydrogen Storage EZ53

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

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Technical challenges to be addressed by HyPSTER in Pilot Phase

- Suitability of materials of construction

Materials of construction

- Test Leak Tightness of completion equipment

Subsurface

- Characterise behaviour of the equipment during pressure cycling

Subsurface

- Measure the interaction of hydrogen inside the cavern
  - Hydrogen dissolution in brine (in-situ)
  - Chemical and bacteriological reaction (in-situ)

Hydrogen quality

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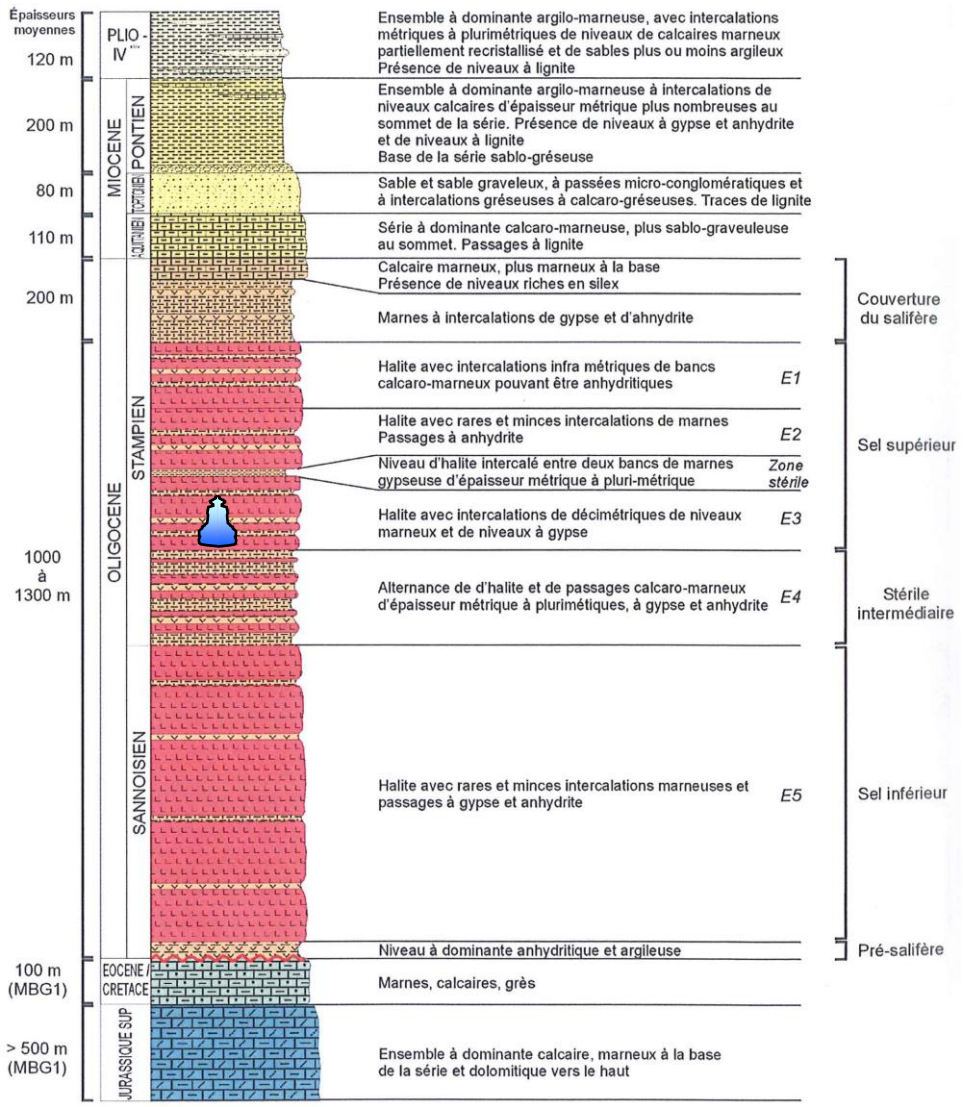
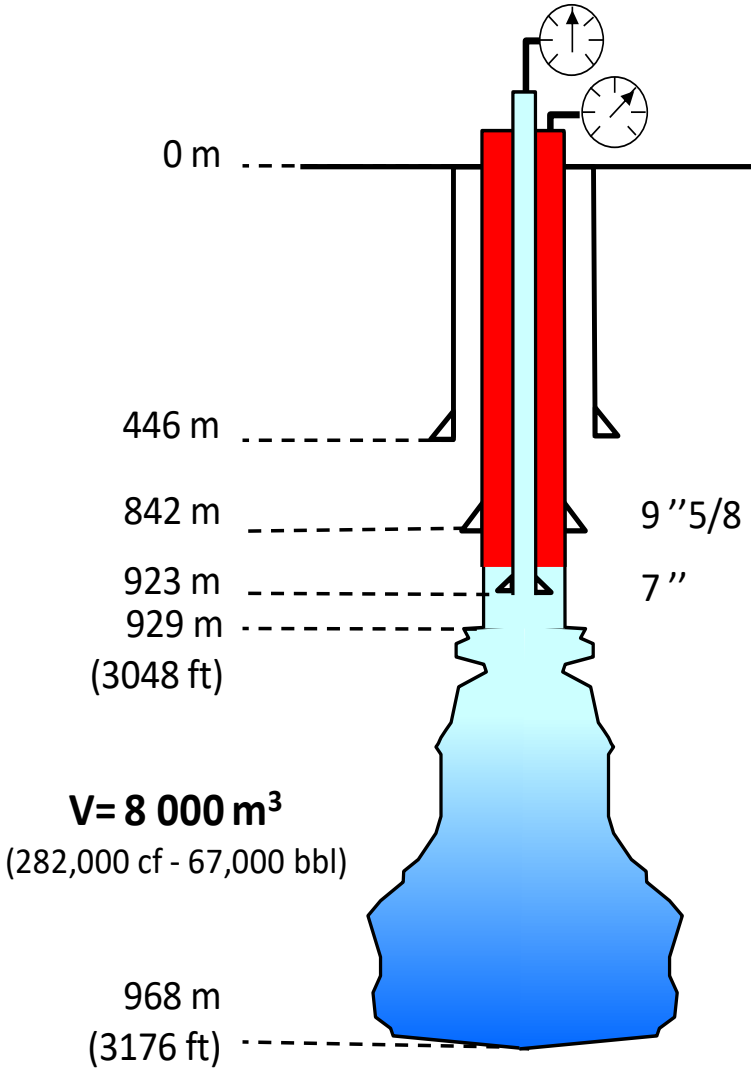
02 | Hydrogen Storage in Salt Cavern

Etrez Salt Cavern (EZ53)

Marls

Salt





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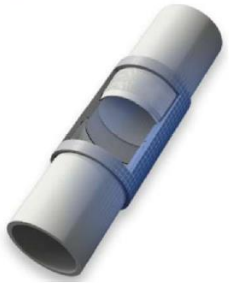
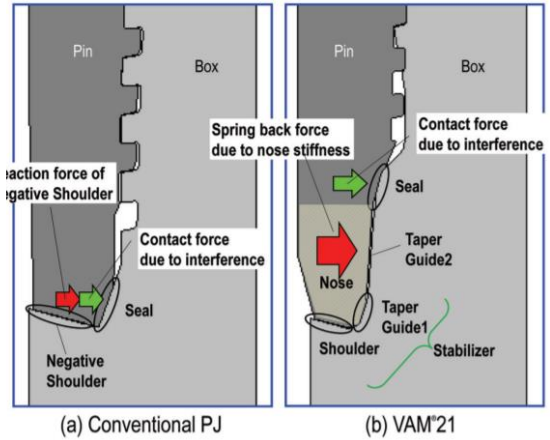
EZ53 – Completion equipment

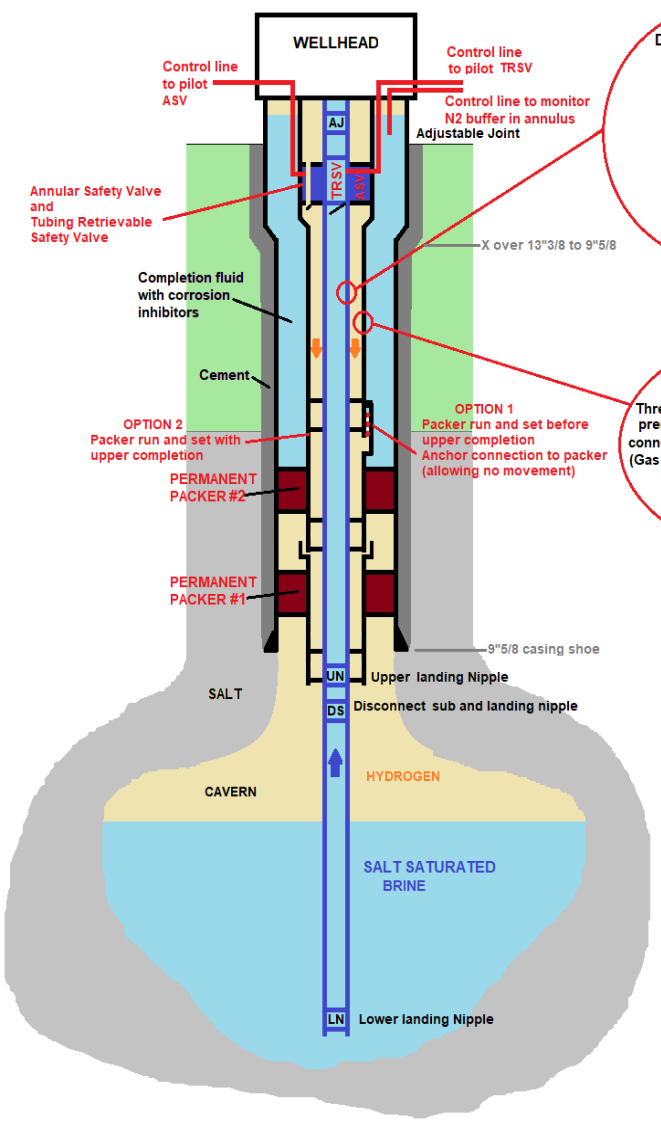
- Wellhead provided by Technip FMC
- Completion equipment provided by Schlumberger (requirement to get annular safety valve)
- Tubulars provided by Vallourec: only supplier to have performed H2 tightness test on the VAM 21

Hydrogen Storage Wells
VAM® 21 Successfully Qualified

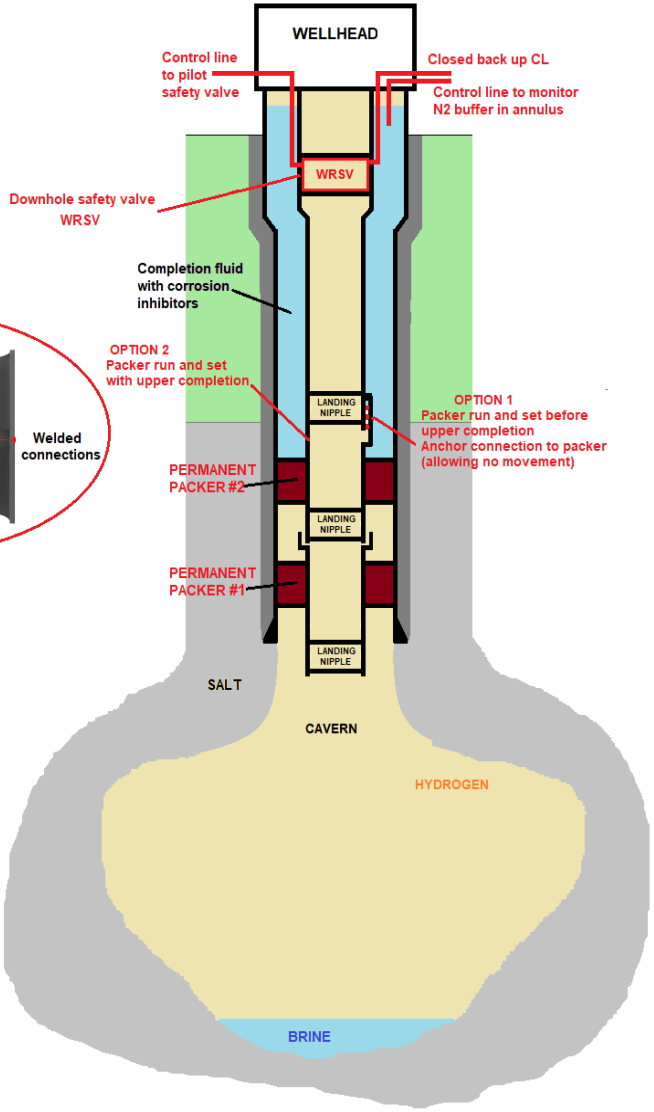




EZ53 Pilot Phase Configuration



EZ53 Phase II Configuration



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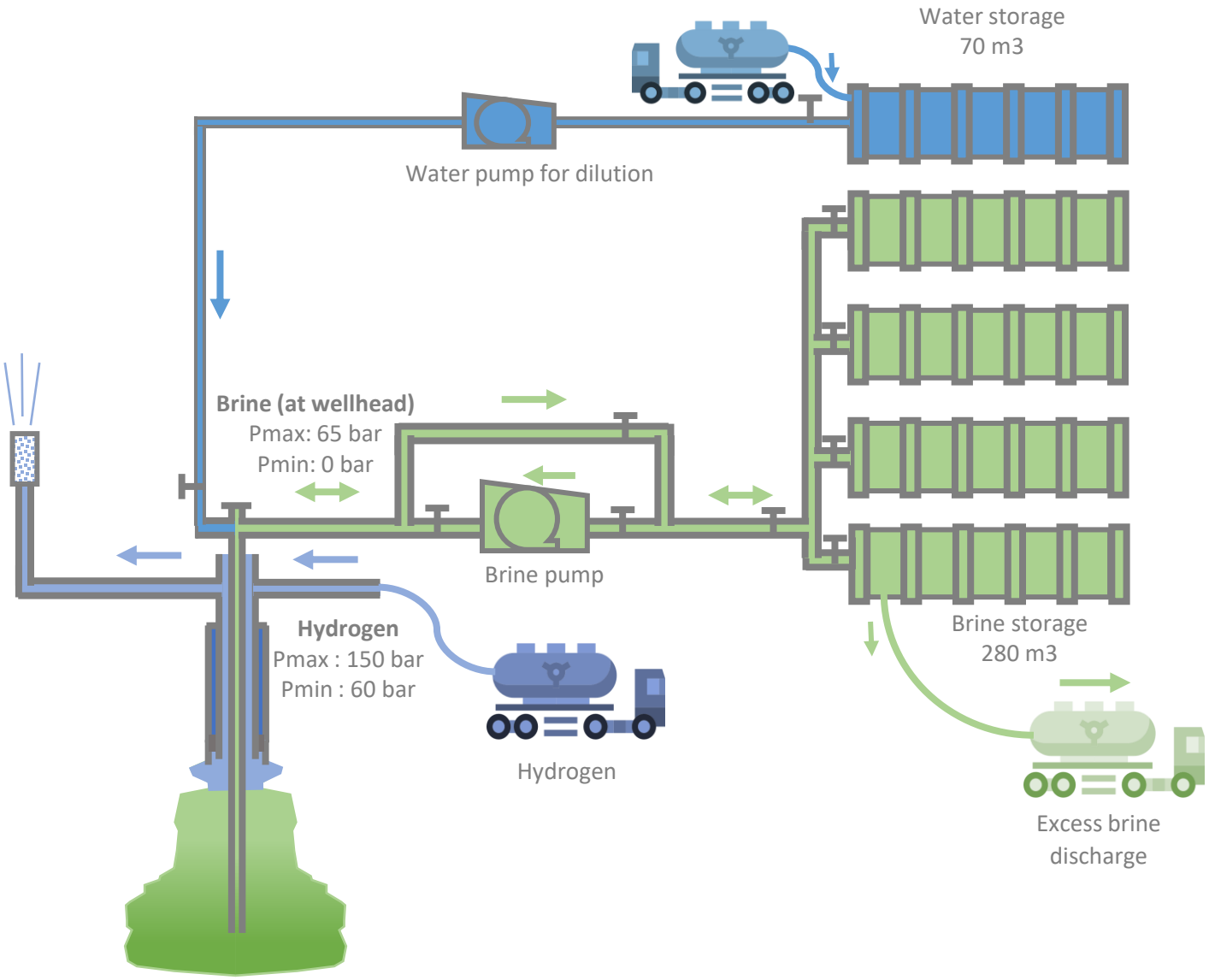
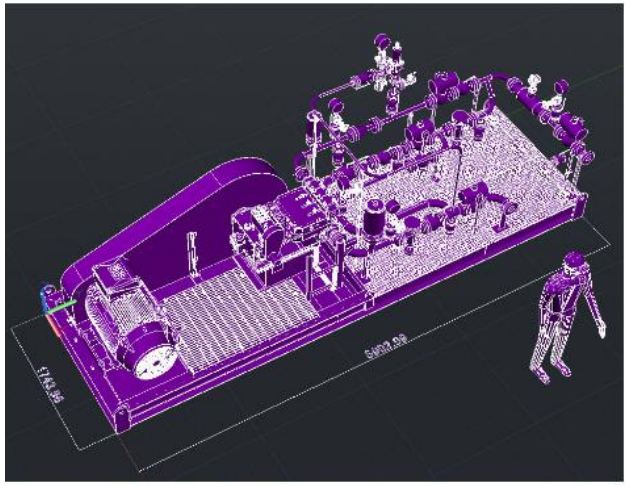
agrement number 101006751

EZ53 Well-Site: Process Overview



Brine Storage Tank



Brine Pumping Skid

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Mechanical Integrity Test

Test Fluids: Nitrogen followed by Hydrogen

Test Pressure: 151 bar

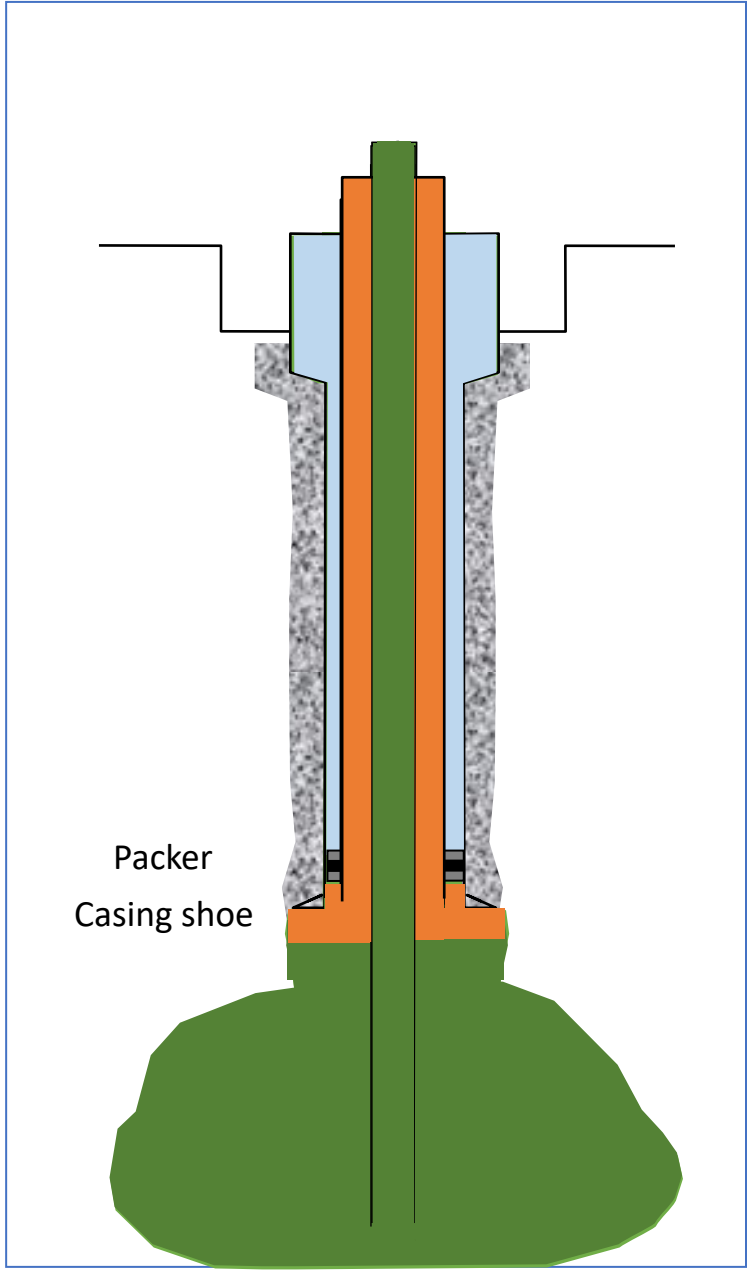
Test Procedure:

- Inject fluids with the interface in the chimney
- 1st measure of the position and temperature at the interface
- Wait 48 hours
- 2nd measure of the position and temperature at the interface
- Calculate leak rate (compensate for temperature variation)

Industry Standard Equipment Acceptance Criteria: 50 litres/day

Output from Testing:

Comparison of Leak tightness in nitrogen and hydrogen – across the tubulars, packers and casing shoe



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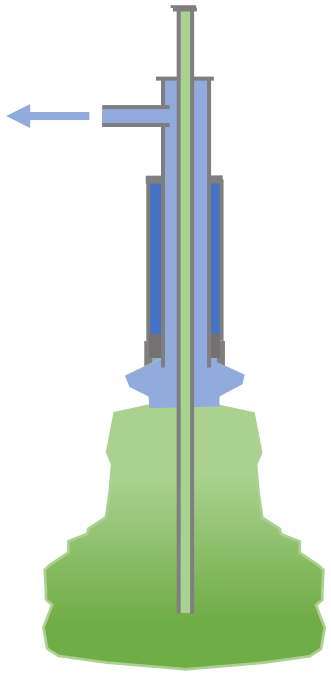
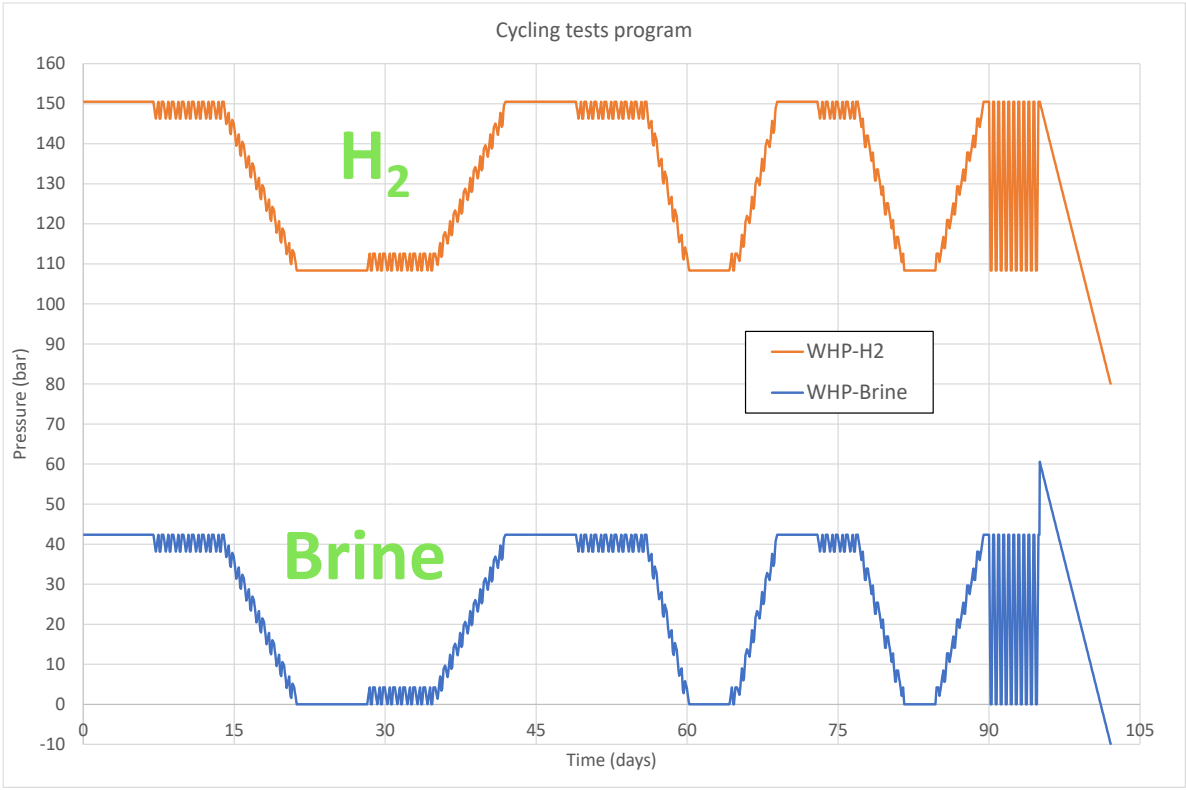
Cavern Pressure Cycling

Proposed Cycling Test Programme:

- 7 days of +/- 4 bar, 2 cycles per day at high pressure
- 7 days of -5 bar / +3 bar until 110 bar (ramp down)
- 7 days of +/- 4 bar, 2 cycles per day at low pressure
- 7 days of +5 bar / - 3 bar until 150 bar (ramp up)
- Repeat cycling programme twice,
- 7 days of +/- 40 bars, 1 cycle per day
- Withdrawal of hydrogen.





Measurements / Survey:

- Wellhead Brine and hydrogen pressures
- Volumes of brine injected/withdrawn
- Brine density

Output from Testing:

- Better understand of thermodynamic behaviour of cavern

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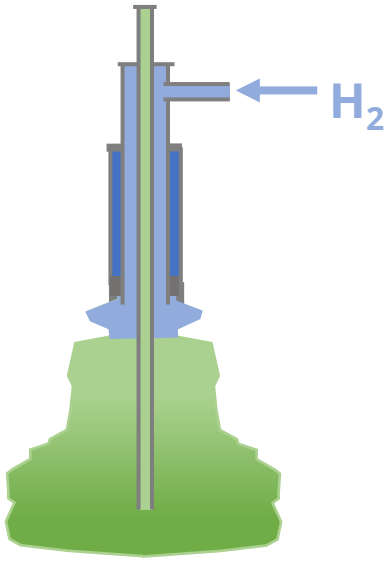
Chemical reactions / bacterial growth in the cavern

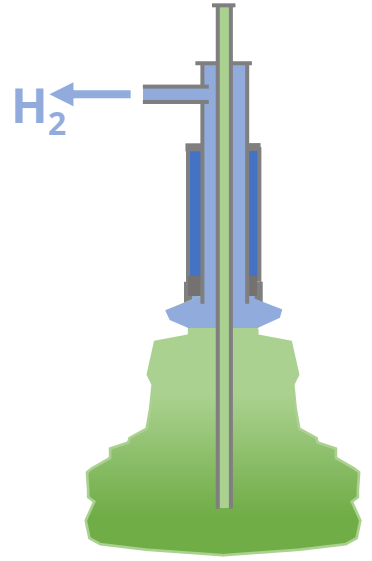
Measurements:

- Brine sampling from the cavern before the injection of hydrogen to confirm base line bacteria levels.
- Brine sampling at the end of the test period (focusing on the brine in close contact with the hydrogen) to identify levels of bacteria growth and hydrogen absorption
- Analysis of H_2 composition before injection
- Analysis of H_2 composition after withdrawal (after 3 months in the cavern)



Output from Testing:

- Estimate the long-term effect of bacterial growth / chemical reactions on the materials of construction.
- Define whether a hydrogen purification system will be required



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03 | Hydrogen Generation

Etrez - Hydrogen Production Area

Electrical substation

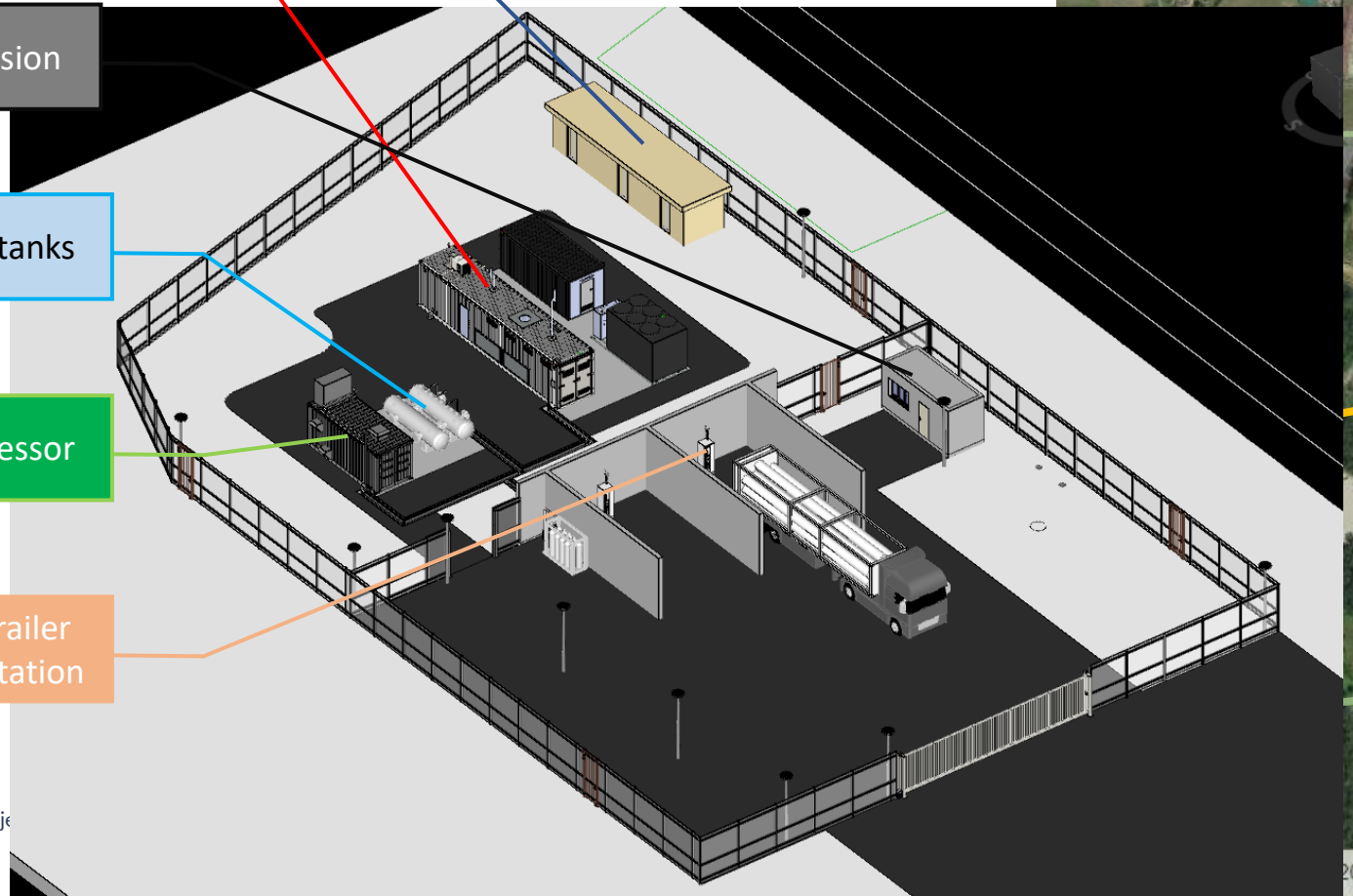
Electrolyzer package

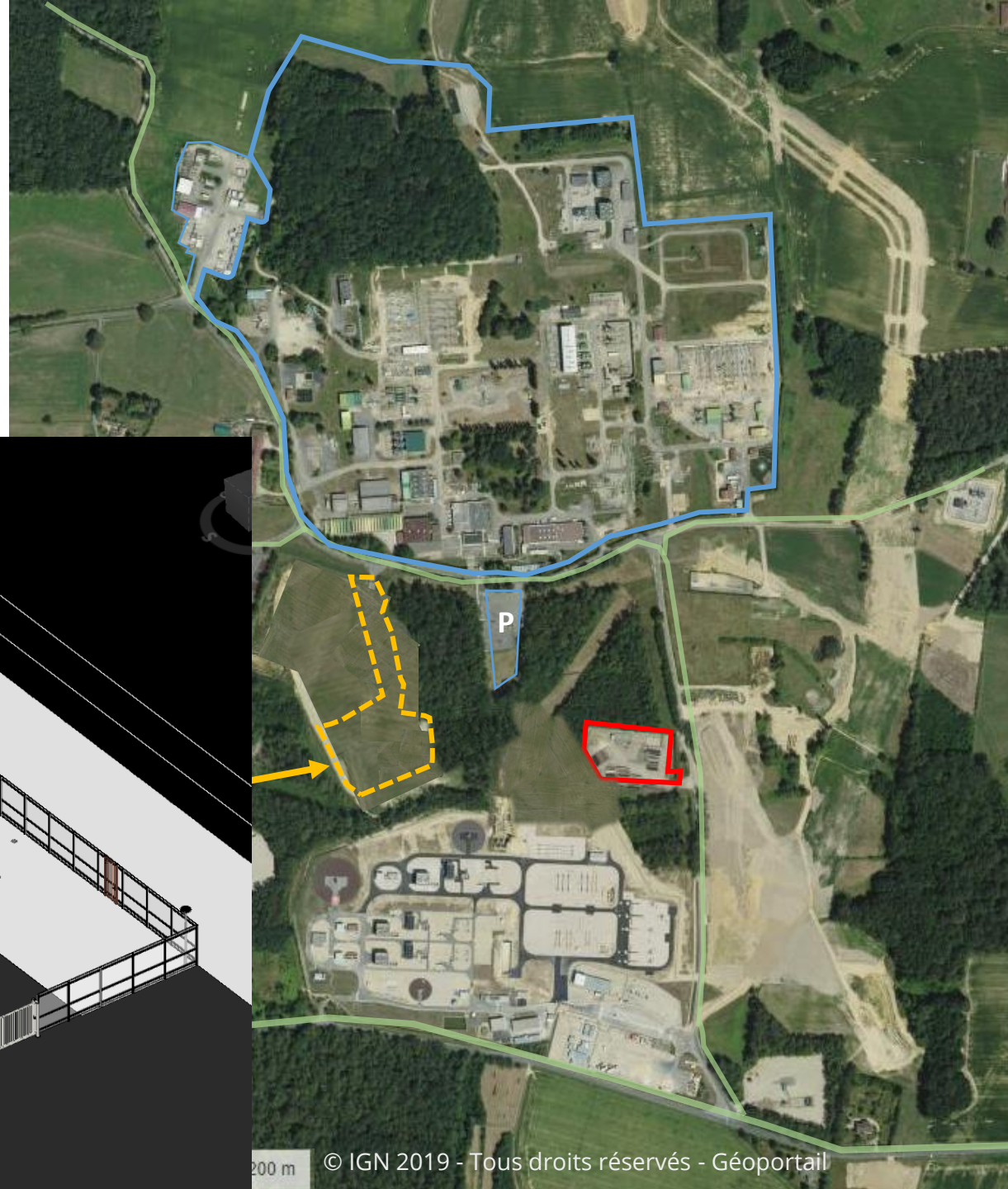
Supervision

Buffer tanks

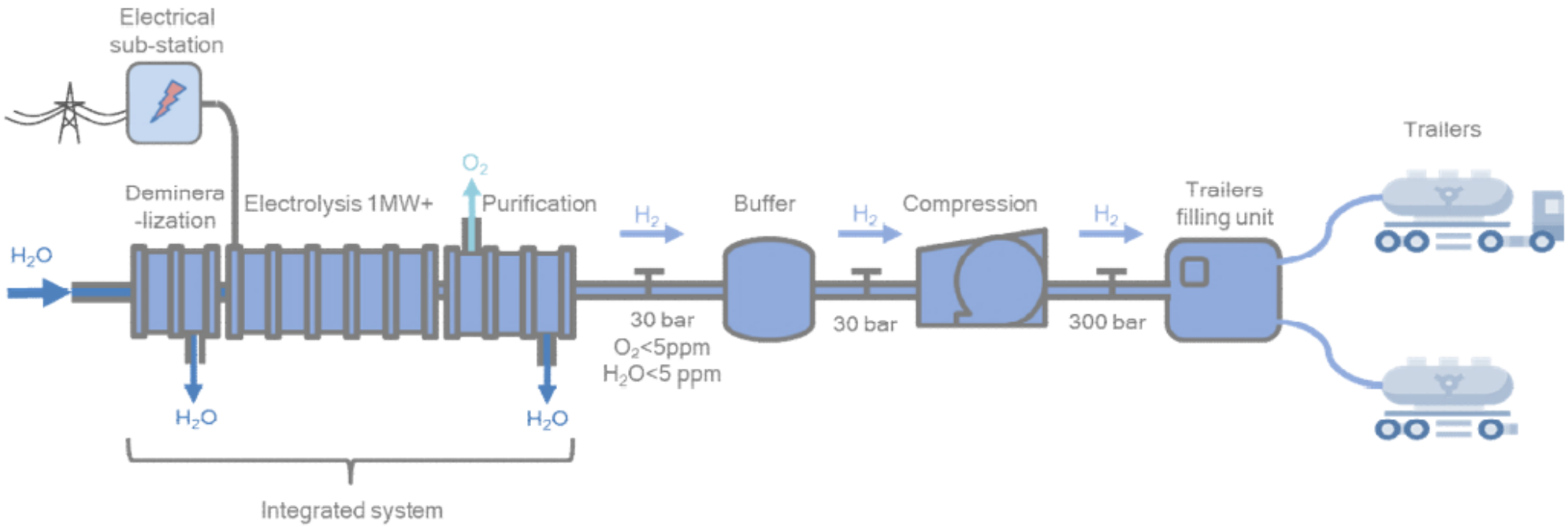
Compressor

Tube trailer Filling station





Hydrogen Platform – Process Overview



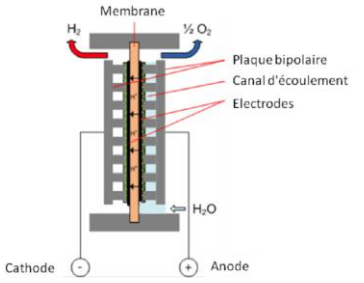


Figure 8 : Monocellule électrolyseur PEM

Figure 9 : Stack d'électrolyseur PEM[17]

- 1 MW electrolyser PEM technology, 4 stacks in container
- Produces Hydrogen at 30 bar and 15°C: 209 Nm3/h at nominal rate (or 400kgH2/day): the package is set on when buffer tank pressure is below 10barg and switch off when the inside tank pressure exceeds 30barg
- Purification produced H2 to get ISO 14687-2 quality (eliminating residual oxygen and water): deoxo catalytic reactor and two adsorption towers

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04 | Summary

Summary

Hydrogen has been successfully stored in salt caverns for many years

But only limited information is available on sub surface equipment design and materials of construction

The Hypster Project aims to:

- **Test manufactures' equipment inside a hydrogen filled salt cavern**
- **Validation test procedures and measure leak tightness of completion equipment**
- **Test material compatibility**
- **Understand whether fast pressure cycling has any implications on cavern, sub-surface and wellhead design**
- **Establish whether there are any chemical reactions / bacterial growth in the cavern**

Initial results should be available in the second half of 2024

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