

Lined Rock Shaft Technology for Hydrogen Storage

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We believe that to achieve **excellence**, **innovation** and **robust engineering** practice must go hand in hand.

Our aim is to drive that innovation to make a positive impact on projects, technologies and the future.



- Two experienced engineers with multi-disciplinary backgrounds
- Engineering services to the energy industry targeting renewables and offshore
- Spent 4+ years developing Lined Rock Shaft H₂ storage technology
- End to end project delivery support
- Technology development
- Edinburgh based

SYSTEMS

STRUCTURAL

MECHANICAL

RIPTIDE

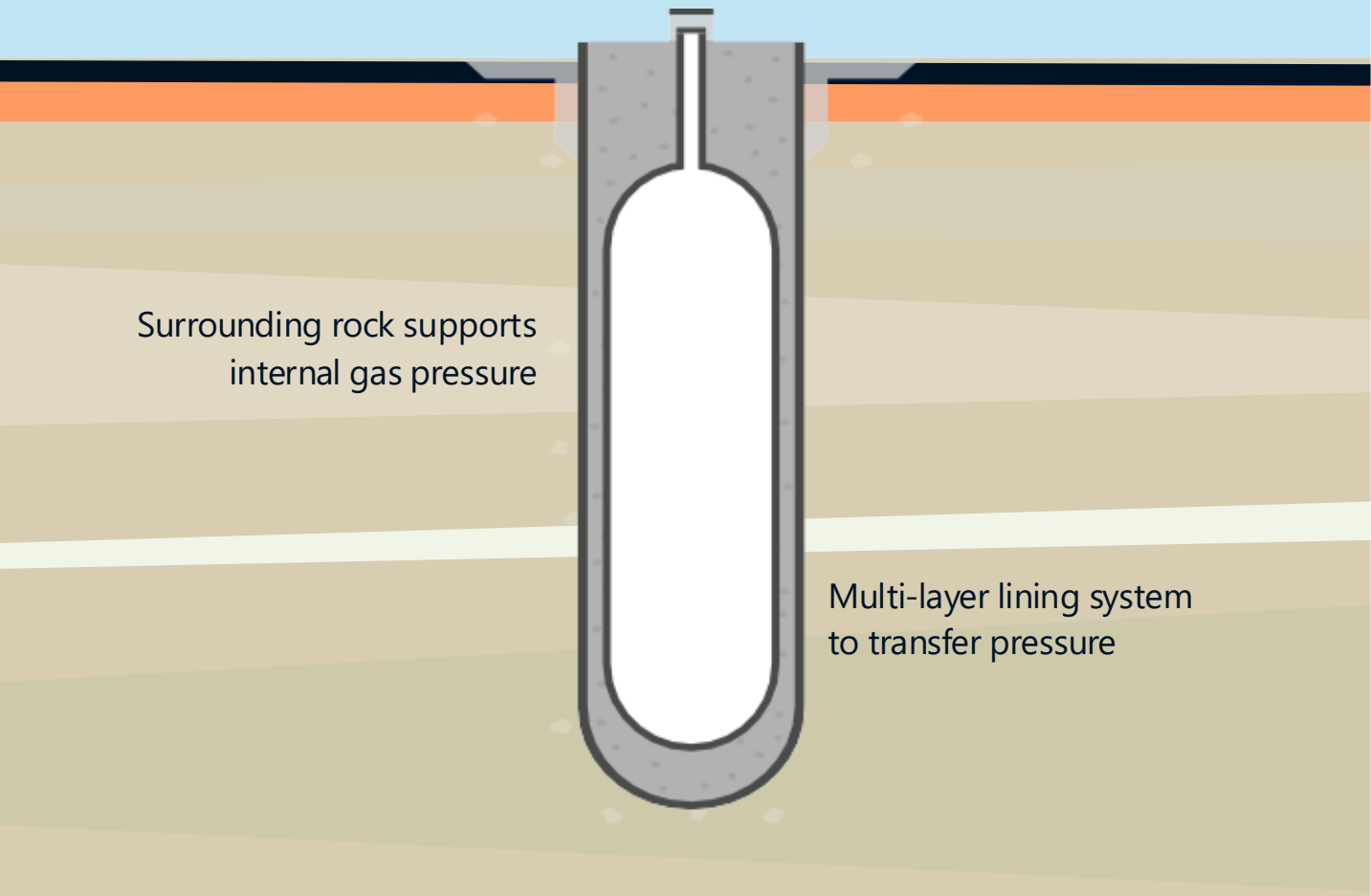
LRS Technology for H₂ Storage

Capacity: 10-100 tonnes at 200 bar

Chemical energy: 3.3 GWh

Electrical energy: 1.6 GWh

Size: 200-300m deep x 4-6m Diameter



Safety sub surface



Cost competitive



Geologically flexible



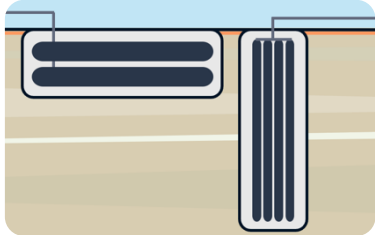
Mid-scale capacity



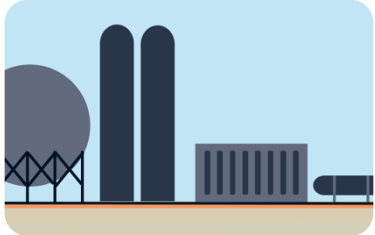
Small-scale storage

High material cost
Large footprint
OPEX costs

Buried vessels



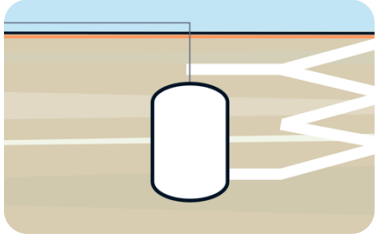
Surface vessels



Mid-scale storage

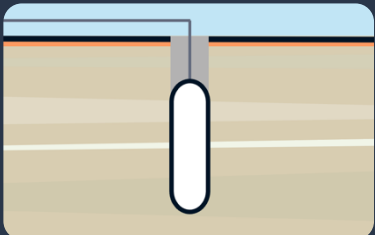
Geological constraints

Lined Rock Caverns



Geologically flexible

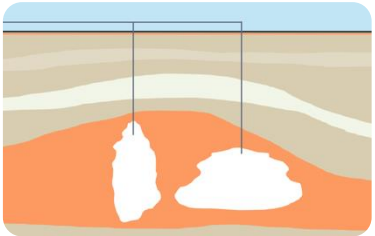
Lined Rock Shafts



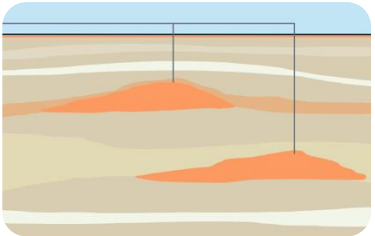
Large-scale storage

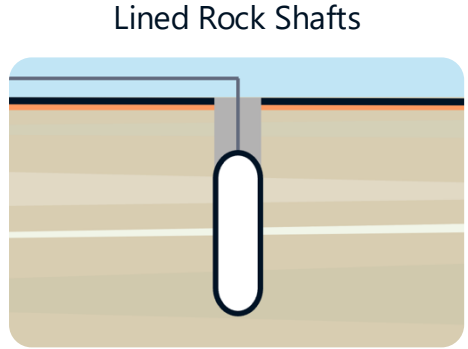
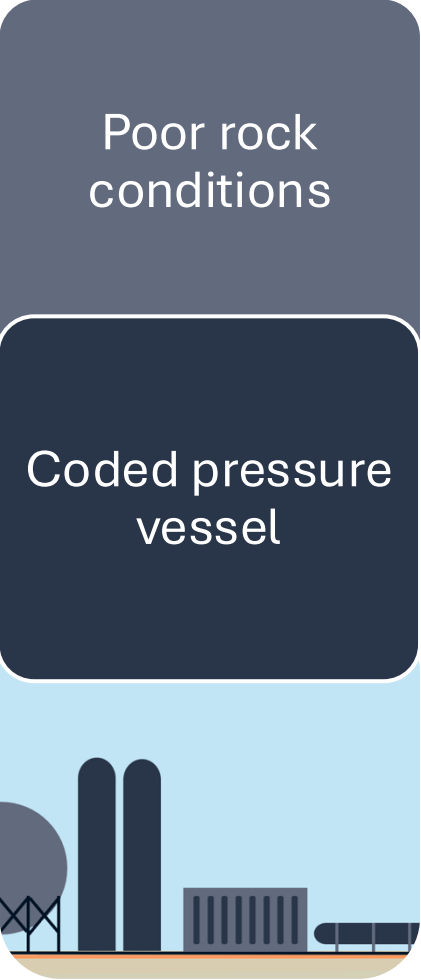
Geological deposits
Technical challenges
Time for deployment

Salt Caverns



Porous Reservoirs



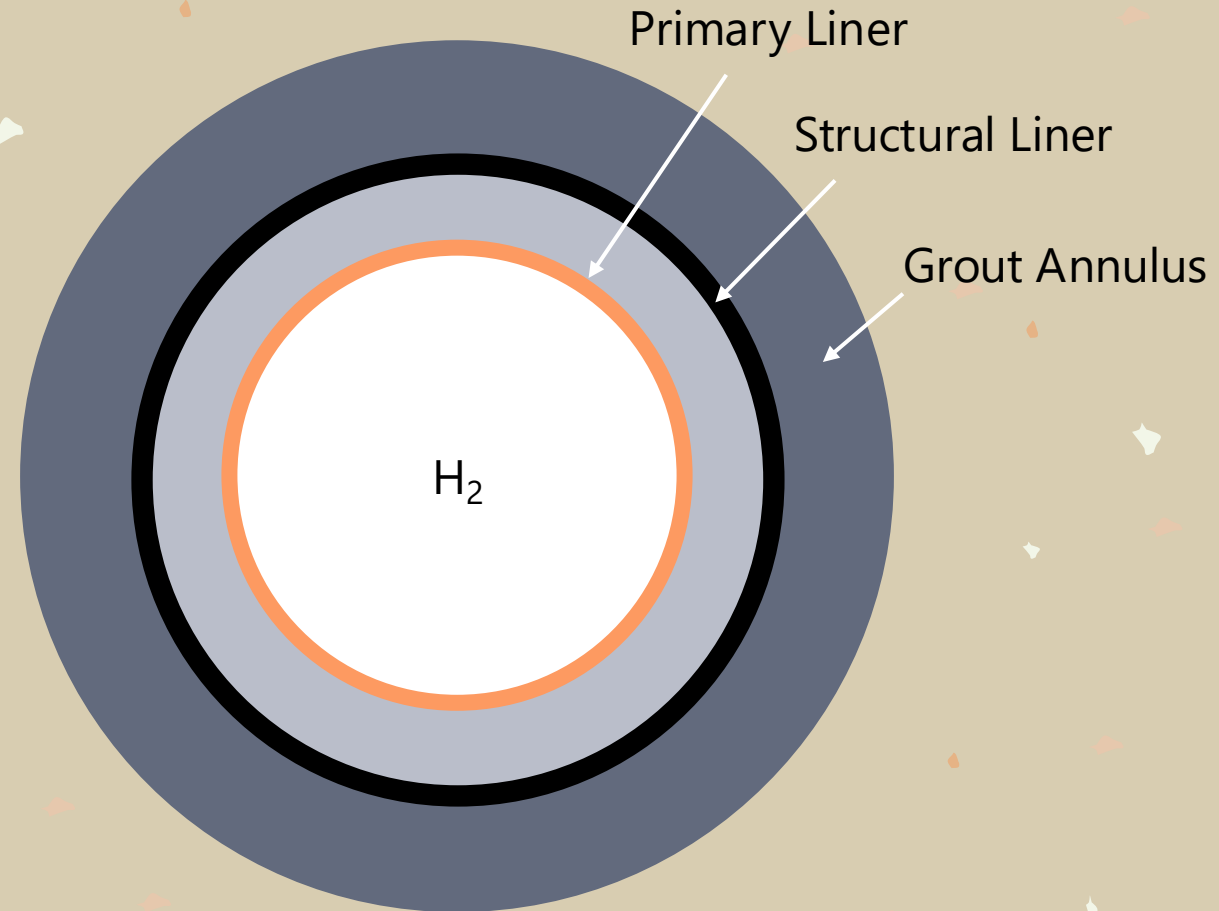


Gas Containment

- Multi-layer shaft liner to contain gas and transfer loading to rock mass
- Gas-tight steel liner (primary liner)
- Structural liner to transfer load to rock mass
- Grout annulus between lining system and rock mass

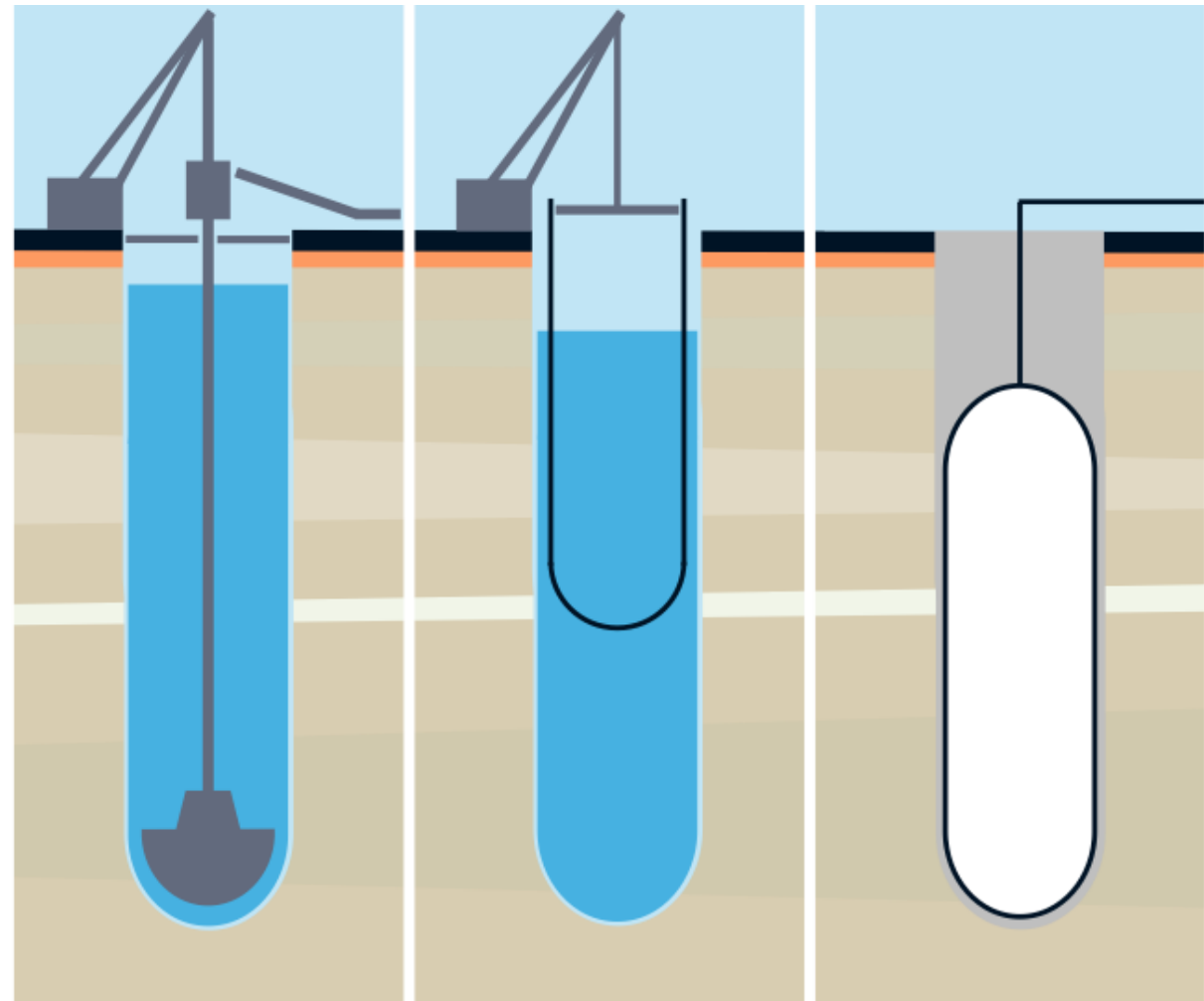
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Rock



Construction and Installation

- Well-established shaft sinking methods such as blind boring or reverse circulation drilling
- Flooded to support shaft walls and aid installation
- Primary and structural liner lowered in sections
- Annulus between shaft liners and ground filled with cementitious material



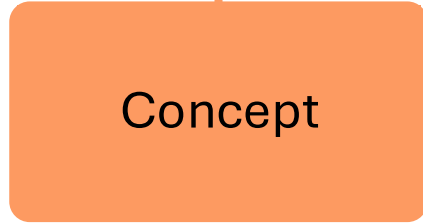
Flooded shaft drilling

Liners lowered

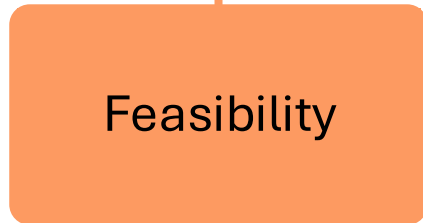
Annulus grouted



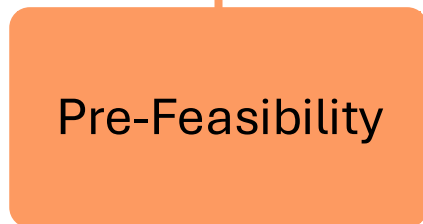
Ofgem SIF (Alpha):
2025



Ofgem SF (Discovery):
2024



EETF: 2023

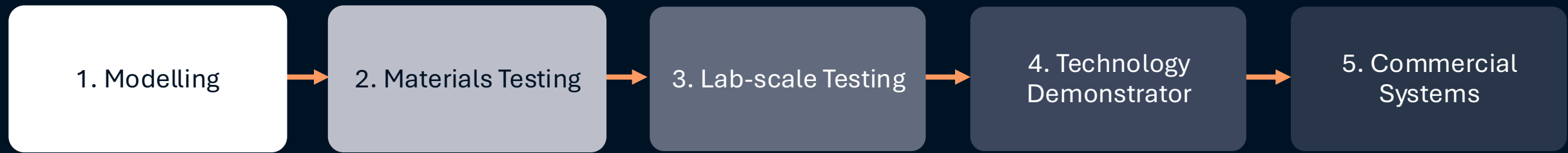


BEIS: 2022

2021

- Design in now at a level of maturity to begin FEED and detailed design.
- End-to-end modelling of Green Steel plant highlighted that LRC technology significantly reduces LCOH compared to other storage assets.
- £2Bn saving: Result of CBA for implementing LRS storage solution in existing UK gas network.





Determine behaviour of system in varying geological conditions

Understand impact of hydrogen embrittlement on primary liner

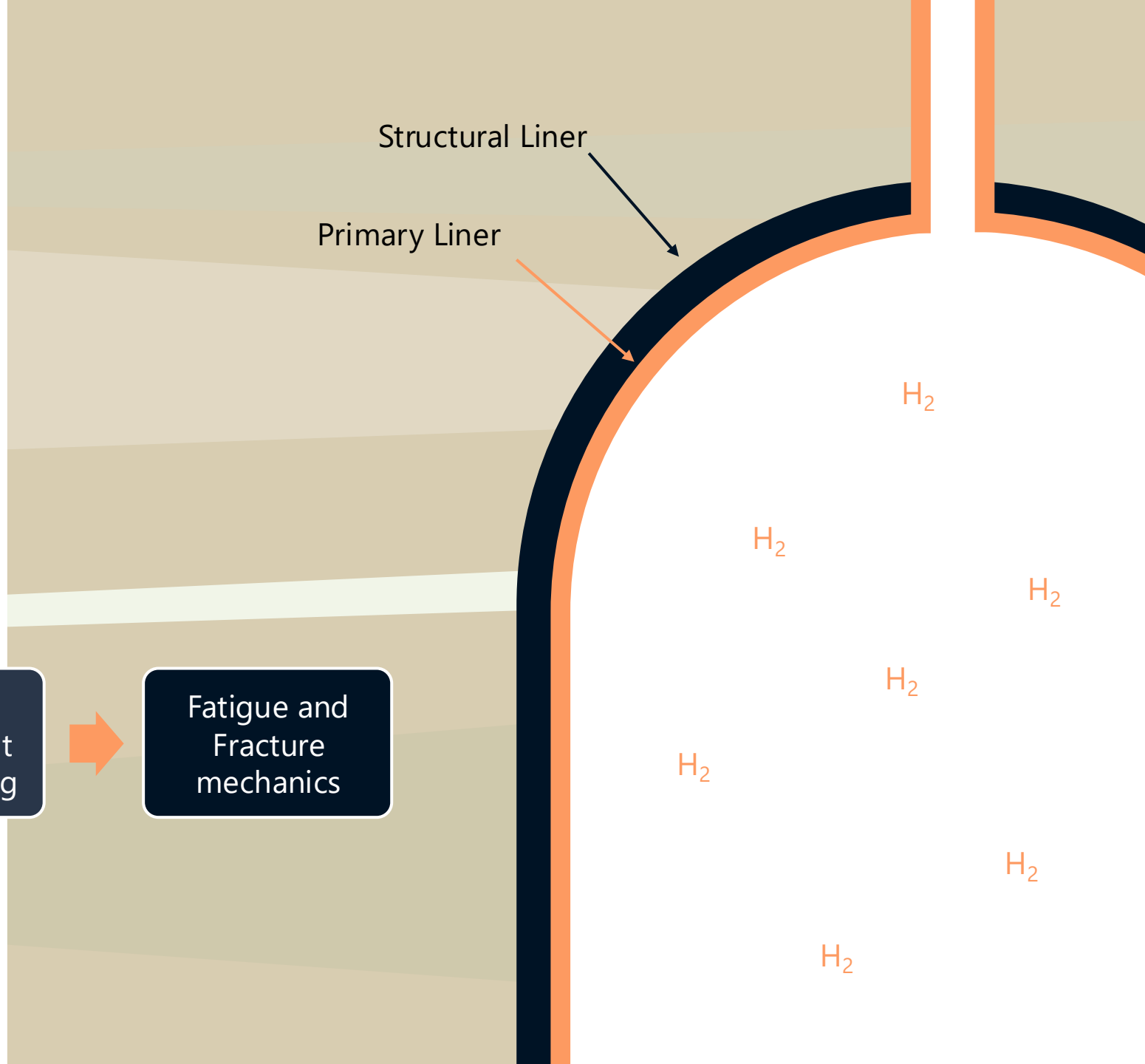
Validate multi-layer liner behaviour subject to pressure

Validate multi-layer liner behaviour with rock support

Fully de-risked using learnings and design data from testing

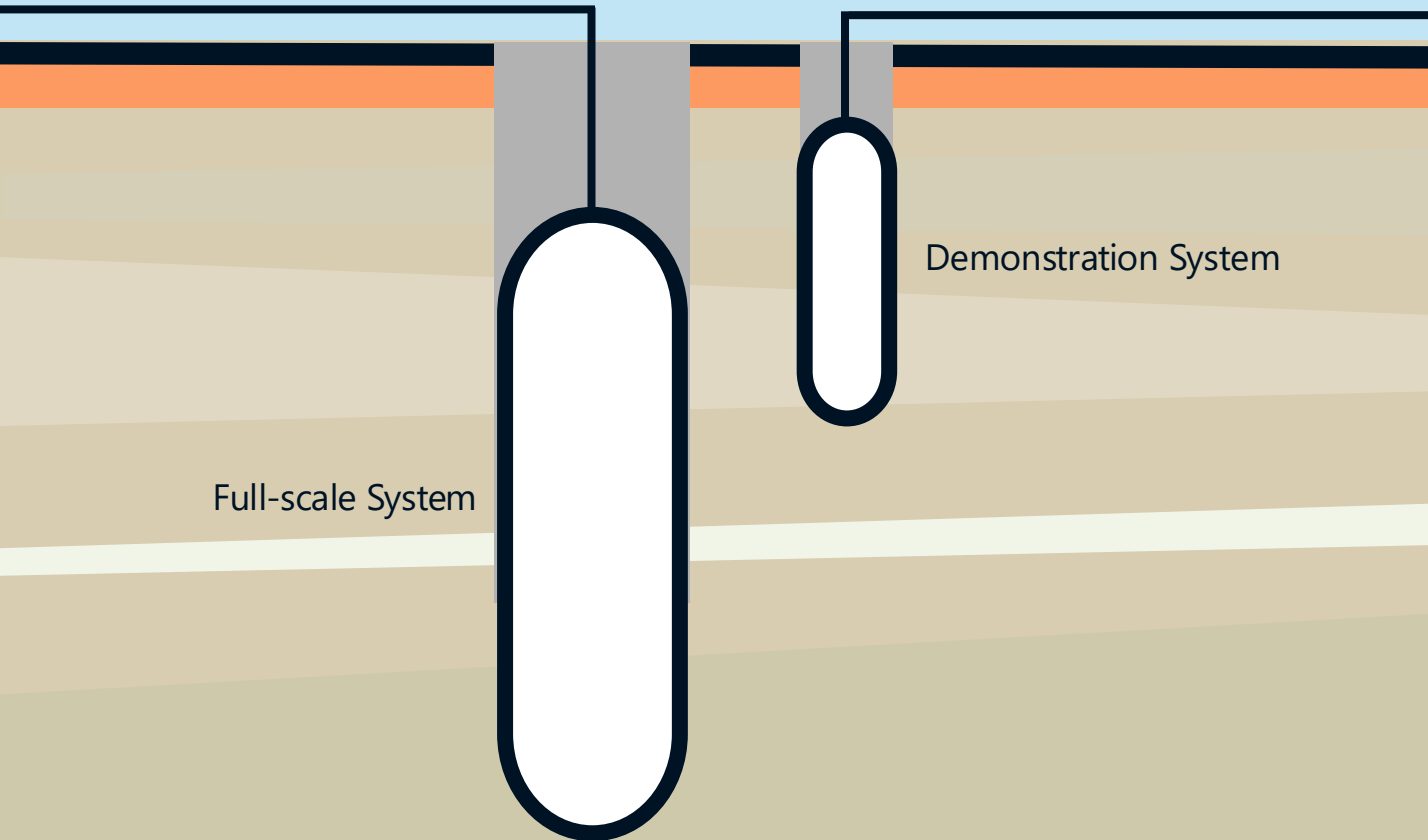
Materials testing program

- Hydrogen embrittlement risk
- Published literature in-sufficient
- Developed materials test program with Swerim
- Design development and validation testing
- Gaseous testing using hollow samples and traditional methods in autoclaves



Technology Demonstration

Capacity: 0.5 tonnes at 200barg
Size: 60-80m deep x 2.5m diameter



- Focus of development work
- Reduced size and storage capacity
- Validate system modelling and testing
- Build partnerships and develop supply chain



**De-risk &
Performance**



**Safety &
Commissioning**



**Commercial
Value**

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Test Program

2 years
5000 pressure tests



Commissioning

- Containment & non-containment
- Hydrotest pressure cycles up to 200bar including overpressure test
- Performed over a period of approx. 3-4 months.

Operational testing

- Hydrogen testing demonstrating system performance
- Linepack supplementation testing
- Performed over a period of approx. 3-4 months.

Accelerated Life testing

- 4,900 hydrotest pressure cycles from 30-200bar
- Performed over a period of approx. 14 months.

Nitrogen and Helium

- Purging & leak testing throughout commissioning and testing program

- **Only viable solution** for mid-scale geographically flexible storage for hard-to-abate industries
- Industrial users, gas pipelines, export/import, transport hubs
- UK gas grid transition – **16 systems** (2029/30)
- Large Steel Plant – **10 systems** (2029/30)
- **\$3.5bn** Project Pipeline
- **\$1.4bn+** Revenue in next 10 years

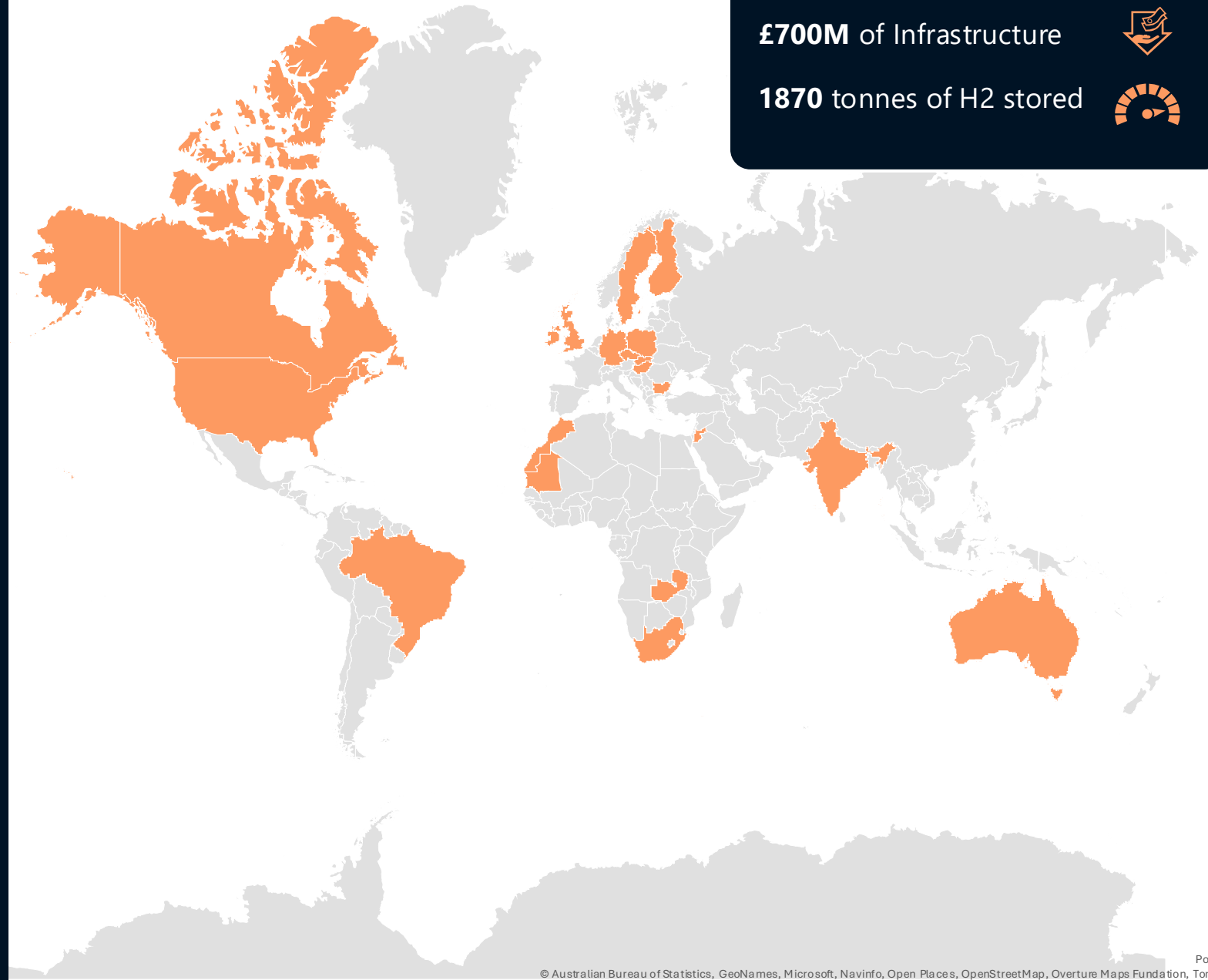
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By 2030

£700M of Infrastructure



1870 tonnes of H2 stored



Next steps

Funding opportunities to continue technology development

Support industrial and academic projects for underground hydrogen storage

Discuss interesting projects and new technologies within renewables industry



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