FutureGrid

IPLOCA
25th April 2024

national gas

The National Transmission System (NTS)

The role of gas:

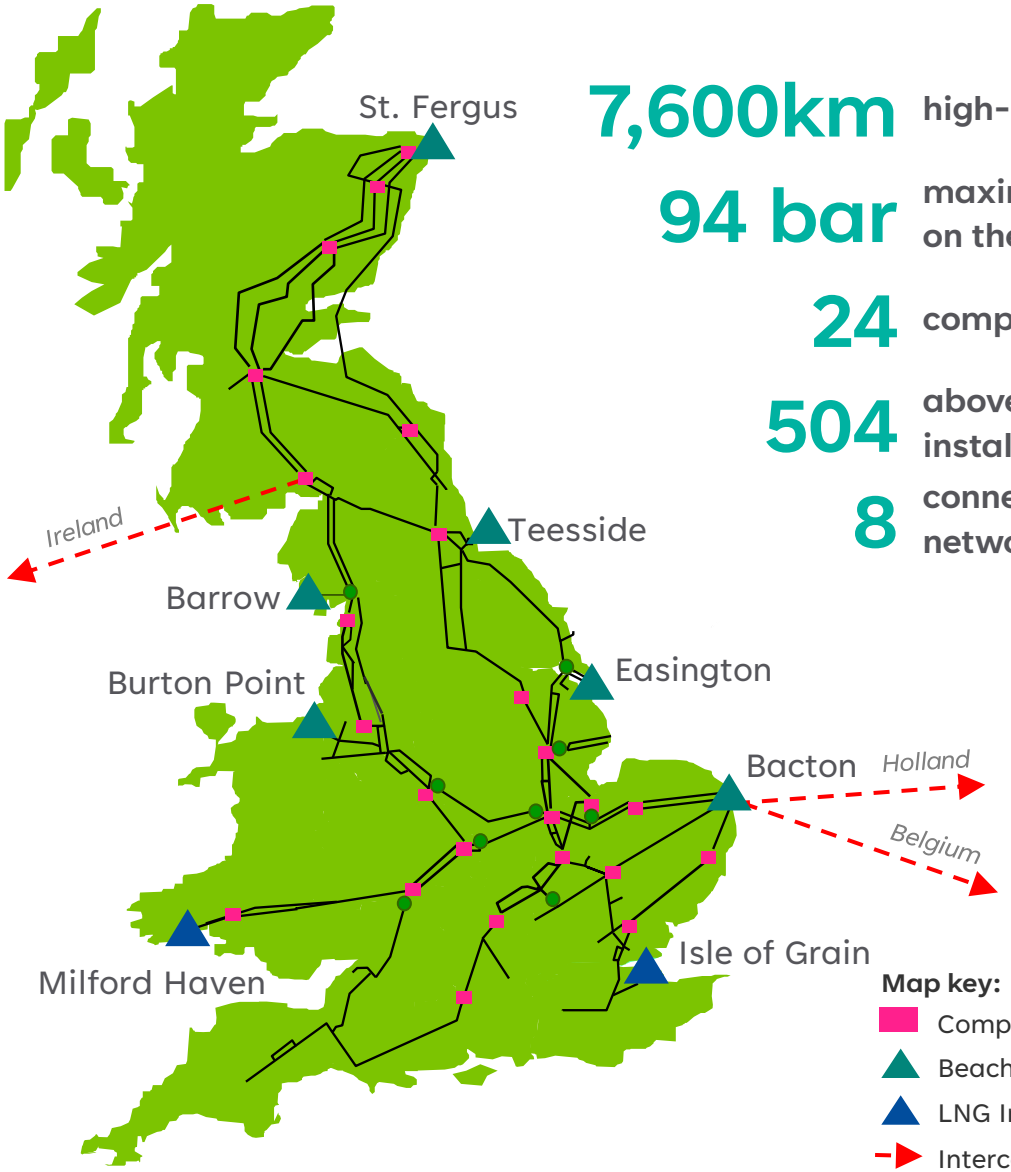
23m
gas customers across the UK

85%
households using gas for heat

881TWh
of energy is delivered by NTS

UK gas demand:

39%	38%	23%
Power Generation	Domestic Use	Industrial & Commercial



7,600km high-pressure pipe

94 bar maximum pressure on the network

24 compressor stations

504 above-ground installations

8 connected distribution networks

Greening Natural Gas

Renewable Bio-gas or synthetic fuels for hard to electrify options could be used in the transition

CCUS

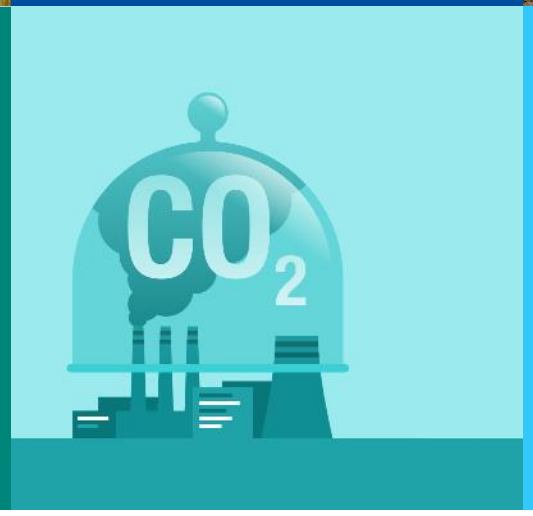
Alongside the use of Natural Gas and its derivatives this could enable us to be Net Zero

Continued Use of Natural Gas

Some users in the UK are hard to electrify, natural gas with carbon capture could support

Hydrogen

Green and Blue hydrogen along with Pink, Yellow etc... will have a role in the future decarbonisation



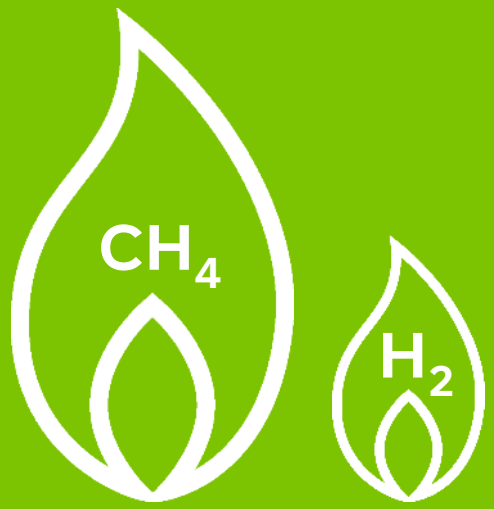
Electrification

Power generation using gas (natural gas or hydrogen) is required to fill the gap when renewables are not available

Net Zero Opportunities for the NTS

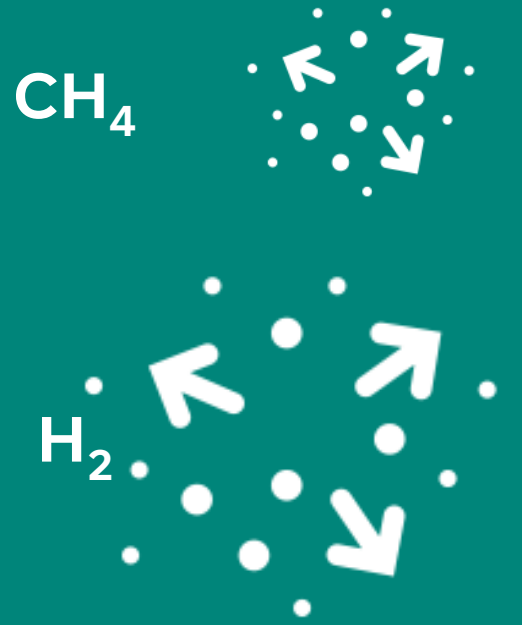
Pathways to Net Zero are expected to require a combination of approaches and technologies

Hydrogen as a fuel

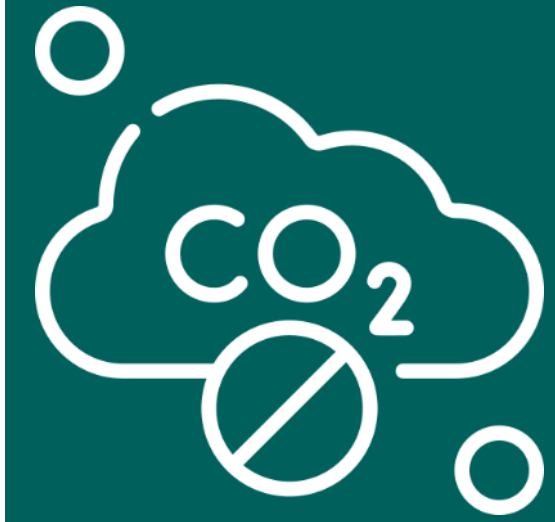


Hydrogen has 1/3 of the energy density of methane

Hydrogen can be be burned like methane and used in homes



Hydrogen disperses more quickly than methane



Hydrogen is a cleaner fuel and doesn't emit CO_2 like methane

Hydrogen applications

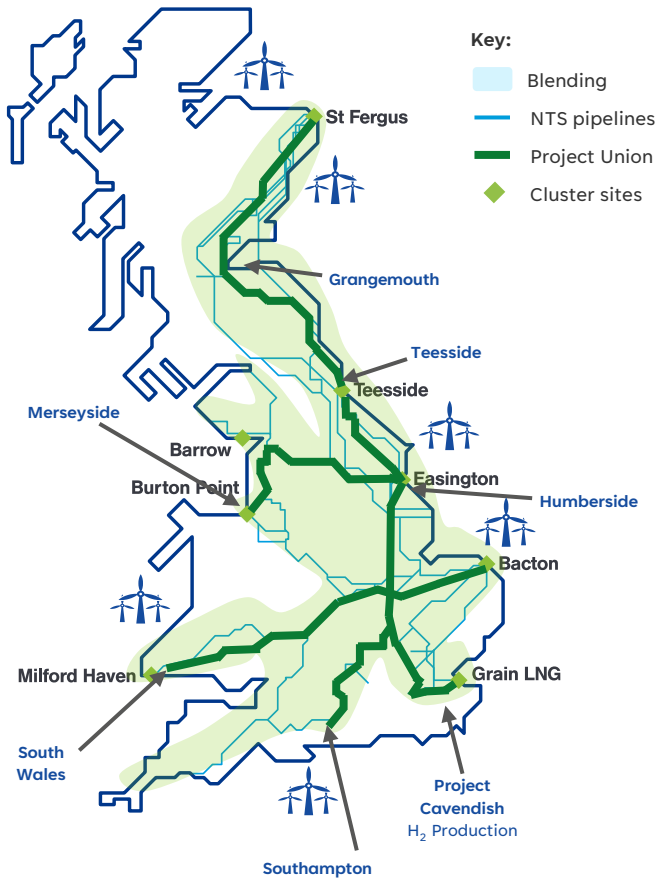
Industry

Power

Transport

Heat

Dual Pathway to a hydrogen NTS: hydrogen blending and rollout of 100% hydrogen pipelines



Rollout of **blending** across the NTS

Strategic rollout of **100% pipeline** connections

Delivering a Dual Pathway to transitioning the NTS to hydrogen:

- In 2024/5 low level hydrogen blending on will be facilitated on the transmission network
- From 2025 onwards blending could extend and increase up to 20% - more if deblending technology can be proven.
- In 2028/9 Project Union will deliver the first phases of 100% hydrogen transmission pipeline between the northern clusters
- By 2033 Project Union will have delivered a circa 2000km hydrogen backbone joining key production and use clusters
- Asset conversion continues to 2045 to deliver a complete 100% hydrogen network.

Net Zero 2050

Levelling up, Job Creation

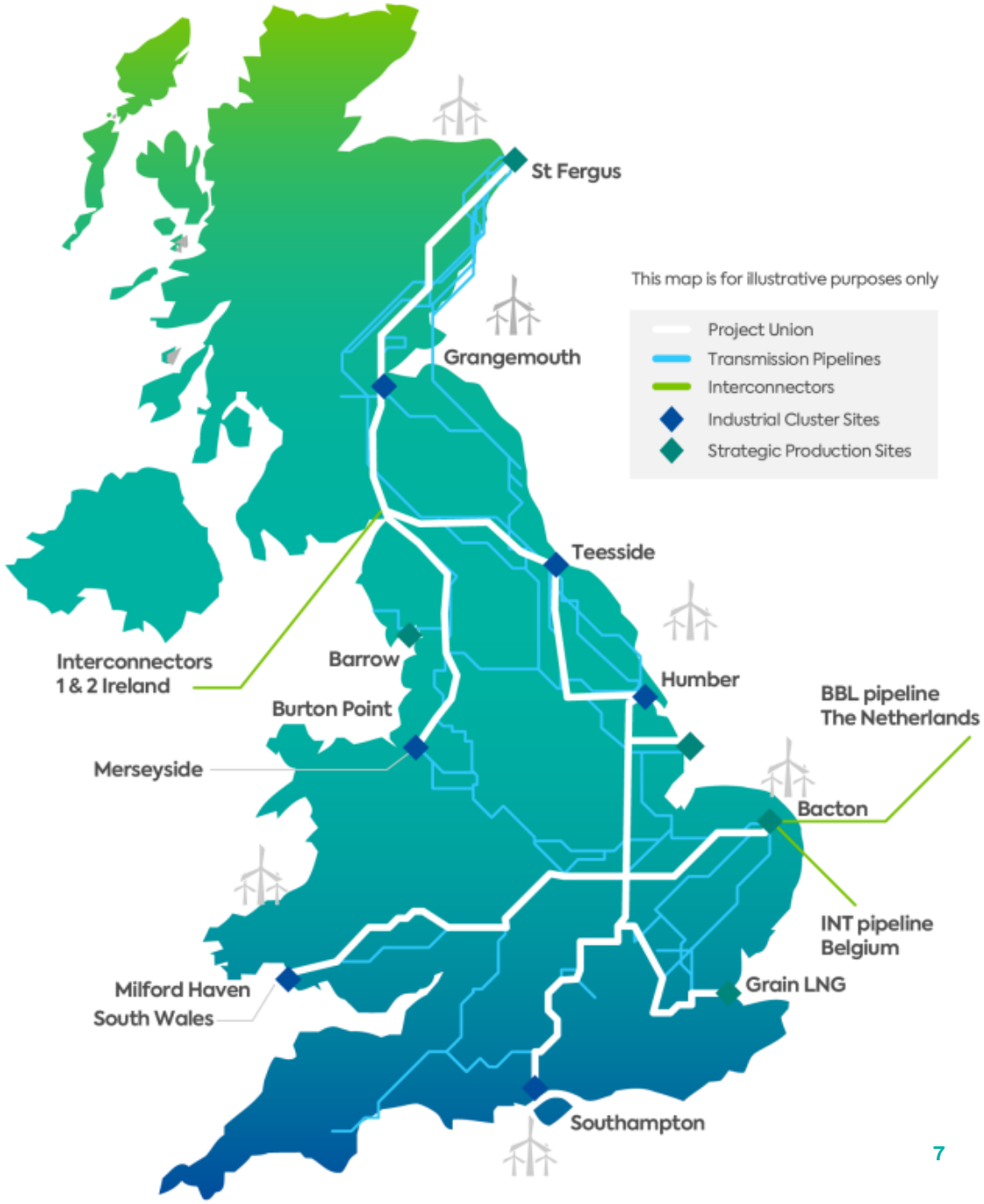
Global Leader in Green Innovation

Providing flexibility and optionality

ProjectUnion

Project Union will connect, enable net zero and empower a UK hydrogen economy, by creating a hydrogen 'backbone' for the UK by the 2030s.

- ~2,500km hydrogen transmission network
- Connect cross GB supply, demand and strategic storage sites
- Use existing infrastructure
- Enable early and affordable market growth of a low carbon hydrogen economy



Getting to the Hydrogen Safety Case

Gas Safety (Management) Regulations & Pipeline Safety Regulations Updated or Deviations attained

Project Union & Blending Commence

Pipeline Section Specific Quantitative Risk Assessment

Health & Safety Executive Review

HyNTS Safety Case for:
- 100% Hydrogen
- <25% Hydrogen Blends

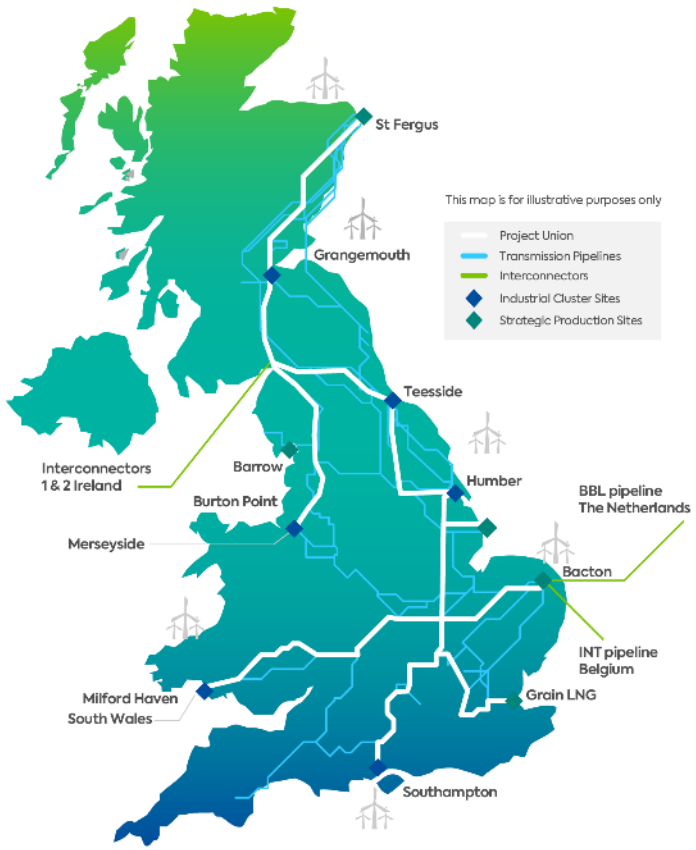
Engineering & Operational Standards and Policies

Regulation	Standards, Policies & Procedures	Surveillance Inspection & Reporting	Operational Procedures & Maintenance Work Instructions	Competence & Skills

Technical Evidence

Asset Capability	Asset State	Hazard Potential	Data & Systems	Benchmarking	Business Process	System Design	Trials & Testing

BUILDING EVIDENCE



HyNTS FutureGrid

HyNTS Innovation Programme

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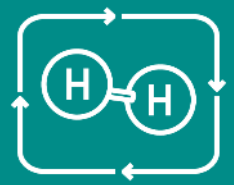
A high-pressure hydrogen test facility using decommissioned transmission assets, to demonstrate the National Transmission System (NTS) can transport hydrogen safely and reliably.

Standalone hydrogen Tests
Standalone hydrogen test modules are operating alongside the main test facility, to provide key data required to feed into the main facility.



Offline hydrogen test facility
A representative range of NTS assets of different types, sizes, and material grades have been supplied from decommissioned assets to build the test facility.

Four key hydrogen concentrations are being tested:

- 2% hydrogen gas
- 5% hydrogen gas
- 20% hydrogen gas
- 100% hydrogen gas

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Offline hydrogen test facility

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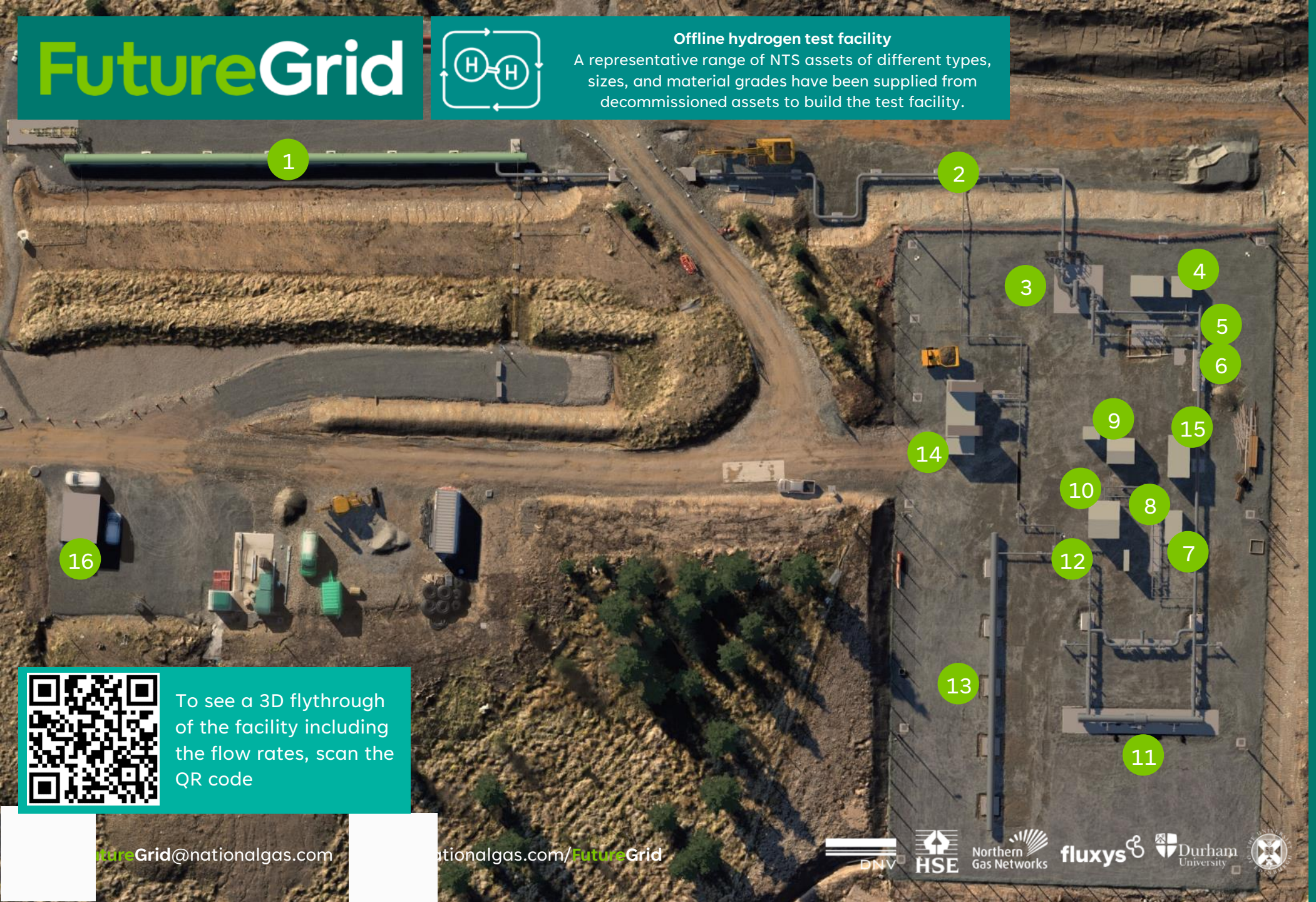

1. High pressure storage
2. Ball valve arrangement
3. Filter
4. Ultrasonic meter
5. Flow control valve
6. Non-return valve
7. Filter skid
8. Orifice plate meter
9. Boiler house & heat exchanger
10. Regulator skid
11. Pipeline isolation valve
12. Flow control valve
13. Low pressure storage
14. Recompression unit
15. Data centre
16. Control room

To see a 3D flythrough of the facility including the flow rates, scan the QR code

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Phase 1 Facility

Testing Timeline

Offline test facility

25 Dec to 31 Dec	1 Jan to 7 Jan	8 Jan to 14 Jan	15 Jan to 21 Jan	22 Jan to 28 Jan	29 Jan to 4 Feb	5 Feb to 11 Feb	12 Feb to 18 Feb	19 Feb to 25 Feb	26 Feb to 3 Mar	4 Mar to 10 Mar	11 Mar to 17 Mar	18 Mar to 24 Mar	25 Mar to 31 Mar

2% Hydrogen testing

5% Hydrogen testing

20% Hydrogen testing

100% Hydrogen testing

Closure Final Report Delivered

2%
hydrogen in natural gas

Initial Observations
- No differences observed during testing operations.
- Initial data review does not identify any deviation from 100% NG baseline.
- More thorough review of asset performance data being carried out to confirm.

5%

Initial Observations
- No differences observed during testing operations.
- Initial data review does not identify any deviation from 100% NG baseline and 2% H2.
- More thorough review of asset performance data being carried out to confirm.

20%

Initial Observations
- No differences observed during testing operations.
- Initial data review does not identify any deviation from 100% NG baseline and 2/5% H2.
- More thorough review of asset performance data being carried out to confirm.

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Standalone hydrogen Tests

Standalone hydrogen test modules will operate alongside the main test facility, to provide key data required to feed into the main facility.

Material permeation testing

These tests are seeking to determine the rate at which hydrogen permeates through the pipe wall in a pressurised hydrogen environment.

Pipe coating and CP testing

This is the assessment of hydrogen impact on external pipe coatings as well as the cathodic protection system to identify any issues.

Flange testing

These tests will assess the effect of hydrogen on RF and RTJ flanged joints.

Asset leak testing

Hydrogen is more prone to leaking than natural gas. These tests will help determine the leakage rates and mitigations required.

Rupture testing

Investigating overpressures caused by delayed ignition of ruptures on a buried line containing 100% hydrogen.

Fatigue testing

Hydrogen asset fatigue testing 36” X60 pipe with 9 different weld types used twice. Running 75k cycles ~ 200 years service

22,000

pressure cycles completed

as of October 2023

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FutureGrid safety & risk management

There is a fundamental difference between how natural gas and hydrogen behaves. We must be able to understand the impacts of different concentrations of hydrogen and develop our safety standards

Procedure Review	Categorisation of NG procedures as high, medium, low impact with a report detailing the methodology findings and next steps for each.
Hazard Assessment of the Transmission System (HATS)	Assess impact of hydrogen on MAPD. Provide an updated HATS for the NTS pipelines, based on the network transporting hydrogen instead of Natural Gas.
Quantitative Risk Assessment (QRA)	Record and update the Hazard Assessment Methodology Manual (HAMM) where deviations are required for assets transporting Hydrogen.
Hazardous Area Impact	Hazardous Area Drawings will be produced for each asset type at 20% & 100% hydrogen and compared to existing Natural Gas drawings. IGEM also working on SR/25 update for hydrogen.
Overpressure Risk (OR)	Identify whether the existing methodology can be adapted for 100% hydrogen. If needed, develop an appropriate methodology for risk analysis and emergency planning purposes.
National Gas Transmission (NGT) Safety Case	Assess and update the NGGT safety case (policies, procedures and work instructions) depending on the impact of hydrogen. Review will involve SMEs.

FutureGrid

Spadeadam Facility

A global-first, world-class facility

national gas

FutureGrid Compression

FutureGrid Compression provides a technical demonstration of hydrogen compression up to 100% hydrogen and will create a strategy for the transition of the UK NTS compression fleet to hydrogen.

This project will develop evidence that our existing compressor fleet can be modified for hydrogen use in a cost-effective manner

A decommissioned gas turbine representative of the current fleet will be fuelled by different blends of hydrogen up to 25% then following modifications upto 100% hydrogen

The full compression system including the power turbine, gas compressor and the cab and ancillary equipment will undergo comprehensive offline testing as part of the FutureGrid facility

A 1km compression test loop will be constructed out of decommissioned NTS assets to test the compressor systems in a range of hydrogen scenarios.

This will demonstrate the capability of both the rotating machinery package and the full system and will give an understanding of how these would operate on a hydrogen network.

This testing is key to provide technical and safety evidence that demonstrates the compression assets can be repurposed for hydrogen blends up to 100% hydrogen

The outputs of this project will ultimately help develop the business case for repurposing compression assets as part of Project Union, National Gas' 100% hydrogen backbone across the UK

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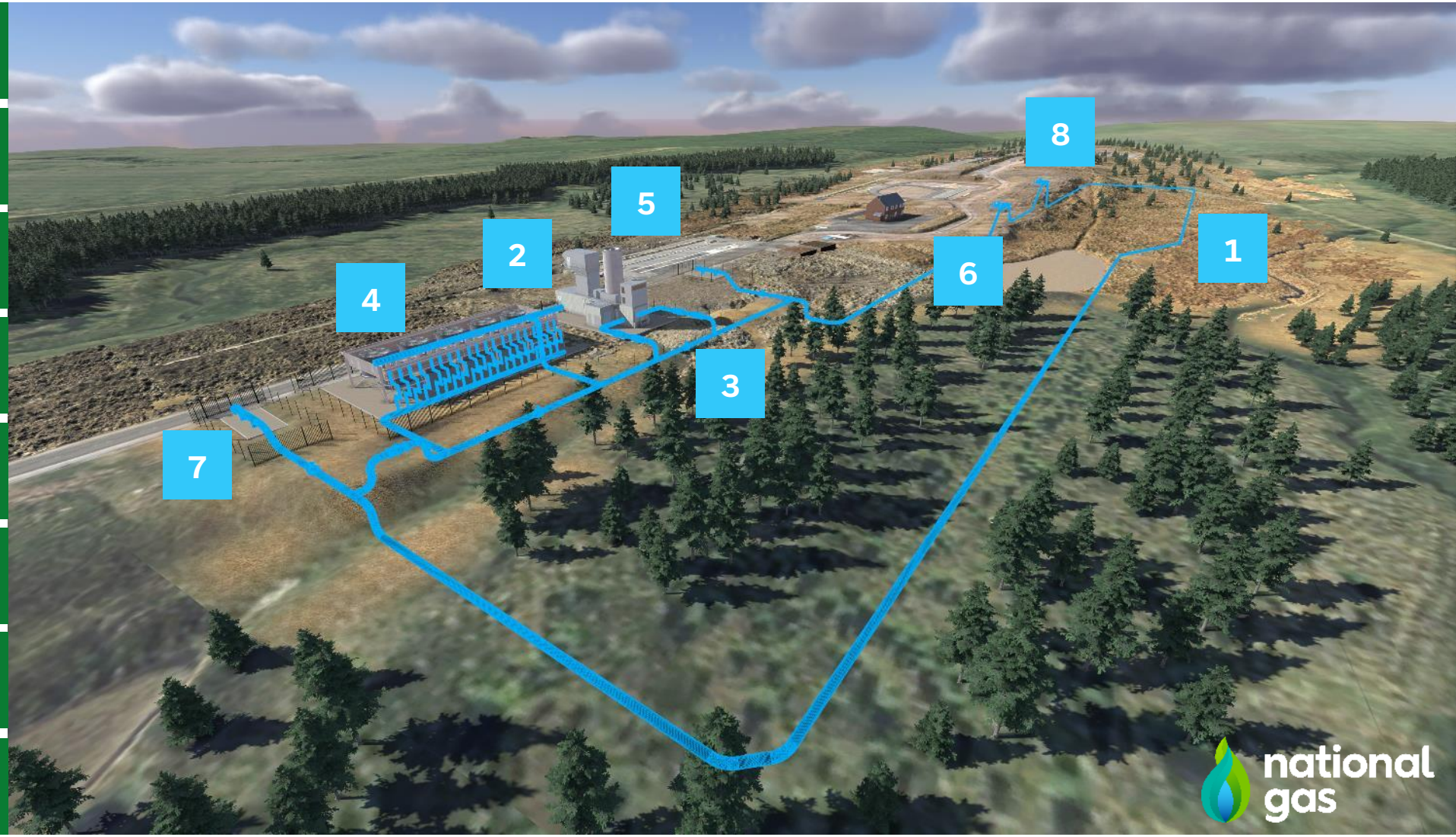
Layout for HyNTS Compression facility

1. 1km High pressure 36” pipeline
2. A20 Gas Turbine Upgraded combustion can to utilise H2 <100%
3. Gas Compressor Repurposed from NTS and replaced for 100% H2
4. Aftercooler to prevent test loop overheating
5. H2 & CH4 Storage 48” 450m x2
6. Buried Pipework to enable operational maintenance testing
7. PIG Traps to enable access to the test loop & for future testing
8. FutureGrid & HyNTS control room



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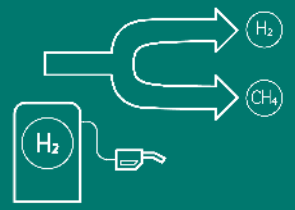
Deblending



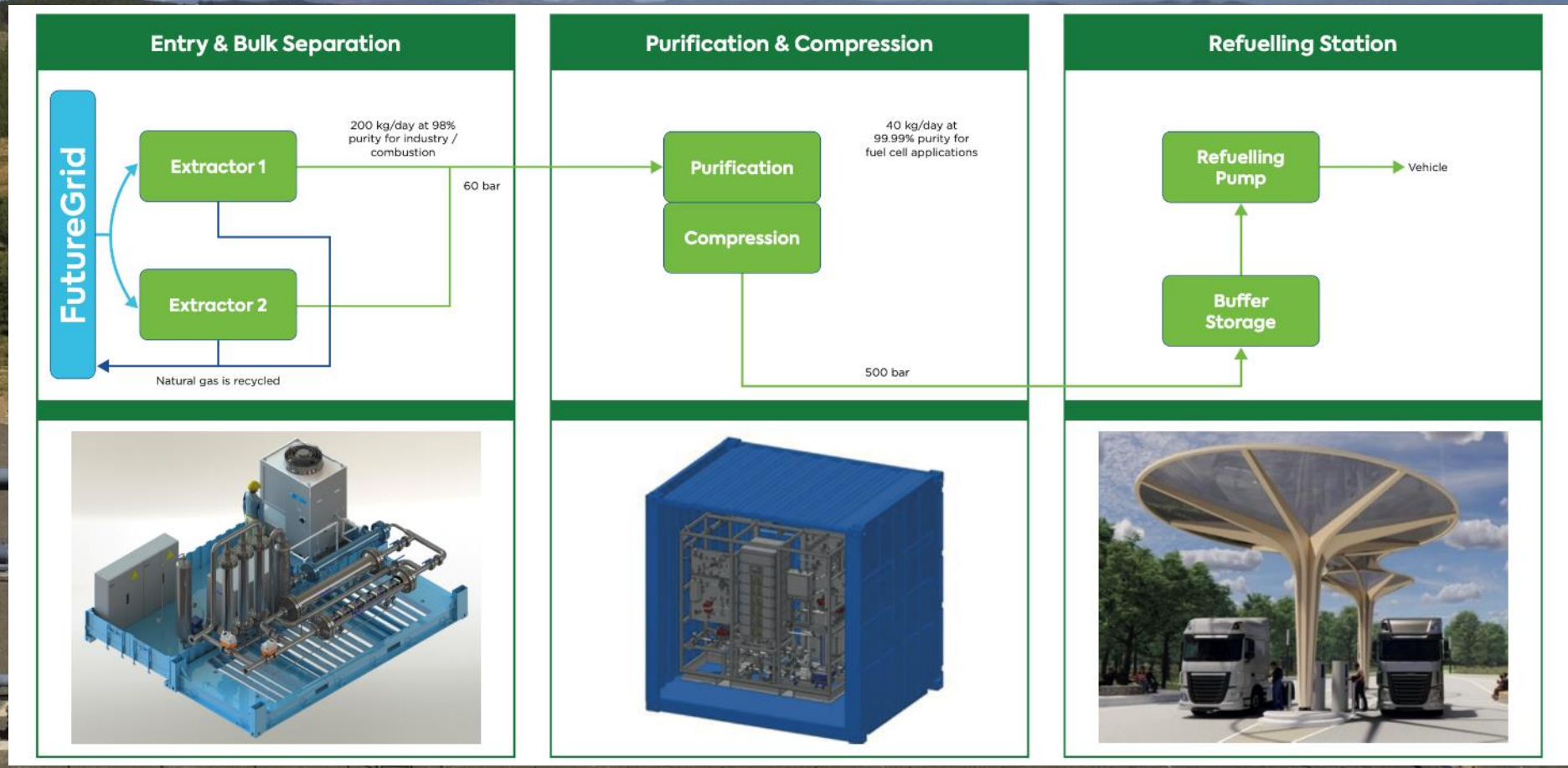
FutureGrid Deblending for transport focuses on the separation of hydrogen from a natural gas blend for use in industry and to demonstrate the purification and compression of hydrogen for hydrogen refueling of vehicles.

This project focuses on the deblending of gases within the high-pressure National Transmission System (NTS) to enable delivery to transport applications.

Without this technology, refuelling of transportation assets will be limited to the use of locally produced hydrogen, until the gas networks can transport 100% hydrogen.

The project will showcase the full process, starting with taking blended transmission gas through the Electrochemical separation system which purifies and compresses the gases, culminating in refuelling hydrogen vehicles of a variety of sizes.

The project will also develop low-cost mobile solutions for deblending and purification that can be migrated around the UK networks as we transition to 100% Hydrogen



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Q&A

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