HyDeploy: The Hydrogen Blend Safety Case

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Agenda

1. Energy Landscape
2. Project Overview
3. Regulatory Structure
4. Safety Case
5. Technical Evidence Highlights

Consortium Partners

Cadent

Northern Gas Networks

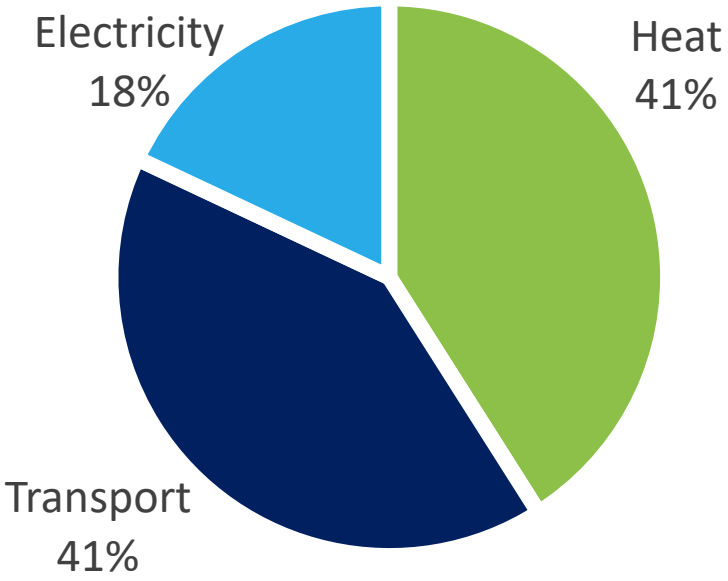
PROGRESSIVE ENERGY

ITM POWER
Energy Storage | Clean Fuel

HSE

Keele UNIVERSITY

Energy Landscape



Heat dominates UK energy consumption compared with electricity

Based on UK Energy Consumption Data 2019, BEIS

The UK energy system must become net-zero by 2050

"Moving beyond an 80% target changes hydrogen from being an option to an integral part of the strategy."

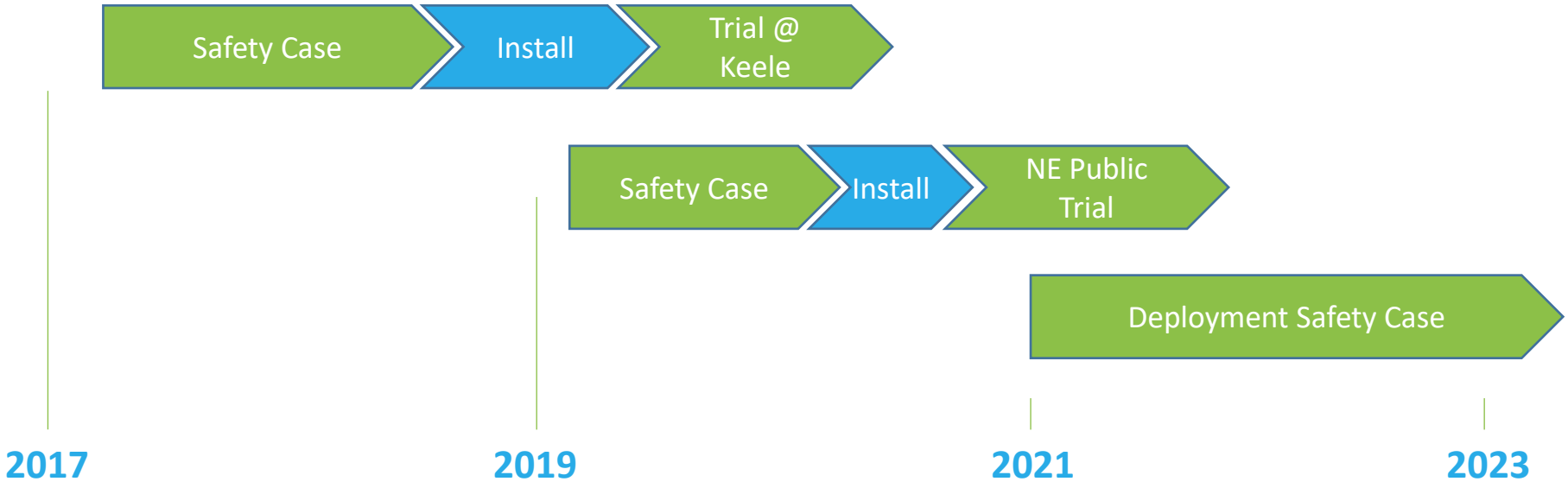
Net Zero Report, Committee on Climate Change, May 2019

Hydrogen Pathway

- Hydrogen blending means…
  - ✓ No change for consumers
  - ✓ Hydrogen supply chain development
  - ✓ Carbon savings equivalent to 2.5 million cars off the road
  - ✓ Deliverable roadmap for deeper savings

Hydrogen Pathway

To enable bulk deployment of hydrogen blending within the UK gas network by demonstrating its safe transportation and use.



Project Funded under OFGEM's Network Innovation Programme

Gas Safety (Management) Regulations GS(M)R

- GS(M)R governs gas quality in the UK grid. Schedule 3 specifies gas quality composition.

SCHEDULE 3 — Regulation 8

CONTENT AND OTHER CHARACTERISTICS OF GAS

PART I

REQUIREMENTS UNDER NORMAL CONDITIONS

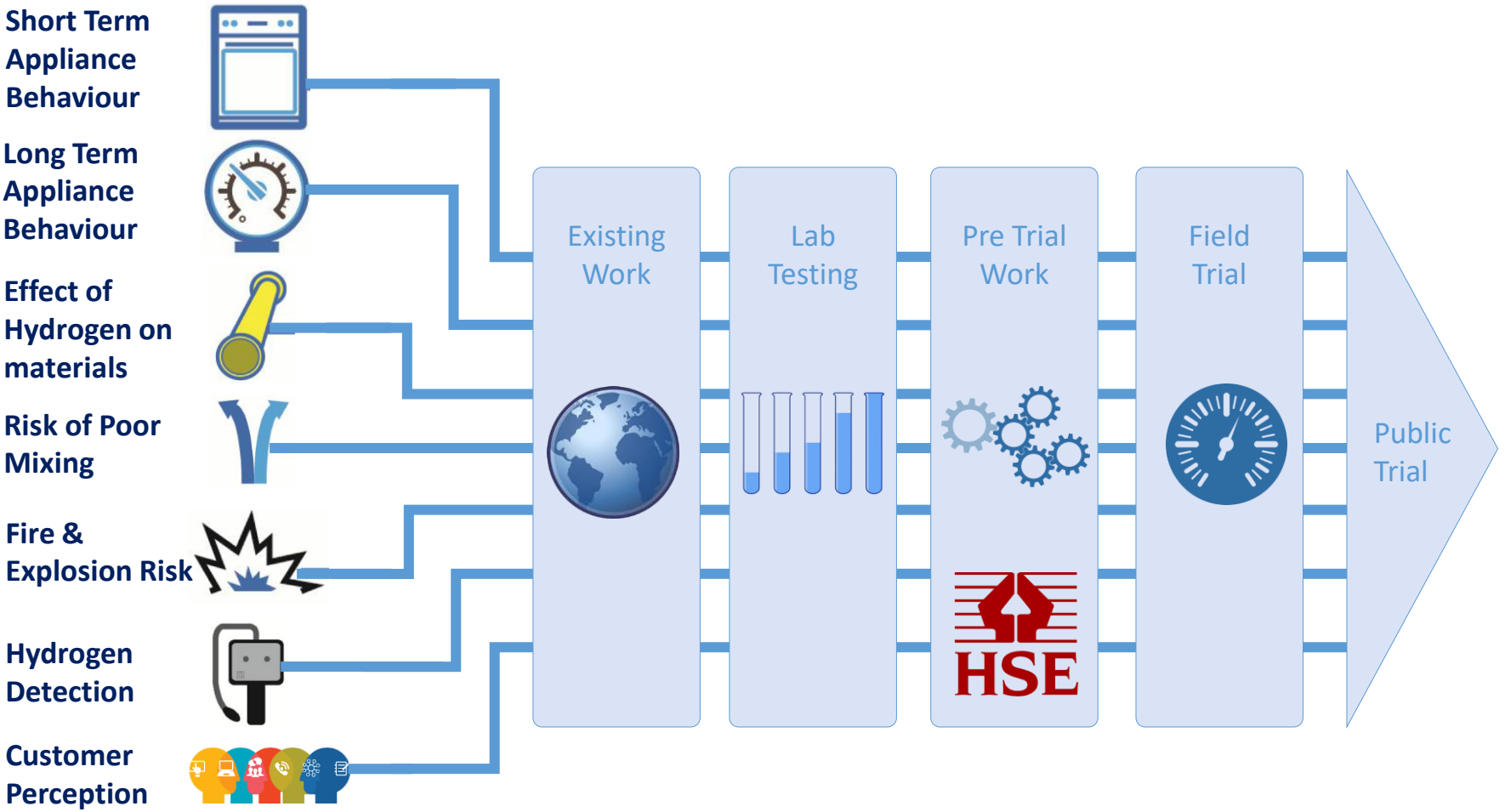
1. The content and characteristics of the gas shall be in accordance with the values specified in the following table.

Content or characteristic	Value
hydrogen sulphide content	≤5 mg/m^3;
total sulphur content (including H_2S)	≤50 mg/m^3;
hydrogen content	≤0.1% (molar);
oxygen content	≤0.2% (molar);
impurities	shall not contain solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance (within the meaning of regulation 2(1) of the 1994 Regulations) which a consumer could reasonably be expected to operate;
hydrocarbon dewpoint and water dewpoint	shall be at such levels that they do not interfere with the integrity or operation of pipes or any gas appliance (within the meaning of regulation 2(1) of the 1994 Regulations) which a consumer could reasonably be expected to operate;
WN	(i) ≤51.41 MJ/m^3, and **(ii)** ≥47.20 MJ/m^3;
ICF	≤0.48
SI	≤0.60

GS(M)R Exemption

- An HSE Exemption is therefore required to transport gas with > 0.1 mol% hydrogen.
- The basis of an Exemption is that “persons affected by the exemption, will not be prejudiced in consequence of it”. Therefore, evidence base required to demonstrate 20% hydrogen is ‘as safe as’ natural gas for the trial.
- HyDeploy achieved UK’s first hydrogen Exemption in November 2018 for the Keele trial.

Building the Safety Case



Rigorous Risk Analysis

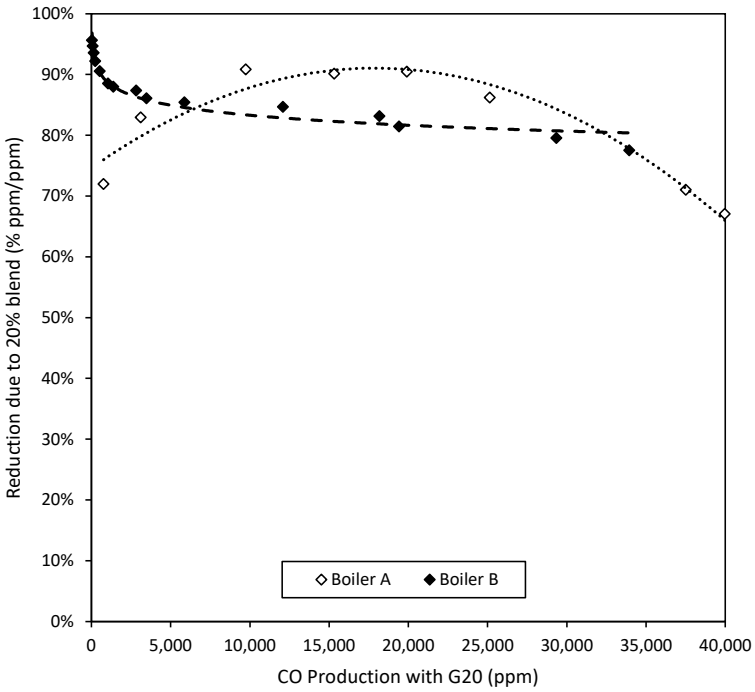
Great Britain

Keele University
'as today'

Keele University
'in trial'

- Analysis was validated using HSE GB data.
- 'Keele in trial' shown to be as safe as 'Keele today'.
- HyDeploy achieved the UK's first hydrogen exemption in November 2018.

Appliances

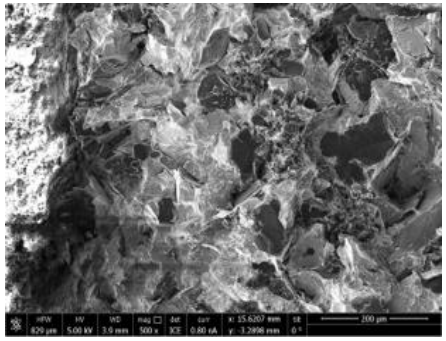


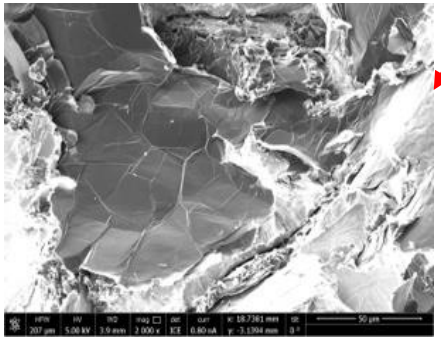
100% CH_4

28% H_2 / 72% CH_4

- CO production reduces by 80-90% due to a 20% hydrogen blend. Significant reduction in CO risk as a consequence.
- No safety or performance issues identified from natural gas domestic appliances (1976 – present) with a 20% hydrogen blend.

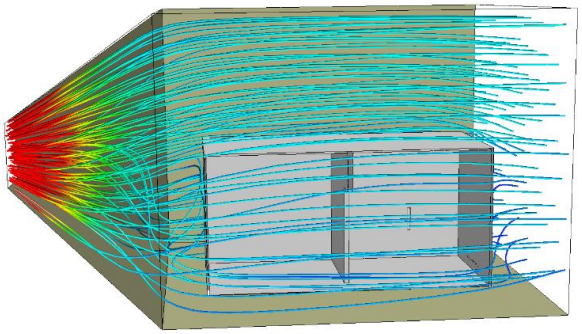
Materials





- All common materials tested (steels, irons, aluminum, brass, plastics, etc).
- Testing comprised of soaking material samples at 8 bar 100% hydrogen over a number of weeks to saturate materials with hydrogen.
- Mechanical integrity testing then performed and fracture surfaces inspected for evidence of hydrogen effects.
- No mechanical integrity issues identified across all materials, indicating general suitability for a 20% hydrogen blend.

Gas Characteristics



- Leakage analysis (modelling and experimentation) undertaken to assess real world accumulation behaviour.
- No change in gas cloud concentration or size due to a 20% hydrogen blend.
- Explosion consequences modelled and measured using bespoke experimental container.
- No change in pressure impulse, however increase in overpressure in line with expectation.

Industrial Trials

- Trial conducted on a 1.2 MW test furnace demonstrating parity of operations.
- Trials are in development with Pilkington Glass and Unilever to supply a 20% blend to a 55 MW furnace and 7 MW steam boiler respectively.
- Industrial trials to be complete by late summer 2021.

Delivering safe and non-disruptive carbon reduction for gas customers