

UK Innovation in Hydrogen for Heating

COP24

10th December 2018



Introduction

Jon Saltmarsh

BEIS



1. Introduction

Jon Saltmarsh, Department for Business, Energy and Industrial Strategy

2. HyDeploy and HyNet

Chris Manson-Whitton, Director, Progressive Energy

3. Hy4Heat and H100

Mark Neller, Director, Arup

4. H21

Keith Owen, NGN

5. Summary

Jon Saltmarsh, BEIS

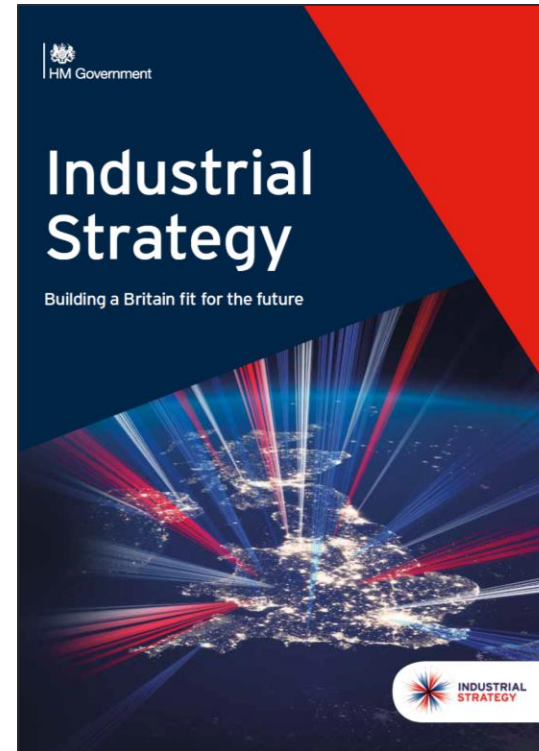


Policy is set out in two key documents

Clean Growth Innovation Challenges

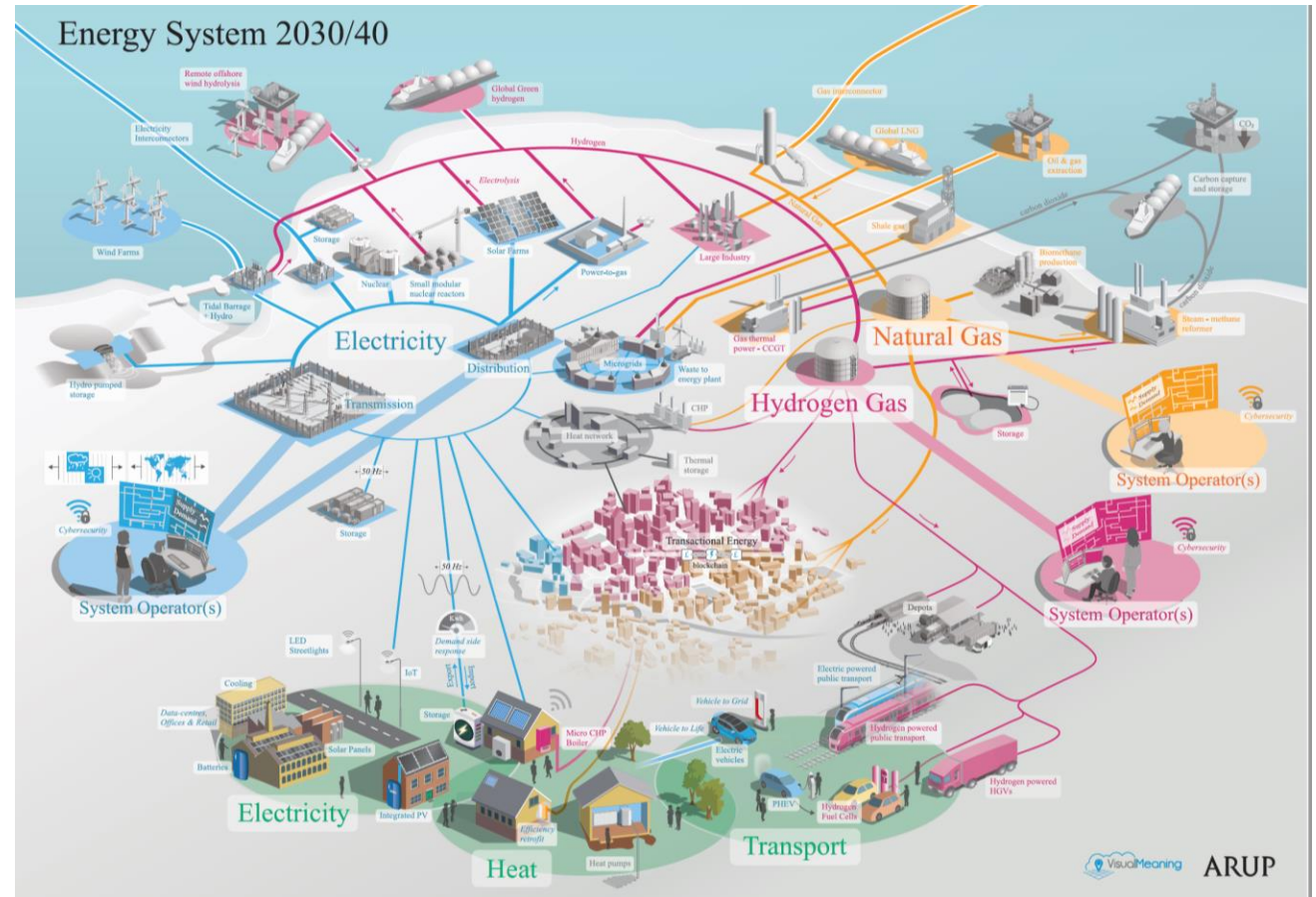
“Clean fuels such as hydrogen and bioenergy could be used for transport, industry, and to heat our homes and businesses. We need to test how they work in the existing gas network, whether they can fire industrial processes, and how they could be used in domestic appliances.”

Clean Growth Innovation Challenges - Clean Growth Strategy

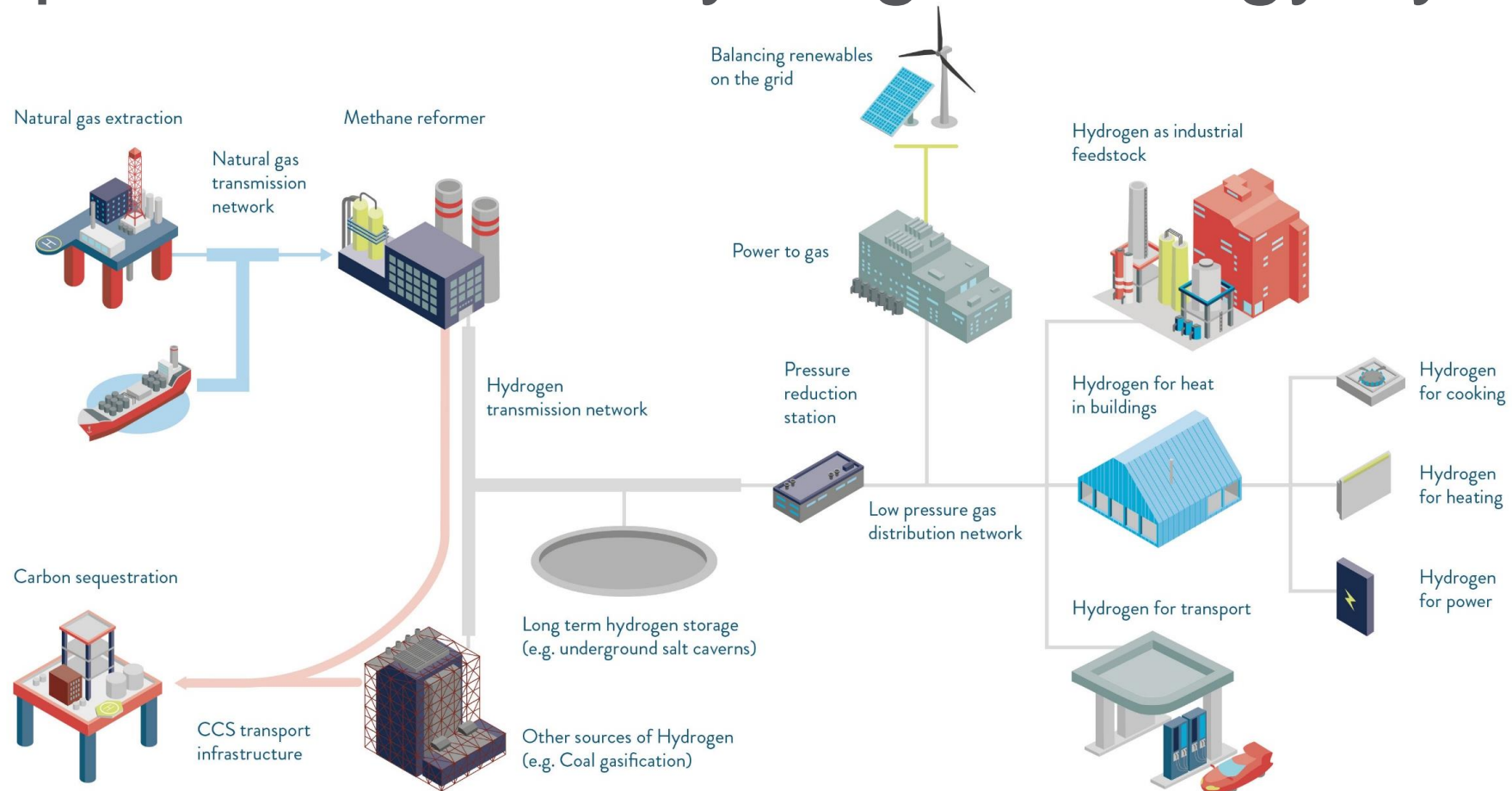


The energy system is becoming more complex

- Many options and pathways for the future energy system
- Likely to involve a variety of:
 - primary energy sources
 - energy carriers
 - local and distributed energy transformation
- Today we are just looking at options around hydrogen

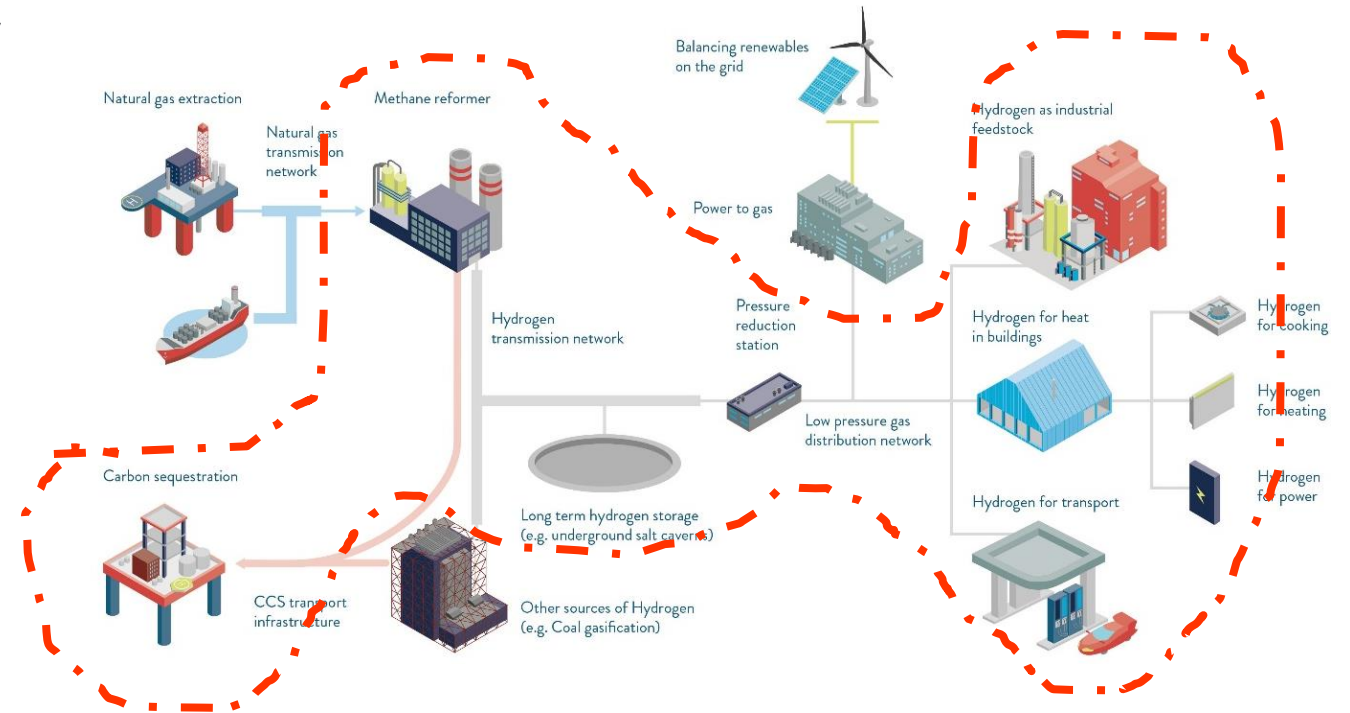


Conceptual view of a hydrogen energy system



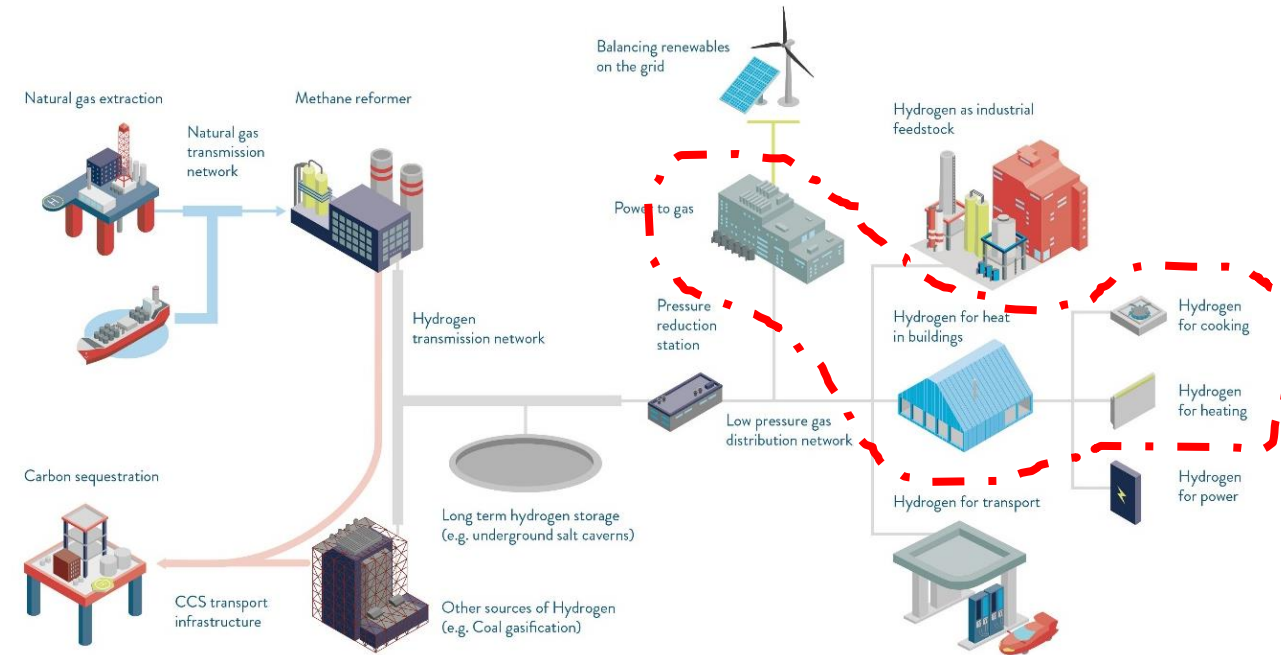
Hydrogen for Heating Innovation Programmes

- HyNet – End to end demonstration
- H21 – North of England feasibility study



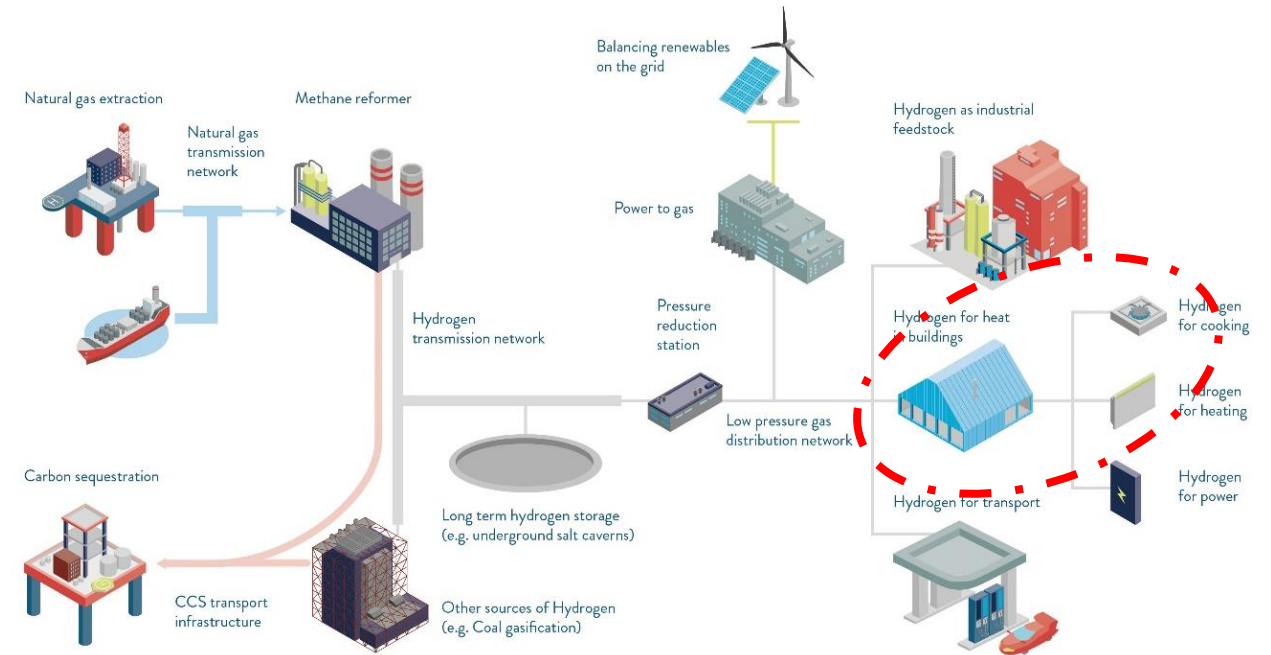
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- HyNet – End to end demonstration
- H21 – North of England feasibility study
- **HyDeploy – Hydrogen blending**



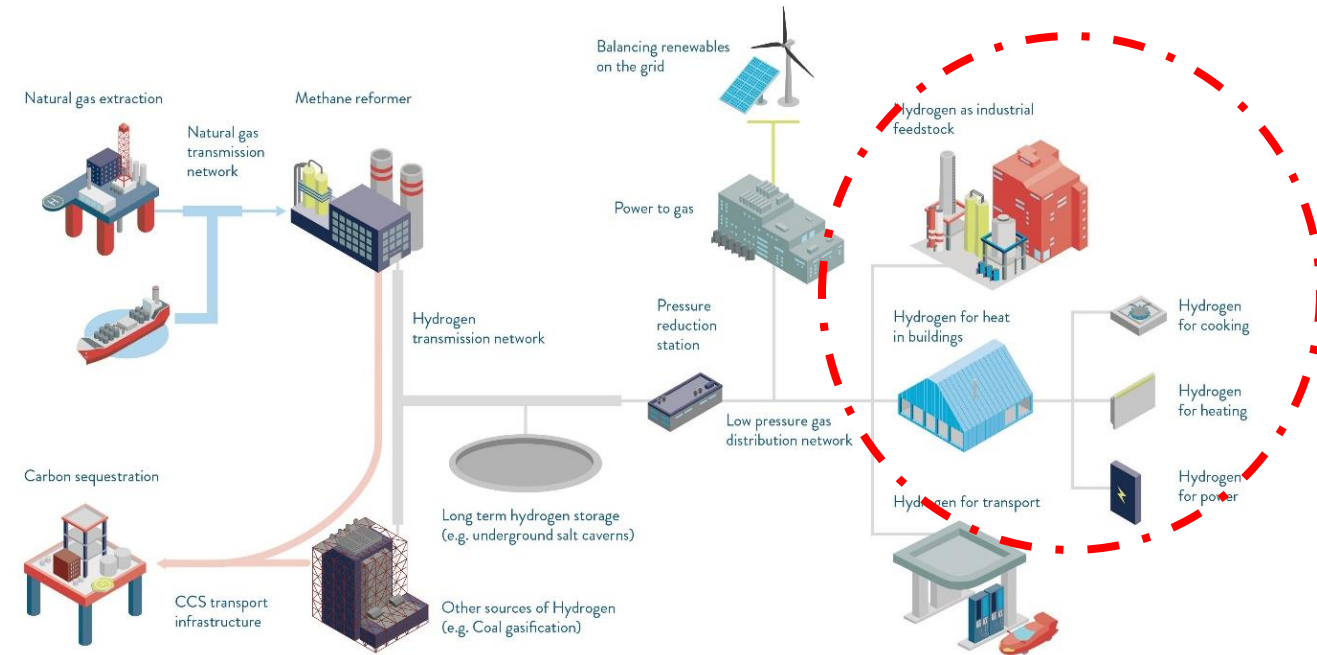
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- **H100 – Hydrogen end use (new build)**



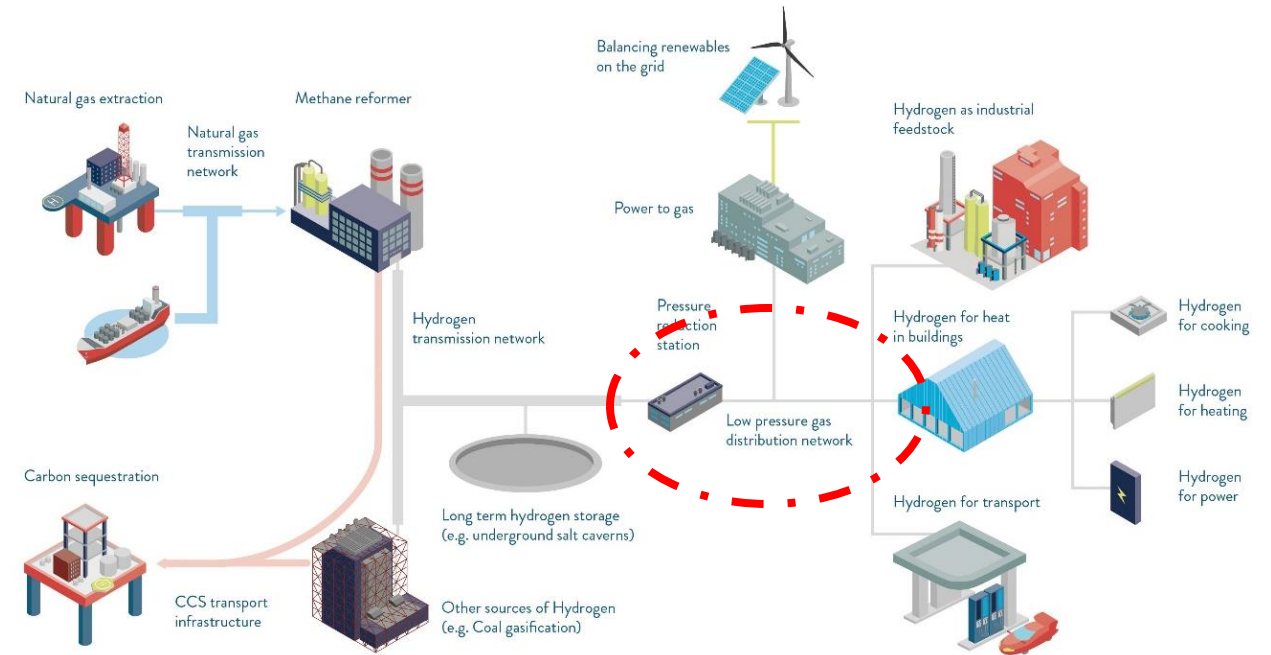
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- H100 – Hydrogen end use (new build)
- **Hy4Heat – Hydrogen end use**



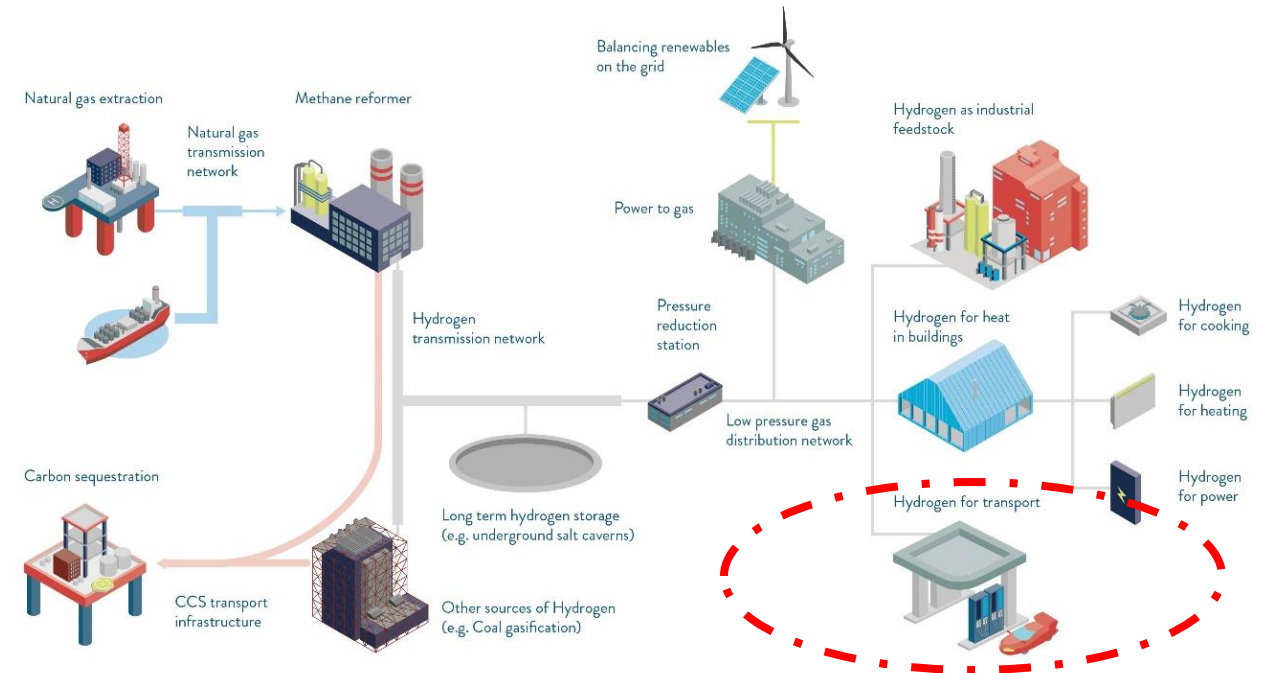
Hydrogen for Heating Innovation Programmes

- HyNet – End to end demonstration
- H21 – North of England feasibility study
- HyDeploy – Hydrogen blending
- H100 – Hydrogen end use (new build)
- Hy4Heat – Hydrogen end use
- **H21 – 100% hydrogen in the distribution network**



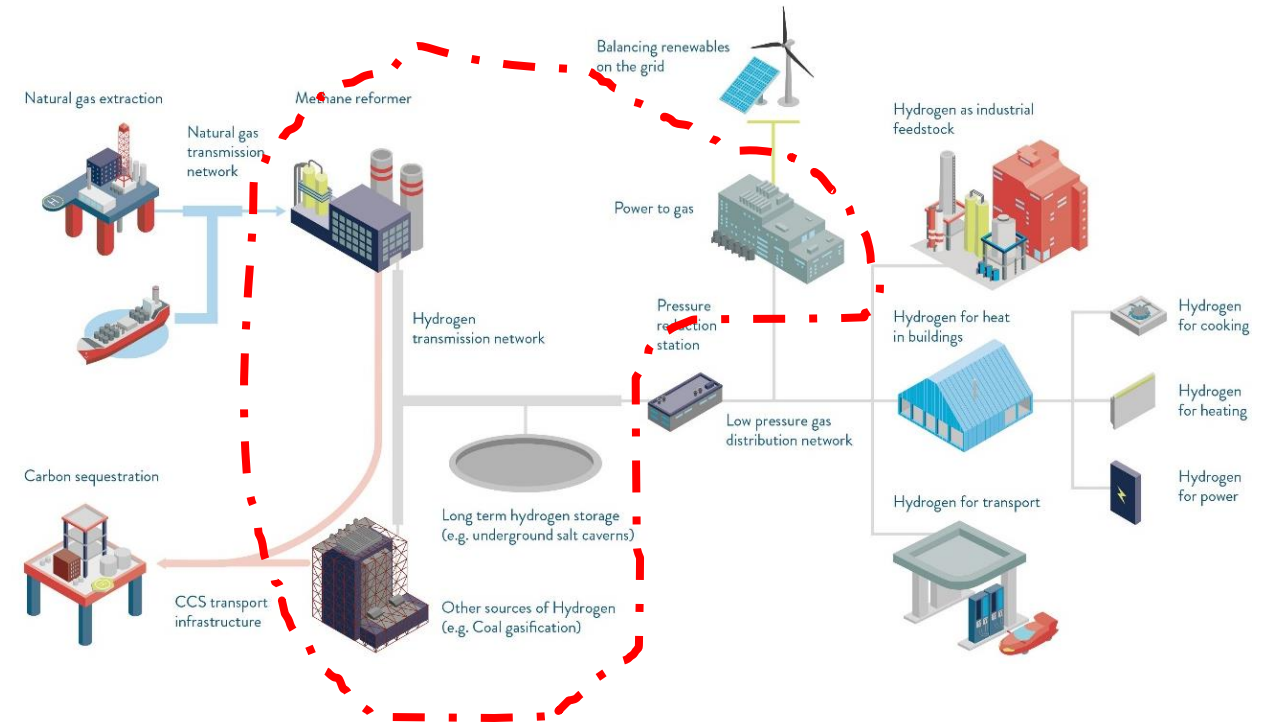
Hydrogen for Transport Programme – DfT

- **£23 million**
- Funding to accelerate the uptake of hydrogen vehicles
- Funding both refuelling stations and the vehicles to use them
- Stage 1 £8.8 million awarded April 2018 brings 200 new vehicles and upgrades / new refuelling stations
- Stage 2 £14 million competition underway to fund up to ten new refuelling stations and associated fleets



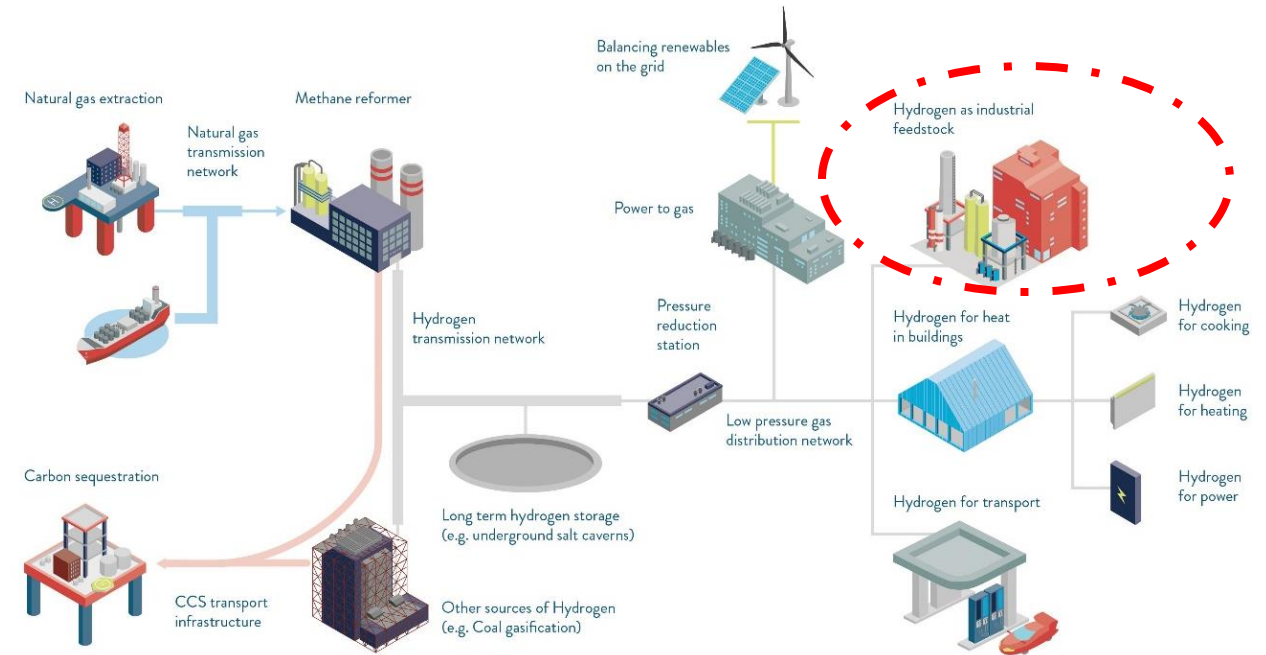
Hydrogen Supply Competition - BEIS

- **£20 million**
- Identify how to supply low cost, low carbon hydrogen at scale
- Reduce costs by accelerating development of low carbon bulk hydrogen supply solutions
- Targeting supply for industry, power, buildings and transport
- Competition for £5m Phase 1 (initial design & engineering study) closes December 2018
- Decisions on £15m Phase 2 (demo) in 2019



Industrial Fuel Switching Programme - BEIS

- **£20 million**
- Innovation competition to stimulate early investment in fuel switching processes and technologies
- Ensure a range of technologies (including hydrogen, biomass and clean electricity) are available by 2030
- Element Energy / Jacobs delivering Phase 1 focusing on market engagement and understanding the scope for fuel switching in industry
- At the end of Phase 1 suitable projects will be identified for demonstration funding



HyDeploy and HyNet Chris Manson-Whitton Progressive Energy





HyDeploy

Cadent

Northern
Gas Networks

Keele
UNIVERSITY

 ITM POWER
Energy Storage | Clean Fuel

 Progressive energy

 HEALTH & SAFETY
LABORATORY



To demonstrate for the first time that a **20%_v blend of hydrogen** and natural gas can be distributed and utilised **safely & efficiently** in the UK distribution network without **disruptive changes** for consumers.



Non disruptive

=2.5mill



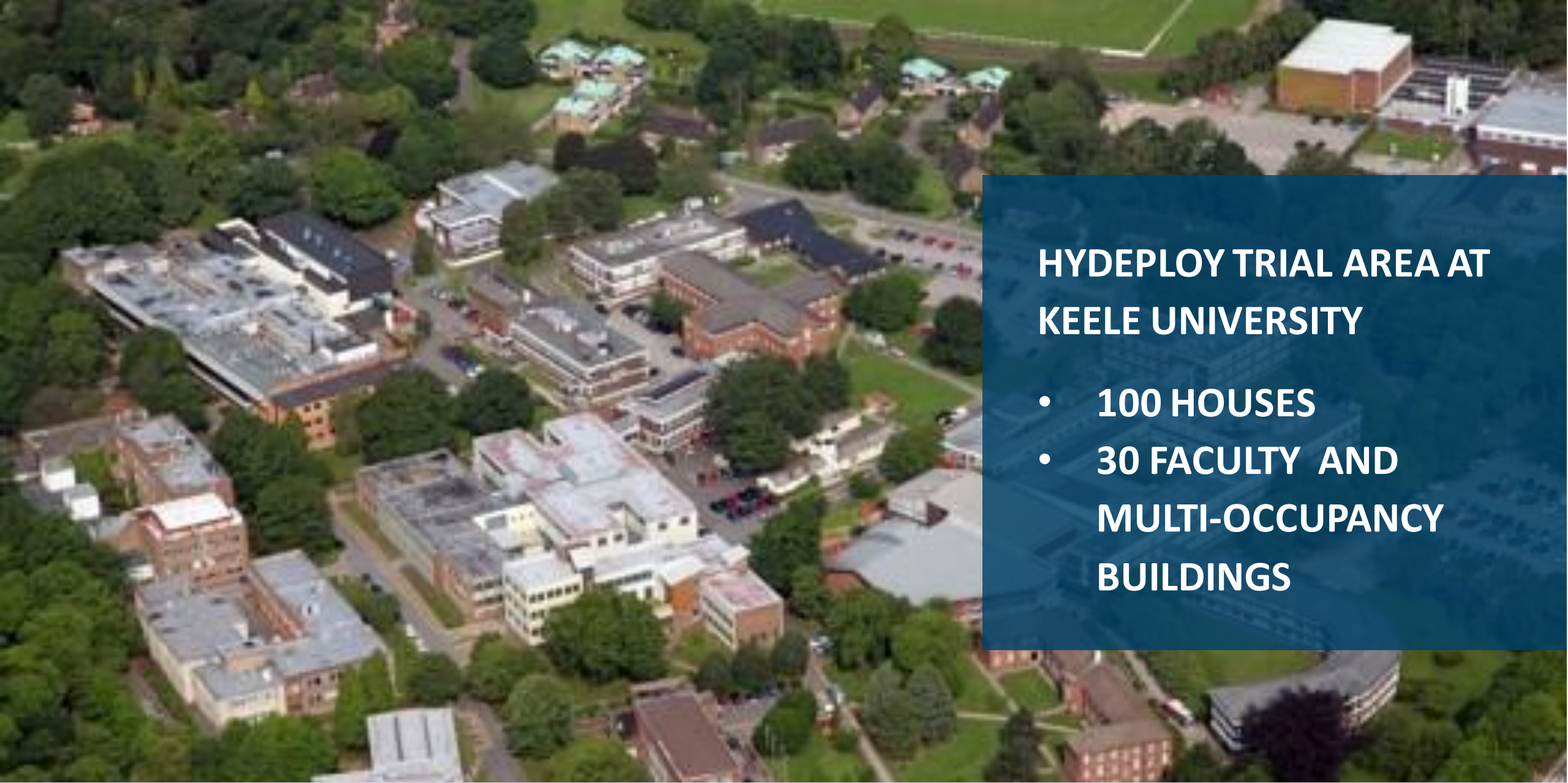
Material CO₂ Savings



Unlock deeper savings

*Project Funded under OFGEM's
Network Innovation Programme*





HYDEPLOY TRIAL AREA AT KEELE UNIVERSITY

- **100 HOUSES**
- **30 FACULTY AND
MULTI-OCCUPANCY
BUILDINGS**



PROGRAMME OVERVIEW

Phase 1

SAFETY CASE



Apr 17

Phase 2

INSTALLATION



Nov 18

Phase 3

TRIAL



July 19



'AS SAFE AS NATURAL GAS'

**THE FIRST PHASE WAS TO
PROVIDE THE RIGOROUS
SAFETY EVIDENCE FOR THE
WHOLE DELIVERY CHAIN.**





APPLIANCE TESTING

In the lab

Detailed tests of appliances operating on a wide range of hydrogen and gas blends.

In the field

Validate the laboratory results and ensure that the installations are fundamentally safe.



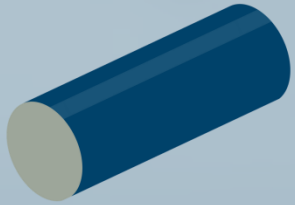


“I am proud of Keele’s involvement in HyDeploy and the UK’s initiative to reduce carbon emissions. I particularly appreciated the wealth of information that was provided about the project”

Scott Romeo Mahadeo



DELIVERING A GAS BLEND TO CUSTOMERS



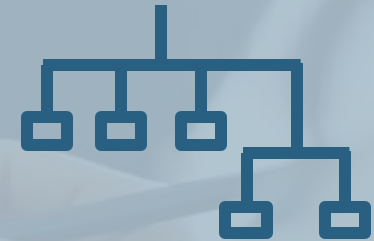
Materials of construction are suitable



Gas characteristics understood & procedures suitable



Properly blended into the network



Quantitative Risk Assessment





Phase 2
CONSTRUCTION UNDERWAY

'EXEMPTION' APPROVED
Permitting 20%_{vol} blend
1st November 2018



HyDeploy @ Keele

 HyDeploy

2017

2018

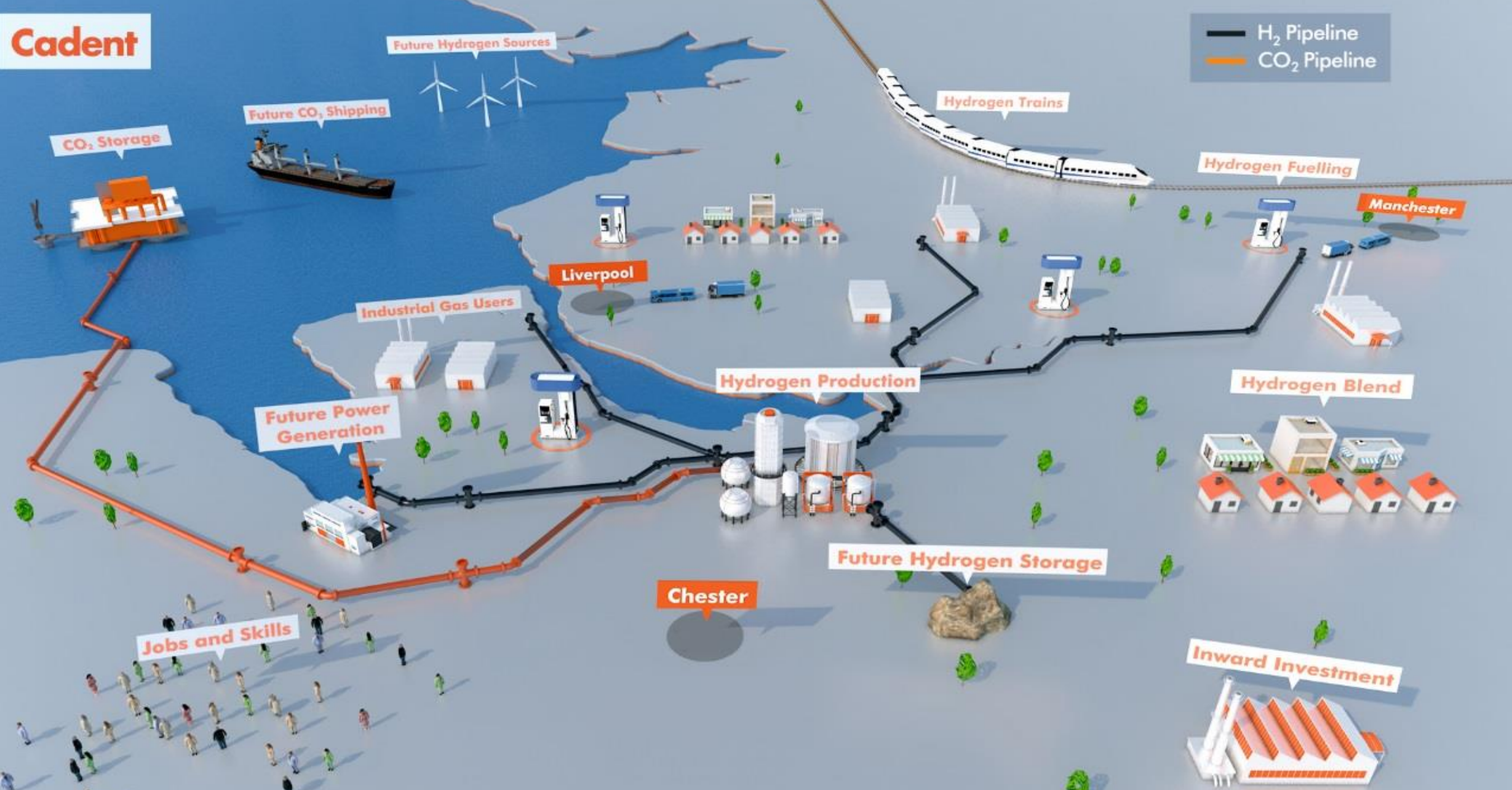
2019

2020

2021

2022

2023



Hy4Heat and H100

Mark Neller

Arup



ARUP +



Hy4Heat

KIWA | EMBERS | YOENERGY
PROGRESSIVE ENERGY

www.hy4heat.info

@Hy4Heat



Hy4Heat mission

To establish if it is technically possible, safe and convenient to replace natural gas (methane) with hydrogen in residential and commercial buildings and gas appliances

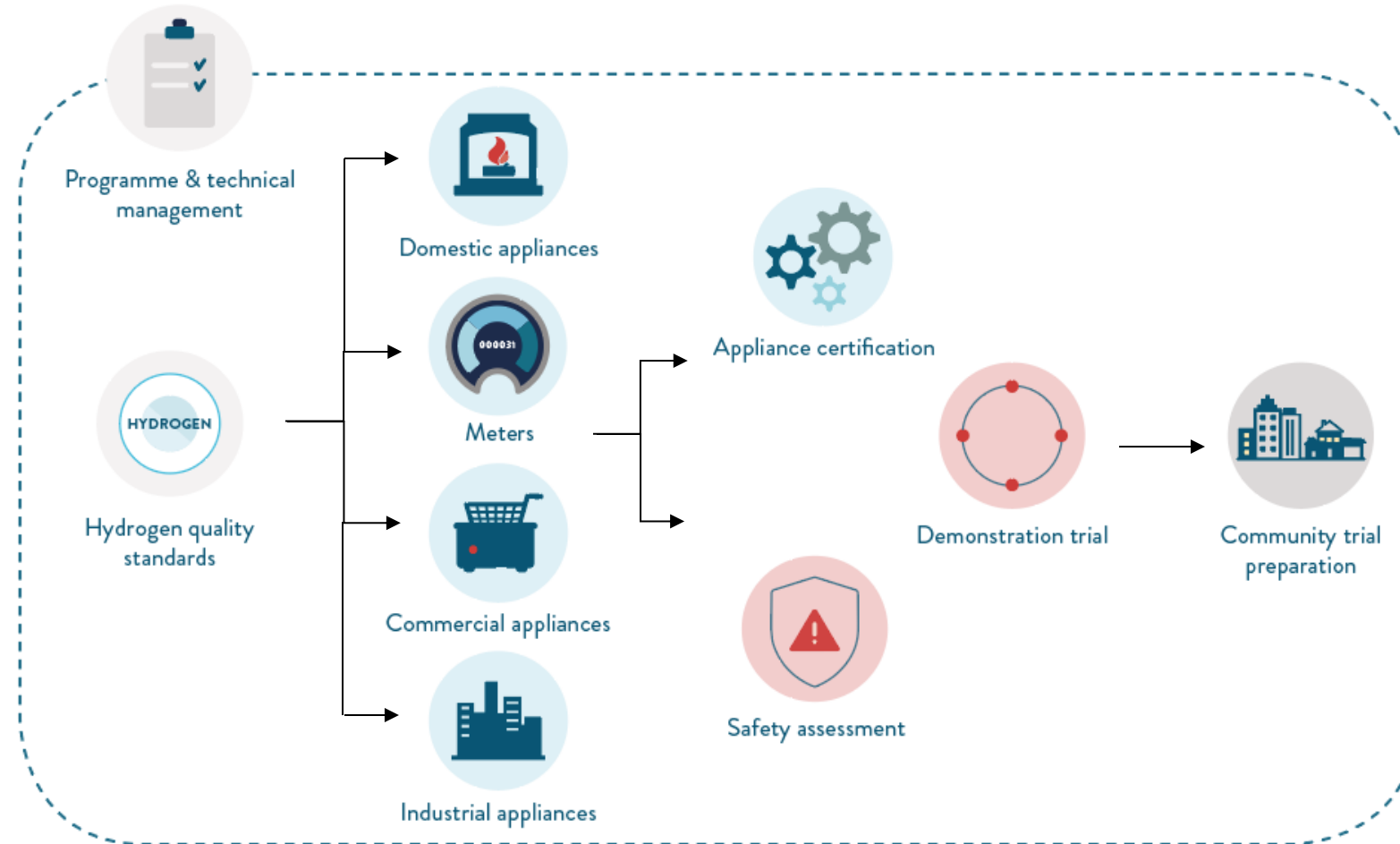
This will help enable the government to determine whether to proceed to a community trial of hydrogen





[Photo: Roger Wollstadt](#)

Hy4Heat programme work packages



Hy4Heat programme overview

2018

2019

2020

2021



WP1&9 PMC Managing WPs in preparation for a Community Trial

Hy4Heat ends



WP2 Quality and standards



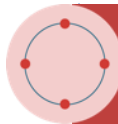
WP7 Safety and risk assessment



WP3 Development of appliance certification



WP4 Development of certified domestic appliances and WP10 Metering development



WP8 Demonstration trials



WP5 Commercial appliances
Understanding the market

Potential commercial appliance development



WP6 Industrial appliances
Understanding the market

Potential industrial appliance development

Possible
Community Trial



Hydrogen quality standards (WP2)

- IGEM revising relevant existing standards and considering:
 - Dangerous substances and explosive atmosphere regulations Materials
 - Leakage rates
 - Ventilation
 - Installation
 - Air supply, etc.
- DNV GL - Purity & Colourant
- NPL - Odorant



Hydrogen appliance certification (WP3)

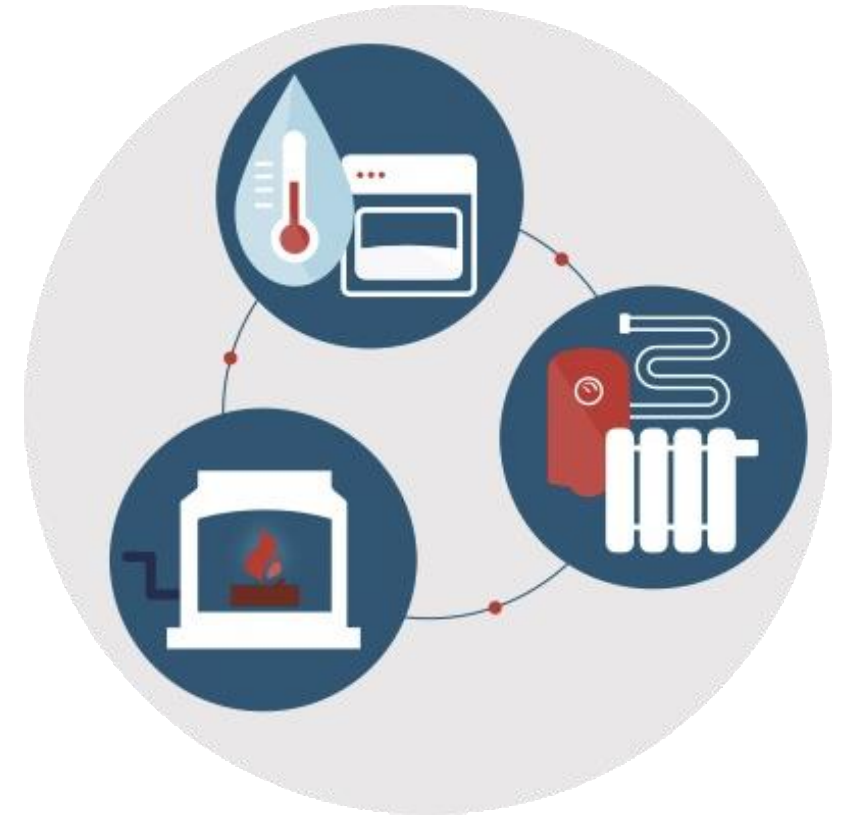
- Hydrogen appliances to be certified under GAR (Gas appliance regulation)
- Establishing an appliance testing and certification committee
- BSI (British Standards Institute)



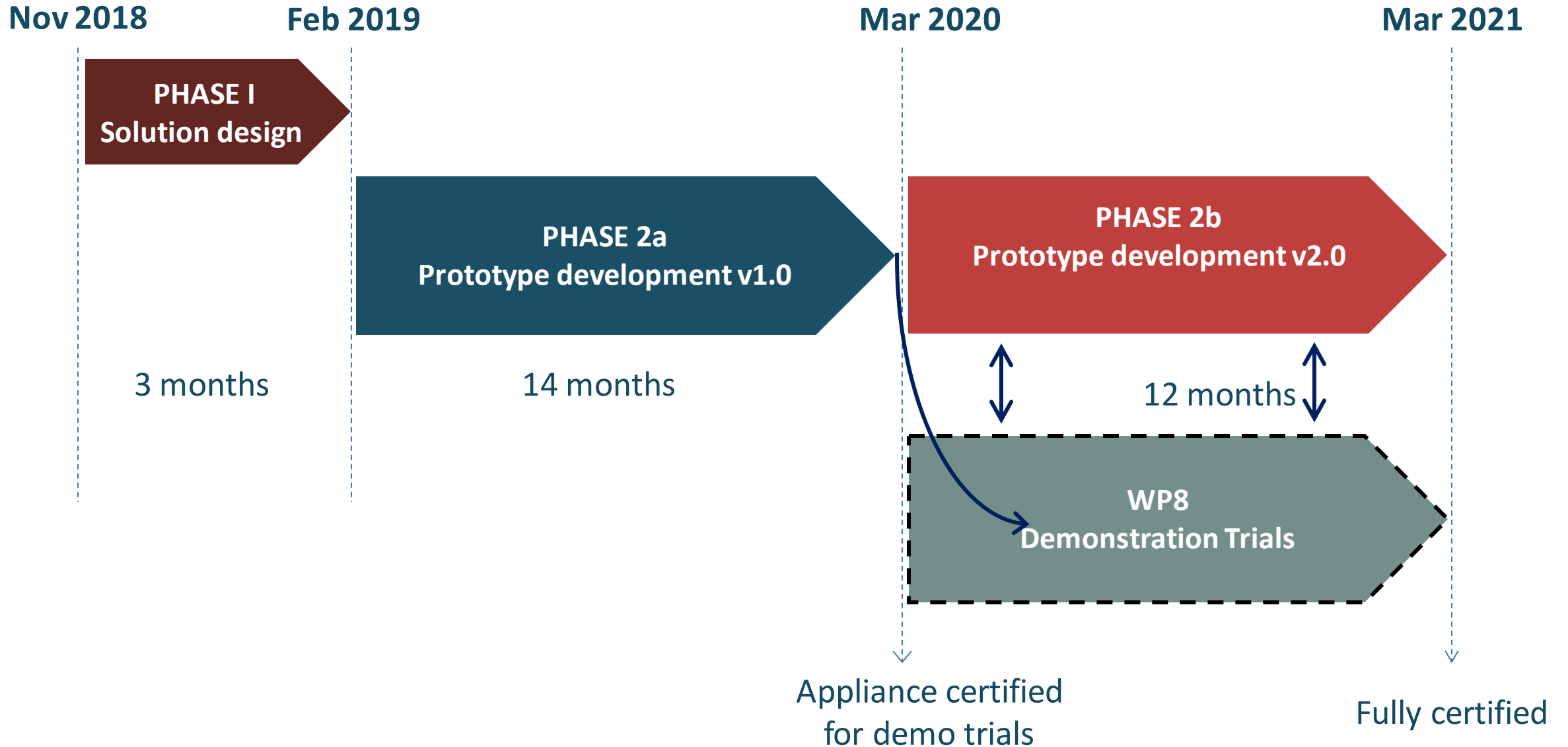
bsi.

Domestic hydrogen appliances (WP4)

- SBRI pre-commercial procurement innovation competition:
 - gas boilers
 - gas cookers
 - gas fire
 - innovative hydrogen appliance
- Phase 1 contracts have been awarded to 16 projects (appliance types)



Phased competition structure



Domestic hydrogen meters (WP10)

- Looking at metering development
- SBRI pre-commercial procurement competition



Commercial & Industrial appliances (WP5 & WP6)

- Market study into commercial and industrial appliance sectors
- Contracts awarded to:
 - ERM (WP5) and
 - Element Energy (WP6)
- Reports by Spring 2019



elementenergy

Safety testing (WP7)

- Comparing hydrogen with natural gas
- Co-ordination group established with GDNOs
- Working on agreeing an approach and aligning Hy4Heat with other hydrogen programmes and initiatives
- H100 research on consequence testing forming key part of quantified risk assessment



Demonstration trial (WP8)

- Unoccupied demonstration trial
- Using prototypes developed in work package 4 & 10

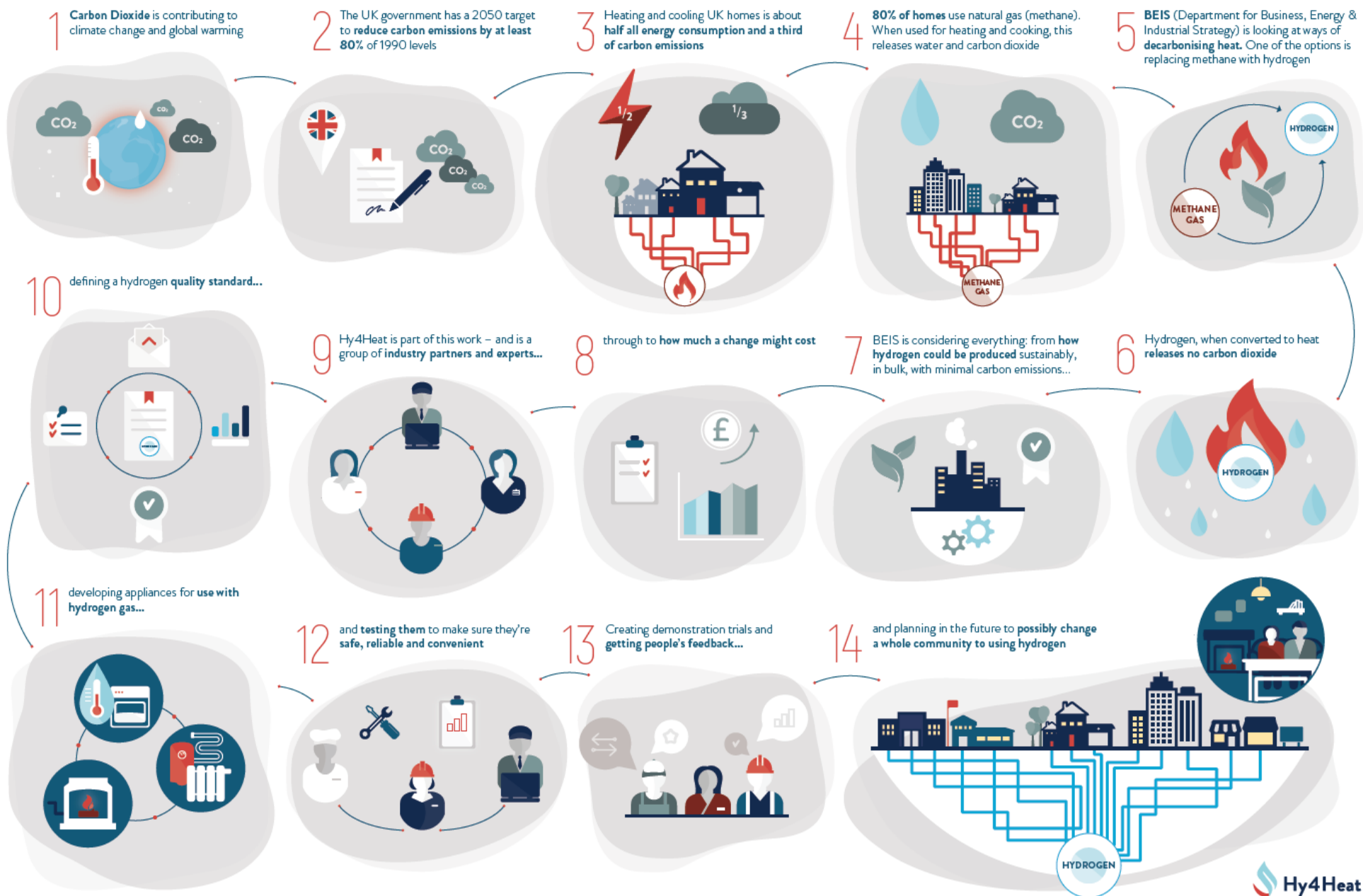


Potential community trial (WP9)

- Planning and preparation necessary for a potential community trial
- Proposed to run from 2021 to 2023



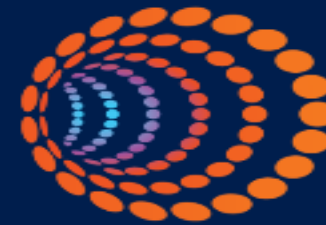
The Hy4Heat Programme



www.hy4heat.info

@Hy4Heat

Hydrogen 100 feasibility study & safety case



SGN
Your gas. Our network.



Method

Three feasibility studies that will run concurrently

All three studies will have the same scope but will be conducted in different locations with very different existing and potential network features.

Study one

Levenmouth, Fife

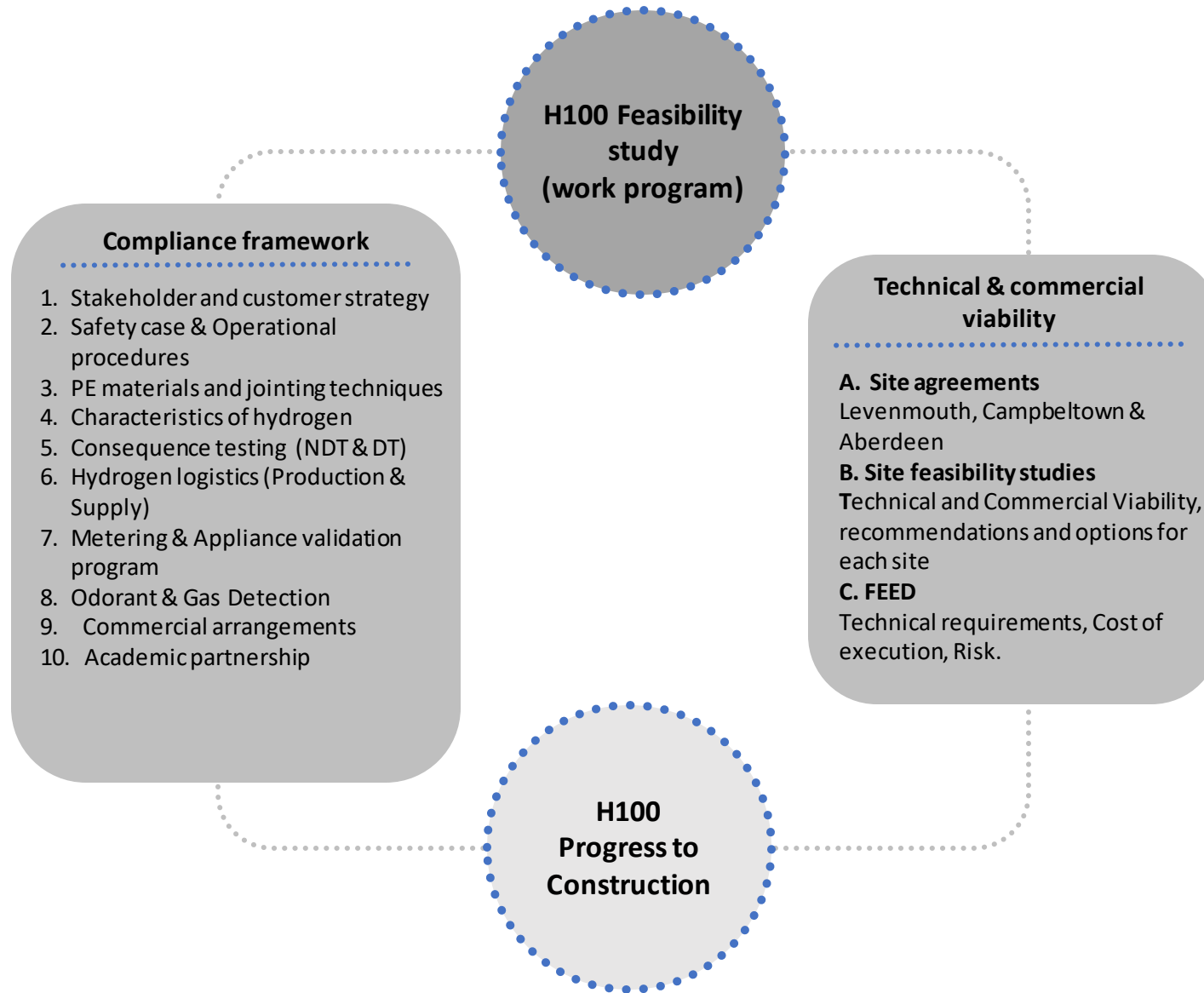
Study two

MACC Developments Ltd,
Machrihanish Airbase

Study 3

Aberdeen conference Centre,
Aberdeen





H21

Keith Owen

NGN





100% Hydrogen in GB distribution networks

 #H21

GB Hydrogen Research - Current

H21: Hydrogen Distribution

GB research investigating how to convert gas distribution networks to 100% Hydrogen.

InTEGReL: Integrated Transport Electric and Gas Research Laboratory, to leverage the benefits of system coupling to deliver decarbonisation.

HyNet: Industrial Hydrogen

Project looking at the use of hydrogen in the industrial sector.

Hy4Heat: Appliances

UK Government project to demonstrate the use of hydrogen for heat.

HyDeploy: Blending H2 and natural gas

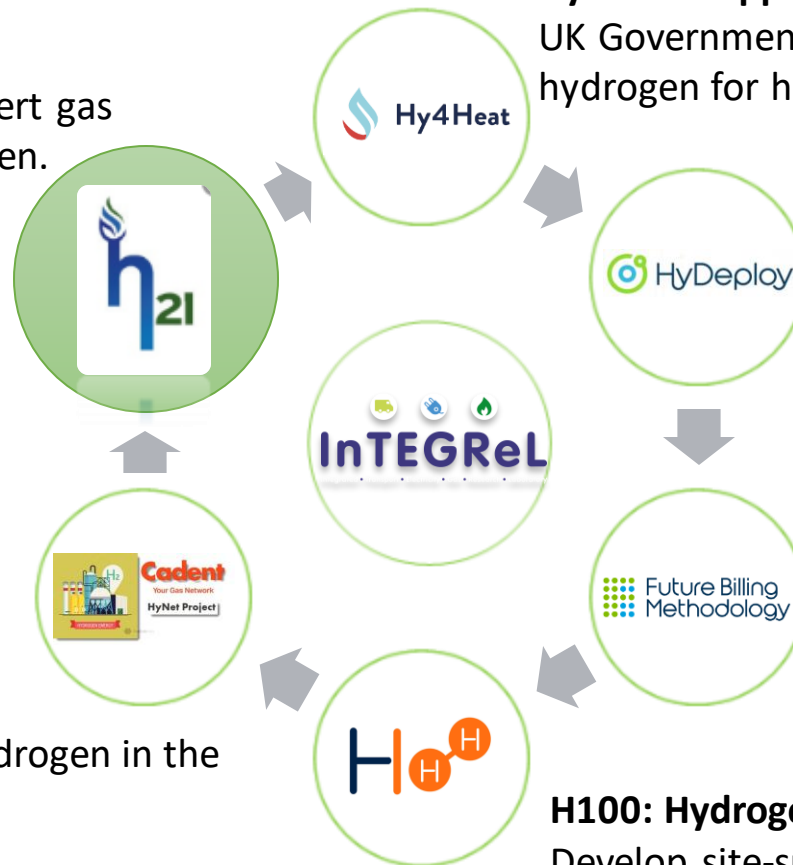
Collaborative Gas Network project to blend hydrogen with natural gas [P2G].

FBM: Measuring and billing new gases

Maximise the amount of renewable or 'green gases' which can be carried in the gas network.

H100: Hydrogen Distribution

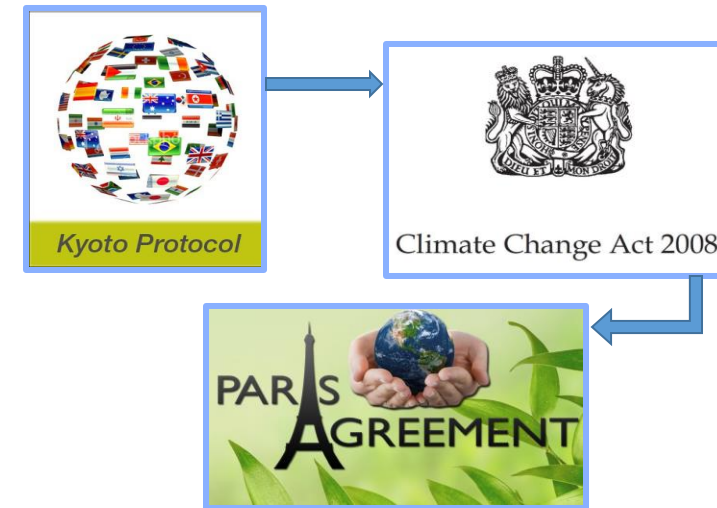
Develop site-specific evidence to support the construction of a 100% hydrogen demonstration project.



H21 Objective

100% Hydrogen in GB distribution networks

- To provide quantified safety based evidence to confirm the gas distribution networks of Great Britain are suitable to transport 100% hydrogen
- To undertake an experimental testing programme to provide the necessary data to quantify comparative risk between a 100% hydrogen network and the existing natural gas network.



H21 Project Partners

100% Hydrogen in GB distribution networks

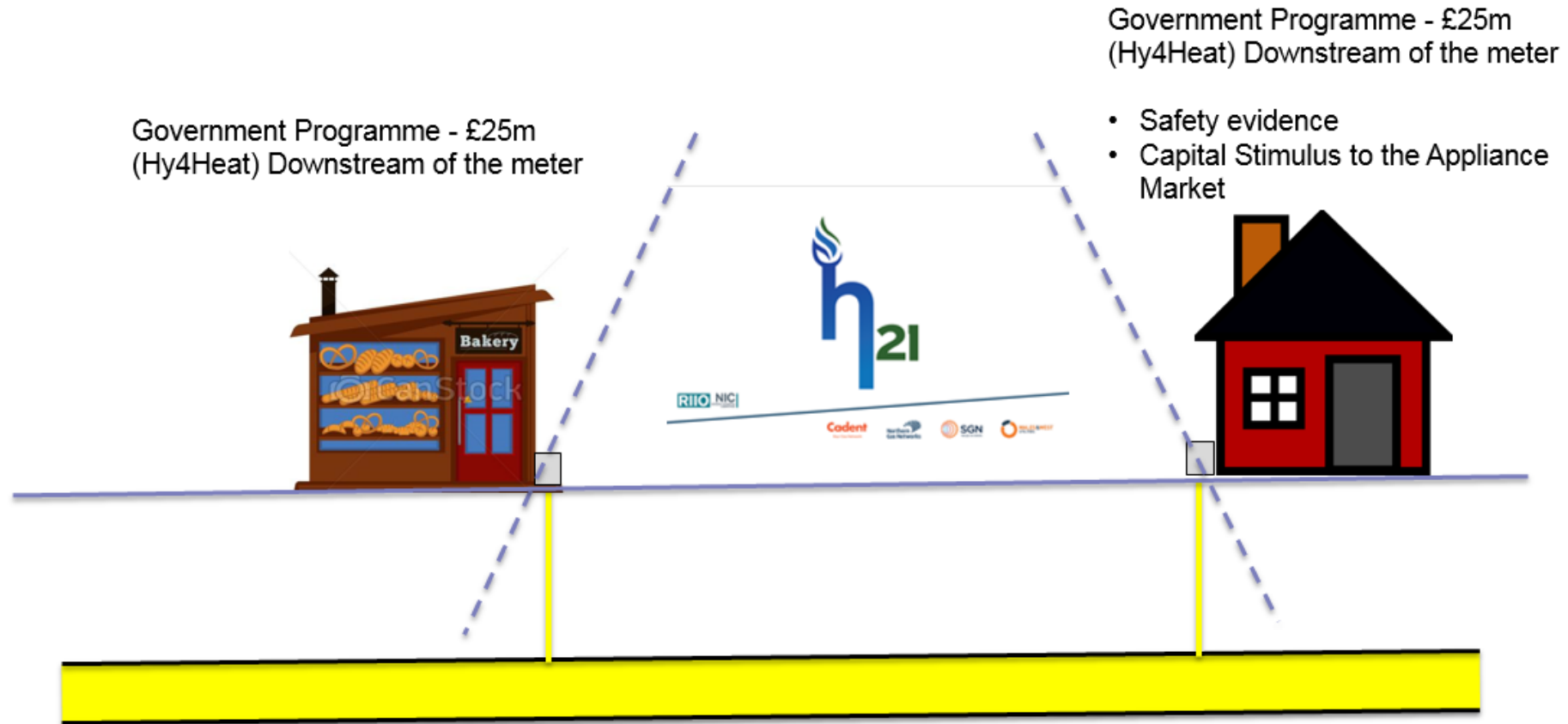
Project Partners



Project Supporters



H21



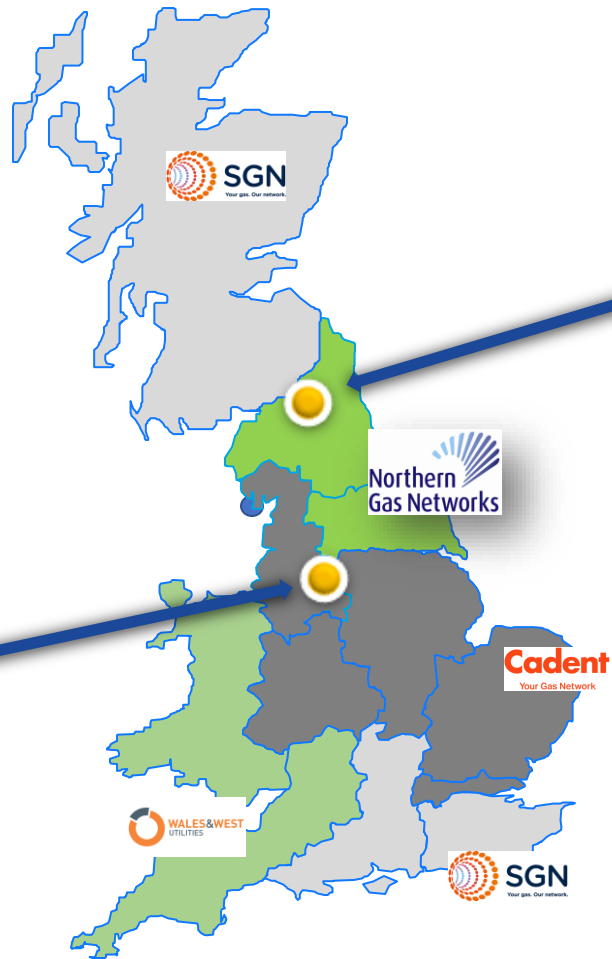
H21 Workstreams: Phase 1a and 1B

100% Hydrogen in GB distribution networks

Phase 1a



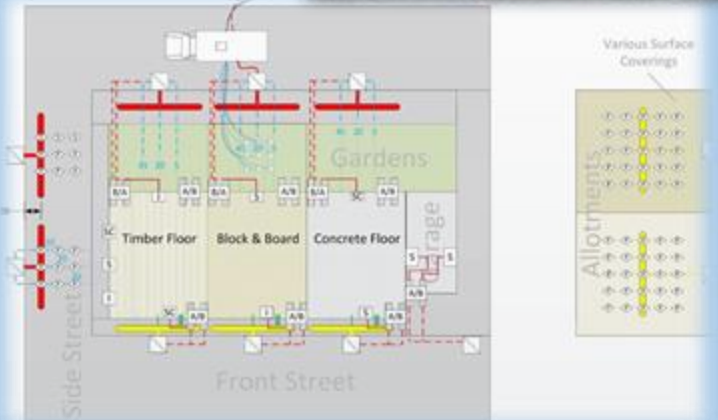
HSL
Buxton Labs



Phase 1b



DNVGL
Spadeadam



H21 Project Timeline

100% Hydrogen in GB distribution networks

January 2018

Project Commences
Tender for build of H21
Test Site, HSL Buxton
and Spadeadam

May 2018

Asset collection
begins across UK
GDN's

Jan 2019

Build of H21 Test
Site Complete

April 2018

Tender Awarded for build of test sites
Master Test Plan produced and
approved by HSL/DNV GL + NGN
Technical proposal for Spadeadam
approved

Feb 2019

H21 Testing Begins

Dec 2019

All assets collected
and tested

Leakage Results of Phase 1A feed into Phase 1B Spadeadam Testing

Dec 2018

Commissioning and testing starts 10th Dec 2018



Department for
Business, Energy
& Industrial Strategy



H21 Project - Phase1A: Background Testing

100% Hydrogen in GB distribution networks

Range of Test Assets

- Identify change to background leakage levels
- Test buried & above ground assets
- Compare leakage of Hydrogen and Natural gas



Assets retained within test frames to maintain integrity



Newly created test rig



Large diameter iron test piece removal

H21 Project - Phase 1B: Consequence Testing

Testing:

- WBS1: Small Releases
- WBS2: Large Releases
- WBS3: Ignition Potential
- WBS4: Explosion Severity



NGN vehicle fitted with metering and detection equipment required to ensure the accuracy of the Hydrogen injection

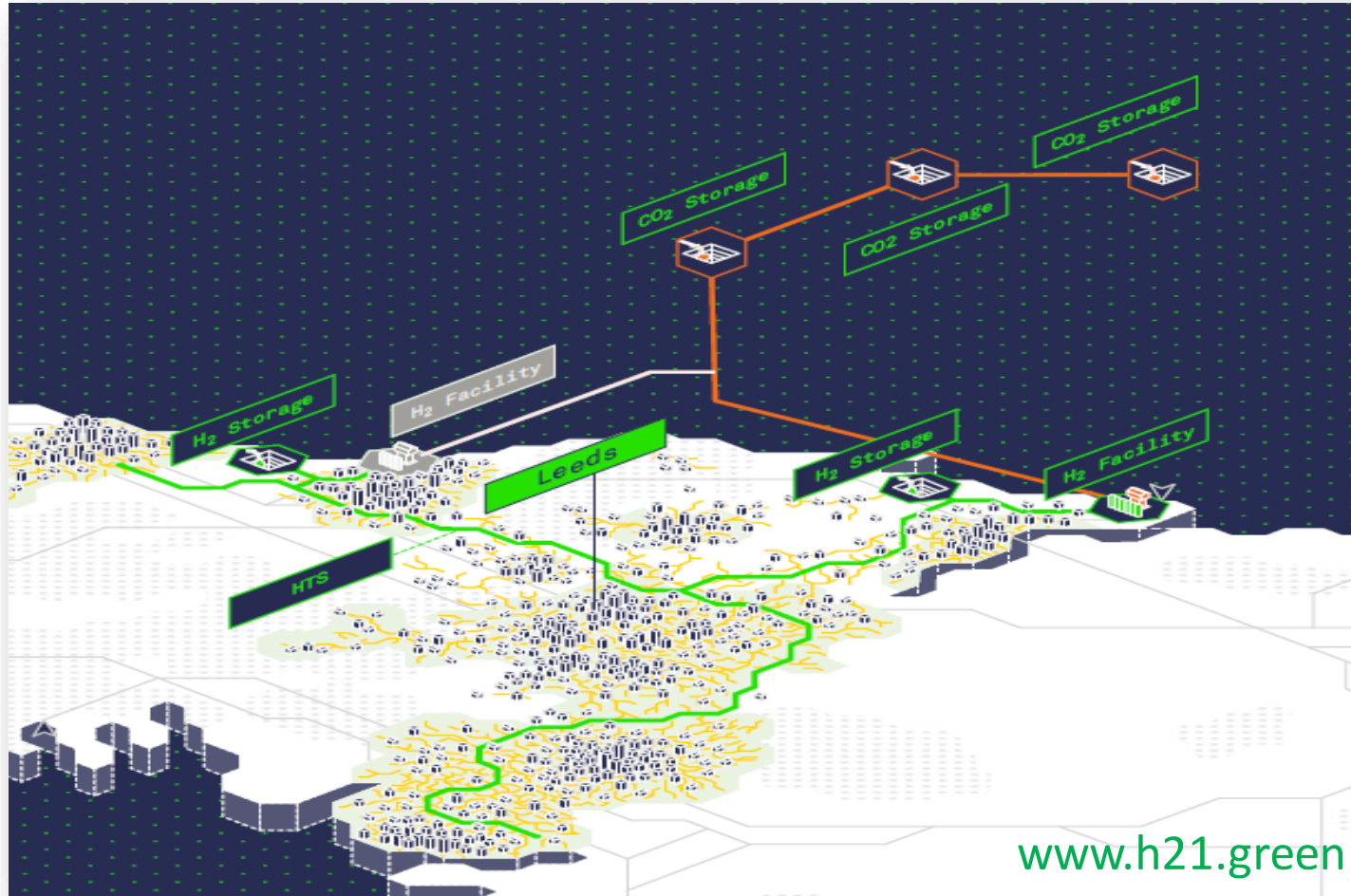


Mini housing complex, and 100mm pipeline network to distribute Hydrogen or methane



Installed Atmospheric monitoring station

H21 Project – North of England Vision



“... converting the UK gas grid to hydrogen has the ability to provide “*deep decarbonisation*” of heat, as well as transport and power generation, with minimal disruption to customers.”

- Potential to **reduce carbon emissions by over 258 million tonnes a year by 2050**,
- Equating to over **80%** of the UK’s remaining reduction target
- **Seven year conversion** beginning in 2028, across 3.7 million properties
- An additional six-phase rollout could see 12 million homes across the rest of the UK converted to hydrogen by 2050.

<https://www.northerngasnetworks.co.uk/event/h21-launches-national/>

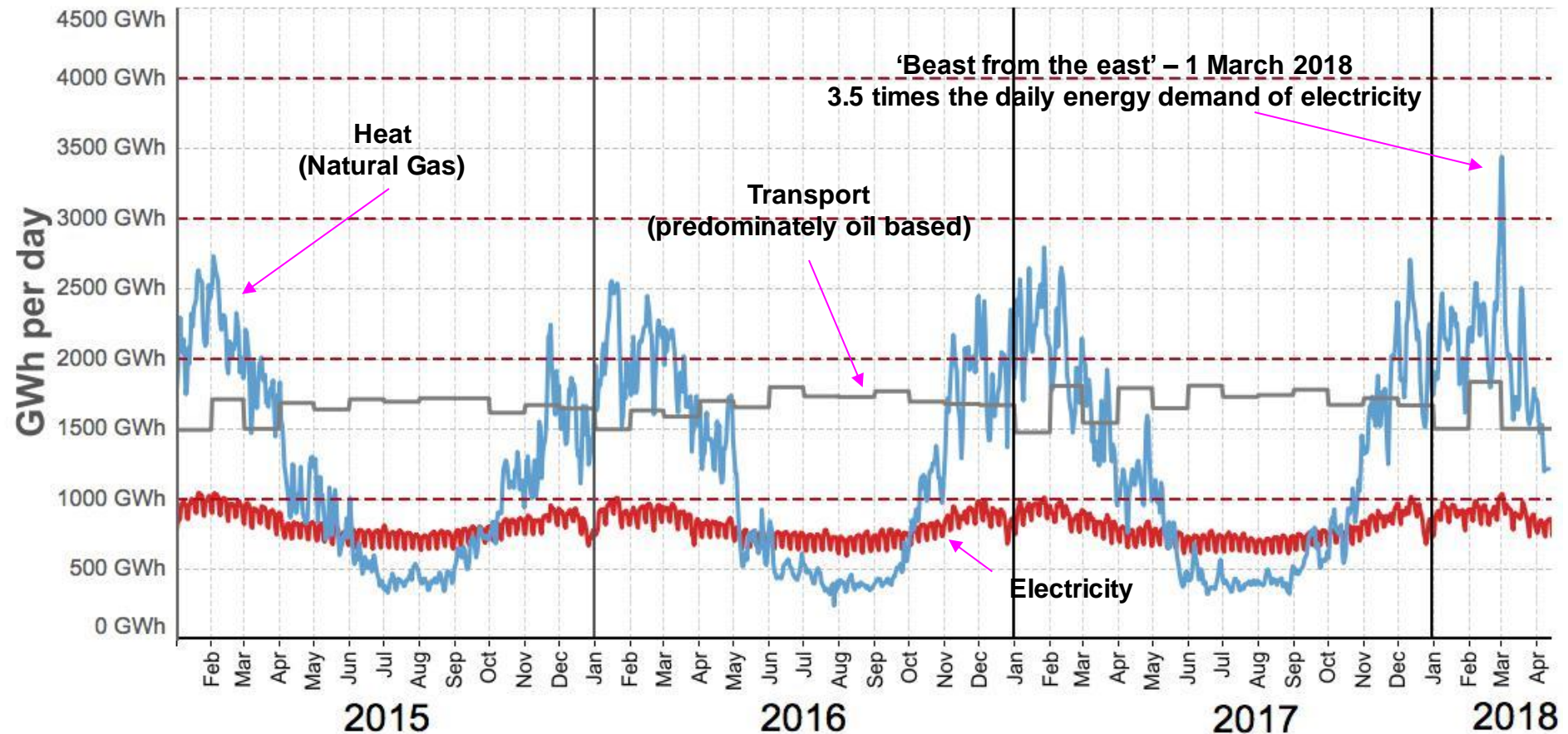
Summary

Jon Saltmarsh

BEIS



The challenge



Data are from National Grid, Elexon and BEIS. Charts are licensed under an Attribution-NoDerivatives 4.0 International license
Charts can be downloaded from <http://bit.ly/energycharts>



by Dr Grant Wilson grant.wilson@sheffield.ac.uk

Conclusions

- Decarbonising heat is arguably the greatest challenge in meeting UK climate change targets
- The UK is undertaking a range of practical trials, tests and demonstrations to provide the evidence required
- It's difficult to envisage a whole energy system solution that doesn't involve hydrogen in some areas
- The UK is delivering 'no regrets' projects today, saving carbon, engaging with consumers, informing policy and de-risking investment
- The UK is looking to share this knowledge and collaborate with countries around the world

Q&A

