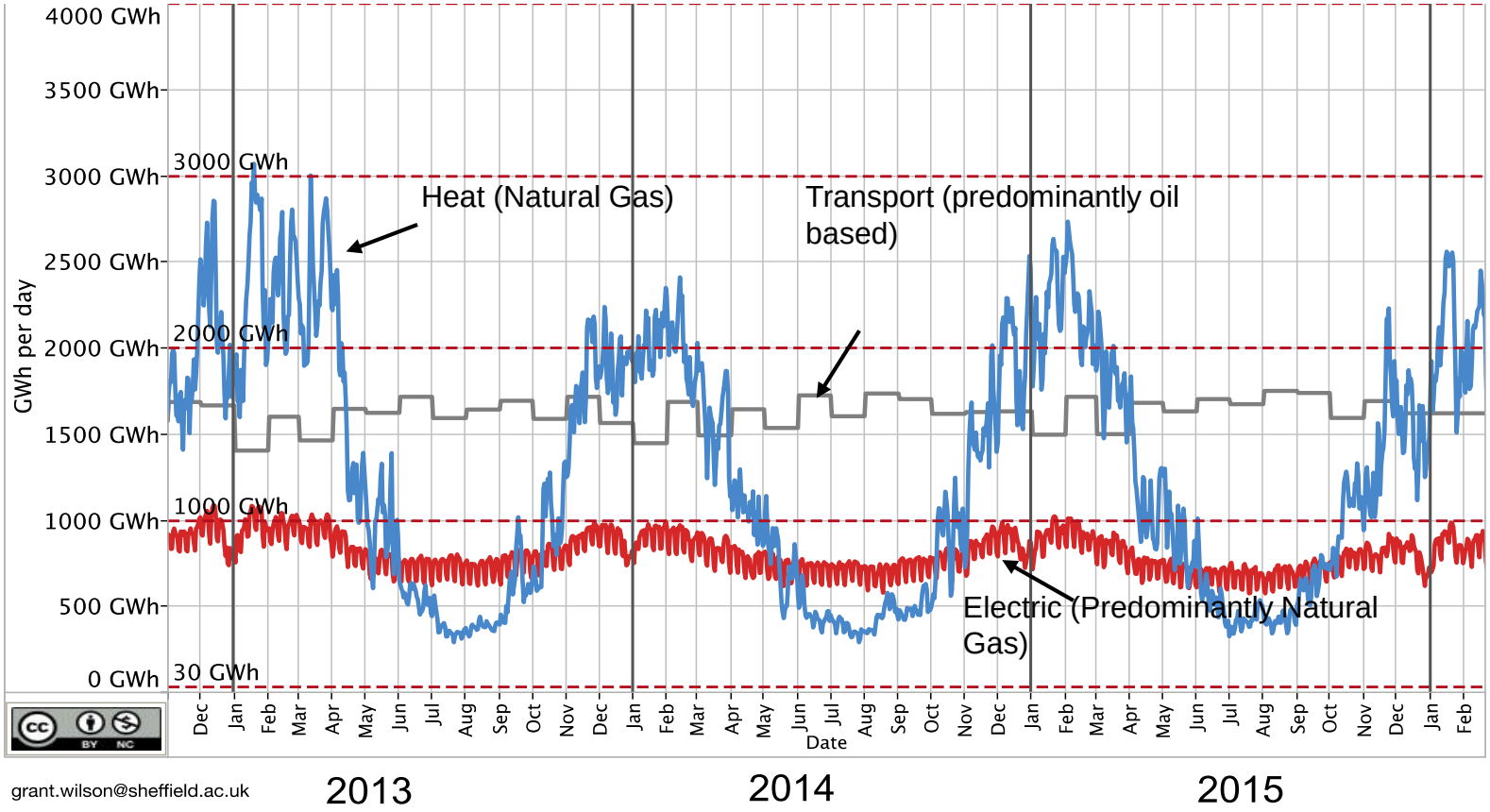
Dan Sadler, H21 Programme Director

@DanSadlerH21

8 November 2018

The Context: Current UK Energy Requirements



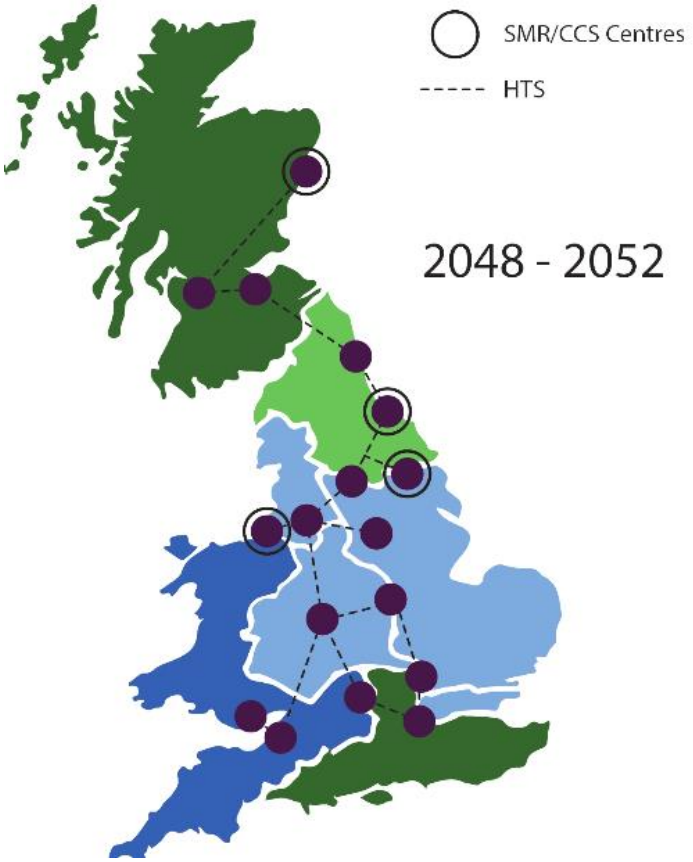
grant.wilson@sheffield.ac.uk

The challenge is to decarbonise all of the above!

H21 Leeds City Gate – The Blueprint

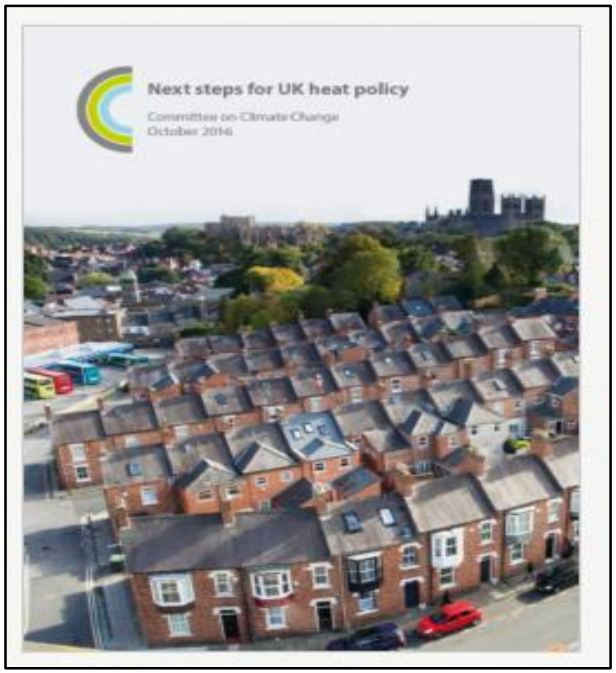
- 265,000 meter points
- 6Twh per annum, 3180MW peak
- 1% of UK population
- 1.5Mtpa CO_2 storage

DEMAND

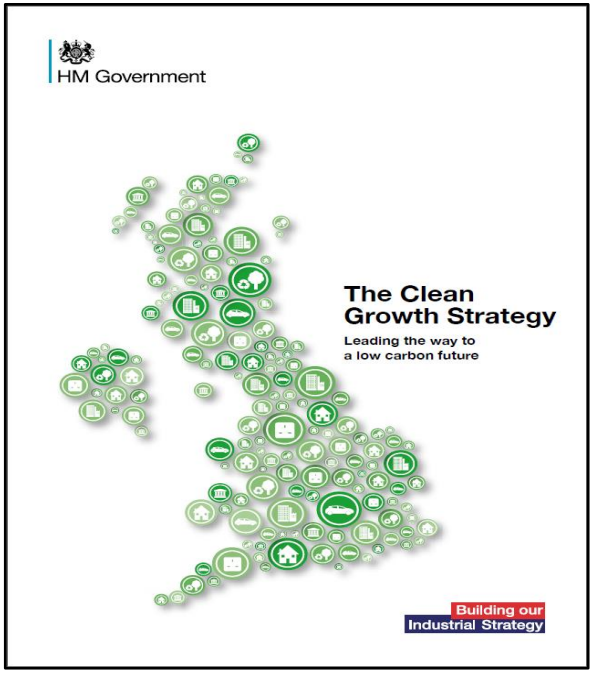


UK City by City Rollout

The UK Government is Setting Strategic Direction



October 2016

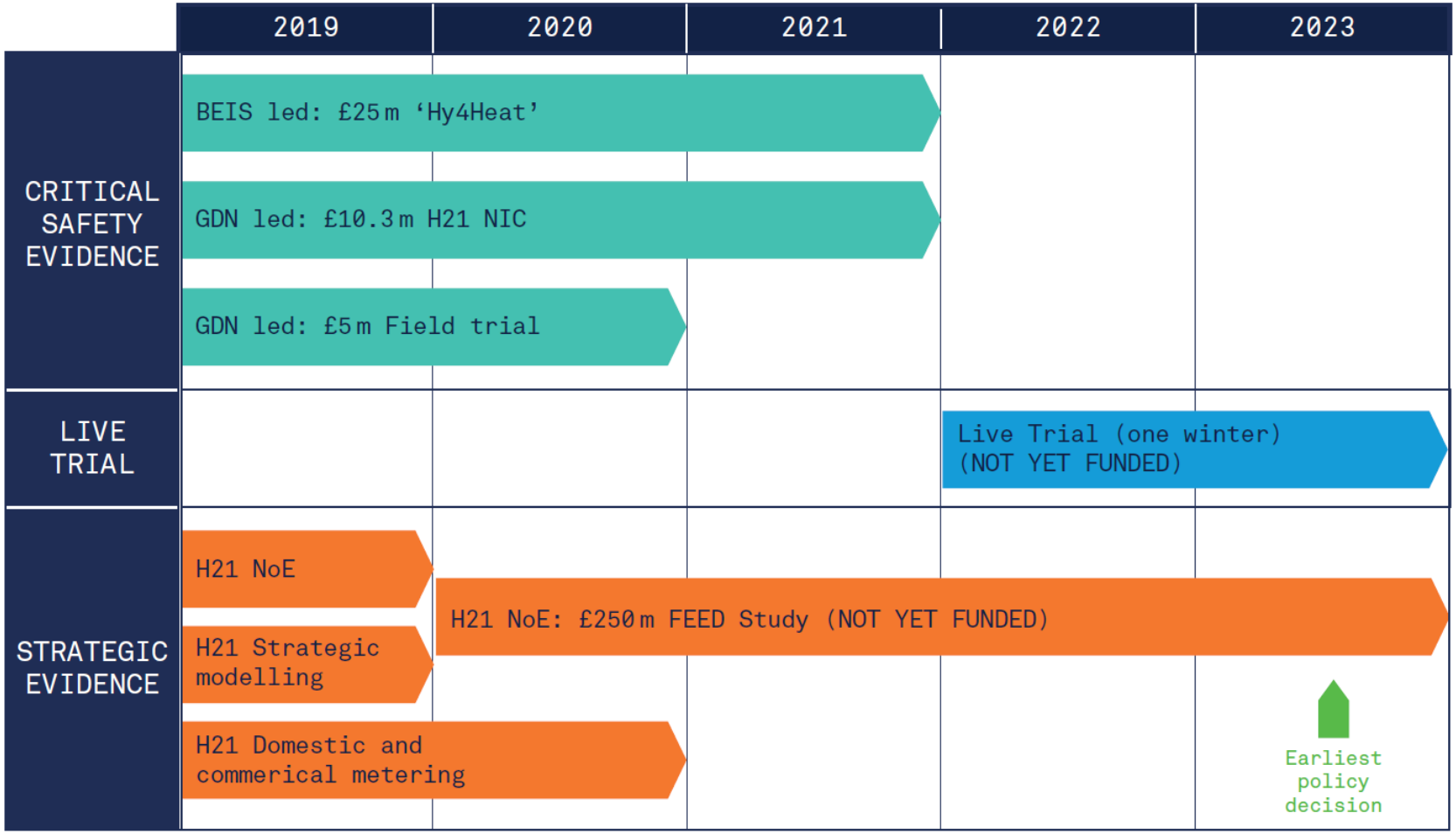


October 2017

Hydrogen pathway: …'**we use hydrogen to heat our homes and buildings, as well as to fuel many of the vehicles we drive in 2050 and power the UK's industry**. We adapt existing gas infrastructure to deliver hydrogen for heating and a national network of hydrogen fuelling stations supports the use of hydrogen vehicles. A large new industry supports hydrogen production using natural gas and capturing the emissions with CCUS.' (clean Growth Plan)

"We will also continue to explore the long-term options for clean heating and the many potential uses of low carbon hydrogen" (page 45, Industrial Strategy)

Timeline to a Potential UK Policy & Conversion

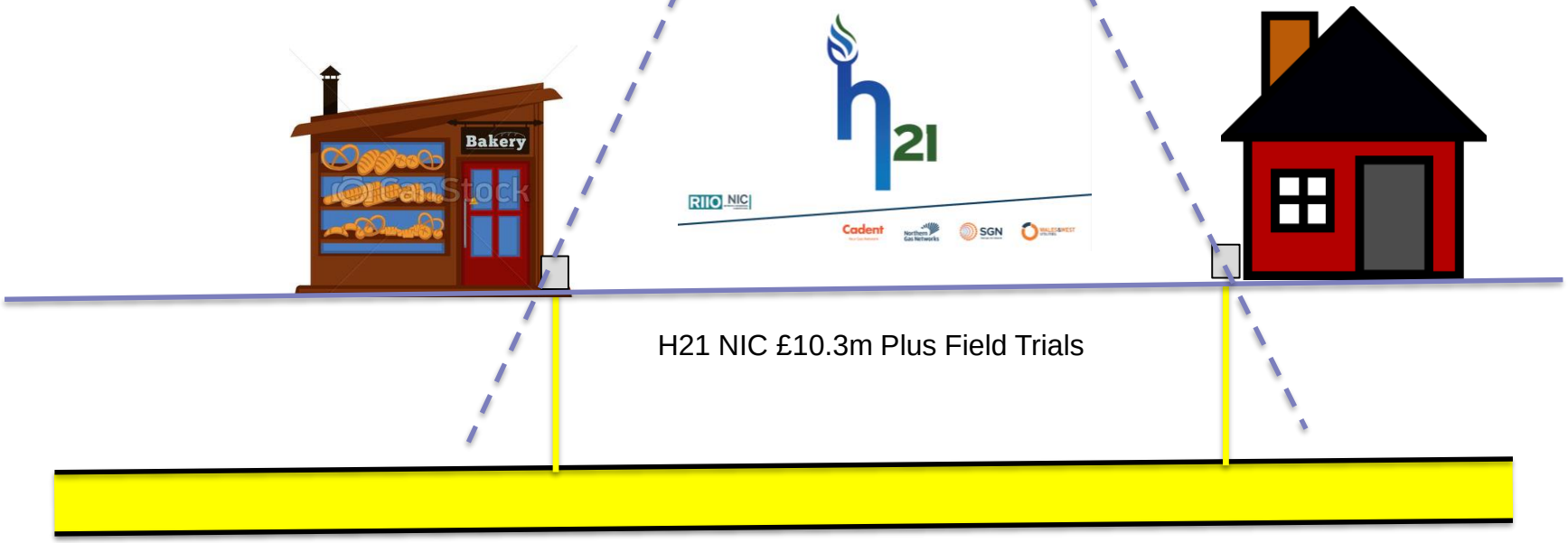


Critical Evidence: Hy4Heat/H21 NIC

Government Programme - £25m
(Hy4Heat) Downstream of the meter

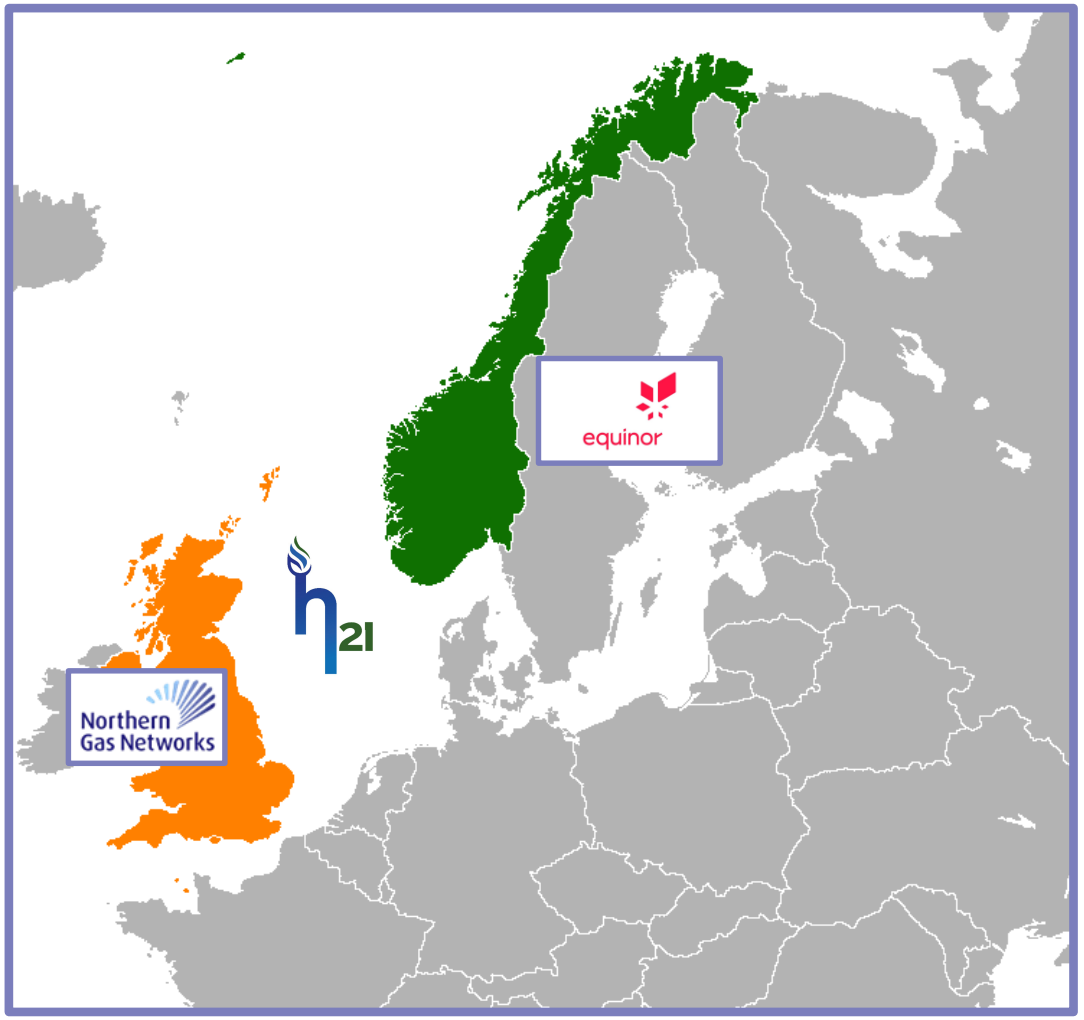
Government Programme - £25m
(Hy4Heat) Downstream of the meter

- Safety evidence
- Capital Stimulus to the Appliance Market




North of England
h21

Strategic Evidence – H21 North of England

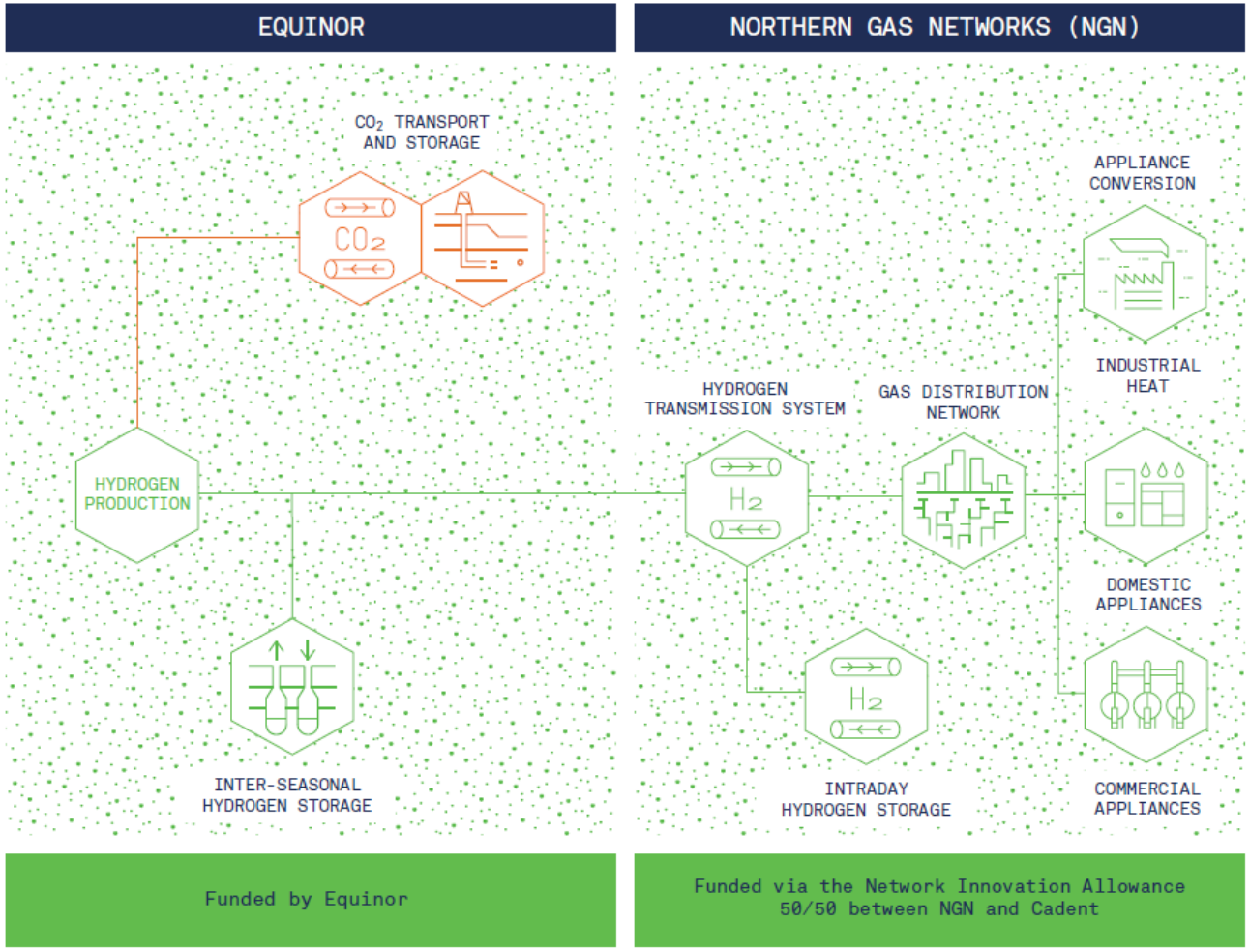


A Strategic Alliance utilising respective areas of expertise:

NGN
Hydrogen conversion
Heat demand profiles
Onshore gas Transmission

Equinor
Carbon Capture and Storage
Hydrogen production

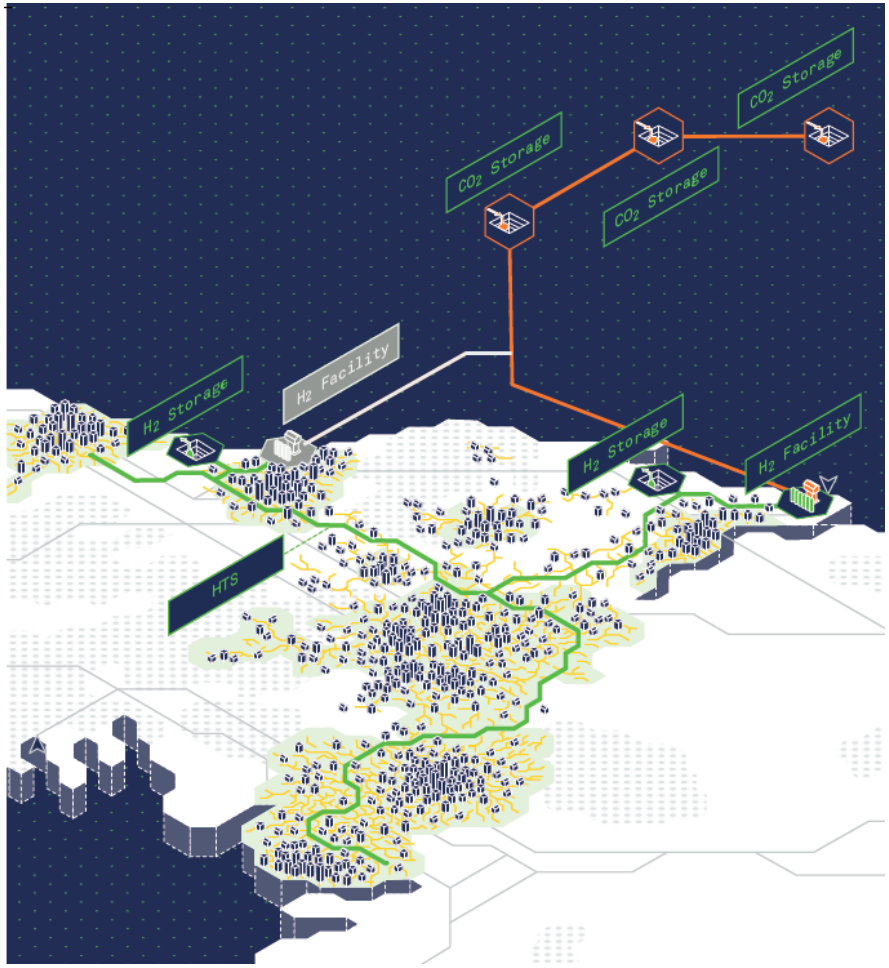
H21 NoE Scope of Works



- **1 X H21 LCG (1.5Mtpa)**
- **$10_{(MIN)}$ x H21 LCG (15Mtpa)**
- **50 x H21 LCG (75Mtpa)**

H21 North of England Hydrogen Supply Concept

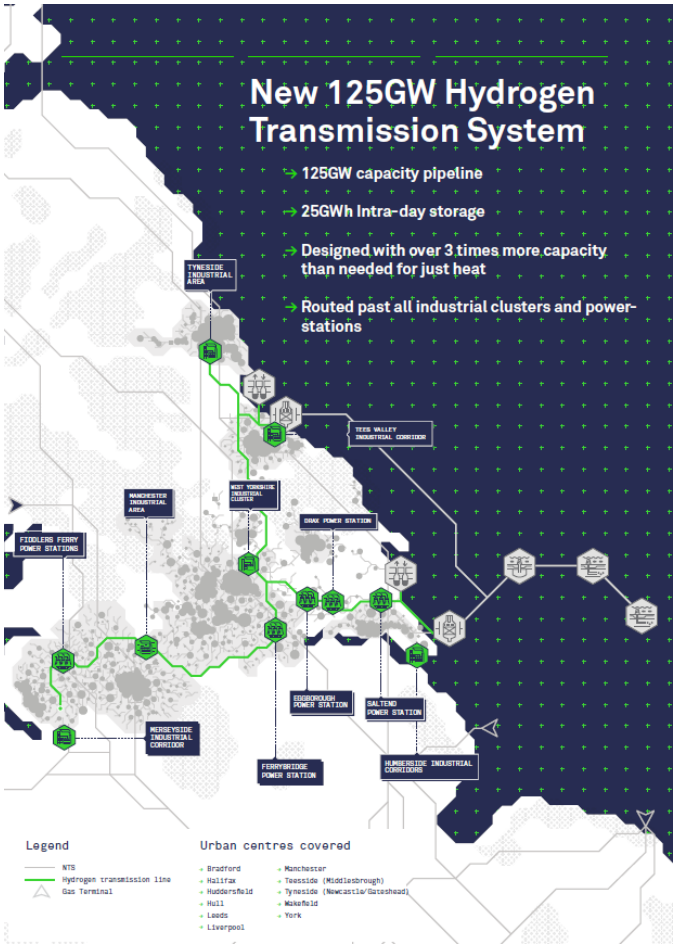
based on proven and referenced technology



Key Features

- Conversion between 2028 and 2034,14% of UK heat, 17% UK domestic meter points covered by one project. (Leeds, Bradford, Wakefield, Huddersfield, Manchester, Liverpool, Hull, York, Middlesbrough, Newcastle).
- Design capacity 12.15GW, 85 TWh for heat, Decarbonising heat using existing gas distribution network infrastructure.
- 8 TWh of inter-seasonal hydrogen storage (equivalent to 62,000 mega batteries)
- 125 GW Hydrogen Transmission System
- **20Mtpa CO_2 storage capability by 2034**
- Equivalent security of supply during peak winter (the beast from the east).

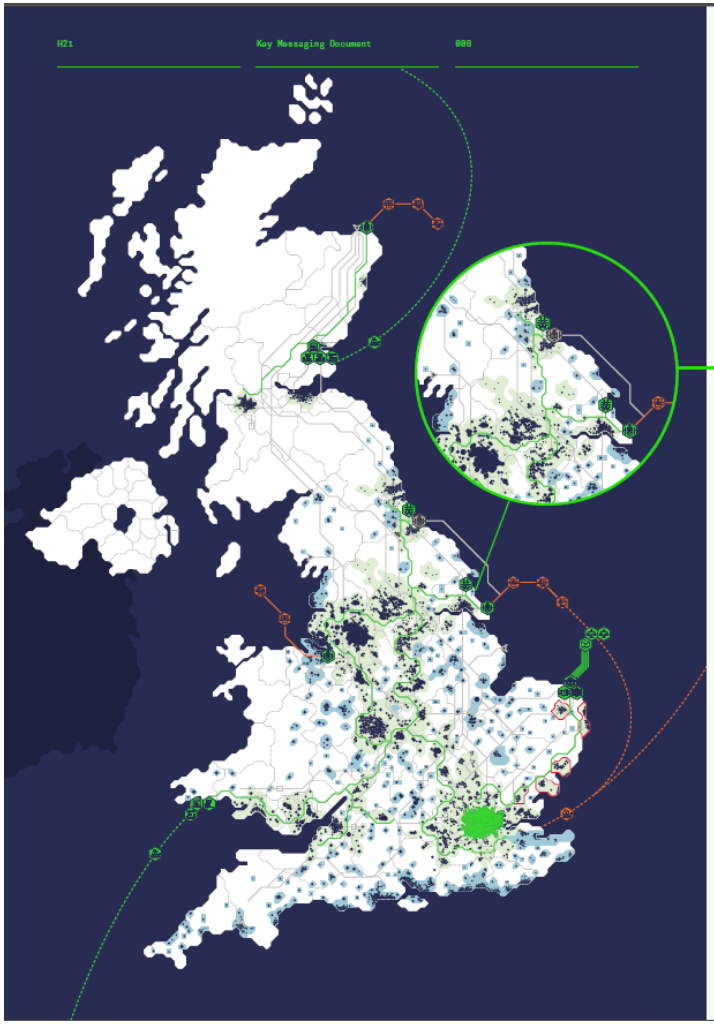
H21 XL – A Wider Energy Strategy



Key Features

- A Hydrogen Transmission system routed past Power stations and **'High Pressure' industrial Clusters**
- **Decarbonising Power** in addition to heat utilising the same system (101 TWh (H21 XL)
- **Decarbonising transport** with hydrogen fuelling stations across the North
- The ability to replace all natural gas in the UK by 2050 based on historical hydrogen production additional capacity.

A Six Phase UK Hydrogen Rollout to 2050.



UK Hydrogen conversion position in 2050

Phase 1
H21 NoE
Conversion 2028 - 2034
14% UK heat
30% Power (H21 XL) for North of England

Phase 2
H21 South Yorkshire & East/ West Midlands
2033 - 2038

Phase 3
H21 Scotland
2030 - 2032

Phase 4
H21 South Wales & South West
2036 - 2037

Phase 5
H21 East Anglia & Home Counties
2040 - 2045

Phase 6
H21 London
2045 - 2050

50-75Mtpa CO_2

Meeting the Paris Agreement - 2100

What is the real scale of the energy problem.

H21 North of England requires 85TWh annual energy in a cold year:

- 85TWh = 85,000,000,000,000 Watt hours (85 million million watt hours), this requires:
- 9.7GW average annual production = 9,700,000,000 Watts

H21 North of England is based on 12.15GW production capacity

- 12.15GW = 12,150,000,000 Watts (12 thousand million watts), based on proven technology utilising an established supply chain
- 12.15GW is 1215 times larger than 10MW (10,000,000 watts, (10 million watts)),
- 12.15GW is 81 times bigger than 150MW (150,000,000 watts, (150 million watts))

H21 North of England requires circa 8TWh of inter-seasonal storage

This is 8,000,000,000,000 Watt hours, this is equivalent to 62,015 Australian 'mega batteries'

8TWh = 62,015 'Mega batteries'


h21