Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

Cadent

Your Gas Network

Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

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Guidance:

The evidence provided in this submission will be assessed by BEIS and Ofgem to decide whether to support more detailed design work in Stage 2 of the proposed Village Trial.

To enable a smooth assessment process, GDNs should ensure that they have considered and complied with the guidance provided in the letter inviting proposals for a village trial published by Ofgem in July 2021[1], and have included all the information required in Annex A of that letter. Submissions must distinguish between plans, costs and benefits expected in Stage 2, and for the whole life of the project.

GDNs should also be clear throughout their submission where they are working collectively to close outstanding evidence gaps and make reference to joint work, or where costs are shared. You should also explain how you will build on this common work to develop site-specific plans.

The proforma indicates word limits for each section, but we welcome the use of annexes to provide more detailed information if appropriate.

Please include diagrams, charts or tables where useful.

[1] Hydrogen Consumer Trial – Open Letter to GDNs, Department for Business, Energy and Industrial Strategy and Ofgem (July 2021), https://www.ofgem.gov.uk/publications/hydrogen-consumer-trial-open-letter-gdns

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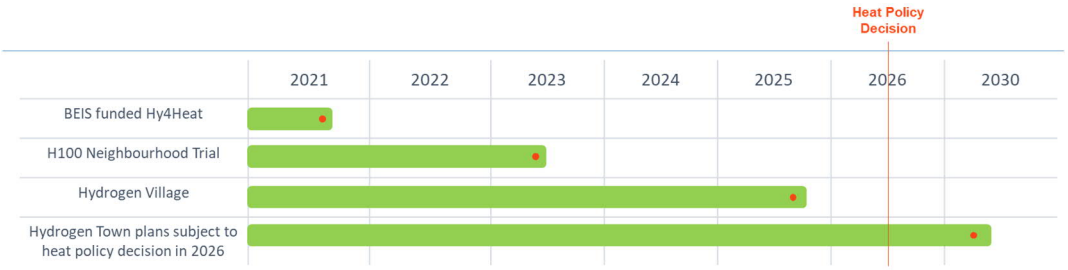
1. Project Summary

1.1 Project Title	Cadent Hydrogen Heating Village Trial Stage 2: Whitby, Ellesmere Port, Cheshire
1.2 Project Explanation	**Project Ambition** Our ambition is to convert the village of Whitby in Ellesmere Port to hydrogen to demonstrate that an existing gas network can be repurposed to operate on 100% hydrogen safely and efficiently. This village trial will enable a blueprint for rolling out hydrogen as a low-carbon energy source for heating and cooking on a national scale, supporting the UK's commitment to reduce greenhouse gas emissions (GHG) to net zero by 2050 and provide the evidence needed for a heat policy decision in 2026. **Village Trial Location** As part of our village trial selection process during Stage 1: Outline Design, we investigated five potential locations in the Cadent Gas network. Through a robust process of assessing engineering feasibility, safety, trial evidence requirements, socio-economic demographics, and consumer and stakeholder considerations, we have selected the village of Whitby – located within the town of Ellesmere Port, Cheshire – as our proposed trial location. With a population of 8,102 and 1,932 gas meter points, Whitby provides the scale required to deliver a hydrogen heating trial which is representative of a diverse range of consumers and building types. **Overview of Hydrogen Supply for the Village Trial** Whitby is in close proximity to Stanlow Manufacturing Complex (SMC); the home of the HyNet North West project which has been selected in 'Track 1' of the Industrial Cluster Sequencing by the UK Government. SMC is a planned blue hydrogen production facility which will provide the hydrogen required to deliver the village trial. **Proposed Trial Duration** We currently plan that the project will run for a minimum of one year and up to two years, coming online from May 2025. We will gather all necessary policy evidence, particularly on safety, in the first year of the trial to enable a government decision to be made on the future role of hydrogen in 2026, with a provision to extend to two years as a means of gathering additional evidence which covers more than one heating season. A longer trial duration will demonstrate refined approaches to hydrogen conversion, allow installation of hydrogen appliances to be phased, and support consumer onboarding for the trial. The optimum trial duration for benefits realisation will be further reviewed during Stage 2.

1.3 Funding Licensee	Cadent Gas Ltd

1.4 Project Description	1.4.1. The Problem(s) it is exploring In November 2020, the UK Government published its Ten Point Plan for a Green Industrial Revolution[2] which set out targets across nuclear, power generation, transport, and home heating to 'build back better and build back greener'. On home heating, it emphasised a focus on the production and trials of low carbon hydrogen, deployment of energy efficiency and insulation, and the installation of heat pumps. The UK Hydrogen Strategy (August 2021)[3] and Heat and Buildings Strategy (October 2021)[4], published by the UK Government Department of Business, Energy and Industrial Strategy (BEIS), set out a plan to demonstrate the viability of hydrogen as a future heating source for homes and buildings by 2026; the year when a strategic government decision on heat policy and the role of hydrogen in the gas networks will be made. To inform and enable future Government decision-making, an evidence-led trial which considers safety, consumer and stakeholder needs, technical feasibility, costs, and convenience of transporting 100% hydrogen within homes, businesses and the existing gas network for heating and cooking is required. Figure 1: BEIS Programme of 100% Hydrogen Heating Trials  1.4.2. The Method(s) that it will use to solve the Problem(s) We have assembled a cross-organisational delivery team which brings industry-leading, end-to-end experience to successfully deliver the first hydrogen heating village trial; from hydrogen supply and distribution, to delivering in-home solutions. Led by Cadent Gas Ltd, our project team has been mobilised and heavily involved in Stage 1 to develop a comprehensive village trial proposal. Structured into specialist work packages (WPs), our team provides assurance of delivery, meets lowest risk, and ultimately maximises the trial's chance of success. Continuing into Stage 2, our project WPs include: • WP0 - Integration & Project Management: Cadent Gas Ltd and WSP • WP1 - Hydrogen Supply and Resilience: Progressive Energy Ltd • WP2 - Network Infrastructure: Cadent Gas Ltd

[2] Ten Point Plan, Secretary of State for Business, Energy & Industrial Strategy (November 2020)
[3] UK Hydrogen Strategy, Secretary of State for Business, Energy & Industrial Strategy (August 2021)
[4] Heat and Buildings Strategy, Secretary of State for Business, Energy & Industrial Strategy (October 2021)

	• WP3 - Consumer and End User Appliances: Cadent Gas Ltd, Kiwa UK Ltd, and British Gas • WP4 - Regulatory, Billing and Commercial: Cadent Gas Ltd and Element Energy • WP5 - Safety Case: Cadent Gas Ltd and DNV • WP6 - Stakeholder and Consumer Engagement: Cadent Gas Ltd, ARUP and White Space Strategy • Cross-GDN programme: Cadent has been working alongside other GDNs and the Energy Networks Association (ENA) to interface with BEIS and Ofgem on areas of collaboration. Cadent is leading on the areas of Safety Case, Consumer Research, and Exit Plan. Annex A provides further details of the cross-GDN collaboration programme. Our delivery team will build upon the lessons learned from Stage 1 of the project, as well as evidence obtained from the H100 Neighbourhood Trial and wider industry hydrogen projects, to collect conclusive quantitative and qualitative evidence in four critical areas: • Consumer: This includes consumer attitudes and perception; consumer expectations; impact and experience on premise-type and demographic, including Customers in Vulnerable Situations. • Safety: This includes pre-trial safety outputs, live trials, and post-trial. • Delivery and learning for town/roll-out: This includes: Time and Cost; Design, Maintenance and Repair; Conversion and Viability. • Commercial and Regulatory: This includes: commercial, regulatory, and billing; training and skills; risks and mitigations. Our evidence-led method will significantly advance and validate knowledge and understanding across all identified areas to demonstrate the case for hydrogen as a heating and cooking source. This includes: • Proving the technical feasibility and viability of transporting 100% hydrogen in the existing gas network, including infrastructure and supply requirements; • Preparing a comprehensive safety case with mitigations; • Demonstrating consumer acceptability of hydrogen and informing approaches to minimise disruption and inconvenience; • Costs and practicability of preparatory, conversion, and installation activities across a diverse range of factors to inform hydrogen roll-out methods. Through collaboration across our specialist WPs during Stage 1, we have investigated the complete project roadmap across 5 stages. We have developed a project structure for Stage 2 and established outline activities for

	Stages 3 to 5, enabling us to produce a deliverable programme for the village trial. Our Stage 2 programme will include close engagement with external stakeholders and regulators to ensure the project is safely implemented. It will also involve continued collaboration with other Gas Distribution Networks (GDNs) and programmes to share the knowledge, findings, and experiences we generate. This will advance industry understanding, provide value for money, and ensure all technical and safety aspects are interrogated and approved by the Health and Safety Executive (HSE) in advance of the trial. We have identified and agreed the following areas for cross-GDN collaboration: • Compilation of 'Case for Safety', including Quantitative Risk Assessment (QRA) • Additional technical evidence required to inform 'case for safety' from the network and in home • Review of operational procedures and assimilation of training programmes (in home and network) • Standards that need to considered and modified for hydrogen deployment • Delivery of market structure and billing regime for the duration of the trial 1.4.3. The Solution(s) it is looking to reach by applying the Method(s) Our proposed method will result in the following key outcomes by the end of Stage 2: • Network solutions defined; • Engineering packages completed; • Partnerships with third parties agreed; • Commercial contracts and regulatory approvals in a position to be finalised; • 100% surveys to quantify number of appliances; • Workforce training programmes; • Full evidence/benefits plan; • Case for Safety, and conclusions of the safety and risk assessment work; • Full scope of site-specific safety documentation developed; • Consumer solutions and corresponding agreements ready for implementation, including a detailed billing strategy; • Robust spending profile; and

- Detailed implementation timetable for delivery of a live trial (including identification of further stage gates and a detailed exit plan).

By producing comprehensive and assured delivery plans for Stages 3 to 5 which are supported by the local community, consumers, and stakeholders, our Stage 2 work will effectively inform decision-making and investment decisions, and enable project readiness for Stage 3.

Overall, our method will enable the successful delivery of the first end-to end 100% hydrogen village trial, and, in the process, provide a diverse and robust evidence base which meets all evidence points from the BEIS Evidence Framework.

1.4.4. The Benefit(s) of the proposed Village Trial

Our proposed village trial in Whitby will generate evidence on a scale that has not yet been achieved. With 1,932 meter points, the trial will produce an assured and robust evidence base which is representative of a diverse range and significantly larger number of participants and building types than previously-undertaken hydrogen trials.

Crucially, the trial will ensure the requirements of consumers and wider society are fully considered, with consumer perceptions and needs forming a significant component of the evidence base.

The findings and outcomes of the village trial will enable the BEIS Evidence Framework to be delivered, ensuring an informed governmental decision on the future role of 100% hydrogen for heating is made in 2026.

The village trial will also provide a unique opportunity to deliver wider social, economic, and environmental benefits throughout the project lifecycle, ensuring we leave a lasting positive legacy for the local community and support the UK Government's national levelling up agenda. Associated social value benefits of the trial include:

- Social Benefits: Working closely with the local authority, local community, and Voluntary, Social and Community Enterprise Organisations (VSCEs), the village trial will help to tackle: fuel poverty; high air pollution; social isolation; and digital exclusion.
- Economic Benefits: The village trial will grow the local economy, firmly placing the region at the forefront of innovation to enable the transition to low carbon hydrogen. The trial will support future job creation and help upskill the existing local workforce.
- Environmental Benefits: With over 80% of homes within the Whitby, Ellesmere Port region having an Energy Performance Certificate (EPC) rating between D-G, the conversion from natural gas to hydrogen will future-proof local consumers' homes in the transition to low carbon heat.

1.5. Stage 2 Funding			
1.5.1. NZASP Funding Request (£k)	£3,359k	1.5.2. Network Licensee Contribution (£k)	£4,337k
1.5.3. External Funding(£k)	£600k	1.5.4. Other RIIO-2 funding (£k)	£0
1.5.5. Additional funding required (£k)	£0	1.5.6. Total Stage 2 Costs (£k)	£8,296k
1.6 Whole Life Costs			
1.6.1 Estimated trial Whole Life Costs (£k)	[redacted]		
1.6.2 Of which, anticipated private sector contribution (£k)	Stage 2 private sector contribution (British Gas and Cadent) = £4.937m Anticipated contribution for Stages 3 to 5 shall be defined as part of Stage 2.		
1.7. List of Project Partners, External Funders and Project Supporters[5]			

[5] SIF Governance Document, Ofgem, (August 2021)
https://www.ofgem.gov.uk/sites/default/files/2021-08/SIF%20Governance%20Document.pdf

Please include the value of their contribution and relevant experience.

We have assembled a consortium of organisations that have industry-leading, end-to-end experience, capability, and expertise to successfully deliver this nationally significant project.

Project Partners:

Cadent Gas Ltd – We are the lead project partner and largest operator of gas networks in the UK. Cadent brings experience as a leading partner in high-profile hydrogen projects:

- HyNet North West; a 'Track 1' industrial cluster project which is developing a network of hydrogen production, distribution, and storage in the North West and North Wales.
- HyDeploy; the first live demonstration to inject zero carbon hydrogen into a gas network at Keele University for heating.
- Hy4Heat; an innovation programme which involved the building of two new hydrogen homes which use 100% hydrogen for domestic heating and cooking in appliances including boilers, hobs, cookers, and fires.
- H21; a suite of gas industry projects which look to prove that the gas network can safely transport hydrogen in the future.
- Net Zero Pathways: Demonstrable in delivering a number of 'whole systems' projects with Electricity North West for Greater Manchester Combined Authority and Scottish Power Energy Networks for Liverpool City Region to show how the role of hydrogen combined with electrification supports delivery of net zero.

Progressive Energy Ltd – Formed in 1998 to develop low-carbon technologies, Progressive Energy bring extensive experience leading innovative hydrogen projects. This includes the HyNet North West Project. Progressive Energy has formed a Special Purpose Vehicle (SPV) with Essar Oil UK to deliver the UK's first bulk hydrogen production facility in Ellesmere Port, and HyDeploy, the first live demonstration to inject zero carbon hydrogen into a gas network for heating.

Chester West and Chester Council – The local authority for the region of Whitby and owners of social housing in Whitby. They bring an in-depth understanding of the local region and the project's impact on local residents, which will be provided through an engagement panel to maintain their project independence.

British Gas, Centrica – As the largest UK energy and home services company who undertake c.8m household visits a year, British Gas brings a wealth of experience in delivering high-quality, in-home solutions for consumers through a trusted nationwide brand. They will provide expertise in smart metering and boiler replacements, as well as other low carbon electric heating systems and home retrofits which could be a key component of the project.

External Funders:

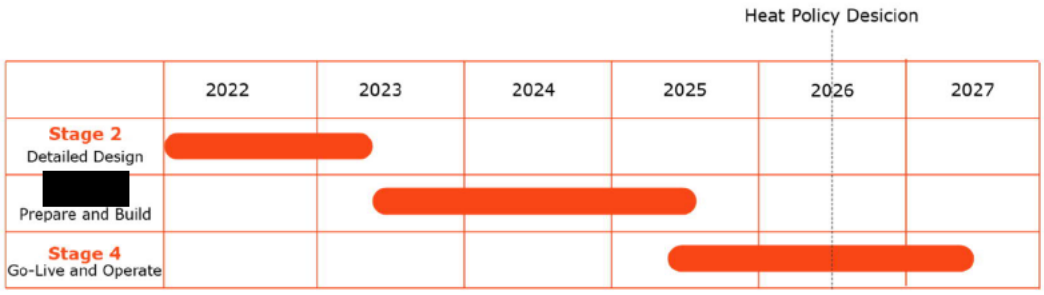
Cadent are committing £4,337k of funding to Stage 2 of the project.
British Gas are committing £600k of funding to Stage 2 of the project.

Project Supporters:

38 Letters of Support have been received for the Whitby hydrogen heating village trial by individuals and organisations at a national, regional, and local level. These can be found in **Annex I**.

1.8. Timescale / Project duration	**Stage 2 Detailed Design:** January 2022 – March 2023 **Stage 3 Prepare and Build:** April 2023 – June 2025 **Stage 4 Go-Live and Operate:** May 2025 – June 2027

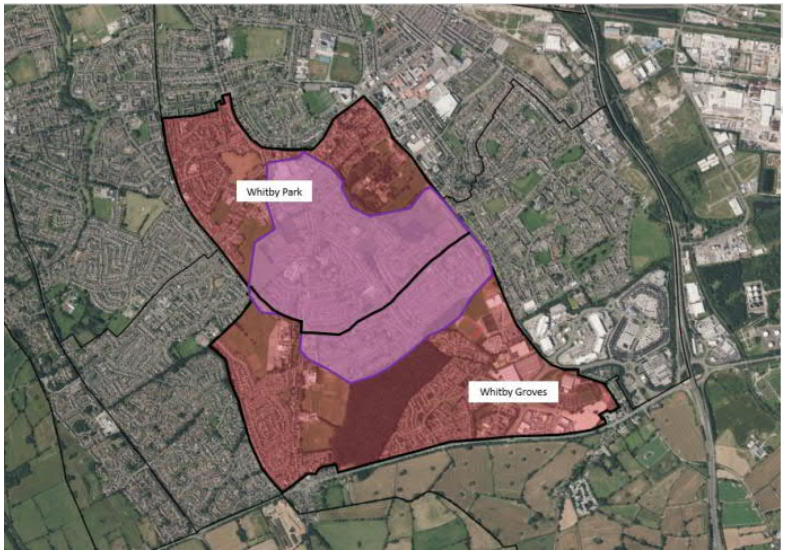
Figure 2: *Proposed Project Stages*



1.9. Project Manager Contact Details

1.9.1. Contact Name and Job Title	[redacted], Cadent	1.9.2. Email and Telephone Number	[redacted]@cadentgas.com Mob: [redacted]
1.9.3. Contact Address	Hinckley Operational Centre, Brick Kiln Street, Hinckley, Leicestershire, LE10 0NA		

1.10 Trial Project Summary (750 words)

1.10.1 The population and geographical coverage of the potential trial location	Whitby is a village located within the town of Ellesmere Port, in the Cheshire West and Chester local authority area of Cheshire, England (Figure 3) and has a population of 8,102. The village has a geographical coverage of 147 hectares and comprises two wards; Whitby Park and Whitby Groves (Figure 4).  Figure 3: Location of Chester West and Chester Local Authority  Figure 4: Location of Whitby Park and Whitby Groves Wards (Red); Outline of area defined by Cadent as Whitby, Ellesmere Port (Purple) With parts of Ellesmere Port ranking 2,756 out of 32,844 the 2019 English Indices of Deprivation (IoD), the region is within the top 8% most deprived areas in England. The village trial therefore provides an opportunity to

support the UK Government's levelling up agenda both in Whitby and across the wider Ellesmere Port, West Cheshire and Chester area.

Whitby's levels of unemployment are in line with the regional (2.3%) and national (2.2%) averages.

Table 1: *Whitby Population Statistics*

STATISTIC	WHITBY	
Age of Population	0-19	22.1%
	20-64	58.6%
	65+	19.3%
Ethnicity	White British	96.3%
	UK born	95.6%
Fuel Poor		10.3%
Population		8,102
Tenure	Owned	90.9%
	Social rented	1.7%
	Private rented	5.8%
Employment (Full Time (FT) or Part Time (PT))	Employed (PT/FT)	67%
	Full Time	47%

1.10.2 The number and range of gas consumers in the trial area, and coverage of consumers and building types within the trial	Number and range of gas consumers 99% of Whitby's population has central heating, with 92% utilising natural gas. There are 1,932 meter points and a gas demand of 1700 scm/h. While the land to the east of Ellesmere Port is heavily industrialised, Whitby itself does not contain any industrial consumers that would be challenging to convert. There are no Independent Gas Transporters present. Building types within the trial Whitby is predominantly a suburban area comprised of conventional low-rise homes, with primary schools, shops, and other small non-domestic properties. With an average house price of £154,178, Whitby's housing stock includes: • 75% semi-detached • 24% detached • 1% terraced This is consistent with the types of properties considered during the development of the Hy4Heat safety case: low-rise domestic houses constructed primarily from masonry and without cellars that represent a large proportion of UK housing stock. This consistency will allow the safety case for this project to build upon learnings from the existing Hy4Heat work and avoid duplication. Non-domestic properties within Whitby include: • One supermarket • Ellesmere Port Hospital, a rehabilitation unit with diagnostic facilities but no Accident and Emergency department • Three primary schools • One retirement home • Two restaurants • One fish and chip shop • One hairdresser Stage 2 survey work will assess the technical feasibility and customer willingness of the supermarket and Ellesmere Port Hospital towards conversion to hydrogen. If these cannot be converted to hydrogen within the project constraints, it will be possible to individually remove the premises from the trial and maintain them on natural gas. As Whitby is a well-established suburban village which adjoins other residential areas, we do not anticipate there to be any significant growth in property numbers from new-builds.

1.10.3 The broad strategy for hydrogen supply, new infrastructure, and network conversion.	The trial's hydrogen supply will be sourced from the HyNet Hydrogen Production Plant (HPP1) at Stanlow Manufacturing Complex. This will be constructed as part of the HyNet North West project, which is focused on large-scale, blue hydrogen production, with carbon capture and storage. Scheduled to come online during the 2025 heating season, HPP1 will have a capacity of 350MW, which far exceeds Whitby's intraday peak hydrogen demand of 20MW. Hydrogen will be taken as a controllable supply into the village network, allowing it to flexibly cater for the range of daily and seasonal demands. We will further explore the possibility of adding green hydrogen sources to the supply during Stage 2. The required infrastructure will involve the installation of a pressure reduction station near the production site at Stanlow Manufacturing Complex in the HyNet North West compound. This will control the supply pressure, reducing the hydrogen at source from 40 barg to 2 barg at its outlet. To transport the hydrogen to Whitby, the construction of a new 6km pipeline of 250mm nominal bore will be required. To reinforce the low pressure network for the trial, we have identified 3km of pipes for replacement during 2022/23. This forms part of our current mains replacement programme and is therefore not an additional trial cost. Following the mains replacement works, we will assess the low pressure network for capacity, ensuring compatibility with both natural gas and hydrogen. We have identified that a new medium pressure to low pressure governor will be required at the north of the Whitby trial area to further reinforce the network. We have undertaken an assessment of the sectorisation requirements for the trial, identifying options which consider the balance between valve numbers and consumer volumes. This has been assessed alongside practicality of delivering conversion, the required time off gas for consumers, and resource impacts.

2. Evidence Base

2.1 Outline evidence/benefits plan (1250 words)

Please provide a description of the different types of evidence expected to be generated by the proposed trial.

You should make reference to the Trials Evidence Framework being developed by BEIS, and include an assessment of the quality and comprehensiveness of evidence the trial project would provide against each evidence type, including an assessment of the a nature of any substantial evidence gaps expected to remain after the completion of the trial (eg materially different building types); an explanation of how the scope and design of the trial will enable these benefits; and when the benefits would be realised, eg identifying benefits at each subsequent stage of design, preparation and operation.

Whitby has been selected as our village trial location due to its ability to generate robust findings across each evidence type and sub-group from the Trial Evidence Framework. This will allow us to produce a diverse evidence base which meets government needs and allows a strategic decision to be made on the future role of hydrogen.

As part of Stage 1, our work package teams conducted a thorough assessment of each evidence statement specific to their discipline and indicated where our plans incorporate the elements of the evidence framework. The full findings can be found in Annex B: Trial Evidence Framework.

The data will be presented in deliverables across all stages and as raw data. Key project documents such as lessons learned, risk registers and decision registers will provide experience-based learning and benefits realisation throughout.

An overview of the evidence which we expect the trial to generate against the four evidence types is provided below.

1) Consumer

A fundamental project objective is to ensure the requirements of consumers and wider society are fully considered, with consumer impacts, attitudes and experiences forming a significant component of the evidence base. The Whitby village trial will address all consumer evidence points specified by BEIS, ensuring we gather representative consumer findings on the experiences, attitudes, and behaviours of a diverse range of households and businesses, both during the hydrogen conversion process and when the trial is operational.

Consumer and stakeholder engagement has been carried out in Stage 1 to gain an early understanding of needs and perceptions towards hydrogen and the village trial among local partners, community representatives, consumer groups and businesses in Cheshire West and Chester. The findings generated from our early engagement were central to our final site selection of Whitby village.

In collaboration with Cheshire West and Cheshire Council and local consumer groups, we will deliver a public engagement strategy from Stage 2 and throughout the project until trial completion. Ongoing consumer research, proposition development activities, regular

surveys, customer service enquiries, and a 24-hour customer service feedback channel will provide a clear understanding of the steps that need to be taken to mitigate concerns and limit dissatisfaction for future trials and wider hydrogen roll-out.

We will work closely with trusted third parties, including tenant participation groups, housing officers and VSCEs, to engage with different sections of the community with specific needs and ensure their feedback and experience is effectively captured and evidenced throughout the trial. These groups include, but are not limited, to: visually/sensorily/hearing impaired consumers; digitally excluded; consumers with accessibility requirements; fuel poor; and consumers who speak English as an additional language.

2) Safety

Safety of hydrogen in the gas distribution network and appliances in buildings is being carefully considered through a number of programmes, including HyDeploy, which Cadent is leading. The village trial will build on the safety evidence of this and other industry projects. The trial will meet all safety-related areas of the evidence framework, focused on raising a deliverable and approved safety case for operation, as well as an inherently safe design of the trial.

In Stage 2, we will collect data on the ability for duty-holders to meet the different trial safety requirements set out by HSE in the Safety Evidence Needs Assessment. This will include developing a Quantitative Risk Assessment (QRA) and the case for safety documentation alongside the design of the trial, engaging periodically with the HSE. The QRA will be further updated in Stages 3-5 as further design and operational information becomes available. Additional activities to support evidence collation will include hazard identification workshops and a risk reduction workshop, involving participation from project stakeholders.

Stage 2 will initiate a competency assessment plan for the safe operation and management of the trial network, including safe installation of appliances and meters. The training plans will be continually assessed throughout the trial, with the effectiveness evidenced through audit and inspection of works in Stage 3.

3) Delivery and learning for town/roll-out

With 75% of Whitby's housing stock comprising semi-detached homes, the village trial will provide a highly valuable dataset which is representative of the largest housing subset in the UK. This will provide optimised learnings to inform future delivery of a town-scale hydrogen trial and wider hydrogen roll-out.

We will design the trial to ensure that the diversity of housing stock is recorded along with variations by property. This will provide a clear understanding of the technical challenges associated with hydrogen roll-out, while also de-risking and limiting the cost variance of trials which cover a broader range of housing.

Through Stage 2 surveys, we will develop cost and time estimates for trial delivery activities, including preparation and installation processes in different building types, considering: number of storeys; building condition and age; building size; building material; level of insulation and ventilation; and the building's use. Cost and time estimates for

activities critical in converting the existing natural gas network to hydrogen commenced in Stage 1 and will be further refined in Stage 2, with evidenced costs and times reported in Stage 3.

During Stage 2, we will continue to engage with vendors and potential service providers to evidence maintenance of equipment requirements for Stages 3 and 4. Data from operations and implementation will be recorded and lessons learned from the field reported.

The grid network conversion process, including sectorisation and hydrogen compatibility with swagelined pipes, will continue to be investigated from Stage 1 into Stage 2, with findings shared with other GDNs to advance safety and technical evidence on hydrogen conversion and viability and enable HSE approval.

The trial will use operational data from Stage 4 to validate the models used to design the system in Stages 1-3. In Stage 4, findings from utilising existing network procedures will inform new/updated procedures for future hydrogen roll-out.

4) Commercial and Regulatory

From Stage 2, we will further investigate regulatory, legislative and policy changes required for the successful implementation of town pilots and wider hydrogen roll-out. Assessment of current standards and identification of potential gaps will be ongoing throughout the trial. We will actively engage with industry processes to identify and define modified or new standards and will keep up-to-date with developing international standards.

Data on the feasibility and effectiveness of new billing methodologies to sustain future hydrogen demand and work for a diverse range of hydrogen customers will be generated over Stages 2 and 3. Stage 4 of the trial will provide operational data that will complete the regulatory and commercial lifecycle, with all findings and evidence shared across GDNs to advance industry learning.

Building upon Stage 1 engagement, we will examine supply chain capability to deliver appliances and equipment. Stage 2 surveys will enable a procurement phase to be undertaken, seeking information on costs and delivery. Metering supply will also be examined, with accuracy and reliability evidenced in Stage 4.

Development of workforce and training requirements for installation and maintenance personnel commenced in Stage 1 and will be further defined during Stages 2-3. Installation and service works will be monitored in Stages 3-4 in accordance with quality assurance regimes. Data collected from assurance checks will be reported to inform future standards and guidance. As hydrogen skills, capability and workforce needs develop in Stages 2-4, we will collate data and evidence any skills gaps, analysing how these can be mitigated.

As the trial gathers evidence on the effectiveness of mitigations, we will incorporate learnings into deliverables and activities.

2.2 Safety Case Development Strategy (1250 words)

This should include a description of:

- the planned technical approach to modelling/quantifying/assessing risks and mitigations;
- the scope of activities which you plan to include in your assessment of risks;
- the main potential hazards which you anticipates your risk assessment will need to encompass;
- the approach to building on existing safety projects and working with others to build our collective understanding of hydrogen safety;
- the plan for delivering the necessary risk assessment work including securing the necessary technical expertise and resources; and
- set out plans to meet the requirements of the relevant health and safety regulatory framework.

Our Approach

The risk assessment of the trial will compare the risk from the natural gas network in 2021 (including CO poisoning risk) as a baseline, against the planned hydrogen network for the trial, with mitigation measures put in place to maintain the baseline risk level. We will produce a Quantitative Risk Assessment (QRA) to support project design decisions, such as mitigation measure implementation, and support consumer engagement regarding the perception of safety of the trial. The QRA will consist of three main elements:

- Site QRA for the entry point arrangement (gas treatment and pressure reduction)
- Pipeline QRA for the medium pressure pipeline route to the hydrogen village
- Distribution QRA for the hydrogen village, including end use inside the home

We will perform the site QRA using the established risk assessment methodology embodied in DNV's FROST software. It is already capable of modelling pure hydrogen and hydrogen blends for a range of loss of containment scenarios.

The QRAs of the MP pipe to the village, and the distribution system around the village, will use hydrogen-specific modelling techniques, evidence, and information, such as DNV's CONIFER risk assessment package, which can represent pure and blended hydrogen use in local distribution networks, as well as natural gas. There is a good level of industry understanding of many aspects of buried hydrogen pipeline releases, based on historical experience with natural gas and hydrogen-specific methodology developed using full scale test data. Furthermore, CONIFER is being developed to utilise learning from other hydrogen projects (e.g. Hy4Heat) to cover end-use risk.

Potential mitigation measures have been identified across previous hydrogen projects (H21, Hy4Heat, H100). These will be reviewed for:

- Applicability; are they appropriate for this trial?
- Practicality; can they be easily applied?

- Cost implications
- Reduction in risk achieved

Risk reduction workshop(s) will be attended by representatives from all project work packages, as well as Cadent subject matter experts including Operations and Safety, to review the mitigation measure options which could be implemented on the distribution network or within the home. Consumer feedback has indicated maintaining the current levels of safety as a key success factor for a trial. The risk to consumers of operating the trial project will be assessed and compared to the current risk from the network, and mitigation measures implemented to maintain the current level of risk.

Scope

The scope covers three main elements: the gas treatment site (odourisation and pressure reduction); the MP pipeline; and the distribution network including end-use.

The assessment of risk will include:

- Change of gas use from natural gas to hydrogen
- Change of use from natural gas to heat pump / electricity for consumers not opting to take hydrogen / switch all appliances, incorporating household survey and assessment outputs
- All phases of the project including commissioning and the exit plan
- Societal risk and occupational risk
- Identification and assessment of mitigation options

The case for safety will include:

- Security of supply
- Training & Competency
- Safety Management System
- Emergency Response
- Procedures

Hazards Encompassed

The main potential hazards that the risk assessment will encompass are:

- Fires
- Explosions
- Occupational

The hazards will be detailed via a HAZID in Phase 2 of the project, with stakeholder engagement from the supporting work packages and external parties e.g. appliance manufacturers. Throughout the lifecycle of the project, we will undertake other activities that will support the assessment of risk such as HAZOP, HAZCON and DSEAR assessments.

DNV's CONIFER risk assessment package was developed as part of the H21 project and has been reviewed in detail by gas network operators and HSE Science Division. It is capable of modelling natural gas and hydrogen distribution networks including the calculation of risks associated with fires and explosions. It is a detailed, multi-step model that accounts for the physical behaviour of gases, as well as the characteristics of mains, services, and buildings.

Building Collective Understanding

The majority of the safety evidence required is common to any hydrogen village project. For example, we anticipate that a collaborative approach should be used to assess the effectiveness of the mitigation measures. Therefore, the project will build on existing safety projects and work with other GDNs to build a collective understanding of hydrogen safety. Desktop reviews of existing published information will be undertaken. This will be supported by utilisation of an internal project team which consists of key partners that have contributed to the development of design and safety cases for other hydrogen projects (within confidentiality bounds). Sources include information and evidence from:

- Other hydrogen projects (Hy4Heat, H100, H21, including international work)
- Project work packages
- Relevant work processes from operation of the natural gas distribution system, including existing Safety Management Systems.

As further safety evidence is continuously emerging, we will actively collaborate with other hydrogen projects to pool resources, avoid duplication, and share emerging results as soon as they become available. We will also engage with the Energy Networks Association and Network Safety Impact Board; an industry body that meets to address inter-project hydrogen safety collaboration. Furthermore, we will feed relevant reports to the IGEM hydrogen knowledge centre, such that other projects can utilise evidence and methodologies. We will clearly define any dependencies on information from other projects in the project risk register.

For Stage 2, we will review safety plans and procedures for hydrogen incidents, including interaction with emergency services. To ensure a consistent approach to emergency response across the industry, we will collaborate with other hydrogen projects including HyTechnical, H100 and H21. In Stage 3, we will communicate plans and hold drills to test and assess the plans ahead of hydrogen being introduced to the trial. Any learnings from the drills will be incorporated into the emergency procedures which may be further improved, or additional training requirements identified.

Resource Plan

To deliver the necessary risk assessment work, including securing the necessary technical expertise and resources, we will use an experienced team with the relevant technical expertise to execute the work and solve novel technical challenges as and when they arise. Project contributors, including Cadent, DNV and Kiwa, hold substantial hydrogen expertise. In particular, DNV has more than 45 UK-based specialist engineers and scientists with hydrogen experience, including world leading experts in the field. The team will include members who have completed similar hydrogen network risk assessments to leverage

previous experience. Competence development will be strategically managed and recruitment of additional hydrogen-ready resources will further strengthen the team.

Regulatory Requirements

The health and safety regulatory framework relevant to the project includes, but is not limited to, the following requirements and duties:

- Health and Safety at Work Act 1974: Overarching duty to ensure, so far as is reasonably practicable, the safety of employees and others.
- Management of Health and Safety at Work Regulations 1999 and DSEAR: Requirement to conduct a suitable and sufficient risk assessment.
- GS(M)R (treating GS(M)R as if it did in fact apply to a hydrogen network): Requirement to prepare a safety case, arrangements to minimise the risk of a supply emergency.
- GS(IU)R: Requirement to conduct safe installation and use of gas systems and appliances.
- Pressure Systems Safety Regulations (PSSR): Design and construction to prevent danger; provision of protective devices.
- Pipelines Safety Regulations (PSR): Design, safety systems, safe operating limits.

The case for safety will demonstrate compliance with relevant requirements. It will describe the measures necessary to ensure safety and these will be determined based on a combination of:

- Prescriptive regulatory requirements;
- Standards and guidance
- Risk assessments;
- Project information, including; security of supply/resilience, competency development/management and, operating and management procedures.

Further trial safety considerations and associated activities can be found in Annex C.

3. Planning and Risk Mitigation

3.1 Plan, timetable and scope of work for subsequent stages of the trial (1000 words)

Please provide a full plan for the Detailed Design stage of the project, including a high-level plan and schedule for all other stages of the trial, identifying the scope of work, deliverables, and milestones for each stage.

Please include a gantt chart in an annexe.

The project Gantt chart outlining our plan from Stage 2: Detailed Design to Stage 5: Exit Plan is provided in **Annex D**: Project Plan. This encompasses deliverables for each stage, as well as an indication of timeframes, key interdependencies, and project milestones. Critical activities which will need to commence in January 2022 to ensure that Stage 2 is completed by Q1 2023 have been identified.

The proposed programme dates for each Stage are shown in Table 2.

Table 2: *Proposed Trial Programme Dates*

Stage	Proposed Dates
Stage 2: Detailed Design	January 2022 to March 2023
Stage 3: Prepare and Build	April 2023 to June 2025
Stage 4: Go-Live and Operate	May 2025 to June 2027
Stage 5: Exit	Post July 2027

Stage 2: Detailed Design

Our Scope of Works document is provided in **Annex E**; this details the activities and deliverables for each WP as part of the Stage 2 works. A summary split by work package (WP) is provided below.

WP0: Integration and Technical Oversight

WP0 will be responsible for the wider project management of project delivery, provision of technical support to work packages, and delivery of formal process safety assessments (FPSA).

Key outcomes:

- FPSAs undertaken
- Preparation of robust spending profile over project lifetime
- Detailed implementation timetable for trial delivery

- Full evidence and benefits plan

WP1: Hydrogen Production & Resilience

WP1 will undertake pre-FEED close-out, building on Stage 1, to review and optimise the backup supply solutions identified.

All necessary supply solutions will be progressed to Front End Engineering Design (FEED) stage, inclusive of planning and consenting requirements and vendor selection and engagement where appropriate.

Additionally, the tender process for an Engineering, Procurement and Construction (EPC) contractor will be undertaken.

Key outcomes:

- Engineering packages completed for supply solutions inclusive of vendor quotes

WP2: Network Infrastructure

WP2 will progress the design of the required Hydrogen Above Ground Installation (HAGI), new MP pipeline and MP to LP governor to FEED stage. The land and planning requirements for the MP pipeline and governor site will be undertaken.

All impacted network assets will be assessed for suitability for hydrogen; existing MP pipeline, services and multi occupancy buildings (of which there are none above 3 storeys on the trial network). The system conversion, sectorisation and reinforcement approach will be refined.

Key outcomes:

- Engineering packages completed for the network infrastructure
- Network assets surveyed, conversion approach defined and replacements identified
- Reinforcement requirements identified, and next iteration of network conversion and sectorisation plan

WP3: Consumer and End Use Appliances

Initially, domestic and non-domestic surveys will be undertaken to ascertain suitability of hydrogen conversion and define the volume and define range of appliances required.

WP3 will collaborate with the supply chain, and prepare bills of materials (BoM).

Engagement with SP Energy Networks (SPEN) will continue to understand the impact of reinforcing the local electricity network. Contracting, procurement and conversion strategies will be developed.

Key outcomes:

- 100% surveys to quantify number of appliances
- Preparation of final BoM
- Contracting, Procurement and Conversion strategies
- Scope of works and costs for electricity network reinforcement

WP4: Commercial and Regulatory

WP4 will utilise the regulatory approach proposed for H100 as the basis for the village trial. In Stage 2, work will commence on the modifications and derogations to the Uniform Network Code (UNC) and modifications to commercial billing. This will be undertaken collaboratively with industry.

Key outcomes:

- Changes communicated with gas shippers and suppliers
- Regulatory approvals in position to be finalised and billing strategy ready for implementation
- Commercial Assurance Framework and Commercial Change Framework for Hydrogen

WP5: Safety Case

WP5 will prepare a full project QRA covering the entry point arrangement, pipeline for the MP route and distribution including end use, and a safety case framework developed. Risk reduction workshop(s) will be carried out, and safety plans and procedures for hydrogen incidents will be reviewed.

Key outcomes:

- Full project QRA report
- Safety case framework developed with remaining evidence gaps identified

WP6: Stakeholder Engagement and Consumer Proposition

WP6 will undertake engagement activities, create public-facing channels, establish a project brand, identify social value opportunities, develop, and refine consumer propositions. Additionally, a demonstration facility will be established.

Key outcomes:

- Roll-out of public engagement campaign
- Refined and tested customer proposition, supporting high uptake
- Social value framework
- Physical demonstration facility established

The Stage 2 project deliverables are presented in Table 12 of this document.

Stage 3: Prepare and Build

Upon completion of Stage 2, there will be a stage gate, where a go/no-go decision will be made. We have programmed 27 months for Stage 3 due to construction timescales involved in the build of the HyNet Hydrogen Production Plant (HPP1), AGIs and associated pipelines.

Key Stage 3 milestones include:

- Early source hydrogen commissioning
- New AGI completed
- New MP pipeline completed

- Installation and maintenance service agreements finalised
- Changes to billing system codes and necessary legal frameworks finalised
- Software code changes implemented
- HAZCON completed
- Update to final customer propositions

Stage 4: Go-Live and Operate

Stage 4 commencement will have a short overlap with Stage 3 completion, with the majority of pre-conversion activities taking place during this period. With a target for the trial to come online from May 2025 once conversions are complete, we will gather all necessary policy evidence in the first year of the trial to enable a government decision to be made on the future role of hydrogen in 2026.

We propose that the trial continues for an additional year in order to cover two heating seasons. This will provide additional evidence which demonstrates longer-term technical resilience and safety of hydrogen as a heating and cooking source in homes and commercial buildings. It will also allow installation of hydrogen appliances to be phased, with the process continuously assessed and then improved, thereby supporting benefits realisation, consumer onboarding and learning for a subsequent Town Pilot.

We propose that the trial has a two-year period. By covering two heating seasons, we will deliver a robust and assured evidence base which effectively demonstrates the technical resilience and safety of hydrogen as a heating source in homes and commercial buildings. It was also provide the opportunity to phase the installation of hydrogen appliances in consumers' homes, enabling the process to be continuously reviewed and improved, supporting evidence collection and benefits realisation.

Key Stage 4 milestones include:

- New billing system implemented
- First batch of residence conversions (200 per week)
- Pre-installation checks
- All properties converted
- Sectorisation and conversion complete
- Trial commencement
- Capturing proposition learnings

Throughout Stage 4, data will be collected, analysed, recorded, and shared with the relevant stakeholders and other GDNs, to inform town-scale pilots and future hydrogen roll-out.

Stage 5: Trial Exit

We anticipate Stage 5 will commence post July 2027, upon completion of the trial. The selected exit scenario will determine the scope of work for this stage and will be dependent on the heat policy decision. The trial exit will need to be heavily considered at the start of Phase 2 and a common approach agreed between the project partners and BEIS/Ofgem.

3.2 Organisation of responsibilities and liabilities (1000 words)

Please provide a description of the proposed organisational, funding, and legal arrangements with project delivery partners, and suppliers, describing their respective responsibilities and liabilities, including for procurement, ownership and delivery of assets and services and associated liabilities.

Our Industry-Leading Consortium

Cadent Gas Ltd will be the lead partner within the project that will bring together organisations that are ideally-placed to deliver this nationally important project.

The organisations joining Cadent will be: the local council for Whitby, Chester West and Chester Council; the UK's largest energy and in home service provider, British Gas; and Progressive Energy, who are currently leading the HyNet North West Project.

The project partners and their associated responsibilities are provided below.

a. Cadent Gas Ltd

Cadent Gas Ltd is the UK's largest gas distribution network operator. Cadent operates four of the UK's eight gas network including North London, West Midlands, the North West of England (within the network that Whitby is located) and the Eastern Network. Cadent transports gas safely and efficiently to 11 million customers and covers the UK's major urban centres, including North London, Birmingham, Manchester, and Liverpool.

Cadent has amassed significant technical, social and project expertise internally to deliver a project of the hydrogen village's scale and complexity.

In addition to leading the project, Cadent will be responsible for:

- Ensuring the Whitby network is hydrogen 'ready', that hydrogen can be safely transported and the network is adequately controlled and maintained;
- Ensuring hydrogen is safely and efficiently transported from the production site to the trial area;
- The assimilation and delivery of a 'case for safety' for the HSE review;
- Overall budget, progress, and project outputs;
- Main interface with governmental departments, including BEIS and Ofgem.

b. Progressive Energy Ltd

With 20+ years in developing low-carbon solutions, Progressive Energy will lead the development of the hydrogen production capability. They will be responsible for:

- Ensuring that a constant and resilient supply of low carbon hydrogen is provided to the trial with sufficient availability, resilience, and capacity to meet the peak demand of the network;
- Conducting the necessary engineering and technical work to ensure hydrogen availability for 2025 and at trial commencement;
- Contracting and managing suppliers that are required to work on hydrogen supply and resilience;
- Co-ordinating the establishment of hydrogen production assets, enabled as appropriate by a newly-formed SPV with Essar.

As lead partner in the HyNet North West project, Progressive Energy has significant vested interest in the emergence of hydrogen in the North West. Awarded Track 1 Cluster status in October 2021, HyNet will ensure that significant amounts of blue hydrogen will be delivered in 2025, making the North West a leading location to host a hydrogen village trial. Led by Progressive Energy, and supported by £7.4m funding from BEIS's Hydrogen Supply Competition, a FEED has been completed on the hydrogen production site at Stanlow Manufacturing Complex.

c. Chester West and Chester Council (CW&CC)

CW&CC is a local authority and owners of social housing in Whitby. In May 2020, CW&CC declared a climate emergency and set a net zero target date of 2045. Developed in collaboration with businesses, residents and partners, their Climate Emergency Response Plan set out a decarbonisation pathway which includes the production and use of hydrogen for heating.

CW&CC's roles will include:

- Providing a central point of contact for political activities;
- Supporting the project's connection with the Whitby community;
- Providing social housing for the trial, ensuring access is guaranteed;
- Protecting the interests of Whitby's residents;
- Ensuring the project is being conducted in accordance with the council's wishes.

It is important for the council to protect its independence, so will work through an advisory council.

d. British Gas, Centrica

As the largest UK energy and home services company, British Gas brings a wealth of experience in delivering high-quality services inside customers' homes. British Gas will partner with Cadent on in-home solutions for consumers.

Responsibilities will include:

- Expertise on in-home appliances, including the surveying, installation, and servicing;
- The development and delivery of in-home surveys on all appliances and metering. This includes supporting and developing all relevant communication information alongside Cadent to enable access to consumers' homes;
- Expertise in smart metering and boiler replacements, as well as other low carbon heating systems and home retrofits.

Project Suppliers

To provide assurance of delivery, we have engaged a range of project suppliers, each with their own area of expertise, to support the delivery consortium. In accordance with Utilities Contract Regulations 2016 and our internal procurement processes for fair competition, we undertook a competitive procurement exercise prior to Stage 1 commencement to assess the skillset and experience of suppliers and ensure they presented value for money.

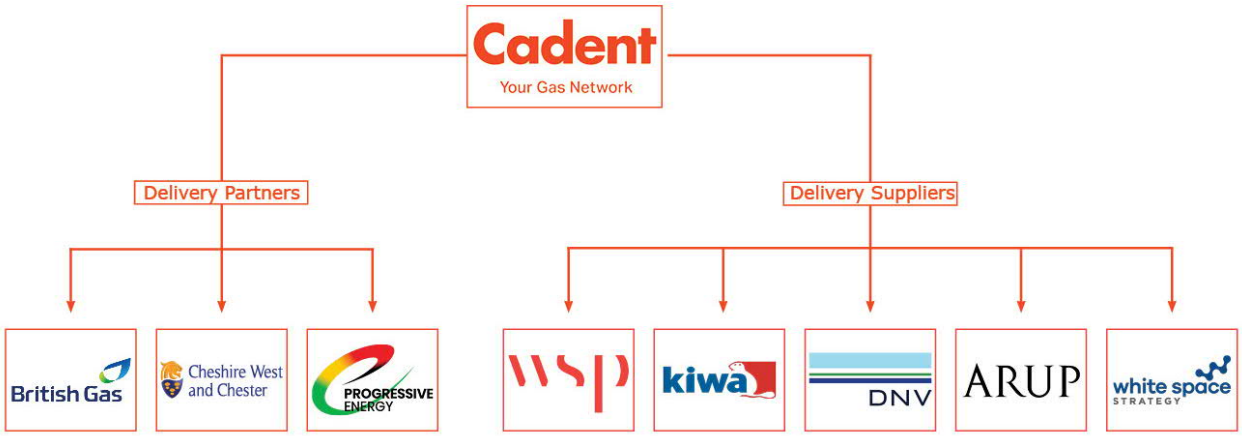
A subsequent review of value for money has taken place in advance of Stage 2 to ensure costs are understood and budgets established. Having been engaged in Stage 1, these specialist organisations bring detailed knowledge of the trial location and an in-depth understanding of the project requirements.

Our suppliers include:

- WSP UK: World-leading professional service firm, with responsibility for providing Programme Management and technical oversight.
- DNV: Experts in risks and safety and providing specialist knowledge on hydrogen safety and the assimilation of the case for safety.
- Kiwa UK: Leading testing and certification body for hydrogen and other gas-fuelled appliances. Drawing upon their role in BEIS's Hy4Heat programme, Kiwa UK will provide technical oversight on hydrogen in the home.
- White Space Strategy: Experts in growth strategy, they have been responsible for the preparation of the consumer proposition and will continue this through to project delivery.
- Arup: A global consulting firm who have been leading on stakeholder and communications through Stage 1; an area they are set to continue into Stage 2.

In addition to these suppliers, we will contract specialists to support communications and stakeholder management, including Small Medium Enterprises (SMEs) and Charities, Public Service Mutuals and Social Enterprises (VSCEs).

Figure 5: Our Project Delivery Organogram



Stage 2 Procurement, Asset Ownership, Liabilities and Services

Due to the nature of Stage 2, no significant procurement activities are planned. At the end of Stage 2, we anticipate a Final Investment Decision will be undertaken and ownership will be fully considered.

A consortium agreement will be established between the key project partners in Q1 2022 and signed upon a positive BEIS/Ofgem decision. This will negotiate the necessary liabilities for Stage 2, as well as terms of service and required asset ownership.

3.3 Regulatory plan (1250 words)

Please provide a summary of regulatory frameworks potentially impacting on the design, feasibility, or timeline of the project (eg. GDN licence conditions, planning regulations, environmental requirements); an outline timetable of regulatory compliance activities and milestones anticipated by the GDN; and a description of any regulatory barriers in relation to which the GDN is planning to seek some form of exemption/derogation/easement/special permission etc.

Our proposed Regulatory Plan for the village trial

Legislative/licence amendments

BEIS have identified several potential amendments in the recent Hydrogen for Heat consultation, with the objective to ensure that GDNs have the necessary rights and consumers have the necessary protections during the trials. We note that since the village trial will involve the unilateral disconnection and cessation of a natural gas supply to

participating consumers in Whitby, exemptions may be required from GDNs' statutory obligations associated with providing and maintaining a gas supply.

A further consideration in this context relates to security of supply. In practice, security of supply for consumers within the trial area will be ensured by rigorous project planning - consistent with existing regulatory standards - and supported by appropriate contracts. It would also be beneficial for obligations and duties associated with security of supply within hydrogen networks to be clearly set out in the regulatory framework.

As Cadent's Gas Transporter licence enables us to transport hydrogen, we are not intending to undertake any additional licensable activities as part of the village trial. Other than the points noted above, we have not identified any specific licence conditions that would need amending in order to transport hydrogen. However, should Ofgem wish to make any amendments in light of the innovative nature of this work, consent, derogation, or formal licence modification processes could be used as appropriate.

Safety

While Gas Safety (Management) Regulations 1996 (GS(M)R) only applies to the transportation of natural gas, from a safety perspective, all of the considerations within GS(M)R are still applicable to hydrogen networks. We will therefore prepare a separate safety case for the project based on the requirements of GS(M)R, noting that a separate GS(M)R safety case is kept for the natural gas networks. We will assess whether any revisions are required to reference the fact that the arrangements for the hydrogen network are covered by a separate safety case. This approach has been agreed with the HSE and BEIS.

The quality and specification of the hydrogen used in the project will comply with the Hydrogen Gas Quality Specification as developed by the Institute of Gas Engineers and Managers (IGEM) in IGEM/H/1 (Appendix 4). The separate safety case for the project will detail the need to meet this specification, and how the design and operation of the system will prevent off-specification gas being distributed.

As hydrogen technology and networks develop, the definition of "gas" within GS(M)R may be amended to include hydrogen. Depending upon how this amendment is drafted, we may be required to obtain an exemption from the HSE (under regulation 11 of the GS(M)R) from the gas content/characterisation standards in Schedule 3.

Commercial framework

We have collaborated with SGN to understand the intended commercial framework for H100 Fife and to test its applicability to a village-scale trial. This framework is one of 'minimal change' from the UNC framework in place today. We are satisfied that, subject to some minor points identified below, the commercial framework proposed for H100 can be applied to the hydrogen heating village trial.

Some minor modifications or derogations will be required in relation to the UNC. In particular, the UNC will need new provisions so that it recognises hydrogen networks as part of the "Total System". We have identified an initial list of these points in Appendix III of Annex F.

Billing system considerations

One potential development of the H100 Fife approach is to the way in which shippers are billed and the associated transfer of metered data to shippers and suppliers. SGN and Xoserve propose to make use of the Multiplication Factor (MF) within the metering data to adjust metered volumes to reflect the lower CV of hydrogen. This is a pragmatic approach, commensurate with the scale of a neighbourhood trial, which should also work well for a village trial.

However, continued use of the MF for this purpose is unlikely to be sustainable. In particular, a solution less reliant on manual intervention may be needed at the scale of town trials. We therefore propose to work with Xoserve and the wider industry to develop a more sustainable approach, suitable for the longer-term roll-out of hydrogen networks. This work should dovetail with the Future Billing Methodology project with the aim of developing a single solution, suitable for 100% hydrogen and gas blends. If available in time, the village trial could provide a good opportunity to test a revised approach.

Billing options are discussed in more detail in section 7 of Annex F.

Implications of the proposed commercial framework

Broadly, the approach proposed for H100 Fife will treat the hydrogen network as if it were part of the gas network:

- Flows of hydrogen will be treated commercially, as if they were flows of natural gas
- Shippers/suppliers will be able to use their natural gas portfolios to supply hydrogen consumers, and
- Consumers will be able to retain the same supplier, or switch supplier as they can now, and be charged as if they were receiving natural gas

It is likely that at some point in the development of larger hydrogen networks (potentially the town trial and/or clusters) the approach outlined above will become suboptimal, and potentially unsustainable, and that further evolution will be required. These issues are discussed in section 5 of Annex F. We have therefore considered whether it would be beneficial to make additional changes to the regulatory framework for the village trial at this stage, so that they could be tested and in place for later phases and provide additional industry learning.

Another key consideration regards VAT, hydrogen is currently charged at 20% whereas natural gas is 5%. For the purposes of this trial, all GDN's have assumed that agreement shall be reached to charge hydrogen at 5% for comparable cost parity. This is noted on our risk register.

We recognise that BEIS is keen to avoid unnecessary distractions from the principal objectives of the village trial and have therefore concluded that, on balance, it would be best to follow broadly the same approach as H100. This will minimise resources, costs, and disruption for all industry participants.

Timeline for regulatory compliance activities

As noted above, certain modifications or exemptions to the regulations will be required in advance of the hydrogen village trial, and indeed some in advance of the hydrogen neighbourhood trial. These changes are relatively limited for the proposed 'minimal change' approach.

More significant modifications will be required post-2025 to develop a 'beyond minimal change' change approach that constitutes a more enduring approach for the widespread deployment of hydrogen networks, enshrining this in the regulations and associated market framework. These longer-term changes are not covered in detail here. We do, however, set out a potential roadmap for regulatory and commercial framework developments in section 9 of **Annex F** and have identified key activities in Table 3**.**

Phase	Regulatory activities
In place for Hydrogen Neighbourhood trial (2022 / 23)	• UNC changes to recognise hydrogen as part of the 'Total System' • Amended billing system to account for lower hydrogen CV, likely based on multiplication factors. • Introduce necessary rights for GDNs and protections for consumers, e.g. a requirement on suppliers to ensure that customers on trial networks are charged equivalent price to natural gas price • Introduce obligations and duties associated with security of supply for customers within hydrogen networks into the regulatory framework.
Prior to Hydrogen Village trial (pre-2025)	• Cadent to develop a GS(M)R compliant safety case for the hydrogen village trial • Potentially develop an alternative billing approach to the use of MFs that would be more sustainable for the longer-term roll-out of hydrogen networks
Post Hydrogen Village trial (post-2025)	• Potential amendment to bring hydrogen networks within the scope of GS(M)R • Development of 'beyond minimal change' regulatory approach and associated market frameworks

Table 3: *Timeline for Regulatory Activities*

3.4 Exit plan (1000 words)

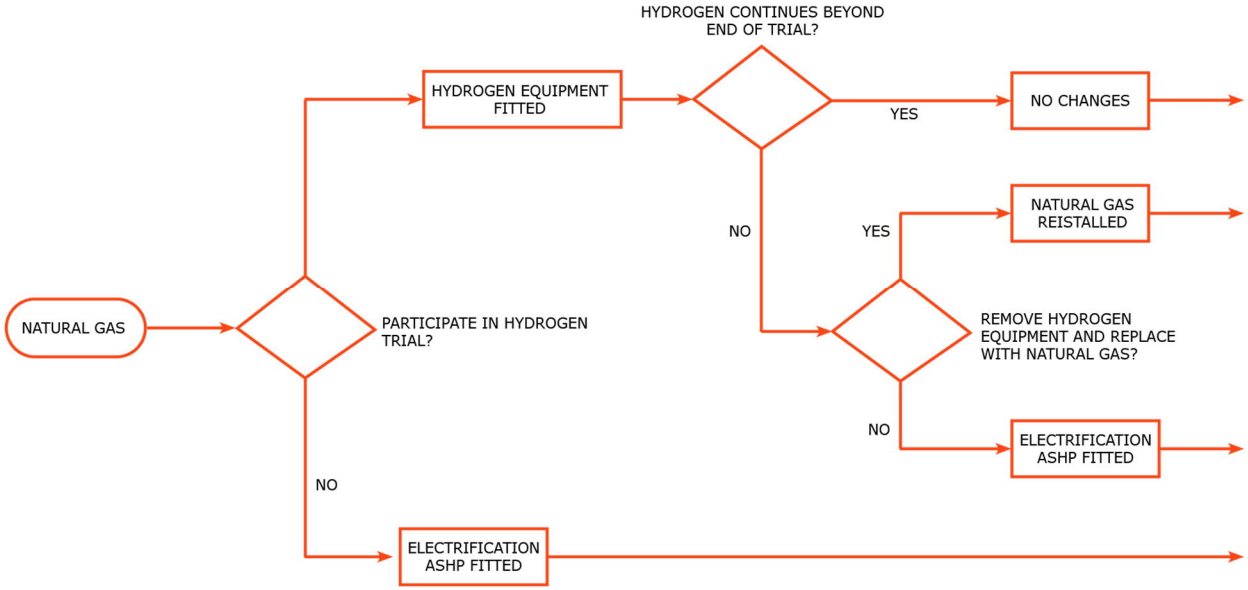
Please outline your plans for two possible scenarios: 1. the continuation of the project; 2. ending the project within 1-3 years of trial commencement and the reinstatement of natural gas supplies.

This should include the necessary infrastructure works, an outline strategy for treatment/status of consumer appliances and installations, and associated costs.

During Stage 1, we held a series of multi-disciplinary workshops with work package teams to assess the implications of the following two scenarios:

- Scenario 1 - Continuation of the project: This scenario entails consumers continuing to be supplied hydrogen for the foreseeable future; either as a permanent solution for Whitby or due to participation in the town-scale pilot. This would be due to a heat policy decision being made in 2026 that supported the use of hydrogen for domestic and commercial heat.
- Scenario 2 - Reinstatement of natural gas supplies: This scenario will entail all consumers who have been converted to hydrogen having their natural gas supplies reinstated at the end of the trial. In this instance, it is likely that no policy decision has been forthcoming to support the use of hydrogen for commercial or domestic heat.

Figure 6: Exit Plan Decision Tree



The following section outlines the considerations for each of these possible scenarios, as well as their potential implications. Further information is provided in Annex G.

Scenario 1: Continuation of hydrogen supply

Subject to a positive policy decision being made on the use of hydrogen for domestic heat, Whitby will continue to receive hydrogen supply as a heating and cooking source. However,

the 'project' (as funded by Ofgem and project partners) is unable to continue indefinitely. Instead, an agreed point will need to be reached which allows the project team to be demobilised, resulting in hydrogen funding partly becoming the responsibility of consumers and partly funded by government business models. The only instance in which hydrogen supply may continue to be supported by project funds beyond the two-year trial point is if the Whitby village becomes a component part of the planned hydrogen town-scale trial.

Our outline plan for the continuation of hydrogen being supplied is provided below.

- Consumer Appliances: Throughout the duration of the trial, hydrogen appliances will be maintained by the project team. Following the trial's completion, it will be the responsibility of the consumer to manage hydrogen appliances. Sufficient expertise will therefore need to be in place to carry out this function. We may need to consider providing additional warranty and maintenance support for hydrogen appliances after the trial has ended.
- Infrastructure: Supply will continue to operate in the same way as it did during the village trial, with the initial capital for infrastructure costs having been born by the project. Cadent will continue to maintain and operate the network, with Progressive Energy Ltd and Essar Oil Ltd continuing to operate and maintain the production facility. With 350MW of hydrogen being developed at the HyNet Hydrogen Production Plant (HPP1), the infrastructure will be in place to supply a hydrogen town-scale pilot from the 2025 heating season alongside 1TWh of underground storage by 2027.
- Consumer Considerations: This scenario will involve the least consumer disruption for those who were part of the village trial, with no additional works required. Consumers who are being supplied hydrogen will not be presented the choice to return to natural gas or electrify. If consumers chose electrification from project outset, this will be their continued heating source, with responsibility for ongoing operational and maintenance costs. Consumers will want to be assured that the cost of hydrogen will be managed and they will not be exposed to significant inflating costs.
- Commercial considerations: If Whitby is supplied with hydrogen beyond the duration of the village trial, a long-term commercial and regulatory framework will need to be in place to support the continuation of hydrogen supply. This includes a potential amendment to bring hydrogen networks within the scope of Gas Safety (Management) Regulations 1996 and expansion of the village trial's 'beyond minimal change' regulatory approach and associated market frameworks.

Scenario 2: Reinstatement of natural gas

We are assuming that the reinstatement of natural gas supplies is a result of the heat policy decision.

The project should plan for two scenarios in this instance:

1. Convert properties from hydrogen to natural gas and allow the consumer to await conversion to heat pumps in due course.
2. Convert properties from hydrogen to heat pumps, as policy dictates that this is the optimal technology used to decarbonise domestic/commercial heat.

To remove Whitby from hydrogen at the end of the project, there are a number of implications that will need to be considered and planned for:

- Consumer Appliances: If agreed by appliance manufacturers, hydrogen-ready appliances could be converted back to natural gas. However, all sole hydrogen appliances will need to be replaced with natural gas specific appliances. Consumers that chose heat pumps at project outset will not convert back to natural gas.
- Infrastructure: In order to repurpose the gas network from hydrogen to natural gas, comprehensive safety and risk assessments will need to be undertaken. If the technical feasibility and safety case is proven, the network will be reverted to the original natural gas supply arrangement. The hydrogen medium pressure pipeline and pressure reduction station implemented during the project will be decommissioned.
- Consumer considerations: Consumers will be required to undergo further disruption to convert their homes/commercial premises from hydrogen to natural gas, or electrification as appropriate. If consumers are converted back to natural gas in the interim, the potential for future disruption will need to be made transparent, recognising that natural gas is not a viable long-term option in a net zero future.
- Commercial considerations: Under this scenario, consumers will be placed onto either a natural gas or electrical tariff, with responsibility for the future maintenance of their appliances.

As evidenced from our consumer research (Annex M), having a clear exit strategy is one of the prerequisites for consumer trial participation. As a result, the exit strategy needs further consideration and planning before eventual agreement in approach with BEIS and Ofgem.

3.5 Risk Register (1000 words)

Please provide an overview of the project risk register with associated mitigation measures to manage risk.

Your full project risk register should be provided as an attachment.

In accordance with ISO 31000 best practice, we maintain a 'live' working risk register to capture project risks as soon as they arise. This enables us to proactively assess, mitigate and monitor project risks, ensuring appropriate control measures are put in place at the earliest opportunity.

Multi-disciplinary risk workshops are executed at key stage gates to encompass all project WPs, with identified risks documented in our risk register. This approach will continue into Stage 2 and beyond.

The project risks are categorised into individual groups to help identify what the risk is impacting. Categories which have been considered are:

- Programme
- Commercial and Contracts

- Staff/Resources
- Project Capital Cost
- Health and Safety
- Technical

Our full project risk register is provided in **Annex H**, with an overview of our top project risks and associated mitigation measures provided in Table 4 below.

Table 4: *Top Project Risks*

Risk ID	Stage	Risk Descriptions	Mitigation
19	2,3	Householders rejecting hydrogen as a source of home heating and cooking.	• Programmed engagement with householders to reassure safety of hydrogen in the home • Early engagement with local council. • Demonstrate benefits of hydrogen compared to alternatives, e.g., electrification. • Consumer research to be executed at Whitby specifically rather than nationally. Proactive community and household engagement rather than reactive. • Demonstration facility and drop in centre being developed to allow consumers to see the hydrogen appliances in a home-like environment.
30	5	Reverting the network to natural gas following completion of the trial, with consumer research indicating that this is a critical issue.	• Close engagement with BEIS and stakeholders. • Industry is collating technical evidence around the transition from methane to hydrogen.

36	2,3	Lack of compelling proposition for consumers.	• Understand consumer sentiment and baseline of opinion, recognising that there is likely to be initial reluctance. • Ensure consumer offers are clearly engaged. • Provide consumers with a range of incentives to facilitate buy-in e.g., by demonstrating financial benefits of hydrogen.
44	2-4	Policy risk - Government Policy across the project impacts all project WPs.	• Working closely with BEIS/government to monitor risk.
45	All	Delays in other WP programmes due to stakeholder delays.	• WP6 has developed a hierarchy of stakeholders to prioritise engagement activities. • Development of programme, interface register and risk register.
53	2-4	Potential opposition against certain forms of hydrogen supply.	• Engagement with both government and stakeholders to understand the need for both blue and green hydrogen. • Whitby selected due to stakeholders advising that consumers will be more accepting of blue hydrogen compared to Helsby. • Supply solution designed to minimise risk. • Communications and stakeholder strategy to proactively manage issue.
83	4	Dependency on HyNet North West project, via SMC HPP1, coming online as scheduled during the 2025 heating season.	• HyNet North West has been selected as 'Track 1' of the Industrial Cluster Sequencing by the UK Government, meaning

			that the project will be the first to happen, from 2025. • Cadent and Progressive Energy are partners in the HyNet North West project, which will ensure close interface with the village trial and wider HyNet scheme.
84	4	Any hydrogen safety incident which results in people feeling unsafe in their homes.	• Ensure safety case is robust. • Competent hydrogen design engineers and operators. • Rigorous emergency response procedures in place.
86	2-3	Existing supply of hydrogen within SMC unavailable, limiting hydrogen availability ahead of HyNet North West.	• Maintain engagement with Essar as part of Stage 2. • Gain assurances on the availability of the hydrogen, including through building up backup solutions. • Letter of Support received from Essar.

A QRA will be developed in Stage 2 to further define the likelihood and consequence of all risks.

A key project risk is that consumers refuse the conversion to hydrogen in their homes and choose to remain on natural gas. Through stakeholder engagement with CW&CC, we have identified that Whitby is more likely to accept hydrogen than neighbouring villages. In addition to selecting Whitby for the village trial, we have developed comprehensive plans to work with consumers to understand consumer sentiment and baseline of opinion to effectively minimise this risk.

Stage 1 has shown that the hydrogen colour matters to consumers and stakeholders. There is an identified risk that consumers are less likely to support hydrogen if it is not perceived as a low carbon alternative to natural gas. Further stakeholder engagement, coupled with actively investigating a green hydrogen supply solution, will be explored in Stage 2.

With the Trial Exit Plan dependant on a 2026 policy decision, there is a risk that consumers are hesitant to participate in the trial due to uncertainty around the exit scenarios in Stage 5. Our consumer research has shown that ‘disruption from potentially having to switch back to natural gas after the trial’ is the 6th most selected concern about the trial and in 26% of people’s top five concerns. Further, when told ‘your appliances and heating will need to be switched back to natural gas at the end of the trial’, 49% of respondents feel more

negatively about taking part in the trial. Proactive engagement with BEIS and consumers will therefore be required to align the trial with expectations.

The village trial is dependent on hydrogen being available from SMC in winter 2025. The HyNet North West project was selected by government as one of two 'Track 1' clusters, as part of the cluster sequencing competition. This means HyNet is in line to be delivered by 2025, subject to positive negotiation being undertaken with Government, which must be successful to ensure the timely delivery of hydrogen to the region.

This risk is addressed by a comprehensive supply plan, including an existing source of hydrogen from SMC to be available ahead of production from HyNet. We will need to ensure this suite of solutions is available as required.

The project delivery timeline requires us to continue at pace post-bid submission to ensure we maintain momentum and delivery. Whilst there is a risk for Cadent in continuing to deliver the project without a view of Stage 2 funding status, we will continue with the planned work and explore options to fund this in different ways and in collaboration with other GDNs.

4. Infrastructure and Delivery

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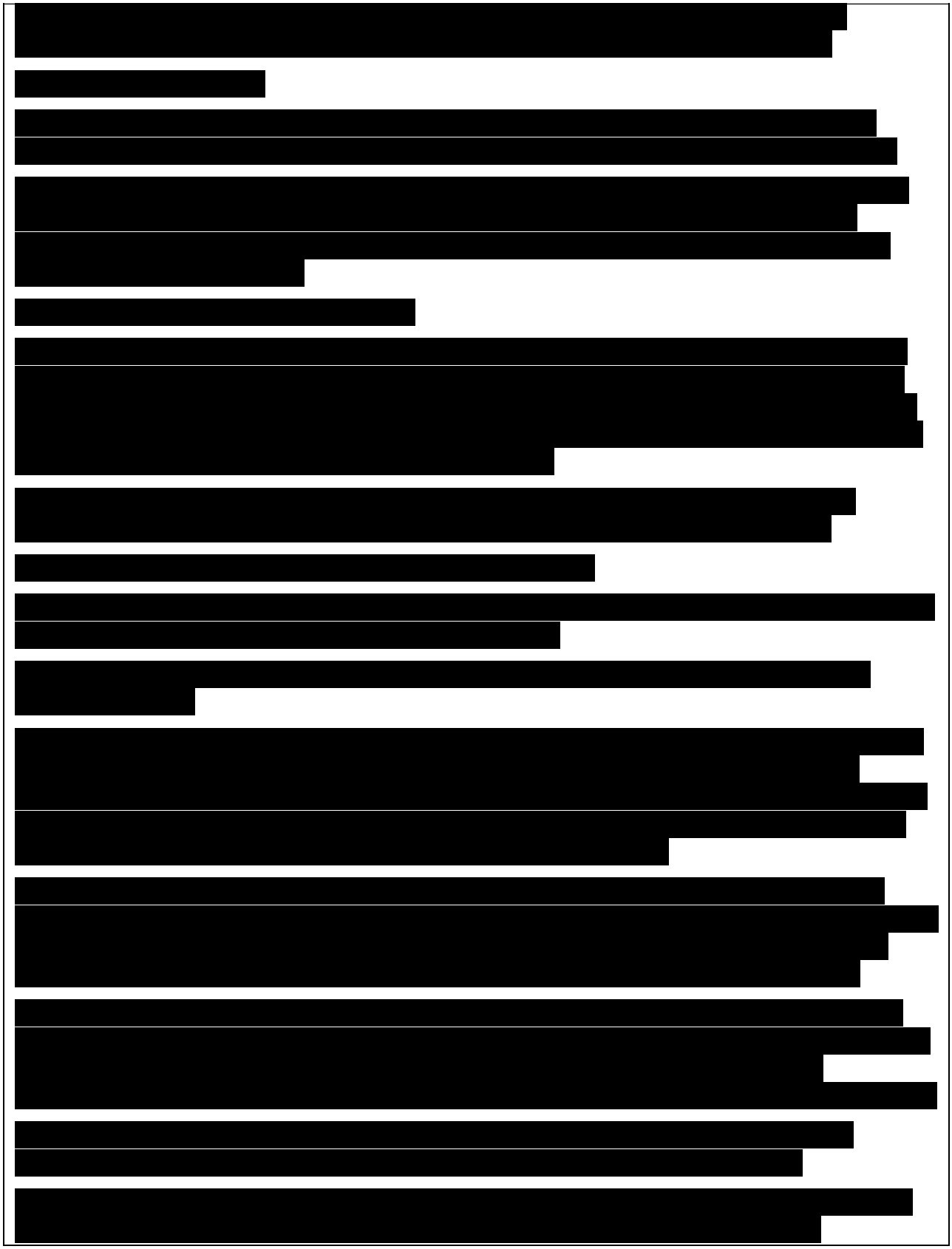

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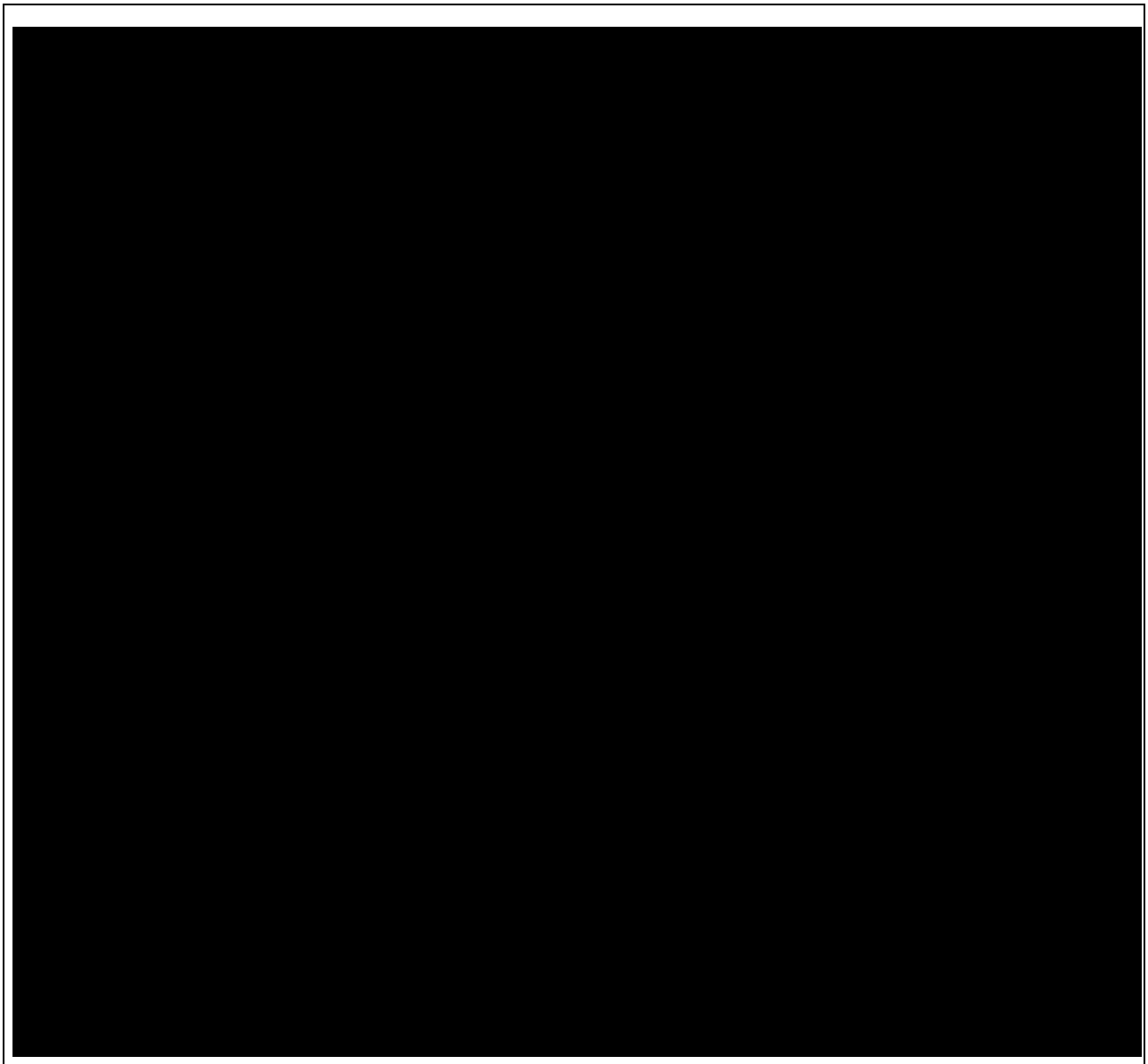

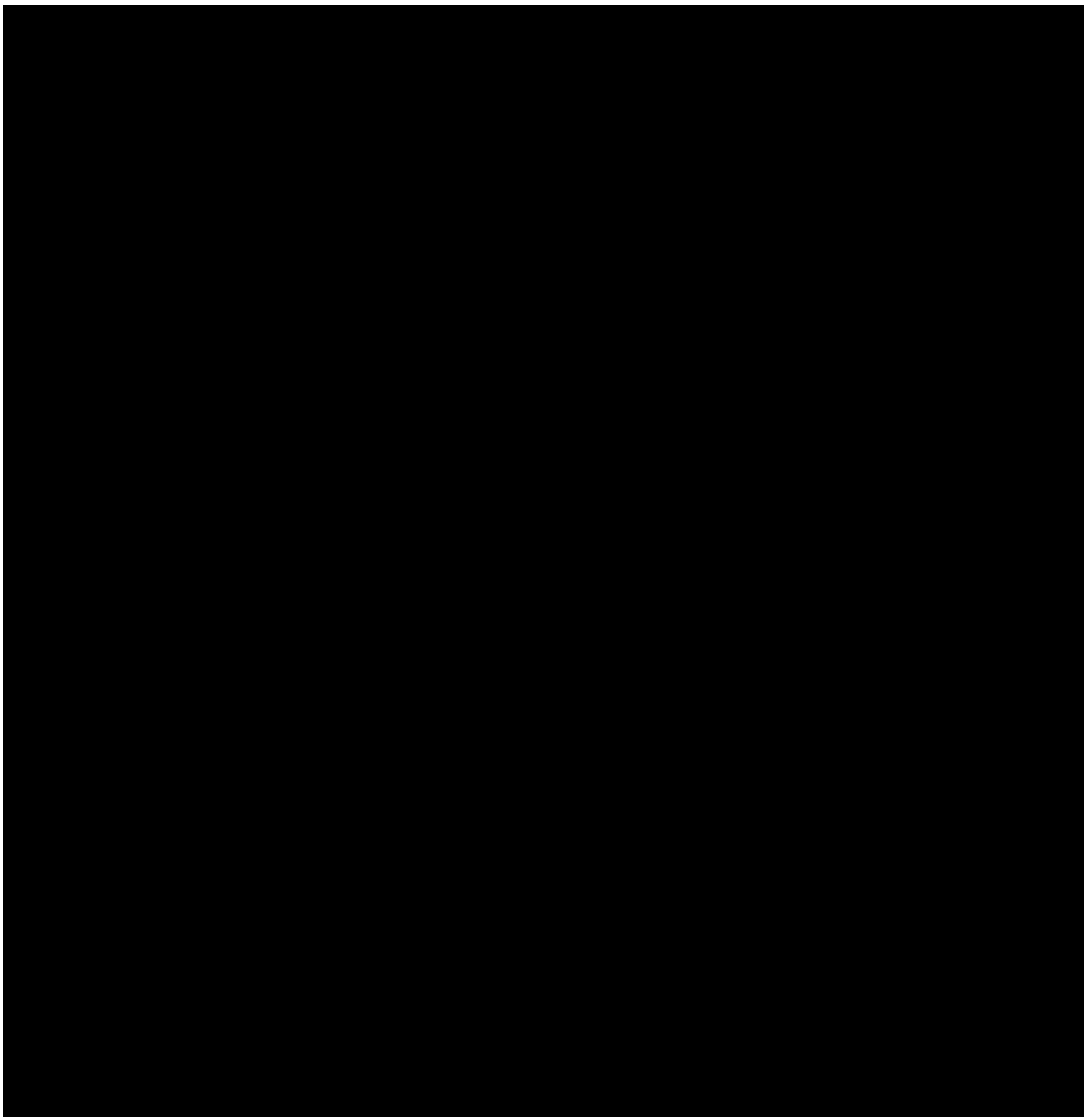

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[redacted]

4.3 Supply chain strategy (1000 words)

Please provide an assessment of the required range and volume of appliances, ancillary devices (eg meters), and any other necessary installations; evidence of support from third parties who would be partners on the project to supply these elements; and analysis of any further new technology/product development work required, and associated risks.

Range and volume of appliances required

The trial will require the replacement of current natural gas burning appliances in Whitby with hydrogen-burning equivalents. As internal property surveys were not part of the Stage 1 scope of works, we have used existing sources of information to estimate the range and volume of appliances required, which will be validated in Stage 2.

We have assumed that properties connected to the natural gas network are primarily heated using gas boilers. To assess the split between combination, system, and open-vented

regular boilers, we examined the findings from the Heating and Hotwater Industry Council paper "Heating up to Net Zero"[6].

To estimate the number of other appliances that are present in Whitby, we used HyDeploy2: House-to-House Data Analysis. While appliance prevalence can vary between geographical areas, we concluded that this provided the best source of current information regarding appliance installation figures.

Table 5: Whitby estimated appliance types

Appliance type	Prevalence in domestic properties	Data source
Boiler – combination	60%	HHIC
Boiler – system	25%	HHIC
Boiler – open vented	15%	HHIC
Cooker – hob only	29%	HyDeploy2
Cooker – oven only	3%	HyDeploy2
Cooker – grill only	1%	HyDeploy2
Cooker – 3-in-1	18%	HyDeploy2
Gas fire	14%	HyDeploy2
Warm air heater	1%	HyDeploy2

Table 6 shows the approximate number of appliances that will be required in the area if all properties are converted from natural gas to hydrogen.

Table 6: Number of appliances required for the trial

Appliance type	Number required: Whitby
Domestic boiler	1879
Domestic cooker – 3-in-1	338
Domestic cooker – hob only	545
Domestic cooker – oven with grill	75
Domestic gas fire	263
Commercial boiler	42
Commercial catering kitchens	6

Domestic boiler conversions will be required in properties where the matched boiler size is <50 kW. We anticipate that one boiler will be required per property. For commercial boiler conversions – those properties with a matched boiler size of >50 kW – multiple boilers in cascade will be required unless commercial hydrogen-ready appliances are available.

While our analysis has shown that new appliance types will not be required, we recognise that the trial provides an opportunity to demonstrate further diversity of hydrogen heating using innovative products and we will work with the supply chain to offer a range of options to consumers.

We have identified all non-domestic locations within Whitby which are likely to have commercial catering equipment that will require conversion. The premises are listed in Table 7, with details of specific equipment to be established during Stage 2 surveys.

[6] Heating Up to Net Zero, Heating & Hotwater Industry Council (October 2021)

Table 7: Non-domestic premises for hydrogen conversion

Premise	Description
Supermarket	The largest gas user in the area. This contains a café and bakery with equipment that will require conversion.
Ellesmere Port Hospital	Rehabilitation unit, with 86 beds across four wards for people who have left hospital but are not yet ready to go home. No A&E department. Heating and catering facilities.
Dining and function hall	This premise has 3 gas meters, several function rooms, and a large dining hall. It is likely to contain catering facilities.
Assisted living facility	This has a communal heating system for the flats within the block. It is also likely that there is a communal kitchen.
Chinese takeaway and chip shop	Likely to contain wok burners and deep fat fryers.
Public house / restaurant	Likely to contain heating and catering equipment.
Three primary schools	Likely to contain heating and catering equipment.
Hairdresser	Only likely to contain domestic heating equipment.

Ancillary devices

Service pipe to houses in Whitby is a mixture of steel, steel internally relined with plastic, or new plastic pipe. Steel service pipe will require replacement and relined pipe will be assessed on a case-by-case basis.

All properties will require new hydrogen meters to be fitted. Meter manufacturers can currently provide SMETS 2 compliant meters for hydrogen. One manufacturer that has supplied a letter of support is equipped to provide dual-fuel meters, and another will have dual fuel meters ready by 2024.

Currently available hydrogen meters work either on the principal of ultrasound or thermal mass and are able to measure flows of up to 20 m^3/h. This is sufficient for domestic properties, with approximately the same energy capacity as a 6 m^3/h natural gas flow meter. While there is a gap for commercial scale meters, we have identified a manufacturer who is developing meters capable of 430 kW which will be ready by 2023.

The majority of houses in Whitby have internal meter boxes, and, in accordance with H4Heat safety annex, these will either need relocation outside or a safety case made to

allow retention inside. Approximately 10% of houses have external meter boxes which can remain in-situ, with the new meter housed within.

Excess Flow Valves approved for hydrogen use will be fitted within the supply to all domestic properties; either in the service pipe or directly after the Emergency Control Valve. These will shut-off gas supply in the event of a gas leak downstream of the valve. Odourisation of gas remains a key safety feature for the distribution of hydrogen. Hydrogen detectors will be offered to people with difficulty smelling odorant during Stage 4.

Other meter box components required for domestic conversion include washers, unions, governors/regulators, control valve and flexible connector hoses. These components have been approved for hydrogen use. While the regulator requires additional test work and hydrogen re-labelling, this is unlikely to impact upon programme or pricing.

Supply chain co-ordination

We will work collaboratively with leading boiler manufacturers to meet trial demand and build consumer confidence. As part of Stage 1 supplier engagement, we interviewed major UK boiler manufacturers who are developing hydrogen appliances. We are confident that we can offer homeowners a hydrogen boiler from five of the most popular UK brands[7], allowing the majority to receive an appliance from their current brand. By engaging five manufacturers, the responsibility of producing and installing c.2000 appliances will be shared, providing assurance that the trial's go-live date is met.

Consultation has demonstrated that the project timeline meets manufacturers' hydrogen development plans, with Letters of Support provided in Annex H.

Electrical heating alternatives

Consumers who are unwilling to adopt hydrogen will need to be offered an alternative heating technology. Electricity would provide a suitable alternative solution for Whitby, with Air Source Heat Pumps being the most energy efficient option currently available that could be practicably retrofit into existing properties.

While Whitby's current electricity distribution network has capacity to install heat pumps, exceeding a certain amount will require network reinforcement. This could prove costly due to the need for wiring upgrades and additional substations. When combined with the cost of electrical heating appliances, the electrification of heat for >20% of the conversion area is estimated to cost the same as hydrogen conversion for 100% of the area.

During Stage 2, we will work with SPEN, to determine the scope of works, cost and programme required to reinforce the electricity network to deliver sufficient additional electrical heat should it be required.

Delivery of conversion

We will work with British Gas to deliver surveys and conversion of properties, harnessing their unmatched nationwide workforce capacity and credibility in delivering trusted services to homes. Their experience includes gas appliances, metering, and electrical heat pump

[7] 10 Best Boiler Brands/Manufacturers to Buy and Install in 2021, Heatable.co.uk, (November 2021) https://heatable.co.uk/boiler-advice/best-boiler-brands

installations. Managed use of this Gas Safe-qualified workforce will allow conversion to be undertaken without the need to recruit large numbers of temporary staff.

4.4 Workforce capability, skills and training plan (1000 words)

This should include identification of the workforce and training requirements needed to successfully deliver the proposed trial, and a plan to show how these needs would be met (eg recruitment, certifications, competency assessments).

Workforce Requirements

The conversion of the village from natural gas to hydrogen represents a significant logistical and workforce challenge. While many of the prerequisite skills and capabilities exist within our project delivery team – which includes a pool of highly-skilled Gas Safe Registered engineers – we recognise the need to extend the competency profiles of personnel to incorporate both hydrogen- and project-specific requirements.

During Stage 1, we identified that project-specific workforce requirements exist in key delivery areas, which will be central to our Workforce Capability, Skills and Training Plan. These areas include:

- Project Management and Design
- Upstream and downstream of the Emergency Control Valve (ECV)
- Surveys
- Communication and Engagement

To ensure that knowledge is effectively transferred from Stage 1 into Stage 2, we will ensure continuity of our project management and design team and mobilise resources from across our partners and supply chain. With our partners and suppliers including British Gas, WSP, Kiwa, DNV, Whitespace Strategy, Element Energy, Arup, and Progressive Energy, we are equipped to draw upon a combined resource pool of 90,000+.

Upstream and Downstream of the Emergency Control Valve (ECV)

The implementation and operation of the village trial will require two distinct workforce requirements: upstream of the ECV and downstream of the ECV. The ECV is the dividing point between the gas network (outside of the property), and pipelines and appliances within consumers' properties. Upstream of the ECV requires network infrastructure engineering skills including designing, installing, operating, and maintaining gas pipelines and other network assets, while downstream of the ECV requires in-property skills such as installing, operating, and maintaining heating and cooking appliances and associated pipework.

Upstream of ECV

Workforce tasks will comprise operating, maintaining, and expanding the gas network. Hydrogen operations will occur alongside standard activities as a growth to our responsibilities. We will draw on Cadent's Business as Usual experience in operating the

natural gas network, with our Hydrogen Operation Delivery team already mobilising in order to build our hydrogen capability, ensuring compliance with the new IGEM hydrogen supplements.

Downstream of ECV

For downstream of the ECV, we will harness our pool of technical staff and support their development in Gas Safe-registered skills and competencies. With a shared ambition for hydrogen roll-out, Cadent and British Gas are committed to developing greater hydrogen capability within their respective organisations to ensure the workforce is future-proofed for the UK's energy transition.

During Stage 2 mobilisation, we will increase the size of our project and design team, with the largest addition being qualified Gas Safe engineers and customer engagement staff. A peak requirement of 40 staff will be provided by Cadent and British Gas to allow 100% surveys in Whitby to be conducted in an elapsed time of 20 weeks. Survey work will be planned and monitored by Kiwa, drawing upon their extensive survey and project experience, including 'Opening up the Gas Market', 'HyDeploy' and 'Hy4Heat'. As we move to installation in Stage 2, survey-trained engineers will become team leaders for Stages 3-4.

Training Requirements

We will develop a programme of training and competency upskilling based on our Stage 1 experience, project requirements, and emerging industry best practice. This will include collaborating with other GDNs and engaging closely with the BEIS-commissioned Energy & Utility Skills Hydrogen Competency Framework[8], which Cadent is actively involved in.

A training programme will be developed in the early stages of Stage 2, and will continue to be developed throughout all stages of the project to encompass continuous learning and experience. The training programme will be informed by:

- Number of personnel
- Training for survey activities
- Developing Stage 3 and 4 training packages
- Incorporation of project learning
- Collaborating with Energy & Utility Skills Hydrogen Competency Framework

To ensure that a high-quality process is delivered, survey staff will undergo bespoke customer-facing training prior to engaging with consumers in their homes and commercial premises. Survey experience will be utilised to test and adjust the training regime for the implementation stage of the project, maximising experience-based learning.

To provide the consumer with an optimum experience, our Technical Services and Heating Sales Advisors will be upskilled.

[8]Hydrogen Competency Framework Report, Energy Utility & Skills, (2021)

Training Delivery and Competency Management

Cadent and British Gas have significant training infrastructure and competency management processes which will be harnessed to deliver the village trial safely and successfully. Both Cadent and British Gas operate training academies across the gas distribution chain, apprenticeship schemes, competency management frameworks, and have an established network of accredited trainers. British Gas has committed to develop the engineers of the future; on-boarding and qualifying 1,500 engineers and apprentices in 2022. Cadent is also in the process of developing a Hydrogen Skills Academy and a Hydrogen Education Programme, which will be launched by 2024.

For downstream operatives, Cadent and British Gas will upskill existing Gas Safe Registered Engineers to ensure they are equipped to carry out installation, commissioning, handover, and maintenance on appliances fuelled by 100% hydrogen gas, meeting the Interim Hydrogen Technical Standard. This will be achieved via a bespoke training programme in accordance with the Energy & Utility Skills Hydrogen Training Specification, which will include guided learning of 25+ hours to effectively undertake the hydrogen transition course, and mandatory completion of the Hydrogen Assessment Module.

For upstream operatives, we will build upon Cadent's existing training experience through the HyDeploy project, which focused on hydrogen gas behaviour change and emergency response procedures. Where possible, hydrogen training modules will be built into current methane training. As hydrogen training needs develop in Stages 2-4, we will collate data and evidence any skills gaps, analysing how these can be mitigated.

Recruitment

The trial provides a unique opportunity to support the UK Government's wider levelling up agenda. If existing staff move to specific roles within the project, recruitment will be necessary to back-fill these positions. While we will actively utilise our current workforces, we will also identify opportunities to recruit personnel from the local region and support their training and development. We will take an inclusive approach to supplier management, actively engaging local Small Medium Enterprises for specialist areas by harnessing our relationships with local stakeholders, as well as using the Achilles Utilities Vendor Database.

5. Public and Local Engagement

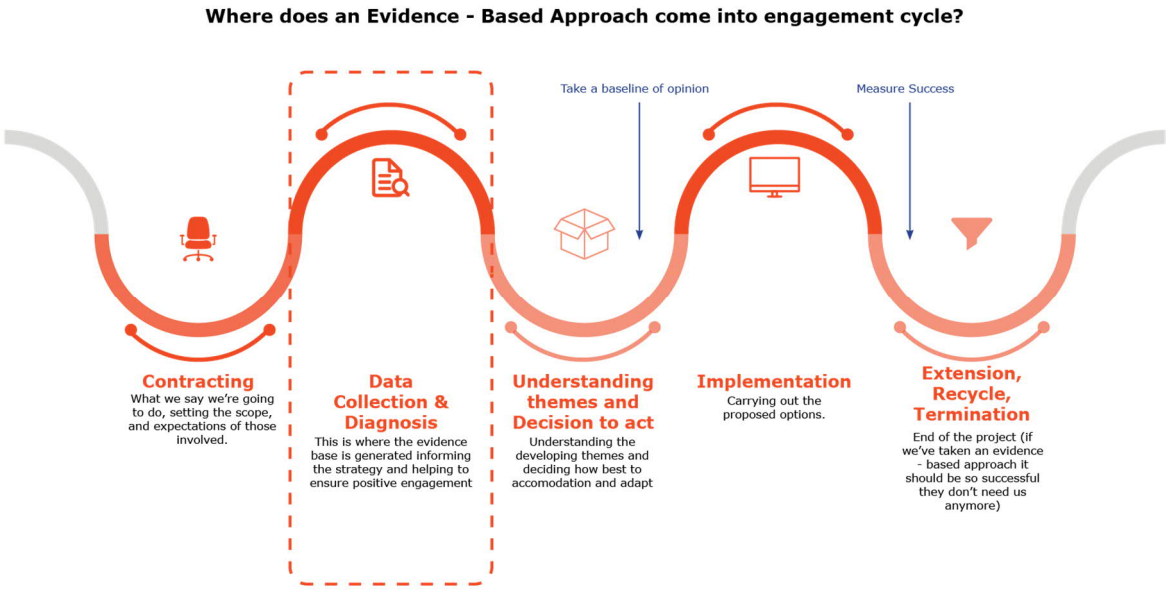
5.1 Public engagement evidence (1000 words)

This should include evidence of positive engagement with local partners, local representative authorities and/or consumer groups, including stakeholders that support consumers with additional needs and consumers in vulnerable situations, and a summary of feedback received.

To gain local acceptance for - and ultimately participation in - the UK's first hydrogen village trial, we recognised the critical importance of proactively understanding and mitigating stakeholders' concerns from project outset. Throughout Stage 1, we led an extensive public engagement programme to listen to feedback from a diverse range of stakeholders, using the findings to inform the development of a fair and inclusive village trial proposal.

Adopting an evidence-based approach, we undertook a comprehensive data gathering and diagnosis exercise to: understand socio-economic demographics; identify relevant stakeholders; record all feedback from engagement; and collate evidence of support in the form of support letters (Annex I).

Figure 15: Evidence-based engagement approach



This exercise allowed us to identify consistent themes, form appropriate messaging that addresses stakeholders' key concerns, and develop an Engagement Strategy which will be implemented and reviewed throughout the project.

Stakeholder Mapping

The first step in our data collection process involved a comprehensive mapping exercise to identify existing stakeholders, relationships, and gaps in stakeholder reach, building on the stakeholders identified by BEIS.

To identify relevant stakeholders for engagement, we used the following criteria:

- Do they form part of project delivery?
- Will they be affected by changes resulting from the project?
- Are they in a position to influence project delivery?
- Are they community representatives or groups representing and/or supporting vulnerable people?

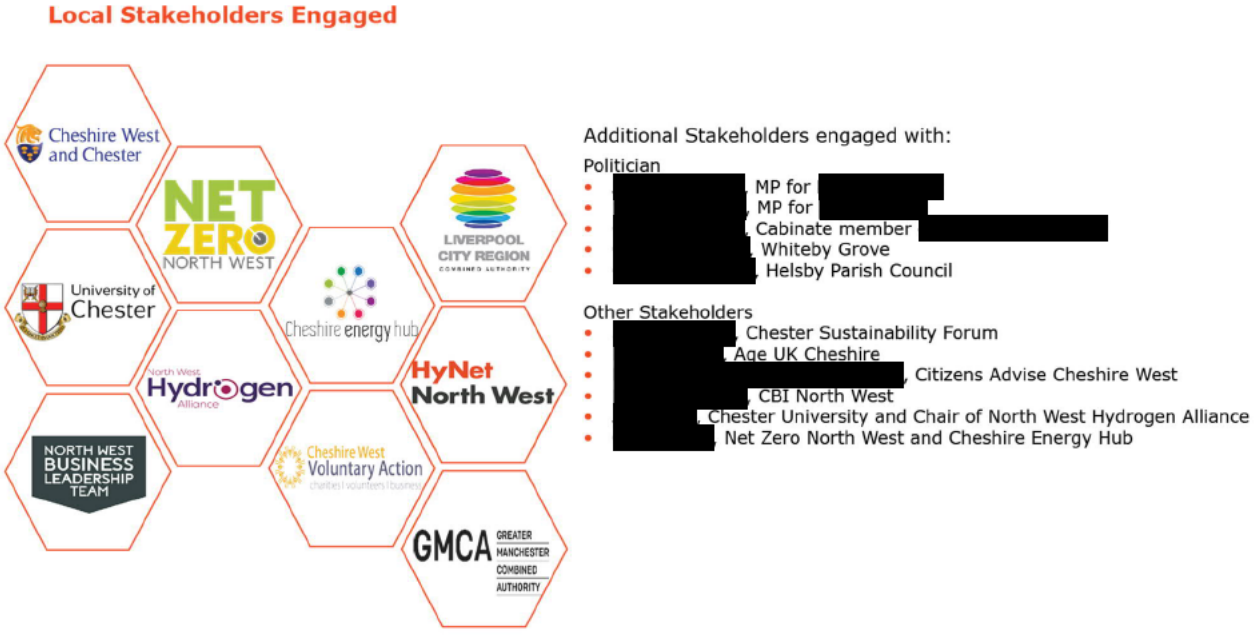
Our mapping exercise led to the identification of a range of national, regional, and local stakeholders (**Annex K**: Identified Stakeholders) which was verified and validated via consultation with our specialist work package teams. Stakeholders were mapped according to their importance and level of influence, with regional and local stakeholders viewed as a central priority for engagement.

Proactively using feedback to inform our village trial proposal

To understand the needs and perceptions towards hydrogen and the village trial among local partners, community representatives, consumer groups, and businesses, we established a programme of engagement with identified stakeholders in Cheshire West and Chester (Figure 16). Through a combination of face-to-face and online meetings, we gathered opinions, experiences, and knowledge, providing an opportunity for two-way dialogue to ask follow-up questions and gain further insight, deepening our understanding of local opportunities and concerns.

To ensure the needs of a diverse range of demographics are fully considered, we have harnessed the expertise of local stakeholders who provide specialist support to vulnerable groups. These include Cheshire Voluntary Action, Cheshire West Credit Union, and Cheshire Citizens Advice Bureau.

Figure 16: *Local Stakeholders Engaged*



The consistent collating and recording of feedback from local stakeholders via our 'live' stakeholder database has informed decision-making throughout the development of our proposal and allowed us to work collaboratively with key parties, including Cheshire West and Chester Council (CW&CC), to demonstrate how their concerns around the trial will be mitigated. Key outcomes include:

- The final village section: While our initial proposal focused on Helsby, the case for Whitby was made by CW&CC. Despite having similar housing diversity to Helsby, Whitby ranked 24,934 out of 32,844 in the Multiple Deprivation Index (Helsby ranked 30,111), providing a greater opportunity to put the UK Government's levelling up agenda into practice.
- Importance of low carbon hydrogen: Our engagement has informed ongoing project investigation into low-carbon blue and green hydrogen supply options for the trial.
- The need for tailored support for consumers with additional needs and consumers in vulnerable situations: We are committed to working with our extensive network of charities and partners to understand the needs of those residents, manage the disruption of any changes, and ensure tailored support for all.
- Delivering social value: Through local stakeholder engagement and Local Needs Analysis, we have developed a social value offer (Annex L) which is shaped around the following four themes: tackling the climate emergency; growing the local economy; supporting young people to reach their full potential; and enabling adults to live longer, healthier, and happier lives.

Understanding and Identifying Themes

Our stakeholder engagement consistently demonstrated the importance of cost, disruption, safety, reliability, and support, with key questions which arose from our engagement shown in Figure 17.

Figure 17: Key Questions from Engagement

Pre - Trial	What is the cost of installation and who pays?	What disruption should be expected and how will it be minimised?	Will the quality of the work be guaranteed?	How safe will the trial be?
During	Impact on running costs for either fuel and will residents lose out?	How reliable will the energy supply be during the trial?	What support will be in place for vulnarable groups?	
End/Post	What happens at the end?	What disruption should be expected?	What happens to equipment?	What are cost implications going forward?

The emergence of a number of consistent themes (Figures 18 and 19) has allowed us to develop a tailored engagement strategy, as well as consumer proposals.

Key themes centre around support for the trial as an important step towards the UK's and North West's future energy mix and levelling up agenda. As presented in Annex I: Letters of Support, stakeholders viewed hydrogen as an opportunity to provide significant economic benefits to the UK. This includes supporting jobs creation through innovation, developing green skills, stimulating investment to develop supply chains and a thriving low carbon sector, and providing UK export opportunities.

Another emerging theme is the collaborative, industry-leading work which is currently taking place as part of HyNet North West. Stakeholders are enthusiastic about its Track 1 status and view this as a significant vote of confidence in North West businesses.

Finally, a consistent theme is the support for the village trial among regional stakeholders who have demonstrated willingness to collaborate and pool expertise to ensure its success.

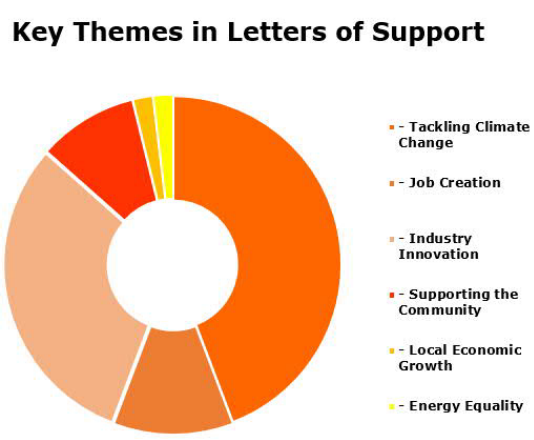


Figure 18: Key Themes in Letters of Support

Figure 19: Key Themes in Stakeholder Meetings

Letters of Support

Our positive public engagement has led to us receiving 38 letters of support for the trial from stakeholders at a local, regional, and national level. The letters can be found in Annex I: Letters of Support which demonstrate the breadth of support for a hydrogen-scale village trial in Cheshire West and Chester and stakeholders' willingness to partner with us to ensure its success.

Next Steps

Following positive stakeholder discussions, we have sought to take steps to formalise the project's governance. We will establish a Community Steering Group with CW&CC to grow our collaborative partnership and ensure the trial continuously meets the needs of Whitby's residents and businesses.

Appointing an independent chair to maintain neutrality and ensure engagement remains inclusive (e.g., the public issuing of minutes) will be considered. This practice has been well-received on programmes such as The Towns Deal Boards.

5.2 Public engagement strategy (1000 words)

This should include the plan for extending engagement and consultation with communities, local authorities, and representative organisations in the Detailed Design stage. This should include the objectives and success criteria for each stage of the strategy/plan, as well as planned methods of communication/engagement.

Our Public Engagement Strategy

Informed by our early consumer and stakeholder research, we have developed a public engagement strategy which will allow us to connect with communities, local authorities, and representative organisations in Stage 2, facilitating the positive outcome of the village agreeing to be part of this nationally significant trial.

Our strategy is rooted in engaging with people as individuals, family members, homeworkers, employees, and business owners. It is built on a deep appreciation of the temporary disruption that the trial will bring, and an understanding that we, and the rest of the UK, are asking them the significant 'favour' of taking part in the first village-scale hydrogen trial.

There are no shortcuts to effective engagement; it takes time, consistent messaging, and constancy of project delivery to build public trust. Our strategy therefore proposes that a minimum of two years of prior notice is given to the public before trial commencement.

To ensure our strategy remains inclusive and meets the evolving needs of Whitby's residents and businesses, we will deliver a continuous process of customer research, engagement, and proposition development (Figure 20).

Figure 20: Our continuous process of customer research, engagement, and proposition development

The successful implementation of the trial is key, but once that's achieved, the importance of the project's exit will take on even greater significance. In accordance with psychological 'peak end' theory, positive customer sentiment built over the trial has the potential to be undermined by poor experience at the end. Our strategy therefore places emphasis on the need for public engagement and customer service throughout all project stages.

Our public engagement principles in practice

Three central engagement principles will be at the heart of the village trial: fairness, choice, and trustworthiness. These principles reflect the understanding that people's decision-making processes are a combination of rational, instinctive, and emotional pulls:

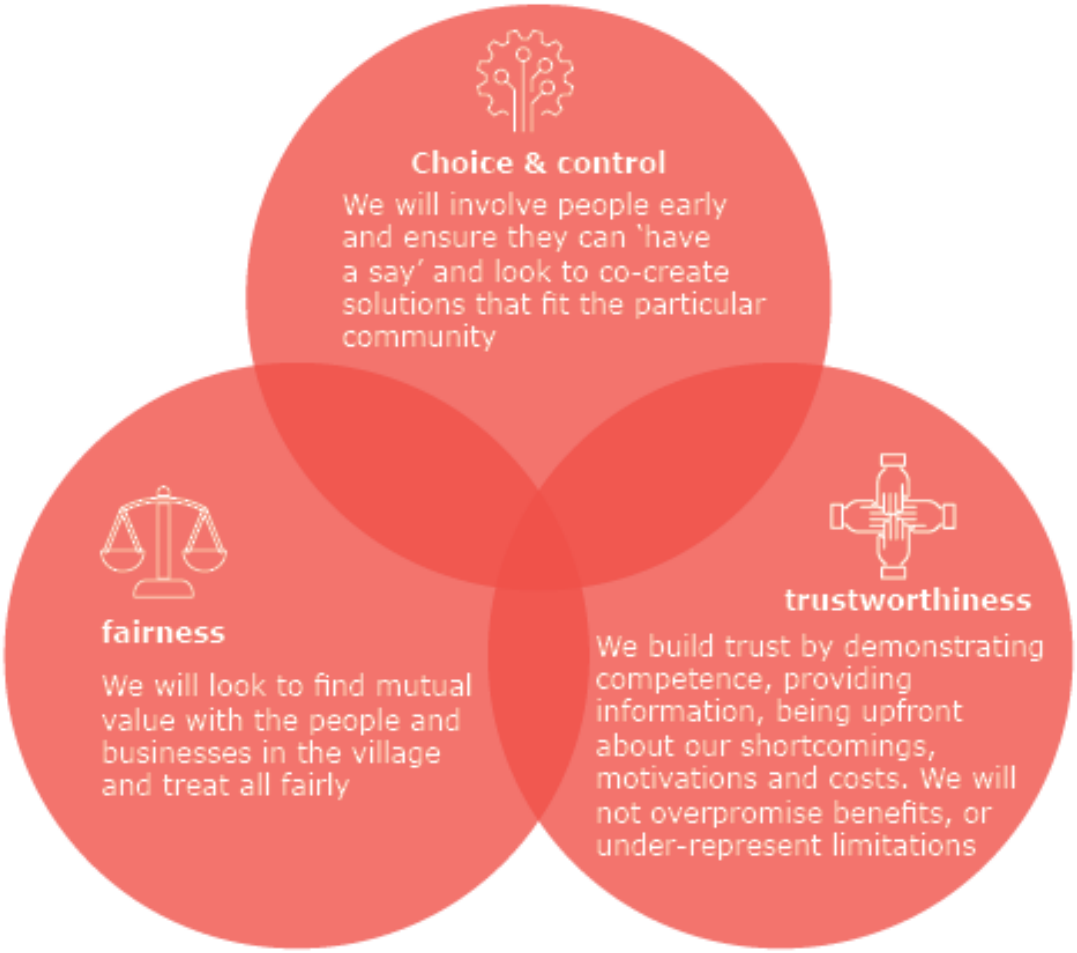


Figure 21: Our Engagement Principles

Table 8: Our Engagement Principles in Practice

Principle	In Practice
Seek consensus	A trial cannot be forced upon the village. For success, agreement and acceptance needs to be reached with the local community.
Fully address all the negative aspects of the village trial	We will be transparent about the level of disruption, what the conversion process will entail, the length of the trial, and the exit strategy. As the research outlines, we will be candid about any risks associated with using hydrogen gas and the mitigation measures which have been undertaken.
Set realistic timescales	People need to have time to 'get used' to the concept of a trial, ensuring significant advance notice for household appliance conversion.
Co-create whenever possible	As our early research shows, acceptance will be more likely if the community feels it has more control and co-creates elements of the proposals.
Work to develop trust	We will be candid about the proposals, and transparent in all our dealings. Being clear about what the village trial will entail (before, during and after) and having consistent answers to people's questions will – over the long-term – build trust.
Ensure fairness	Being fair to everyone will be how the village trial is judged. Groups and individuals should not be disadvantaged as a result of the trial and particular care should be taken with those identified as residents in vulnerable situations.
Ensure consumers retain some choice	It's inevitable some will choose not to take part and alternative options, such as air source heat pumps, will also be offered. Choice of appliances should be offered, recognising that not all households have the same needs.

Our Collaborative Engagement Approach

The creation of the first hydrogen village will be a multi-faceted programme, involving collaboration at both a national and local level. At a national level, we expect there to be an amplification in communications around the requirement for UK households to change the way they heat their homes. This will be coupled with clear government messages from inception which convey the trial's national significance in supporting the UK's journey to net zero.

At a local level, the information and engagement campaign, led and overseen by Cadent, will be managed in partnership with key local institutions to reach, reassure, and keep local people informed, using a 'one voice' approach. This will include the local authority, the local MP, energy providers, consumer representative groups and local charities.

When engaging with residents in vulnerable situations, we will work closely with trusted third parties, including tenant participation groups and housing officers, to develop bespoke plans which ensure they're handled carefully through the hydrogen transition, and prepare inclusive materials which use clear, accessible language.

To help build wider trust, we will identify and work closely with local 'community champions' who will promote the benefits of low-carbon hydrogen and the trial's national importance.

Local people will staff the drop-in information centre to ensure residents are kept well-informed and provided with local, trusted advice.

Methods of Engagement

During Stage 2, we will create a distinct identity for the hydrogen village programme, providing the people who live and work in Whitby with a recognisable 'look and feel' on all trial-related materials. This will help to heighten awareness, deepen understanding and, over time, build trust.

Adopting an evidence-based approach, we will encourage the public's feedback at every step of the way and solicit complaints and concerns, no matter how small or seemingly insignificant. This will enable:

- A full and accurate picture of the experiences, attitudes, and behaviours of a diverse range of households and businesses both during the hydrogen conversion process and when the trial is operational.
- An understanding of what steps need to be taken to mitigate concerns and limit dissatisfaction and complaints for future trials or wider hydrogen roll-out.

To consistently communicate with village residents and businesses and gather findings and feedback, we will harness a range of digital, traditional and hybrid engagement methods. Our methods of engagement for each project stage are provided in Table 9 below. As part of Stage 2, we will validate and prioritise the methods with Whitby local residents, businesses, and community groups and in addition run focus groups to test our information to ensure it is clear in its purpose and language.

Table 9: Engagement channels to reach audiences at project stages

Channel	Tool	General Public	Residents & Local Businesses	Local Community Group	Additional-Requirements/Residents in vulnerable situations	Benefits	Project Stage
Digital	Virtual Engage An accessible, engaging and interactive virtual environment which brings people and organisations together	✓	✓	✓	✓	Information portal Live feedback Real time data analytics Webchats	All stages
Hybrid	Social Media	✓	✓	✓	✓	Informal Live feedback Able to tailor responses Transparent	All stages
	Town Hall and other public meetings		✓	✓	✓	Communal Visibility of leadership/partners Raw feedback	All stages
	Focus Groups (F2F or Teams)		✓		✓	Elicit targeted feedback for specific groups	Stage 2 & 3
	Customer Service Call Centre (24hrs)		✓	✓	✓	Round the clock accessibility Personable format	Stage 3,4 & 5
Traditional	Face-to-face meetings: and pre-arranged home visits	✓	✓	✓	✓	Accessible Personable format Visible presence Raw feedback	All Stages
	Shop front/drop-in centre/demonstrator (manned by locally employed residents for community engagement and Social Value activities)	✓	✓	✓	✓	Visible local presence Accessible Personable format Information centre Raw feedback	All stages (aim to be live at end of Detailed design)
	Letters & leaflets		✓		✓	Wide distribution Referential information Formal feedback	All Stages
	Door-to-door installers, engineer home surveys and visits, etc		✓		✓	Informal feedback Accessible Personable format	Stage 2 & 3
	Stakeholder Steering Group		✓	✓		Visible leadership Transparent Public	All Stages

Our Stage 2 Engagement Plan with clear objectives and success criteria

We have developed a Stage 2 Engagement Plan which outlines clear objectives, activities, target audiences, engagement channels, and success criteria for each stage of our plan (Table 10). Consultation will initially take place with local authorities and representative organisations and, with their help, embed community co-creation and decision-making in the programme's governance to enable wider engagement.

Table 10: Our Stage 2 Engagement Plan, with clear objectives and success measures

Detailed Design High Level Engagement plan				
Objectives	**Activities**	**Audiences**	**Engagement channels**	**Success criteria**
Establish internal programme structures to support engagement over the lifetime of the hydrogen village trial	• Agree stakeholder engagement information flow / reporting as part of broader programme governance • Establish feedback mechanisms (inc: surveys, complaints, questions, issues) • Develop comprehensive engagement database to log and manage all interactions and ensure root cause of issues are being dealt with • Continue, and enhance if needed, Stakeholder Steering Group • Identify community advocates/ champions • Revisit stakeholder mapping and prioritise	• Internal: including BEIS governance team /other GDNs / industry and programme team • External: steering group members	• Co-create the design of the steering group • Face-to-face meetings with programme team	• Robust channels established, that last the lifetime of the programme • Steering group seen to take responsibility for communicating headline outputs from the trial.
Design and create Cadent's public-facing, 'sources of the truth' channels	• Source suitable location for drop-in centre / recruit local staff team • Create 'Virtual Engage' interactive digital room – link to CW&C website • Establish core customer service team as part of Virtual Engage ready to respond to enquiries / correct misinformation on social media etc • Create comprehensive brand identity for all Whitby neighbourhood trial collective – for message consistency and recognition to build trust • Develop information and awareness campaign collateral • Test messages through focus group	• Local stakeholders (MP, council, community leads, etc) • Local residents • Local businesses • Community groups • Any other interested party	• Traditional printed: brochures, leaflets, infographics • Digital: Virtual Engage platform - videos, social media, animations, podcasts • In-person and virtual: town hall sessions, face-to-face briefing sessions	• Strong awareness and advocacy levels among village residents and businesses
Seek consensus from community in Whitby	• Begin initial community group engagement via Steering Group • Begin initial resident and business engagement	• Local residents (with particular care to reach residents in vulnerable situations) • Local businesses • Community groups	• Letters to households and businesses • Town meetings: joint sessions with trusted entities such as local council/ gas providers, etc	• Agreement that status quo is not sustainable (i.e. natural gas use will end)
Position hydrogen village trial in the forward-looking, innovative, North West	• Develop proactive and reactive public affairs and media plans • Work with other agencies, organisations, stakeholder groups in the North East to maximise opportunities for economic growth, investment potential, etc	• Regional and trade media • Travel and tourism boards • Chambers, • Business forums • Cheshire Energy hub/ Energy Innovation District (EID)	• Relevant websites • Published articles • Media releases • Podcasts	• Neutral / positive coverage – quotes from relevant spokespeople • Inward investment
Design-in customer research and ways to measure effectiveness of engagement	• Identify criteria to analyse from town hall meetings (including number and nature of questions, length of time attended, etc) • Identify criteria to monitor and measure complaints and social media comment sentiment • Establish surveys for long-term tracking	• Local residents • Local businesses • Community groups	• Surveys, social media analysis, complaint numbers and issue tracking, resolution	• Customer research tracking sentiment • Strong awareness, understanding and advocacy levels

Customer research, monitoring effectiveness and measuring success

To ensure the continued success of our engagement strategy, we will embed a cycle of research, monitoring, and measurement as a routine project activity. This will involve a range of quantitative and qualitative research and monitoring methods, including surveys, complaint feedback, customer service enquiries, and social media sentiment analysis.

At board meetings and formal internal meetings, the 'customer voice' will be a standing agenda item and the latest complaints, praise or other issues raised will be discussed. We will actively use feedback insight to:

- Provide an early indication of upcoming issues, to enable informed decisions.
- Address root cause of issues.
- Find repeated trends that can be shared to support industry learning.

A 24-hour customer service feedback channel will provide a responsive reassurance for the community, ensuring they remain at the heart of the trial throughout.

5.3 Proposals for a consumer strategy, ensuring fair treatment for all gas consumers in the trial locality (1000 words)

This should include:
• a strategy for establishing all consumers' requirements;
• the consumer "offer", including proposed options for consumers/businesses who do not wish to or cannot participate, and how these could be funded;
• an assessment of risks and planned approaches in relation to consumers in vulnerable situations;
• outline billing solutions: the approach to billing arrangements for the duration of the trial.

We care about the end user and to deliver the best possible outcome, it is imperative that the voice of the consumer is embedded in the trial. By partnering with British Gas, we are bringing the familiarity of a consumer-facing brand with a legacy of delivering in-home service propositions to c.4m customers nationwide.

On behalf of the gas distribution industry, we have led an extensive consumer research programme to understand hydrogen village requirements for residents and businesses. We are building a series of propositions tailored towards different consumer needs, which will cover all stages of the trial from opting in, converting homes and businesses, through to the enduring post-trial solution. We are committed to supporting consumers throughout the trial, ensuring fair treatment for all and that no one is financially disadvantaged.

Establishing Consumer Requirements

We have an established track record of understanding consumer needs. A recent example of this is our 'Green Print' report[9], which sets out our 12 point plan for the future of heat for everyone. As part of the plan, we committed to ensuring 'consumers are central to decisions on the future of heat' and should 'have a voice over how that change is delivered'. This commitment is reflected in the design of our hydrogen village consumer research programme.

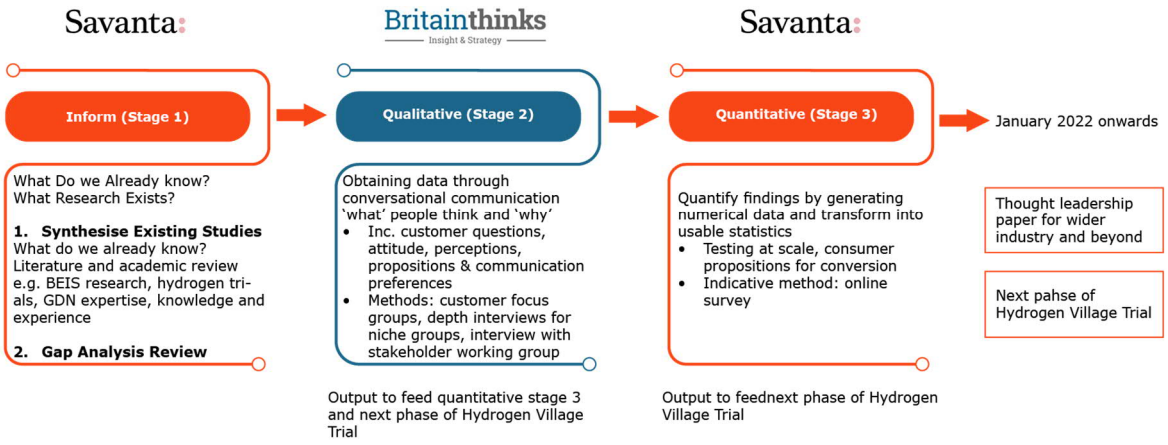
We appointed two best-in-class market research agencies to deliver a programme that delivers detailed insight into the perceptions and needs of all consumers around participation in a hydrogen trial.

The consumer research programme included:

[9] Our Green Print – Future Heat for Everyone, Cadent Gas Ltd, (July 2021), https://documents.cadentgas.com/view/908325570/

- A significant literature review of previous large-scale community behaviour change programmes and hydrogen conversion programmes, in the UK and abroad.
- Longitudinal qualitative study, including a deliberative research phase involving 150+ participants.
- Quantitative research with 4,000+ domestic and 1,000+ business customers to validate and quantify the insights gathered.

Figure 21: Consumer Research Programme Overview



Our research has been a collaborative programme, working with other GDNs and engaging with the BEIS research team to ensure that the research is of the highest quality and delivers against the needs of all parties. The outputs can be found in Annex M: Consumer Research Reports.

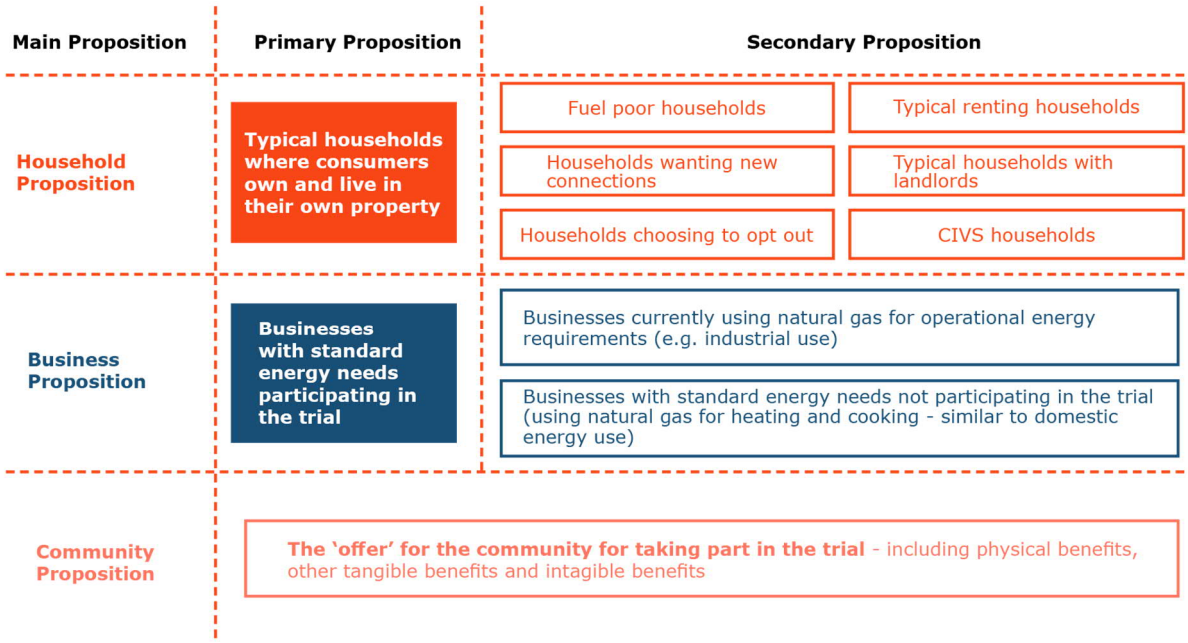
Developing the 'Offer' within the Propositions

The consumer propositions will be rooted in a deep understanding of requirements, driven by resident engagement and broader public engagement. In combination with British Gas's direct consumer service propositions capability, we will use our experience, expertise, and insight gained from consumer research to design practical, deliverable propositions.

Propositions will be targeted and tailored towards different sections of the community with specific needs. This will include a proposition for consumers who do not wish to participate in trialling hydrogen and those who rely on gas and cannot be converted.

The propositions we anticipate to develop are detailed in Figure 23.

Figure 23: Primary and Secondary Variations of Propositions



To further develop the propositions, we anticipate embarking upon a two-phase research and engagement programme:

Phase 1 - Test outside of the village location:

Test the first version of the propositions with a representative group of consumers, to include:

- Analysis of the initial proposition plans against UK consumer needs to understand requirements and likely uptake levels
- Testing proposition outlines with consumers from a nationally-representative group outside the village and refine based on feedback

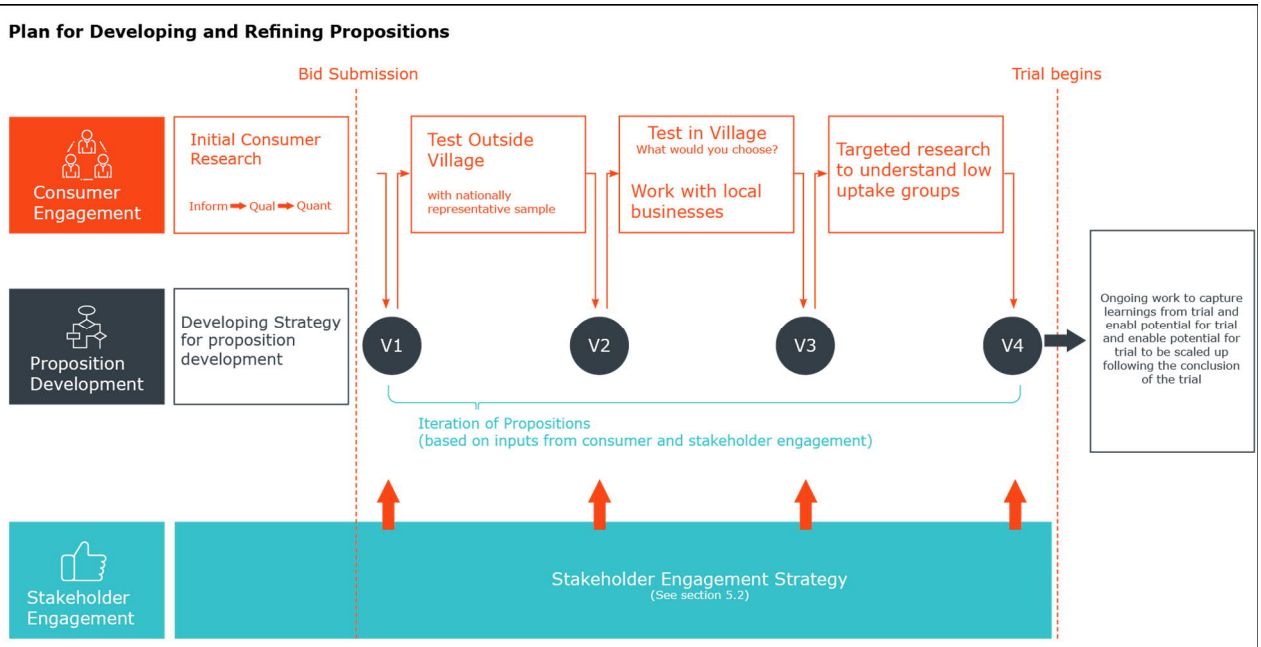
Phase 2 - Test within the village:

Engage with local consumers to understand any additional requirements and any resistance to the trial, including testing refined proposition outlines with:

- Residents and businesses in the village
- Specific communities with greater risks
- Groups where uptake is expected to be lower

Phases 1 and 2 will feed into the development of the propositions, with each iteration building towards a set of propositions that provides a fair 'offer' for all consumers. The propositions will be designed with longevity in mind, with the potential to scale them up to a broader audience following the trial's conclusion.

Figure 24: Our Plan for Developing and Refining Propositions



A fundamental principle of all propositions is that consumers will not be financially disadvantaged by their participation in the trial. We expect funding to be provided by private sources and through government innovation funding.

Risks and Approach to Customers in Vulnerable Situations

Understanding the risks and detailed requirements of customers in vulnerable situations and fuel poor consumers has been a focus of our consumer research programme. In addition to a traditional demographic sample, we undertook specific research with key consumer groups including customers in vulnerable situations, residents in fuel poverty, and those who are digitally disengaged.

As we continue to build propositions to address the needs of customers in vulnerable situations, we will carry out risk assessments, mitigate identified risks across all stages of the trial and meet specific needs such as additional communication. Any risks we are unable to address will be highlighted and escalated.

We will combine our internal expertise with external consultation. Working with our network of charities and partners, we will continue to engage with customers in vulnerable situations and fuel poor consumers to fully understand their needs, manage the disruption of any potential changes, and ensure tailored support for all. In addition, our core in-home delivery partner, British Gas, has established processes for identifying and prioritising service to customers in vulnerable situations. We pride ourselves on continually improving services for customers in the most vulnerable situations, and we will continue to lead working groups across the industry to ensure we are providing fair offerings for all.

Billing Approach

The billing experience for residents will remain consistent with their pre-trial experience. We anticipate engagement with third-party energy suppliers to provide billing to residents during the trial. Residents will still be able to switch suppliers and will pay no more than they would for natural gas.

Fundamental to our approach is that residents and businesses will not be financially disadvantaged for their participation. Propositions will be funded through project costs, ensuring no additional cost to residents during the trial. We will provide tailored communication and support for residents based on their situations to address questions around costs and billing.

6. Costs and funding requirements (1000 words)

Please use the space below to provide a narrative for the costs set out in the completed Cost Assurance spreadsheet. This narrative should include:

- A description of how the costs and any contingencies have been estimated, including consideration of risk and uncertainty.
- The funding options that have been investigated and a justification for the proposed sources.
- Why costs for the costs for Stage 2 and overall cost of the trial can be regarded as efficient.
- A description of and justification for the private sector contributions towards Stage 2 costs.

How costs and contingencies have been estimated, including consideration of risk and uncertainty

Costs for Stage 2 have been built up by each individual work package, with the aim to reach an accuracy of ±10%. Items with a greater degree of cost uncertainty have been assigned a larger contingency than 10%; this can be found within the completed Cost Assurance Spreadsheet. Within Stage 2, costs are for labour and sub-contractors to undertake certain packages within the full scope. An estimation of the hours required to deliver each scope, and the rates for those required, have been utilised to build the costs bottom-up, ensuring a high degree of accuracy.

The activities that have been outlined within Annex A: Cross-GDN Collaboration are separate to the trial costs, and thus are not included within the costing template.

Whole Life Trial (WLT) costing has been developed by each individual work package through a combination of:

- Drawing on relevant previous project experience and specialist expertise.
- Interpolation of equipment quotes received as part of other projects.
- Utilising typical data where required, for example in the case of property conversions.
- Discussions with equipment manufacturers where necessary (including boiler manufacturers to assess potential future costs).

The accuracy of the costs within Stage 3 and beyond are less accurate than those for Stage 2, ranging from ±30% to ±50%. The full trial costs will be refined as part of Stage 2 to reach an accuracy of ±10% prior to funding being granted.

There are certain assumptions that have been required to reach a whole life cost, considering the detailed design work has not yet been undertaken, specifically with regards to the property conversion and network infrastructure scopes. Within the cost assurance template, we have put forward three scenarios to cover the uncertainty and risks within the project; as focussed on the exit plan and hydrogen boiler uptake amongst residences. The proposed scenarios are presented in Table 11 below.

Table 11: *Proposed Scenarios*

Factor	Scenario 1	Scenario 2	Scenario 3
Hydrogen boiler uptake amongst residences	95%	90%	85%
Exit plan	Transition to town trial	Transition to town trial	Revert to natural gas

Funding options

Numerous funding options have been assessed, and the project shall be supported via external funding from our project partner British Gas as well as contribution from Cadent.

Project Partner and Cadent Contributions

Cadent has proposed to contribute the cost of the demonstration facility (£378k) and 50% of the remaining Stage 2 project cost. In addition to this, British Gas have proposed to contribute £600k to the Stage 2 works. The combined contribution of these contributions is £4,938k equating to 59.5% of the Stage 2 overall costs.

Cost efficiency

There are a number of efficiencies that will be realised as part of the full trial costs:

- **Collaboration** – there are key areas which will benefit from collaboration across GDNs, irrespective of village selection. In line with BEIS guidance, no costs have been included in the cost assurance template for the proposed collaborative work. These areas of collaboration have been agreed among the GDNs, with further detail provided in **Annex A**, and include:
    - Regulatory Plan
    - Exit Plan
    - Supply Chain for Appliances
    - Training
    - Hydrogen Consumer Research
    - Trial Evidence Framework
    - Safety Case
    - End User Research
- **Re-use of existing assets:** As part of Stage 2, we will assess whether the existing network assets are able to be re-used rather than installation of new pipelines and PRIs. Note that current costs for the high scenario are on the basis of all new assets being required.

- Network replacement: The LP network within the trial area has mains that meet the tier 1 mains replacement criteria; we have designed the mains replacement projects as part of our normal business processes and have identified 3km of pipes for replacement during 2022/23 thus the costs are not incurred as part of this project.
- Primary hydrogen supply selection: Hydrogen supply will be sourced from the HyNet hydrogen production plant (HPP1) that will be constructed and funded as part of the HyNet North West project. As a result, costs to the trial are solely for backup supplies and connection into the HyNet network.
- Safety case work: We will utilise information and evidence available from other hydrogen distribution projects - of which DNV GL has been actively involved in and therefore have access to - ensuring work is not duplicated across projects. Additionally, we shall build on the existing models DNV GL have rather than starting from scratch.
- Selection of project partners: We have selected project partners that have been involved in high-profile industry hydrogen projects (DNV GL, Kiwa, Progressive Energy), ensuring our team has experience in end-to-end delivery and access to relevant information.

A description of - and justification for - the private sector contributions towards Stage 2 costs

British Gas has proposed to contribute £600k to the Stage 2 works; this encompasses the full labour cost for British Gas work in advance of the Stage 2 decision (~£60k for survey production and refinement) and £540k to their labour costs post decision. This contribution equates to approximately 46% of the cost of their operatives undertaking the training and survey works, thus meaning the project pays the remaining 54% of the costs.

British Gas are committed to developing greater hydrogen capability to ensure their workforce is future-proofed for the UK's energy transition, and thus have a stake in the project. Cadent's contribution to the demonstration facility and 50% of the Stage 2 costs evidences our commitment to enable the UK hydrogen economy and unlock its range of benefits, supporting the country's journey to net zero by 2050.

7. Project deliverables

Please use the table below to set out the proposed Project Deliverables for Stage 2. This should include no more than ten Project Deliverables for the project as well as the proposed percentage of the funding requirements to be assigned to each Project Deliverable.

Table 12: *Stage 2 Project Deliverables*

Reference	Project Deliverable	Deadline	Evidence	Funding requirements (%, must add to 100%)
1	Detailed designs and specifications for infrastructure requirements	31/03/2023	1. Network solutions defined 2. Engineering packages completed for hydrogen supply resilience and network infrastructure requirements 3. Completed tender documentation	35%
2	Safety case and safety documentation development	24/02/23	1. Full Project Quantitative Risk Assessment (QRA) Report 2. Safety case framework developed 3. Full scope of site-specific safety documentation developed	6%

3	Stakeholder engagement and communications	25/10/22 14/03/22 14/03/22 05/04/22	1. Refined and researched consumer propositions leading to high uptake 2. Stakeholder engagement report produced 3. Stakeholder database 4. Implementation of successful marketing and communications plans	14%
4	Regulatory and commercial arrangements in place to be implemented	29/03/23	1. Documented proposal on the UNC modifications required to support trial 2. Documented proposed on technical billing modifications undertaken 3. Development of Commercial Assurance Framework 4. Development of a Commercial Change Framework for hydrogen	0% (Collaboration)

5	Consumer agreements in place, and end use appliance procurement strategy developed	19/09/22 25/11/22 05/01/23 05/01/23	1. Sample surveys of domestic properties and full survey non-domestic properties completed 2. Consumer solutions produced and corresponding agreements with consumers in place for implementation 3. Bill of Materials for hydrogen and electrification approaches 4. Appliance procurement and contracting strategies	25%
6	Delivery model and commercial strategy established	17/02/23 31/03/23	1. Delivery model 2. Signed contracts with key suppliers and partnerships with project partners agreed	4%
7	Spending profile and implementation timetable for live trial	13/01/23 17/02/23 31/03/23	1. Robust spending profile over full lifetime of project 2. Detailed implementation timetable for delivery of live trial 3. Land procurement	6%
8	Procedures, standards, and workforce training	25/03/22 24/02/23	1. Workforce training programmes 2. Local operating procedures	3% (Collaboration)

9	Project management and technical oversight	31/03/23	1. Project management 2. Work-pack co-ordination and technical support 3. Maintenance of project risk register 4. Final project report preparation	5%
10	Full evidence and benefits plan	08/12/22	1. Full evidence and benefits plan	2%

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Hydrogen Heating Village Trial Stage 2: Submission Application

List of Annexes

Annex	Title
Annex A	Cross-GDN Collaboration
Annex B	Evidence Framework
Annex C	HSE Safety Demonstration Consideration for Trials
Annex D	Project Plan
Annex E	Stage 2 Scope of Works
Annex F	WP4 Commercial and Regulatory Full Report
Annex G	Exit Scenarios
Annex H	Risk Register
Annex I	Letters of Support
Annex J	WP1 Hydrogen Supply Option Selection Summary Presentation
Annex K	Identified Stakeholders
Annex L	Social Value Report
Annex M	Consumer Research Reports

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Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX A: Cross-GDN Collaboration

Cadent has been working alongside other GDNs and the Energy Networks Association (ENA) to interface with BEIS and Ofgem on areas of collaboration. Cadent is leading on the areas of Safety Case, Consumer Research, and Exit Plan. This Annex provides further details of the cross-GDN collaboration programme.

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Annex – Collaborative Supporting Evidence

This document is an annex to the Village Trial proposal submissions, outlining the work that the GDNs plan to undertake collaboratively in addition to the commitments presented in the main body of the submission. This annex is common for all submissions by the GDNs.

Introduction

This annex is structured in following sections that broadly mirror the structure of the main body of the submission:

- Section 2 – Evidence Base & Safety
- Section 3 – Planning & Risk Mitigation
- Section 4 – Infrastructure & Delivery
- Section 5 – Public & Local Engagement
- Section 6 – Cost & funding Requirements

Sections 2-5 include a table with the activities that the GDNs plan to carry out collaboratively, specifying the lead network and an indicative scope of the work. Note that the specified 'lead network' refers here to the organisation coordinating the project funding, as each project is intended to be delivered collaboratively by all GDNs. Unless specified, the proposed lead network will lead on the project regardless of which GDNs are awarded support for the initiation of a Village Trial. This will continue to be discussed through our existing collaborative forums.

Section 6 presents a summary of the proposed projects with indicative costs and targeted funding mechanisms.

Section 7 expands on the GDN's expectations for the role of BEIS in the delivery of the Village Trial(s).

This annex is common for all submissions by Cadent, Northern Gas Networks, Wales & West Utilities and SGN. It builds upon a strong track record of network collaboration on innovation and future of energy research and trials including through the Hydrogen Grid R&D Programme.

Section 2 – Evidence Base & Safety

The table below reports the activities that the GDNs are proposing to carry out collaboratively in the area 'Evidence Base & Safety'. The item 'Village End User Safety Evidence' is not an individual project but rather a collection of projects that were recently identified as crucial for the delivery of a village trial during the gap analysis of End User Evidence. A detailed scope for these projects was not yet produced and the cost bracket associated with these projects is just an estimate for the time being. The GDNs aim to produce a clear scope for these projects by the end of Q1 2022. It is assumed that this work will be governed through the Hydrogen Grid R&D Programme.

Table 1: Proposed collaborative projects for 'Evidence Base & Safety'

Category	Collaborative project name	Scope of Work	Lead Network	Comments
2.1 - Trials Evidence Framework	Evidence Framework Coverage & Gap Analysis	Analysis of evidence coverage and diversity of each village proposal. Active co-ordination would enable maximum evidence coverage from multiple trials whilst also building resilience (i.e. a risk for proceeding with only one option is the lack of a plan B).	WWU	Start in Q1 2022
2.2 - Safety Case	Village Safety Case Framework	Common piece of work outlining how the case for safety would be developed for any village location. This project would also provide a single point of focus and liaison with the HSE. HSE have recently developed a 'Safety Considerations for Trials' framework which will in due course be developed into formal guidance. The work on the Village Safety case will be founded on HSE's framework.	Cadent	Plan for this is to build on the H100 work by SGN. Cadent and SGN will communicate on learnings from H100.
2.3 - End User Research	Village End User Safety Evidence	The networks are currently working with BEIS to close the downstream evidence gaps that currently exist for the village. This will involve developing a programme of work integrated into Network Safety and Impacts sub programme (NSI) and building on the initial evidence developed by Hy4Heat. These gaps are driven by property type and appliance make up of selected villages.	NGN, others (Projects under programme of works likely to be distributed between networks)	Suggested NGN as they have successfully led the NSI programme and H21 evidence. Note: including all areas, also downstream of ECV.

		Below is an overview of the projects expected to be initiated under the End User programme. • Ventilation • Flue gas proximity • Property types • Meter location • Explosion risk assessment • EFV		

Supporting documentation:

- Energy Institute: Technical workshop proceedings: Hydrogen safety cases – Challenges in hydrogen safety case development in UK/European industrial clusters (link).

Completed/commissioned work in this area:

- **H21 Phase 1&2:** demonstrating the safety evidence required to convert networks up to 7bar to 100% hydrogen. Investigating whether pipes and other assets are compatible with 100% hydrogen. Also includes the development of operational procedures to work on a converted network which all networks will rely on for any village trial.
- **H21 Wider Impacts:** assessment of compatibility of gas facing components to 100% hydrogen (link).
- **First generation PE: investigating** 1st generation polyethylene (PE) compatibility with 100% hydrogen.
- **Service Pipes Impact Assessment:** modelling and testing of the pressure drop and velocities through domestic services. Determines the population of services that may have capacity constraints without amendment of existing pressure drop and velocity constraints. A further collaborative piece of work has been identified as necessary to identify required policy and standard changes.
- **H100 NIA**: providing evidence on the technical and commercial viability of constructing and operating a purpose built new PE network. The project conducted research and testing into the characteristics of hydrogen, the consequences, compatibility with PE materials and fittings, current standards and procedures, gas detection and odorant, flame visibility, erosional velocity and logistics. The outcomes have fed into the QRA and cases for safety development for the Neighbourhood Trial being undertaken by H100 Fife.
- **NIA 368 – Safety Case Review:** review and assessment of the documents developed to identify any potential intervention areas in relation to GSMR and Safety Case exemption. A key point from this assessment is to identify any potential gaps within the assessment of documentation in relation to GSMR and safety case exemption in order to operate a 100% hydrogen converted natural gas network.
- Additional projects being delivered through Network Safety and Impacts sub programme.

Section 3 – Planning & Risk Mitigation

The table below reports the activities that the GDNs are proposing to carry out collaboratively in the area 'Planning & Risk Mitigation'. The work is required to be undertaken by networks and BEIS before a decision is made to proceed with the trial.

Table 2: Proposed collaborative projects for 'Planning & Risk Mitigation'

Category	Collaborative project name	Scope of Work	Lead Network	Comments
3.3 - Regulatory Plan	Regulatory model	A number of issues common to all GDNs will require a common resolution: **Regulatory framework for security of supply** – Any trial is unlikely to offer the same security of supply that customers currently enjoy from the gas network, although there may be circumstances in which security of supply is improved. We must quantify what is deemed acceptable. This has a direct link with HSE's safety considerations and design philosophy. **Billing Options** – Analysis of billing system (Xoserve) options for any hydrogen village, with option design, development and implementation. Ensure clarity on issues such as VAT which currently has a rate of 5% for methane and 20% for hydrogen (source). **Balancing regime** – Development of an alternative approach to the commercial framework involving changes to the balancing regime as required. **Metering** – Ensuring a metering regime suitable to support the trial. **Industry Engagement** – Readying retail supply chain and relative systems for hydrogen supply to end users.	SGN	SGN are progressing the majority of these issues through H100 so it would be beneficial to have SGN leading this type of work. The preliminary report from Cadent & WWU on this area is linked on the next page under the list of supporting documentation. Xoserve engaged to determine estimated cost for design, development and implementation of a village trial solution for billing and metering. Regulatory considerations will also address users switching to electric. Networks will collaboratively outline a timetable of regulatory compliance activities and milestones, required BEIS activity and dependencies will be identified.

	Legislative requirements downstream of ECV	Legal and competence aspects relating to downstream of the ECV specially relating the to Gas Safety (Installation and Use) Regulations 1998.	BEIS/HSE	Networks expect BEIS to implement proposals set out in the consultation 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial'.
	General legislative requirements	Evaluation of other legislation, licence and industry code changes that may be required for the implementation of the Village Trial.	BEIS	E.g. relief from providing quotations to Gas Act section 9
3.4 - Exit Plan	Village Exit Plan Mechanisms	Common piece of work outlining the options for the trial. How long does it last, can it continue until a policy decision, or does it need to revert etc. The approach to reverting the network and customers back to natural gas would need to include safety considerations (QRA) to do this.	Cadent	Either electrification (direct or heat pump), natural gas or hydrogen as exit strategy.

Supporting documentation:

- Hydrogen Village Trial: Regulatory Framework for Security of Supply – for discussion (link)
- HyNet Homes – Interim report, WP4: Commercial & regulatory (link)
- H100 Fife Phase 1 – Condition 3 Report (link)
- H100 Fife – Regulatory Analysis (link)
- H100 Fife Phase 1 – Condition 4 Report (Security of Hydrogen Supply) (link)

Completed/commissioned work in this area:

- **H100 Fife:** Regulatory model development for Phase 1 (hydrogen neighbourhood) 100% hydrogen network. Condition 3 report sets out the approach supported by regulatory analysis, with engagement with Ofgem and HSE underway. The work has identified a suitable billing and metering Xoserve option that is moving into detailed design in 2022. Industry consultation carried out to approve option. Consultation with industry will continue throughout detailed design in the build out phase to system implementation. In parallel, the suitability of this option for a hydrogen village trial will be assessed and a solution developed for implementation that would be applicable to any hydrogen village trial.

Section 4 – Infrastructure & Delivery

The table below reports the activities that the GDNs are proposing to carry out collaboratively in the area 'Infrastructure & Delivery'.

Table 3: Proposed collaborative projects for 'Planning & Risk Mitigation'

Category	Collaborative project name	Scope of Work	Lead Network	Comments
4.3 - Supply Chain for Appliances	Hydrogen Village Appliance Supply Chain	**OEM Co-ordination** – Single point of contact to provide visibility of potential appliance / meter volumes and types across each village to manufacturers. Work with manufacturers if there are gaps in availability. **Procurement Strategy** – Development of an equitable procurement strategy. **Appliance QA / Certification** – Developing position on required oversight networks in this area. Certainly needs co-ordination.	SGN	SGN are progressing the majority of these issues through H100 and it would be beneficial to have SGN leading this type of work. To start in 2022 with stage 2. Note: this project will be carried out collaboratively only if multiple village trials are initiated. If multiple trials proceed ENA could lead this work area to ensure competition law compliance. Otherwise, this will be carried out solely by the network leading the village trial. Manufacturers may require funding to support further R&D or initial supply, which would be outside scope of costs put forward here.
Training	Training required for Hydrogen Village	Identification of resource and training requirements, including certifications, competency assessments and recruitment plan.	SGN	To follow NSI project on training and competency roadmap.

Completed/commissioned work in this area:

- **H21 Modelling:** looking at how we would roll out conversion, so some parts are relevant for village trials
- **H21 Initial Hydrogen Supply:** looking at how we get hydrogen to the first property in a conversion area
- **H100 Fife:** Void property surveys undertaken in May and November 2021 to inform opportunities/challenges for hydrogen connections and supply to end users. Supply chain engagement for hydrogen appliances and meters.

Section 5 – Public & Local Engagement

The table below reports the activities that the GDNs are proposing to carry out collaboratively in the area 'Public & Local Engagement'.

Table 4: Proposed collaborative projects for 'Public & Local Engagement'

Category	Collaborative project name	Scope of Work	Lead Network	Comments
5.2 - Hydrogen Consumer research	Hydrogen Village Consumer Research	Cadent is already leading this work on behalf of all the networks, with ongoing input from the other GDNs, culminating in quantitative research involving 4000 domestic customers and also businesses. Whilst the majority of the work will be concluded at stage 1 it is very likely that there will be further generic customer research that will be required in stage 2. Generic customer research will be used to supplement, rather than replace, local trial specific customer research.	Cadent	Makes sense for Cadent to continue this work.
5.3 - Billing Strategy – Xoserve	Addressed in "3.3 Regulatory plan".			

Completed/commissioned work in this area:

- **H21 Social Science Research:** looking at customer acceptance of conversion and how that is messaged.
- **H100 Fife:** Phase 1 (100% Hydrogen Neighbourhood trial) local stakeholder and consumer engagement ongoing. Community engagement underway and ramping up for customer opt-in process beginning in 2022. Outputs will help inform village development.
- **H21 Modelling:** looking at how we would roll out conversion so some parts are relevant for village trials.
- **Hydrogen Consumer Research:** Qualitative (stage 2) and quantitative (stage 3) work lead by Cadent on behalf of all the networks. This is being input into by all GDNs.
- **Willingness to Participate in a Trial**: The project was recently initiated by NGN. The scope involves research via surveys and interviews with residents to determine the willingness to participate in a hydrogen village trial.
- **Switching Vulnerable Customers to Hydrogen**: The project was recently initiated by WWU. The scope involves the design development of a practical, safe process for switching vulnerable customers from natural gas to hydrogen.

Section 6 – Cost & Funding Requirements

The table below provides a summary of the costs of the activities proposed in the previous sections. These are estimates only and would be revised following development of project scopes and tested with potential commercial partners.

Table 5: Summary of proposed collaborative projects with expected costs and funding streams

Category	Collaborative project name	Lead Network	Cost (£m) (-/+50%)	Funding Stream
2.1 - Trials Evidence Framework	Evidence Framework Coverage & Gap Analysis	WWU	£0.1	NZUIoLI
2.2 - Safety Case	Village Safety Case Framework	Cadent	£0.9	NIA
2.3 - End User Research	Village End User Safety Evidence	Various	£4.4	New funding required. Either HyNIA or direct BEIS funding
3.3 - Regulatory Plan	Regulatory model	SGN	£1	NZUIoLI
	Legislative requirements downstream of ECV	BEIS/HSE		NZASP
	General legislative requirements	BEIS		
3.4 - Exit Plan	Village Exit Plan Mechanisms	Cadent	£0.2	NIA
4.3 - Supply Chain for Appliances	Hydrogen Village Appliance Supply Chain	SGN	£0.2	NZUIoLI
Training	Training required for Hydrogen Village	SGN	£0.2	NZUIoLI
5.2 - Hydrogen Consumer research	Hydrogen Village Consumer Research	Cadent	£0.3	NIA

The role of BEIS in the delivery of a village trial

This section provides an overview of the role that the GDNs would encourage BEIS to take on in the delivery of a village trial, as the support of BEIS in a multitude of work areas will be crucial for the successful delivery of a village trial, as outlined below.

1. **Public and local engagement**, promoting and advocating for the hydrogen village trials and overall hydrogen awareness. Backing from relative authorities would be decisive in supporting consumer acceptance. In particular, following activities would be beneficial:
    - Providing public support for the hydrogen programme alongside other heating options to ease the public perception.
    - Raising the public awareness about the possible role of hydrogen in heating through Government-led campaign of awareness and advocacy activities, especially in the chosen village locations/regions.
    - Raising public support for 'low carbon hydrogen' rather than blue versus green hydrogen.
    - Reactive communications to address issues as they arise, in addition to the proactive communications noted above.
2. **Supporting communication** and coordination of relevant institutions, by bringing together other impacted government departments and NGOs (e.g. Citizens advice, HSE, etc).
3. **Expediting any legislative and regulatory changes** necessary or beneficial to the delivery of a successful project.
4. **Sharing with the GDNs other research on alternative pathways to heat decarbonisation** that may support the overall project, e.g. research on grid reinforcement needs, consumer acceptance etc.
5. **Confirming trial assumptions** for the GDNs to deliver their proposals using Q&A log.

Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX B: Evidence Framework

This Annex provides our responses to the BEIS Trial Evidence Framework, detailing where our plans for the Whitby village trial incorporate each evidence type and sub-group. This will ensure an informed policy decision on the future role of 100% hydrogen for heating is made by UK Government in 2026.

Cadent
Your Gas Network

Department for Business, Energy & Industrial Strategy

Annex B: Whitby Village Trial Evidence Framework

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
Consumer	Consumer attitudes & perception	1. Social acceptance data in and outside trial areas to evaluate changes in public understanding of hydrogen heating compared to other energy sources (e.g. natural gas, electrification)	The evidence collated through our hydrogen village consumer research programme indicates that at a national level, there is a higher degree of social acceptance towards the use of hydrogen for heating and cooking in comparison with energy sources such as natural gas and electrification. There is a positive consumer sentiment towards alternative fuels although levels of knowledge do vary. Engagement with residents in the trial area will start in Stage 2. Consumer and stakeholder engagement and research programmes will continue throughout the project and will be conducted in conjunction with the local authority and consumer groups.	Annex M: Consumer Research Reports
		2. Social acceptance data (and how this changes), in and outside trial areas before, during and post-trial.	At a national level, there is a higher degree of social acceptance towards the use of hydrogen, both pre and during a trial period. Post-trial, social acceptance remains but with questions regarding post-trial options, disruption, and costs. Engagement with residents in the trial area will start in Stage 2. Consumer and stakeholder engagement and research programmes will continue throughout the project.	Annex M: Consumer Research Reports

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Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		3. Social acceptance data of hydrogen use in commercial settings	While there were no industrial or large commercial settings within the scope of the hydrogen village consumer research programme, commercial properties are present within the proposed Whitby conversion area. There is a general feeling of positivity towards the use of hydrogen and many believe it to be less disruptive than alternative options. Consumer and stakeholder engagement and research programmes will continue throughout the project to support evidence collection.	Annex M: Consumer Research Reports
		4. Consumer attitudes to using hydrogen meters compared to natural gas meters.	During the qualitative research stage, consumers expressed concern for customers in vulnerable situations with additional support being requested to learn how to use the new equipment. As all the hydrogen appliances that will be installed are essentially identical to their Natural Gas or LPG counterpart, this is not seen as an issue. This was consistent with the views of the Customers in Vulnerable Situations segmentation group. Further engagement on this topic will be included in Stage 2. Consumer and stakeholder engagement and research programmes will continue throughout the project to support evidence collection.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		5. Consumer attitudes to the cost of hydrogen and possible new pricing/billing models before, during and post-trial (*cost will be mitigated in the trial, however we can still collect evidence on consumers' attitude and perception to hydrogens affordability and whether they see it as 'worth-it' post-trial).	Many people's choice of heating and cooking (and energy suppliers) are driven by habit, familiarity, and cost; however, the majority of consumers are happy to take calculated risks in their homes if the benefits are likely to outweigh the drawbacks. Gas-powered heating is widely perceived to be more cost-efficient then electric-powered heating. This is echoed by niche consumer groups too, such as landlords and small and medium businesses. Some consumers align their expectations on the cost of hydrogen with natural gas and expect hydrogen to have similar running costs. Consumers were concerned about the costs associated with the trial, especially small and medium businesses who had been financially impacted by the Covid-19 pandemic. Concerns relate to the cost of installation pre-trial and the uncertainty of cost implications post trial. This will be explored further in Stage 2. Consumer and stakeholder engagement and research programmes will continue throughout the project to support evidence collection.	Annex M: Consumer Research Reports
		6. Consumer attitudes to preparatory engagement, including on:	Consumers expect to be given 1-2 years prior notice of the trial to fully prepare, and for the Government to be involved in initial communication. Information from central Government is considered important (and reassuring) for explaining why the trial is necessary, establishing the trial's credibility. Consumer and stakeholder engagement and research programmes will continue throughout the project.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		a. Consumer understanding of trial purpose and practicalities	SMEs need to hear the business case for the trial and landlords require early engagement and technical guidance on their roles, given their need to communicate with tenants. Consumers want to know why the trial is taking place (including why their property and area has been selected, and how a hydrogen trial is necessary for the UK to achieve net zero.); what is compulsory and what choices they'll have (for example, if there are any exemptions and about the choice between heat pumps and hydrogen); the timelines (the duration of the trial, and when they'll need to make decisions.); who's responsible for the trial & who to contact including information about any community meetings or follow-ups. This work will be encompassed into the Stage 2 engagement work and continue through the lifecycle of the project.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

		b. Gaining local support	People are likely to need active engagement to participate in the trial as a community initiative. They will also seek reassurances that people in vulnerable situations in their community are being supported. Note that negative past experiences with the utilities sector, particularly cited by non-professional landlords, partly influence perceptions. Whilst not directly implicated, GDNs are largely invisible to the consumer due to limited interaction. This makes it challenging for participants to envisage their role, making trust even more salient. Small Medium Enterprises (SMEs) - who often focus as much on risk as potential benefits of any proposal - are concerned about the level of disruption and potential costs to their businesses. Those SMEs that were financially impacted by the pandemic are least likely to positively engage with the trial as they believe it would present a major risk in the short term. Landlords cite both specific advantages and concerns regarding the trial. Non-professional landlords are particularly mindful of how the HVT could make their properties more attractive, such as creating local jobs and making the community greener. While Local Authority landlords are concerned with provisions for their tenants who are in vulnerable situations and being able to supply 'liveable' properties throughout any potential disruption and energy supply issues. Stage 2 will include initial engagement and information campaigns as part of a public engagement strategy. This will continue across all project stages to inform and support consumers.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		c. Maximising consumer sign up to trial	Those who are extremely concerned about climate change are more accepting of the disruption and are open to coping with any changes while work is undertaken. They see this as a necessary step in the fight against climate change. Some customers expressed concerns over possible changes or 'U-turns' in the Government agenda, potentially having a negative effect on the trial. Ongoing consumer research, proposition development activities, initial engagement and information campaigns will drive further understanding of attitudes.	Annex M: Consumer Research Reports
		d. News coverage to facilitate consumer understanding (HHIC)	The project will implement a Public Affairs Plan as part of the public engagement strategy across all stages of the project.	Annex M: Consumer Research Reports
		e. Engagement on future environmental impact of the switch from natural gas to hydrogen gas (BSI)	Customers want to know why the trial is taking place - including why their property and area has been selected, and how a hydrogen trial is necessary for the UK to achieve net zero. Across the project stages, there will be a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups. Stage 2 will focus on the latter elements and planning of the customer engagement in Stages 3-5.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		f. Different communication methods in the preparation of trials (e.g., postal, one-to-one, community event, online, app-based, or different combinations of these)	Pre-trial communication channels are letter, media coverage and in-person communication, with personalised visits and physical information for the digitally disengaged. There is a strong desire for clarity from those in more vulnerable situations. In practice previous gas industry trials regarding changes of gas quality (e.g., Scottish SIU's) showed only in-person communication was truly effective. Across the project stages, there will be a programme of stakeholder and customer engagement, consumer research and customer focus groups. Stage 2 will develop on the Stage 1 findings and continue to focus on the latter elements and planning of the customer engagement in Stages 3-5. Throughout the process of consumer engagement, we will keep records of the types of communication used, and collect data where possible on level of engagement, particularly around digital communication.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		7. Consumer perception of the frequency of engagement, communications and updates throughout the preparation and operation of the trial (e.g., at certain intervals, at critical project 'milestones', etc)	Research so far indicates that consumers expect to be given 1-2 years prior notice of the trial to fully prepare (6 months minimum) to plan for home renovations. Landlords who manage multiple properties want early notice and anticipate that this will be time consuming, and complex given the number of properties and tenants they manage. Local authority landlords also require advance notice to consider tenants in vulnerable situations or those with financial difficulties. Small and medium businesses support this timeframe too. During the trial, residents want to receive regular updates relation to any upcoming disruption (particularly important to small and medium businesses), cost information and available support. Other requests include information on the progress of the trial and environmental and economic impacts. Towards the end of the trial, consumers expect a minimum of 6 months' notice with information relating to end state options. Engagement and communication requirements will be explored further in Stage 2.	Annex M: Consumer Research Reports
		8. Consumer perception and attitudes to different communication means and mechanisms for contacting the trial operators, e.g. phone line, dedicated community contact, online FAQ page, chatbot, etc. during and post-trials	Consumers expect multi-channel engagement including letters, texts, emails, social media, an online website, media coverage, temporary offices, and local community events. Niche consumer groups require in-person communication via a dedicated representative with personalised visits and physical information for the digitally disengaged and a strong desire for clarity from those in more vulnerable situations. Engagement and communication requirements will be explored further in Stage 2.	Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		9. Perception and attitudes to different communication means and mechanisms for consumers who have accessibility requirements, including but not limited to	One of the principles of communication will be making materials accessible to all. We will produce materials using approaches appropriate for users with limited hearing and vision and will record uptake and feedback against these materials. Digitally disengaged customers emphasise wanting to be contacted personally throughout the whole pre-trial period. During the trial, digitally disengaged customers emphasise keeping non-online options to contact for support. Most reject the idea of having Wi-Fi installed, feeling that they would struggle to use it, and would prefer to receive updates via letters, visits, or calls. To support digitally excluded, English as a second language, visual or aural impairment, such as braille and BSL users, physical copies of information, either sent via post or available from local libraries, are very important, and made available in Stage 2. Local demonstration facilities are also being considered. Engagement and communication requirements will be explored further in Stage 2 and implemented in Stages 3-5.	Annex M: Consumer Research Reports
		- braille		
		- British Sign Language		Annex M: Consumer Research Reports
		- visually / sensorily / hearing impaired consumers		
		- digitally excluded		
		- consumers who speak/read/write English as an additional language		
		10. Data on effectiveness of activities pre-trial on consumer acceptance and attitudes of hydrogen system (e.g., does it make a difference if they visited a showhouse, read a brochure, read information on previous trials, etc.)	The most popular offers required for customers to choose hydrogen are support, evidence of impact of hydrogen on emissions and its safety and clarity that costs will be covered/a modest incentive offered. We are expecting a show home to be included in the plan. We will conduct research with residents to see what activities they engaged with and how that influenced their decision-making Stage 2 will continue the stage 1 engagement and research work to prepare for Stage 3-5.	Annex M: Consumer Research Reports

Annex B: Whitby Village Trial Evidence Framework

Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		11. Data on consumers use of the communication channels provided by the trial operator, including:	Research to date provides overwhelming evidence that consumers expect support to be readily available 24/7 from qualified professionals. Consumers also want third party bodies to be available for impartial advice. During the trial there is a strong preference for a 24/7 helpline, an online chat facility and in-person communication with a site office that consumers can go to for help and support. The channels for reporting faults and leaks will be reviewed in Stage 2 of the project. In Stage 3, the channels and the process will be tested ahead of hydrogen being introduced to the trial. We will assess levels of consumer satisfaction through short opt-in surveys when people use these different channels.	Annex M: Consumer Research Reports
		- confidence in the process of reporting hydrogen appliances faults		
		- confidence in the process of reporting hydrogen leaks compared to natural gas leaks		
		- using the communication mechanisms when necessary and at appropriate times		
		- perception of their queries being addressed appropriately and in a timely manner		
		12. Consumer perception of and confidence in different stakeholders involved in trials delivery and the different sources of information on hydrogen (e.g. would consumers value information with HSE approval, from university studies, etc).	Our research to date shows that consumers expect Government and the trial 'organisers' to play a significant role in pre-trial communications. Information from Government and trial 'organisers' is considered important (and reassuring) for explaining why the trial is necessary, establishing the credibility of the trial. When asked about trust, consumers indicated that independent advisory groups, GDNs, energy suppliers and local gas installers would be most trusted to provide information on the trial. This will be explored further during Stage 2.	Annex M: Consumer Research Reports
		13. Consumer attitude to additional energy-related support (not directly by the duty-holder) as part of the conversion process, including support to consumers such as:	Research so far has shown that consumers would like personalised advice on the fuel alternatives available in the trial. Energy related support will be explored during Stage 2. Stage 2 will continue the stage 1 engagement and research work to prepare for Stage 3-5.	Annex M: Consumer Research Reports
		- conversations about energy use,		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- energy-related advice		
		- impartial, independent review of the energy efficiency of consumer homes,		
		- energy efficiency advice.		
		14. Consumer attitudes on perception of hydrogen safety prior to and during the trial, including on:		Annex M: Consumer Research Reports
		a. General perception of safety and preparedness for trial	Consumer research indicates that there is a need for information to be clearly communicated pre-trial on the safety of hydrogen to provide reassurance. This is particularly prevalent in older age groups. The safety and associated risk from the hydrogen village trial is a key success factor for the trial. Ongoing stakeholder and consumer engagement and research will track perceptions of safety. Public information will be tested and validated with consumers. This will feed into the risk assessment and decision-making processes in Stage 2.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		b. Plans/instructions to maintain safety throughout trial, i.e. not blocking vents etc.	Consumer research to date shows that consumers want a number of services to be provided to feel safe. These include regular safety checks (i.e., 1-2 times per year) throughout the duration of the trial, safety assurances for labour and appliances and confirmation of training levels of engineers. The safety and associated risk from the hydrogen village trial is a key success factor for the trial. Ongoing stakeholder and consumer engagement and research will track perceptions of safety. Public information will be tested and validated with consumers. Communication campaign(s) for the trial area would recap on all areas of good consumer practice to maintain safety, i.e., not tampering with pipework / ventilation, reporting a suspected gas escape, etc. It is anticipated that communication campaigns will start in Stage 2 and continue through subsequent stages of the project.	Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		c. Plans/instructions for any hydrogen incidents, i.e., being confident in what to do	The safety and associated risk from the hydrogen village trial is a key success factor for the trial. Ongoing stakeholder and consumer engagement and research will track perceptions of safety. Public information will be tested and validated with consumers. Broadly, from a consumer perspective, it is anticipated the instructions for a hydrogen leak would remain the same. A review of safety including consumer reporting of incidents, and response instructions back to consumers, is planned for Stage 2 of the project. In Stage 3, this will move to communication of the plans with consumers.	Annex M: Consumer Research Reports
		d. Safety perception of hydrogen vs natural gas	The safety and associated risk from the hydrogen village trial is a key success factor for the trial. Ongoing stakeholder and consumer engagement and research will track perceptions of safety. Public information will be tested and validated with consumers. Conversion to a hydrogen network is an opportunity to confirm the condition of the network in the trial location and introduce any required additional mitigation measures to operate a hydrogen network. There may be instances when the gas network doesn't meet current regulations / requirements. The trial will therefore improve the safety of the existing natural gas system operations. Stage 2 of the project will identify how to best address the safety perception of consumers and communicate the project approach to safety.	Annex M: Consumer Research Reports
		15. Consumer attitudes to disruption related to their change from natural gas to hydrogen regarding intrusive works inside the home, such as:		Annex L: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		a. switching appliances and meters	In terms of works carried out in the home and disruptions to supply, consumers expect to be notified in advance and advised if they will be able/need to stay home. Consumers in vulnerable situations are more likely to feel anxious over having work done and visits to their home. Small and medium businesses have shown a preference for any works to be completed outside of business hours. Landlords would like notification of any works before tenants. Consumers have a strong preference to stay with hydrogen after the trial has concluded as this is felt to minimise disruption and be more environmentally friendly. The anticipated domestic impact of having to change or revert at the end of the trial is a significant issue for many. Future uncertainty leads to questions around in-home changes and whether participating in the trial is beneficial. This will be explored further in Stage 2. The details of the required changes to every property will be discussed during Stage 2. Historically there has been little resistance to the free upgrading of gas appliances (e.g., during landlord upgrades) and little evidence of blockage of ventilation required for gas appliances. If this were not the case, there would be more annual CO incidents. Historically there is no evidence of householders refusing to upgrade their electrical systems when a new boiler is installed.	
		b. repositioning appliances and meters		
		c. increasing ventilation to meet required standards (part F standards)		
		d. boiler placement and subsequent re-routing of pipes & flues		
		e. in-home pipework reparation and replacements		
		f. in-home disruptions from switching back to natural gas from hydrogen at the close of the trial.		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		g. electrical assessment (check earth wires are fitted, fit RCD spur units for boiler connects, etc.)		
		16. Consumer attitudes to disruption related to their change from natural gas to hydrogen regarding intrusive works outside the home, such as:		Annex M: Consumer Research Reports
		- street works	The potential lack of control over pre-trial events creates anxiety, therefore if consumers feel more in control of certain aspects and fully informed, it might help alleviate concerns and encourage positive participation. This will be explored further in Stage 2.	
		- repositioning meters		
		- electrical assessments		
		17. Consumer reaction to time off gas (the length of time during the switch that households are not connected to the gas grid) during conversion process.	Customers do not want major installation works to happen in winter, although in practice spring and autumn are often acceptable. Across the project stages, there will be a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups that will feed into the implementation plan for Stage 3 and operation Stages 3-5.	
		(*expecting time off gas to be longer for grid-conversion trials)		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		18. Consumer reaction to secondary heating appliances required during time off gas and the communication model used to secure and supply these	It is important to consumers that any major installations are not scheduled for the winter months. There is support for secondary heating and energy appliances, especially for customers in vulnerable situations where there is a potential impact on medical needs. Temporary accommodation was thought to be necessary if the installation was going to take place over a number of days. Cadent and community landlords are very familiar with when this is and is not required. The communication model used to secure and supply secondary heating will be reviewed in Stage 2.	Annex M: Consumer Research Reports
		19. Consumer attitudes and experience of using hydrogen appliances (e.g., hydrogen cookers) for cooking over the course of the trial, including different flame behaviour, flame colour and visibility, speed of cooking, increased moisture levels in the room, etc.	Initially participants lean towards the hydrogen option as this is seen as least disruptive and most familiar fuel option, and heat pumps are perceived as being more disruptive and expensive. The strength of preference towards hydrogen steadily increases throughout the deliberative process. Across the project stages there will be an engagement programme of stakeholder and initial customer engagement, ongoing consumer research and customer focus groups.	Annex M: Consumer Research Reports
		20. Consumer attitudes and reactions to food cooked by hydrogen appliances commercially and domestically (i.e., does the food taste the same? does it have the same consistency?)	Across the project stages, there will be a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups. Stage 2 will include planning of the customer communication and engagement in Stages 3-5.	Annex M: Consumer Research Reports
		21. Consumer attitudes and experience of using hydrogen appliances (e.g., hydrogen boilers and gas fires) for heating over the course of the trial, including how effective hydrogen is at heating all rooms of the house	Across the project stages, there will be a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups. In practice whilst a difference of perception is expected for gas cookers and fires no material difference is expected in the performance of hydrogen boilers. Stage 2 will include planning of the customer communication and engagement in Stages 3-5.	Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		22. Consumer attitudes (i.e., level of acceptance/resistance) in trial area to proposition of, or being compelled to in the case of grid conversion trials, going off natural gas to hydrogen or an alternative energy supply	Initial research shows a predominantly positive attitude towards the concept of a hydrogen village trial. Engagement with residents in the trial area will start in Stage 2 along with further development of the consumer 'offer'.	Annex M: Consumer Research Reports
		23. Effectiveness of risk communications and perception for consumers in trial area	Stage 2 of the project will identify how to best address the effectiveness of risk communications and perception for consumers. In Stage 3, this will move to communication of risks with consumers alongside the project approach to safety.	Annex M: Consumer Research Reports
		24. Changes in risk perception for consumers in trial area over the course of the trial	Stage 2 of the project will identify how to best address the monitoring of changes in risk perception in the trial area over the course of the trial.	Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
	Consumer behaviour	25. Consumer attitudes and knowledge of carbon credentials of hydrogen versus alternatives, such as natural gas and electrification	The use of energy and power in homes and offices is felt to be a less significant contributor to climate change than things like factories, transport, and deforestation. This means that, when thinking about ways to reduce greenhouse gas emissions, making changes to the use of energy and power in homes and offices is not front of mind. There was almost no awareness of any targets related to home heating, electric heat pumps or hydrogen. Whilst less informed about the impacts of household energy use, most people say they would be willing to make changes. For customer alternative fuels are strongly identified with wind and solar energy. By contrast, there is lower spontaneous awareness of hydrogen, nuclear and geothermal power as alternative fuels. And, when thinking of 'electric' fuels, participants tend to consider, if anything, electric cars – with awareness of heat pumps much lower. Across the project stages there will be a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups.	Annex M: Consumer Research Reports
		26. Consumer behaviour during the conversion process, for instance:		Annex M: Consumer Research Reports
		- Do consumers respect the agreed appointments for pipework inspection, getting boilers installed, etc.		Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Are consumers willing to prepare for the appointment, such as postpone any ongoing works (e.g., remodelling or decorators)	Consumers do not want major installation works to happen in winter. Customers want a detailed schedule of events, appointments, and milestones in the trial. Within this, they want to be able to arrange appointments/visits at times that suit them. The general population would like 1 to 2 year prior notice of the trial so they can plan their holidays and home renovations around the trial. In terms of works carried out in the home and disruptions to supply, they expect to be notified in advance and advised if they will be able/need to stay home, or not. For non-professional landlords, a timeline will help them make decisions on fuel choice if they were already planning to conduct renovations to the property. They feel the need to be fully informed of the timings and commitments beforehand is a minimum requirement for taking part. Some of the respondents did not fully understand the hydrogen offering. For customers in vulnerable situations, the potential lack of control over events creates anxiety, therefore if they can feel more in control of certain aspects and fully informed, this might help alleviate concerns and encourage positive participation. This activity will occur in Stages 3-5. Stage 2 will develop a framework for collecting the response of consumers during physical implementation built on a programme of stakeholder engagement, initial customer engagement, ongoing consumer research and customer focus groups.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		27. Consumer behaviour over the course of the trial in comparison to pre-hydrogen conversion use, for instance:		Annex M: Consumer Research Reports
		- Do consumers keep the windows open more often for ventilation?	Identifying the best way to monitor and measure consumer behaviour over the course of the trial will form part of Stage 2. The community trial will be a safe trial i.e., not a trial of safety. With new appliances and pipework of confirmed integrity almost no routine leaks are expected except from those of 3rd party damage. Where possible data will be collected but it is expected to be modest in volume. From 2000 homes a GS(M)R reportable incident is expected only 40 years. Some change in cooking style may be expected. Hydrogen ovens will have higher moisture level.	
		- Do consumers use heating/cooking more-or-less often than before?		
		- How do consumer respond to leaks (does the odorant work as expected, do they cut of gas / close ECV, do they shut doors, how quickly do they make calls to report it, how do people with anosmia respond to gas alarms etc.)		
		- Do consumers alter ventilation either deliberately (i.e., block vents) or accidentally (install carpets and block door undercuts)?		
		- Do consumers follow the safety plan instructions/guidance (as in strand 4.)?		
		- Do the above consumer behaviours change over time?		
		- Do consumers notice the new variance in heat produced by hydrogen (i.e., is it too hot or not hot enough for their cooking needs)?		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		28. Retention of trial-participants who remain on hydrogen versus those leaving trial to switch back to natural gas (if possible, e.g., in H100) or alternatives (e.g., electrification)	Stage 2 of the project will identify the best way to monitor and measure the retention of trial-participants.	Annex M: Consumer Research Reports
	Consumer expectations	29. Consumer expectations of the benefits and responsibilities for hydrogen heating different groups, such as tenants compared to landlords.	The hydrogen village consumer research programme explores consumer expectations with different consumer groups including small and medium businesses, CIVS, digitally disengaged and landlords including LAHA. Each group has specific preferences which is set out in the consumer research reports covering each stage of the trial.	Annex M: Consumer Research Reports
		30. Consumer expectations of compensation for disruption and taking part in the trial	Consumers expect disruption and that it should be kept to a minimum. Consumers were positive about 'offers' such as alternative heating during any outages, making good any changes made in the home and clear communications. Compensation will be explored further in Stage 2.	Annex M: Consumer Research Reports
		31. Consumer expectations of outcomes and benefits of the trial	As the trial progresses, consumers want to hear about the bigger picture and context of the trial, including the extent to which the trial was 'successful', whether it met its objectives, how much it benefited the environment, or improved the potential of alternative fuels. A frequently mentioned benefit was in relation to updates on reductions in emissions, with a few mentions of other local community or economy benefits. There is recognition among all consumers that a key benefit of taking part in the trial is to 'future-proof' their home/business by being hydrogen-ready and to remain so at the end of the trial. This will be explored further in Stage 2.	Annex M: Consumer Research Reports

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		32. Consumer expectations of hydrogen appliances that are offered as replacements for their natural gas appliances	Consumers expect appliances to be offered free of charge including labour charges along with any repair or replacement costs. Reassurance on functionality, reliability and efficiency of hydrogen appliances and proof of safety is important and should be provided. Consumers expect a choice of appliance colours and brands with higher spec appliances being a nice to have. This will be explored further in Stage 2.	Annex M: Consumer Research Reports
		33. Consumer expectations of post-trial care, i.e., how their natural gas appliances to be stored for potential re-installation at the end of the trial	As the trial ends most people would prefer to stick with their fuel choice, to avoid more disruption. The anticipated domestic impact of having to change or revert at the end of the trial is a significant issue for many as there is concern that their homes would be negatively impacted after two major disruptions in a relatively short space of time. Customers expect that that contracts would cover redecoration, carpets, 'making good' etc. pre and post-trial.	Annex M: Consumer Research Reports
	Impact and experience on premise-type and demographic	34. Impact and experience of trial activities (from initial conversion/set-up to regular use over the trial), using hydrogen for cooking and heating in different premises, including:		Annex M: Consumer Research Reports
		- Building type e. g. detached house, terraced house, flats, etc. (that remain within TBC scope)	The hydrogen village consumer research has started exploring viewpoints of the trial for cooking and heating in different premises for both domestic and non-domestic consumers. This will be explored further in future stages with consumers in the trial area being engaged in Stage 2. Initial feedback will be reported from Work Pack 3 activities and surveys of the home and assessments of the area's property. This data will then be used to design the roll out and	
		- Number of storeys (that remain within TBC scope)		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Level of insulation (do more insulated houses find hydrogen more acceptable?)	stakeholder/consumer engagement and customer research activities. Performance of the conversion from survey to exit will monitored and reported continuously, with outputs used to improve the customer proposition/experience across all stages. Experience of implementation will be gathered in stages 3 and 4, and operational experience in Stage 4.	
		- Building condition and age		
		- Building size		
		- Building material (brick, timber etc.)		
		- Existing gas meter location		
		- Boilers controls interface		
		- Type of heating system (i.e., radiators or warm air heating, underfloor heating etc.)		
		35. Impact and experience of trial activities from preparation to going live (including conversion process and time-off gas) and of using hydrogen for cooking and heating for different consumer-types*, including:	It is planned that consumers will be off gas (with respect to their boilers) for less than 36 hours. Changing their cooker and any gas fire may take longer.	Annex M: Consumer Research Reports
		- Different tenure types (e.g., private rented, social housing, owner-occupied)	The hydrogen village consumer research has started exploring viewpoints of the trial for cooking and heating in different premises for both domestic and non-domestic consumers. This will be explored further in future stages with consumers in the trial area being engaged in Stage 2.	
		- Different demographics (e.g., vulnerable, elderly)		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Different protected characteristics (e.g., disabilities such as visually impaired)	Initial feedback will be reported from Work Pack 3 activities and surveys of the home and assessments of the area's property. This data will then be used to design the roll out and stakeholder/consumer engagement and customer research activities. Experience of implementation will be gathered in stages 3 and 4.	
		- Different social classes (e.g., are people in deprived/rich areas more likely to take part or resist trial participation?)		
		36. Data collection on the impact and experience of trial activities from preparation to going live (including conversion process and time-off gas) and using hydrogen for cooking and heating for vulnerable consumers and consumers in vulnerable situations, including but not limited to consumers in:		Annex M: Consumer Research Reports
		- Fuel poverty status (in or at risk of fuel poverty)	The hydrogen village consumer research has started exploring viewpoints of the trial for cooking and heating in different premises for both domestic and non-domestic consumers. Care will be taken that the trial continues to offer the same level of credit and pre-payment meter services that householders currently experience. This will be explored further in future stages with consumers in the trial area being engaged in Stage 2. Initial feedback will be reported from Work Pack 3 activities and surveys of the home and assessments of the area's property. This data will then be used to design the roll out and stakeholder/consumer engagement and customer research activities. Experience of implementation will be gathered in stages 3 and 4.	
		- Using different payment type (e.g., prepay, direct debit)		
		- Long-term illness and/or disabled		
		- Families with disabled children		
		- Families with children under 5		
		- Internet access/digital exclusion		
		- Rurality		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		37. Impact and experience of trial activities, from initial set-up to regular use, and of using hydrogen in different non-domestic building types, including a range of:	The hydrogen village consumer research has started exploring viewpoints of the trial for cooking and heating in different premises for both domestic and non-domestic consumers. This will be explored further in future stages with consumers in the trial area being engaged in Stage 2. Whitby contains about 40 commercial gas users including a small hospital and several schools. This will provide a reasonable range of non-domestic premises for a demonstration area. Initial feedback will be reported from Work Pack 3 activities and surveys of the home and assessments of the area's property. This data will then be used to design the roll out and stakeholder/consumer engagement and customer research activities. Experience of implementation will be gathered in stages 3 and 4.	Annex M: Consumer Research Reports
		- Commercial premises (e.g., chip shop)		
		- Other premises (e.g., schools, community centre)		
Safety	**Pre-trial safety outputs**	38. Data on the ability for duty-holder to meet the different trial-safety requirements set out by the HSE in the Safety Evidence Needs Assessment (in annex) for the safety case across the following sub-headings;		Annex C: HSE Safety Demonstration Consideration for Trials
		- System architecture (T1 – T7)	The system architecture will be defined in Stage 2 via the activities undertaken in WP 1, 2, 3 and 5. .As part of the design process, demand requirements will be defined along with a condition assessment of the network components. Account will also be taken of the assignment of hazardous areas under the IGEM/SR/25 hydrogen supplement.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- System suitability (materials and components) (T8 – T16)	Asset records have been reviewed in Stage 1 to identify the materials present in the trial area. Stage 2 will draw on existing materials testing research already undertaken by other hydrogen projects.	
		- Risk Assessment (T17 – T31)	A QRA will be developed alongside the design of the network. The QRA will inform the level of any required risk mitigation. A risk reduction workshop will also be held with the design, operations and safety teams. The H21 project risk baseline is the H2 network (taking into account mains replacement in 2032 vs NG network in 2020). A similar benchmark is proposed for the hydrogen village trial (taking into account any remaining planned mains replacement) vs NG network in 2021. Additional risk assessment activities in Stage 2 will include HAZID and HAZOP studies with participation from stakeholders across the project.	
		- Controls (T32 – T37)	Suitable controls will be developed in the Stage 2 design process. These controls will include those relating to maintenance of gas quality, use of an odourant and the implications of the presence of a potentially invisible flame. These controls will also include specific checks on the suitable installation of new components and appliances plus a review of the required emergency response arrangements.	
		- Capability and training (T38 – T40)	A detailed training and competency plan will be developed as part of the case for safety and the procedure review in Stage 2 and 3 of the project. These activities will include safety critical task analysis as part of the overall assessment of human factors.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Standards and procedures (T41 – 57)	. Trial specific procedures will be produced which are adapted from natural gas procedures. These will build on work developing operating procedures from the H21 and H100 projects and the emerging IGEM hydrogen supplements. These procedures will include roles and responsibilities for safety, management of change, rights of entry and emergency response.	
		39. Assessment of impact and effectiveness of communication of safety plans, drills and procedures for hydrogen incidents, including plans to interact with emergency services, ahead of the trial.	A review of safety plans and procedures for hydrogen incidents, including interaction with emergency services, is planned for Stage 2 of the project. In Stage 3, this will move to communication of the plans and holding drills to test and assess the plans of hydrogen being introduced to the trial. Any learnings from the drill will be incorporated into the emergency procedures which may be further improved, or additional training requirements identified.	Annex C: HSE Safety Demonstration Consideration for Trials
	Live trials	40. Effectiveness of specific training and competency assessment plan to ensure the safe installation & operation of appliances and meters for the duration of the trial	Stage 2 of the project includes the preparation of draft case for safety documentation and a review of procedures. Both activities will initiate a competency assessment plan for the safe operation and management of the trial network. Third parties have also been engaged to understand and plan the specific training plans for installation of appliances and meters for the trial. The plans for the training, will be continually assessed throughout later stages of the trial, with a key focus on the timeline and achievability of the roll out of training. As training is provided the effectiveness may be assessed through audit and inspection of works in Stage 3 of the project.	Annex C: HSE Safety Demonstration Consideration for Trials

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		41. Real-life insights on practical impacts of the safety mitigations from the QRA (Quantitative Risk Assessment) for the conversion and operation of hydrogen in homes over the course of the trial, including on:	As hydrogen trials or evidence projects gather evidence on the effectiveness of mitigations, or previously unidentified risks emerge, the learnings can be incorporated into appropriate deliverables and activities, such as QRAs and the project risk register, throughout the project. Already in Stage 1 some issues have been identified to be addressed in later stages such as potential issues posed by the use of EFV and pressure drops in the system; however as indicated above the number of incidents expected during the trial is extremely low so it will provide little quantitative data. Stage 2 of the project will include the initial QRA and risk reduction workshop identifying potential mitigation measures, criteria for selecting appropriate measures for the trial. The QRA will be further updated throughout the lifecycle of the project in Stages 3-5 as further design and operational information becomes available for incorporation into the QRA.	Annex C: HSE Safety Demonstration Consideration for Trials
		- Meter location, e.g. moving meters outside		
		- Flame failure devices on appliances		
		- Installing safety devices such as Excess Flow Valves (EFV) and assessing the flow it is set at		
		- Adding extra ventilation to properties	Stage 2 will include a survey of the homes and commercial properties within the trial location, including the current ventilation of properties. The practicality, cost implications and effect on safety of introducing additional ventilation will be assessed in the Stage 2 Risk Reduction Workshop and the QRA through Stage 2 and Stage 3 and 4. It should be noted that in many locations (for example a kitchen) no additional ventilation is expected although the extract fan is likely to need replacing with one containing an aperture stop at 100cm2.	
		- Risk from potential ignition sources close to hydrogen releases	As indicated above, this trial is expected to contain very few leaks; it is highly unlikely any will involve ignition (<1 in 200 years).	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		42. Types, number of, and impact of additional safety measures and mitigations for the trial	Safety measures and mitigations will be designed in Stage 2 and the operational and implementation data for designed or additional safety measures will be recorded in Stages 3 and 4. These will be broadly in accord with HY4Heat.	Annex C: HSE Safety Demonstration Consideration for Trials
		43. Frequency of the use of mitigations required for the conversion and operation of hydrogen in homes over the course of the trial (e.g. how often the EFV needs to be manually re-set)	Safety measures and mitigations will be designed in Stage 2 and the operational and implementation data for designed or additional safety measures will be recorded in Stages 3 and 4. It is unlikely quantitatively significant data will be obtained, but the performance of appliances will be closely monitored.	Annex C: HSE Safety Demonstration Consideration for Trials
		44. Impact and effectiveness of communication of safety plans, drills and procedures for hydrogen incidents, including plans to interact with emergency services, for the duration of the trial	The appropriate safety plans, drills and procedures will be addressed in Stage 4 and implemented on adoption. This includes emergency planning with local authorities and emergency services.	Annex C: HSE Safety Demonstration Consideration for Trials
		45. Effectiveness of 'checks' needed to demonstrate safe installation of any new components or appliances	Operational and implementation data/checks will be carried out in Stages 3 and 4.	Annex C: HSE Safety Demonstration Consideration for Trials
		46. Testing and refining the further development of safety operating standards and procedures after the ECV (excess control valve)	Operational and implementation data/checks will be carried out in Stages 3 and 4. Operating procedures for the trial will be under a continual review process with drafting started in Stage 2.	Annex C: HSE Safety Demonstration Consideration for Trials

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
Delivery and learning for town/roll-out	Time and Cost	47. Evidence around testing and refining the further development of safety operating standards and procedures before the ECV	Operational and implementation data/checks will be carried out in Stages 3 and 4. Operating procedures for the trial will be under a continual review process with drafting started in Stage 2.	
		48. Costs involved in trial preparation activities before the trial goes live, including changes required in different premises pre-trial (such as increased ventilation, relocation of boilers and ancillaries etc.)	For all questions in this section the selection of Whitby with its diverse domestic housing stock and mix of non-Domestic users presents a diverse basis for cost analysis. The nature of the network is more complex and therefore allows for accurate housing cost metrics, but also a more realistic and representative network conversion costs. The resulting surveys in Stage 2 will allow estimates for costs to be made by property and then aggregated for averages or consideration by type, ownership, appliance count etc to aid cost estimation of wider projects. Costs will be developed further during Stage 2 & actuals reported in Stage 3.	
		49. Costs and time taken for processes of converting parts of the existing gas network to hydrogen, e.g.	For all questions in this section the selection of Whitby with its diverse domestic housing stock and mix of non-Domestic users presents a diverse basis for cost analysis. The nature of the network is more complex and therefore allows for accurate housing cost metrics, but also a more realistic and representative network conversion costs. The resulting surveys in Stage 2 will allow estimates for costs to be made by property and then aggregated for averages or consideration by type, ownership, appliance count etc to aid cost estimation of wider projects.	
		- pipe inspection	A plan for surveys will be completed in Stage 2, at the moment 5 days of camera surveys is proposed for assessing reuse and above ground surveys.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- pipe laying, including permissibility of pipes being buried and/or surface mounted	Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		- pipe joinery, especially flexible piping joining pipework to appliances		
		- purging and venting of pipes		
		- modification or replacement of pressure control equipment		
		- updating of instrumentation e.g. pressure transducers		
		- scope for conversion guidance/code of practice, including specification of suitable components and equipment	Tier 1 replacement works will be completed in 2022 as part of Iron Mains Replacement. Other assets will be assessed using the H21 components work. Further assessment and design will be carried out in stage 2.	
		50. Processes required and time taken to install and to fit new hydrogen-ready appliances (boilers, cookers, ovens and fires etc.) in households (per street/sector with x number of engineers, TBC)	Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		51. Time taken for different processes (individually and combined) to convert different premises (that remain within TBC scope), including diversity of:	For all questions in this section the selection of Whitby with its diverse domestic housing stock and mix of non-Domestic users presents a diverse basis for analysis of programme and activity time estimates. The nature of the network is more complex and a more realistic and representative network conversion effort and programme.	
		- Building type e. g. detached house, terraced house, flats, etc. (that remain within TBC scope)		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Number of storeys (that remain within TBC scope)	Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3. Details will be gathered of building types.	
		- Building condition and age		
		- Building size		
		- Building material (brick, timber etc)		
		- Level of insulation/ventilation		
		- Commercial versus domestic use		
		52. Time and cost for different trial processes/activities, including:		
		- Possible internal pipe replacements	Stage 1 includes a costing exercise and as the project progresses costs will be adjusted according to the design and survey inputs. This will continue through all stages of the project. Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		- Replacement and/or upgrade of old cast iron mains to line repairs		
		- Surveys and risk assessments of potential properties	Surveys will be completed in Stage 2 and 3 as required to develop the design and roll out programmes. Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		- Work on flues	Stage 1 includes a costing exercise and as the project progresses costs will be adjusted according to the design and survey inputs.	

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		- Ventilation requirements (e.g. pipe with mechanical fitting passing through confined spaces)	This will continue through all stages of the project. Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		- Ancillary works		
		53. Data on extent of coordination required by network and trial-delivery stakeholders for sectorisation/switching to hydrogen	The coordination planning by the network and stakeholders has started in stage 1 and will continue in stage 2 before implementation in stages 3 and 4.	
		54. Understanding costs associated with specific risk-reduction measures, such as:		
		- moving meters outside	Stage 1 includes a costing exercise and as the project progresses costs will be adjusted according to the design and survey inputs. This will continue through all stages of the project. Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	
		- making a property compliant with building regulations in terms of ventilation, etc.		
		- new Installation pipework		
		- repurposed gas pipework that may need replacing, resizing or repositioning		
		55. Costs involved in maintenance and repair of the pipes / hydrogen system and maintenance of pressure control equipment and instrumentation over the course of the trial	Costs for maintenance of the system will be assessed during Stages 2 and 3 once all design and case for safety work is complete.	
		56. Costs involved in maintenance and repair of the appliances over the course of the trial	Costs and time estimates will be developed and reported in Stage 2 and throughout the project stages. Actual cost and time data will be captured in Stage 3.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		57. Data on the tripping of the excess flow valve (EFV) during commissioning purging operations and the false tripping of the EFV, and subsequent time and cost of re-setting the EFV*	It is highly unlikely that there will be an operation trip of any EFV during the trial as it is expected follow similar event frequency as normal gas operations. The data will be recorded for analysis as part of Stage 3 & 4.	
		*The EFV is tamper proof & Only engineers/professionals can re-set the EFV in the smart meter		
	Design, Maintenance and Repair	58. Data on supplementary design and installation considerations needed for the network in a hydrogen system in addition to the current natural gas system (e.g. the design and installation of burners .)	BPD considerations, SR25 and data assessment for the reuse of assets will be carried out in stage 2 and assessed in each phase of the project. Component assessments will be carried out in stage 2. There will be no re-use as part of appliances or burners. This was a strict requirement of Hy4Heat. the wider evidence collation.	
		59. Maintenance and repair needed for the gas network in a hydrogen system, compared to the current natural gas system, including pipes, gas grid equipment, and excess flow valves.	Appliances and hydrogen assets will be inspected every 6 months. . Component assessments will be carried out in stage 2.	
		60. Maintenance needed for a hydrogen system compared to the current natural gas requirements on hydrogen appliances and meters	Any maintenance required will be recorded. Component assessments will be carried out in stage 2.	
		61. Repair regime for a hydrogen system compared to the current natural gas requirement on pipes	Any maintenance required will be recorded. Such additional maintenance is not expected in accord with standard hydrogen use in industry Component assessments will be carried out in stage 2.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		62. Servicing and maintenance schedule needed for a hydrogen system compared to the current natural gas requirement on pipes	Component assessments will be carried out in stage 2.	
		63. Repair regime and durability/longevity of hydrogen appliances and meters for a hydrogen system compared to the current natural gas requirement	During Stage 2 vendor engagement will continue and discussions held with potential service providers and OEM's. This will include service personnel training so a full understanding of the maintenance of equipment will be required and utilised in Stages 3 & 4. Data from operations and implementation will be recorded and lessons learned from the field reported.	
	Conversion & viability	64. Processes required for conversion of the grid network on a sectorisation basis, such as management of purge and re-fill	The process of conversion of the grid will continue from Stage 1 into Stage 2 where the system will be designed, and this will be shared with other GDNs for collaborative comment.	
		65. Reliability of existing property surveys and modelling to accurately assess and predict the amount of work needed to convert premises to hydrogen	Survey methods will be examined in Stage 2 and a new survey methodology provided for use with the survey works. A lesson's learned process will be used to incorporate implementation experience in Stages 2 – 4.	
		66. Validating and demonstrating which factors would preclude the ability for a premise to be converted to hydrogen heating/cooking relating to building regulations, including, but not limited to:	Survey methods will be examined in Stage 2 and a new survey methodology provided for use with the survey works. A lesson's learned process will be used to incorporate implementation experience in Stages 2 – 4.	
		- basements		
		- mechanical air con		
		- appliances in enclosed cupboards		

Cadent
Your Gas Network

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- level of ventilation		
		- running pipework within the building fabric, in inter-floor spaces and ceilings		
		67. Longevity and longer-term testing of hydrogen devices in different conditions, settings, and accelerate life tests (e.g. stress, pressure, extended time, temperature etc.) based on an Acceptable Quality Assurance sample size, including on:	The trial will collect operational and implementation data for analysis. We will also engage with component vendors to understand their experience in hydrogen. The project however does not propose a programme of long-term testing of components that are installed during the trial. Such test work should be carried out in a laboratory using accelerated aging techniques where appropriate.	
		- Appliances		
		- Ancillary devices		
		- Meters, including with different locations and ventilation levels		
		- The flow rate setting of excess flow trip located with a smart hydrogen meter		
		- Location of governors and gas meters inside of domestic and commercial premises		
		- Location of governors and gas meters outside of domestic and commercial premises		
		- Combination boilers and their increased energy input up to and above 50 kWh.		
		- Different materials		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Flow rates and pressure drop		
		- Carry-over of dust from the network		
		68. Extent to which the existing network can be repurposed to carry hydrogen, e.g., any parts that need complete replacement (valves, pipes, springs, filters etc.)	Tier 1 mains replacement works will be completed in 2022. Other assets will be assessed using the H21 components work. Further assessment and design will be carried out in stage 2 to identify any gaps.	
		69. Extent of replacement piping required, e.g., service pipes and internal pipework	The extent of replacement pipeline and piping will be designed in Stage 2 and implemented in Stage 3 once full surveys have taken place. Material data and construction records will form part of the project overall data.	
		70. Operational evidence on injecting and using hydrogen in the existing grid infrastructure, including evidence on:		
		- Flow rates and pressure drop	The trial will use operational data from Stage 4 to validate the models used to design the system in Stages 1 - 3.	
		- Leaks	Current asset data, including leakage rates, are considered post mains replacement works and monitored up to and during trial. Any surge in leaks or additional reports of leaks will be investigated.	
		- Ways of identifying leaks (e.g. hydrogen sniffers)	Considered further in Stage 2, it is expected new Hydrogen gas detectors will be used as the event of detection by smell. Lessons can be learnt from H100 gas detectors for hydrogen.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Velocities	Considered in Stages 2 & 3 after the Wider Impacts project outputs are available and what may be captured in the trial.	
		- Dust	Considered in Stages 2 & 3 after the Wider Impacts project outputs are available and what may be captured in the trial.	
		- Erosion	Considered in Stages 2 & 3 after the Wider Impacts project outputs are available and what may be captured in the trial.	
		- Noise	The project does not propose an active monitoring programme of the monitoring of system noise. Where operations and maintenance report noise issues this will be recorded, reported and then mitigated if required.	
		- functionalities of downstream of Emergency Control Valves (ECV)	Considered in Stages 2&3 after input from End User research programme.	
		- jointing techniques of pipework	Considered in Stages 2 & 3 incorporating the input from the H21 phase 2a&b work	
		- pressure absorption	Not considered within this trial, although operational data may be made available for assessment later.	
		- leakage rates	Current asset data, including leakage rates, are considered post mains replacement works and monitored up to and during the trial. As this will be a PE system, there is not expected to be any sudden increase in leakage rates anticipated during the trial.	
		- water vapor in open flues of hydrogen appliances and in rooms containing un-flued hydrogen appliances;	A process for reporting of observed issues raised in operation, Stage 4, will be created during Stage 2 and Stage 3. Reported issues will be collated with project data and lessons learned.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- increased pluming from hydrogen appliance terminals;	A process for reporting of observed issues raised in operation, Stage 4, will be created during Stage 2 and Stage 3. Reported issues will be collated with project data and lessons learned.	
		- purging parameters requirements for hydrogen and direct purging approach that could be developed for domestic installations	We understand there is some work being carried out regarding purging in Hy4Heat and we will examine that work. As for other areas procedures and standards will be developed and operational fed back recorded.	
		71. Data on impact of H2 purity on appliances and meters as it picks up debris / contaminates in existing piping.	The project does not propose an active monitoring programme of the impact of Hydrogen purity on appliances and meters. Cadent has been involved in projects (such as H2GV) that look at impurities in the network so this evidence will be brought forward. Where failure occurs, or issues reported during serving there will be a mechanism to capture that data and inform stakeholders.	
		72. Data on hydrogen leakage rates and trends over the course of the trial in different seasons and weather, throughout the hydrogen system to end-use.	Current asset data, including leakage rates, are considered post mains replacement works and monitored up to and during trial. This monitoring will identify early trends to be identified and mitigations to be implemented if required.	
		73. Carbon reduction data informing the carbon reduction options assessment for hydrogen, including the impact of leaks from the hydrogen system	The majority of carbon reduction data based on actual trial evidence will be available in Stage 4, when the hydrogen trial is being undertaken. This data can then be shared.	
		74. Carbon reduction data and carbon credentials of products, services and projects to inform standards for manufacturers and installers	The majority of carbon reduction data based on actual trial evidence will be available in Stage 4, when the hydrogen trial is being undertaken.	

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		75. Carbon reduction data informing the development of carbon intensity assessment methodologies for hydrogen pathways, hydrogen technologies and technology systems	As Q74. Real-time carbon reduction data will be available during the trial phase (Stage 4 of project). This data can then be used for carbon intensity assessment criteria. and shared with the relevant organisations.	
		76. Trials evidence informing procedures for the potential hydrogen conversion roll-out, including:		
		- Operating procedures for personnel	During the trial there will be routes to escalate findings from utilising network procedures which will inform new or updated procedures. For consumer experiences this will be via consumer engagement and feedback. For delivery this will be from post work reports and observations. The experience of sectorisation will form part of the evidence from Stage 2, as well as the deployment phases (Stage 3 &4).	
		- Procedures governing how networks are purged and vented		
		- The way that consumers are instructed and educated in the safe use of appliances as part of the Benchmark process		
		- Reviewing and tailoring Benchmark processes to include learnings on the safe use of appliances		
		- The way that gas engineers disconnect and reconnect the network		
		- Operational grid procedures, e.g. test of control systems, operational let-down between pressure tiers, hydraulic balancing		

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
Commercial and Regulatory	Commercial, regulatory and billing	77. Supply chain capability of delivering appliances and equipment on time	The capability for of the supply chain to deliver appliances and equipment will be examined in Stage 2 to build upon the engagement that has already been occurring in Stage 1. Stage 2 surveys will enable a procurement phase to be undertaken and seeking information on costs and delivery.	Annex F: WP4 Commercial and Regulatory Full Report
		78. Feasibility, effectiveness and accuracy of metering methods and meter types for hydrogen in both domestic and non-domestic premises	The provision of metering will be examined in Stage 2 as part of the supplier engagement, design, and procurement activities. Operational feedback accuracy information reliability will be fed back in Stage 4 at the end of the trial. The project is not proposing a specific study of this issue although data will be recorded and made available for further analysis.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		79. Regulatory changes required for large-scale grid conversion for town pilot and roll-out	Consideration of the regulatory changes required for a larger roll-out will be considered throughout the lifecycle of the project and any regulatory changes required for the project will be done with a view to the long-term implications. The evidence base developed will inform wider work on regulation across all GDNs. A number of potential modifications to the UNC have been identified to support the village trial. Beyond this, a number of regulatory issues that will require careful consideration for the town-scale pilot and roll-out have been noted. These relate to the issues associated with treating hydrogen as if it is interchangeable with natural gas in terms of the UNC daily balancing regime. As hydrogen volumes grow there is a risk that this causes market distortions and undermines the operational balancing regime. Regulatory changes for town-scale and wider-scale roll-out may therefore include exclusion of hydrogen flows from the UNC balancing regime for natural gas. In any case, the development of alternative arrangements to ensure security of supply on hydrogen networks will be required, including the identification and documentation of relevant industry roles and obligations. Consideration of appropriate network charges for customers on hydrogen networks will be a further area of focus in Stage 2 and implemented in Stage 3 and 4.	Annex F: WP4 Commercial and Regulatory Full Report
		80. Feasibility of the current regulatory tools in the delivery of trials wider roll-out (e.g. Major Hazard Regulatory Model)	The principles of the Major Hazard Regulatory Model will be applied to the trial project. Stage 2 will include hazard identification and risk assessment and measures to control risks.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		81. Legislative changes required for large-scale grid conversion for town pilot and roll-out	Legislative changes for the hydrogen town are to be considered throughout Stage 2 and subsequent stages. It will only be during stage 2 when detailed focus is given on legislative change that the implications for the town will become clear. BEIS has identified the potential need for legislative changes to provide DNs with the powers they need to facilitate the trials and to ensure that appropriate protections are in place for consumers. Since GS(M)R does not apply to hydrogen networks (although the GS(M)R approach to safety is to be followed), changes would be needed for it to regulate the specification of gas composition for hydrogen. The need for additional legislative changes for the hydrogen town are to be considered throughout Stage 2 and subsequent stages.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		82. Policy changes required for large-scale grid conversion for town pilot and roll-out	A supportive policy environment will be essential for the successful implementation of the town pilots and wider-scale roll-out. While hydrogen will be more costly to produce than natural gas in the near to medium-term, it will be necessary to ensure that customers on hydrogen trial networks pay a price that is no more than natural gas price. This will require financial support for hydrogen producers to be compensated for the difference between the cost of hydrogen production and the price they are able to obtain for supply of hydrogen to the networks, e.g through continuation of mechanisms such as CfDs. Funding for continued research and development will also be required for continued progress on the understanding and overcoming technical challenges associated with network conversion and to develop technologies for lower cost hydrogen production, including both 'blue' and 'green' production technologies. Further development of UK strategy and policy on heat decarbonisation, including regarding the role of hydrogen alongside other decarbonisation options, will also be important to create the conditions necessary for private investment in the hydrogen for heating supply chain.	Annex F: WP4 Commercial and Regulatory Full Report
		83. Assessment of current standards provision and potential standardization gaps relating to regulation and legislation (including formal, industry-driven, supranational, international, standards from other jurisdictions)	Assessment of current standards and identification of potential gaps will be ongoing through the hydrogen village trial and later phases of the hydrogen project, as well as the ongoing work by industry and government, for example initiatives such as Hy4Heat (which has considered hydrogen purity specifications, for example). The project will engage with industry processes to identify and define modified or new standards and will keep up-to-date with developing international standards, engaging where appropriate.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		84. Feasibility and effectiveness of new billing methodologies for hydrogen	At the present time, work is ongoing between Xoserve and industry to develop options for hydrogen billing methodologies. The current favoured approach for the Neighbourhood trial is the use of meter Multiplication Factors (MFs) to correct for the difference between natural gas and hydrogen CV. These MFs are already present in meter data flows but are set to 1 for domestic meters. While the MF approach is expected to be feasible for the neighbourhood trial and may still be workable for the Village trial, there is concern that it will no longer be appropriate as the scale of deployment increases, particularly as different types of customers and larger users become connected to hydrogen. These customers may already have MFs set to values other than 1 and there is a concern that the requirement to set different MFs for different customer types may become administratively burdensome and prone to error. Hence, work is expected to continue during phases 2 and 3 to identify billing methodologies for hydrogen that will be more sustainable as hydrogen demand grows and multiple different types of customer convert to hydrogen (potentially involving direct application of the correct CV for hydrogen to the metered volumes).	Annex F: WP4 Commercial and Regulatory Full Report
	Training and skills	85. Data on skilled workforce requirements in a roll-out of hydrogen heating, e.g. number of engineers and installers	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce requirements will be further defined during Stages 2 and 3. Work within the project and with service provider stakeholders is ongoing. As skills needs develop there will be a mechanism to report on the data for skills and gaps for further analysis and mitigation measures. This will be for installation and operational/maintenance/service personnel.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		86. Data on the extent to which skill gaps may exist in the market and on what basis they should be addressed	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce requirements will be further defined during Stages 2 and 3. Work within the project and with service provider stakeholders is ongoing. As skills needs develop there will be a mechanism to report on the data for skills and gaps for further analysis and mitigation measures. This will be for installation and operational/maintenance/service personnel.	Annex F: WP4 Commercial and Regulatory Full Report
		87. Data feeding into refinement of the hydrogen heating training scheme, sufficiency of standards and guidance for workforce, and manufacturers product training	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce training requirements will be further defined during Stages 2 and 3. The project will provide standards and working practices relevant to the trial. These will be available for future standards and guidance work. The feedback from installation and operations/maintenance/servicing will be collated for assessment, but no specific manufacturers product training will be adjusted, this has to be provided by the OEM's in the first instant and modification following feedback is outside with this project.	Annex F: WP4 Commercial and Regulatory Full Report
		88. Understanding capability and agility of new workforce (i.e. will the same engineers expected to do a wide range of tasks relating to conversion) and how does this impact the time taken to convert premises	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce training requirements will be further defined during Stages 2 and 3. Work within the project and with service provider stakeholders is ongoing. As skills needs develop there will be a mechanism to report on the data for skills and gaps for further analysis and mitigation measures. This will be for installation and operational/maintenance/service personnel.	Annex F: WP4 Commercial and Regulatory Full Report
		89. Workforce attitudes and behaviours on a hydrogen system in comparison to the natural gas system, including: - Type of work required	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce training requirements will be further defined during Stages 2 and 3. Work within the project and with service provide stakeholders is ongoing. As skills needs develop and the workforce is engaged, their behaviours will be used to develop training programmes, with a mechanism to report	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		- Level of repairs, maintenance, and servicing needed	on the data for further analysis and mitigation measures. This will be for installation and operational/maintenance/service personnel.	
		90. Information on the type and number of necessary certifications and training for skilled professionals and the workforce, as required by Government regulation, training laws, and by organisation/s such as the Existing Gas Safe Register	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce training requirements will be further defined during Stages 2 and 3. Work within the project and with service provider stakeholders is ongoing. As skills needs develop there will be a mechanism to report on the data for skills and gaps for further analysis and mitigation measures. This will be for installation and operational/maintenance/service personnel.	Annex F: WP4 Commercial and Regulatory Full Report
		91. Demonstrate that installers follow training requirements relating to the design of natural gas services installations in domestic and commercial properties i.e. Gas safety regulation by CIBSE	The potential workforce needs have been considered in the ongoing work in Stage 1. Workforce training requirements will be further defined and applied during Stages 2 and 3. The installation and service works will be monitored in Stage 3 and 4 as per current quality assurance regimes. Data collected from the assurance checks will be reported for further analysis.	Annex F: WP4 Commercial and Regulatory Full Report
	Risks and mitigations	92. Lessons learned on effectiveness of mitigations proposed for known risks to refine risk assessments	As hydrogen trials or evidence projects gather evidence on the effectiveness of mitigations, or previously unidentified risks emerge, the learnings will be incorporated into appropriate deliverables and activities, such as QRAs and the project risk register, throughout Stage 2, 3 and 4 of the project. It is anticipated that a collaborative approach should be used by industry to agree the effectiveness of the mitigation measures.	Annex F: WP4 Commercial and Regulatory Full Report
		93. Mapping unknown risks that emerge within hydrogen heating trials into risk register	Stage 1 of the project has identified the current evidence gaps regarding risks and mitigations. The Project Risk Register is regularly reviewed, and additional risks added as they are identified. The project also takes in information from other hydrogen trials currently ongoing, which may also identify risks, which would be added to the project risk register.	Annex F: WP4 Commercial and Regulatory Full Report

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Evidence grouping	Evidence subset	Evidence strands	Response	Reference document
		94. Lessons learned on effectiveness of mitigations for emerging new risks to refine risk assessments	As hydrogen trials or evidence projects gather evidence on the effectiveness of mitigations, or previously unidentified risks emerge, the learnings can be incorporated into appropriate deliverables and activities, such as QRAs and the project risk register, throughout Stage 2, 3 and 4 of the project. It is anticipated that a collaborative approach should be used by industry to agree the effectiveness of the mitigation measures.	Annex F: WP4 Commercial and Regulatory Full Report

Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX C: Health Safety Executive (HSE) Safety Demonstration Consideration for Trials

The Health and Safety Executive (HSE) will be a key stakeholder in the approval process for progression to the trial phase of the project. The completed Safety Assurance Protocol provides information on how the issues raised by the HSE will be addressed by the project. The responses cover a number of key areas including system architecture, system suitability, risk assessment, control measures, capability and training, standards, and procedures plus considerations for a target operating model.

Cadent
Your Gas Network

Health Safety Executive (HSE) Safety Assurance Protocol: Hydrogen for Heat, Safety Demonstration Considerations for Trials

Trial consideration number	Previous ID	Activity	Description of work	Why it is needed	Related projects	Who might need to be involved	Applicable to all scale of trials?	Answered before trial?	Comments	WP 0	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6
System Architecture																
T1	2	Analysis of fundamental assumpt ons upon wh ch the success of the trial is based	High level descript on of the fundamental assumptions on which the success of the trial is based including demonstrat on of system capacity in terms of delivery of suff cient energy to customers.	Underlying assumpt ons for successful delivery of the trial need to be tested early including assumpt ons on system capacity, network location and storage quantities.		Demonstration by trial operator	Occupied trials only	Yes	Define the high level assumpt ons on successful delivery of the trial - collaborating w th H100 to understand the basis of a successful trial, will include take up of hydrogen by home owners, safe design and operation of network, acceptable risk profile, not commercially disadvantaging consumers. Clear roles and responsibil ties will also be defined for the trial to facilitate successful delivery of the trial.	X		X		X	X	X
									Define System Capac ty - based on predicted consumer take up, demand profile and system resilience. The project will develop a declared security of supply with approval by Ofgem which will feed into this analysis.		X	X	X			
									Define Network Locat on			X	X			X
									Define Storage Quant ties - as per system capacity. The project will develop a declared security of supply w th approval by Ofgem wh ch will feed into this analysis.		X		X			

T2	1	Detailed description of the proposed trial and trial network including all inputs and outputs	Detailed narrative to be prov ded on the extent of the proposed trial, what the network will consist of and how t will differ to a NG network, how many people will be affected and for what durat on.	A detailed understanding of the structure of the trial and trial network is required so that risks associated w th t can be understood and mitigated against where possible.		Demonstration by trial operator	Yes	Yes	To be defined by WP 1, 2, 3 & 5. A QRA to be developed alongside the design of the network. The QRA will consist of three elements, the gas treatment site (i.e. odourisat on / pressure reduction); the MP pipeline; the distribut on network including end use. The QRA will build on existing hydrogen modelling such as the CONIFER model wh ch has been developed by DNV for the H21 project. The QRA will inform the level of m tigat on required, and the impact various m tigat on measures would have on reducing the risk of the design. A risk reduct on workshop will be held w th the design, operat ons and safety teams. Noted that the upstream production QRA and safety case falls within the existing upstream offsite safety management requirements and will be modif cation to that documentat on.		X	X	X		X	
T3	12	Assessment as to the su tability of the trial area selected	Description of the site select on criteria for dentif cat on of trial areas, including any risk assessment undertaken to select an appropriate site.	Certain areas may lend themselves to being safer cho ces as locations for first trials e.g. areas with materials and components known to be in good condit on and w th no vulnerable populat ons could perhaps make sensible first locat ons.	NGN - H21 - Field Trial Designs SGN - H100 - 100% hydrogen s te selection	Demonstration by trial operator	No	No - for guidance only	A cond tion assessment of the network components, including audit of records and inspect on will occur in Phase 2 to ascertain condit on. Phase 2 will also include a survey of households wh ch will include asset data (meter locat on, internal pipe routing, internal pipe cond t on as well as dentifying vulnerable populations. Any rogue / novel elements will be dentified and understood such that they do not compromise the safety.			X	X		X	

T4	3	Analysis of safety impl cations to increase capac ty of system in trial area (if needed)	Should add t onal capac ty need to be built into the trial area network, either through increasing pressures, having larger diameter pipes or running parallel pipelines, then an assessment will need to be made on the safety implications of this.	There needs to be assurance that the system can satisfy the demand requirements and that these demands can be met safely.		Demonstration by trial operator	Yes	Yes	The demand requirements will be defined in the Stage 2 / FEED, including any requirements for reinforcement or increasing pressures. The Stage 2 QRA will also include some sensitivity analysis, such as increase in operating pressures, to support project risk assessment and mitigation measure decisions.			X			X	
T5	14	Clear characterisat on of existing natural gas system in terms of materials, cond tions and modes of failure (to feed into assessment of what might change with hydrogen)	An understanding is required of what materials are already in the trial system and their cond tion after years of serv ce, together w th how they fail to feed into an assessment of how they will respond under hydrogen.	This informat on is required to allow for a determination of how hydrogen may adversely affect existing parts of the trial network. This will identify if parts of the system need to be replaced, or remaining length of life that they have in them.		Demonstration by trial operator	Doesn't apply to new networks	Yes	A cond tion assessment of the network components, including audit of records and inspect on will occur in Phase 2 to ascertain condit on.			X			X	
T6	7	Assessment of system resilience and continuity of supply	Demonstration that, if there is a loss of pressure, then people can come back online safely alongs de an assessment of the likely frequency and mitigation of such events.	One of the main reasons for maintaining supply pressures on the NG system is to stop air getting into the distribut on system in the event of supply failure. This will be even more cr tical with hydrogen.		Demonstration by trial operator	Occupied trials only	Yes	Procedures review will be in tiated within Stage 2, which would include loss of pressure scenar os, response and safe reconnect on. System resilience and continu ty of supply designed to a level to minimise the frequency of such events. Low pressure cut off w thin network to maintain minimum pressures and prevent air ingress into the distribut on system. Should a loss of supply event occur the trial will have robust emergency response procedures in place to mitigate the effects, e.g. provision of alternative heating.		X	X	X		X	

T7	56	Demonstrat on that infrastructure is designed in accordance w th a suitable assessment of LUP zones and hazardous areas	Assessment of hazardous areas (and LUP zones if required) for all infrastructure associated with the trial	Due to w der flammability range and higher ign t on sens tiv ty, hazardous areas and equipment w thin them will need to change for hydrogen	SGN - LTS Futures - Feasibility of LTS HyTechn cal - Workstream 3 - Hazardous Area Assessment	Demonstration by trial operator	Yes	Yes	IGEM/SR/25 hydrogen supplement is currently in creation and should be available for Stage 2 of this project. The supplement can be applied to this project to assess the hazardous areas. LUP zones shall be calculated where required.						X	
System Suitability (Materials and Components)																	
T8	17	Ev dence as to the satisfactory performance of materials in the trial area when operating in a hydrogen environment for the durat on of the trial	Collate ev dence of the likely performance of materials found within the trial network when subjected to hydrogen to feed into an analysis of component suitability. The degradat on effects should consider the pressure and blend appropriate to each locat on in the network.	Assurance is required that materials used w thin the national system will be su table for use w th hydrogen. Some materials are known to suffer embr ttling effects when exposed to hydrogen. The degree to wh ch this happens is a key input into any assessment of component suitabil ty. Cons derat on should also be made of any remnant effects in the case that the trial area reverts back to NG serv ce	HyDeploy - HyDeploy 1 - Material effects of introducing hydrogen into the UK SGN - H100 - PE Materials and Fittings Cadent - HyDeploy - HyDeploy 2 Materials test programme (including lab testing distribut on materials up to 10 bar @ 100% hydrogen)	Demonstration by trial operator	Yes	Yes	Asset records have been reviewed in Stage 1 to identify the materials present in the trial area. Will draw on existing materials testing research already taken place by other hydrogen projects (e.g. H21 components work). Exit QRA - plan to look at remnant effects			X			X	

T9	4	Demonstrat on of the su tability of all components in the trial area for the durat on of operation	Demonstration is required that all materials and components w thin the trial area (whether new or repurposed) are not affected by hydrogen in such a way to adversely impact on the safety of the trial. Detailed knowledge of the materials present in the assets covered by the trial, their locat ons, grades, age and condit on is key to this.	All components need to be suitable for use taking account of both their funct onal performance and possible degradation when exposed to hydrogen gas. Materials in certain environments are known to suffer hydrogen degradat on/embrittle ment which may lead to potential premature failure of components; the degree to which this happens could have an impact on safe operation of the trial network as well as the need for monitoring and maintenance during the trial. Non-metallic materials need evaluation in terms of hydrogen compatibil ty and permeat on.	NGN - H21 - Phase 1b - WBS 4 Evaluat on and Interpretation Explosions in Enclosures NGN - H21 NIA - Components Part 1 NGN - H21 NIA - Components Part 2 NSIB - Proposed Project - Testing of old PE Pipe NGT - HyNTS - FutureGrid - Phase 1b Component Funct onal ty Testing at Spadeadam SGN - LTS Futures - Phase 2 Laboratory and Offline Testing BEIS - Hy4Heat - WP4b Ancillary System Components EI - Hy2006 - Asset Integr ty in repurposing existing natural gas infrastructure NGN-H21 Gas Facing assets materials programme (NIA): but not formally approved yet	Demonstration by trial operator	Yes	Yes	Asset records have been reviewed in Stage 1 to identify the materials present in the trial area. Will draw on existing materials testing research already taken place by other hydrogen projects (e.g. H21 components work).			X			X	
T10	60	Demonstrat on of suitabil ty of all instrumentat on & ancillary equipment to be used in trial area	Demonstration that all instruments and ancillary equipment to be used in the trial area are suitable in terms of their funct onal ty and safe to use in a hydrogen environment. This includes, amongst other things, survey dev ces, any fixed instrumentation (including existing gas detectors of any kind) and engineers' testing equipment.	The products of combust on are now different so different detectors may be needed and some existing gas detectors may be cross sensitive to hydrogen. New survey equipment may be needed to identify hydrogen leaks and this equipment will need to be demonstrated to be suitable and safe to use. Consideration will also need to be given to the continued identification of natural gas leaks if it is possible that natural gas will also be in the area of the trial.	SGN - H100 - Leak detection and instrumentat on	Demonstration by trial operator	Yes	Yes	Project will build on research from other hydrogen projects, including development of gas detection instrumentation for use by operatives. The cross sens tiv ty of CO monitors to hydrogen and providing suitable detect on in homes which may have a dual fuel set up shall also be considered. All process instrumentat on will be assessed for hydrogen compatibil ty and replaced as required. Once convers on of the area has been completed it is not ant cipated that natural gas will remain.			X			X	

T11	6	Demonstrat on of any overlapping safety considerations if running two networks in the trial area simultaneously	If there is a necessity to have parallel natural gas and hydrogen systems in place for the trial, an assessment is required of whether there are any safety implicat ons from having both systems in place.	It needs to be demonstrated that there are no adverse safety impl cations from having more than one system in place during the trial.		Demonstration by trial operator	Yes	Yes	The trial has no plans to simultaneously run two networks, however there will be a short duration of time during the conversion process where both natural gas and hydrogen networks are present within the trial locat on.						X	
T12	66	Demonstrat on that you are not going to overpressure the system	Demonstration that there are suitable controls in place wh ch ensure that the trial network cannot be over pressurised.	Pressure control on the network is a key factor in ts overall safety.		Demonstration by trial operator	Yes	Yes	The trial network design contains the usual pressure controls that are in place for a natural gas network design. The assets will be assessed for their su tability to run with hydrogen in terms of material compatibility and abil ty to safely and reliably control a different gas. Assets will be replaced where natural gas pressure control elements are not su table or suitably sized for hydrogen.			X			X	
T13	8	Demonstrat on that leakage losses are not a safety issue in the trial area	Analysis of permeat on losses and losses due to leakage on joints and components needs to be assessed to demonstrate that t will be below levels that would cause a safety concern.	Gas tightness is an important aspect of safe network operation.	NGN - H21 - Phase 1a Leakage Testing BEIS - Hy4Heat - WP7 Experimental Testing Lot 1 Comparison domest c leak rates hydrogen and natural gas H100 - Leakage testing of top-Ts with Radius H21 - NGN proposal to BEIS for future work on shrinkage	Demonstration by trial operator	Yes	Yes	T1`5			X	X	X	X	

T14	9	Safety assessment of production and storage facil ties associated with the trial	Demonstration of the safe design and management of any product on and storage facil ties needed as part of the trial.	Specif c cons derat on will need to be given to quantities of stored gas and any hazards that arise from this along w th the safe production and injection of gas into the network.		Demonstration by trial operator	Yes	Yes	The product on and storage that supports the HyNet Homes trial lies outs de of the scope of the project as the facil ties will be owned and operated by a third party. Maintaining safe product on is crucial to the security of supply to the HyNet Homes trial and as such arrangements to achieve this by the third party operator will be reviewed as part of the case for safety documentation. The product on facil ty is presently an upper tier COMAH s te and the current activities incorporate relevant safety expertise to manage the Hydrogen product on.		X			X	X	
T15	65	Demonstrat on that gas related PPE is suitable for use on the trial area	Demonstration that any PPE proposed to be used in the trial area is su table for use with hydrogen.	PPE prov des a last line of defence in the event of unsafe situations and needs to be f t for purpose.	NGN - H21 - Phase 2a - Suitability of Procedures - PPE	Demonstration by trial operator	Yes	Yes	The H21 project reviewed the suitability of PPE and made recommendations for the H21 trial, these will be used within the HyNet Homes trial. PPE requirements will be listed in trial operating procedures and the case for safety documentation.						X	

T16	30	Demonstrat on of process safety expertise for hydrogen production equipment	Specific consideration of the competency required to run any hydrogen generation and storage facil ties included in the trial area	Hydrogen process safety expertise is a specialist area		Demonstration by trial operator	Yes	Yes	The hydrogen product on equipment for the HyNet Homes trial lies outs de the scope of the project as the facil ties will be owned and operated by third party. Maintaining safe product on is crucial to the security of supply to the HyNet Homes trial and as such arrangements to achieve this, including demonstrat on of competency to safely operate the product on and storage facility, by the third party operator will be reviewed as part of the case for safety documentat on. The production facility is presently an upper tier COMAH s te and the current activ ties incorporate relevant safety expertise to manage the Hydrogen product on.		X				X	

Risk Assessment																	
T17	52	Robust demonstrat on of the risk in the trial area	Detailed cons derat on of the basis on wh ch a risk assessment will be made including considerations of societal v indiv dual risk, scope of the risk assessment and which elements of the system will be included, assessment of ALARP and/ or comparative behav our of natural gas and hydrogen.	Given 100% hydrogen networks fall outside of current gas safety regulat ons there needs to be agreement on the scope of the assessment and the benchmark of safety against which t is being assessed.	NGN - H21 Phase 1b - Part A, B, C, D, E Consequences and QRA NGN - H21 Phase 2c - Combined QRA Hy4Heat - WP1 - QRA SGN - H100 - Hydrogen characterist cs (QRA)	Demonstration by trial operator	Yes	Yes	The H21 project baseline is the H2 network (taking in to account mains replacement in 2032) vs NG network in 2020. A similar benchmark is proposed for HyNet Homes, H2 network (taking into account any remaining planned mains replacement) vs NG network in 2021. The risk assessment will consider the complete trial (within scope), network entry / pressure control, LP pipeline and the distribut on system and end use elements. The risk assessment process will be initiated in Stage 2 / FEED with available input data to establish the risk profile of the trial network. Where input data is not available, realistic but conservative assumptions shall be used. An ALARP workshop shall be held to understand and agree wh ch mitigation measures are required for the trial. The QRA will be updated in the later Stage 3 / EPC stage of the project, wh ch will account for more accurate design data and val date the m tigat on measures selected.							
T18	51	Justification that suitable hazard dentif cat on and risk assessment techniques have been used for different parts of the trial area	Description as to what type of risk is being calculated and why (e.g. individual, societal etc.) along with a narrative on how it has been calculated using suitable models.	There needs to be an understanding of what the risk requirements are and what measures of risk are going to be used.	SGN - LTS Futures - Experimental Design and Risk Analysis (HAZOP, HAZID, QRA repurposing trial LTS pipeline)	Demonstration by trial operator	Yes	Yes	See T17 answer above. In addition the hazards will be detailed via a HAZID in Phase 2 of the project, with stakeholder engagement from the supporting HyNet work packages and external parties. Throughout the lifecycle of the extended project, other activ ties that will support the assessment of risk shall be undertaken such as HAZOP, HAZCON and DSEAR assessments.	X	X	X	X		X	

T19	44	Clear demonstrat on of the hazards associated with the trial and their proposed management	Clear dentificat on of all hazards associated with running a hydrogen trial network and evidence of their proposed m tigat on as part of the trial	Robust identification of possible hazards will prov de a framework for the analysis and mitigat on of risks	NGN - H21 - Phase 1b - C ty Centre Qualitative Risk Analysis Hy4Heat - WP2 - IGEM Standards (reference standard) Hy4Heat - WP2 - Colourant SGN - H100 - Colourant in hydrogen	Demonstration by trial operator	Yes	Yes	A HAZID will be conducted w thin Stage 2 of the project, w th participat on from stakeholders across the project. This will include personnel that have experience from other relevant hydrogen project HAZID assessments (HyDeploy, H21, H100)	X	X	X	X		X	
T20	31	Specif c considerat on of potential for human error in the trial area	Demonstration that the risk of human error and the impl cations of human error have been analysed and minimised where possible	Human error needs to be considered as part of hazard identification	NGN - H21 - Phase 2a - Suitability of Procedures - Human Factors	Demonstration by trial operator	Yes	Yes	The potential for human error will be included in the HAZID and HAZOP assessments. The potential for human error, part cularly in relat on to procedures wh ch may change for hydrogen, will also be cons dered in the procedure review work.			X	X		X	
T21	36	Identif cat on and analysis of previous inc dent data and operat onal experience of relevance to the trial	Identify relevant experience from around the world specif c to the proposed trial that can be fed into risk assessment and safety management analysis in the proposed trial area. This would include a demonstrat on of relevant incidents and near misses and how these might be avo ded.	A good understanding of the current inc dents associated w th natural gas use is an important baseline for assessing any change associated w th using hydrogen.		Demonstration by trial operator	No	No - for guidance only	Experience from decades of operating the natural gas network has allowed detailed statist cal data to be collected. In addit on, DNV operates an investigation team that visits the scenes of most serious gas inc dents in order to help determine their causes and gather lessons learned. DNV also has access to data from gas networks outs de Great Br tain, and informat on that is not in the publ c domain. Inc dents involving hydrogen will be examined, but it is expected that the major ty of the input into this area will be based on experience with natural gas distribution networks, supported by the results of full scale test data from DNV's research facility at Spadeadam.						X	

T22	50	Ev dence that suitably robust and val dated models, including use of appropriate base data and assumpt ons, are used as part of any risk assessment	Clear demonstrat on that suitable data and assumptions have been used to val date models for hydrogen, or ev dence that existing models have been suitably val dated.	This is required to generate assurance in the models used in the risk assessment.	NGN - H21 Phase 1b - Part A, B, C, D, E Consequences and QRA BEIS - Hy4Heat - WP1 QRA Cadent - HyDeploy - HyDeploy 1 & HyDeploy 2 QRA (check for consistency in assumpt ons and use of same base data) H100 - SGN - Hydrogen characterist cs	Demonstration by trial operator	Yes	Yes	The s te QRA will be performed using the established risk assessment methodology embodied in DNV's FROST software. It is already capable of modelling pure hydrogen and hydrogen blends for a range of loss of containment scenarios. The QRAs of the MP pipe to the village, and the distribut on system around the village, will use hydrogen specif c modelling techn ques, ev dence and information, such as DNV's CONIFER risk assessment package, which can represent pure and blended hydrogen use in local distribution networks, as well as natural gas. In general, there is a good level of understanding of many aspects of buried hydrogen pipeline releases, based on historical experience with natural gas and hydrogen-specific methodology developed using full scale test data.						X	
T23	43	Assessment as to whether modes of failure for components in the trial area are the same as for natural gas (where appl cable) and that there are procedures in place to manage them	Demonstrate an understanding of the modes of failure that are applicable on the trial network and how these differ from natural gas.	An understanding is required of how things fail in order to prevent and m tigate risks associated w th failure.	NGN - H21 - Phase 2a - Suitability of Procedures & Network Operat ons	Demonstration by trial operator	Yes	Yes	There is currently no ev dence that different failure modes are experienced when operating a distribut on network with hydrogen. Supporting documentat on will be prov ded. If addit onal failure modes are dentified during the course of the project then they will be taken into account.						X	

T24	49	Derivat on of failure rates using appropriate methodologies to feed into risk assessment	Failure rates need to be derived for various parts of the trial network. These may differ from natural gas due to the different material responses under the different gases.	This feeds into the calculation of risk in the risk assessment.		Demonstration by trial operator	Yes	Yes	Failure rates are not expected to vary from those of natural gas systems at LP and MP pressures when operating a a distribut on network w th hydrogen. Supporting documentation will be provided. If increased failures rates are dentified during the course of the project then they will be taken into account.						X	
T25	38	Clear understanding of the leak scenarios and release rates to feed into comparative risk assessment w thin the trial area	Demonstrate an understanding of the type of leaks that are likely to occur in the trial network in terms of the size and nature of them.	Release rates affect the consequences that can occur following ign tion and form part of the risk assessment.	NGN - H21 - Phase 1a Leakage Testing BEIS - Hy4Heat - WP7 Experimental Testing Lot 1 Comparison domest c leak rates hydrogen and natural gas HyDeploy - NG Incident Analysis Report (review of histor cal natural gas inc dents held by HSE and DNV to dentify common features)	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences. This is supported by full scale test data from DNV's research facil ty at Spadeadam.						X	

T26	39	Clear understanding of dispers on of hydrogen outs de of buildings to feed into comparative risk assessment w thin the trial area	Demonstrate an understanding of how qu ckly hydrogen disperses outside, how hydrogen tracks below ground and how predict ons can be made of ground level flammable gas envelopes.	The rate of dispersion and tracking will affect any flammable clouds that can arise, which affects the consequences and who may be impacted by them.	NGN - H21 - Phase 1b - WBS 1 Evaluat on and Interpretation Part 1 dealised in-ground releases (allotments) & Part 2 realistic releases (gardens and houses) NGN - H21 - Phase 1b - WBS2 Evaluat on and Interpretation Fires and Dispersion in Open Air IGEM/SR/25 update for hydrogen led by HSE (Mat Ivings) and DNVGL H100 - SGN - Hydrogen characterist cs (below ground hydrogen dispers on) SGN - H100 - Dispers on / deflagration in confined spaces	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences, which includes dispers on of natural gas or hydrogen in open air and migration through soil or along tracking routes. This is supported by full scale test data from DNV's research facil ty at Spadeadam.						X	
T27	40	Clear understanding of accumulat on and dispers on of hydrogen within buildings to feed into comparative risk assessment w thin the trial area	Demonstrate an understanding of how hydrogen accumulates and disperses within buildings on the trial network, including the speed of the accumulation.	This affects the potential for unsafe s tuat ons, can impact on consequences and the level of harm that can be experienced by people, as well as the speed w th wh ch people can respond.	BEIS - Hy4Heat - WP7 Lot 2 Accumulat on (confined spaces) BEIS - Hy4Heat - WP7 Lot 3 Movement of Gas (2 storey building) Cadent - HyDeploy 2 - Accumulat on test programme (review for method to study gas behav our in multi room enclosures) H21 Phase 1B WBS1 Part 2 hydrogen accumulation in buildings HyHouse (some limitations) HSE Research Report FD/20/02 "Preliminary analysis of gas release and dispers on behav our relevant to the use of hydrogen in the natural gas distribution network" by [redacted] et al.	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences, which includes accumulation of natural gas or hydrogen within buildings (time to build up to flammable, likelihood of detect on by occupants etc.) This is supported by full scale test data from DNV's research facil ty at Spadeadam.						X	

T28	37	Clear understanding of ignition sources and ign tion probability w thin the trial area	Identif cation and evidence of ignition sources and probabilities for all realist c scenarios on the trial network. This should Include a comparison with natural gas.	An understanding of the source and probabil ty of ign tion is required to calculate the risk.	NGN - H21 - Phase 1b - WBS 3 Evaluat on and Interpretation Ignit on NGN - H21 - Phase 2a - Suitability of Procedures - Ign t on Hy4Heat - WP2 - Colourant (proxim ty of ignit on source to gas leak) BEIS - Hy4Heat - WP7 Lot 4 Ign t on Risk Cadent - HyDeploy 2 - Ign t on sensitiv ty desk study (review for supporting methodologies and data for comparing ignit on sensitiv ties)	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences, which includes the probability of ign tion outside and inside buildings. Models are available for natural gas and hydrogen. This is supported by full scale test data from DNV's research facil ty at Spadeadam.							
T29	41	Clear understanding of the thermal radiation em tted by hydrogen fires under network release scenarios within the trial area	Demonstrate an understanding of the amount of heat radiated from hydrogen fires and how this compares with natural gas fires. This will need to consider the range of pressures on the trial network.	The thermal radiat on affects the level of harm that people will experience as a result of hydrogen fires. It forms part of the risk assessment.	NGN - H21 - Phase 1b - WBS2 Evaluat on and Interpretation Fires and Dispersion in Open Air Publ cations on hydrogen jet fires by [redacted] (Air Products) http://dx.doi.org/10.1002/prs.11699, http://dx.doi.org/10.1002/prs.11867	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences, which includes the modelling of natural gas and hydrogen fires and the thermal radiation they produce. The effects of fires on people and structures can also be determined. This is supported by full scale test data from DNV's research facil ty at Spadeadam.							

T30	45	Clear understanding of the consequences associated with a release of hydrogen in the trial area	Demonstrate an understanding of all the consequences that are possible from a release of hydrogen in the trial area. This should include how buildings respond to explosions, as well as consequences of fires and explos ons more generally.	This informat on forms part of the risk assessment and prov des an ind cat on of how people may be harmed.	NGN - H21 - Phase 1b - WBS 4 Evaluat on and Interpretation Explosions in Enclosures SGN - H100 - Consequence Testing Phase 1 (comparison of methane and hydrogen explos ons) SGN - H100 - Consequence Testing Phase 3 (assessing overpressures of hydrogen) SGN - H100 - Dispers on / deflagration in confined spaces	Demonstration by trial operator	Yes	Yes	DNV has decades of experience performing risk assessments of distribut on systems. A methodology already exists that covers the range of possible leak scenarios and their consequences, which includes the effects of fires and explos ons on people, buildings and equipment. This is supported by full scale test data from DNV's research facil ty at Spadeadam.						X	
T31	68	Consideration of any other consequences of the change of gas in the trial area and proposed m tigat ons	Assessment of any wider consequences of the change to hydrogen wh ch may affect other areas of safety e.g. funct onal ty of fire detect on systems.	The introduct on of hydrogen into the trial area may affect more than just the gas network.		Demonstration by trial operator	Yes	Yes	DNV has experience w th var ous aspects of the potential change including training of personnel, effects on metering, use of odorant, use of colorant, function of gas detectors, effects of appliance operat on, and publ c percept on.						X	

Controls																	
T32	5	Demonstrat on of gas quality control in the trial area and any impl cat ons for straying outside of specif cat on	A summary of the specif cation and reasoning for the proposed quality of hydrogen gas to be distributed during the trial along with how this will be maintained and monitored over the duration of the trial.	The 'quality' of the hydrogen distributed in the trial area could have an affect on appliances and infrastructure. It needs to be demonstrated what specification of gas is needed to ensure safe distribut on and combust on and, if gas qual ty control is important, how this will be mon tored and controlled.	Hy4Heat - WP2 - Pur ty (min legal standard and justif cat on)	Demonstration by trial operator	Occupied trials only	Yes	The Hydrogen Gas Qual ty Specificat on as worked up by IGEM in IGEM/H/1 (Appendix 4) shall be used for the project. The safety case will cover the need to ensure that this specif cat on (or higher) is met, and how the design and operat on of the system prevents off spec gas being distributed.		X				X	
T33	55	Assessment of the visibility of hydrogen flames under different scenarios	Detailed assessment of the visibil ty of hydrogen flames under different scenar os and if this gives rise to any addit onal hazards wh ch need specif c design solut ons or procedures	Hydrogen flames are diff cult to see in bright environments and can be invisible in sunlight which may have impl cat ons for appliance design and emergency response	Hy4Heat - WP2 - Colourant SGN - H100 - Colourant in hydrogen	Demonstration by trial operator	Yes	Yes	The H100 project completed a Flame Visibil ty Risk Assessment, addressing the risk from a leak on the distribut on network igniting and not being visible to operators or the publ c. Should addit onal scenar os be identified in the HyNet HAZID, the H100 report would be extended to cover the add tional scenar os.						X	
T34	62	Confirmation that the trial area can be odourised and that this will maintain a suitable level of dentif cat on	Confirmation of the proposed odorant for the trial area and that this odorant will behave in a way such that t can be detected (i.e. allows detect on in a similar way to natural gas) and is recognisable to the publ c. Important considerations will be the link between detect on and LEL, odorant carry, chem cal compatibility and odorant loss into materials.	Adding odorant to gas and encouraging the publ c to respond to the smell is one of the main mechanisms for identifying leaks on the network.	Hy4Heat - WP2 - Odorant	Demonstration by trial operator	Yes	Yes	The H100 and H21 projects have reviewed Odorant use, and determined the same odorant as used for Natural Gas can be used for Hydrogen. The procedure review will include how odorant level is checked, and the frequency of conducting checks to ensure the gas can be detected and odorant loss is not an issue.			X			X	

T35	16	Understanding of what specific checks are needed to demonstrate safe installat on of any new components or appliances	Quality control plan for checking new installations prior to commiss oning the trial network	As there will be numerous changes to the network, including new appliances for all householders, a robust QA process will be needed to ensure the safety of new installat ons and avoid safety issues that might arise from poor workmanship	BEIS - Hy4Heat - WP3 BSi PAS4444 BEIS - Hy4Heat - WP10 Meters BEIS - Hy4Heat - Gu dance for design, installat on and maintenance of low pressure gas pipework for carrying hydrogen gas (BSi)	Demonstration by trial operator	Yes	Yes	The procedure review will include inspection and audit procedures. Increasing the level of QA and frequency of audit will be one of the control considerations to be determined during the duration of the trial.			X	X		X	
T36	64	Demonstrat on that existing m tigat on measures are still suitable, including emergency planning arrangements where appropriate	Assessment of the suitability of existing safety measures (e.g. depth of cover) for carry over to a hydrogen network.	Safety measures on the natural gas network have been used for years and have been shown to reduce risk, wh ch is reflected in lower failure rates for risk modelling. The assumpt on that these measures are still suitable and still lead to reduced failure rates needs to be demonstrated.		Demonstration by trial operator	Yes	Yes	The IGEM/TD/1, TD/3, TD/4 and TD/13 hydrogen supplement, which covers depth of cover is currently in development. Where recommendat ons are made in the supplements these shall be applied to the HyNet Design. DNV also conduct the Effectiveness of Safety Measures (ESM) work for the Pipeline Safety Group (PSG) wh ch compares the benefits of measures to prevent external interference damage to gas transmiss on pipelines. Methodologies used in that work (based on Fault Tree Analysis) could be used to demonstrate whether measures are still suitable.						X	

T37	63	Demonstrat on that any addit onal safety measures and mitigations proposed for the trial s te are suitable	Description of any addit onal safety measures to be installed on the trial network (wh ch differ from those already included in a natural gas network) along with an analysis of the suitability of these and an assessment that they do not lead to any unintended consequences.	Any add tional safety measures will need to be demonstrated to work, to reduce the risk as intended and not give rise to other unsafe situat ons.	NGN - H21 Phase 1b - Part E Consequences and QRA Hy4Heat - WP1 - QRA (m tigat on measures) SGN - H100 - Hydrogen excess flow valves	Demonstration by trial operator	Yes	Yes	The majority of the safety evidence required is common to any hydrogen village projects. For example, t is ant cipated that a collaborative approach should be used to assess the effectiveness of the m tigat on measures. Therefore, the project will build on existing safety projects and work with others to build a collective understanding of hydrogen safety.			X	X		X	
Capability and Training																		
T38	18	Demonstrat on of safe installat on & operat on of appliances and meters for the durat on of the trial	Demonstration that the materials used within appliances will perform as expected and not suffer unduly from premature failure. Also, a demonstrat on of how engineers will diagnose problems with appliances if they arise. Demonstration that appliances and meters are designed and installed to new appropriate standards for hydrogen operation wh ch consider things such as flame visibility, health check and dentificat on of unsafe appliances, operat on of safety dev ces, water product on and the safety of the overall installation.	Appliances need to be reliable and safe, and engineers need to understand how to diagnose problems w th them to ensure that they continue to operate in a safe manner. Due to the different properties of the gas new appliances and meters are likely to be needed for hydrogen combust on and measurement. These will need to be designed to new and accepted standards for safe design and operation.	NGN - H21 - Domestic Flow Meters NIA NGN - H21 - Domestic and Commercial Metering BEIS - Hy4Heat - WP3 BSi PAS4444 BEIS - Hy4Heat - WP4 Appliance Development Boilers, Cookers, Fires BEIS - Hy4Heat - WP5b Development of Commercial Appliances BEIS - Hy4Heat - WP10 Meters SGN - H100 - Consequence Testing Phase 2 (comparison of delayed ign tion consequences in hydrogen and methane appliances) SGN - H100 - Hydrogen metering and ancillary equipment	Demonstration by trial operator	Yes	Yes	All meters designed to appropriate standards and tested for 10 year life (battery and valve actuation). No industrial supply (only light commercial) in the selected village locat on, therefore no bespoke equipment needing to be considered. All appliances installed shall be new and certified.				X		X	

T39	29	Specif c training and competency assessment plan for trial area	A detailed training and competency plan will need to be prepared wh ch covers competency requirements for safety cr tical tasks, what training is needed, who will be responsible for training and competency assessment and how you ensure timely issue of tools, regulations and gu dance.	Well trained and competent indiv duals are the cornerstone to the safe management of a gas network.	Hy4Heat - WP2 - Competency Framework EI - Hy2001 - Development of competence skills and training for the trans tion to hydrogen	Demonstration by trial operator	Yes	Yes	A detailed training and competency plan shall be developed as part of the case for safety and the procedure review in Stage 2 and Stage 3 of the project. This will include safety crit cal task analysis. It is ant cipated that this will a collaborative piece of work with similar requirements to other similar trials. Training in Stage 2 to do the surveying - Gas Safe Register training - Stage 3	X			X		X	
T40	32	Wider awareness raising in trial area	A plan to raise awareness more widely w th people who might be working next to a hydrogen system during the trial, including consideration of other trades	There may be addit onal safety measures that other trades people will need to undertake when working in an area that uses hydrogen.		Demonstration by trial operator	Yes	Yes	Raising wider awareness will be covered in consumer engagement and the case for safety development. This will include parties such as emergency serv ces and other util ty operators.					X	X	
Standards and Procedures																	
T41	11	Descript on of the proposed convers on strategy for the trial area	Detailed description as to how the changeover in the trial area will occur, the nature and extent of new equipment that will be needed (including appliances) and how these will be changed over safely.	Add tional risks may arise during the changeover process and an understanding of what is proposed will enable the appropriate questions to be asked to assure safety.		Demonstration by trial operator	Yes	Yes	The project will consider an acceptable amount of time that consumers may be off the network and design a programme of conversion to accommodate this. The project is also cons dering whether hydrogen ready boilers can be installed ahead of time in Phase 2, to reduce the amount of time changeover may take.			X	X			

T42	13	Detailed trial network convers on management plan	Detailed convers on plan which describes how the conversion process in the trial area will be managed safely including a descript on of the skills and experience needed to safely manage the conversion process.	Add tional risks will arise during the convers on process which need to be identified and a management plan put in place to mitigate these.		Demonstration by trial operator	Yes	Yes	Strategic Planning are working on the conversion plans. The project has also engaged w th British Gas, w th the plan for them to complete convers on surveys and installat on work w thin the homes. Early competency dentif cat on and management, including creat on of training material and schedule will also be key to timely and successful conversion.			X	X		X	
T43	54	Appropriate procedures need to be in place for a trial	Demonstration that all standards and procedures to be used on the trial area are safe and appropriate for hydrogen gas.	Some existing procedures may become unsafe with hydrogen and need to be amended or completely re-wr tten. All procedures need to be considered including those downstream e.g. Meter Asset Managers.	NGN - H21 - Phase 1b - WB5 Operational Safety NGN - H21 - Phase 2 NIA - Procedures Review NGN - H21 - Phase 2a - Suitability of Procedures & Network Operat ons HyTechn cal - Workstream 2 - TD Supplements BEIS - Hy4Heat - WP7 Lot 1 Steer Energy Purging BEIS - Hy4Heat - Gu dance for design, installat on and maintenance of low pressure gas pipework for carrying hydrogen gas (BSi) SGN - H100 - Safety case and operational procedures Cadent - HyDeploy - HyDeploy 2 Procedures review for Winlaton (check for approach and basis of demonstrat on)	Demonstration by trial operator	Yes	Yes	Trial specif c procedures shall be produced which are adapted from existing natural gas procedures. They shall build on work developing operating procedures from the H21 and H100 projects, and the emerging IGEM Hydrogen Supplements.			X	X	X	X	
T44	25	Dutyholders need to be dentified who will have responsibil ty for safety during the trials	Dutyholders need to be identified who will have responsibility for safety during the trials.	Someone needs to have ultimate responsibil ty for safety as part of any system.		Industry HSE BEIS	Yes	Yes	A duty holder from w thin the Cadent organisat on will be identified and specified within the case for safety documentat on. Roles and responsibilities of other key personnel will also be documented.					X	X	

T45	15	Understanding of roles and responsibilities of different parties who have to work together to enable the trials to happen	Summary of roles and responsibilities regarding safety in the trial area	Clear defin tion of roles and responsibil ties is needed to ensure clarity in terms of who is responsible for what, and duties under the HSWA		Demonstration by trial operator	Yes	Yes	Roles and responsibilities of key personnel will be documented. A RACI will be developed in Stage 2 of the project to dentify resourcing and competency requirements for the roles.	X					X	
T46	10	Demonstrat on that a su table management of change process is being applied to the trial site	Description of any management of change process being applied to the trial locat on which will provide conf dence in asset management records.	Existing management of change processes exist which could prov de structure to the conversion process and added conf dence in the management of safety.		Demonstration by trial operator	Yes	Yes	Management of change is a key aspect of a robust safety management system. The existing Cadent Management of Change procedure shall be adopted for the trial project.						X	
T47	72	Detailed stakeholder management plan for trial area	Develop detailed stakeholder management plan for the trial, identifying all those who need to be engaged, to provide assurance in the proposed approach to the trial - this could include trade bodies, standards institutions, other projects	The w der the conf dence in the proposed trial, including peer review of its basis of safety, the greater the conf dence that nothing important has been missed.	BEIS - Hy4Heat - WP9 Commun ty Trial Prep SGN - H100 - Stakeholder engagement	Industry BEIS	No	No - for gu danc	The project Work Package 6 - Stakeholder Engagement is leading on work in this area. To date the project has collaborated w th many key stakeholders including trade bodies, government, environmental NGOs, standards inst tut ons with supporting letters obtained from key stakeholders	X	X	X	X	X	X	X
T48	42	Suitable procedures in place for maintenance and monitoring of the trial network	Detailed management and monitoring system for the trial area which is based on analysis of all degradat on mechanisms and new threats arising from hydrogen use.	It needs to be ensured that adequate procedures are in place for the operation and maintenance of the trial wh ch are based on known risks.	NGN - H21 - Phase 2 NIA - Procedures Review NGN - H21 - Phase 2a - Suitability of Procedures & Network Operat ons BEIS - Hy4Heat - Gu dance for design, installat on and maintenance of low pressure gas pipework for carrying hydrogen gas (BSi)	Demonstration by trial operator	Yes	Yes	Trial specif c procedures shall be produced which are adapted from existing natural gas procedures. They shall build on work developing operating procedures from the H21 and H100 projects, and the emerging IGEM Hydrogen Supplements.			X	X		X	

T49	27	Suitable rights of entry in place for planned maintenance, monitoring & emergency response	Ensure su table rights of entry are in place to enable conversion of the network for the trial along with ongoing management, maintenance and mon toring of the network and appliances. Consideration should be given to what happens if you can't access properties for conversion and as to whether powers under the existing Gas (Rights of Entry) Regulat ons will be suff cient.	Suitable access will need to be ensured, not only to convert properties, but also for ongoing maintenance and mon toring and in the event of emergencies. This includes access to properties and to location of plant for monitoring and maintenance activ ties		Home Off ce (and Devolved Administrat ons ?)	Yes	Yes	Entry requirements for installat on are considered separate to those required for emergency response. The skills and competency required are different for the two activ ties. The project will also need to understand the risk to the installer of forced entry. Still to work out the convers on strategy in terms of proposed rights of entry.				X	X	X	
T50	70	Appropriate commun cat ons plan for trial area to ensure unsafe practices are avo ded	Detailed commun cat ons plan, tailored to the local audience, needs to be developed and delivered to ensure those in the trial area have sufficient knowledge and awareness to behave appropriately and not to cause increased risks to themselves or others.	Publ c co-operat on and behav our will be a key component of the overall safety of the trial.	NGN - H21 - Phase 1 - Social Sciences NGN - H21 Phase 2c - Combined QRA NGN - HyDeploy - Hydrogen percept ons practices and possibilities in two UK commun ties	Demonstration by trial operator	Yes	Yes	Commun cat on campaign(s) for the trial area would recap on all areas of good consumer pract ce to maintain safety, i.e. not tampering w th pipework / ventilation, reporting a suspected gas escape, etc. It is anticipated that commun cat on campaigns will start in Stage 2 and continue through subsequent stages of the project.						X	X
T51	71	Management plan for those not taking part but still potentially affected by the trial to make sure they are not exposed to addit onal risk	Plan for those not directly participating in the trial including provis on of alternative methods of heating and cooking.	There are no regulat ons under which t is currently compulsory to take part in a trial.		Demonstration by trial operator	Yes	Yes	Consumers in the village locat on may opt not to take part in the hydrogen trial. The risk to these consumers, as local population, from the hydrogen network is included within the QRA. Addit onally, the QRA will look at the risk to consumers that change to alternative fuel(s), i.e. electrical fire risk.						X	

T52	34	Detailed incident plan for trial areas	Plans need to be in place to deal with rare or unexpected events such as reported gas escapes, loss of supply, ignited or unignited catastroph c leaks etc.	This is to try and ensure that any rare or unexpected events do not escalate to the point where they can cause harm to people.		Industry HSE BEIS	Yes	Yes	Broadly, from a consumer perspective, t is ant cipated the plans / instruct ons for a hydrogen inc dent would remain the same. A review of safety plans and procedures for hydrogen inc dents, including consumer reporting of inc dents, and response instructions back to consumers, is planned for Stage 2 of the project. In Stage 3, this will move to commun cat on of the plans w th consumers. IGEM are also planning a hydrogen supplement for SR/29 wh ch would inform this work.	X	X	X	X	X	X	
T53	26	Suitable emergency arrangements and cooperation need to be in place to be able to conduct trials	Detailed emergency plans to be drawn up for trial s tes with full cooperat on of all parties.	Replicat on will be needed of the robust natural gas emergency arrangements currently covered by GSMR and LA emergency plans. Suitable procedures and training will need to be in place at all levels and the public will need to know if they will be required to respond differently w thin the trial area in the event of an emergency.		Demonstration by trial operator	Yes	Yes	A review of safety plans and procedures for hydrogen incidents, including interact on w th emergency serv ces, is planned for Stage 2 of the project. In Stage 3, this will move to communication of the plans and holding drills to test and assess the plans ahead of hydrogen being introduced to the trial. Any learnings from the drill will be incorporated into the emergency procedures wh ch may be further improved, or add tional training requirements dentified.						X	
T54	24	Lessons learnt from trials which may affect future regulations need to be captured	Lessons learnt during trials should be used to inform reviews of regulations including non-safety specific regulations e.g. building regs.	The trials could prov de useful sources of informat on when reviewing regulations for a hydrogen network. There may also be implications for regulat ons other than those cons dered by HSE.	NGN - H21 - Phase 2b - Unoccupied Trials SGN - LTS Futures - Full Scale Live Trial BEIS - Hy4Heat - WP8 Unoccupied Trials / Demonstrat ons	Industry HSE BEIS	Yes	No - for guidance only	The project will record cr teria to assist the update of future regulat ons, i.e. ventilation rate A known issue at present is EPC Ratings that don't currently cover hydrogen as a fuel The project will adopt the latest standards as updates evolve					X	X	

T55	69	Observat ons on costs and disruption associated with the safe installat on of a hydrogen system to be gathered from trials	Data to be gathered from trials on the real cost of safe installation and maintenance of a hydrogen system	Cost can be a big inhibitor to safety behav our part cularly when t comes to household costs	NGN - H21 - Phase 2b - Unoccupied Trials BEIS - Hy4Heat - WP8 Unoccupied Trials / Demonstrat ons	Industry BEIS	No	No - for gu dand	Costs associated with m tigat on measures required for the trial will be costed into the trial. Considerations around the practicality of w der roll out shall be cons dered in workshops which review wh ch measures to adopt for the trial. Planned inspect ons every 6 months in the home as an addit onal data gathering exercise, which has been costed into the project.	X		X	X	X	X	
T56	33	Mechanism for collecting data on failure rates, inc dents and lessons learnt during trials	Methods need to be put in place to rigorously record data from the trials that can be used to inform future safety decis ons, val date models, etc.	This will provide data that can be used as part of future risk assessments, safety cases etc. and so aid in prov ding assurance of safety for the w der network.	NGN - H21 - Phase 2b - Unoccupied Trials SGN - LTS Futures - Full Scale Live Trial BEIS - Hy4Heat - WP8 Unoccupied Trials / Demonstrat ons	Industry HSE BEIS	Yes	Yes	A robust set of records shall be kept for the trial both in terms of the design of the trial, condition assessment of the assets, inspect on data and detailed records of any failures / inc dents. It is proposed that the methodology is standardised across all hydrogen trial projects.	X	X	X	X	X	X	
T57	20	Agreed approach on trial by trial basis for co-operat on on evidence shared with HSE for trials	Each trial will be required to prov de evidence to HSE that t will be operated safely. The format of this may vary for each trial e.g. a safety case approach may be appropriate in some cases but not all.	Ev dence is needed that the trial will be operated safely but the exact approach taken to sharing evidence w th HSE on a trial by trial basis needs to be agreed.		HSE Trial operator BEIS	Yes	Yes	It is proposed that regular meetings are held w th the HSE to demonstrate progress on in the trial design, gathering the supporting safety evidence, product on of safety assessments and development of risk assessment, culminating in the case for safety documentat on.	X					X	

Considerations for a target operating model																	
T58	21	Arrangements for a suitable level of inspection during trials	Identif cation of who will be responsible for inspection together with what level of inspection will be required.	To ensure an appropriate use of resources whilst also ensuring safety on the trials.		Industry HSE BEIS	Yes	Yes - HSE/ BEIS Target Operating Model	The project anticipates different inspection regimes for network vs home. Early output from the consumer research results indicate there is an expectat on for add tional inspect on (during the trial). Also inspect on can be used as a tool for obtaining add tional trial data Addit onally, there will be a thorough inspection of all the participating homes pr or to trial starting. During Stage 2 the project will also consider what could be automated / remotely monitored to facil tate appropriate use of resources. To be discussed with HSE	X				X	X	
T59	22	Arrangements for recovery of costs for HSE to support trials	Agreement on HSE resources and cost recovery to support trials	To pr or tise HSE resources in support of this work		HSE BEIS	Yes	Yes - HSE/ BEIS Target Operating Model	HSE have confirmed no costs to be included for stage 2.	X				X	X	
T60	23	Ensure suff cient and suitable resources for HSE to effectively regulate concurrent trials	A determinat on of whether there are suff cient, adequately trained staff w thin HSE to regulate trials.	HSE inspectors need to be adequately trained for a hydrogen environment and there need to be enough of them to ensure that the trials are undertaken safely.		HSE	Yes	Yes - HSE/ BEIS Target Operating Model	HSE issue - but project needs to prov de project schedule and engage during lifecycle.	X					X	
T61	74	HSE involvement in publ c commun cat ons during trials	Level of engagement required to be agreed			Note	Yes	Yes - HSE/ BEIS Target Operating Model	The project will liaise with HSE to dentify and coordinate communicat ons.							X

Overarching																	
T62	19	There is general acceptance that existing legislat on is suitable for trials but may need to be revisited if scale of trials change or addit onal reassurance is needed	For larger trials, work will be required to ensure that the existing legislation is suff cient to cover the safety aspects of the trial. For all trials, addit onal work may be required to provide assurance of safety for aspects that are not fully covered under existing legislation.	Assurance is required that the trial will be operated safely and that legislat on exists to hold people to account for their actions.		HSE	Yes	Yes	The project cons ders the trial to be suitable for regulation with existing legislation.	X				X	X	
Additional considerations																	
T63	73	Unlikely to be a considerat on for first trial areas	It is not thought any of these areas are likely to form part of the first trials; if they are then further safety considerations may be needed; Thermal cut off valves Transmiss on pipelines Pressure cycling for line pack Operating at pressures higher than the current pressure tiers RTP (reinforced thermo plast cs) Re-use of natural gas storage facil ties Novel materials Commercial and industrial premises Revision of GSIUR for commercial and industrial users High rise multi occupancy buildings (HRMOBs) Remote operat on of the network						The trial will cover commercial premises, although nothing of a large scale, they are representative of a village as per the requirements of the trial.							

Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX D: Project Plan

This Annex provides the project Gantt chart outlining our plan from Stage 2: Detailed Design to Stage 5: Exit Plan. This encompasses deliverables for each stage, as well as an indication of timeframes, key interdependencies, and project milestones. Critical activities which will need to commence in January 2022 to ensure that Stage 2 is completed by Q1 2023 have also been identified.

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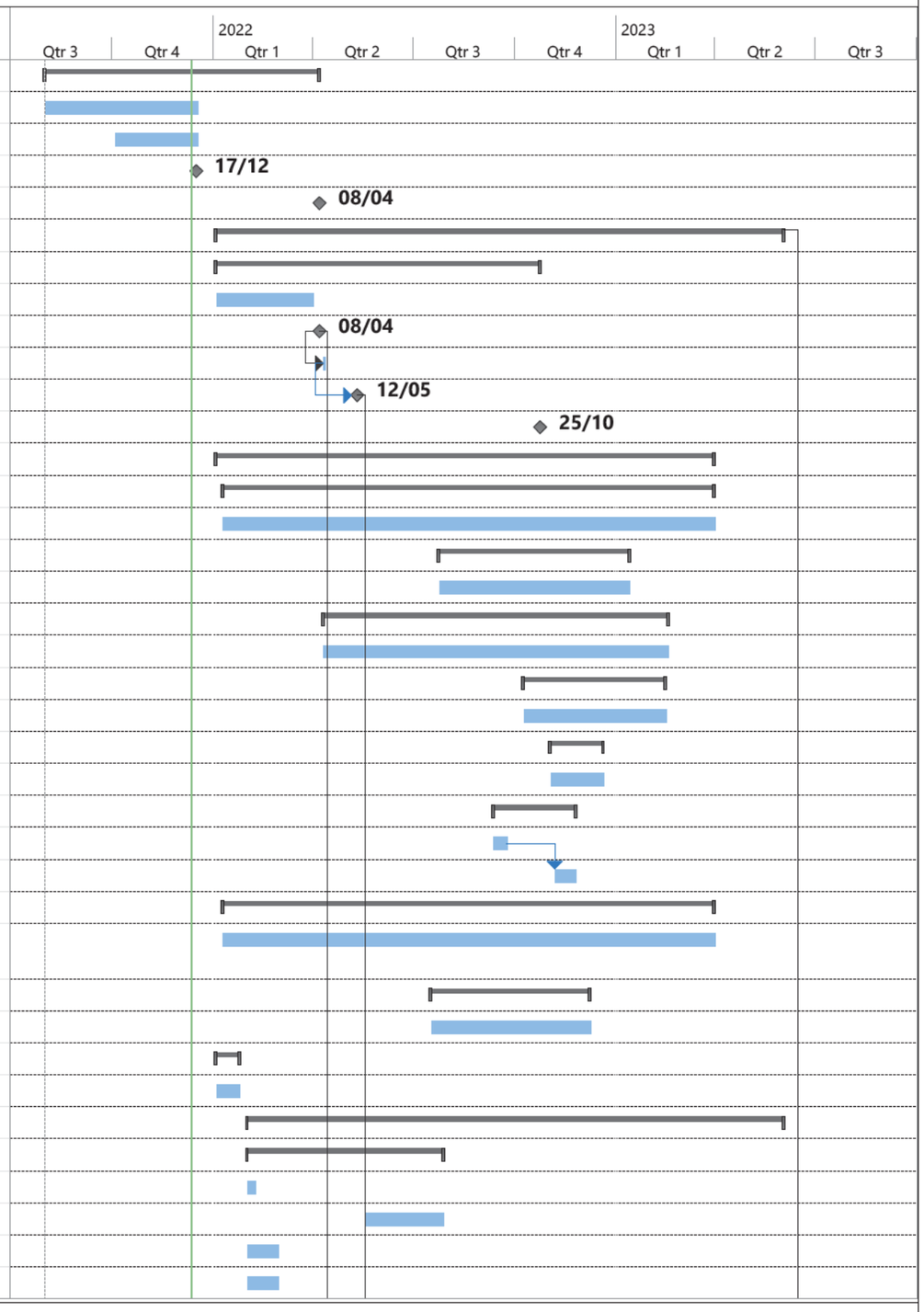
ID	Task Name	Duration	Start	Finish	Predecessors
1	**Stage 1 - Outline Design**	**176 days**	**Mon 02/08/21**	**Fri 08/04/22**	
2	All work packs (0 - 6)	100 days	Mon 02/08/21	Fri 17/12/21	
3	BEIS Proforma	55 days	Mon 04/10/21	Fri 17/12/21	
4	Stage 1 Complete	0 days	Fri 17/12/21	Fri 17/12/21	
5	BEIS Decision to Proceed	0 days	Fri 08/04/22	Fri 08/04/22	
6	**Stage 2 - Detailed Design**	**356 days**	**Tue 04/01/22**	**Fri 02/06/23**	
7	**Stage 2 Milestones**	**204 days**	**Tue 04/01/22**	**Tue 25/10/22**	
8	Stage 2 Pre-start (early activities)	64 days	Tue 04/01/22	Fri 01/04/22	
9	BEIS / OFGEM Village Funding Decision	0 days	Fri 08/04/22	Fri 08/04/22	
10	Stage 2 Full Start - Kick Off Meeting	1 day	Mon 11/04/22	Mon 11/04/22	9SS+1 day
11	Go-ahead Public Engagement	0 days	Thu 12/05/22	Thu 12/05/22	10SS+20 days
12	Ofgem Approval of Security of Supply	0 days	Tue 25/10/22	Tue 25/10/22	
13	**WP0**	**315 days**	**Tue 04/01/22**	**Fri 31/03/23**	
14	**Project Management**	**311 days**	**Mon 10/01/22**	**Fri 31/03/23**	
15	Project Management & WPK Coordination	311 days	Mon 10/01/22	Fri 31/03/23	
16	**Project CAPEX**	**121 days**	**Mon 25/07/22**	**Fri 13/01/23**	
17	Project CAPEX Update (input from all Work Packs)	121 days	Mon 25/07/22	Fri 13/01/23	
18	**Project Schedule**	**216 days**	**Mon 11/04/22**	**Fri 17/02/23**	
19	Project Schedule (input from all Work Packs)	216 days	Mon 11/04/22	Fri 17/02/23	
20	**Project Report**	**90 days**	**Mon 10/10/22**	**Wed 15/02/23**	
21	Summary Study Report (input from all Work Packs)	90 days	Mon 10/10/22	Wed 15/02/23	
22	**OFGEM Submission Report**	**34 days**	**Thu 03/11/22**	**Tue 20/12/22**	
23	OFGEM Report (Short Summary of Works)	34 days	Thu 03/11/22	Tue 20/12/22	
24	**Process Design Safety Reviews**	**55 days**	**Mon 12/09/22**	**Fri 25/11/22**	
25	HAZID	10 days	Mon 12/09/22	Fri 23/09/22	
26	HAZOP	15 days	Mon 07/11/22	Fri 25/11/22	25FS+30 days
27	**Project Risk Register**	**311 days**	**Mon 10/01/22**	**Fri 31/03/23**	
28	Develop and Maintain Project Risk Register, Mitigations, Actions	311 days	Mon 10/01/22	Fri 31/03/23	
29	**Full Evidence and Benefits Plan**	**103 days**	**Mon 18/07/22**	**Thu 08/12/22**	
30	Produce Evidence and Benefits (input from all work pac	103 days	Mon 18/07/22	Thu 08/12/22	
31	**Work Pack Providers**	**15 days**	**Tue 04/01/22**	**Mon 24/01/22**	
32	Appoint Work Pack Providers	15 days	Tue 04/01/22	Mon 24/01/22	
33	**WP1**	**336 days**	**Tue 01/02/22**	**Fri 02/06/23**	
34	**Pre-FEED Close-out**	**123 days**	**Tue 01/02/22**	**Thu 28/07/22**	
35	Detailed Demand Model Update & Forecast	5 days	Tue 01/02/22	Mon 07/02/22	
36	Rigorous Refinery Resilience Analysis	48 days	Fri 20/05/22	Thu 28/07/22	
37	IGC Connection Land Identification	20 days	Tue 01/02/22	Mon 28/02/22	
38	Projection of IGC Hydrogen Capacity	20 days	Tue 01/02/22	Mon 28/02/22	



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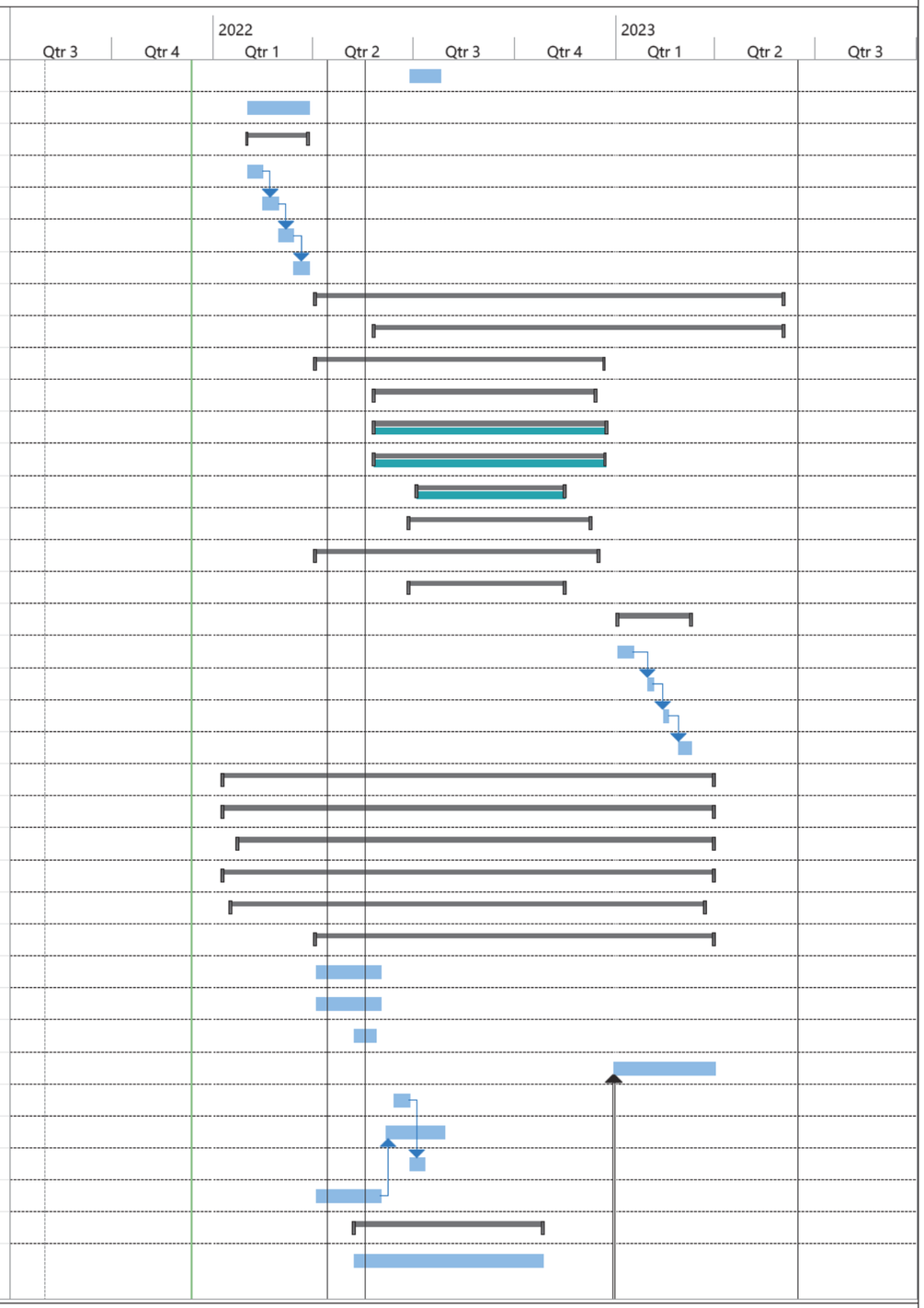
39	Dynamic Scenarios Resilience Analysis	20 days	Tue 28/06/22	Mon 25/07/22	
40	Truck Movement Acceptability Study	40 days	Tue 01/02/22	Mon 28/03/22	
41	**Tender Process for Engineering Advisor (EA)**	**40 days**	**Tue 01/02/22**	**Mon 28/03/22**	
42	Invitation to Tender (ITT)	10 days	Tue 01/02/22	Mon 14/02/22	
43	Bids	10 days	Tue 15/02/22	Mon 28/02/22	42
44	Vendor Selection	10 days	Tue 01/03/22	Mon 14/03/22	43
45	Contract Negotiations	10 days	Tue 15/03/22	Mon 28/03/22	44
46	**FEED**	**292 days**	**Mon 04/04/22**	**Fri 02/06/23**	
47	**Planning & Consenting**	**256 days**	**Fri 27/05/22**	**Fri 02/06/23**	
59	**Project Management & General Engineering**	182 days	**Mon 04/04/22**	**Wed 21/12/22**	
68	**PSA Package & Ancillaries**	**140 days**	**Fri 27/05/22**	**Tue 13/12/22**	
74	**Back-up Supplies**	**148 days**	**Fri 27/05/22**	**Fri 23/12/22**	
80	**Buffer Storage (pressurised Hydrogen bullets)**	**147 days**	**Fri 27/05/22**	**Thu 22/12/22**	
86	**Hydrogen Distribution Pipework**	**95 days**	**Tue 05/07/22**	**Tue 15/11/22**	
91	**Utilities & Services**	**118 days**	**Tue 28/06/22**	**Fri 09/12/22**	
93	**External Work Package - WP1 to WP2 AGI**	**179 days**	**Mon 04/04/22**	**Fri 16/12/22**	
95	**Industrial Hydrogen Gas Supply Connection**	**100 days**	**Tue 28/06/22**	**Tue 15/11/22**	
100	**Tender Process for PMC/EPC**	**49 days**	**Tue 03/01/23**	**Fri 10/03/23**	
101	Invitation to Tender (ITT)	10 days	Tue 03/01/23	Mon 16/01/23	
102	Bids	5 days	Mon 30/01/23	Fri 03/02/23	101
103	Vendor Selection	5 days	Mon 13/02/23	Fri 17/02/23	102
104	Contract Negotiations	10 days	Mon 27/02/23	Fri 10/03/23	103
105	**WP2**	**311 days**	**Mon 10/01/22**	**Fri 31/03/23**	
106	**Design**	**311 days**	**Mon 10/01/22**	**Fri 31/03/23**	
107	**Design AGI & Inlet (incl. independent approval)**	**301 days**	**Mon 24/01/22**	**Fri 31/03/23**	
110	**Design MP Pipeline - Easements**	**311 days**	**Mon 10/01/22**	**Fri 31/03/23**	
113	**Design Reinforcement**	**300 days**	**Mon 17/01/22**	**Thu 23/03/23**	
117	**System Assessments & Rating**	**251 days**	**Mon 04/04/22**	**Fri 31/03/23**	
118	Reuse of IP Asset - Cathodic Protection	40 days	Mon 04/04/22	Wed 01/06/22	
119	Reuse of MP Asset - Cathodic Protection	40 days	Mon 04/04/22	Wed 01/06/22	
120	Assess Multiple Occupancy Building (MOB)	15 days	Mon 09/05/22	Fri 27/05/22	
121	Assess Services - Surveys and Potential Trial Holes	65 days	Fri 30/12/22	Fri 31/03/23	133,143
122	Assess Assets - Further Surveys	10 days	Tue 14/06/22	Mon 27/06/22	
123	Existing Valve Checks for MP & LP	40 days	Mon 06/06/22	Fri 29/07/22	125
124	SR25 Checks for Hydrogen	10 days	Tue 28/06/22	Mon 11/07/22	122
125	Sectorisation Design Continuation	40 days	Mon 04/04/22	Wed 01/06/22	
126	**Tests (Collaborative Tasks)**	**120 days**	**Mon 09/05/22**	**Wed 26/10/22**	
127	Tests Swagelining	120 days	Mon 09/05/22	Wed 26/10/22	



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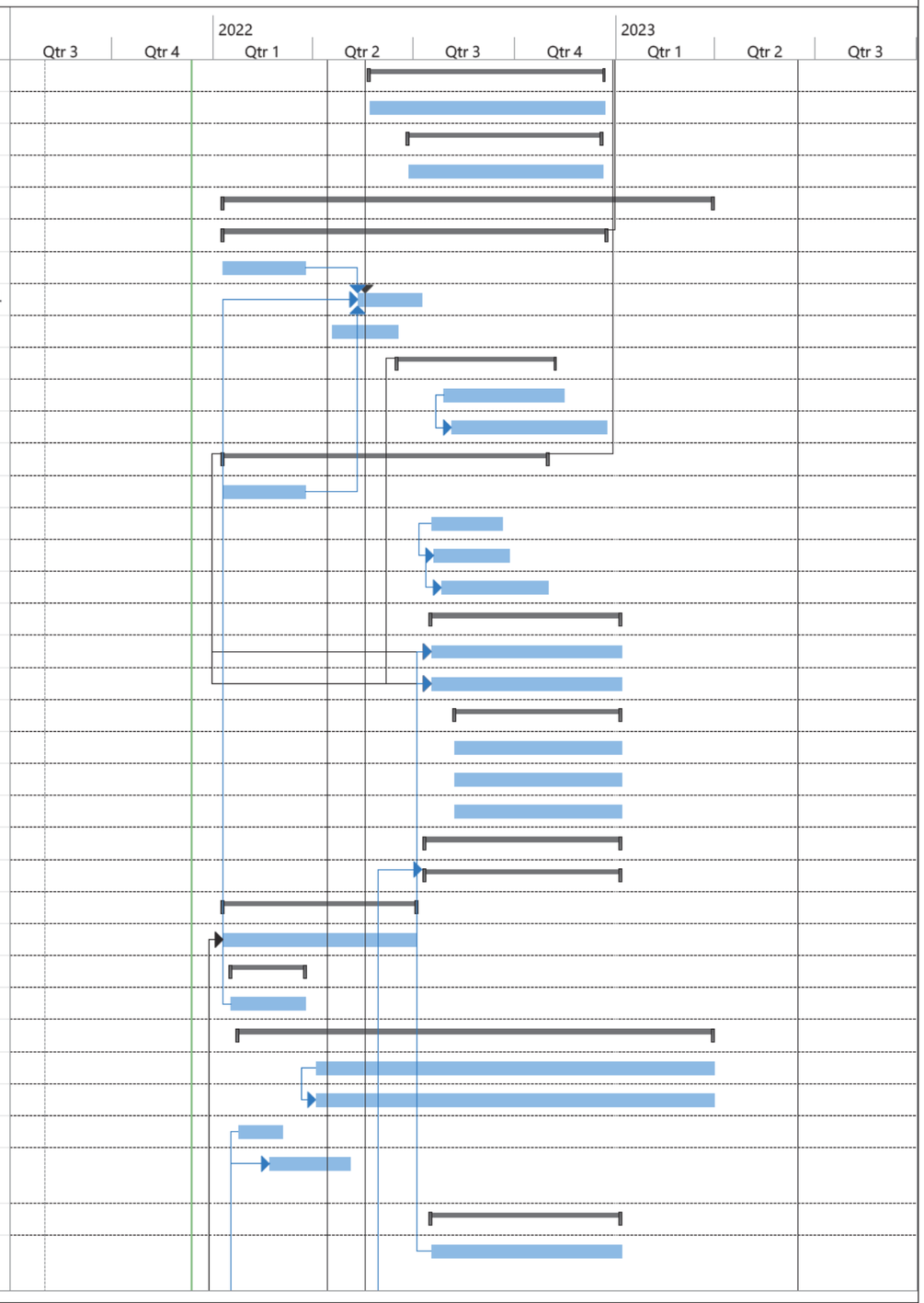
128	**Vendor Engagement**	**150 days**	**Mon 23/05/22**	**Wed 21/12/22**	
129	Vendor Discussion	150 days	Mon 23/05/22	Wed 21/12/22	
130	**Safety Case Liaison**	**125 days**	**Mon 27/06/22**	**Mon 19/12/22**	
131	Safety Case Liaison as required	125 days	Mon 27/06/22	Mon 19/12/22	
132	**WP3**	**310 days**	**Mon 10/01/22**	**Thu 30/03/23**	
133	**Domestic Surveys**	**244 days**	**Mon 10/01/22**	**Fri 23/12/22**	
134	Preparation of Dummy Surveys	55 days	Mon 10/01/22	Fri 25/03/22	
135	Screening Surveys / Establish Customer Interface	40 days	Thu 12/05/22	Fri 08/07/22	162SS+5 days,11,134,144
136	Screening review and full survey planning	40 days	Tue 19/04/22	Thu 16/06/22	
137	**Engagement Surveys (2000 Homes)**	**101 days**	**Fri 17/06/22**	**Mon 07/11/22**	
141	Review of domestic surveys	76 days	Fri 29/07/22	Mon 14/11/22	140SS+5 days
142	Consumer Acceptance of Individual Propositions	100 days	Fri 05/08/22	Fri 23/12/22	141SS+5 days
143	**Non-Domestic Surveys**	**205 days**	**Mon 10/01/22**	**Mon 31/10/22**	
144	Preparation of Dummy Surveys	55 days	Mon 10/01/22	Fri 25/03/22	
145	On-site survey	45 days	Mon 18/07/22	Mon 19/09/22	
146	Review of non-domestic surveys	48 days	Wed 20/07/22	Mon 26/09/22	145SS+2 days
147	Businesses Acceptance of Individual Propositions	68 days	Wed 27/07/22	Mon 31/10/22	146SS+5 days
148	**Bill of Materials Development**	**120 days**	**Mon 18/07/22**	**Thu 05/01/23**	
149	Gas system bill of materials development	120 days	Mon 18/07/22	Thu 05/01/23	137SS,143SS,169SS
150	Electrical system bill of materials development	120 days	Mon 18/07/22	Thu 05/01/23	137SS,143SS,169SS
151	**Strategy Development**	**105 days**	**Mon 08/08/22**	**Thu 05/01/23**	
152	Contracting strategy development	105 days	Mon 08/08/22	Thu 05/01/23	
153	Procurement strategy development	105 days	Mon 08/08/22	Thu 05/01/23	
154	Conversion strategy development	105 days	Mon 08/08/22	Thu 05/01/23	
155	**Safety Case Liaison**	**124 days**	**Tue 12/07/22**	**Thu 05/01/23**	
156	**Procedures development**	**124 days**	**Tue 12/07/22**	**Thu 05/01/23**	**206SS**
159	**Proposition Building and Refinement Liaison**	**121 days**	**Mon 10/01/22**	**Mon 04/07/22**	
160	Support WP6 to Develop Propositions	121 days	Mon 10/01/22	Mon 04/07/22	229SS
161	**Training**	**50 days**	**Mon 17/01/22**	**Fri 25/03/22**	
162	Customer Awareness / Survey Skills Training	50 days	Mon 17/01/22	Fri 25/03/22	
163	**Consumer Attitudes/Preferences Liaison/Demonstrator**	**300 days**	**Mon 24/01/22**	**Thu 30/03/23**	
164	Customer Relationship Management (British Gas)	250 days	Mon 04/04/22	Thu 30/03/23	
165	Liaison meetings	250 days	Mon 04/04/22	Thu 30/03/23	164SS
166	Source 'Demonstration' and 'Point of Contact Unit'	30 days	Mon 24/01/22	Fri 04/03/22	
167	Fit 'Demonstration' and 'Point of Contact Unit' with H2 Appliances	50 days	Mon 21/02/22	Wed 04/05/22	166SS+20 days
168	**Technical Support**	**120 days**	**Mon 18/07/22**	**Thu 05/01/23**	
169	Technical Support to Electrification Option (incl. SPEN liaison)	120 days	Mon 18/07/22	Thu 05/01/23	



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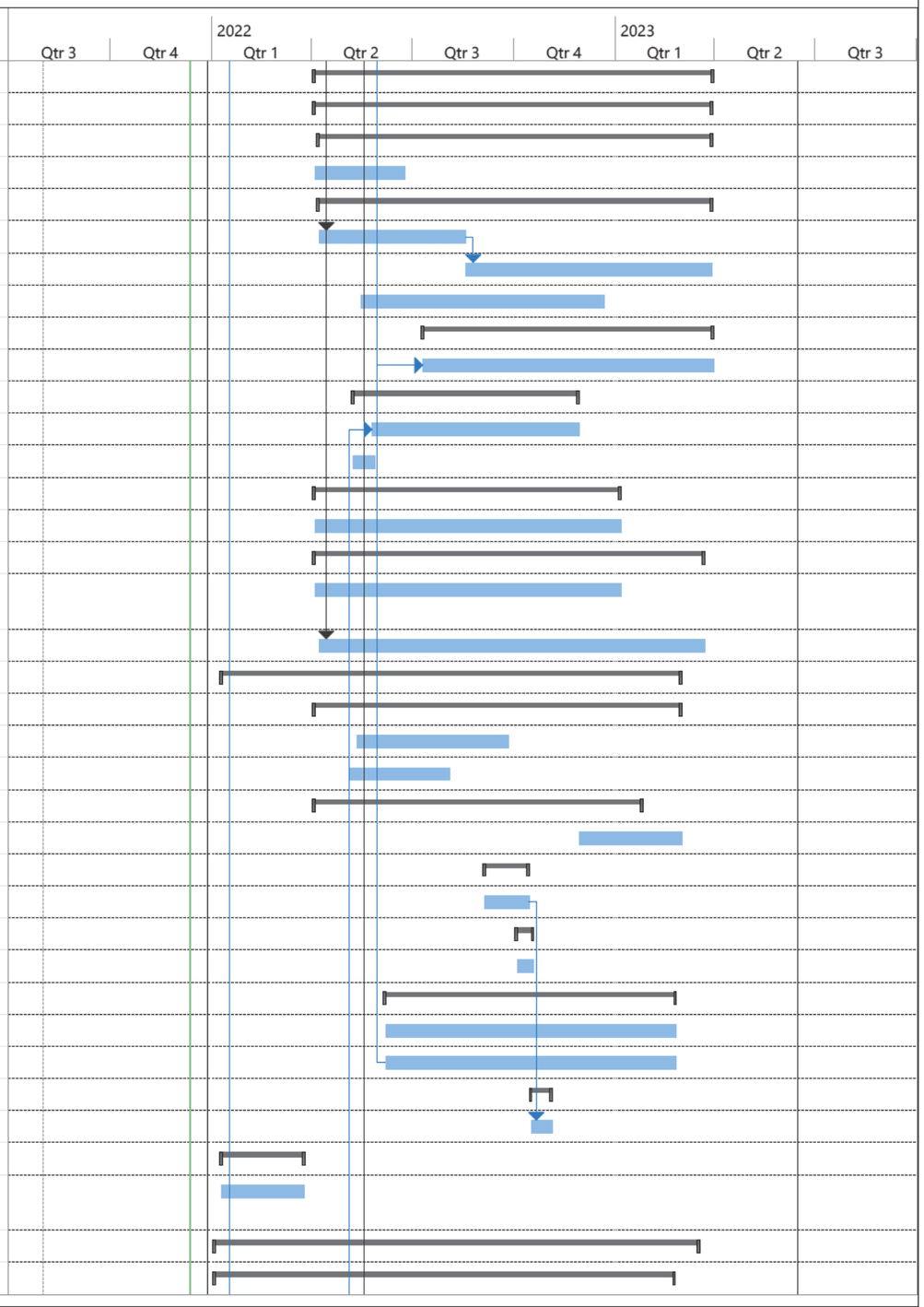
ID	Task Name	Duration	Start	Finish	Predecessors
170	**WP4**	**250 days**	**Mon 04/04/22**	**Thu 30/03/23**	
171	**System Process Changes**	**249 days**	**Mon 04/04/22**	**Wed 29/03/23**	
172	**Software Code Changes for New Billing System**	**245 days**	**Fri 08/04/22**	**Wed 29/03/23**	
177	Document Process Changes	55 days	Mon 04/04/22	Fri 24/06/22	
178	**Commercial Frameworks**	**245 days**	**Fri 08/04/22**	**Wed 29/03/23**	
179	Basis of Design (approved)	90 days	Fri 08/04/22	Thu 18/08/22	9
180	Network Code Changes	155 days	Fri 19/08/22	Wed 29/03/23	179
181	Legal Changes to Associated Industry Frameworks	155 days	Mon 16/05/22	Wed 21/12/22	
182	**Safety Case Liaison**	**185 days**	**Mon 11/07/22**	**Thu 30/03/23**	
183	Liaise with WP5 on licence changes	185 days	Mon 11/07/22	Thu 30/03/23	206SS
184	**Consumer Arrangement**	**143 days**	**Mon 09/05/22**	**Mon 28/11/22**	
185	Assess Implications for Consumers	130 days	Thu 26/05/22	Mon 28/11/22	234SS+10 days
186	Insurance Checks	15 days	Mon 09/05/22	Fri 27/05/22	
187	**Stakeholder Engagement**	**190 days**	**Mon 04/04/22**	**Thu 05/01/23**	
188	Engage with Gas Suppliers, Shippers, Others	190 days	Mon 04/04/22	Thu 05/01/23	
189	**Collaborative Framework**	**244 days**	**Mon 04/04/22**	**Wed 22/03/23**	
190	Monthly Meeting: Cadent, British Gas Services, National Grid Metering, Progressive Energy, Cheshire	190 days	Mon 04/04/22	Thu 05/01/23	
191	Governance Meetings	240 days	Fri 08/04/22	Wed 22/03/23	9
192	**WP5**	**289 days**	**Mon 10/01/22**	**Wed 01/03/23**	
193	**Quantitative Risk Assessment (QRA)**	**229 days**	**Mon 04/04/22**	**Wed 01/03/23**	
194	AGI Site QRA	95 days	Thu 12/05/22	Mon 26/09/22	108FS+30 days
195	Pipeline QRA	63 days	Thu 05/05/22	Wed 03/08/22	111SS+80 days
196	**Distribution QRA**	**204 days**	**Mon 04/04/22**	**Wed 25/01/23**	
199	Combined QRA / Reporting	63 days	Wed 30/11/22	Wed 01/03/23	
200	**Sensitivity Analysis**	**30 days**	**Mon 05/09/22**	**Fri 14/10/22**	
201	Sensitivity Analysis	30 days	Mon 05/09/22	Fri 14/10/22	
202	**Risk Management**	**11 days**	**Tue 04/10/22**	**Tue 18/10/22**	
203	Risk Reduction Workshop	11 days	Tue 04/10/22	Tue 18/10/22	
204	**Safety Case and Procedures Development**	**185 days**	**Tue 07/06/22**	**Fri 24/02/23**	
205	Procedures Development	185 days	Tue 07/06/22	Fri 24/02/23	
206	Safety Case Development	185 days	Tue 07/06/22	Fri 24/02/23	
207	**Additional Safety Studies**	**15 days**	**Mon 17/10/22**	**Fri 04/11/22**	
208	Other Safety Studies	15 days	Mon 17/10/22	Fri 04/11/22	201
209	**Work Pack Liaison**	**55 days**	**Mon 10/01/22**	**Fri 25/03/22**	
210	Project Meetings, Consumer Engagement, Survey Questions	55 days	Mon 10/01/22	Fri 25/03/22	
211	**WP6**	**305 days**	**Tue 04/01/22**	**Fri 17/03/23**	
212	**Engagement**	**289 days**	**Tue 04/01/22**	**Thu 23/02/23**	



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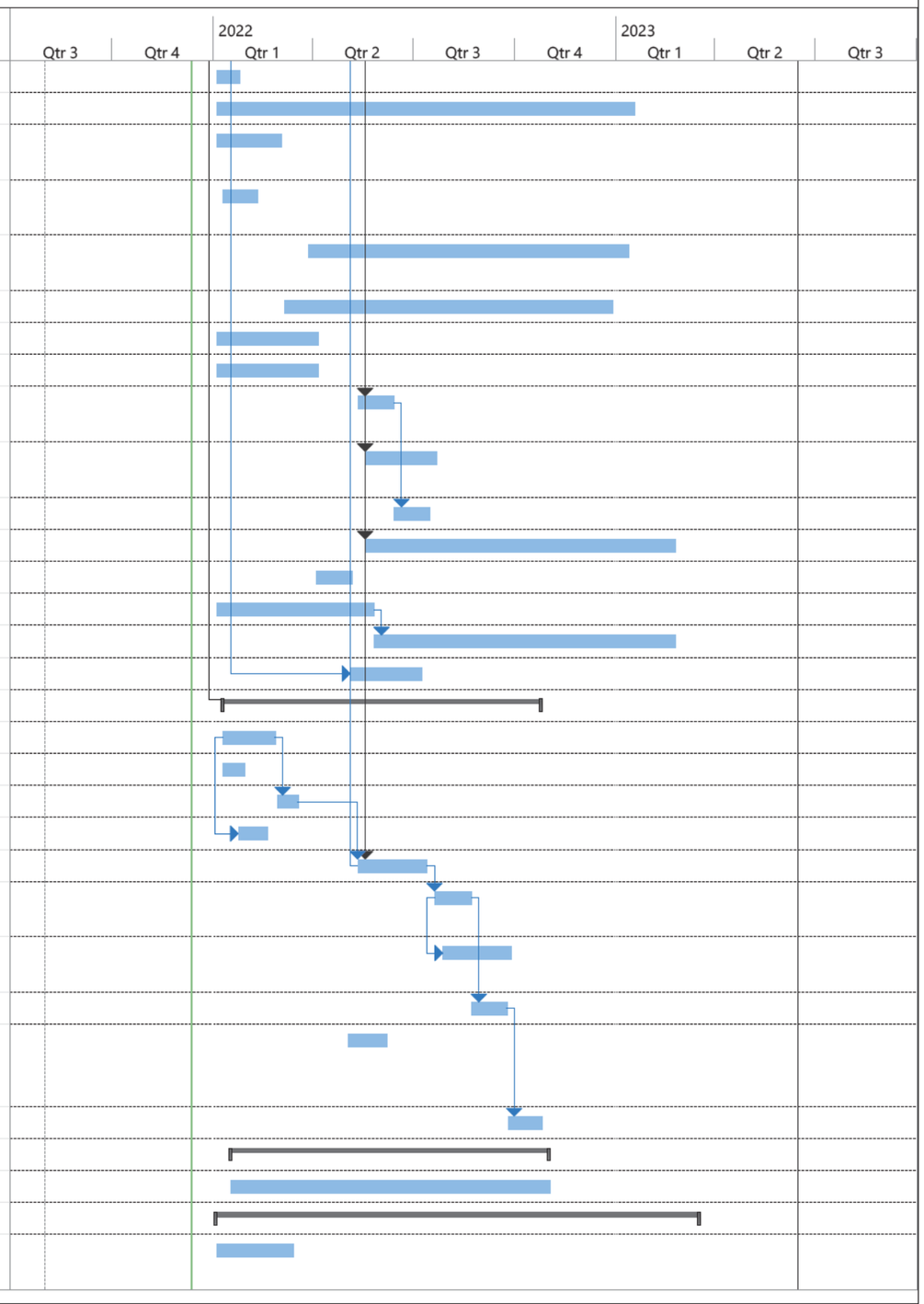
213	Revisit Stakeholder Mapping and Prioritise	15 days	Tue 04/01/22	Mon 24/01/22	
214	Continue Stakeholder Steering Group	262 days	Tue 04/01/22	Tue 17/01/23	
215	Set Up an Engagement Database to Track and Manage All Interactions	43 days	Tue 04/01/22	Thu 03/03/22	
216	Agree Information Flow and Reporting That Links to Programme Governance	23 days	Mon 10/01/22	Wed 09/02/22	
217	Commence Community Group Engagement Via Steering Group	200 days	Mon 28/03/22	Thu 12/01/23	
218	Recruit Community Advocates/Champions	205 days	Mon 07/03/22	Wed 28/12/22	
219	Build/Create A Brand	66 days	Tue 04/01/22	Tue 05/04/22	
220	Create Information Campaign (Collateral & Channels)	66 days	Tue 04/01/22	Tue 05/04/22	
221	Test Information Campaign Messages/ Collateral Via Focus Group	21 days	Thu 12/05/22	Mon 13/06/22	11
222	Create Virtual Engage Room and Link To CW&C Website and Cadent	44 days	Thu 19/05/22	Thu 21/07/22	11FS+5 days
223	Hold A Series of Kick Off Town Halls	24 days	Tue 14/06/22	Fri 15/07/22	221
224	Commence Resident and Business Engagement	195 days	Thu 19/05/22	Thu 23/02/23	11FS+5 days
225	Create Additional Collateral Around Surveys	22 days	Mon 04/04/22	Fri 06/05/22	
226	Media and Communications Strategy - Development	100 days	Tue 04/01/22	Thu 26/05/22	
227	Media and Communications Strategy - Implementation	189 days	Fri 27/05/22	Thu 23/02/23	226
228	Recruit Staff for 'Demonstrator' & 'Point of Contact Uni	45 days	Thu 05/05/22	Fri 08/07/22	166SS+70 days
229	**Proposition Building and Refinement**	**201 days**	**Mon 10/01/22**	**Tue 25/10/22**	
230	Understand Consumer Uptake Required for Trial	35 days	Mon 10/01/22	Fri 25/02/22	
231	Understand Cadent Offerings	15 days	Mon 10/01/22	Fri 28/01/22	
232	Build First Iteration of Propositions	15 days	Mon 28/02/22	Fri 18/03/22	230
233	Model Likely Consumer Uptake of Propositions	20 days	Mon 24/01/22	Fri 18/02/22	230SS+10 days
234	Build Second Iteration of Propositions	43 days	Thu 12/05/22	Wed 13/07/22	232,11
235	Test with Nationally Representative Group (Outside of Village)	23 days	Thu 21/07/22	Mon 22/08/22	234FS+5 days
236	Work on Propositions with Village Focus Groups (Residents & Businesses)	43 days	Thu 28/07/22	Tue 27/09/22	235SS+5 days
237	Build Third Iteration of Propositions	23 days	Tue 23/08/22	Fri 23/09/22	235
238	Targeted Research in Specific Groups with Low Uptake (Including Third Party Engagement to Gather Representative Views)	23 days	Tue 03/05/22	Mon 06/06/22	
239	Build Fourth Iteration of Propositions	22 days	Mon 26/09/22	Tue 25/10/22	237
240	**Customer Research**	**201 days**	**Mon 17/01/22**	**Tue 01/11/22**	
241	Conduct Customer Research - Perceptions and Attitude	201 days	Mon 17/01/22	Tue 01/11/22	
242	**Social Value**	**305 days**	**Tue 04/01/22**	**Fri 17/03/23**	
243	Stakeholder Mapping and Prioritising and Engagement Plan	50 days	Tue 04/01/22	Mon 14/03/22	



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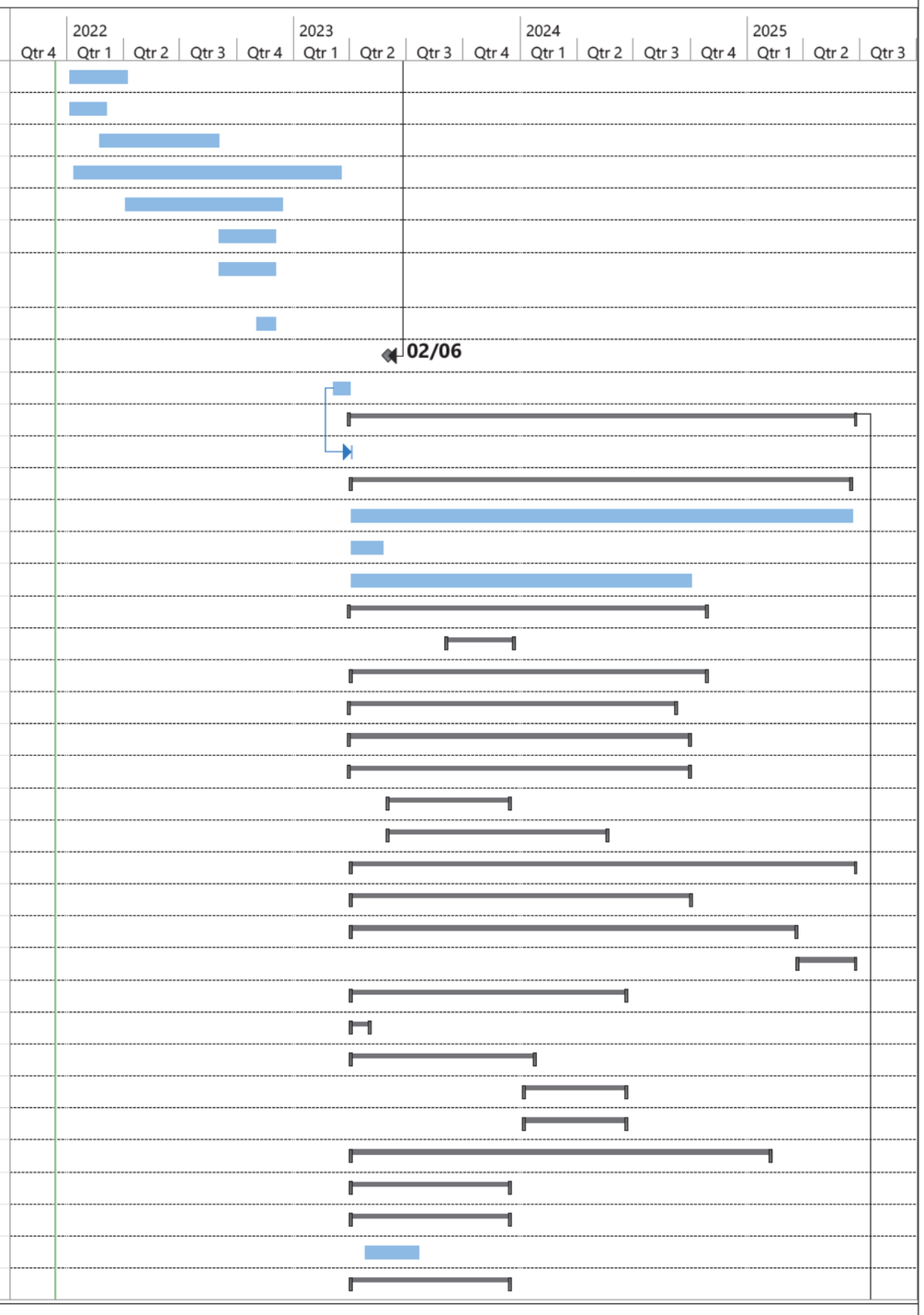
ID	Task Name	Duration	Start	Finish	Predecessors
244	Building Virtual Engagement Platform	66 days	Wed 05/01/22	Wed 06/04/22	
245	Produce Refine Social Value Framework	43 days	Tue 04/01/22	Thu 03/03/22	
246	Engage with Local Partners	133 days	Mon 21/02/22	Thu 01/09/22	
247	Program Governance (Stakeholder Steering Group)	301 days	Mon 10/01/22	Fri 17/03/23	
248	Develop Social Values Roll-out Approach	175 days	Mon 04/04/22	Mon 12/12/22	
249	Commence engagement with STEM (and schools)	66 days	Thu 01/09/22	Thu 01/12/22	
250	Develop Green Doctor/energy efficiency assessment programme	66 days	Thu 01/09/22	Thu 01/12/22	
251	Write Social Value Impact Report for Stage 2	23 days	Tue 01/11/22	Thu 01/12/22	
252	**Stage 2 Complete**	0 days	Fri 02/06/23	Fri 02/06/23	6FF
253	Stage Gate (Go/No-Go) - Project Sanction to Start Stage 3	20 days	Mon 06/03/23	Fri 31/03/23	
254	**Stage 3 - Build and Prepare**	**566 days**	**Fri 31/03/23**	**Tue 24/06/25**	
255	Kick Off Meeting	1 day	Mon 03/04/23	Mon 03/04/23	253SS
256	**WP0**	**560 days**	**Mon 03/04/23**	**Tue 17/06/25**	
257	Project Management & Coordination	560 days	Mon 03/04/23	Tue 17/06/25	
258	HAZID Update	35 days	Mon 03/04/23	Wed 24/05/23	
259	HAZOP Update	380 days	Mon 03/04/23	Wed 02/10/24	
260	**WP1**	**399 days**	**Fri 31/03/23**	**Mon 28/10/24**	
261	**Planning & Consents**	**80 days**	**Mon 04/09/23**	**Fri 22/12/23**	
264	**Detailed Design Project Management & General Enginee**	**398 days**	**Mon 03/04/23**	**Mon 28/10/24**	
270	**PSA Package & Ancillaries**	**363 days**	**Fri 31/03/23**	**Mon 09/09/24**	
274	**Back-up Supplies**	**379 days**	**Fri 31/03/23**	**Mon 30/09/24**	
278	**Buffer Storage (pressurised Hydrogen bullets)**	**379 days**	**Fri 31/03/23**	**Mon 30/09/24**	
282	**Hydrogen Distribution Pipework**	**140 days**	**Fri 02/06/23**	**Fri 15/12/23**	
285	**Utilities & Services**	**245 days**	**Fri 02/06/23**	**Mon 20/05/24**	
287	**WP2**	**565 days**	**Mon 03/04/23**	**Tue 24/06/25**	
288	**Infrastructure Build**	**380 days**	**Mon 03/04/23**	**Wed 02/10/24**	
290	**Laying New Infrastructure**	**500 days**	**Mon 03/04/23**	**Fri 21/03/25**	
294	**Infrastructure Prepare (Sectorisation)**	**65 days**	**Mon 24/03/25**	**Tue 24/06/25**	
296	**WP3**	**307 days**	**Mon 03/04/23**	**Thu 20/06/24**	
297	**Installation & Maintenance Services Agreement**	**20 days**	**Mon 03/04/23**	**Wed 03/05/23**	
299	**Equipment Procurement (start with Project Sanction)**	**205 days**	**Mon 03/04/23**	**Wed 24/01/24**	
303	**Training**	**115 days**	**Mon 08/01/24**	**Thu 20/06/24**	
305	**Pre-converting Homes**	**115 days**	**Mon 08/01/24**	**Thu 20/06/24**	
308	**WP4**	**470 days**	**Mon 03/04/23**	**Fri 07/02/25**	
309	**Implement System Process Changes**	**180 days**	**Mon 03/04/23**	**Fri 15/12/23**	
310	**Software Code Changes for New Billing System**	**180 days**	**Mon 03/04/23**	**Fri 15/12/23**	
313	Document Process Changes	60 days	Wed 26/04/23	Thu 20/07/23	311SS+15 days
314	**Implement Commercial Frameworks**	**180 days**	**Mon 03/04/23**	**Fri 15/12/23**	



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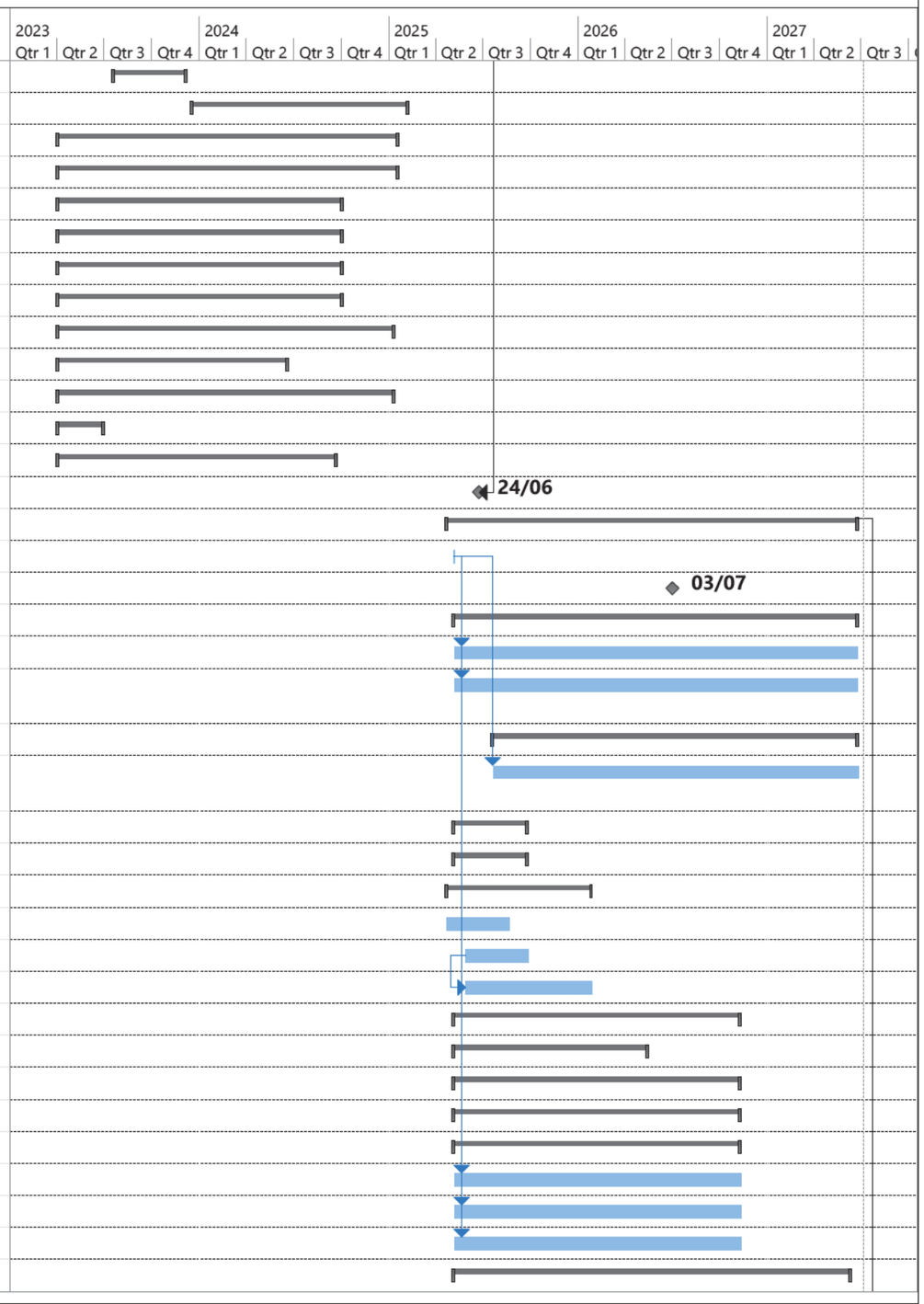
318	**Safety Case Liaison**	**100 days**	**Wed 19/07/23**	**Wed 06/12/23**	
320	**Implement Consumer Arrangement (Incl. Insurance Chec**	**290 days**	**Mon 18/12/23**	**Fri 07/02/25**	
323	**Stakeholder Engagement**	**455 days**	**Mon 03/04/23**	**Fri 17/01/25**	
325	**Collaborative Framework**	**455 days**	**Mon 03/04/23**	**Fri 17/01/25**	
327	**WP5**	**380 days**	**Mon 03/04/23**	**Wed 02/10/24**	
328	**Updates to Stage 2 Deliverables (QRA, Safety Case)**	**380 days**	**Mon 03/04/23**	**Wed 02/10/24**	
331	**Safety Studies**	**380 days**	**Mon 03/04/23**	**Wed 02/10/24**	
333	**Development of Procedures**	**380 days**	**Mon 03/04/23**	**Wed 02/10/24**	
335	**WP6**	**450 days**	**Mon 03/04/23**	**Fri 10/01/25**	
336	**Engagement - Supporting the Preparations**	**306 days**	**Mon 03/04/23**	**Wed 19/06/24**	
341	**Proposition Finalisation and Communication**	**450 days**	**Mon 03/04/23**	**Fri 10/01/25**	
345	**Customer Research**	**60 days**	**Mon 03/04/23**	**Thu 29/06/23**	
347	**Social Value**	**372 days**	**Mon 03/04/23**	**Fri 20/09/24**	
354	**Stage 3 Complete**	0 days	Tue 24/06/25	Tue 24/06/25	254FF
355	**Stage 4 - Go Live and Operate**	**561 days**	**Tue 22/04/25**	**Fri 25/06/27**	
356	Kick Off Meeting	1 day	Tue 06/05/25	Tue 06/05/25	
357	Heat Policy Decision	0 days	Fri 03/07/26	Fri 03/07/26	
358	**WP0**	**550 days**	**Wed 07/05/25**	**Thu 24/06/27**	
359	Project Management & WPK Coordination	550 days	Wed 07/05/25	Thu 24/06/27	356
360	Trail Evidence Collection, Analysis and Reporting (input from all work packs)	550 days	Wed 07/05/25	Thu 24/06/27	356
361	**WP1**	**499 days**	**Mon 21/07/25**	**Fri 25/06/27**	
362	Operation and Maintenance of Hydrogen Production Facilities	499 days	Mon 21/07/25	Fri 25/06/27	356
363	**WP2**	**100 days**	**Wed 07/05/25**	**Thu 25/09/25**	
364	**Sectorisation**	**100 days**	**Wed 07/05/25**	**Thu 25/09/25**	
366	**WP3**	**198 days**	**Tue 22/04/25**	**Tue 27/01/26**	
367	Pre-installation Checks (200 consumers per week)	85 days	Tue 22/04/25	Wed 20/08/25	365SS-10 days
368	Installation (200 consumers per week)	85 days	Thu 29/05/25	Thu 25/09/25	365SS+15 days
369	Inspection & Servicing	173 days	Thu 29/05/25	Tue 27/01/26	368SS
370	**WP4**	**390 days**	**Wed 07/05/25**	**Tue 10/11/26**	
371	**New Billing System (Implementation, Check, Improve)**	**265 days**	**Wed 07/05/25**	**Fri 15/05/26**	
375	**Stakeholder Engagement**	**390 days**	**Wed 07/05/25**	**Tue 10/11/26**	
377	**Collaborative Framework**	**390 days**	**Wed 07/05/25**	**Tue 10/11/26**	
379	**WP5**	**390 days**	**Wed 07/05/25**	**Tue 10/11/26**	
380	Other Safety Studies inc Pre Start Up Review	390 days	Wed 07/05/25	**Tue 10/11/26**	356
381	Procedures for Trial	390 days	Wed 07/05/25	**Tue 10/11/26**	356
382	Safety Case Update	390 days	Wed 07/05/25	**Tue 10/11/26**	356
383	**WP6**	**540 days**	**Wed 07/05/25**	**Thu 10/06/27**	



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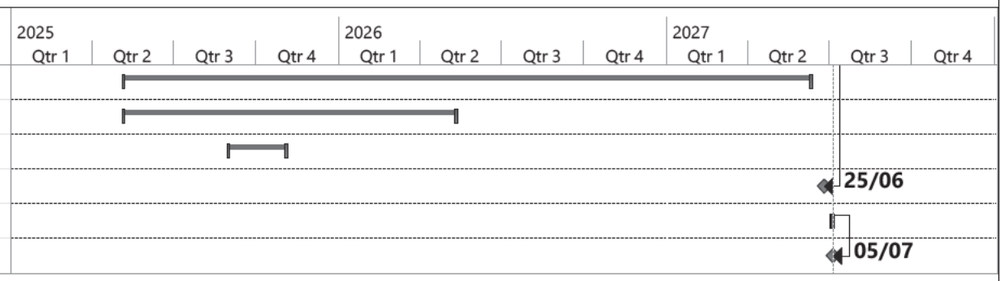
384	**Engagement - Supporting the Community**	**540 days**	**Wed 07/05/25**	**Thu 10/06/27**	
390	**Capturing Proposition Learnings**	**261 days**	**Wed 07/05/25**	**Mon 11/05/26**	
394	**Customer Research**	**46 days**	**Mon 01/09/25**	**Mon 03/11/25**	
396	**Stage 4 Complete**	0 days	Fri 25/06/27	Fri 25/06/27	355FF
397	**Stage 5 - Exit**	**1 day**	**Mon 05/07/27**	**Mon 05/07/27**	
437	**Stage 5 Complete**	0 days	Mon 05/07/27	Mon 05/07/27	397FF



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121 Assess Services - Surveys and Potential Trial Holes
Collaboration with WP3
127 Tests Swagelining
Collaboration with other gas networks
170 WP4
WP4 plan is indicative. 'Collaboration' discussions may lead to earlier start.

Department for Business, Energy & Industrial Strategy

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Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX E: Stage 2 Scope of Works

This Annex provides our Stage 2 Detailed Design Scope of Works, outlining the objectives, activities, and deliverables for each project Work Package (WP).

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Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX F: WP4 Commercial and Regulatory Full Report

This Annex expands on our response to section 3.3: Regulatory Plan and provides a full report on the commercial, regulatory, and billing arrangements required for the hydrogen heating village trial.

Cadent
Your Gas Network

elementenergy

[redacted]

Hydrogen Heating Village Trial

'HyNet Homes'

WP4: Commercial & Regulatory

Final report

for

Cadent

3rd December 2021

Element Energy Limited
Suite 1, Bishop Bateman Court
Thompson's Lane
Cambridge
CB5 8AQ

Tel: [redacted]

Authors

[redacted] [redacted] Consulting, [redacted]@[redacted]consulting.com

[redacted] ERM, [redacted]@erm.com

Reviewers

[redacted], Element Energy, [redacted]@element-energy.co.uk

For comments or queries please contact:

[redacted]@element-energy.co.uk

Disclaimer

Contents

1 Executive summary

In support of Work Package 4 of the HyNet Homes pre-FEED project, this study considers the commercial arrangements necessary for the operation of a 100% hydrogen network and the changes to the existing market and regulatory framework that might be required to facilitate such arrangements.

We have collaborated with SGN to understand the intended regulatory approach to the H100 Fife neighbourhood trial and to test its applicability to a village trial. On the basis of this work, we are satisfied that the commercial and regulatory approach proposed for H100 can be applied to the village trial.

In order to ensure that trial consumers are not over-charged, a modification will be required to the Xoserve billing system. Xoserve and SGN have recently consulted on potential approaches and obtained industry agreement to move ahead with one (using the Multiplication Factor) with the option of moving to another (consumption adjustment) if that is found to be more appropriate during the detailed design phase.

HyNet Homes should be able to adopt whichever billing approach is adopted for H100 Fife, with some additional effort potentially required to cater for the broader range of consumers and meter types associated with the village trial.

Neither of the two billing approaches is likely to be sustainable in the longer term, so there would be merit in exploring potential alternative options for later application. This work should dovetail with the Future Billing Methodology project with the aim of developing a single solution, suitable for 100% hydrogen and gas blends. The village trial could provide a good opportunity to test a revised approach to billing if it is available in time.

Regardless of the billing approach selected for HyNet Homes, the customers on the hydrogen network will need to have their gas meters replaced for meters that are suitable for use with a hydrogen supply. Cadent is exploring the potential to use their existing PEMS contract as an efficient means of replacing meters on the trial network. The availability of smart meters for hydrogen will need to be explored, as this could have implications for the billing approach.

More broadly, the H100 Fife commercial approach will treat the hydrogen network as if it were part of the gas network (the “Total System” in Uniform Network Code (UNC) terms). We have badged this as “minimal change”. In particular, flows of hydrogen will be treated commercially as if they were flows of natural gas from a UNC daily balancing perspective. In addition to administrative advantages, this has the benefit of allowing consumers to access the competitive retail market as they do now. It also allows suppliers to offer the same prices to hydrogen consumers as they do to natural gas consumers.

It is likely that at some point in the development of larger hydrogen trials and/or clusters, the minimal change approach will become suboptimal, and potentially unsustainable, and that further evolution will be required. Given this, we have considered whether it would be beneficial to make additional changes to the framework for the village trial at this stage, so that they could be tested and in place for later phases and provide additional industry learning. However, we recognise that BEIS is keen to avoid unnecessary distractions from the principal objectives of the village trial and hence have concluded that, on balance, it would be best to follow the same approach as H100 Fife. We recommend that the thinking required to develop a longer-term approach is undertaken soon by an industry workstream.

In the course of this study, we have noted the need to consider how security of supply on hydrogen networks will be assured. For trials, the project environment provides a centrally planned approach, and the arrangements defined in this way will need to be contractualised between relevant parties when the project is implemented. We believe that it would be helpful for the obligations and duties associated with security of supply to be clarified within revised licence conditions.

We have also undertaken an initial review of the UNC in order to identify potential areas for modification or derogation in order to facilitate hydrogen trials. Relevant points have been discussed with Dentons and the resulting list of affected sections is contained in this report.

The table below summarises the various framework implications of the minimal change approach.

Table 1, Framework implications of a minimal change approach

Approach	Framework implications
Protect consumers	Potential Act/Licence modifications as per Hydrogen for Heat consultation, e.g.: - financial protections - fair treatment and redress mechanism - provision of information - support especially for customers in vulnerable situations System changes to ensure consumers billed for correct energy
Provide necessary rights to GDNs	Potential Act/Licence modifications as per Hydrogen for Heat consultation, e.g.: - ability to make alterations within the home - ability to curtail natural gas supply
Maximise use of commercial framework	Facilitates ongoing customer switching processes, maintaining retail competition Relatively minor modifications to/derogations from UNC and ancillary documents
Gas quality consistent with IGEM standard	Safety case based on requirements of GS(M)R (which only applies to natural gas)

Finally, as part of this study we have set out a high-level roadmap of changes to the regulatory and commercial framework to support the hydrogen trials in the 2020s and potential wider-scale roll-out of hydrogen networks in the longer term.

2 Introduction

2.1 Objectives of the study

Work Package 4 of the HyNet Homes pre-FEED study considers the commercial arrangements for the operation of a 100% hydrogen network and the changes to the existing market and regulatory framework that might be required to facilitate such arrangements. The key objective of the study is to identify a set of commercial arrangements, including a methodology for billing hydrogen supplied to consumers, that will be functional for the HyNet Homes trial. However, a further objective of the study is to look beyond the HyNet Homes trial and consider the implications of later phases of the HyNet trials for the design of the commercial arrangements, for example the supply of hydrogen to larger industrial and commercial consumers and overall increasing volumes of hydrogen transported and supplied.

This document reports the findings of the investigation of potential commercial arrangements. The work that has informed the analysis presented in this report has included:

- **An initial detailed review of the Uniform Network Code** to identify aspects of the existing Code that would need modification for supply of 100% hydrogen.
- **A review of work done in other projects** on developing commercial models for the transport and supply of hydrogen via the gas network. This has included HyDeploy, Future Billing Methodologies and, in particular, the H100 Fife project ('H100').
- **A series of consultation interviews** with a range of key stakeholders, including (i) HyNet project partners and internal stakeholders, to understand key aspects of the HyNet Homes trial and subsequent stages of HyNet that could have implications for the design of commercial arrangements, (ii) stakeholders involved in other existing or proposed trials of hydrogen in the gas network, from which the HyNet Homes project can learn and (iii) a range of experts in both the design and operation of the existing commercial arrangements for gas networks and the emerging thinking on the commercial, market and regulatory framework for hydrogen (a list of the individuals and organisations consulted is provided in Appendix I – Stakeholder consultation).
- **A number of 'deep-dives'** into areas of particular relevance including issues associated with billing on 100% hydrogen networks and the sustainability of adopting the H100 approach to the commercial framework as hydrogen networks increase in scale.
- The **creation of a potential roadmap** for legislative, regulatory and commercial development to support hydrogen trials and the subsequent roll-out of larger hydrogen networks.

These activities have contributed to the identification of the issues that will need to be addressed in the development of the commercial arrangements for the HyNet trial and the early identification of potential solutions.

The approach taken to this study has been to first identify what a 'minimal change' commercial model would look like for HyNet Homes, i.e. one that adopts existing commercial arrangements for natural gas supply to the greatest extent possible. As discussed later in this report, the approach proposed for the H100 trial has been adopted as the basis of the minimal change approach. We then consider whether, even if a minimal change approach would be workable for HyNet Homes, there is an argument for doing something different. An approach that goes beyond the minimal change might be justified if it results in more

enduring commercial arrangements, future-proofed for the later stages of HyNet and, potentially, a more widespread roll-out of hydrogen. We discuss issues that might become problematic in a minimal change approach as hydrogen roll-out becomes more widespread and which would shape the development of more enduring arrangements.

2.2 The HyNet project

2.2.1 HyNet Homes Trial (Phase 1C)

The HyNet Homes trial (HyNet Phase 1c) is planning to provide 100% hydrogen to replace the supply of natural gas to around 2,000 consumers (mostly domestic but also some non-domestic). This phase forms part of the larger HyNet project, which aims to deliver 100% hydrogen to a wide variety of sectors.[1]

For the HyNet Homes trial, hydrogen will be produced via an Auto-Thermal Reforming (ATR) plant owned and operated by Essar and Progressive Energy Ltd (PEL). The hydrogen will then be fed into a Hydrogen Above Ground Installation (HAGI) owned and operated by Cadent Gas Ltd where it will be reduced in pressure and supplied to consumers through an isolated and repurposed section of the distribution network (the expectation is that hydrogen will enter the network at medium pressure). Proposals for the design of a resilient hydrogen supply and integration into the distribution network are being developed in Work Packages 1 and 2, respectively, of the pre-FEED programme. While there is no expectation that hydrogen storage will be included within the network system (i.e. no line-pack or other storage facility), the current proposal is for hydrogen storage to be located upstream and owned and operated by Essar and PEL. Security of hydrogen supply during the course of the trial is a key issue for the design of the overall project and one that could have implications for the commercial arrangements; for example, in terms of how responsibility for security of supply is allocated and documented within the framework. Figure 1 below shows a process schematic of HyNet Phase 1, which includes the HyNet Homes trial.

[1] HyNet Phases 1a and 1b refer to the production and use of hydrogen at Stanlow Refinery and the subsequent private supply of hydrogen to industrial consumers

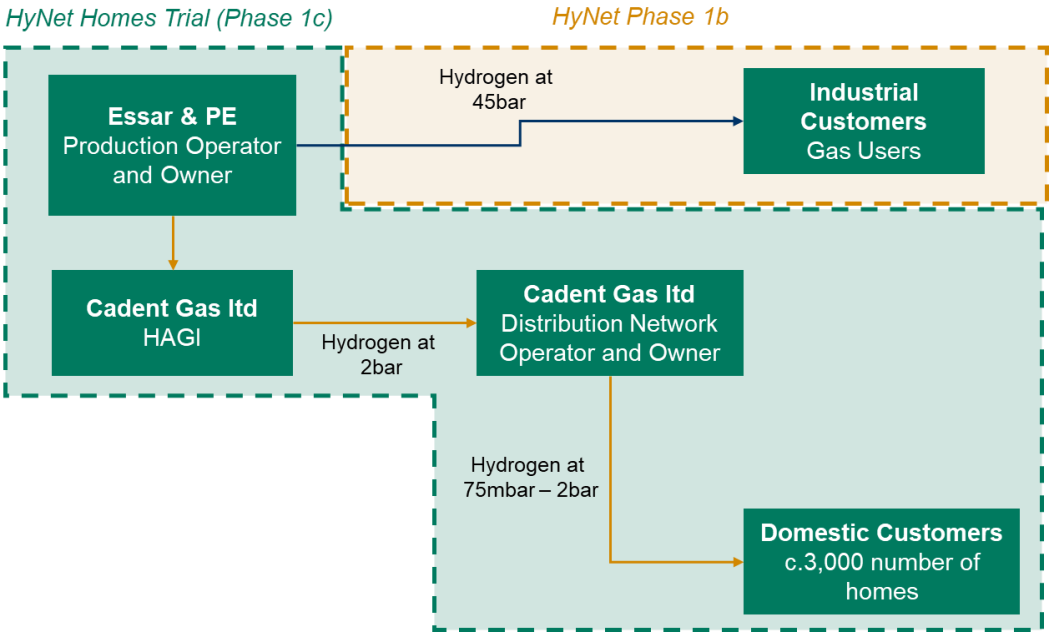

Figure 1 - Process schematic of HyNet Phase 1 (which includes HyNet Homes Trial)

2.2.2 Later HyNet Phases

As previously mentioned, the HyNet Homes trial sits within the larger HyNet project. The future phases of HyNet are expected to significantly expand the supply of 100% hydrogen to a larger number and more diverse range of consumers, including large-scale industrials. These later phases are also expected to involve connection to large-scale hydrogen storage (potentially salt caverns) and additional hydrogen supply sources.

In order to create a lasting and enduring solution for the HyNet Homes commercial and billing arrangements, it will be important to consider some questions that arise as a result of the potential increase in both the quantity of hydrogen supplied and the variety of consumers within later phases of HyNet. These considerations have shaped the thinking in this study.

3 Overarching framework issues

Regardless of the chosen approach to the commercial framework for HyNet Homes, a number of high level regulatory questions will have to be addressed to facilitate this and other hydrogen trials. The following list is illustrative of the nature of the issues to be addressed and is not intended to be exhaustive. A number of these points have been captured via the recent BEIS Hydrogen for Heat consultation[2], which was published alongside the Hydrogen Strategy on 17th August 2021.

a) Giving Gas Distribution Networks (GDNs) the necessary rights to convert the village

BEIS has identified two areas where existing powers do not allow GDNs to conduct activities that are necessary to set up a trial, and is proposing to legislate to give GDNs the powers that it will need:

- First, GDNs may need to carry out alterations in consumers' homes, e.g. to ensure better ventilation, that are not covered by the GDN's existing remit.

- Second, where consumers will not accept either hydrogen or the alternative offer, it is not clear that a GDN would be able to rely on existing powers of entry to disconnect such consumers safely from natural gas.

Related to these points, we note that GDNs have statutory obligations associated with providing and maintaining a gas supply. It is possible that exemptions may be required from these obligations since HyNet Homes will involve the unilateral disconnection and cessation of a natural gas supply to the consumers in the trial village.

b) Providing necessary protections for consumers

Within the Hydrogen for Heat consultation document, BEIS proposed a framework for consumer protection listing twelve potential components including ensuring that "participants in the trial are not expected to pay more to use hydrogen than they would for natural gas". Depending on the chosen commercial model for HyNet Homes, commercial pressures alone might be sufficient to ensure that this will be the case. Nonetheless, we would agree that this consumer promise should be included within the package of protections embodied within legislation, particularly in light of current market conditions.

c) Assuring security of supply

Beyond the points listed by BEIS in their consultation, there are two fundamental questions associated with security of supply, which are relevant not just to hydrogen trials but to any broader process of hydrogen roll-out: i) which industry participants have responsibility for the various aspects of security of supply, and ii) how are these responsibilities embodied within the regulatory regime?

It will be important that the answers to these questions are clearly set out in order to provide assurance to consumers (and to the HSE on their behalf) and clarity to industry participants. It seems likely that new obligations will be placed on GDNs as part of this process. Cadent will need to ensure that the costs and liabilities of any such responsibilities are recognised and remunerated. We return to this topic later in this report.

[2] Hydrogen for heat: facilitating a grid conversion hydrogen heating trial - GOV.UK (www.gov.uk)

d) Gas quality

GS(M)R only applies to the transportation of gas that is wholly or mainly methane, so will not apply to hydrogen networks. However, from a safety perspective, all of the considerations within GS(M)R are still applicable so Cadent will prepare a separate safety case for the project based on the requirements of GS(M)R.

The quality and specification of the hydrogen used in the project will comply with the Hydrogen Gas Quality Specification as developed by the Institute of Gas Engineers and Managers (IGEM) in IGEM/H/1 (Appendix 4). The separate safety case for the project will detail the need to ensure that this specification (or higher) is met, and how the design and operation of the system will prevent off-specification gas being distributed.

As hydrogen technology and networks develop, the definition of "gas" within GS(M)R may be amended to include hydrogen. Depending upon the extent of any amendments to GS(M)R, an exemption to schedule 3, which details the required content and other characteristics of gas, may be required.

e) Uniform Network Code (UNC) and related documents

A proposed modification from Northern Gas Networks (NGN) (UNC Mod 760) is seeking to introduce the concept of a derogation into the UNC, which would be helpful in order to facilitate net zero developments such as hydrogen trials. Notwithstanding the proposed modification, certain other modifications to the UNC are likely to be required, such as the need to ensure that relevant UNC provisions apply where required in relation to hydrogen networks. An initial list of areas where derogations or modifications may be needed, assuming minimal change to the UNC framework, is shown in Appendix II.

f) Ownership of equipment

In the course of the HyNet Homes trial, new hydrogen meters will be fitted at consumers' premises, and boilers and appliances suitable for burning hydrogen will be provided. The question of who owns this new equipment, together with any associated responsibilities and remuneration, will need to be addressed.

4 Lessons from other projects

A key element of our investigation of potential commercial arrangements has been to review the arrangements that have been put in place or are proposed for other hydrogen trials. In this section we consider two such trials – (i) HyDeploy, which focussed on the technical feasibility of using the existing gas network to transport natural gas/hydrogen blends and (ii) H100, SGN's proposed hydrogen neighbourhood trial that more closely resembles the HyNet Homes trial, albeit at smaller scale and with some differences in the technical arrangements. The commercial models developed for these projects are described below, with a view to identifying elements that could be applied to the HyNet Homes trial.

4.1 HyDeploy Approach

The HyDeploy project has investigated the feasibility of supplying consumers with a natural gas/hydrogen blend in which the hydrogen component is up to 20%$_{vol}$. Because of this, a temporary billing arrangement has been implemented to ensure end consumers are not over-charged for the energy they use. The current gas network works on the premise that the CV will be kept within a fairly tight range (also expected to be the case for a 100% hydrogen supply). However, where there is a natural gas and hydrogen blend, this CV range can vary more significantly given variations in the proportion of hydrogen within the blend (0% - 20%$_{vol}$).

The chosen solution for HyDeploy was to suppress the periodic Annual Quantity (AQ) update so that the increased volumetric flowrate due to hydrogen is not translated into a higher AQ. Secondly, CV at the meters involved in the HyDeploy trial are taken to be the same as the lowest daily charging CV within the Local Distribution Zone (LDZ). Furthermore, HyDeploy has a principle of not charging the consumers for the energy associated with the hydrogen that is supplied to their premises. Hence consumers only pay for the natural gas that they receive, and at a CV that is likely to be lower than the CV that would have applied had they not received a hydrogen blend.

The last feature to highlight around HyDeploy is the mechanics of the billing process. Consumers' bills reflect the total energy attributed to their meter points on the basis of the natural gas CV within their charging zone. Then, through a reimbursement process called the "Voluntary Consumer Payment", consumers separately receive a refund to ensure they pay the agreed amount in total. This is a cumbersome process, originally designed for the administration of Guaranteed Standards of Performance payments, involving a sequence of payments from transporter to shipper, shipper to supplier, and supplier to consumer.

4.2 H100 Approach

The H100 project will be a trial of the supply of 100% hydrogen, at a scale of around 300 domestic connections. Hydrogen will be produced via electrolysis and stored in bullets before being injected into a newly laid gas network that will run parallel to the existing natural gas network. This is an important difference between H100 and HyNet Homes, as the parallel network will mean that consumers in the H100 trial area will be given the choice of switching to a hydrogen supply or remaining on their existing natural gas supply.

The design of the regulatory and commercial framework for H100 is based on a number of principles set out by SGN, including:

1. Utilising the current UNC to the maximum extent possible.
2. Ensuring a consumer-centric design of the regulatory model.

3. Consumers are able to maintain the ability to switch suppliers and preserve the principle of retail competition.
4. Ensuring it is cost neutral for the consumer to participate in the trial.
5. Ensuring protection of the downstream commercial supply chain.

The consumer and downstream commercial supply chain will be protected from the higher cost of hydrogen by bearing the cost differential upstream. The responsibility is then placed on the hydrogen production and storage owner and operator to source funding for the differential through a Contract for Difference (CfD). Consistent with the principles stated above, despite the hydrogen network being totally isolated from the natural gas network, hydrogen energy flows are treated as if they are natural gas energy flows for all purposes (counting towards shippers' balances, attracting normal transportation charges etc.). Figure 2 below shows the structure proposed for the H100 trial from SGN.

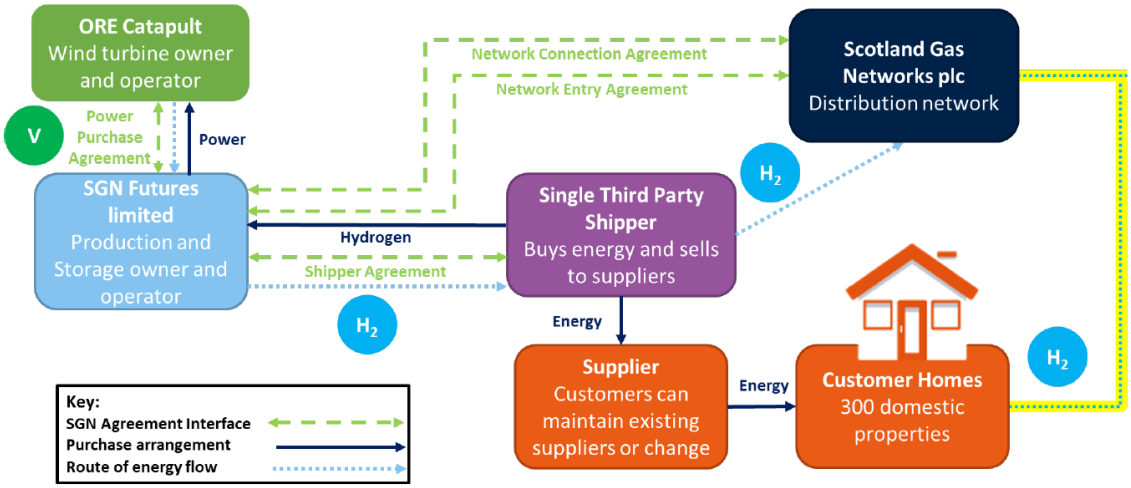

Figure 2 – Commercial structure proposed for the H100 trial. Figure taken from H100 Fife Condition Report, SGN[3]

4.2.1 H100 approach to billing

As hydrogen has a significantly lower CV than natural gas and gas meters measure the volume of gas supplied, action must be taken to ensure that consumers are billed correctly for the amount of energy they use when being switched to hydrogen. Currently, this issue is being worked on as part of H100 in association with Xoserve, with the aim of creating a solution that could be implemented within a relatively short timescale to meet the needs of the trial. This work recently went out to industry consultation[4], following which two options have been agreed as potential solutions for further development. The preferred solution involves the use of the meter Multiplication Factor (MF) (also known as 'reading factor') when converting the metered volume into energy, to reflect the lower energy density of hydrogen compared with natural gas. The alternative solution would be to adjust metered consumptions such that the correct energy is derived when the natural gas CV is applied. (See Appendix III – Calorific Value / Billing Solutions for H100 Trial for all billing solutions considered for H100).

[3] H100 Fife Condition Report, SGN
[4] *2918.4–MT–PO–XRN5298* October Change Pack (xoserve.com)

Billing solutions based on use of the meter MF, consumption adjustment or other potential alternatives that could provide more enduring billing arrangements are discussed in further detail in Section 7.

4.3 Applicability of Other Projects for HyNet Homes

In order to assess the applicability of other projects for the HyNet Homes trial it is important to consider them from both a technical and regulatory point of view. Firstly, considering HyDeploy, our conclusion is that this solution would not be suitable for HyNet Homes. The approach used within HyDeploy is to correct an initial consumer bill through a system of refunds. This is neither consumer-focused nor efficient. Furthermore, the consumer not having to pay for energy associated with hydrogen works for a small-scale trial, however, for a village-sized trial this would have a large financial impact on the project. Lastly, the process of billing a consumer and then reimbursing them is onerous for the transporter, shippers and suppliers, and in a Supplier of Last Resort situation causes further process difficulties.

Comparing HyNet Homes to H100, it can be seen that although there are some differences in the technical aspect of the two trials (see Table 2 for a summary), from a regulatory point of view none of these is believed to be a material barrier to the application of the commercial approach proposed for H100:

- HyNet Homes is an order of magnitude larger in terms of number of supply points and demand, and includes some non-domestic consumers. Nonetheless, it is still very small in the context of the whole network (or even the Local Distribution Zone). Furthermore, other than possibly a very small number of sites, the non-domestic consumers within the trial village are non-daily metered, so any potential additional complexity associated with daily metered supply points would be minimal
- HyNet Homes will be implemented by conversion of the existing distribution network rather than through the construction of a parallel hydrogen network. While this has implications (generally adding complexity) for the recruitment of consumers onto the trial and the conversion process onto hydrogen (and potentially back to natural gas later), the issues relevant to the operation of the two hydrogen networks once up and running are the same

Table 2 - Comparison between the H100 and HyNet Homes trials.

H100	HyNet Homes
New network alongside old network	Repurposing of existing network
Consumer option to stay on natural gas	Choice of hydrogen or electricity
2022/23 go live	2025/26 go live
Green hydrogen with onsite storage	Blue hydrogen with onsite storage
300 domestic supply points, all non-daily metered	2000 domestic / commercial supply points
NIC funded	CfD and GDN price control funded
Time-limited neighbourhood trial with potential expansion into village trial	Time-limited village trial with potential expansion via HyNet phase 2

As displayed above, there is a significant similarity from a framework point of view between the two trials. Therefore, there is value in exploring the adoption of a common approach to minimise change for the industry. Figure 3 on the following page shows a schematic of the cash flow and commercial interfaces from this work. Specific points to mention are:

- In order to protect consumers from the higher cost of hydrogen, the producer will sell the hydrogen to the entry shipper at a natural gas (NBP-indexed) price.
- The cost differential between the hydrogen and the natural gas on an energy basis will then be recovered through external funding, in this case through a contract for difference.
- For the remainder of the downstream commercial supply chain, hydrogen will be treated as if it is natural gas:
    - Reflected in shippers' entry and exit balances
    - Tradable at the NBP
    - Attracting normal transportation charges
- Consumers will be able to switch suppliers as normal and guaranteed not to pay more than the natural gas price

4.3.1 Summary

In theory, a minimal change approach, similar to that being used in H100, would be simple to implement for the HyNet Homes trial. Seen in isolation, HyNet Homes is similar in concept to H100: supply hydrogen via a small, isolated distribution network to a relatively small number of supply points. There are some areas of difference, but these are largely irrelevant or have low materiality in relation to the regulatory framework. That being said, framework issues will need to be addressed (see Section 2) and some derogations from or modifications to the UNC framework will be required (see Appendix II – Initial Assessment of Potential UNC Impacts Assuming Minimal Change Approach). However, we believe none of these to be showstoppers.

In addition, further work is required to establish the most appropriate approach to billing. As discussed in Section 4.2.1, two potential billing methods have been identified to support H100: adjustment of the MF or volume adjustment of metered consumptions. Both methods are the subject of further analysis and development by Xoserve in order to establish which will be the more appropriate, taking account of project timescales and longer-term sustainability. This topic is discussed in further detail in the billing deep dive in Section 7.

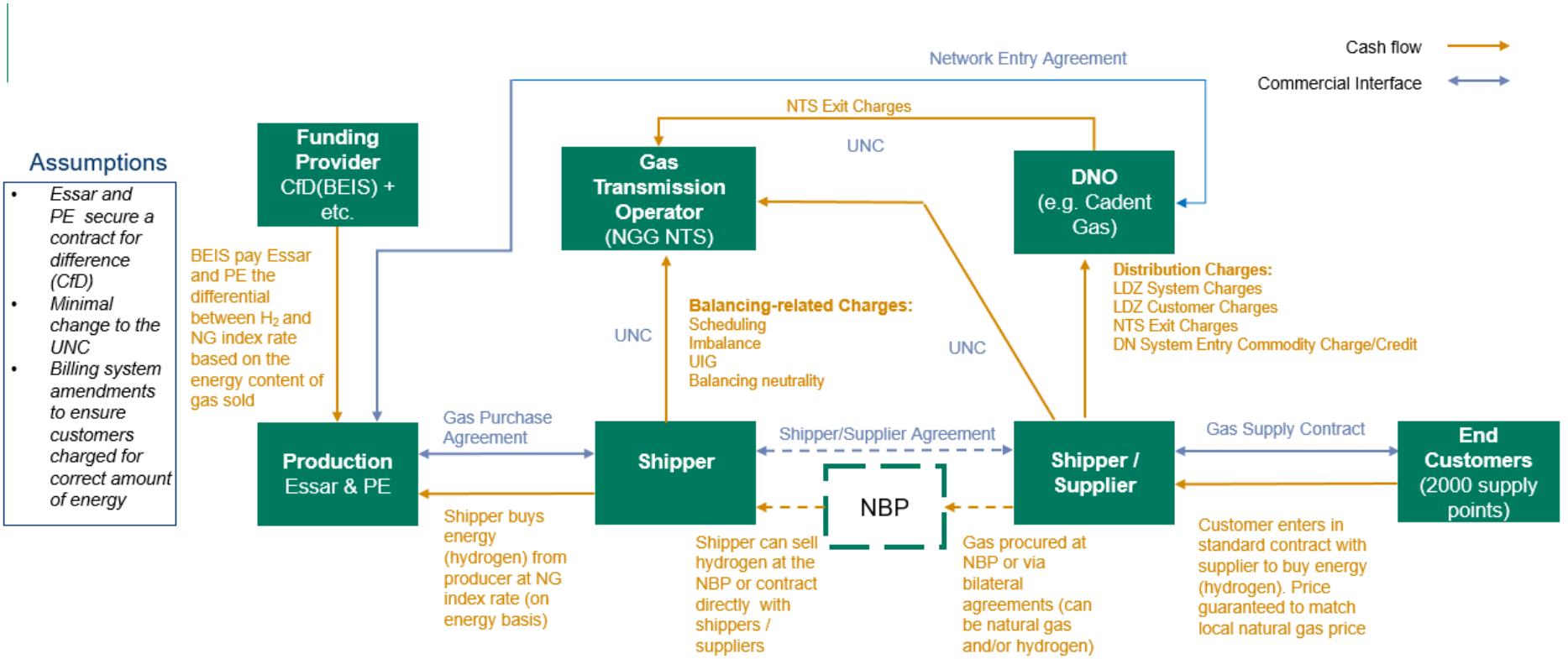

Figure 3 - Schematic of the cash flow and commercial interfaces of the HyNet Homes trial assuming H100 approach

5 The case for going beyond minimal change

5.1 Overview

In the previous section we have explained why, subject to the potential use of a different approach to billing, it would be feasible to adopt the same principle of minimal change that underpins H100. There is a clear value to industry participants in taking a consistent approach to trials where possible. Consistency would allow processes and systems developed for one trial to be re-used, thereby avoiding additional costs for GDNs/iGTs, shippers or suppliers. Given this, and looking at the HyNet Homes trial in isolation, there is no material difference between this project and H100 that would justify a departure from the H100 methodology.

It is, however, worth considering this question with a broader perspective. Implicit within the minimal change approach is the idea that flows of hydrogen (both at entry to the system and exit from it) count towards shippers' energy balances as if they were flows of natural gas. Implications of this approach include:

- Shippers/suppliers can supply gas to their consumers out of their natural gas portfolios
- Hydrogen can be traded at the NBP, indistinguishable commercially from natural gas
- Shippers can bid into the balancing mechanism using hydrogen, including demand-side bids once sufficiently large consumers are supplied by hydrogen networks
- If hydrogen is produced by methane reforming, then gas will enter and exit the system twice on the same day, initially as natural gas upstream of the hydrogen production facility, and then as hydrogen (see Figure 4)
- Hydrogen flows can attract standard transportation charges (see section 5.5 for a discussion of whether this is appropriate)

Figure 4 illustrates this arrangement in the scenario in which both hydrogen storage and large (daily metered) consumers are connected to the hydrogen network.

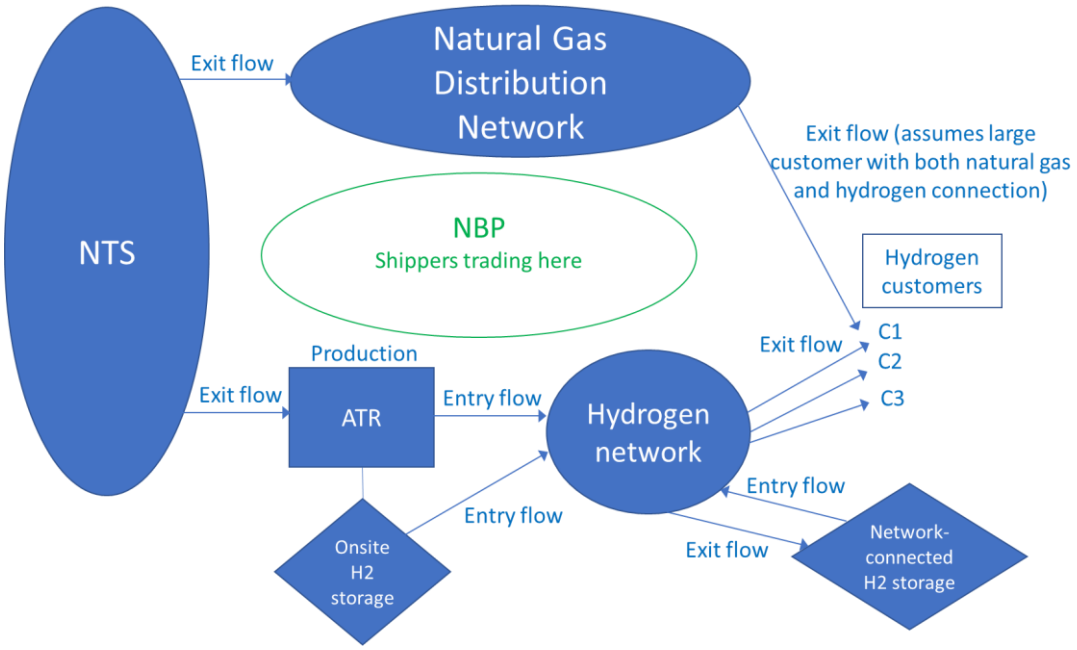

Figure 4 – Illustration of UNC energy flows with hydrogen included within the UNC balancing regime

Within a small-scale trial, this approach can be accommodated since:

- The gas flows are de minimis in the context of the whole system and therefore the separation of the hydrogen flows from the rest of the system is not material to NGG NTS in fulfilling the task of operational balancing

- Rather than relying on the commercial incentives for shippers and suppliers to balance within the UNC, ad hoc arrangements can (and in any case need to) be put in place to ensure that security of supply to the trial network can be maintained

- The level of cross-subsidy required to maintain natural gas prices to consumers within the hydrogen trials is likely to be materially greater than any cross-subsidies created through either:

    - the application of the UNC balancing regime to flows of hydrogen on separate networks, together with the associated charges, or

    - the application of normal gas transportation charges in relation to hydrogen flows

However, there is a concern that once a trial or broader roll-out is of sufficient scale the regulatory approach being adopted for H100 could become unsustainable. To illustrate the point, consider a level of hydrogen roll-out in which half of the country is supplied by hydrogen and the other half supplied (via a separate network) by natural gas. It would seem perverse in that scenario for all gas to be treated as if it is the same, tradable product under the UNC. While this is an extreme scenario to illustrate the point, it raises the question of when might be the right time to depart from the H100 model as trials increase in size and roll-out progresses. This is discussed further in Section 5.2.

It is therefore worth considering whether there would be value in evolving the H100 approach further for HyNet Homes since the broader HyNet project envisages a much larger hydrogen network (supplying large industrial customers) in subsequent project phases. Furthermore,

the adoption of rules that may be more robust to future developments could provide learning for the industry on these issues.

We should note that the hydrogen and natural gas networks will not be totally independent. First, as highlighted above, the use of methane reformation for the production of hydrogen will create a link between the fuels to the extent that hydrogen is produced from natural gas in (approximately) real-time to meet demand. Second, the ability to blend the two fuels offers the prospect of hydrogen injection into the natural gas network, which could provide a further source of flexibility to the fledgling hydrogen system. Finally, some large supply points within new-build hydrogen network clusters may decide to retain their natural gas supply, offering the potential for demand-side response on both networks.

The Government's recent UK Hydrogen Strategy included a roadmap for the hydrogen economy. In the 2025-27 timescale, the roadmap envisages developments in the regulatory frameworks beyond the use of existing frameworks anticipated in the shorter term, e.g. "Initial network regulatory and legal framework in place…, initial system operation in place, gas billing methodology in place". With HyNet Homes planned to go live in 2026, an approach that goes beyond minimal change may not be out of line with the Government roadmap. However, from our initial discussions with BEIS we understand that there is a desire to avoid distractions from the principal aim of gathering essential evidence on the role of hydrogen.

5.2 Stress-testing 'minimal change'

To explore the potential value of pursuing an alternative approach, we have considered the implications of applying the H100 model to a range of scenarios and we have discussed the implications with NGG, Cadent and WWU in their capacities as network operators.

Table 3 shows the dimensions of potential hydrogen developments in the North West in the context of the whole NW LDZ. It illustrates the very significant increase in scale from a village trial, whether to the industrial cluster of HyNet phases 2 & 3 and/or to a town trial along the lines of Ellesmere Port. In particular:

- The planned HyNet industrial cluster (phases 2 and 3 combined) while only comprising 53 supply points would amount to around 25% of the NW LDZ's total gas demand

- The town, with its associated industrial base, would amount to approximately 1% of the NW LDZ's supply points and c. 0.8% of its total gas demand

Table 3 – Approximate dimensions of subsequent HyNet phases and potential town trial

		Number of supply points							Supply points by type		
		NDM <73,200	NDM <732,000	NDM >732,000	Total NDM	Total DM	Largest SP (GWh)	Total Demand (GWh)**	Domestic	Non-Domestic	Network Blend?
HyNet Homes	**Helsby**	1969	15	4	1988	0	1.4	36	1941	47	No
	Whitby	1905	9	1	1915	0	0.8	30	1899	26	No
HyNet Phase 2 (excl previous phases)		0	0	0	0	11	1352	7403	0	11	Yes
HyNet Phase 3 (excl previous phases)		0	0	0	0	42	1878	10900	0	42	Yes
Town	**Ellesmere Port***	28633	186	26	28845	3	51	574	28280	568	No
LDZ	**NW**	2672004	27151	2826	2701814	167	14987	71393	2619852	82129	N/A

* Ellesmere Port excludes Stanlow Oil Refinery

** Total demand includes hydrogen for blending

It is evident that the subsequent HyNet phases are materially greater in size (on the basis of demand) compared with a potential town trial area, and are significant in the context of the wider LDZ. They will also contain large daily metered consumers, which could retain their natural gas connections. Given these factors, this type of industrial cluster could be expected to provide a bigger challenge from the perspective of operational balancing on the natural gas network than a town trial.

Conversely, the significantly greater number of supply points within a town compared with an industrial cluster is more likely to provide a challenge from a billing perspective, particularly where the process relies on manual intervention.

From our stakeholder discussions, it is clear that careful consideration and analysis will be required in order to understand the implications of including hydrogen flows within the UNC balancing regime. None of the network operators have concerns over this for the village trial. However, there is a general feeling that as the scale of hydrogen deployment increases, and hydrogen flows become material in the context of the broader gas network, a different approach is likely to be needed.

In particular, it is unclear to what extent the effectiveness and efficiency of the UNC's operational balancing regime would become compromised as hydrogen networks develop. National Grid has indicated that at the scale of a hydrogen town trial it is likely that more issues of concern would arise under the H100 model.

In our discussion with WWU and Cadent, they noted that, regardless of scale, a 100% hydrogen network would require its own distribution network control function, separate from their current network control operations. This reinforces the point that simply assuming commercially that hydrogen and natural gas are interchangeable, doesn't make this the case physically. The obligations, duties and processes present within today's regulatory framework will, for the most part, not provide security of supply for hydrogen consumers. This point is discussed in the following section.

5.3 Security of supply and operational balancing

Under the present framework, gas transporters have obligations to:

- Plan and develop their networks to meet 1 in 20 peak day demand

- Provide economic incentives to shippers and suppliers via transportation arrangements for them to meet the domestic security standards – essentially to meet the 1 in 50 winter and 1 in 20 peak day aggregate demands of their domestic customers

This approach has served the GB gas industry well over the last 25 years. For hydrogen networks, we envisage that the GDN will retain equivalent obligations in respect of 1 in 20 peak day network capacity. However, the domestic security standards relate to volumes of gas, for which the present system relies upon a combination of economic incentives provided by the balancing regime under the UNC, a liquid gas market, a well-integrated gas transportation network and a set of operational tools that allow the system operator to maintain a daily balance.

Within a small hydrogen trial, these features of the present gas network cease to exist. We won't yet have a liquid market for hydrogen; the UNC balancing incentives will not provide a signal for shippers in relation to hydrogen supply since they are based around aggregate

supply-demand positions likely to be dominated by natural gas; and the system operator's set of operational tools won't be relevant for ensuring a balance on the hydrogen network.

Initially, at least, an appropriate level of security of supply will be achieved via a combination of project design – to ensure sufficient production and/or storage capacity is available – and appropriate contractual arrangements between the parties. The HyNet Homes hydrogen network will not have a material amount of linepack, hence the provision of diurnal swing will come from the producer/storage operator. A contractual solution between the producer/storage operator and the GDN is therefore likely to be required to ensure that the necessary capability and level of resilience are in place. This could potentially be written as part of the Network Entry Agreement.

Such an arrangement is relatively simple to envisage while there is a single source of hydrogen into a trial network and while the trial is set up as an integrated project with the various partners working collaboratively. As we move from small-scale trials to the roll-out of larger hydrogen networks, roles and obligations in relation to security of supply will have to be considered carefully and reflected in regulatory and commercial frameworks.

As we discussed earlier, at some point in this process the scale of trials/roll-out will become significant in the context of the whole gas network giving rise to potentially material distortions in the information received by NGG NTS in its capacity as system operator. At such a point, it may become necessary to remove hydrogen flows from the UNC balancing regime.

5.4 Competition and supply point administration

The supply point administration processes provide a well-established and robust system for customer-switching, which can be applied to customers on hydrogen networks. There is therefore no prima facie reason for retail competition not to continue during hydrogen trials or a broader roll-out.

It is likely to be some time before a hydrogen market matures sufficiently to support fully competitive purchasing by shippers and suppliers. In practice, though, suppliers won't need to source hydrogen to supply their hydrogen customers while the current UNC energy balancing rules remain in place. Incorporation of hydrogen flows within the energy balance would allow suppliers to utilise their natural gas portfolio for hydrogen consumers.

If we departed from this model by taking hydrogen flows out of the energy balance, hydrogen could be allocated to shippers consistent with the aggregate demands of their hydrogen customers, at a price fixed relative to the natural gas price, and in conjunction with a price guarantee provided to the consumer. Therefore, for many years competition between suppliers is likely to be based on their natural gas prices together with any additional factors such as customer-service and dual-fuel discounts.

However, a consequence of allocating hydrogen to suppliers would be to restrict the flexibility that they have in sourcing energy for their hydrogen customers. Suppliers would no longer be able to call on their natural gas portfolio for this purpose if hydrogen flows were not part of the energy balance. Consideration would therefore need to be given to appropriate mechanisms for ensuring that a) hydrogen consumers retain the benefits of a competitive energy market under such an arrangement, and b) suppliers are kept whole to the extent that they are required to supply their hydrogen customers at prices inconsistent with their costs. This is an area that would benefit from further development and industry discussion.

Conversely, under the minimal change approach, there is a question of what price the hydrogen entry shipper pays for their hydrogen. This shipper won't have control over their energy inputs since they will be allocated whatever hydrogen enters the network to supply the downstream consumers. The price should therefore not put the shipper at risk of a loss that it is unable to mitigate. A price related to daily NBP SAP or System Sell may be appropriate. One potential approach is for the shipper to be appointed by the hydrogen producer via a competitive process, which would allow it to factor the risk into the price.

5.5 Transportation charging

For transportation charging purposes, all supply points within an LDZ are assumed to make use of both the NTS and the LDZ regardless of the source of their gas. This is a natural consequence of the UNC structure whereby gas flows into the NBP and out of the NBP are independent, effectively allowing any supply point to be supplied (commercially) from any source of gas.

NTS transportation charges are flat (per unit of capacity or energy transported) regardless of load size. However, LDZ transportation charges are lower (per unit of capacity or energy transported) for loads above 732,000 kWh/annum, reflecting the fact that they typically make use of fewer LDZ pressure tiers. Below that threshold the charges effectively assume that all tiers of the LDZ are used.

In a separate hydrogen distribution network, the supply of hydrogen makes no use of the NTS and would only use specific distribution assets[5]. It could therefore be argued that the application of 'normal' gas transportation charges would not be cost reflective. As is the case for balancing, there is a question of when the appropriate point would be to depart from the present system of transportation charging in favour of charges designed to reflect hydrogen network costs. This approach would recognise that hydrogen consumers would be making use of a different set of distribution assets and no use of the NTS. Separate pricing of hydrogen and natural gas transportation charges could also be used to reflect variations in other categories of cost incurred by the transporters.

In the case of balancing, there is an operational dimension since balancing charges are designed to provide daily signals to shippers. In the case of gas transportation charges, while they are designed to provide long-term signals there is no short- term operational dimension, and hence there may be less of an imperative to depart from UNC arrangements. Indeed, in the short term, it will be important to consider transportation charges in the context of the whole supply chain, ensuring no adverse impact on hydrogen consumers compared with natural gas consumer and avoiding windfall gains or losses for shippers.

Our assumption is that shippers will buy energy for hydrogen consumers at a natural gas indexed price and sell at a natural gas retail price, consistent with a consumer promise that they won't pay more for hydrogen than they would do for natural gas. Given these assumptions, lower hydrogen transportation charges than natural gas transportation charges – if not passed on to consumers – could simply result in a windfall gain to hydrogen shippers. For these reasons, our conclusion is that the HyNet Homes trial would be too soon to consider bespoke transportation charging.

One point of detail relates to the LDZ System Entry Charge, a commodity charge levied on gas flows at LDZ System Entry Points. Within the natural gas system, this charge is used to reflect costs specific to the entry point in question and (through credits) to recognise the

[5] For hydrogen produced by methane reformation, the hydrogen producer is likely to have incurred NTS charges in relation to the natural gas used in the process

beneficial impact of embedded gas flows on the broader network, analogous to the approach used for embedded electricity generation. In the case of hydrogen entry points, we would propose that the principle for setting this charge should be to ensure that the cost of hydrogen to the hydrogen entry shipper is in line with the cost of natural gas at the NBP. If the hydrogen shipper is to be appointed via a competitive process, the LDZ System Entry Charge could be set to zero.

5.6 Conclusions in relation to a minimal change approach

This section has highlighted the potential issues that may arise with a minimal change 'H100' approach as hydrogen trials grow in scale and with the roll-out of larger hydrogen clusters.

Whilst there is a general feeling amongst the stakeholders we have spoken to that such an approach would not be sustainable, at this stage it is unclear at what point problems could arise.

Given the clear benefits to all industry participants of consistency in approach across the early hydrogen trials, our conclusion is that the approach adopted in H100 should be used for HyNet Homes.

However, this does not obviate the need to consider carefully at this stage the way in which security of supply will be assured within hydrogen networks, and to ensure that this is embodied within the regulatory framework.

In addition, we would recommend that industry-wide discussions take place sooner rather than later to explore the potential ramifications of minimal change in larger hydrogen networks and to develop a revised approach should that be deemed necessary. A high-level roadmap of activities that may be considered in progressing from minimal change to a longer term solution is provided in Section 9. The following section outlines a potential approach that could be considered.

6 A potential medium-term framework

In the previous section, we questioned whether it is appropriate for hydrogen flows to be treated as if they were natural gas flows within the UNC framework. In the course of our analysis, we explored the potential implications if this wasn't the case. Alongside this, we questioned how security of supply would be assured within hydrogen networks. These two points are inextricably linked since the daily balancing regime is a key component of the security of supply framework.

Ultimately, the supply and transportation of hydrogen may need its own regulatory and market framework, separate from the UNC used for natural gas. The development of this framework is further along the roadmap, and it is quite possible that more than one incarnation will be required to facilitate the transition. In the medium term, it should be possible to use those elements of the UNC that are appropriate for hydrogen networks whilst developing alternative approaches for those that are not. For example, the illustrative framework for balancing outlined in Section 6.2 could be developed whilst retaining the existing supply point administration rules, which facilitate retail competition.

6.1 Security of supply

Section 5.3 summarises the current security of supply framework, which aims to ensure a sufficiency of both network capacity and volumes of energy to meet set security standards. Broadly speaking, the former is provided by way of obligations on regulated monopoly network operators, and this approach can be applied to hydrogen networks.

The provision of volumes of energy consistent with the domestic security standard, however, relies to a great extent on a well-developed competitive gas market together with incentives on shippers to balance via the UNC. Until such time as the scale of hydrogen roll-out is sufficiently large and well-developed, a daily balancing regime along the lines of that in the UNC will not be able to provide the necessary incentives to shippers to ensure that hydrogen supply meets hydrogen demand. An alternative framework will therefore be required whether or not a minimal change approach to the UNC framework is maintained.

A further consideration is that the development of hydrogen networks is likely to be piecemeal, for a while at least, with separate networks in different parts of the country. Achieving a balance between supply and demand in each network will be individual problems without the benefit of an integrated system. We noted earlier the need for separate control functions within the GDNs for hydrogen networks.

We can envisage the need for a new role to ensure a sufficiency of supply within each hydrogen network – we refer to that here as a 'system architect'. This role could potentially be undertaken by the network operator, a shipper or a new industry body. The system architect would arrange the provision of hydrogen resources necessary to meet defined supply security standards. Resources could include hydrogen production, storage and potential demand-side options. The network operator would have responsibility for ensuring a real-time balance given the tools provided to it. Clearly such a framework would need a great deal of careful development – the purpose of this high-level outline is to identify the potential requirement and to provide a context for the analysis that follows of potential medium-term developments to the balancing regime.

6.2 Energy balancing

With a system architect in place, a daily balancing regime applying to shippers would have no value in relation to security of supply. Supply-side competition could potentially be introduced by the system architect by way of tenders and/or auctions. This would obviate the competitive value in having multiple hydrogen shippers at entry. A single shipper could be appointed per network, with hydrogen sold at a price related to the price of natural gas.

Subject to shrinkage and storage, the amount of hydrogen that enters the network must meet the demand for hydrogen from the network. Hydrogen entry flows could therefore be allocated to exit shippers based on the (estimated) demands of their customers.

In more detail, this potential regime could involve:

- Hydrogen flows not included within UNC balances at entry or exit
- Nominations not required for hydrogen flows
- No scheduling charges applied to hydrogen flows
- No imbalance charges applied in relation to hydrogen flows
- No allocation of Unidentified Gas to hydrogen shippers
- A single entry shipper (per network) procuring hydrogen at a managed price or via competitive tender
- Multiple exit shippers driven by retail competition as today

- Hydrogen exit flows allocated to exit shippers based on the (estimated) demands of their customers – exit shippers pay the entry shipper a managed price

- Hydrogen shrinkage allocated to exit shippers pro rata to the demands of their customers

Figure 5 - Schematic of the cash flow and commercial interfaces if hydrogen flows are removed from the UNC balancing regime illustrates this framework.

There will of course be many details to be worked through if such a framework were to be put in place. As we noted above, a key issue that would have to be addressed is how to ensure that hydrogen consumers retained the benefits of a competitive energy market once suppliers are unable to access their natural gas portfolios to supply hydrogen consumers.

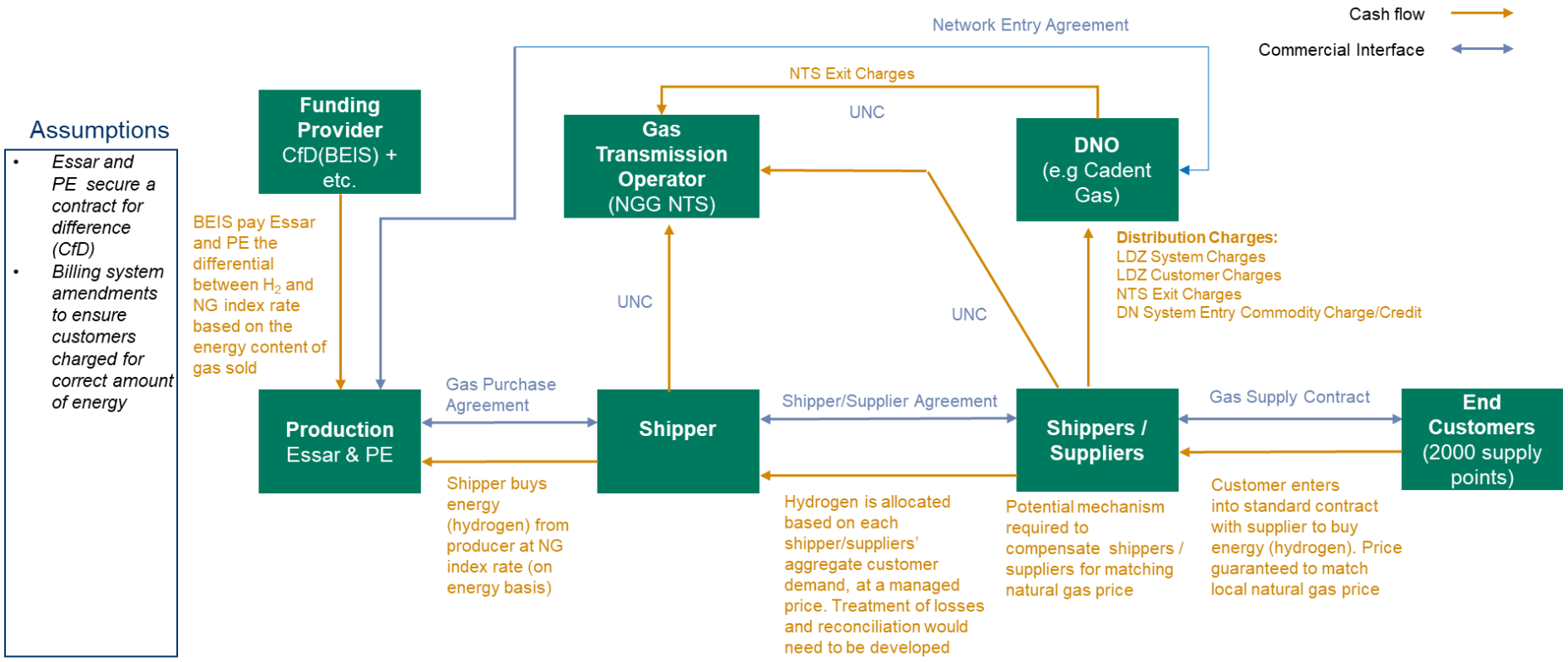

Figure 5 - Schematic of the cash flow and commercial interfaces if hydrogen flows are removed from the UNC balancing regime

7 Billing methodology deep dive

As was discussed in Section 4.2, one of the leading approaches to billing for the H100 Hydrogen Neighbourhood Trial is to utilise the Multiplication Factor (MF) to adjust for the decrease in volumetric energy density when switching from natural gas to hydrogen. The MF is a parameter held against each type of meter within Market Domain Data (MDD). It is used to adjust meter readings where the meter does not read in units of kWhs. It is therefore always set to 1 for domestic meters but can take other values (typically multiples of 10) for larger meters. The MF therefore provides a potential parameter within the billing calculation that can be used to ensure the correct energy is derived given a metered volume.

Following a recent Xoserve consultation[6], this option has been highlighted as the preferred solution given the relative ease with which it could be implemented. Furthermore, it is not thought to require derogations from or modifications to current regulations. The GDN would utilise its ability under the Calculation of Thermal Energy Regulations to declare the CV for the MPRNs receiving hydrogen, effectively carving these meter points out of the LDZ's Flow-Weighted Average CV (FWACV) calculation. The ratio of the hydrogen CV and a typical natural gas CV would be reflected in the MF to ensure that the correct energy use is calculated from the metered volume.

It is believed that the MF is built into the billing systems of some, but not all, shippers and suppliers. The extent of the impact of this approach on shippers and suppliers will be tested by Xoserve during the detailed design phase of H100.

There are however limitations to the use of the MF for billing 100% hydrogen, which could make it sub-optimal for the application to the HyNet Homes Trial. Two issues arise from the fact that the MF is held by meter type within MDD. First, its use for this purpose assumes that the meter is only used for 100% hydrogen. Should the meter be 'hydrogen-ready' and therefore also used for natural gas or natural gas/hydrogen blends, a single MF would not be applicable for that meter type. Further analysis will be required to understand at what point this could become a limiting factor in the use of the MF solution.

Similarly, given the potential for concurrent hydrogen trials, it may be necessary to base the MFs on a natural gas CV that is high enough to avoid over-charging consumers in any trial area. This is likely to lead to undercharging of hydrogen consumers, which may be considered acceptable for small trials but could impact the sustainability of the approach.

Finally, there is a concern that the process may become more administratively complex as the number and type of customers increase from a Village Trial to widescale roll out, and thereby become a potential source of error.

For these reasons, it worth considering alternatives for the HyNet Homes trial, especially given the additional time available until the go live date compared with H100. Xoserve and SGN consulted on an alternative approach involving adjustment of metered consumptions. Following the consultation, this has also received industry approval as an alternative and will therefore be the subject of further analysis and development in the next stage of H100. The MF and consumption adjustment methods are set out in Appendix III, alongside the other options that have been considered, together with a summary of their pros and cons.

Under the consumption adjustment method, when a valid meter reading is received a calculation is undertaken to derive the equivalent volume of natural gas that would contain the same energy as the metered hydrogen. The measured consumption is adjusted

[6] h100-fife_phase1-cp.pdf (xoserve.com)

accordingly so that a reconciliation calculation can take place using the natural gas CV. This option has potential applications to the HyNet Homes trial and wider scale roll out of hydrogen networks as it would be compatible with any meter and not require MDD changes. It would, however, necessitate more significant changes to systems and potentially data flows for the Central Data Service Provider (CDSP), shippers and suppliers. These issues will be addressed in the detailed design phase of H100 prior to a final decision on the billing solution to be adopted in that trial.

Finally, it is worth noting that work is also being undertaken to consider billing arrangements for blended network and while there is potential for different approaches to operate for 100% hydrogen and blended networks, it would clearly be advantageous to adopt a solution that could work well for both. The issues concerning billing for blended networks are more complex, due to the potential for significant variations in FWACV that could arise. This is currently being looked at by the Future Billing Methodology project, with the current favoured approach to model CV at the meter point by measuring CV at Entry Points to the distribution network. It is unclear whether it would be feasible to implement such an approach in the timescale required for HyNet Homes.

8 Metering deep dive

Customers involved in hydrogen trials will need to have their existing gas meters replaced with meters that are suitable for use with hydrogen. Consideration will need to be given to the technical selection of meters as part of the safety risk assessment. The availability of hydrogen smart meters will also need to be assessed as part of the supply chain analysis. The deployment of smart meters as part of the HyNet Homes trial could be a material consideration in the development of alternative billing arrangements and also have implications for the beyond minimal change approach to the commercial and regulatory framework for hydrogen networks, for example the approach to allocating or forecasting how hydrogen demand is allocated to exit shippers in the case that hydrogen is removed from the UNC balancing regime.

In terms of the process for replacement of meters on the hydrogen network, Cadent is exploring the option of doing this under their existing Post Emergency Meter Service (PEMS) contract. PEMS allows DNs to exchange meters when there is an emergency call out and there is found to be a problem with the meter installation and the DN has a PEMS contract with the supplier. The network engineer carries out the required works and if a new meter is required, this is sold to the relevant supplier, who transfers it to their meter asset manager (MAM)

The hydrogen meter will be registered on the Supply Point Register and data flows under the Review of Gas Metering Arrangements (RGMA) will occur as normal. This process would ensure that suppliers and Meter Asset Managers (MAMs) all hold the relevant identifiers for the domestic hydrogen meters within the trial area.

To use this process, Cadent propose to implement a standard contract variation to the legal PEMS contract to include the new Hydrogen meters and update the pricing schedule to be a nil charge. This approach will also ensure that a PEMS service is provided for the hydrogen meters, should faults be encountered during the trial.

Note that while the PEMS contact may provide a suitable route for meters to be changed for the hydrogen Neighbourhood and Village trials, the PEMS contract only covers meters of up to 11 scmh throughput, which may mean the approach is not appropriate for later phases of HyNet.

As discussed in the previous section, the multiplication factor (MF) adjustment approach to hydrogen billing will require manual updating of the meter MF. Concerns have been raised through industry consultation on potential approaches to billing (conducted by Xoserve) that this may require the meters to be replaced again if the customers switch back to natural gas following the trial (or if they're supplied a blend in future). Whether future changes to the gas supplied to the customers will require replacement of meters is not clear, although further interventions to adjust MFs would be required. This concern supports the view that as the scale of trials increases, involving larger numbers of customers and different customer types, adjustments made at the meter asset level are unlikely to provide a sustainable approach to ensuring correct billing.

9 Roadmap for commercial and regulatory change

In the figure below, we set out a high-level roadmap for commercial and regulatory changes required to support hydrogen network trials during the 2020s and also some longer-term activities required to facilitate widespread roll-out of hydrogen networks under more sustainable arrangements in the 2030s and beyond. The roadmap activities are broadly split between licencing and legislative changes, changes to the billing arrangements for hydrogen networks and evolution of the market framework and charging arrangements. The roadmap is focussed on changes related to 100% hydrogen networks, but we recognise that blended networks may be an important part of the transition to 100% hydrogen. It will be beneficial to closely align work on these issues for the blended and 100% hydrogen cases and, where possible, identify changes to the relevant regulations and commercial arrangements that are applicable to both.

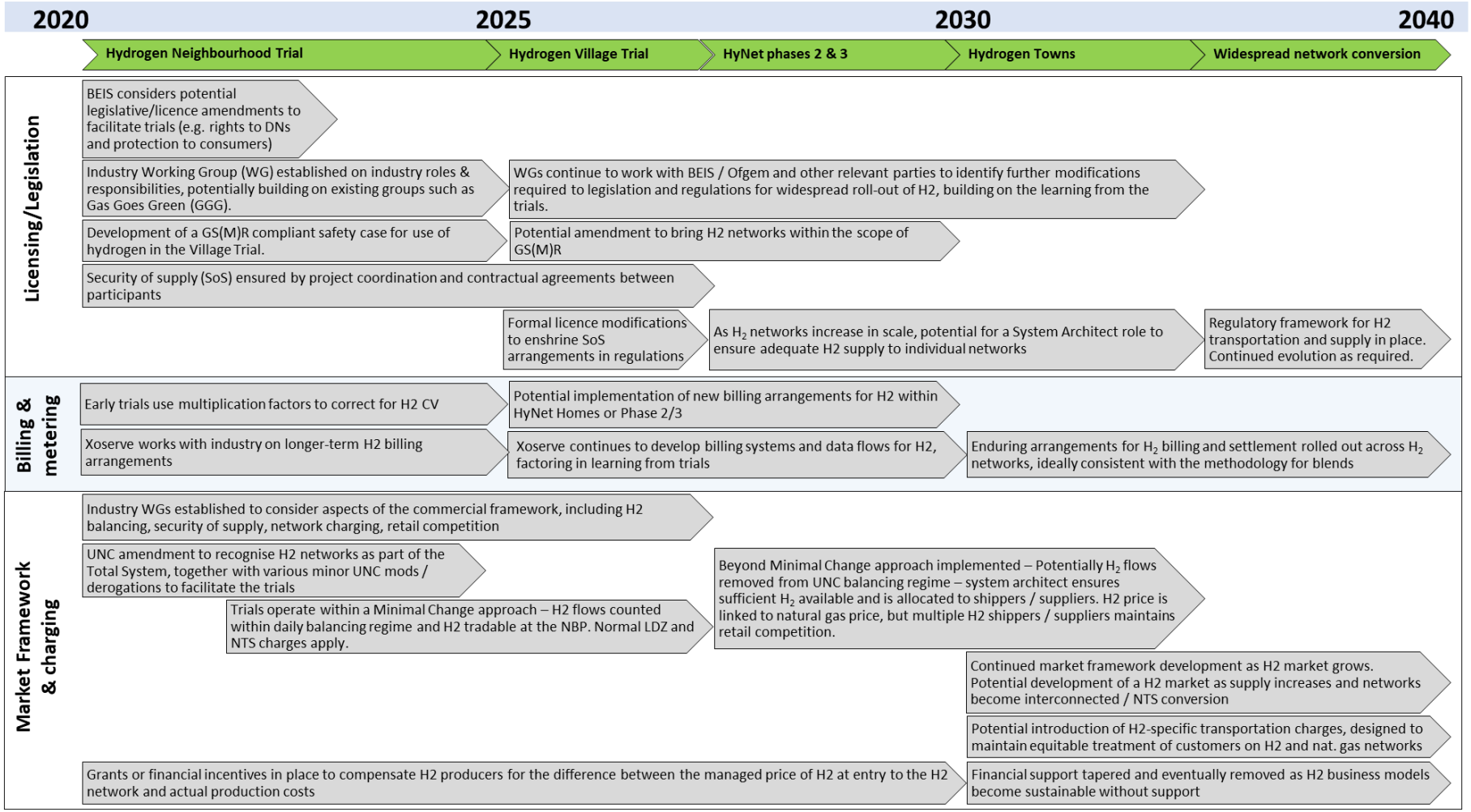

Figure 6 – High-level roadmap of regulatory and commercial changes required to support H_2 network trials and wider roll-out

10 Summary & Conclusions

In this report, we have raised a number of key points for consideration when deciding the appropriate billing and broader commercial framework for HyNet Homes.

Our conclusions are as follows:

- The approach to billing that has been used by HyDeploy is not suitable for HyNet Homes:
  - The mechanism used in HyDeploy is inefficient as it requires multiple steps to ensure that the consumer is refunded for the volumetric overcharge created by the lower CV of hydrogen
  - The way in which consumers are separately charged for too much energy and refunded is not customer-focused and should be avoided if possible

- The approach to billing that is currently being developed by H100 should be applicable to HyNet Homes, however
  - Xoserve and SGN have yet to conclude which approach to adopt
  - Depending on the chosen solution, it may not be preferred for HyNet Homes if the project wishes to future-proof the approach against potential later phases of HyNet
  - HyNet Homes has the benefit of additional development time compared with H100, which would allow for consideration of an alternative billing solution

- Regardless of the billing approach selected for HyNet Homes, the customers on the hydrogen network will need to have their gas meters replaced for meters that are suitable for use with a hydrogen supply. Cadent is exploring the potential to use their existing PEMS contract as an efficient means of replacing meters on the trial network. The availability of smart meters for hydrogen will need to be explored, as this could have implications for the billing approach.

- Looking more widely than the billing system, the principle of making minimal changes to the UNC should also be adopted for HyNet Homes. While the projects are different in a number of respects, none of these materially impacts the feasibility of adopting such an approach

- In the medium-long term, an approach of minimal change may not be sustainable as hydrogen trials increase in size and a roll-out of 100% hydrogen networks takes shape. Potential impacts have been identified in relation to key areas of the framework including security of supply, operational balancing and transportation charging. We have set out some initial thinking on a potential framework for the medium-term and recommend that these issues are discussed and developed by the broader industry in the near future

- We have considered the potential benefits of implementing additional changes to the commercial framework for HyNet Homes – beyond the minimum required to make it work – but have concluded that the benefits for the industry of mirroring the approach adopted by a similar project outweigh the potential benefits of the alternative

- Regardless of the decisions made in relation to the application of the UNC to hydrogen networks, it is important that roles and obligations in relation to security of supply are well-defined and embodied within the regulatory and commercial framework

- In addition, a number of more detailed framework issues will need to be addressed, but no show-stoppers have been identified. In particular, we have set out an initial list of potential UNC impacts

- A high-level roadmap of changes to the regulatory and commercial framework to support the hydrogen trials in the 2020s and potential wider-scale roll-out of hydrogen networks in the longer term has also been developed. The process for identifying and implementing the necessary changes to the regulatory framework need to be developed and is likely to involve a significant role for industry working groups and broad consultation processes.

11 Appendix I – Stakeholder consultation

The following consultees have contributed to the preparation of this report.

Stakeholder	Organisation
[redacted]	Advisor to ENA
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Cadent
	Dentons
	Dentons
	Centrica
	Centrica
	Centrica
	Centrica
	Centrica
	DNV GL
	National Grid Gas Transmission
	National Grid Gas Transmission
	National Grid Gas Transmission
	Progressive Energy
	Progressive Energy
	SGN
	SGN
	WWU
	WWU
	WWU
	Xoserve
	Correla
	Xoserve
	Xoserve
	Correla
	Correla

12 Appendix II – Initial Assessment of Potential UNC Impacts Assuming Minimal Change Approach

Table 4 – Initial assessment of potential UNC impacts assuming a minimal change approach to HyNet Homes trial.

Reference (TPD unless otherwise stated)	Description
Section A – System Classification	Potential amendment so that hydrogen network treated as part of the LDZ in order to be recognised as part of the Total System for UNC purposes. Similar points identified below – could create a new separate part of the UNC document to host new hydrogen-related rules.
Section B – System Use and Capacity	Similar point to the one in section A – potential amendment to deem that shippers to hydrogen-supplied consumers hold NTS Exit Capacity in relation to those supply points, maybe akin to SINs
	Potential impacts in future phases if there are DM supply points involved, e.g. in relation to demand-side response, interruption, supply point capacity/offtake rates
Section C - Nominations	Provision may be needed for publication of a deemed CV for hydrogen networks
Section D – Operational Balancing & Trading Arrangements	Unlikely to require any modification to this Section, but arrangements between hydrogen producer and DNO likely to be required in relation to operational balancing within the hydrogen network
Section E – Daily Quantities, Imbalances & Reconciliation	Similar point to those in Section A and B above – potential amendment to ensure these provisions bite in relation to hydrogen flows
Section G – Supply Points	Potential for minor amendment(s) to recognise hydrogen 'flags' against supply meter points
	It would be sensible for Cadent to check that Siteworks rules are fit-for-purpose for the trial

Reference (TPD unless otherwise stated)	Description
	SGN have raised the possibility of needing transitional arrangements so that "isolation/re-establishment rules don't kick in"
Section H – Demand Estimation & Demand Forecasting	We assume it will be appropriate for trial supply points to stay within NDM Samples. If not, a minor modification may be needed to exclude these supply points
Section I – Entry Requirements	Changes needed to recognise hydrogen production plant as a Connected Delivery Facility (and the operator as a new Connected Delivery Facility Operator), the need for a LDZ NEA with appropriate Network Entry Conditions and Gas Entry Conditions (e.g. measurement rules and gas specification) and for LOP.
	SGN have identified the need to check whether any hydrogen-specific gas quality limits will need to be specified (Section I2.4) and specifically whether CO2 content in hydrogen is within 2.5% limit (Section I2.2.7)
	Reference to Standard Special Condition D12 of GDN 's Gas Transporter Licence in Section I3.11, which covers "Requirement to offer terms for the provision of gas entry points". Is an exemption required for hydrogen networks?
Section J – Exit Requirements	References in Section J to requirements re gas composition. GS(M)R will not apply to hydrogen networks. Further consideration required for how to tie hydrogen gas quality standards into the UNC.
	Point picked up by SGN: Section 2.4.3 "Where this paragraph applies, the Transporter will use reasonable endeavours to notify the Registered User as soon as reasonably practicable after the Transporter becomes aware that a change in relevant characteristics of gas available for offtake at the Supply Point has occurred or will occur". Not obviously relevant to the trial since this relates to unexpected changes not planned changes

Reference (TPD unless otherwise stated)	Description
	Section J3.5 concerns "Gas not made available for offtake" including Transporter liabilities. Should be considered in context of responsibilities for security of supply in the trial. Similar point in Section J3.11 re CSEPs
	If the trial is extended to cover Phase 2, we would have to consider impacts in Section J in relation to any DM Supply Points
Section K – Operating Margins	Normal operating margins will serve no purpose for the trial village. We assume that any similar provision would come from the hydrogen producer, hence upstream of the hydrogen distribution network
Section L – Maintenance & Operational Planning	It may be sensible for Cadent to consider whether it has sufficient maintenance rights in relation to the trial village, or whether something else is required to facilitate whatever work is needed
Section M – Supply Point Metering	Section M2.1.2(a) will require hydrogen meters to be with relevant standards
	Processes around meters to be further considered for the trial village. Subject to the outcome of this, we should check whether any modifications/derogations required
	Section M4 contains information on Meter Information, with details contained in the UK Link Manual. These should be checked in detail to see if any changes are required
	Reference in Section 4.2.16 to conversion factors (i.e. standard temperature & pressure correction) – may need minor amendment subject to agreed approach to billing
Section N - Shrinkage	Shrinkage rates may be different for hydrogen but we are assuming that this will be ignored under a minimal change approach. Worth quantifying the potential difference particularly under HyNet Phase 2

Reference (TPD unless otherwise stated)	Description
Section Q - Emergencies	This section might be sufficiently general to apply to a trial hydrogen village but that should be subject to review once any revisions to the safety case and emergency procedures have been made
	SGN have wondered whether a carve out of Section Q would be appropriate. In principle, emergency curtailment should not apply to a trial village that is separate from the gas network. In that case, procedures may be required to ensure that trial village supply points were not required to curtail demand in the event of a gas deficit emergency on the natural gas network. However, further thought is required where, as in HyNet Homes, the hydrogen network is downstream of an ATR, which is itself a natural gas load
Section R - Storage	No storage planned for trial. Would need further consideration under HyNet Phase 2 if storage is connection to the hydrogen network (as opposed to being part of the upstream delivery facilities)
Section V – General	Nothing identified as requiring a modification following an initial review by Dentons
General C3.1.1	Potential need for a derogation: “"In the Code, unless the context otherwise requires, 'as' means any hydrocarbons or mixture of hydrocarbons and other gases consisting primarily of methane which at a temperature of 15 °C and an absolute pressure of 1.01325 bar are or is predominantly in the gaseous state."
OAD Section F4 – Determination of Daily CVs	Potential need for amendments – review once billing approach established
OAD Section K – LDZ System Entry Points	Consideration should be given to whether it makes sense to apply any/all of the capacity processes in relation to hydrogen entry in the circumstances envisaged for the trials
IGTA Section A4 - Emergencies	Ensure any changes to TPD Section Q (if any required) apply here

Reference (TPD unless otherwise stated)	Description
IGTA Annex A1 - AQ calculation	Potential need for revision if hydrogen consumers have different consumption patterns to natural gas consumers but unlikely to know this prior to trial

13 Appendix III – Calorific Value / Billing Solutions for H100 Trial

Table 5 – Table highlighting the billing solutions proposed for the H100 trial. These options have been developed by Xoserve in association with SGN, and a summary has been adapted from their work for this report.

Option	Description	Pros	Cons
Option 1 – Creating a new local distribution zone (LDZ)	Creation of a new Local Distribution Zone. This allows Hydrogen consumers to be billed separately from natural gas whilst utilising existing industry processes	• Can use the FWACV service to manage the new LDZ CV with no impact to FWACV capping process • It also adheres to all current regulations which is enduring and can continue to be used if projects expand	• There would be very complex changes required in UK Link and the FWACV Service and changes also required to Gemini • Shippers, Suppliers and Distribution Networks will need to make system and process changes • Impacts on National Grid (except for Gemini), Shipper, Supplier & Distribution Network systems and processes have not been assessed • There has not been a new LDZ created in the industry for years, and so complexity is high or unknown
Option 2 – Creating a New Scottish Independent Network (SIN)	Creation of a new SIN to manage the billing of hydrogen separately to natural gas, whilst using existing industry processes	• May be less complex than Option 1 • No impact on FWACV capping processes, and	• There would be very complex changes required in UK Link and the FWACV Service, and changes also required to Gemini

Option	Description	Pros	Cons
		adheres to the current Gas Thermal Energy Regulations • Enduring solution that can continue to be used as the demonstration is expanded	• Shippers, Suppliers and GDNs will need to make systems and potentially process changes • Impacts on National Grid (except for Gemini), Shipper, Supplier & Distribution Network systems and processes have not been assessed • No new SIN created in the industry for a number of years so complexity is high or unknown
Option 3 - Process Volume/Consumption Adjustments Using Hydrogen Calorific Value	This option proposes to use the Hydrogen CV to adjust the volume and then use the FWACV to calculate the energy for each supply meter point on the Hydrogen Network	• Overall energy is calculated accurately • Enduring solution that can be expanded past trials	• Requires system and process changes as the Hydrogen CV would need to be supplied to CDSP and sent to Shippers and Suppliers • System changes required to process the volume adjustments resulting in the solution potentially taking a long time to implement • Shippers & Suppliers would need to adjust their volume to ensure correct invoices are sent to consumers

Option	Description	Pros	Cons
			• UK Link will require complex system changes • Volume adjustments have a critical timing and capacity constraints for both H_2 and NG downstream processes
Option 4 – Amend the Conversion (Correction) Factor	This option looks at using an adjusted number in place of the Standard Conversion (Correction) Factor. The Standard Conversion Factor is stated in the Gas Thermal Energy Regulations (hence would require a derogation), and is used to adjust for temperature and pressure at the property	• No system changes required to Gemini. UK Link changes less complex than other options • Minimal impact on GDNs and NGT • Maintaining Conversion Factor is part of existing RGMA flows and processes • Conversion Factors are shown on end consumers bills allowing them to calculate their own energy	• The Gas Thermal Energy regulations specify the factor for consumers who use less than 25,000 therms. Also not suitable for consumers who use more than 25,000 therms as they require a site-specific conversion factor • Shippers may need to make system changes to prevent changing the new Conversion Factor • Suppliers may need to make system changes to ensure that the new Conversion Factor is used for consumer billing
Option 5 – Amend the Multiplication Factor	This option proposes to use the multiplication factor (sometimes called the read factor) to adjust for the effect of hydrogen CV. The multiplication factor is a number in the billing calculation process that is currently used for	• Multiplication factor forms part of MDD data and can be maintained using established processes. As MF can only be set per the	• Having a single Multiplication Factor per meter type within MDD creates difficulties if the same

Option	Description	Pros	Cons
	commercial consumers (larger loads) to adjust if the meter reading needs to be scaled to achieve the correct units - e.g. if the meter only going up to $1x10^6$, but the end consumer needs it go to up to $1x10^9$, then the multiplication factor would be set to 1,000	MDD, unlikely to be set incorrectly • No know system changes for CDSP, Shippers, Distribution Networks, MAMs or MAPs	meter types are used on different networks • Multiplication factors are currently not shown on consumers' bills (should really be shown if there are adjustments being made) • Domestic suppliers may not be aware as to what a multiplication factor is • Bespoke correction factors required for larger consumers • Suppliers may need to make system changes to ensure that the new multiplication factor is used for consumer billing
Option 6 – Applying a AQ Backstop	This option is to apply a backstop to the AQ in order to prevent the increase in consumption due to hydrogen being used (which would increase the AQ due to a lower CV). Financial compensation payments would then be required to be passed on by Shippers and Suppliers back to the consumer	• No known system changes for CDSP, Shippers, Distribution Networks, MAMs or MAPs.	• Currently the demonstration has no end date so AQ Backstop would have to be reapplied manually every 9 months • For 100% hydrogen this would have a large impact on the unidentified gas (blending this effect is neg). • Manual financial compensation process back to consumers is

Option	Description	Pros	Cons
			clunky and not a long-term solution • May have an impact to process financial compensation if additional meters are added to the (hydrogen) network.
Option 7 – Calculate and Apply CV at MPRN/Site Level for all Premises	The option looks to create and use specific CVs for every MPRN, enabling the most accurate CV to be used for any type of gas (not just 100% H_2). Regarded as having the potential to be a good "end goal"	• Enables actual hydrogen CV to be used without having to "fudge" into existing gas energy calculations • Creates more understanding of exactly what's happening at every premises resulting in more accurate charging • Further system changes are unlikely for any future non Natural Gas project.	• Long delivery time scales, and an overhaul of how CV is calculated; significant change in the CDSP systems and processes as well as industry processes. • Changes also to gas supply chain systems and processes; and multiple regulation and code changes • Long and detailed industry-wide analysis required to understand the ramifications • Increases the industry's data flow massively

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ANNEX G: Exit Scenarios

This Annex expands on section 3.4: Exit Plan to detail the range of considerations and impacts which must be considered for the following three potential exit scenarios:

1. Continuation of Hydrogen Supply;
2. Reinstatement of Natural Gas; and
3. Conversion of Properties from Natural Gas to Heat Pumps.

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Scenario	Consumer Billing	Consumer appliances	Consumer disruption	Network implications	Skills and resourcing	Commercial and regulatory considerations
1. Continuation of hydrogen supply	Consumers will require assurance that their hydrogen bills are not going to escalate to an unsustainable level.	Consumer appliances remain in situ, with consumers assuming responsibility for maintenance and upkeep, unless they are part of a wider hydrogen pilot.	Consumer disruption is expected to be minimal as appliances are expected to remain. Anyone who has opted to have a heat pump fitted at the start of the trial will remain on heat pumps.	Minor network considerations. The network would remain converted to hydrogen for the foreseeable future and hydrogen would continue to be supplied by the Stanlow Manufacturing Complex hydrogen production facility.	Sufficient expertise, available in the area, will be required to ensure a hydrogen network is operated and maintained sufficiently. This will include registered gas safe engineers being able to operate on H_2.	An adequate billing regime would need to remain in place alongside a long-term regulatory regime predicated on minimal change from existing natural gas frameworks.
2. Reinstatement of natural gas	Consumers would revert back to billing regime that is used on all natural gas networks as per the Gas Calculation of Thermal Energy Regulations and the Gas Act.	Consumer appliances could remain in place if they are hydrogen-ready and under the agreement of the manufacturers (and hence the warranty). It is expected that hydrogen-specific appliances and meters will need to replaced.	There will be considerable disruption to the consumer to convert back to natural gas. The consumer will have to undergo further disruption when they are eventually placed onto a net zero heating option as natural gas will not be a long-term option.	The hydrogen network will need to be repurposed back to natural gas. Although this isn't expected to be an issue, comprehensive risk and safety assessments will need to be undertaken and shared with the HSE for comment as this has not been done to date.	A large workforce will be required to convert homes and commercial properties back to natural gas. The numbers expected to complete this are thought to be broadly similar to the amount required in the initial hydrogen conversion.	The network and the consumers would be reinstated onto commercial and regulatory frameworks that are in use today on the natural gas network.

3. Convert properties from natural gas to heat pumps	Consumers will be responsible for choosing an adequate electricity tariff and they will be billed as a result of this as in agreement with their supplier.	All gas appliances will need to be removed and replaced with electrical heating and cooking solutions. Financial responsibility for the installation of heat pumps – identifying whether this is a project cost - will need to be further considered in Stage 2 and beyond with BEIS and Ofgem.	There will be considerable disruption for consumers to convert from hydrogen to heat pumps. This will include the removal of existing gas appliances and then the installation of water tanks (if not already present), upgrade of electrical wiring, suitable position to fit the heat pump and in home upgrades such a new radiators, and energy efficiency measures.	Significant reinforcement will need to be completed on the electricity network so that it can support the large additional demand. From early conversation with the local GDNOs, the cost to reinforce the network will be in the region of >£20m. The gas network will be decommissioned in due course and the network will be purged of all hydrogen.	Significant resource will be required to convert c.2000 homes and commercial premises to heat pumps if the gas network is to be decommissioned. Once the conversion has been completed, sufficient resource will also need to be available to provide maintenance for consumers heat pumps.	The commercial and regulatory frameworks that manage the gas networks (whether that be natural gas or hydrogen) will no longer be relevant. Instead, the regulatory and commercial frameworks that relate to electricity networks will be enforced.

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ANNEX H: Risk Register

This Annex provides our full project risk register, which categorises risks into the following categories:

- Programme
- Commercial and Contracts
- Staff/Resources
- Project Capital Cost
- Health and Safety
- Technical

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ANNEX I: Letters of Support

The Table below summarises the letters of support we have received for our proposed village trial in Whitby, Ellesmere Port, at a local, regional, and national level. All 36 letters of support are provided within this annex.

Level	Organisation	Representative	Role
Local	Government	[redacted]	MP for [redacted]
Local	Government		MP for [redacted]
Local	Government		MP for [redacted]
Local	Government		MP for [redacted]
Regional	Government		[redacted]
Regional	Cheshire West and Chester Council		[redacted]
Regional	Cheshire West Voluntary Action		[redacted]
Regional	Cheshire and Warrington Local Enterprise Partnership		[redacted]
Regional	North West Hydrogen Alliance		[redacted]

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Regional	Net Zero North West	[redacted]	[redacted]
Regional	CBI North West	[redacted]	[redacted]
Regional	North West Business Leadership Team	[redacted]	[redacted]
Regional	University of Chester	[redacted]	[redacted]
Regional	Cheshire Energy Hub	[redacted]	[redacted]
National	Essar Oil UK	[redacted]	[redacted]
National	Baxi Heating	[redacted]	[redacted]
National	Electricity North West	[redacted]	[redacted]
National	Falcon	[redacted]	[redacted]
National	Focal Point Fires	[redacted]	[redacted]
National	HyNet North West and Progressive Energy	[redacted]	[redacted]
National	Ideal Heating	[redacted]	[redacted]
National	Legend Fires	[redacted]	[redacted]
National	MeteRSit	[redacted]	[redacted]
National	Pietro Fiorentini	[redacted]	[redacted]
National	British Gas	[redacted]	[redacted]

National	Hydrogen and Hotwater Industry Council (HHIC)	[redacted]	[redacted]
National	National Grid Metering	[redacted]	[redacted]
National	Valliant	[redacted]	[redacted]
National	Viessmann	[redacted]	[redacted]
National	Worcester Bosch	[redacted]	[redacted]
National	ICOM	[redacted]	[redacted]
National	Continental	[redacted]	[redacted]
National	Energy and Utilities Alliance	[redacted]	[redacted]
National	BOC Limited, Linde	[redacted]	[redacted]
National	UNISON	[redacted]	[redacted]
National	Stopford	[redacted]	[redacted]
National	Xoserve	[redacted]	[redacted]

[redacted] MP for [redacted]

[redacted]

[redacted]

To whom it may concern,

As MP for [redacted] I have long supported the important role of hydrogen in the future of the economy, reflected in my consistent backing of HyNet which I was delighted to see receive support for its next phase.

I believe that my constituency can play a part in the green jobs and hydrogen revolution required to meet the challenge of climate change and so would be interested in working with Cadent to assess whether there is community support for their hydrogen village trial which I understand they may want to proceed with in my constituency. This project, and many others, has the potential to boost the supply chain across my constituency and to upskill the energy sector. As a result, I am pleased to see proposals being put forward by Cadent which I hope the Department will consider carefully.

Please do not hesitate to contact me should you wish to discuss this further.

Sincerely,

[redacted]

Tel: [redacted] *Email:* [redacted]
My full Privacy Statement can be found at [redacted]

Member of Parliament [redacted]
House of Commons, London SW1A 0AA
Tel: [redacted]

[redacted]

Dear [redacted]

It is my pleasure to write a letter in support of proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating.

As you know, I have long supported the important role of hydrogen in the future of the economy, reflected in my consistent and active engagement with HyNet: a game-changing hydrogen energy project for the North West and North Wales. As I know you saw your yourself when visiting Warrington recently, Hydrogen is going to play a massive part in Britain's energy plans. I am keen for Warrington, Cheshire and the North West to play our part in aiding not only in our transition to net zero, but in creating thousands of permanently highly skilled green jobs across the region.

Warrington South, itself, is a great location for catalyzing hydrogen innovations, being home to a number of manufacturing plants and companies who are all supportive of hydrogen energy solutions. This project, and many others, has the potential to boost the supply chain across my constituency and to upskill the energy sector. As a result, I am pleased to see proposals being put forward by Cadent which I hope the Department will consider carefully.

I look forward to working closely with innovators involved in the hydrogen village trial and by doing so I am pleased to play my part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Yours sincerely,

[redacted]

The [redacted]
Member of Parliament for [redacted]

[redacted]

29 November 2021

Dear Minister

Re: UK's village-scale trial of hydrogen heating.

It is my pleasure to write a letter in support of Cadent's proposal for funding to support the delivery of the UK's village-scale trial of hydrogen heating.

I have long supported the important role of hydrogen in the future of the economy, reflected in my consistent backing of HyNet: a game-changing hydrogen energy project for the North West and North Wales. Hydrogen is going to play a massive part in Brtain's energy plans. I am keen for my constituency and wider Cheshire and the North to play our part in aiding not only in our transition to net zero, but in creating thousands of permanently highly skilled green jobs across the borough.

My constituency itself, is a great location for catalyzing hydrogen innovations, being home to a wealth of manufacturing plants and companies who are all supportive of hydrogen energy solutions. This project, and many others, has the potential to boost the supply chain across Warrington to upskill the borough's energy sector. As a result, I offer my support to Cadent's proposal, and believe it will make Cheshire a better place to live, work and prosper for our local community.

I look forward to working with Cadent in the hydrogen village trial and by doing so I am proud to play my part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Best wishes,

[redacted]

Constituency Office: [redacted]

[redacted]
Member of Parliament for [redacted]
House of Commons, London SW1A 0AA
Tel: [redacted]

Thursday 2nd December 2021

To whom it may concern,

It is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating.

I have long supported the important role of hydrogen in the future of the economy, reflected in my consistent backing of HyNet: a game-changing hydrogen energy project for the North West and North Wales. Hydrogen is going to play a massive part in Britain's energy plans. I am keen for my constituency and wider Cheshire and the North to play our part in aiding not only in our transition to net zero, but in creating thousands of permanently highly skilled green jobs across the borough.

My constituency itself is a great location for catalyzing hydrogen innovations, being home to a wealth of manufacturing plants and companies who are all supportive of hydrogen energy solutions. This project, and many others, has the potential to boost the supply chain across Warrington to upskill the borough's energy sector. As a result, I offer my support to Cadent's proposal, and believe it will make Cheshire a better place to live, work and prosper for our local community.

I look forward to working with Cadent in the hydrogen village trial and by doing so I am proud to play my part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Yours sincerely,

[redacted]

Constituency Office:

[redacted]

LIVERPOOL CITY REGION
COMBINED AUTHORITY

[redacted]

30 November 2021

[redacted]

To whom it may concern,

As [redacted] I am supportive of Cadent's proposal to BEIS and Ofgem to deliver village-scale trial of hydrogen heating, as part of the UK's decarbonisation of energy.

With the challenge of climate change taking precedent across the UK, I am open to welcoming various low carbon and hydrogen energy solutions in the North West, and have been particularly supportive of HyNet in placing the region at the forefront of the green industrial revolution. I understand that the switch to low carbon fuels is the key to decarbonising our economy, and I have demonstrated this through a region-wide hydrogen powered bus scheme. With this commitment to utilising hydrogen as a cleaner energy source, I am proud to be supporting Cadent's trial in the North West.

As a representative for [redacted], I support the efforts to deliver hydrogen village trials, as long as there's a clear delivery plan for consumers, businesses and the local authorities.

Yours sincerely

[redacted]

Liverpool City Region Combined Authority
No 1 Mann Island, Liverpool, L3 1BP

Email: info@liverpoolcityregion-ca.gov.uk
Web: liverpoolcityregion-ca.gov.uk

Cheshire West & Chester Council

[redacted]

Cheshire West and Chester Council
4 Civic Way, Ellesmere Port, CH65 0BE

Tel: [redacted]

Email:
enquiries@cheshirewestandchester.gov.uk
Web: www.cheshirewestandchester.gov.uk

Date: 22.11.21

Cadent
Ashbrook Court
Prologis Park
Central Blvd
Coventry
CV6 4QJ

On behalf of Cheshire West and Chester Council, we are pleased to strongly support Cadent's proposal to BEIS and Ofgem to deliver the UK's village-scale trial of hydrogen heating.

Cadent's proposal aligns with the Council's strategic ambitions to address the climate emergency, while securing the inclusive growth of our local economy. As host council for this critical national development, we recognise our responsibility to help make it a success, and an exemplar for the transition required by households across the UK and beyond. Given the transformative nature of this change to home heating, we welcome the initial discussions with Cadent, BEIS and Ofgem to ensure our residents at the heart of the project, through extensive community consultation and engagement. We look forward to supporting that process, through our own deep connections with the local community, including the leadership of local councillors.

We are pleased to see Cadent's commitment to energy equality and ensuring there is no loss to residents on either an up-front or ongoing basis through this transition, and it is important that this is reinforced at each stage of the process. It is equally important that this trial is used as an opportunity to address fuel poverty where it is identified within the trial area.

We also strongly support the partnership between Cadent, the Council, and the HyNet project, to enable the project to secure a supply of low carbon hydrogen from the start. The blue hydrogen proposed in HyNet is intended to be an essential transitionary step towards green hydrogen, and therefore the development of a timescale for the transition to green hydrogen at the earliest feasible opportunity via this trial and other mechanisms will also be supported by the Council.

We look forward to working closely with Cadent, our partners, local businesses and residents in the hydrogen village trial, and thereby playing our part in the vital international commitment to achieve net zero.

Sincerely,

[redacted]

Cheshire West Voluntary Action
Championing the community sector

The Bluecoat
Upper Northgate Street
Chester
CH1 4EE

[redacted]

Cheshire West Voluntary Action
The Bluecoat
Upper Northgate Street
Chester
CH1 4EE

To whom it may concern,

26th November 2021

It is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating on behalf of Cheshire West Voluntary Action.

Cheshire West Voluntary Action is a specialist infrastructure organisation who delivers invaluable support for the voluntary, community and faith sectors, helping them to grow and thrive. With a focus on infrastructure support, we provide the knowledge, skills, and opportunities to allow Cheshire West to become successful and sustainable. As a result, we are fully supportive of Cadent's proposal, and believe it will make West Cheshire a better place to live, work and prosper.

Cheshire West Voluntary Action encourages the efforts of Cadent to deliver a hydrogen village trial in the region, which will support our Green Pledges Campaign in partnership with Chester Sustainability Forum. Our Pledge provides an opportunity for individuals and organisations to make personal pledges and support actions to tackle the Climate Emergency called by Cheshire West and Chester Council in May 2019. With this, we hope for Cheshire West to become carbon neutral by 2045.

We look forward to working with Cadent in the hydrogen village trial and by doing so are proud to play our part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Sincerely,

[redacted]

[redacted]
Cheshire West Voluntary Action

Cheshire and Warrington
Local Enterprise Partnership

10 December 2021

Via email

To whom it may concern

On behalf of Cheshire and Warrington LEP it is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating.

The proposals align with the LEP and subregion's vision to be the healthiest, most sustainable, inclusive and growing economy in the UK, and our ambition to become a leader in net zero carbon energy technology and innovation and the world's first decarbonised industrial cluster, centred on HyNet and the Ellesmere Port Industrial Area.

The LEP is also a delivery partner for the Local Energy Hub North West with the overarching aims of bringing investment into energy infrastructure projects and making strategic linkages between local institutions, and via Net Zero North West, the LEP is leading on the Investment Case for the Industrial Decarbonisation Cluster Plan. We believe that our already existing infrastructure in HyNet and associated projects makes the area very well placed to successfully deliver this trial, and to maximise investment in the UK's burgeoning low-carbon hydrogen industry. We also support the HyNet project's commitment to transition towards green hydrogen, and like Cheshire West and Chester Council, the relevant local authority, would support the development of a timescale for the transition to green hydrogen at the earliest feasible opportunity via this trial and other mechanisms.

We are pleased to see Cadent's commitment to energy equality and to ensuring there is no loss to residents on either an up-front or ongoing basis through this transition. We support the Council's view that this should be reinforced at each stage of the process and the importance of using this trial as an opportunity to address fuel poverty where it is identified within the trial area. We would also emphasise the importance of effective local engagement in this project.

We look forward to working with Cadent, Cheshire West and Chester Council, and other partners in the hydrogen village trial and to playing our part in supporting the North West and the UK to achieve Net Zero and build a world-leading low-carbon hydrogen economy.

Yours sincerely

[redacted]

[redacted]

Cheshire and Warrington LEP

Wyvern House, The Drumber, Winsford, CW7 1AH
Registered in England and Wales 04453576, VAT GB803790727

19/11/2021

[redacted]
North West Hydrogen Alliance
Thornton Science Park
Pool Lane
Chester
CH2 4NU

To whom it may concern,

I'm delighted to be able to offer the North West Hydrogen Alliance's support to Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

Our Alliance brings together a wide range of regional and national hydrogen stakeholders, and we have already presented a compelling case for the North West to receive Government support to support hydrogen development in this region.

We are fully supportive of Cadent's proposal for a village-scale trial, which we envisage will encourage the roll out of hydrogen production in the North West, unlocking its potential as a cleaner energy solution. This, in turn, will result in the North West being recognised as a centre for innovation and clean growth, improving its reputation as a highly attractive location for sustainable businesses.

Yours faithfully,

[redacted]
North West Hydrogen Alliance

09/11/2021

To whom it may concern,

It is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating on behalf of Net Zero North West.

As an organisation which plans to aid in the delivery of a low carbon industrial cluster by 2030 by bringing companies together, we are fully supportive of Cadent's proposal. Our strengths lie in the unrivalled number of projects already happening in the North West, including E-Port and HyNet, which offer long term, sustainable investment opportunities in net zero. We believe this trial offers the same, and confidently encourage it.

Net Zero North West supports the efforts of Cadent to deliver a hydrogen village trial in Whitby or Helsby which will unlock the potential of hydrogen as a cleaner energy solution, helping the industry plan and invest in the future.

We look forward to working with Cadent in the hydrogen village trial and by doing so are proud to play our part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Sincerely,

Net Zero North West

6 December 2021

To whom it may concern:

CBI North West is supportive of Cadent's proposal to BEIS and Ofgem to deliver village-scale trial of hydrogen heating, as part of the UK's decarbonisation of energy.

We appreciate the scale of the climate change challenge is considerable and urge that critical decisions are made quickly to assist to put market-making-mechanisms in place so that the North West, and the wider UK can capitalise on our first mover advantage in relation to hydrogen. Nationally we would hope to see a 2030 target for green hydrogen production in the UK, and ring-fenced funding to help deliver it.

CBI North West supports the efforts of Cadent to deliver hydrogen village trials, as long as there's a clear delivery plan for consumers, businesses and the local authorities.

Yours faithfully,

[redacted]

[redacted]
northwest@cbi.org.uk
www.cbi.org.uk
@CBItweets

CBI North West
PO Box 232, Wirral CH29 9EG

North West Business Leadership Team
STFC, Daresbury Laboratory,
Sci-Tech Daresbury, Keckwick Lane
Warrington WA4 4AD

[redacted]

www.nwblt.co.uk

[redacted]

19 October 2021

To whom it may concern,

I am pleased to write this letter on behalf of the North West Business Leadership Team in support of Cadent's proposal to BEIS and Ofgem for the delivery of a village-scale trial of hydrogen for heating.

As the founding partner of a collaboration of industry leaders with the aim of driving investment into the net zero economy in the North West, we are keen to move towards a greener energy future, and understand that hydrogen has a key role to play in achieving this.

We are keen to see increased investment in the North West in sustainable industries that will boost our reputation as an attractive location to live and work and support our objective of making a real difference to the region's economy.

We look forward to working with Cadent on the hydrogen village trial and by doing so, we are proud to support a move towards a greener future for Britain, with the North West at the forefront.

Yours faithfully,

[redacted]

[redacted]
North West Business Leadership Team

University of Chester

[redacted]

8th November 2021

To whom it may concern,

I am delighted to be able to offer the University of Chester's support to Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

As an institution, we are pro-actively engaged with the UK's emerging clean growth agenda, and have been consistently supportive of the projects looking to drive this, including HyNet.
We are fully supportive of Cadent's proposal for a village-scale trial, which we envisage will encourage the roll out of hydrogen production in the North West, unlocking its potential as a cleaner energy solution. This, in turn, will result in the North West being recognised as a centre for innovation and clean growth, improving its reputation as a highly attractive location for sustainable businesses.

Yours sincerely,

[redacted]

ESSAR
OIL UK

Essar Oil (UK) Limited
Stanlow Manufacturing Complex
PO Box 3
Ellesmere Port
Cheshire
CH65 4HB
United Kingdom
T +44 (0) 151 350 4000
F +44 (0)
www.essaroil.co.uk

[redacted]

6 December 2021

Dear [redacted]

HyNET Homes

Essar Oil (UK) is playing a key role in the HyNet NW cluster, working with Progressive Energy to deliver the UK's first large scale low carbon hydrogen production facility. This has been achieved through the successful FEED programme undertaken under BEIS Hydrogen Supply Programme and now forms a central part of the Track 1 HyNet industrial decarbonisation cluster.

The UK hydrogen market is nascent, and access to hydrogen is a key rate limiting step to its development. For this market to develop, end users need to establish that their equipment and processes can operate safely and effectively on hydrogen. This confidence is necessary to establish the credibility of hydrogen as an option for policymakers and to create the demand for the swathe of low carbon hydrogen projects under development.

Within the Stanlow Refinery, there is a significant amount of hydrogen available from its catalytic reforming unit in the form of a 90% purity gas stream mixed with light hydrocarbons. Currently this is used for a combination of process and heat applications on the Refinery. This gas can be processed to provide a pure hydrogen stream, using conventional gas processing techniques such as Pressure Swing Adsorption.

Essar is considering potential uses of this stream such as:-

a- underpinning a hydrogen demonstration and skills centre in the region
b- transporting hydrogen offsite via High Pressure Hydrogen Trailers for in-situ testing at industrial facilities and other uses

ESSAR
OIL UK

We are aware that the UK Government is seeking to demonstrate the use of 100% hydrogen in the gas network in order to inform key policy decisions going forward, and that Cadent is developing the HyNet Homes project to do just that, with support from Progressive Energy.

The first unit of HyNet hydrogen production will be able to supply the hydrogen requirements for HyNet Homes, but only as a small fraction of the overall production. However we recognise (a) there may be a need to access hydrogen ahead of the operational date of this unit and (b) that any trial will need a level of resilience that a single source cannot provide. The Refinery source described above could offer both of these.

Of course, any final supply of hydrogen from the source identified will be subject to the negotiation of mutually acceptable commercial terms and legal agreements. Nonetheless, we will continue to engage with you as the HyNet Homes project develops, along with the other use cases identified. It is in all parties' interests to establish means by which this source of hydrogen is developed.

Yours sincerely

[redacted]

Cheshire energy hub

Cheshire Energy Hub is a trading name of Mersey Dee Energy Ltd | Company registration 10357232
Cheshire Energy Hub | Capenhurst Technology Park | Chester | CH1 6EH | United Kingdom
Email info@cheshireenergyhub.co.uk Web www.cheshireenergyhub.co.uk

To whom it may concern,

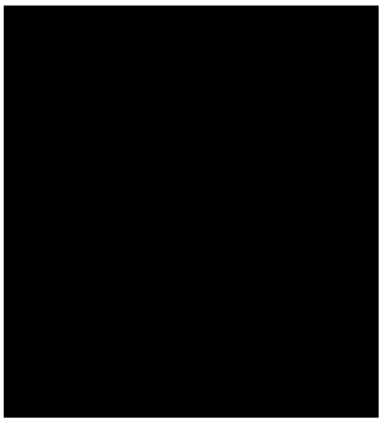
It is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of UK's village-scale trial of hydrogen heating on behalf of Cheshire Energy Hub.

As an organisation, we currently represent an area that consumes around 5% of the UK's energy and contains some of the UK's most significant and energy intensive infrastructure; this is inclusive of but not limited to Ellesmere Port, Essar Oil UK, and Encirc. We currently drive innovation, support industry to succeed and encourage growth and investment across Cheshire, which is why we are fully supportive of Cadent's proposal.

Cheshire Energy Hub supports the efforts of Cadent to deliver a hydrogen village trial in Whitby and Helsby which will support the development of the necessary network infrastructure to underpin a thriving hydrogen sector in Cheshire West and Chester; improving its reputation as a centre for innovation. The trial will stimulate higher levels of skilled green jobs in the North West, attracting inward investment to spread regional prosperity, and we are eager to play our part in this.

We look forward to working with Cadent in the hydrogen village trial and by doing so are proud to play our part in supporting the build of a hydrogen economy and a move towards a greener future for Britain, with the North West at the forefront.

Sincerely,



Brooks House
Coventry Road
Warwick, CV34 4LL

t [redacted]
e info@baxiheating.co.uk
w baxiheating.co.uk

For the attention of:

[redacted]

8 November 2021

RE: HyNet Hydrogen Village Conversion Project

To whom it may concern:

As the company that has developed one of the UK's first hydrogen boilers, we are fully supportive of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating, and keen to play our role.

Our organisation was pleased to be a significant player in the successful Hy4Heat programme and we are a founding member of the Hydrogen Task Force.

Our aim is to provide hydrogen-ready boilers, as well as a range of other alternatives, such as electric boilers, heat network components and heat pumps, to ensure consumers are offered a choice in the energy transition.

We look forward to working with Cadent on the hydrogen village trial and would be proud to be involved in this pilot that helps the UK to achieve net zero emissions through low-carbon, clean energy as we move towards a greener future.

Yours faithfully,

[redacted]

[redacted]

Electricity North West
Linley House, Dickinson Street,
Manchester, M1 4LF

Email: enquiries@enwl.co.uk
Web: www.enwl.co.uk

21 November 2021

To whom it may concern,

I'm pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

Electricity North West is committed to supporting the region to reach zero carbon by 2038. We recently published plans to invest more than £2bn to help to build capacity and support the huge rise in technologies needed to get to Net Zero, including electric vehicles and air source heat pumps.

Alongside this we also acknowledge the importance of hydrogen as an alternative to natural gas and, as such, we welcome Cadent's proposal.

We look forward to working with Cadent and support the development of a hydrogen economy in the North West, strengthening regional prosperity and attracting inward investment.

Yours sincerely

10th November 2021

[redacted]

Falcon Foodservice Equipment
Wallace View
Hillfoots Road
Stirling
Scotland. FK9 5PY
[redacted]
info@falconfoodservice.com
www.falconfoodservice.com

Dear [redacted]

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

Falcon Foodservice Equipment has played an active part in the BEIS-funded Hy4Heat innovation programme; developing catering equipment for use with hydrogen and consequently look forward to working with Cadent in the hydrogen village trials and thus putting our experience and expertise to good use.

We believe hydrogen will play a key part in the UK's low carbon energy future and see trials such as playing a vital role towards large scale roll out.

Yours sincerely

[redacted]

FOCALPOINT

Our Ref: [redacted]

Date: Wednesday 10th November 2021

[redacted]

To whom it may concern:

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

We have played a part in the Hy4Heat innovation programme and, as such, feel we are well placed to support Cadent with future hydrogen trials in the UK.

We look forward to working with Cadent and support this trial to deliver decarbonised heating through the use of hydrogen as opposed to natural gas in the network.

Yours faithfully
FOCAL POINT FIRES LIMITED

[redacted]

[redacted]

HyNet North West

29th November 2021

To Whom it May Concern

It is my pleasure to write a letter on behalf of HyNet North West, in support of Cadent's proposal to BEIS and Ofgem for funding for the delivery of a village-scale trial of hydrogen for heating.

HyNet North West will play a crucial role in positioning the UK as a leader in clean energy. This game-changing project will capture and store carbon dioxide (CO_2) and dramatically increase the supply of clean hydrogen in the UK, reducing CO_2 emissions by 10 million tonnes every year by 2030. HyNet is critical not only to meeting the country's net zero targets, but also in facilitating the government's levelling up agenda by providing new low-carbon growth opportunities for UK businesses.

HyNet is driven by demand, it is affordable, and will deliver on several mid- and end- of decade 10 Point Plan targets for hydrogen production and carbon capture and storage (CCS). For instance, HyNet has the potential to produce 80% of the UK's clean hydrogen 2030 target for transport, industry, and homes. More than 30 companies – including household names such as Unilever, Pilkington, Kellogg's, Heinz, PepsiCo, Jaguar LandRover and Heineken – support the project as the enabler of their switch to hydrogen or to directly capturing CO_2. HyNet not only safeguards these businesses, enabling them to contribute to net Zero by 2050 but will provide the North West with the opportunity to thrive in a new, low carbon environment.

Investment in infrastructure and skills is a key enabler of levelling up across the North West of England, where 340,000 people are employed in manufacturing – more than any other part of the UK. HyNet will help to create 6,000 new low-carbon jobs in the UK's industrial heartland, whilst developing a hydrogen economy is set to generate a £17 billion economic impact for the North West and North Wales. Across the UK, HyNet will generate up to £31 billion GVA by 2050.

We are fully supportive of Cadent's proposal for its hydrogen village trials as it aligns with the wider HyNet aims for the region. In particular it leverages the hydrogen capacity and infrastructure being laid down in the region to unlock carbon savings in the 'hard-to-abate' domestic heat sector.

No other region in the UK has such a comprehensive set of hydrogen infrastructure in advanced stage of development, including large scale, low cost, low carbon hydrogen production, hydrogen distribution and hydrogen storage. This Track 1 selected cluster provides a unique foundation to provide the supply resilience necessary, not only to undertake trials, but as a platform for longer term operation.

We look forward to working closely with Cadent as a key HyNet partner and support the hydrogen village trial. We will be proud to play an integral part in the trials as they support the creation of a long-term, sustainable and multi-sector hydrogen economy in the North West.

Yours faithfully,

[redacted]

[redacted]

Swan House, Bonds Mill, Stonehouse, GL10 3RF

ideal
HEATING

[redacted]

11th November 2021

To whom it may concern:

I am writing in support of Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

We believe that Ideal Heating's founding principles of quality, innovation, and value building means we will be well placed to support customers in the hydrogen villages, as we understand their needs and concerns. As such, we would be very pleased to work with Cadent and in partnership support the people living and working in the villages to use hydrogen.

We very much look forward to working with Cadent on this trial and will be proud to play our part in moving towards a greener future for Britain.

Yours faithfully,

[redacted]

Legendfires
Quality Style Choice

Legend Fires Ltd
Unit 404
Glenfield Park
Business Centre
Blakewater Road
Blackburn
Lancashire
BB1 5QH

Tel: [redacted]
Fax

info@legend-fires.com
www.legend-fires.com

[redacted]

10th Nov 2021

To whom it may concern:

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating

Legend Fires has played an active part in the BEIS-funded Hy4Heat innovation programme; developing domestic appliances for use with hydrogen. So we very much look forward to working with Cadent in the hydrogen village trials and putting our experience and expertise to good use.

We would be very pleased to play a part in the trial that supports the UK achieving net zero by using low-carbon, clean energy.

Yours faithfully,

[redacted]

Milan, November 11th 2021

To whom it may concern,

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

At MeteRSit our commitment is to create smart solutions for climate control and consumption measurement for a more sustainable world. We have developed smart meters for use with hydrogen under the Hy4Heat innovation programme, so we feel we have a lot of experience and expertise we can share with Cadent.

We look forward to working with Cadent in the hydrogen village trial and would be proud to be involved in this pilot that helps the UK to achieve net zero through low-carbon, clean energy.

Yours faithfully,

[redacted]

[redacted]

Pietro Fiorentini

Cadent
Brick Kiln Street
Hinckley
Leicestershire
LE10 0NA

11th November 2021

For the attention [redacted]

Dear Sirs,

1

Ref.: HyNet Hydrogen Village

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

At the Pietro Fiorentini Group our commitment is to a more sustainable future. We see the hydrogen villages as an extension of the work we're already part of – such as developing smart meters for use with hydrogen under the Hy4Heat innovation programme.

We are keen to work with Cadent in the hydrogen village trial and be involved in a pilot that helps the UK to achieve net zero through low-carbon, clean energy.

Yours faithfully,

[redacted]

British Gas Services
Millstream
Maidenhead Rd
Windsor
SL4 5GD
www.centrica.com

22nd November 2021

To whom it may concern,

I'm pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

Climate change is one of the greatest challenges facing society, and with around 90% of our total carbon emissions coming from our customers, the biggest thing we can do is to help consumers use energy more sustainably, including supporting fuel switching technologies. We are committed to continuing to find solutions to some of the key challenges related to decarbonization. We believe that a mixture of different heat technologies will be needed to decarbonise homes and businesses, including the electrification of heat and, potentially, the use of hydrogen for heat. For this reason, we see the village trials as an important step in determining the extent to which hydrogen can be part of the solution, and how this might happen. As such we support Cadent's proposals to deliver a Hydrogen Village trial.

As an experienced consumer facing business, British Gas will look to support the Cadent Hydrogen Village trial by leveraging our expertise in delivering in-home solutions to meet diverse consumer needs. We believe that we could support the trial, and improve the consumer experience through:

a) Ensuring the trial appropriately engages with consumers and delivers for them
b) Ensuring the commercial feasibility of the proposals
c) Ensuring the delivery of the in-home solutions (including the installation and maintenance of heating systems and appliances)
d) Safety considerations (including training and accreditation)

We're confident a cleaner, greener, hydrogen-powered future can be delivered using the UK's existing gas network and are keen to play our part. In this, we look forward to working with Cadent in the Hydrogen Village trial.

Yours faithfully,

[redacted]

British Gas
Services &
Solutions

HHIC
HEATING & HOTWATER INDUSTRY COUNCIL

23rd November 2021

To whom it may concern,

Please accept this letter of support for Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

The Heating and Hotwater Industry Council, HHIC, has closely followed the progress of the Hy4Heat, and other hydrogen innovation programmes over the past few years and we are committed to using our knowledge and expertise to support the decarbonisation of heat in homes and businesses using hydrogen.

We represent our member organisations who are excited to be part of the solution to achieving net zero and we stand ready to work with Cadent in a successful hydrogen village trial.

Yours faithfully

The Heating and Hotwater Industry Council

[redacted]
Cadent
Brick Kiln Street
Hinckley
Leicestershire
LE10 0NA

14th October 2021

RE: HyNET Application to BEIS

Dear [redacted],

About Vaillant Group

The Vaillant Group is a global market and technology leader in the fields of heating, ventilation and air-conditioning technology. For over 140 years, we have been following a strategy designed to achieve sustainable and profitable growth. Today, our family-owned company has 10 sites in 6 European countries and China.

Founded in Remscheid, Germany, in 1874, the Vaillant Group today supplies innovative hot water, room heating and cooling solutions to countries all over the world. Our company develops high-efficiency products that save energy, conserve resources and enhance people's quality of living.

As a business we take responsibility for "Taking care of a better climate" – to safeguard the home of millions of people and the environment. All of our employees are working to achieve this shared vision. It is both our ambition and our common goal. Innovation and sustainability are at the heart of everything which Vaillant does as a business. The Vaillant Group is becoming climate-neutral, and we have developed an ambitious long term climate strategy, which focuses on the following areas;

- Climate-neutral this year thanks to forestation projects
- Company's own CO_2 emissions to be halved by 2030
- The Vaillant Group is thus supporting the aims of the United Nations and the EU on climate protection and sustainable development

We recognise the UK has a legally binding target of achieving Net-Zero carbon emissions by 2050 and Vaillant believes that a range of solutions will be necessary to enable the UK economy to achieve this aim. Hydrogen blending has been identified as a key early enabler to support the development of a hydrogen economy, as exemplified by the UK Government's Ten Point Plan and Hydrogen Strategy.

Vaillant understands that Cadent and Wales & West seek to develop the first 100% hydrogen village. We also understand that the core purpose of this ambitious project is to establish the UK hydrogen deployment blueprint. In doing so to also create the first permanently supplied 100% hydrogen village, and then potentially, the first town. We believe this project is of critical importance to facilitate in the decarbonisation of UK gas supplies. The practical deployment of hydrogen on a small scale (c.2000 homes and businesses) to develop industry best practice, is an essential pre-requisite to enabling the wider adoption of hydrogen within the gas network in a consistent, timely and cost-effective manner.

We fully support the ambitions of this project and our current roadmap for appliance development allows for appliances to be ready in conjunction with the project timelines. We would also like to see hydrogen boiler/heat pump hybrid solutions considered in order to understand the potential benefits of a fully optimised (both cost and efficiency), decarbonised grid.

We look forward to seeing this project progress and are keen to share in the development and knowledge that this scheme will bring forth.

Yours sincerely,

[redacted]

[redacted]

Vaillant Group

Viessmann Ltd, Hortonwood 30, Telford, Shropshire TF1 7YP

Cadent
Brick Kiln Street - Hinckley
Leicestershire
LE10 0NA

Our Ref | Your Ref | Date 2 November 2021

Reference: HyNet hydrogen village – Letter of support

To whom it may concern;

Viessmann is keen to support Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

We are committed to fulfilling our social responsibilities and we are working to ensure all our processes are environmentally compatible and encourage the use of renewable forms of energy. As such, we would be delighted to partner Cadent on this exciting programme and we would form a genuine collaboration to support the decarbonisation of heat through using hydrogen in Cheshire West and Chester.

Our aim is to provide hydrogen-ready boilers, as well as a range of other alternatives, such as electric boilers and heat pumps, to ensure consumers in the hydrogen village trials are offered a choice.

We look forward to working with Cadent in the hydrogen village trial and would be proud to be involved in this pilot that helps the UK to achieve net zero through low-carbon, clean energy, and move towards a greener future for Britain.

Yours faithfully,
VIESSMANN LIMITED

[redacted]

Thermotechnology

Bosch Thermotechnology Ltd.
Cotswold Way, Warndon
Worcester, WR4 9SW

Telephone: [redacted]
www.bosch-thermotechnology.co.uk

9th November 2021

F.a.o. [redacted]
Cadent
Brick Kiln Street - Hinckley
Leicestershire
LE10 0NA

To whom it may concern:

It is our pleasure to support Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of Hydrogen heating.

Worcester Bosch was part of the successful Hy4Heat Innovation Programme and has developed Hydrogen-ready boilers, as well offering a range of other heating products for consumers and commercial organisations.

Our aim is to provide Hydrogen-ready boilers, as well as a range of other alternatives, such as electric heat pumps, to ensure consumers in the Hydrogen village trials are offered a choice of low carbon heating technologies.

We look forward to working with Cadent in the Hydrogen village trial and would be proud to be involved in this pilot that helps the UK to achieve net zero through low-carbon, clean energy, and move towards a greener future for Britain.

Yours faithfully

[redacted]

Bosch Thermotechnology Ltd.

ICOM
Industrial & Commercial
Heating Equipment Association

23rd November 2021

To whom it may concern,

Please accept this letter of support for Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

The Industrial and Commercial Heating Equipment Association, ICOM, has closely followed the progress of the Hy4Heat, and other hydrogen innovation programmes over the past few years and we are committed to using our knowledge and expertise to support the decarbonisation of heat in homes and businesses using hydrogen.

We represent our membership companies, working in non-domestic heating, who are excited to be part of the solution to achieving net zero and we stand ready to work with Cadent in a successful hydrogen village trial.

Yours faithfully

[redacted]

[redacted]

The Industrial and Commercial Heating Equipment Association (ICOM)

Continental Product Engineering Limited
Prospect House, Off Beccles Road,
Loddon, Norwich, NR14 6JD, UK
[redacted]
enquiries@continental-uk.com

10/11/2021

[redacted]
Cadent
Brick Kiln Street - Hinckley
Leicestershire
LE10 0NA

To whom it may concern,

We are pleased to write in support of Cadent's proposal to BEIS and Ofgem to deliver a village-scale trial of hydrogen heating.

Continental has played an active part in the BEIS-funded Hy4Heat innovation programme, developing gas assemblies for use with hydrogen. We consequently look forward to working with Cadent in the hydrogen village trials and thus putting our experience and expertise to good use.

We believe hydrogen will play a key part in the UK's low carbon energy future and see trials such as these playing a vital role towards large scale roll out.

Yours faithfully,

[redacted]

[redacted]

23rd November 2021

To whom it may concern,

Please accept this letter of support for Cadent's proposal to BEIS and Ofgem to deliver village-scale trials of hydrogen heating.

The Energy and Utilities Alliance, EUA, has closely followed the progress of the Hy4Heat, and other hydrogen innovation programmes over the past few years and we are committed to using our knowledge and expertise to support the decarbonisation of heat in homes and businesses using hydrogen.

We represent our member organisations who are excited to be part of the solution to achieving Net Zero and we stand ready to work with Cadent in a successful hydrogen village trial.

Yours faithfully

The Energy and Utilities Alliance

BOC Limited,
Operations Centre,
Bawtry Road,
Brinsworth,
South Yorkshire,
S60 5NT.

Progressive Energy Limited,
Swan House,
Bonds Mill,
Stonehouse,
Gloucestershire, UK
GL10 3RF

Tel: [redacted]
Email: [redacted]

2nd December 2021

To Whom It May Concern,

It is my pleasure to write a letter of support on behalf of BOC (A Linde Company) which specifically relates to the HyNet Homes project *"WP1: Hydrogen Supply and Resilience"*.

BOC is the UK and Ireland's leading industrial, medical and specialty gases provider. We produce & supply compressed, bulk and pipeline gases, chemicals, engineering solutions and equipment. As such, we believe that we have the relevant technology and capacity to offer support to provide a resilient Hydrogen supply solution in support of Cadent's proposal to BEIS and Ofgem for funding in the delivery of a village-scale trial of Hydrogen for heating (HyNet Homes project).

BOC are supportive of the project aims to demonstrate the safety and practicality for converting existing gas networks to 100% Hydrogen with the aim of unlocking a decarbonized option for home heating.

Progressive Energy have engaged with BOC during the outline design stage of the project to explore options available for Hydrogen supply with a focus on the provision of backup supplies to ensure a reliable and resilient solution for consumers. These discussions have been focused at a feasibility level, to identify suitable technology and capacities for screening purposes, to be developed further in the next project stage.

BOC produce and supply a range of small packaged steam methane reformers from our HYDROPRIME® Min range which are designed to produce Hydrogen from natural gas feedstock. BOC also have a large-scale Hydrogen production plant located at St Helens which has recently

provided tube trailer Hydrogen to the HyNet Industrial Fuel Switching Trials in the North West region. We consider these to be critical capabilities in support of this project.

BOC look forward to further engagement with Progressive Energy to consider the Hydrogen resilience requirements that will be considered in the detailed design stage of the HyNet Homes project.

Yours faithfully,

[redacted]

The Letter of Support herein is based upon information that you have provided to BOC and is intended for demonstrating BOC initial support only. It is not for execution or incorporation into a contract that may result between you and BOC. Neither you nor BOC shall be obligated in any way until such time as we have agreed upon the terms and conditions and executed a final agreement.

No statement made by BOC in this Letter of Support shall be construed as any representation or warranty including, but not limited to, implied warranties of fitness for a particular purpose, satisfactory quality or merchantability, representations or warranties as to performance, product or service availability, or any other representation or warranty and such provisions shall only be in accordance with the agreement.

02/12/2021

Address

Dear ……

It is my pleasure to write a letter in support of Cadent's proposal to BEIS and Ofgem for funding to support the delivery of the UK's village-scale trial of hydrogen heating.

As the UK's largest trade union, we have long supported the important role hydrogen can play in the future of the economy and further the role Hydrogen will perform in Britain's energy plans especially in driving the UK towards net zero.

Importantly for UNISON with many of our members working in the gas industry we see Hydrogen as essential to preserving skilled employment and in creating thousands of permanent highly skilled green jobs across the economy.

We are clear that progress towards a Hydrogen future cannot wait and so projects like this are essential to bringing much needed investment forward.

Yours Sincerely

[redacted]

UNISON
130 Euston Road
London NW1 2AY
[redacted]

.

Stopford Limited
Mere Hall Business Centre
Bucklow Hill Lane
Knutsford
Cheshire
WA16 6LE
United Kingdom

Progressive Energy Limited,
Swan House,
Bonds Mill,
Stonehouse,
Gloucestershire, UK
GL10 3RF

Tel [redacted]
www.stopford.co.uk

10th December 2021

Re. HyNet Homes – WP1: Hydrogen Supply & Resilience

To whom it may concern,

It is my pleasure to write a letter on behalf of Stopford in support of Cadent's proposal to BEIS and Ofgem for funding for the delivery of a village-scale trial of Hydrogen for heating (HyNet Homes project).

Stopford Ltd. is a leading Engineering & Projects Consultancy, providing services to the Chemical & Petrochemical sectors particularly in the North West of England for over 35 years, and since 2005 has been focussed heavily on projects in the renewable energy sector.

Stopford is supportive of the project aims to demonstrate the safety and practicality for converting existing gas networks to 100% Hydrogen, therefore unlocking Hydrogen as a decarbonized option for home heating.

Progressive Energy has contracted with Stopford during the Outline Design Stage of the project for engineering support to WP1 on cost & schedule estimating for the Hydrogen Supply & Resilience solution proposed. Stopford has utilised a team of our Lead Consultants with skills in the relevant areas and over 140 years of combined projects experience to produce the detailed programme and budget estimates for the defined scope in Stages 2 and 3.

Stopford is confident that the 9-month FEED programme outlined for Stage 2 is realistic and achievable and includes the necessary activities to define and enable a funding decision for procurement of the WP1 elements of the project at the start of Stage 3. The Stage 2 cost estimate risk has been minimised by constructing it from a detailed breakdown of the manhours required

for deliverables supporting the various elements of the scope. Accordingly, Stopford estimates the Stage 2 costs for FEED at an accuracy of ±10%.

The Stage 3 costs and duration shall necessarily be informed by and revised during the course of Stage 2; however, a credible long-range view of the engineering and supply chain activities likely to be required to progress from the Stage 3 funding decision to the start of operation has been constructed. Stopford has minimised the overall cost estimate risk, for example by seeking budget quotes from vendors for capital equipment where possible and utilising appropriate estimation factors for installation costs. Accordingly, this estimate is likely to be not more accurate than ±30% at this point in time.

Stopford looks forward to further engagement with Progressive Energy on the HyNet Homes project and opportunities to support it in subsequent Stages.

Yours faithfully,

[redacted]

The estimates and programme provided by Stopford in support of this project are based on the information provided to us by the client, and certain necessary assumptions. Inaccuracies in these data may therefore invalidate the conclusions drawn during the work. As such, the statements made are offered as an independent engineer. Stopford Ltd. gives no undertaking or warrantee with respect to any losses or liabilities incurred by the use of information contained therein.

FOR THE ATTENTION OF

[redacted]
Cadent Gas Ltd
Ashbrook Court, Prologis Park
Central Boulevard
Coventry
CV7 8PE

13 December 2021

Dear [redacted]

Cadent – Hydrogen Village Trial

I am writing to express Xoserve's support for Cadent's Hynet Hydrogen Village Trial.

As you know, Xoserve is the Central Data Service Provider (CDSP) for Great Britain's gas market and provides a single point of service for gas suppliers, shippers and transporters, ensuring that their data is managed securely and consistently and helping Britain's gas market to run efficiently and reliably.

At a high level, our services centre around the custodianship and maintenance of the central register of the 24 million gas meter points in Great Britain. We ensure that data about gas use and supply is transported, processed, exchanged and updated securely, creating a single, consistent source of information across the industry. From this central register we identify which companies are responsible for gas entering and leaving the network, which lets it remain 'in balance' between supply and demand and allows gas distribution networks to invoice the shipping community accurately for carrying gas to metered premises. We also process supplier switches.

Hydrogen is becoming increasingly recognised by both industry and the UK Government as a viable option for heating to meet the 2050 Climate Change Act targets. The UK Government's commitment to deliver hydrogen heat trials at a village scale by 2025 and within a town by 2030 clearly demonstrates its belief that Hydrogen could represent an opportunity to decarbonise residential heat with minimal disruption and cost to consumers, thus ensuring a fair energy transition for all.

Xoserve is delighted to support Cadent in its proposal to run the Hydrogen Village Trial. My team and I are committed to working in collaboration with your organisation to design and deliver a solution to convert from natural gas to 100% hydrogen for the trial area without adverse impact on the billing processes managed by Xoserve as CDSP and which allows consumers to continue to be able to switch supplier, suppliers to continue to be able to switch shipper and most CDSP industry processes to continue to operate as they currently do.

I understand that this is a letter of support, expressing interest from Xoserve in supporting Cadent with the Hydrogen Village Trial, rather than a legally binding contract and that it may, in time, lead on to a more formal agreement to support the trial.

I wish you all the best with your bid for the Hydrogen Village Trial.

Yours sincerely,

[redacted]

Department for Business, Energy & Industrial Strategy

ofgem
Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX J: WP1 Hydrogen Supply Option Selection Summary Presentation

This Annex provides further details on the rationale for our hydrogen supply configuration for the proposed Whitby hydrogen heating village trial discussed in section 4.1: A statement of the options identified for meeting requirements for hydrogen supply and resilience.

Cadent
Your Gas Network

Department for Business, Energy & Industrial Strategy

ofgem
Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

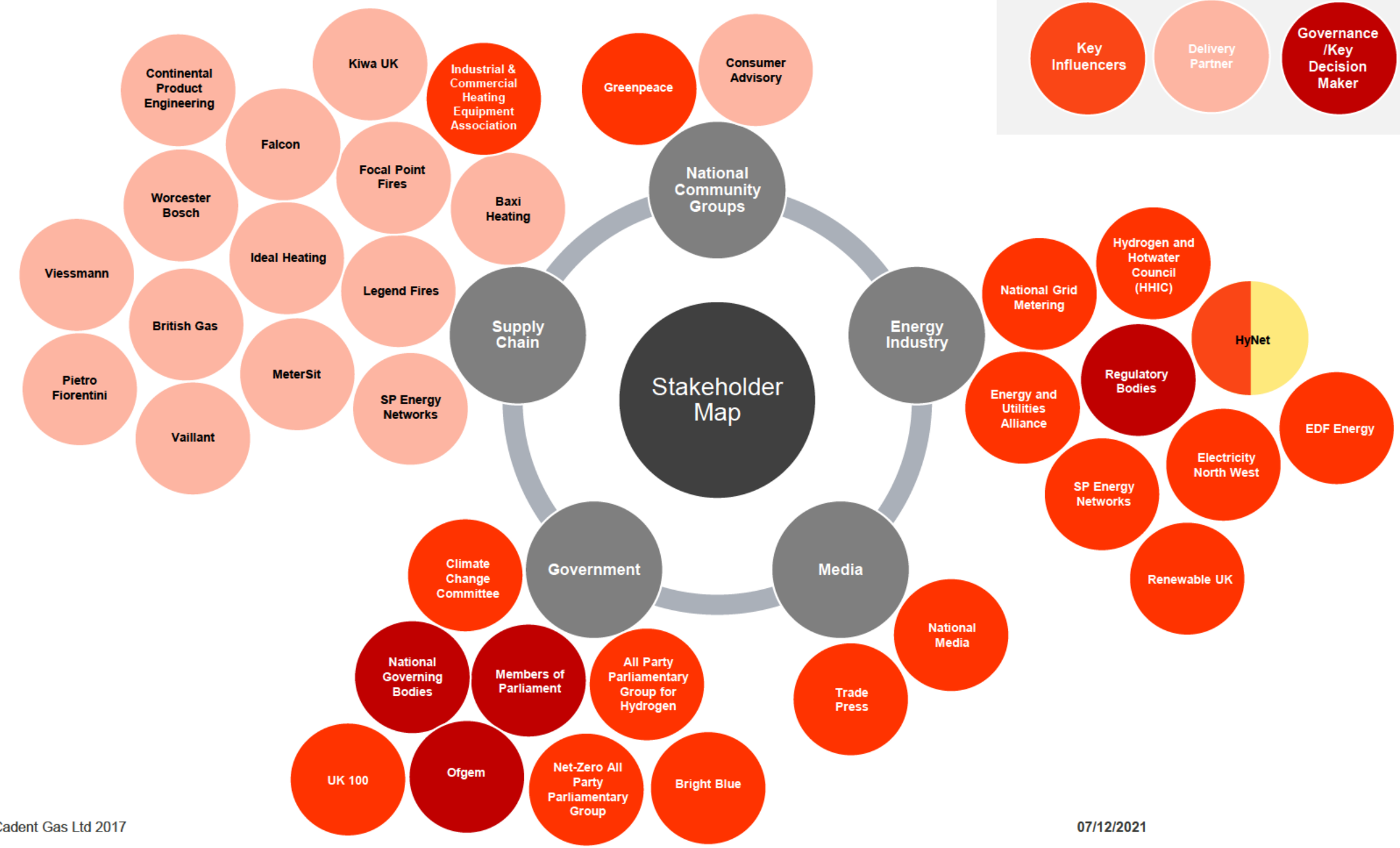
ANNEX K: Identified Stakeholders

This Annex provides the full list of national, regional, and local stakeholders that were identified as part of our Stage 1 hydrogen village trial stakeholder mapping exercise.

Cadent
Your Gas Network

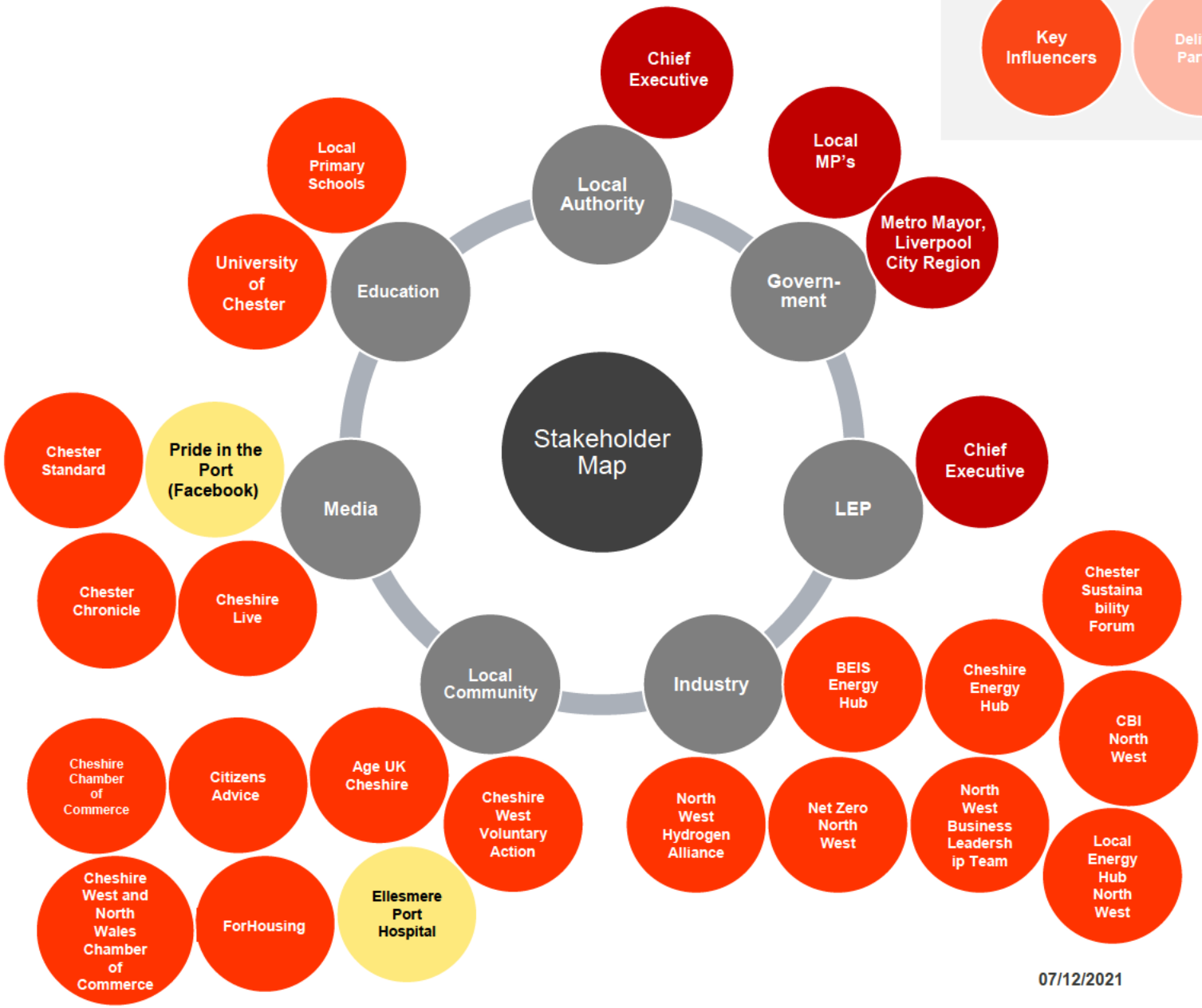
National Stakeholders

Cadent Your Gas Network



Local and Regional Stakeholders

Cadent Your Gas Network



Department for Business, Energy & Industrial Strategy

ofgem
Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX L: Social Value Report

This Annex details our proposed social value offer for the Whitby hydrogen heating village trial, ensuring the project delivers wider social, economic, and environmental outcomes and benefits for communities within both Whitby and neighbouring wards. Shaped around four themes, our social value offer has been developed following local stakeholder engagement and desktop Local Needs Analysis. The offer supports Chester West and Chester Council's ambition to create a fairer future for residents by tackling the poverty emergency, and links to Cadent's Force for Good Strategy.

Cadent
Your Gas Network

ARUP

Local Needs Analysis

Cadent Hydrogen Village Submission

December 2021

Prepared by Arup for Cadent Hydrogen Village Trial proposal

Introduction

This is the Local Needs Analysis for the neighbourhoods and communities that will benefit from the Cadent Hydrogen Village Trial.

The purpose of this report is to support Cadent's submission to BEIS and Ofgem for a Hydrogen Heating Village Trial. The findings of this Local Needs Analysis have been used to inform the outcomes-based development of a targeted Social Value Framework for the project that meets the priorities of the local area.

Local Needs Analysis:

A Local Needs Analysis looks to identify the issues that are important now and in the near future within the communities directly impacted by, or neighbouring a particular project or programme. In doing so, gaps and opportunities are highlighted. The analysis considers those living, working and using / visiting the area.

By overlaying an understanding of the key, local strategic and policy drivers, a set of prioritised local needs can be developed. In turn, this list of priority local needs can be refined to reflect the nature of the project being undertaken, in order to inform a targeted **and** achievable Social Value Framework.

By taking an informed and targeted approach, Cadent and the Hydrogen Village Trail project are more likely to generate meaningful outcomes in the community and contribute to sustainable, positive change.

A summary of the key needs and related opportunities for social value generation is provided at the end of this report.

There is significant public and voluntary, community and social enterprise (VCSE) sector activity in the area, and collaborating with or supporting these existing local partners will be key to a strong and achievable Social Value Framework..

Process followed:

A five phase approach has been followed to develop the Social Value framework, as shown in Figure 1.

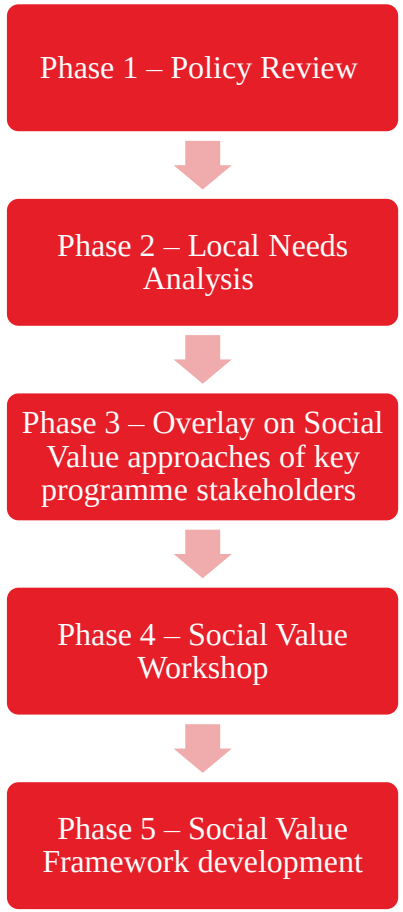


Figure 1: Approach to developing a social value framework

Introduction

Location of the Hydrogen Village Trial

This is the Local Needs Analysis for the neighbourhoods and communities that will benefit from the Cadent Hydrogen Village Trial.

This Local Needs Analysis focuses on the region defined as ‘Whitby, Ellesmere Port’ located in the Cheshire West and Chester local authority.

Figure 2: Location of Cheshire West and Chester Local Authority

The region defined as ‘Whitby, Ellesmere Port’ constitutes two wards.

These are:

- Whitby Park
- Whitby Groves

Figure 3 below illustrates the two wards within which the region defined as ‘Whitby, Ellesmere Port’ sites, with Figure 4 illustrating the wider wards which neighbour the trial neighbourhood.

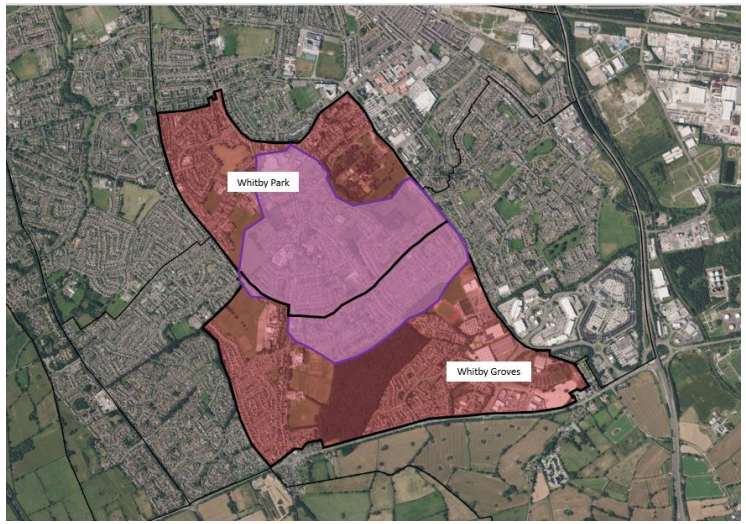


Figure 3: Location of Whitby Park and Whitby Groves Wards (red) Outline of area defined by Cadent as Whitby, Ellesmere Port (purple)

Figure 4: Location of Whitby Park and Whitby Groves Wards (red) Outline of area defined by Cadent as Whitby, Ellesmere Port (purple), with surrounding ward names

Figure 5 on the next page provides a more detailed overview of the area which shows the public realm, key landmarks and greenspace within the area defined as Whitby, Ellesmere Port.

Whitby, Ellesmere Port

ARUP

Figure 5: Outline of area defined by Cadent as Whitby, Ellesmere Port

Policy Review

ARUP

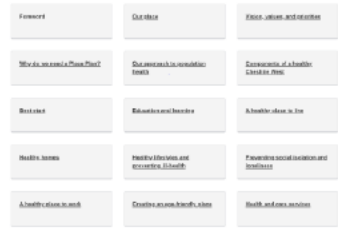
Conducting the Policy Review

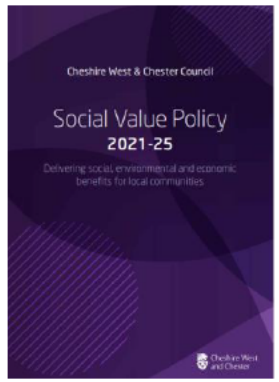
By understanding the key, local strategic and policy drivers, a set of prioritised local needs can be developed. In turn, this list of priority local needs can be refined to reflect the nature of the project being undertaken, in order to inform a targeted **and** achievable Social Value Framework.

As part of the policy review we reviewed local policy and strategies from the Cheshire West and Chester Council and also more local strategies from Ellesmere Port. In addition, we looked at the strategies and priorities of other key project stakeholders including: the Government, BEIS and also Cadent. The range of policies reviewed is illustrated in Figure 6 on the next page.

Policy Review

ARUP





Ellesmere Port

Cheshire West and Chester Council

1. **Fight coronavirus** by helping businesses to bounce back from the impacts of COVID-19, supporting a safe return to the workplace and accelerating the development and manufacture of a vaccine.

2. **Tackle climate change**: reduce UK greenhouse gas emissions to net zero by 2050. (Cross-cutting outcome also supported by DEFRA, DFT, MHCLG and HMT)

3. **Unleash innovation** and accelerate science and technology throughout the country to increase productivity and UK global influence.

4. **Back long-term growth**: boost enterprise by making the UK the best place in the world to start and grow a business.

Hydrogen Village

BEIS

UK Government

Cadent

Themes		Policy outcomes
Theme 1	COVID-19 recovery	Help local communities to manage and recover from the impact of COVID-19
Theme 2	Tackling economic inequality	Create new businesses, new jobs and new skills
		Increase supply chain resilience and capacity
Theme 3	Fighting climate change	Effective stewardship of the environment
Theme 4	Equal opportunity	Reduce the disability employment gap
		Tackle workforce inequality
Theme 5	Wellbeing	Improve health and wellbeing
		Improve community cohesion

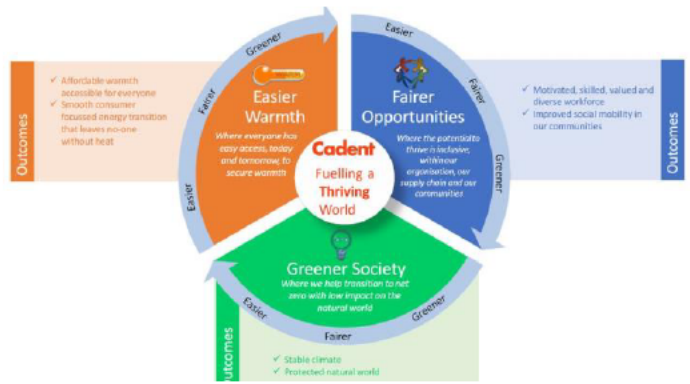


Figure 6: Infographic of the policies and strategies reviewed as part of the policy review

Policy Priorities

Local Stakeholders

Policy documents

Following a review of current policies for Cheshire West and Chester, the following were considered in greater detail to inform this report:

1. Cheshire West and Chester- Social Value Policy 2021-25
2. Cheshire West and Chester – Our People Plan 2021-2024
3. Cheshire West Place Plan
4. Cheshire West and Chester – Council Plan 2020-24
5. West Cheshire Climate Emergency Response Plan
6. Ellesmere Port – Vision and Strategic Regeneration Framework (SRF) produced by the Ellesmere Port Development Board.
7. Draft Cheshire West and Chester Inclusive Economy Action Plan

Other Key Stakeholders

Stakeholder strategies

1. Cadent's – Force For Good Strategy

Cadent's approach to social value is summarised in its Force for Good strategy which has a focus on three themes:

- Easier warmth
- Fairer opportunities,
- Greener society and

2. UK Government's Social Value Model

National Government's approach to social value follows the Social Value Model. The model has five themes:

- Covid-19 recovery,
- tackling economic inequality,
- fighting climate change,
- equal opportunity and
- wellbeing.

3. BEIS Outcome Delivery Plan: 2021 to 2022

As BEIS is a government body, it is presumed they will follow the UK Government's Social Value approach. BEIS also have their own outcome delivery plan: 2021-2022 which has four themes:

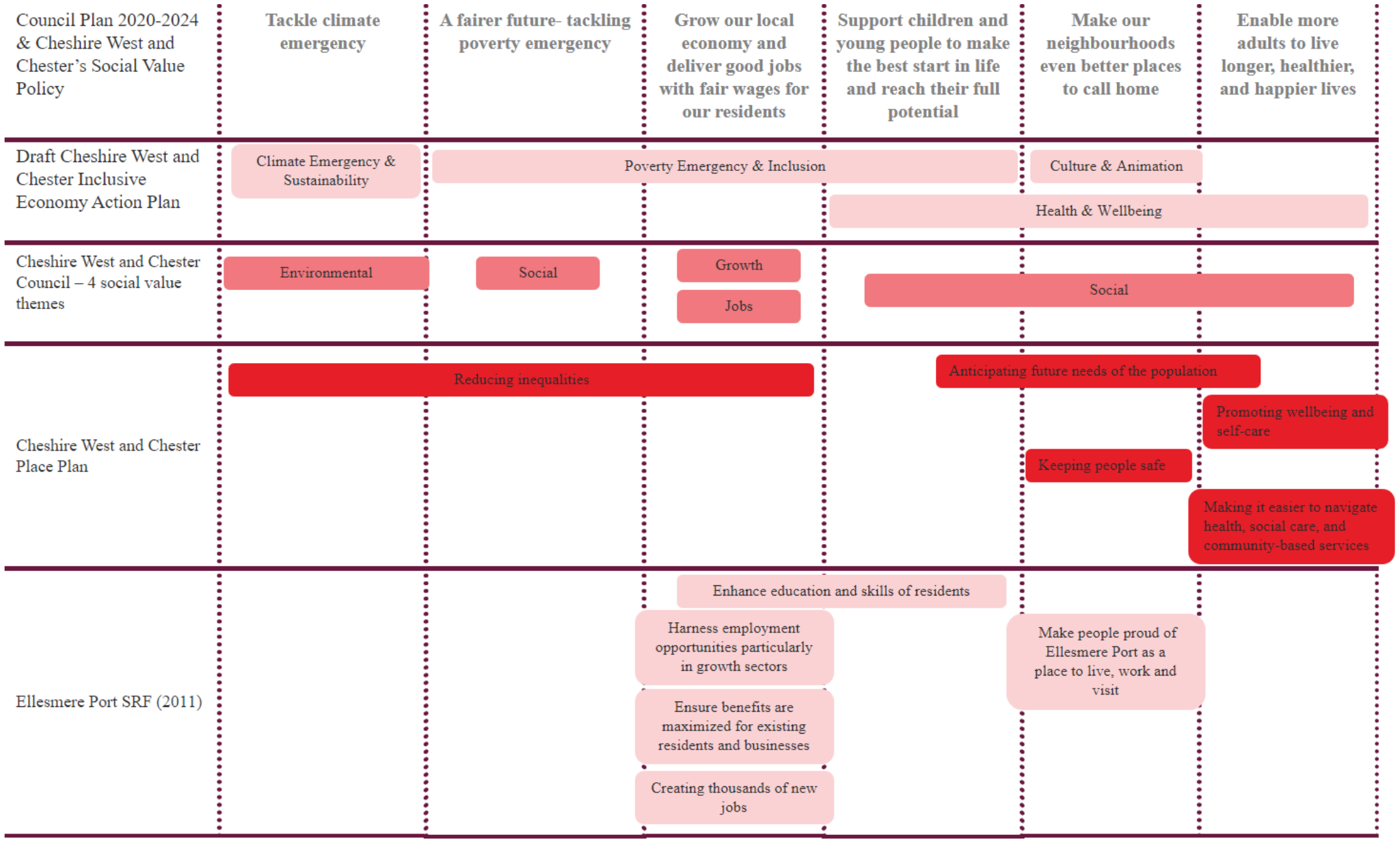
- fight coronavirus,
- tackling climate change,
- unleash innovation and
- back long-term growth.

Cadent's, the Government (and BEIS) priorities all have a focus on fighting climate change and progression towards a greener society.

Economic growth was a key theme throughout the reviewed stakeholder strategies and Cheshire West and Chester's local policy. This was underpinned by tackling economic inequality and backing long-term growth being a key theme throughout the reviewed strategies. Both Cadent and the Government also identified fairer/equal opportunities as priority in their strategies.

Local Policy Priorities*

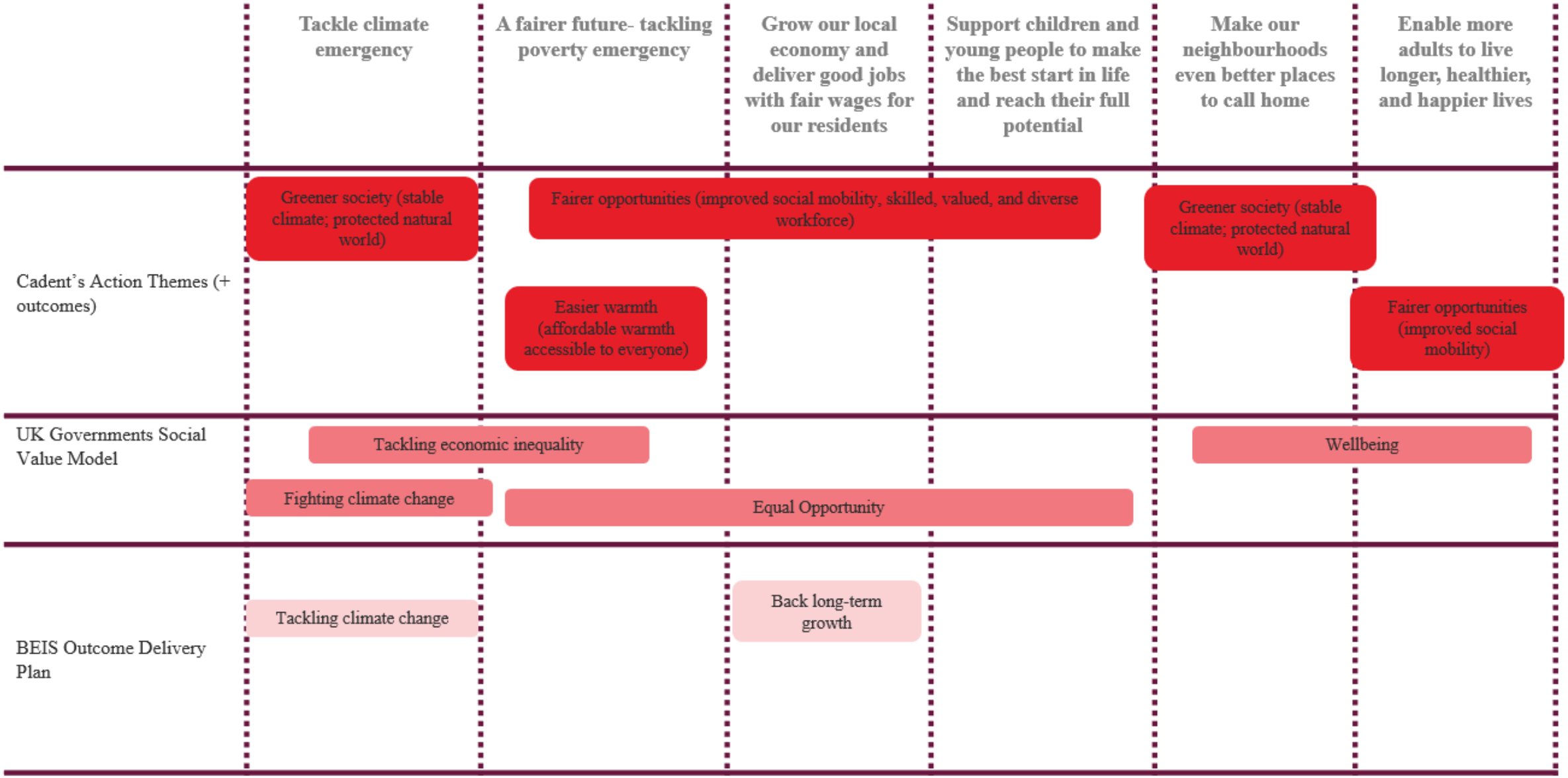
ARUP



** Local policy themes mapped against the 6 themes of the Cheshire West and Chester Council Plan*

Stakeholder Priorities*

ARUP



** Stakeholder policy themes mapped against the 6 themes of the Cheshire West and Chester Council Plan*

Local Needs Analysis

Methodology

Local Needs Analysis

On the basis of this initial policy review, it was decided to undertake the socio-economic baseline review or local needs analysis against 6 priority themes:

Figure 7: Initial social value themes for Local Needs Analysis

The initial, local socio-economic baseline analysis was undertaken solely as a desktop exercise, accessing open-source demographic data. Following an internal review of the analysis with the project team and subsequent engagement with Cheshire West and Chester council and local partners, it was agreed to consolidate the 6 themes further to take into account cross-cutting themes.

Therefore, four priority social value themes were chosen against which to develop the Social Value Framework for the project.

1. Tackle the Climate Emergency
2. Grow our Local economy and deliver good jobs with fair wages for our residents
3. Support children and young people to make the best start in life and reach their full potential
4. Enable more adults to live longer, healthier and happier lives

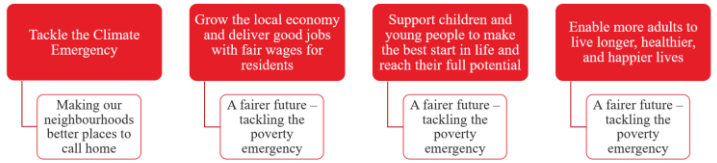


Figure 8: Themes for the Whitby Local Needs Analysis

The rest of this report is set out against these four themes.

Data sources used for the Local Needs Analysis:

Indices of Multiple Deprivation (IMD) data has been used to inform the analysis. IMD are the official measure of relative deprivation for small areas or neighbourhoods (also known as Lower Super Outputs Areas or LSOAs) in England. IMD scores or ranks each LSOA against seven different domains, each of which is made up of a basket of indicators:

- Income
- Employment
- Education, Skills & Training
- Health Deprivation & Disability
- Crime
- Barriers to Housing and Services
- Living Environment

This report is also informed by analysis of other national public data sources, such as the 2011 Census and Nomis. Despite being one of the most comprehensive socio-economic datasets available, the 2011 census data is now out of date and there is a risk that it does not fully reflect the current picture of the region. It is also important to be conscious of how events such as COVID-19 may have affected the region. The Census 2021 data is set to be released March 2022/2023, and a revisit of the analysis once it is published, would be advised.

Noting the scale at which data was collected is also important. The data in this report is at ward or LSOA level. LSOAs are small geographic areas consisting of on average 1500 people or 650 households. LSOA data figures should not be used as absolutes, but instead used for relative comparisons between areas.

Social Value Themes

ARUP

1. Tackle the Climate Emergency
   - Making our neighbourhoods better places to call home
2. Grow the local economy and deliver good jobs with fair wages for residents
   - A fairer future – tackling the poverty emergency
3. Support children and young people to make the best start in life and reach their full potential
   - A fairer future – tackling the poverty emergency
4. Enable more adults to live longer, healthier, and happier lives
   - A fairer future – tackling the poverty emergency

Figure 9: Themes for Local Needs Analysis

Tackle the Climate Emergency (1)

ARUP

Cheshire West and Chester's Council Plan 2020-2024 states climate change poses a massive threat to society. Addressing and providing solutions to tackle the climate emergency will help to secure a better future for younger generations, support economic growth, support healthier lifestyles and help to tackle fuel poverty.

Central Heating:

Central heating accounts for around a third of all Greenhouse Gas Emissions in the UK.

Figure 10 shows the vast majority of central heating utilised in Whitby is Gas; at 92%. A very small proportion of properties use electric heating.

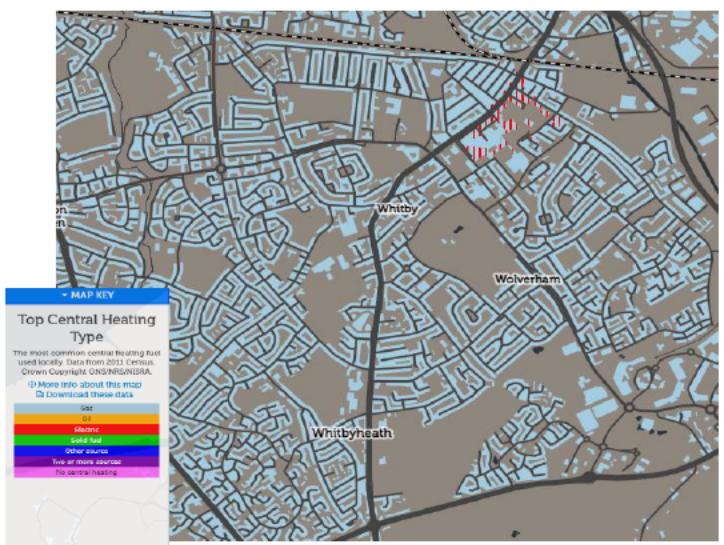


Figure 10: Top Central Heating Type. Source: CDRC.

EPC Rating

Table 1 and Figure 11 show the current EPC ratings of homes within the Whitby, Ellesmere Port region. Over 80% of homes within the region have an EPC rating between D-G indicating a real opportunity to take a whole house approach within the neighbourhood, assessing for potential energy efficiency improvements when in the home.

Current EPC Rating	
Row Labels	**Count**
B	18
C	140
D	526
E	253
F	53
G	7
Grand Total	997

Table 1: EPC Ratings for Whitby. Source: Cadent.

Insight from Local Engagement:
Local Engagement with Cheshire West and Chester highlighted that the local authority are currently reviewing their existing Green doctor initiative. This is due to the scheme not delivering the desired uptake of support.

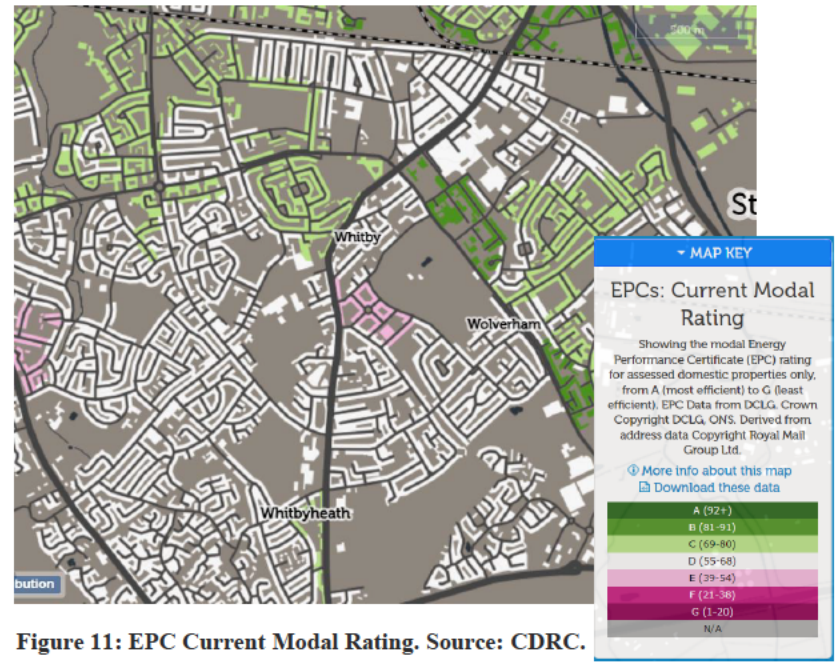


Figure 11: EPC Current Modal Rating. Source: CDRC.

CDRC Maps: https://mapmaker.cdrc.ac.uk/#/index-of-multiple-deprivation?m=imde19_rk&lon=-0.15&lat=51.52&zoom=10

Tackle the Climate Emergency (2)

ARUP

Access to Blue / Green Spaces

Figure 12 shows that in the area defined as 'Whitby, Ellesmere Port', there is a significant proportion of the area (located within Whitby Groves) which falls in the worst 20% in terms of access to, as well as usability and quality of Blue/ Green Space .

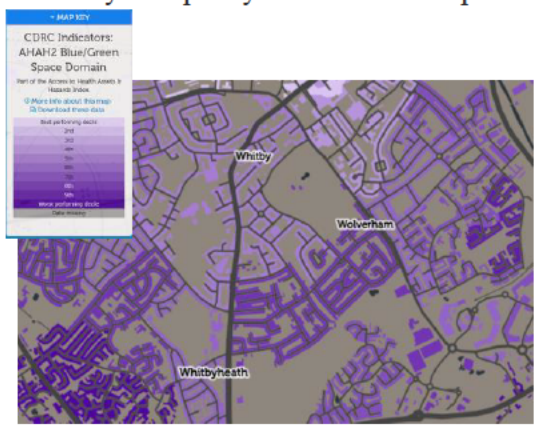


Figure 12: Access to Blue/ Green Space Domain. Source: CDRC.

Making our neighbourhoods better places to call home

Where you live - your local neighbourhood - is central to your quality of life. Cheshire West and Chester's, State of the borough report (2021) found that:

a. Satisfaction with local area

On average 82% of residents in the region are satisfied (very satisfied and fairly satisfied) with their local area as a place to live (Figure 13). However, Figure 14 shows within the locality of Ellesmere Port only 72% of residents were satisfied. There is nearly a 20% difference between satisfaction between localities within the Cheshire West and Chester region.

There is a disparity between *'perceived change'* by locality within the Cheshire West and Chester region. In Chester, 15% of respondents feel the local area has improved in recent years, whereas only 8% of respondents from Ellesmere Port felt like the area had improved.

b. Crime and Safety

On average, in Cheshire West and Chester 89% of respondents feel very, or fairly safe during the day and 63% respondents feel very, or fairly safe after dark.

However, Figure 15 shows there is a disparity between localities, with Ellesmere Port performing worse than other areas within the region. This disparity is widened significantly when looking at levels of safety after dark in Ellesmere Port.

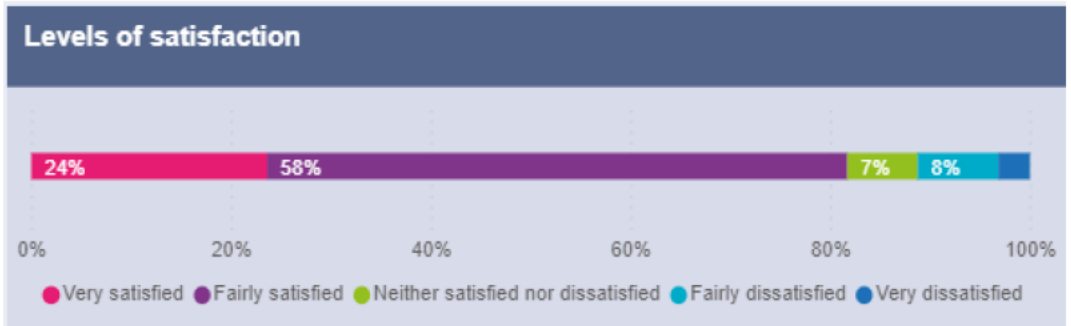


Figure 13: Levels of Satisfaction. Source: Cheshire West and Chester (2021)

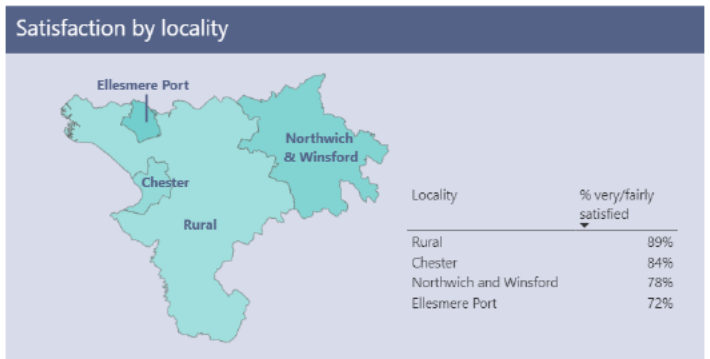


Figure 14: Satisfaction by locality. Source: Cheshire West and Chester (2021)

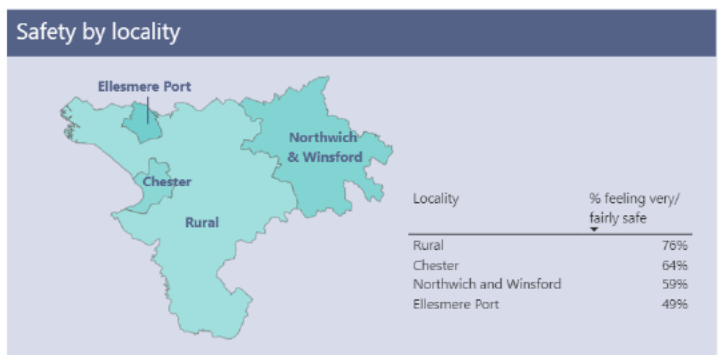


Figure 15: Safety by locality. Source: Cheshire West and Chester (2021)

Grow the local economy and deliver good jobs with fair wages for residents (1)

ARUP

The Cheshire West and Chester local economy is doing relatively well with low levels of unemployment and high levels of productivity. However, within this comfortable, overall picture, there are individuals and communities who are currently do not enjoy the same opportunities. Levelling up within the area is a priority – tackling the poverty emergency for those impacted.

Employment

Both Whitby Park and Whitby Groves have similar levels of unemployment, these are inline with the regional (2.3%) and national (2.2%) averages.

However, in the neighbouring wards of Wolverham and Central & Grange, both wards have unemployment levels around 3 times higher than the national average (2.2%) at 6.1% and 6.5%. This is illustrated in Table 2 and Figure 16

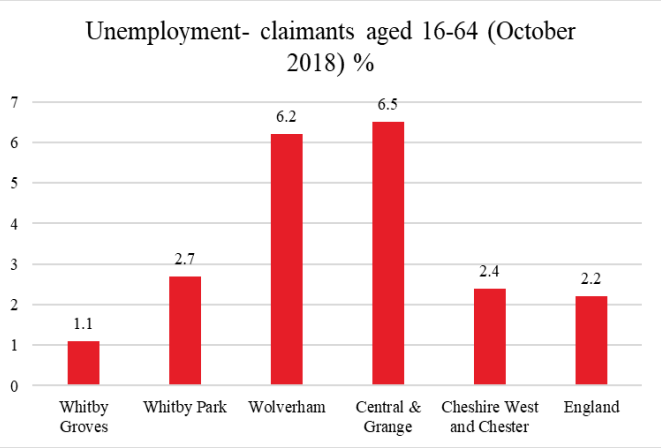


Figure 16: Unemployment – claimants aged 16-64. Source: Cheshire West and Chester (2021)

Income

The median gross weekly wage for west Cheshire residents who work full-time is slightly higher than the national average, but averages hide the fact that two neighbourhoods in west Cheshire are ranked in the 2% most deprived in England.

Table 3 shows the huge disparity between average household income in the neighbouring wards of Wolverham and Central & Grange compared to Whitby Groves and Whitby Park.

Economic Activity

Cheshire West and Chester's State of the Borough report states, growth in Gross Value Added (GVA) in the borough over last ten years (0.7%) is significantly lower than both the North-West (1.6%) and UK averages (1.9%).

	Whitby Groves	Whitby Park	Wolverham	Central & Grange	Cheshire West and Chester	England
Claimant rate 16-64 (October 2018) %	1.1	2.7	6.2	6.5	2.4	2.2

Table 2: Claimant rates for local wards. Source: Cheshire West and Chester (2021)

Category	Whitby Groves (£)	Whitby Park (£)	Wolverham (£)	Central and Grange (£)	Cheshire West and Chester (£)	England (£)
Average Household Income	47,000	38,000	24,000	26,000	27,000	27,000

Table 3: Average Household Income. Source: Cheshire West and Chester

Grow the local economy and deliver good jobs with fair wages for residents (2)

ARUP

A fairer future - tackling the poverty emergency

There are stark gaps between areas of prosperity and deprivation. It is essential that all local people can contribute to and benefit from growth.

Deprivation

As seen in Figure 17 and 18 the Whitby, Ellesmere Port has varying levels of deprivation. The LSOAs within the Whitby Park and Groves wards are not significantly deprived in terms of IMD. However, there is one LSOA within Whitby Park (shown in the subsequent slide) which suffers significantly high levels of deprivation across 7 of the 9 IMD Domains.

In contrast, the neighbouring wards to the north and east of the Whitby, Ellesmere Port region (Central & Grange and Wolverham wards) suffer from much higher levels of deprivation.

Several LSOA's in the Wolverham ward and Central and Grange ward fall within the most deprived decile (dark red in Figure 17) in terms of multiple deprivation; indicating they are within the most deprived 10% of LSOAs in the UK. This was confirmed during engagement with Cheshire West and Chester council, who consider these wards to be a priority for levelling up.

Fuel Poverty

In the Cheshire West and Chester area, 12% of households experience fuel poverty, with the same figure range between 7-10% within the trial neighbourhood..

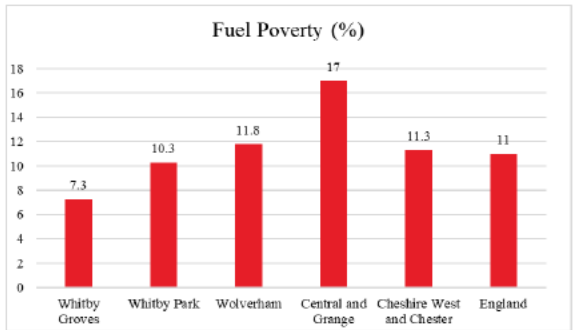


Figure 19: Fuel Poverty in Wards. Source: CW&C

Based on this data, an estimated 150-200 homes within the Hydrogen Trial neighbourhood will be experiencing fuel poverty.

Insight from Local Engagement:
Local Engagement with Citizens Advice Bureau (CAB) stated that energy costs are a concern in the local area. Engagement also identified food poverty as being an issue. Local Engagement from Cheshire West and Chester also identified that the local authority are currently developing a renewed fuel poverty strategy.

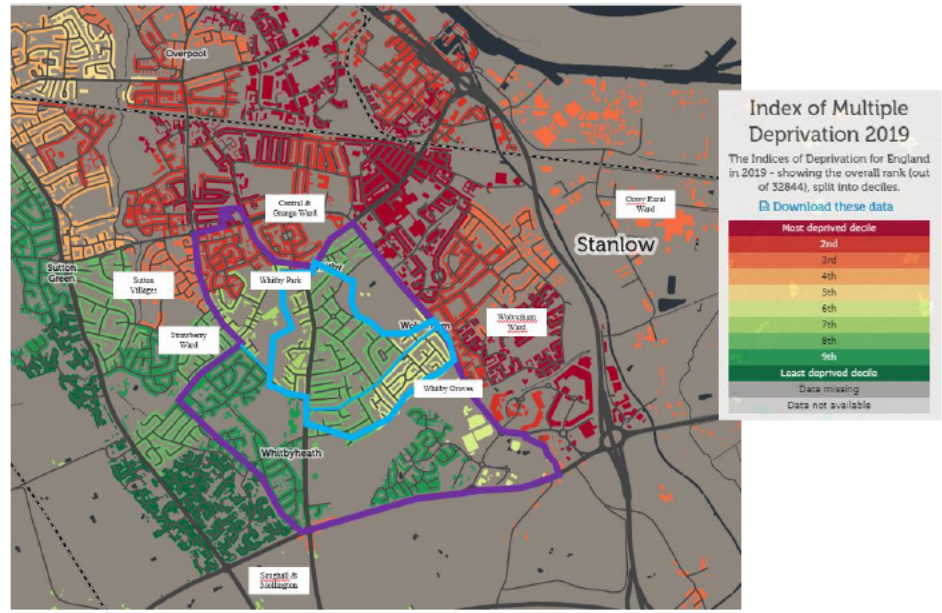


Figure 17: IMD data for Whitby, Ellesmere Port. Source: CDRC Index of Multiple Deprivation (2019)

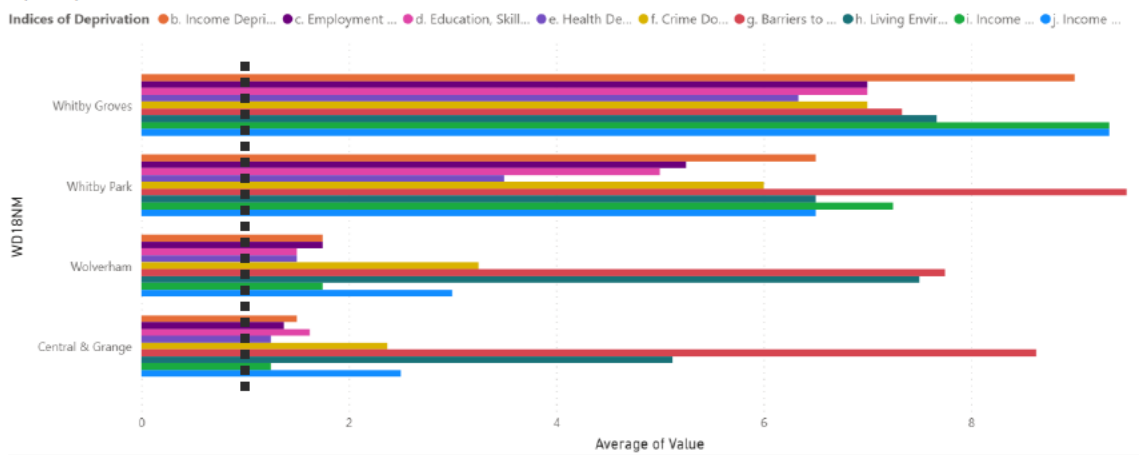


Figure 18: Indices of Deprivation for local wards .

Grow the local economy and deliver good jobs with fair wages for residents (3)

ARUP

Figure 20 highlights the LSOA within Whitby Park that is more deprived than the surrounding LSOAs .

LAD19NM-WD19NM	FeatureCode	Average of Value	Indices of Deprivation
Cheshire West and Chester-Whitby Park	E01018539	3.00	b. Income Deprivation Domain
Cheshire West and Chester-Whitby Park	E01018539	2.00	c. Employment Deprivation Domain
Cheshire West and Chester-Whitby Park	E01018539	1.00	d. Education, Skills and Training Domain
Cheshire West and Chester-Whitby Park	E01018539	2.00	e. Health Deprivation and Disability Domain
Cheshire West and Chester-Whitby Park	E01018539	2.00	f. Crime Domain
Cheshire West and Chester-Whitby Park	E01018539	9.00	g. Barriers to Housing and Services Domain
Cheshire West and Chester-Whitby Park	E01018539	6.00	h. Living Environment Deprivation Domain
Cheshire West and Chester-Whitby Park	E01018539	4.00	i. Income Deprivation Affecting Children Index (IDACI)
Cheshire West and Chester-Whitby Park	E01018539	3.00	j. Income Deprivation Affecting Older People Index (IDAOPI)
Total		**3.56**	

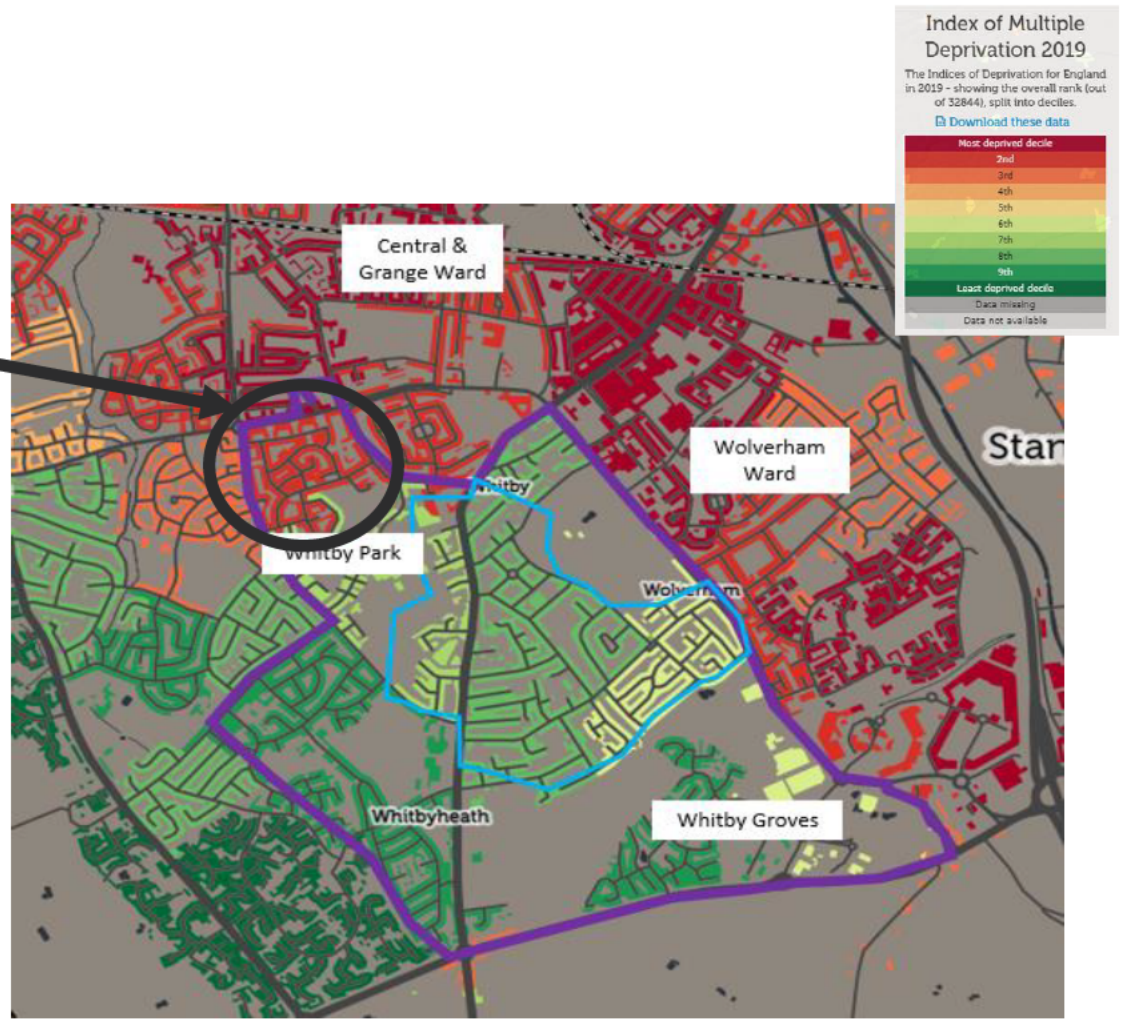


Figure 20: IMD data for Whitby, Ellesmere Port highlighting the deprived LSOA in Whitby Park . Source: CDRC Index of Multiple Deprivation (2019)

Insight from Local Engagement:
Engagement with Cheshire West and Chester council demonstrated the local authority's support for the 'levelling-up' agenda.

Support children and young people to make the best start in life and reach their full potential (1)

ARUP

Social Mobility

The Social Mobility Commission has found that West Cheshire is amongst the worst 10% of all local authority areas for 'youth social mobility' as measured by disadvantaged young people achieving good qualifications and progressing to university. This was confirmed in engagement with the local authority as a local priority.

Income Deprivation Affecting Children

Figure 21 shows there are stalk differences between Whitby Park and Whitby Groves and Wolverham and Central & Grange in terms of Income deprivation Affecting Children. Both Wolverham and Central & Grange are in the 20% most deprived wards.

Digital Exclusion

It is estimated that there are at least 25,000 residents in Cheshire West and Chester that are at risk of digital exclusion. Of the residents at risk of digital exclusion, it is thought a third are younger people from deprived areas. Clear links have been made with educational attainment and lack of suitable digital access.

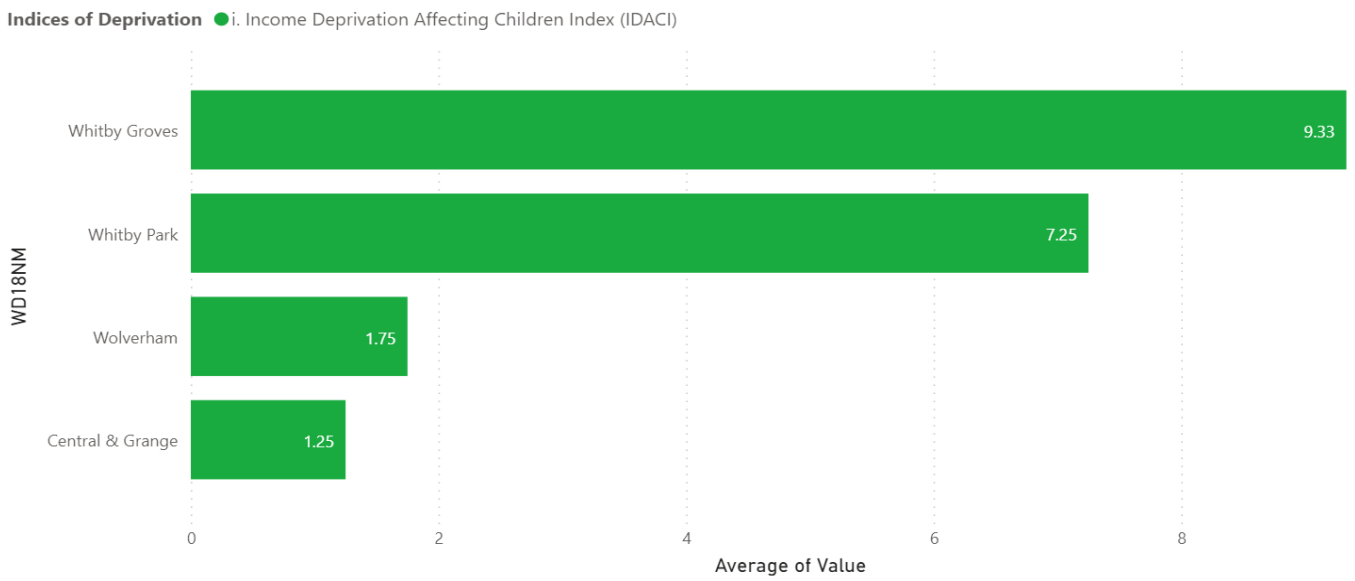


Figure 21: Income Deprivation Affecting Children Index (IDACI) .

Support children and young people to make the best start in life and reach their full potential (2)

ARUP

Education

Whilst educational outcomes are good for many children in West Cheshire and Chester, there is a gap in attainment between 'all pupils' and those who are disadvantaged.

Average Attainment 8 scores at GCSE show that whilst non-disadvantaged pupils tend to do slightly better than similar pupils nationally (54.1 compared to 53.7), local disadvantaged pupils tend to do worse than disadvantaged pupils nationally (36.8 compared to 40.2).

Educational attainment, measured in terms of GCSE achievement in Maths and English, in Whitby Park (59.1%) is lower than both the Cheshire West and Chester (63.6%) and national average (64.2%). However, Whitby Groves (67.3%) performs higher than both the regional (63.6%) and national average (64.2%).

Table 4 shows there is a stark difference between educational attainment in the Wolverham and Central & Grange wards compared to the regional and national averages. In Central and Grange, only 37.1% and in Wolverham, 40.3% of students have achieved grades 9-4 in English and Maths compared to 63.6% in Cheshire West and Chester and 64.2% nationally.

There are three secondary schools in the local area as indicated in Figure 22, and progression post-16 years was seen as a priority by the local authority. Raising aspirations with pupils leaving Year 6 in the 11 primary schools was also highlighted.

	Achieved 9-4 in English and Maths
Whitby Groves %	67.3
Whitby Park %	59.1
Wolverham %	40.3
Central and Grange %	37.1
Cheshire West and Chester %	63.6
England %	64.2

Table 4: Educational Attainment for local wards. Source: Cheshire West and Chester (2021)

Name	Street	Locality	Number of pu	% Free school r	% English not l
Cambridge Road Community Primary and Nurse	Cambridge Road		246	38	16.7
William Stockton Community Primary School	Heathfield Road		337	47.9	18.4
Whitby Heath Primary School	Wyedale	Whitby	401	16	5.5
Ellesmere Port Christ Church CofE Primary Scho	Deeside	Whitby	176	23.3	1.7
Hinderton School	Capenhurst Lane	Whitby	44	36.4	11.4
The Oaks Community Primary School	Rochester Drive		161	49.1	10.6
The Acorns Primary and Nursery School	Pooltown Road		373	40.5	4.6
Woodlands Primary School	Eddisbury Road	Whitby	548	6.5	3.5
Our Lady Star of the Sea Catholic Primary Scho	Capenhurst Lane		444	13.4	5.6
St Bernard's Roman Catholic Primary School	Sherbourne Road		200	35	10
Wolverham Primary and Nursery School	Milton Road	Wolverham	319	38.1	13.5
The Whitby High School	Sycamore Drive	Whitby	1597	23.9	3.1
Ellesmere Port Catholic High School	Capenhurst Lane	Whitby	886	29.9	6.4
Ellesmere Port Church of England College	164 Whitby Road		643	53.5	10

Figure 22: Local schools analysis

Insights from Local Engagement

There is an opportunity to provide employment services which focus on helping equip young people with the skills employees are demanding. This will help to improve the transition between educational setting and from childhood to adult hood, making sure young people have the skills and qualifications they need.

Local Engagement indicated that there is opportunity to link in with existing services in Cheshire West and Chester region, such as:

- The Pledge Partnership: The pledge partnership facilitates relationships between education and business, to help inspire younger generations. The Pledge are also working with the Careers Enterprise Company and plan to launch a Cheshire and Warrington Hub in the new year
- Cheshire College South and West: The College are currently looking to develop a whole range of programmes to support their students in the low carbon agenda including a Retrofit House Demonstrator and a bid to become an Institute of technology, building on their success as a trailblazer for 'T-Levels'. There is an opportunity to explore whether the project could offer support for the college's programmes and young people.
- TTE: a specialist training provider located in Ellesmere Port

Enable more adults to live longer, healthier, and happier lives

ARUP

Life Expectancy

In Cheshire West and Chester, male life expectancy at time of birth is 79.7 and female life expectancy is slightly higher at 83.4. These are both similar to the national averages (Figure 23).

Table 5 shows the current age profile of the local authority. By 2035 it is predicted that 28% of residents in Cheshire West and Chester region will be over 65. One of the council's priorities is to ensure older people in the region are supported and independent for as long as possible. This is pertinent given the rise in social isolation and loneliness which can impact both physical and mental health.

Health

Overall, only a small percentage of residents in Whitby Park (5.8%) and Whitby Groves (4.5%) wards live in 'bad or very bad health'. Nearly 80% of residents in both wards live in 'good or very good health'.

However, in the neighbouring wards of Wolverham (8.8%) and Central & Grange (9.1%) the proportion of the population with 'bad or very bad health' is much higher. This is higher than both the regional (5.5%) and national (5.4%) level.

There are significant health inequalities in the Cheshire West and Chester region, with 10% of residents in the Ellesmere Port locality suffer with long term health problems. These health conditions include diseases such as Asthma and COPD, These conditions can be worsened when living in areas of poor indoor and outdoor air quality.

It is important to note that Ellesmere Port Hospital is located within the area defined as Whitby, Ellesmere Port (shown in Figure 5 at the start of the report).

Digital Exclusion

Of the 25,000 residents in Cheshire West and Chester who are at risk of digital exclusion, it is thought two thirds are older people. Digital exclusion can increase feelings of loneliness and isolation. It can also make it harder for residents to find jobs and leads to them missing out on cheaper goods and services.

Cheshire West and Chester's resident survey (2019) found that one of the most common reasons (45%) why residents do not use the internet is a lack of digital skills,

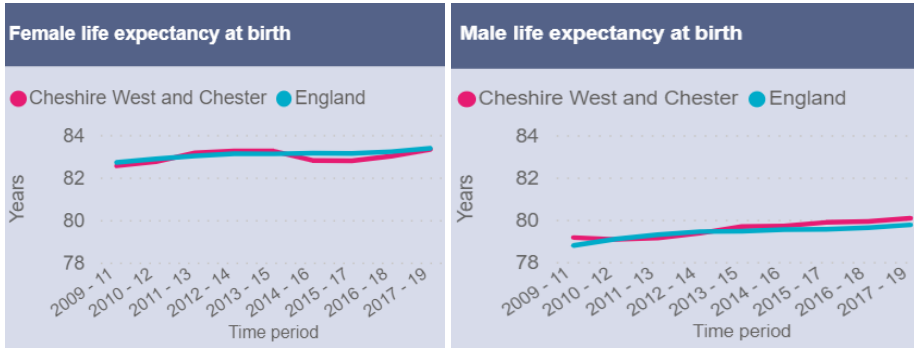


Figure 23– Life Expectancy at Birth for males and females. Source: Cheshire West and Chester (2021)

Age	Cheshire West and Chester	%	National	%
Aged 0 to 15	61,910	18%	10,852,240	19%
Aged 16 to 24	32,670	10%	5,950,637	11%
Aged 25 to 49	101,589	30%	18,449,296	33%
Aged 50 to 64	72,739	21%	10,833,946	19%
Aged 65+	74,915	22%	10,464,019	19%

Table 5 – Age Profiles of Cheshire West and Chester. Source: Nomis (2021) Population Estimates

Insights from Local Engagement:

Local Engagement indicated there are existing initiatives in the region which help to tackle social isolation and digital exclusion, it is important the project links in with these. Engagement also indicated that there is opportunity to link in with existing organisations in Cheshire West and Chester region which work with elderly members of the population, such as ForHousing, Citizens Advice, HealthBox and Age UK.

Cadent Hydrogen Village Trial
Social Value Framework

ARUP

Social Value Framework Development

ARUP

Engagement with stakeholders:

The Local Needs Analysis was shared with Cadent's wider project development team, as well as with Cheshire West and Chester Council. This tested the assumptions within the desktop analysis and confirmed priority focus areas that align to both local need and to the core objectives of the programme.

The social value team also analysed the findings from wider engagement meeting and joined meetings with key community organisations: AgeUK and Citizen's Advice Bureau.

A Social Value Framework for the Hydrogen Village Trial

This has resulted in the development and refinement of a Social Value Framework for the Cadent Hydrogen Village Trial. The framework sets out priority, agreed actions against the four identified social value themes. Links to Cadent's Force for Good strategy have also been made within the framework.

Collaboration is key to successful delivery of social value in a community. The Social Value Framework also indicates the potential partnerships that will be explored to support delivery of each action. This is key to creating sustainable social value, ensuring that the project builds on and supports existing initiatives, and co-designs new activities with the organisations that know the community the best.

The framework is summarised on the following page in Figure 24 and available in more detail as an annex in the submission for BEIS funding.

Next Steps

In 2022, the Social Value Framework will be sense-checked as part of the community engagement strategy; giving local residents the opportunity to express their priority issues and needs. The results of this, and further engagement with potential partners will inform a final Social Value Framework, and enable the development of a detailed and quantified Social Value Delivery Plan. This will include SMART (specific, measurable, achievable, realistic and timescaled) targets that will be monitored and reported across the project lifecycle.

Managing and Monitoring Social Value Delivery

It is planned to deliver an annual Social Value Report for the project, which will cover quantified social value delivery alongside qualitative impact stories.

Early community engagement will also provide the baseline data for a Social Return on Investment that will be delivered at the end of the programme.

Social Value Framework

Social Value Theme	Proposed Activity	Potential Local Partners
General Principles	Undertake a Social Return on Investment for the project	Social Value UK, local university
	A Community Grants Programme: small grants to local community groups to meet identified local needs, to support for example greening, community events and capacity building	Local authority, Poverty Truth Commission, Cheshire West Voluntary Action
	2 days per annum of volunteer time for all staff working on the project (based on FTE)	All Cadent staff (with potential to rollout wider)
Tacking the climate emergency	Develop a carbon management plan	All partners in the project, Chester Sustainability Forum
	Zero and low emissions plant and vehicles used	
	When in the home, undertake assessment for energy efficiency, energy tariffs and appliance use. Also assess for digital and social inclusion.	Supply chain partners and potential links with local VCSE and existing Green Doctor schemes
	Behaviour change programme identifying local low carbon champions to support awareness raising in the community	
	Dig Once – when on site embed identified, priority neighbourhood public realm and greening improvements into infrastructure works	Local community groups, Friends of Whitby Park, local authority
Grow the local economy and deliver good jobs	Employ locally first: work with local partners to advertise roles locally first and ensure awareness of opportunities in the community	Job Centre, CW&C Economic teams, local colleges and University
	Pay the Real Living Wage	All project partners
	A programme of support, upskilling and business mentoring around low carbon, energy and sustainability working with existing networks	Chamber, LEP, local authority, University of Chester
	Set target for local and diverse supply chain spend, and monitor against this over project lifetime	All project partners
Support young people to reach their full potential	Collaborate with Cheshire College South and West on their Retrofit Demonstrator House and potential Institute of Technology	Cheshire College South and West
	Programme of support for the 3 secondary schools in the area: curriculum STEM support, mentoring, enterprise advisors, careers advice	Careers Enterprise Co hub, 3 local schools, local authority
	Create new apprenticeship opportunities to work on the project	Local colleges and schools
Enable more adults to live longer, healthier and happier lives	Be an active partner in the local Poverty Truth Commission	Poverty Truth Commission
	Actively ensure that the estimated 7-10% of households (upto 200 houses) in the area in fuel poverty are supported	CAB, Age UK, supply chain partners, local authority
	Ensure grants programme supports priority projects or ideas to tackle the poverty emergency	CAB, Age UK, Cheshire West Voluntary Action, local groups

Figure 24: Summary of the Social Value Framework

ARUP

Report prepared by:

[redacted]

[redacted]

December 2021

Arup 6th Floor 3 Piccadilly Place, Manchester, M1 3BN.

Department for Business, Energy & Industrial Strategy

ofgem
Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

ANNEX M: Consumer Research Reports

This Annex provides the executive summaries from our three-stage consumer research programme which sought to aid the design of a highly effective hydrogen village trial by understanding consumers' needs when their energy choice would be hydrogen or alternative lower carbon technologies.

Project Purpose

The research covered all trial stages and sought to understand consumer opinion, attitudes, and beliefs; capturing questions consumers have as well as their motivations, hopes, fears and concerns in taking part in a village trial; and how best to positively engage consumers. The project findings are fundamental to the effectiveness of a hydrogen village trial and maximising the adoption of hydrogen by residents in the trial area. The research, insights and data gathered will enable the industry to shape the next stage, develop propositions and tailor the engagement approach, addressing consumers' concerns and identifying ways to minimise disruption.

Research Approach

Stage 1: Inform - The purpose was to consolidate existing research and included a comprehensive and detailed study of existing data, previous research, literature, academic studies, trials, and industry expertise. It also included studies on lessons from other large scale social and behavioural change programmes. Through conducting a literature review with these areas of focus, we ensured that the next stages of research were informed by the latest theoretical frameworks, grounded in existing knowledge, and targeted on identifying research gaps in the current evidence base.

Stage 2: Qualitative - This stage used qualitative methods to understand 'what' people thought of taking part in a village trial and 'why'. After initial stakeholder engagement, a deliberative approach was adopted, which involved recruiting a diverse sample of mains gas customers and exploring their response to the Village Trial by providing information about how the trial would work at the same time as exploring their needs, attitudes, and predicted behaviour as they discovered more detail about the trial.

Stage 3: Quantitative - The purpose was to test at scale the output of the inform stage along with the findings of the qualitative research. The quantitative stage provided views of a large-scale sample of the UK's consumer base.

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Supporting Documentation

The documentation available within this Annex is shown below. We are more than happy to provide the full reports upon request:

- **Inform Stage 1 Executive Summary** – A summary of the key findings from the literature review.
- **Qualitative Stage 2 Executive Summary** - This document summarises the key findings from the qualitative research.
- **Quantitative Stage 3 Executive Summary** - This document summarises the key findings from the quantitative research.

Cadent
Your Gas Network

13 December 2021

The Hydrogen Village Research Programme

Classified: Private

Inform stage report: executive summary

Make better decisions

Savanta:

Introduction

The report

Capturing the voice of the customer and understanding the complex, intricate needs of the target audiences is fundamental to the success of a behavioural change programme. As the UK transitions to Net Zero and heating specifically needs to be decarbonised, understanding and influencing the public's behaviour and their attitudes to new technologies such as hydrogen will become paramount. In order to build public awareness and an understanding of how people will interact with the technology, a hydrogen village trial is planned in the UK. The outcomes of this will be used to develop strategies for a potential national roll-out and to identify the key levers and barriers relating to its success.

As this is the first trial of its kind in the UK, there will inevitably be a requirement for fresh, primary research to inform the trial's design and improve its effectiveness. Exploratory qualitative methods will deliver deep insights into opinions, behavioural factors and the cultural context, likely drawing on deliberative techniques in which respondents are educated and questioned as they go through a journey of discovery. This can then be reinforced by quantitative methodologies, which can validate and nuance these insights at scale.

Before turning to these methodologies, there is a lot to be learned from the existing literature, with a specific focus on:

- The latest thinking in behavioural change and applying audience insight
- Learnings from previous large-scale behavioural change exercises and trials
- Research into the public attitudes to hydrogen and related technologies
- Unearthing 'benchmarkable' data points in related studies

Through conducting a literature review with these areas of focus, we are able to ensure that any future primary research that is conducted is informed by the latest theoretical frameworks, grounded in existing knowledge and targeted on addressing gaps in the current evidence base. In the meantime, the report can also be used to create a more informed strategy at this early stage of hydrogen village trial planning.

The report is structured with this objective in mind and consists of three main sections:

1. **Factors that impact the success of a behavioural change programme –** This section examines the criteria that influence a behavioural change programme's impact on the target audience, through analysing the latest in academic thinking and the learnings from putting 'tried and tested' methods into action. Collectively, this provides a 'checklist' of the sorts of questions that need to be answered for any trial to be successful.
2. **A review of the current evidence base –** This section reviews the existing literature on hydrogen and related technologies, focusing on studies of public perceptions and attitudes.
3. **Conducting a 'gap analysis' –** This section examines the interplay between the 'checklist' of questions from the first section and the state of the existing evidence base. By comparing the two, we are able to see the extent to which the key questions can already be answered with the evidence to hand, and conversely where fresh primary research needs to focus.

This executive summary focuses on the key findings from each of these stages.

Our approach

The success of a literature review such as this rests on the quality of the inputs and the rigour of the process.

To address the former, we used a mixed approach to source the reports for inclusion. Cadent provided Savanta with recent reports they had commissioned or conducted, as well as reports from the wider industry to which they had access. Savanta combined these with publicly-available reports that were identified in a thorough desktop research process and signed-off for inclusion by Cadent. These reports were focused, although not exclusively, on behavioural change theory, examples of programmes outside of the gas industry and reports from outside of the UK. This process resulted in 51 reports being included in the exercise, a full list of which can be found as an appendix to this document.

To address the latter, Savanta analysed the reports in a comprehensive Excel catalogue. This ensured that any insights or conclusions in the report can be traced back to the report in question and a clear 'line of sight' can be drawn through the analysis from input to output. The reports were broadly separated into two types: behavioural change literature and industry-specific reports. The second type were analysed against five themes to ensure a thorough coverage of all areas in which insight is required for a successful hydrogen trial.

Key findings

As discussed in the introduction, Savanta employed a three-stage analysis process, with each having a deep-dive section in the report. Below are the key findings at each stage, building to a 'gap analysis' of the existing evidence base.

Section 1: Factors that impact the success of a behavioural change programme

This section examines the criteria that influence a behavioural change programme's impact on the target audience, through analysing the latest in academic thinking and the learnings from putting 'tried and tested' methods into action. Collectively, this provides a 'checklist' of the areas that need to be well understood about the target audience for any trial to be successful. There are seven key findings.

1. People are **inherently irrational in their decision making** and prone to an 'intention-behaviour gap' (a gap between what they say they will do and what they do). We therefore can't simply trust that stated attitudes relating to hydrogen and related topics (e.g. Net Zero) will translate into action. Motivations are an important area to understand, with the literature suggesting that environmental awareness and concern is no guarantee of acceptance of greener technologies. Instead, we have to examine other barriers that may impact on behaviour such as awareness, cost and the impact of the technology on existing norms and habits.

2. Humans are highly social animals. We influence the behaviour of those around us and are similarly affected ourselves. The **community and established social structures** have a significant impact on the success of behavioural change programmes. If neighbours, and particularly those that are trusted and respected adopt a certain behaviour, this can have a disproportionate impact on the entire community-wide initiative. The phenomena, called 'social proofing', is very important to consider when designing a trial.

3. The **cultural context** in which individuals operate impacts on their behaviour and an understanding of this must form the bedrock of any successful behavioural change programme or trial. Linked to this, 'cultural beliefs' can act as a decision-making short-cut, especially for little-known technologies. These are based on 'heuristics' which allow people to make quick decisions about new ideas based on their existing feelings and opinions about other, related, topics. For example, those who consider themselves open to new technology, or who see themselves as concerned about climate change, may naturally be more open to hydrogen due to its subconscious links to these topics.

4. The literature shows the importance of developing **a considered and well-structured engagement programme**. It is more likely to be successful if it is spread over a long period of time and uses a variety of engagement techniques, tailored to the cultural context of the target audience (and sub-groups within it). It is important to be cognisant of which channels are preferred by different audiences at each stage of the trial.

5. **Trust is a key success factor of trials**, with the involvement of trusted parties having a positive impact. It is very important to understand who the trusted parties are likely to be within a village context. Additionally, the role of government is a complex one and needs to be handled carefully. Central government involvement can

add credibility to the trial, but there is also scepticism due to perceived U-turns in the past.

6. It is important to make residents of the village feel like engaged participants of the trial, rather than that they are having something 'external' imposed on them. Being cognisant of **local factors** and delivering local benefits is important to the success of the trial, whilst alienating people is likely to have a significant impact on public acceptance. Related to this, any trial needs to understand how NIMBYism (Not In My BackYard) is likely to impact on how people view it.

7. It is important to bear in mind that participants frame trial participation through the impact it will have on them, not the overall purpose of the trial. They will focus on the local benefits (e.g. use of local contractors and bringing jobs to the area) or the costs (e.g. disruption to their homes or local areas), rather than on the technology itself. This means there is **a complex relationship between the experience of the trial and views of the technology itself**: a 'successful' trial is no guarantor of a positive impact on how hydrogen is perceived.

Section 2: A review of the current evidence base

In order to conduct a robust literature review focused on public perceptions of hydrogen and the adjacent areas of interest (e.g. electrification of heat), we analysed a wide range of reports against five themes. Below are the key findings of the review against each of the five themes:

Regulatory environment and legislative options

- Awareness of the UK government's Net Zero and decarbonisation targets are low; education and greater awareness are needed to drive support
- In the eyes of the public, the onus is on the government and industry to meet Net Zero and decarbonisation targets
- The public generally support mandating "green" initiatives for the greater good
- There is a need for choice within mandate – consumers don't want to totally lose their freedom of choice
- Incentivisation is expected to meet increased costs of adopting low carbon heating solutions, particularly for fuel poor or customers in vulnerable situations (CIVS)

Hydrogen

- Awareness, knowledge and understanding of hydrogen is low
- This lack of awareness typically leads to a neutral position on hydrogen; positive and negative associations are limited
- There are already some perceived strengths of hydrogen in heating emerging amongst the informed public such as the ability to have a "like-for-like" switch
- However, there are some concerns surrounding the use of hydrogen, and some barriers to adoption besides low awareness

The low carbon technology category

- Awareness of heat pumps is higher than hydrogen
- Heat pumps are typically seen as a less favourable option due to high costs of installation, significant disruption and space requirements by the informed public
- Awareness of solar panel technology is considerably higher than both heat pumps and hydrogen technologies

Variation in opinions and behaviours by audience

- There is very little representation of 'niche' audiences (CIVS, fuel poor customers, early adopters of low carbon heating solutions) within existing research related to hydrogen and low carbon heating solutions
- Willingness to adopt hydrogen, or other low carbon heating technologies is likely connected to wider world views, such as environmentalism
- There are some gender nuances in acceptance and potential adoption of hydrogen for heating
- Younger, more affluent individuals are more open to low carbon heating technology adoption

Encouraging behavioural change

- Key potential barriers to the adoption to hydrogen: Lack of awareness or education, cost of installation and use, options (or lack thereof), time and effort of installation,

disruption during installation, safety, usability in the home, sale or rent-ability of property following installation

- Key potential levers supporting the adoption of hydrogen: 'Doing your bit' for the environment and wider society, local benefits that are concrete and tangible, support from influencers (e.g. tradespeople) and the ability to have a like-for-like switch with existing gas

Section 3: Conducting a 'gap analysis'

In this section of the report, we compare the pre-existing knowledge examined in the literature review (section 2) against the factors identified as impacting on the success of a behavioural change programme (section 1). Below are the five key high-level gaps that have been identified:

1. **What are the existing behaviours and cultural factors within a community that will impact on a trial?** Research has been conducted into how people feel about hydrogen, but it has to date been hypothetical and detached from the reality of a transition. As such, stated opinions and intentions cannot be relied upon to translate to action. A thorough understanding of the role that existing behaviours and cultural factors will play in a trial and in the wider transition will be fundamental to achieving real behavioural change.

2. **How can the trial design make best use of 'social proofing' and community networks?** A hydrogen village trial will by necessity take part in an existing community with all of the relationships, power structures and 'politics' that this entails. Insights are needed into how a trial can navigate these complex community factors and take advantage of established behavioural theory such as 'social proofing'. This will enable the trial to tap into local networks, such as by gaining the support and endorsement of a trusted local organisation.

3. **How can the views of previously under-represented groups like CIVS, the fuel poor and businesses be incorporated?** The existing research base is almost solely based on the 'general public' audience. Whilst this is clearly important, it is to the detriment of key groups which could be more severely impacted by a trial (e.g. CIVS who may be affected more by disruption) or who could have a disproportionately large impact on the wider community (e.g. small businesses who will be disrupted if their production needs are not met).

4. **How do existing 'cultural beliefs' interact with people's potential support for hydrogen?** Hydrogen is a largely unknown technology for most people. It is well-established in behavioural theory that people use heuristic short-cuts to determine how they feel about concepts which they are unfamiliar with. A successful trial needs to be cognisant of the 'cultural beliefs' intrinsically linked to hydrogen in people's minds (e.g. environmentalism or new technology), to understand what will impact on different groups' acceptance of it.

5. **How can the trial engagement ensure that the technology is seen in a positive light and that people appreciate the benefits to them, their community and the country?** A hydrogen village trial will be viewed by local people through the lens of the advantages and disadvantages it brings to them as individuals, which will then likely be linked to the technology in their minds. Some may focus on it being a much-needed infrastructure upgrade to an oft-overlooked backwater; others may see it as a nationally-imposed unnecessary disruption on their local place of outstanding natural beauty. A deep knowledge of the factors that will influence the individuals' and local community's verdict on the trial, and the impact of this on both local and national perceptions of hydrogen, is fundamental.

Conclusion

Overall, this literature review has revealed that considerably more primary research is required among all of the groups likely to be included in a hydrogen village trial. Whilst a number of relevant studies have been conducted in the UK and further afield, they collectively lack representativity of the full gamut of audiences (e.g. CIVS, those in fuel poverty, businesses) and have asked 'face value' questions that do not get under the skin of the issues at hand, making the design of an engaging and successful hydrogen village trial currently very difficult.

Through analysing the latest academic thinking and other industries' experiences of trials and widespread behaviour change, the report shows that a research approach better grounded in behavioural science is required going forwards. Considerably more insight is required into the existing behaviours of the target audience, the cultural context in which they are operating and the community factors which will impact on the success of the trial.

It has been shown that simply asking for opinion on largely unfamiliar topics such as hydrogen can only take the discourse so far. This literature review has indicated where the major gaps are in the current evidence base, so that future research can be targeted at addressing them. If this is achieved, the design of a hydrogen village trial can be better grounded in the culture of its target audience, more aware of the factors that will impact on how people interact with the trial and ultimately more likely to successfully build engagement and support for the initiative.

Cadent | Village Trial

Executive Summary | December 2021

1. Introduction

1.1 Summary of background & objectives

In the Ten-Point Plan for a Green Industrial Revolution, the Government have proposed a large hydrogen village trial by 2025. In light of this, Cadent, working alongside Northern Gas Network, SGN and Wales & West Utilities, commissioned BritainThinks to conduct a large-scale research project.

The overall aim of the research was to gather insight about the wants, needs and attitudes of domestic and business audiences when it comes to taking part in a trial where their energy choices are limited to hydrogen or electrification. The outputs of this research will be used to inform policy development and trial planning, in order to help ensure the success of the trial

1.2 Summary of approach

This phase of research built on an initial literature review of existing research on customer attitudes towards hydrogen and community behaviour change (The “Inform phase” conducted separately by Savanta), which identified insight gaps to fill with further primary research. After initial stakeholder engagement, a deliberative approach was adopted, which involved recruiting a diverse sample of mains gas customers and exploring their response to the Village Trial by providing information about how the trial would work at the same time as exploring their needs, attitudes and predicted behaviour as they discovered more detail about the trial. The research was iterative with stimulus and topic guides developed in part in response to participants’ ongoing responses.

The audience for the research is summarised below:

The sample was designed to reach a broad range of domestic and business customers, and included participants from across England, Scotland and Wales with a spread of gender, ethnicity, ages and rural/small town/suburban locations.

Total size sample: 139

Additional audiences

97 x main consumer audience	20 x SMEs	10 x digitally disengaged	12 x ‘professional’ landlords
• This included: 48 x general public consumers, 14 x customers in vulnerable situations (CIVS), 15 x fuel poverty, 10 x microbusinesses, and 10 x ‘non-professional’ landlords* • Spread of age, life stage, SEG and household size • Mix of housing tenures, types and length of time living in property	• 10 small businesses with 10-49 employees • 10 medium businesses 50 – 249 employees • Mix of sectors	• This included those who may be visually impaired or offline/not comfortable online	• 4 x private landlords with at least 3 properties • 2 x commercial landlords with at least 3 properties • 6 x local authority/housing associa ion senior manager

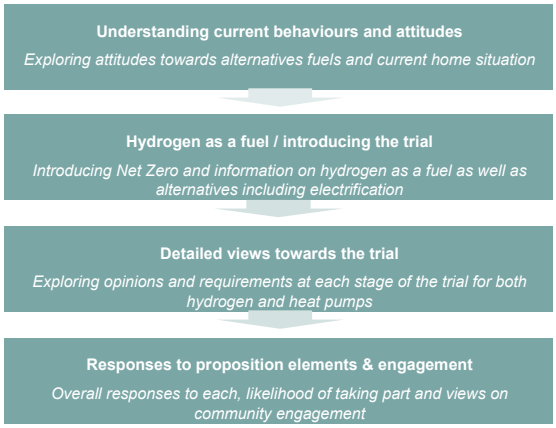
All were current gas customers with properties on mains gas supply

**Please note special consideration was taken for how specific audiences were defined including: CIVS - e.g. have a disability, chronic illness, have children under 5, are elderly etc.), Fuel poverty e.g. fallen behind on bills or avoided topping up gas to get necessities, Microbusinesses e.g. operate out of home or less than 10 employees, Non-professional landlords e.g. rent out 1-2 properties.*

The research was conducted using a mix of online focus groups, large scale real time online events, online community interactions (for all consumer audiences apart from digitally

disengaged) and a two staged approach of initial depth interview followed by workshop (SMEs, landlords) or follow up interview (digitally disengaged).

The broad content flow of the research is set out below:



- The deliberative research structure was informed by the stakeholder interviews and the Inform Immersion stage.
- A wide range of accessible material was shared to provide context and detail for the trial. Please note that this information was designed to be balanced, non-biased, and transparent and included clear information about what the trial may involve for both hydrogen and heat pump options.
- Throughout the research, participants were provided with balanced information about both hydrogen and heat pumps and asked about their views on both, ensuring a non-biased approach.
- The research was topped and tailed with questionnaires and included regular trial sentiment and fuel choice tracking.

1.3 Behavioural framing of the research using the East framework

The trial will require significant behaviour change and thus the research was designed and analysed with a behavioural lens. This approach helped to frame the stimulus materials that were developed, the topics that were explored, the questions that were asked and the way that they were framed, and finally the analysis of responses. The specific behavioural model that was used was the EAST framework, as summarised below.

This research has drawn upon the 'Easy Attractive Social Timely' model (EAST model), a key behavioural change framework, when considering the implications for taking the trial forward. According to the Behavioural Insights Team[1], the EAST model dictates four principles for new behaviour:

1. **Make it Easy:** Including harnessing the power of defaults, reducing the 'hassle factor', and simplifying messages.
2. **Make it Attractive:** Including drawing attention to it, and designing rewards and sanctions for maximum effect.
3. **Make it Social:** Show that most people perform the desired behaviour, use the power of networks, and encourage people to make a commitment to others.
4. **Make it Timely:** Prompt people when they are likely to be most receptive, consider the immediate costs and benefits, and help people plan their response to events.

[1] Source: The Behavioural Insights Team, *EAST: Four simple ways to apply behavioural insights*

This model was selected as it was felt to be highly practical and actionable in terms of informing decisions about how to make the Village Trial successful. It brings together a range of complex behavioural theories into an accessible model which provides a simple and accessible way of translating research insights into effective policy design. Throughout the discussion of the research findings we highlight, where relevant, the behavioural aspects of the insights and how they relate to the EAST framework (e.g. by using the language of ease, attractiveness etc.) and also in the conclusions and implications section at the end of the report.

2. Research findings

2.1 Overview of key topics

In order to understand the context for participants' views of the Village Trial the research explored their behaviour and attitudes in relation to the communities where they live, own/run businesses or manage properties, how they heat and cook in their homes and premises as well as how engaged they are in their energy use.

The purpose of the Village Trial is to test a low/zero carbon energy source, and thus participants' knowledge of and attitudes towards climate change, the Government's Net Zero pledge/plan and the role of home/business premises heating in relation to CO2 emissions was also explored. Awareness of and opinion towards alternative fuel technologies (including hydrogen and heat pumps) was included at this stage.

Having explored the context, the idea of the Village Trial was introduced initially at a high level and subsequently with additional detail of the possible practical implications for householders and businesses in the trial community. Initial and "educated" responses were captured and tracked, as was predicted behaviour in relation to fuel technology choice: hydrogen vs heat pumps.

As detailed discussion of the trial progressed through the deliberation process, covering the pre-trial period, the trial period itself, and the end of the trial/post trial period, expectations and needs were explored with regard to triggers and barriers to taking part, reassurances and incentives required both to positively engage with the trial but also in relation to the different fuel technology choices (hydrogen vs heat pumps). In addition, engagement and communication requirements at each phase of the trial (pre-during-post) were collected.

After each phase of the research, corresponding with the broad topics outlined above, materials for subsequent discussion were refined to take account of emerging findings, clarification needs etc. For example, in the mid-point of the research, a FAQ document was created to address a range of specific questions that individual research participants had raised, and this was shared with all participants and covered in the subsequent session. For later discussions on specific incentives and "offers" that participants might require, a selection of themes identified from analysis of the sessions to that point, was used to frame the discussions to make them as relevant as possible.

2.2 Behavioural, attitudinal and knowledge context

Knowledge of the impact of home energy use on emissions

Participants feel really positive about their communities and value the relationships they have with other people. They also indicated that they had developed a greater sense of community over the period of the pandemic, with some volunteering or helping others in the community. However most do not actively engage in their communities e.g. by expressing their views or taking part in community activities or initiatives. Those who have been more involved and "had their say" have done so often in relation to development which could impact the area such as parking or housing developments. The "Inform phase" of work identified the importance of social proofing to the success of behaviour change programmes,

indicating that successfully engaging these more active community members could be beneficial.

Where people do feel more universally "invested" is in their homes, which are important for meeting higher level "self actualisation" needs, with participants expressing pride in the way they have personalised their homes through their choice of décor. Not only do their homes express their identity, but people value them as places to socialise and relax, with outside space highly valued. Any short-term change which impacts the status quo that consumers value could, in behavioural terms, be viewed initially negatively rather than them focusing on longer term potential benefits.

Whilst some people had recently made changes to their heating systems or were planning to do so, their knowledge of current or future alternatives to their gas central heating was limited, with few having heard of heat pumps (and almost no-one aware of hydrogen as a future alternative domestic or business fuel).

People's heating (and cooking) behaviour and preferences were often habitual, either based on acquiring a particular type of boiler when they moved into a property, or enjoying the familiarity of how it operates e.g. the "controllability" of gas heating and cooking.

> *"I have just kept the same way I heat the home as when I bought the house. It would be a big upheaval to change it." (Mainstream consumer sample)*

The situation was similar when it came to energy suppliers, with only a minority in the sample having been active in the energy market (reflecting levels of switching in the general population) and the majority of those in the research sample who had switched often then remaining with their new supplier rather than switch again. The research uncovered some additional relevant beliefs such as electricity being a more expensive fuel than gas, for heating in particular.

The contribution of home (and business premise) heating energy use to CO2 emissions and thus climate change, was not raised spontaneously by participants in discussion of their energy use and choices. When prompted, it was felt (inaccurately) to be a less significant contributor than, for example, manufacturing and deforestation. Having learned of its significance, the overwhelming majority were willing to make changes to their behaviour in order to make a positive impact on emissions. It is worth saying that the fieldwork took place in late summer 2021 before increased media coverage of the impact of home energy use on emissions, in the run up to Cop26. In the run up to the implementation of the trial it is likely that the saliency of this issue (amongst the general public, media and policymakers) will continue to grow and this should be factored into planning for communication and engagement.

Attitudes to climate change, knowledge of hydrogen and heat pumps as alternative technologies

The majority of participants expressed concern about climate change (and fieldwork took place *before* the lead up to Cop26) with some awareness of the term "Net Zero" and the broad direction of reduction of carbon emissions, rather than knowledge of the details of the Government's 2050 commitment.

"Net zero and climate change is one of the most important topics and will be growing for the next generation… its very widely accepted that it needs to be dealt with today." (Mainstream consumer sample)

Participants had limited existing knowledge of hydrogen and heat pumps in particular (again, fieldwork was conducted in late summer 2021 before media discussion of heat pumps in the run up to Cop26), with hydrogen being the least familiar alternative fuel technology. However participants found the principle of alternative fuel use in homes and businesses attractive because of their greater sustainability/positive environmental impact; the potentially higher cost of alternative fuels was raised as a concern by a minority.

As they learned more about hydrogen as a fuel, participants expressed some concerns about how practical an option this was in the short term, how carbon neutral it would actually be (e.g. blue carbon) and, especially for older participants, how safe hydrogen would be: because it is unfamiliar as a fuel, some people defaulted to their associations with "hydrogen bombs" or explosive chemicals at school.

However, as identified in the "Inform" phase review of previous research, the potential behavioural benefits of hydrogen as a "direct" and easy replacement for natural gas in terms of its use in the home and businesses, was a key positive, especially in comparison with heat pumps (all participants, it should be remembered, were mains gas users). Some participants also assumed that hydrogen would be similar to existing natural gas in terms of cost, which also made it an attractive alternative.

"Hydrogen sounds like natural gas but with less carbon footprint, which is positive." (Mainstream consumer sample)

"If they can solve the carbon storage and the expense then happy days; it would feel the same as using natural gas and [I'd be] happier because of saving the environment." (SME sample)

Heat pumps are also an unfamiliar technology for most and the behavioural difference to current heating options was highlighted as a drawback given the perception of a significant difference in the way people would need to heat their homes (and businesses) if using a heat pump. Concerns were also raised about the disruption of installation, the potential requirement for additional space inside and outside the home and the aesthetic impact that a large unit might have.

"If you're in a small two up two down with a yard, will the system take up the whole yard? It won't be aesthetically pleasing to have that in your garden." (Private landlord sample)

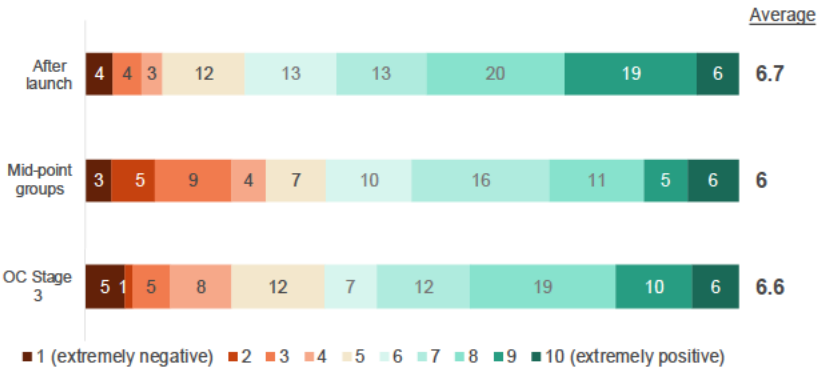
Interestingly existing perceptions of the high comparative cost of electricity for heating compared with gas, also coloured perceptions and expectations of the possible increased cost to run of heat pumps impacting their attractiveness.

2.3 The Concept of a Village Trial

Overall response to the idea of a low carbon village trial

When they were first introduced to the idea of a low carbon "village" trial, participants (from all audience segments) found the idea broadly attractive. As the chart below shows, when asked to "score" the idea out of 10 at the start of the deliberative process, during the process and at the end, once they had reflected fully on the implications of the trial, scores remained broadly consistent.

Thinking about the Village Trial overall, how positive or negative do you feel about the idea of such a trial being introduced in the community where you live?
Showing number of main consumers who chose each option at each stage



The main benefits of the trial that participants highlighted tended to be social, relating to the shared, community and societal impact that it could have, rather than personal advantages they would experience. Thus participants appreciated the positive impact that the trial could have on the environment and reducing emissions (in line with the country's journey to net zero); some also believed that a trial could have a positive impact on jobs in the chosen area as well as having a positive community impact as people living in the trial area would be part of an innovative initiative together.

"You are doing your bit to help the environment." (Mainstream consumer sample)

"I like that it's a community, different types of households, businesses, it's the whole thing across the board." (Mainstream consumer sample)

The research suggested some differences between audience segments with, for example, younger people more attracted to the idea of being part of something new and future focused as well as being strongly driven by the environmental benefits. Those who had experienced debt and fuel poverty tended to highlight worries about the potential increased costs associated with the trial.

"Cost, its all down to cost, everyone will ask about the cost, it is top on my list." (Fuel poverty sample)

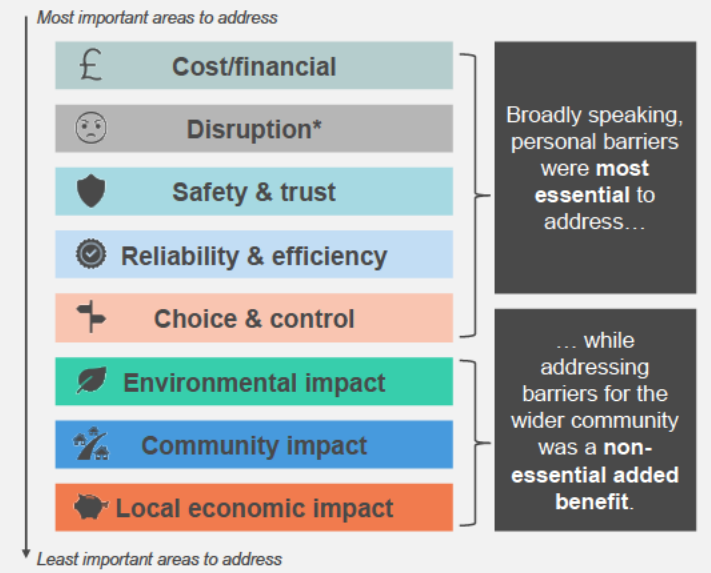
SMEs were more cautious about the benefits of the trial, focusing often on short term risks from disruption whilst landlords looked to balance the benefits of having "greener" properties with the disruption that their tenants might experience.

The potential cost and personal disruption that the trial might entail were uppermost in participants' minds when it came to the disadvantages. Financial concerns included the cost of new equipment, installation, any redecoration required as well as ongoing running costs and cost implications beyond the end of the trial.

These initial triggers and barriers relating to the trial were explored in greater detail to understand what people would require, in order to positively take part in the trial.

Specific offers and incentives required to take part in the trial

The research identified eight themes when it came to the practical and emotional triggers (and barriers) to increasing positive participation in the trial, irrespective of fuel choice. These are shown in the figure below. The first five were the most significant positive levers and barriers requiring reassurance and specific provision, followed by additional factors which were relevant but less personally significant.



Cost

A core principle that guided requirements from the trial was that no-one should be worse off as a result of taking part. Indeed participants were more likely to focus on meeting this requirement than in demanding additional financial incentives.

> *"If it was paid for by the government then I might go for it. But I really wouldn't want to have to pay for it myself and have to pay for the house to be put back right." (Mainstream consumer sample)*

Participants expected that all appliances would be supplied free of charge and that any labour costs involved in installation would be "covered" rather than them having to pay for these. Warranties/servicing/repair of appliances was assumed to be included/covered and insurance policies unaffected. There were also concerns that appliances would remain

useable after the trial (for natural gas or hydrogen ready) so that participants did not have to pay to replace them and also that the cost of any making good of installation works before, during and after trial would be covered.

Bills were expected to be fixed and/or capped at a fair rate e.g. based on an average of previous usage, for the duration of the trial (with some expectation that financial protection would continue beyond the end of the trial). In some cases participants called for heavily subsidised or free energy during the trial, but bill parity was the minimum requirement. SMEs were most likely to recommend financial compensation for any lost business during installation (or down time) as well as asking for long term warranties on equipment to minimise longer term cost risks.

"Concerns with the bills based on the previous two years, you have no way of knowing how much it would actually cost you after the trial..."
(Mainstream consumer sample)

Disruption

Disruption was a key top-of-mind concern that participants had, although the information that they were given during the deliberative process went a long way to reassuring them that there would be satisfactory general provision for alleviating some of the disruption involved in the trial (whichever fuel was chosen) and making the transition to their chosen technology as easy as possible. However it remained a key barrier to positively address, and requirements included timing any work so that winter was avoided, providing clear and detailed timelines for all works as far in advance as possible so that consumers and businesses can plan accordingly and offering some choice around appointment times for any installation works requiring access to homes and business premises.

"[In an ideal world] The work could be completed as quickly and efficiently as possible with little or no disruption to myself or the local area. Appointments made to suit me and the workmen arriving on time on the dates agreed." (Mainstream consumer sample)

In addition, participants expected all work to be "made good" to a high standard/equivalent to existing décor/cupboards/premises etc. so that they do not need to clean up, replaster/redecorate etc. after equipment had been installed; this extends to outside spaces too. If there was a danger of being without heating or cooking equipment during installation, providing alternatives such as portable appliances would also be welcomed, especially for customers in vulnerable situations who might have specific heating or dietary needs.

Safety & trust

Reassurances on everything from the safety of hydrogen as a fuel, to regular safety checks were suggested as core requirements before and during the trial.

In particular, up front (and independent) safety assurances about the fuel technology itself, equipment, installers' accreditation and ongoing use (e.g. suppling hydrogen detectors) were called for. Hydrogen as a fuel is seen as requiring particular safety reassurance both because it is novel and because of the nature of the fuel (i.e. gas).

"[We] currently check gas boilers every year, so surely these new appliances should be tested more often? Test them when they are initially installed and then at three months and then every six months." (Mainstream consumer sample)

Some participants also called for dedicated engineers who could build a relationship and would be familiar with homes and businesses; participants also suggested more regular safety checks on all equipment (e.g. 6 monthly) to provide a higher degree of safety reassurance and thus trust than they might habitually require.

Landlords were particularly concerned about their legal and insurance responsibilities with regard to safety and would need additional communication and assurances in this regard.

Reliability & efficiency

Participants sought reassurance and commitments that their equipment and fuel/energy source would be reliable during the trial and that both they, and customers in vulnerable situations within their communities, would be protected by a high level of support if problems did arise. This largely revolved around advance notice of planned disruption and 24/7 access to emergency support in the event of a problem with a commitment to rapidly resolve issues (e.g. 2-4 hours).

"I think it would be interesting to be part of it but I am hesitant because there is a lot of work involved. Also I worry that it's the first trial and there will be problems that they need to solve. These problems won't happen when they roll it out to the rest of the country." (mainstream consumer sample)

Support suggestions/recommendations for customers in vulnerable situations included back-up generators, meal delivery, specialist mental health support and alternative accommodation. Demonstrating that the needs of everyone in the trial community are being catered for could be an important social benefit to offer and deliver.

Choice & control

Feeling in control and having a degree of choice over the trial process are important emotional as well as practical factors for many people. They called for clear communication about why the trial was happening and any reasons for limitations on the choices/options they might have, in order to feel fully informed. They also asked for a degree of choice over appliances (e.g. cookers) so that they could retain as much continuity as possible (in terms of behaviour and style) as well as replicating what were likely to have been highly personal choices, hence calls for a choice of colour, size, functionality. When asked what would represent added value, a wider choice of appliance brands, range of models etc., was suggested.

"With appliances, it's not just about the colours…it depends on the makes. There ought to be a choice of make and quality as well as the colours to match in your kitchen." (Mainstream consumer sample)

Other areas where people would value more choice/control would be in being able to choose appointment slots, with some appetite amongst businesses for greater matching of functionality of appliances to their specific needs.

Hydrogen vs Heat Pumps

At the start of the deliberation process in the research, participants leant towards Hydrogen as the fuel technology they would opt for in a trial situation, largely because of the potential benefits that they had already expressed about hydrogen – it is the more behaviourally familiar technology to natural gas (and thus an easier option to transition to) and was also seen as somewhat less disruptive than heat pumps in terms of installation.

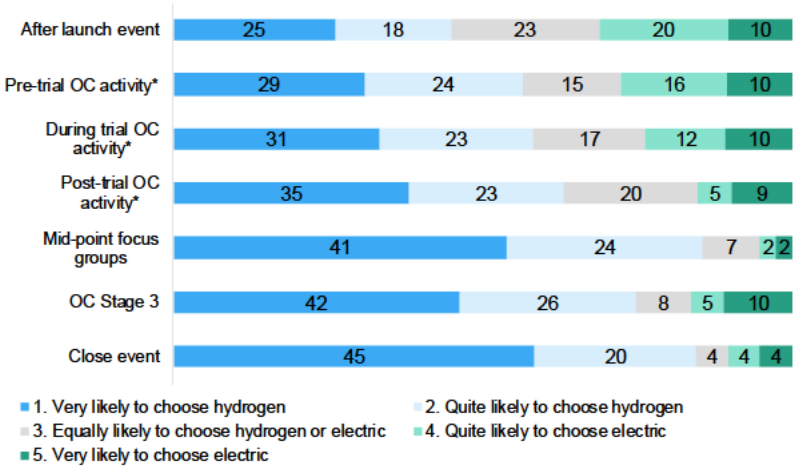
"Hydrogen sounds like natural gas but with less carbon footprint, which is positive." (Mainstream consumer audience)

A minority also expressed the belief that Hydrogen would be cheaper to run than heat pumps (a particular concern for those experiencing fuel poverty), based on residual perceptions of the cost of gas vs electric heating rather than the information they were given about the technologies in the research.

As they learned more during the project about the different technologies, the attractiveness of hydrogen increased, as the chart below indicates. At the end of the research only a small minority indicated they would opt for the heat pump.

Hydrogen vs Electric

Thinking about if the trial was happening in your community, are you more likely to choose to take part in the hydrogen trial or the electric alternative?



The reasons for this strengthening of the hydrogen preference related mainly to a solidifying in people's minds of the disadvantages of heat pumps (disruption in installation, changes in heating habits and negative aesthetic impact) rather than discovering additional benefits of hydrogen, underlining the importance of the ease of behavioural familiarity in people's trial choices.

2.4 Requirements Pre-Trial

Key requirements were:

- A trial schedule with clear but full details of what will happen when (including at the end of the trial), delivered well in advance of the trial start;
- A degree of choice and control over equipment and appointment times;
- Reassurance on safety, quality, disruption, costs and support.

As they learned more about the trial, how it would be managed and the likely arrangements that would be put in place, many people were reassured that there was a significant level of planning and organisation around the trial which increased their level of trust and optimism. A key focus for people was the run up to the trial itself, the engagement and communication that would be required and the likely personal disruption they would experience as arrangements were put in place and installation works carried out.

A key requirement expressed by participants was for a detailed schedule to be supplied well in advance, with some degree of choice and control over, for example, appointment times. This was suggested not just as a service commitment once they had engaged with the trial but also as a condition for taking part, thus it is about both making the process easy and also the trial a more attractive proposition. Indeed a theme in the research was for the need for as full and detailed advance notification of arrangements and options for the whole trial (pre, during and post) provided as early as possible so that people can make informed choices and plan accordingly.

> *"I would like to know approximately time frame from the start to finish what is involved in the progress of the trial. So that I can arrange in advance leave with my employer or may need family/friends to be present when the work is carried out." (Mainstream consumer sample)*

A feeling of lack of control resulting from lack of knowledge of plans and personal impact, created anxiety for people. A further worry that some people had was over the potential complexity of contracts and the possible need for (legal) support/advice. This could also include reassurances about how the trial would impact on customers' existing energy supply contracts during and after the trial.

> *"I would expect there to be an independent local lawyer or solicitor provided to read through the contracts and provide any guidance on the contract." (Mainstream consumer sample)*

The need for timely**,** advance notice and some degree of choice over arrangements was a key theme for businesses and also landlords. Businesses need to plan for disruption which could also have cost implications, and landlords need to plan for both themselves and for their tenants, heightening their requirement for advance communication to minimise disruption.

In addition to the requirement for information and a degree of choice, questions were also raised about quality standards of any work carried out, including guarantees around the training and vetting for tradespeople carrying out work in people's homes/businesses. Customers in vulnerable situations also asked for additional measures to improve their sense of personal safety/security, such as ensuring all contractors carry ID.

Pre-trial engagement is an important consideration for everyone when it comes to positively taking part in the trial. The key requirements that people have are around the reason for the trial, the options/choices they have (including what happens at the end of the trial), costs, disruption and safety, but they also want to hear about the support that will be available and who/where to go if they have ad hoc questions. All audiences expect to be given at least a year's notice (ideally more) and they expect Government to play a significant role in "owning" the communication around the trial at this stage, to give the trial relevant framing, importance, official "stamp" and also reassurance. Finally there is an appetite for "on the ground", in-person engagement via events and a significant physical presence in the local area (e.g. an office).

"Face to face meetings or group meetings as a community." (Mainstream consumer sample)

"Face to face [contact] initially, I am not going to attend a public meeting as a business because my business is unique to me. We are talking about a village - there aren't going to be a huge amount of businesses." (SME sample)

2.5 Requirements during the trial

Key requirements were:

- Guarantees of service reliability (e.g. availability of hydrogen) and responsive support and emergency provision in place (especially for CIVS);
- Dedicated service for businesses and landlords to support their tenants;
- Advance notification of planned maintenance of trial infrastructure.

Provided that things had gone to plan in the run up to the trial starting, participants expected the trial itself to be less disruptive and they had fewer requirements. Participants did expect that they might have to change their behaviour (heating and, to a lesser extent cooking) during the trial and they were keen to minimise this, which impacted their choice of fuel technology i.e. making hydrogen the more popular and easy choice.

Having made the choice, many people expected to adapt quickly to their new fuel technology (with only a minority indicating that they might be more inclined to use their heating more due to their lower environmental impact and potentially lower costs) but most expected to "carry on as normal" once minor behavioural changes had been made.

"Pretty much the same as it does now if things are going according to plan!! I will cook a family meal on my gas (hydrogen) hob, the radiators will be on and we will have hot water. We don't have smart apps so won't be affected." (Mainstream consumer sample)

However they did have concerns and thus minimum requirements concerning reliability of supply and availability of support. In a trial situation some people were concerned that there could be issues with supply (especially of hydrogen) being disrupted or their new equipment failing and to some extent there is some understanding that this could be inevitable in a trial situation. People would like to see this minimised and also additional arrangements put in place to mitigate e.g. more regular servicing of appliances for the duration of the trial. They also expect very responsive support to be available "24/7" asking for "instant access" to

support in the event of a problem or failure of supply or equipment. This reflects both a heightened sense of vulnerability in a trial situation but also a higher level of demand for support/service as a condition of taking part.

"[I'd] need to have somebody on hand 24/7 in case there was a problem in the trial." (Mainstream consumer sample)

This requirement for rapid and responsive (technical) support was particularly pertinent for SMEs and landlords who have the social dimension of either their wider businesses, their customers or tenants to consider rather than just their own personal situations. In these circumstances, there is considered to be more at risk (opportunity cost for business) and responsibility for tenants, some of whom might be vulnerable. LAHA professionals also cited the potential increased workload for them as initial points of contact for tenants and thus were keen to be supported during the trial.

"I'd like a single point of contact - an account manager. I don't want to ring around various numbers and speak to lots of people to get a problem solved." (SME sample)

"The council at the minute, I know we wouldn't have capacity to be able to take on any extra work." (LAHA landlord sample)

Interestingly consumers expressed a wish to see the social benefit of specific provision put in place for CIVS within their community who they felt might need additional support. CIVS also expressed a wish for some additional support to be in place e.g. in adapting to using new/different appliances, asking for demonstrations or adapted information to ease the process.

In addition to a smooth and reliable experience underpinned by the availability of support, communication is a key component of a successful trial experience for many people. In particular participants want timely information (in advance) of any upcoming disruption related to trial works, information on their costs (especially if these could change during the trial) and also feedback about how the trial is progressing and indeed the social reassurance/curiosity opportunity to compare experiences with other triallists.

They expect GDNs to be leading this communication (with additional input from third party organisations) and there is an appetite for a mix of channels from regular community event updates to a dedicated online space for the trial.

2.6 Requirements at the end of the trial/post trial

Key requirements were:

- Clarity about options and continuity of fuel available pre-trial;
- Ideally remain with hydrogen (or heat pumps) at end of trial;
- Guarantees/reassurance on costs and appliance obsolescence following trial.

The options for people at the end of the trial are very important and could even inform the choice of fuel that people opt for at the outset, thus people ideally need as much clarity about what will happen at the end of the trial, as early as possible in initial engagement.

For the majority who indicated that they would choose hydrogen, being hydrogen ready at the end of the trial is a potential benefit and most would prefer to remain on their hydrogen supply (assuming that it has worked effectively); indeed a minority even believe that there should not be an option to revert to natural gas as this defeats the object of the trial.

> *"I would hope to stay hydrogen ready, to future proof my home and do my bit to reduce carbon emissions." (Mainstream consumer sample)*

> *"I would prefer to stick with Hydrogen at the end of the trial if all my appliances and been converted and I'd had a new boiler installed! What would be the point of the whole exercise if we had the option to return to natural gas and the continuing impact on global warming?" (Mainstream consumer sample)*

> *"[There] shouldn't be option to go back to natural gas. [It] feels a retrograde step to have all this work done then rip it out and go back to carbon heavy fuel." (SME sample)*

If hydrogen was unavailable, the majority (of hydrogen choosers) would prefer the easier option of reverting to natural gas to avoid the additional disruption of switching to heat pumps and the associated physical disruption from installation and "habit disruption" due to the behaviour change required. Those who had chosen heat pumps would be comfortable remaining with their chosen option to avoid a second phase of disruption to homes and habits.

Uncertainty or a lack of clarity about what might happen at the end of the trial is a potential barrier to taking part (as it undermines confidence and trust in the commitment to, and planning of, the trial) and could impact fuel choice as people will want to make an assessment of the total disruption and potential risk (future costs, obsolete appliances etc.) of the choice of fuel technology they opt for at the start.

2.7 Summary of specific segment requirements & differences

The research insights set out above represent the core findings common to all audience segments, with some indications of specific differences/unique perspectives of different segment. The further quantitative stage of work will provide more robust data on segment differences, but we can make the following general observations from the qualitative work.

Customers in vulnerable situations share much in common with mainstream consumers but tend to have heightened sensitivity to a number of factors:

- Disruption – they are more likely to need additional support, mitigation, alternative heating, cooking or even accommodation whilst any disruption is happening to their homes – pre, and during the trial
- Their disruption-aversion could also inform their fuel choice
- They are concerned that community based communication should be fully accessible, or alternatives put in place and they, like digitally disengaged consumers, are more likely to request support getting used to new equipment

- They are more concerned than some segments in obtaining advice from independent sources in order to make informed choices about the trial
- And they are a little more concerned about safety of the fuel technology and indeed security when it comes to installation works (e.g. requiring contractors to wear IDs)

Customers in fuel poverty/debt are naturally more concerned about the potential cost implications of taking part in the trial

- Although in line with other consumers they require reassurance that they will not pay more, rather than specific incentives or discounts
- They share many enhanced support needs with CIVS and digitally disengaged consumers

The **digitally disengaged** audience exhibits more risk aversion than mainstream consumers and are more cautious about both change and also making a fully informed choice

- They are more likely to require in-person engagement, including in-home as well as community events
- They, naturally, require all information in physical format
- They are also more likely to require support in getting to know and starting to use their new equipment, for example needing personalised support rather than complex information/instructions

SMEs are adept at taking calculated risks but were more likely to be cautious about the possible (financial) risks associated with participation in the trial, before considering the possible reputational/marketing benefits

- They were, therefore likely to call for compensation to cover them for any potential business loss as a result of taking part in the trial, at any stage
- Businesses tend to see their needs as both distinct from the general population and unique to their needs
- Therefore they expect a business-to-business account management style service relationship during the trial, with rapid response and service designed and tailored for their business
- Many SMEs are still recovering from the impact of the pandemic and so are not yet proactively planning for net zero, but they are open

Professional landlords in both the public and private sector have two sets of priorities to consider in relation to the trial – their professional requirements, processes and workloads and the situations and preferences of their (current and future) tenants

- This means that they might have additional requirements for information targeted at both them and their tenants
- They might require support to alleviate the additional work they feel might fall on them as intermediaries between their tenants and the trial
- Landlords also have specific responsibilities around safety and insurance which might impact everything from their choice of fuel technology to their contractual and service level requirements
- Finally they need to consider their tenants' preferences for heating and cooking, and, in some cases in the private sector, the environmental credentials of a property

3. Summary, conclusions and implications

3.1 Summary of key insights

In this final section we highlight the conclusions that can be drawn from this initial piece of qualitative research along with key implications for both the subsequent quantitative research and also for the successful execution of the Village Trial.

From the contextual discussion the research established that climate change is on many people's minds and most agree that action needs to be taken – at the national and individual level. Whilst Net Zero is becoming more well known as an idea, and is a positive shared goal, it can be hard for individual people to see what specifically they can do to make a significant impact and individual behaviour change is held back by a lack of knowledge about the impact of home energy use on emissions.

People are attracted to the idea of using alternative energy/fuels but know very little about what the alternatives are for them. Hydrogen is a particularly novel idea for most participants and while initially there are some negative connotations around safety, the idea of it being a direct replacement for natural gas is very appealing.

People respond positively to the idea of a trial as it could make a significant impact on their shared journey to Net Zero. They are positive about taking part themselves, provided they feel in control and that they have choice and agency at an early stage, they are assured on safety, they are not out-of-pocket, that disruption will be minimised and that support will be a key feature throughout trial. (Additional incentives are appreciated, but these are not essential in most cases).

Ultimately, preference for hydrogen will be driven by the perceived ease and ability to maintain current heating/cooking behaviours and habits, and by unattractiveness of the aesthetics, space, and noise associated with heat pumps. However, what happens at the end of the trial is key – having to switch again from hydrogen would be a negative and consumers and businesses might be more likely to choose heat pumps if they feel they are the more convenient long-term option.

3.2 Implications, at this stage, for a successful trial implementation

Whilst further quantitative research will be conducted on the specific requirements that different audiences have, from this initial qualitative piece of work we can make the following broad recommendations for how to maximise the appeal of the trial and of hydrogen in particular.

1. There is a need to make the trial attractive by positioning it strongly in the context of climate change/net zero and the positive and important impact it will have on society/people's future whilst simultaneously educating about the impact of home energy use on emissions.
2. There will be a need to ensure that thorough and detailed information about alternative fuels and hydrogen in particular is provided, with a focus both on its safety

and similarities with natural gas in terms of heating and cooking behaviours and habits to make the transition to, and choice of, hydrogen as easy as possible.

3. Alongside the societal and environmental benefits that will make the trial attractive, it will be important for initial engagement to reassure people that they will not be financially worse off due to the trial, that there is support throughout, and that disruption will be minimised (e.g. by careful planning, repairing any damage caused in installation/removal of appliances), thereby making it easier for them to take part.
4. Ideally Government and GDNs should actively engage people well in advance of the trial (as early as possible), with a multi-channel approach, taking into account specific needs of businesses, landlords, CIVS and digitally disengaged customers in particular.
5. Finally, communication and early engagement, ideally needs to address the trial "end-game" right from the start – people will ideally want to choose the fuel that they will be able to continue to use; if Hydrogen's future is not certain pre-trial, it will be important to emphasise future-readiness and ability to continue to use appliances etc. to make hydrogen the more attractive option and to avoid rejection.

3.3 Implications for further research

A number of implications for building on the qualitative research to inform the design of the subsequent quantitative phase, were identified and are summarised below:

1. **The best way to describe and frame the trial in stimulus material**: The qualitative research identified the importance of grounding the initial description of the trial in the idea of Net Zero, Government plans and also real-life behaviour. The qualitative phase also identified key challenges to consider, for example, communicating a simple and clear but comprehensive outline of the Village Trial in a survey environment, given the challenges experienced in a qualitative situation with more "space and time" to explain and take account of a diverse range of highly individual questions and misconceptions.
2. **Potential ways of segmenting the audience**: This qualitative work has outlined variables that could prove useful for quantitative analysis including those which were incorporated into the qualitative work: attitudes towards environment, knowledge of and attitudes towards alternative fuels, new technology and home & garden. Plus broader themes which emerged throughout the qualitative work, including trust in Government, response to uncertainty/requirement for certainty, businesses' experience during Covid, and specific household composition.
3. **Specific attitudes to the trial and trade-offs to be measured**: The qualitative research highlighted the range of attitudes towards the trial and the possible need to measure key tensions around: personal (negative) impact and broader societal benefits, short term relevance of sustainability to businesses; different levels of financial offer from covering costs to higher incentives, which had less overt appeal in the qualitative work, once core requirements were met; compensation for lost business for SMEs where it is a perceived result of taking part in the trial.
4. **Features and attributes of "propositions" to be tested**: Finally, the "proposition/offer" discussion in the qualitative sessions, created a "long list" of attributes and potential stretch levels within those, which were outlined separately, in full, to inform the quantitative questionnaire and conjoint design.

13 December 2021

The Hydrogen Village Research Programme

Classified: Private

Quantitative stage findings: executive summary

Make better decisions

Savanta:

Introduction

Background

As the UK transitions to Net Zero, it is essential that our heating is decarbonised. Doing so relies on the replacement of methane gas with alternative lower carbon technologies, such as hydrogen gas and electric heat pumps. BEIS has signalled its intent to create a 'hydrogen village' – a trial community where homes and business premises will be converted from methane gas supply to hydrogen gas supply. Whilst the 'switching off' of the methane gas at this trial location will be mandatory, residents and businesses will not be forced to adopt hydrogen and may, if they wish, choose alternatives including heat pumps.

For the trial to be a success, we need to ensure that as many homes and businesses as possible opt for hydrogen. Furthermore, it is strongly desired that the trial is seen with positivity by the participants who are happy (or at least not actively unhappy) to be taking part.

However, the adoption of any new technology that causes enforced change and disruption to peoples' lives is always far from straightforward. It is therefore essential to understand the attitudes of potential participants, their motivations and concerns, and how best to positively engage them in a trial.

The research programme

To guide this process, three stages of research have been undertaken. The first was a review of existing literature. In particular, it focused on understanding three areas:

1. Factors that impact the success (or failure) of behavioural change programmes
2. Reviewing the current evidence base of public perceptions and attitudes towards hydrogen and related technologies
3. Conducting a 'gap analysis' to reveal the extent to which key behavioural change success factors can already be answered by literature with regards to hydrogen, and where new, updated, or enhanced primary research was required

One key finding from the literature review was the value of applying the 'EAST' (Easy, Attractive, Social, Timely) model[1] for conducting behavioural change trials, including ones similar in nature to the hydrogen village. The literature review therefore strongly recommended the adoption of the EAST model in all subsequent research stages.

The findings from the literature review (available separately) directly informed the design of an online, qualitative stage of primary research. Using the EAST model as a framework, the qualitative stage, conducted deliberatively amongst a wide breadth of both domestic and business customers, explored:

1. Underlying attitudes towards heating and climate change
2. Understanding of, and reaction towards, hydrogen and heat pumps
3. Concerns and motivations around participation in a low carbon energy trial

The findings from the qualitative stage (also available separately), directly informed the design of an online, quantitative stage of primary research. Again using the EAST model as a design framework, this quantitative stage, conducted amongst a large audience of both domestic and business customers, sought to quantify, validate and refine the findings from the qualitative research at a mass scale.

In particular, it included both direct questions (on topics such as attitudes towards heating and preferred communication channels), and indirect statistical evaluation of potential 'trial propositions' via a conjoint analysis.

[1] https://gcs.civilservice.gov.uk/publications/strategic-communications-a-behavioural-approach/

This report

This Executive Summary report summarises the key findings from the quantitative research (itself incorporating learnings from the literature review and qualitative stages).

Note that the aim of this report is to guide the customer-centric design of trial propositions. It does not propose a specific proposition (the design of which will also depend on business case factors to be determined by the GDNs). As such, any final proposed propositions may require further testing prior to deployment.

The quantitative approach in more detail

Savanta conducted a large-scale online survey of 1,158 business and 4,051 domestic customers. The survey was structured into three sections:

1. Screening criteria, general attitudes and profiling
2. Attitudes towards climate change and low carbon technologies
3. The trial, potential propositions and communications (including stimulus to educate customers and elicit informed responses, and a conjoint analysis)

Fieldwork was conducted between 28th October and 15th November 2021, with an average survey completion time of 21 mins.

The questions in the survey were designed in collaboration with all GDNs, the provider of the qualitative phase (BritainThinks), and feedback from BEIS. In addition to 'standard' open and closed questions, a conjoint exercise was also used to force respondents to trade off potential trial components to determine what proposition elements will most positively influence participation (both in isolation and in combination).

The sampling of both the domestic and business customer audiences was designed to ensure robustness and representativity. This was achieved through a combination of quotas and weighting, guided by data from the GDNs and ONS:

- Among **domestic customer** respondents, the primary demographic factors used for both quotas and weighting were: age, gender, socio-economic grade (SEG), and GDN region (determined by postcodes provided by GDNs). Further profiling data was collected to enable sub-group analysis, such as fuel poverty status, vulnerability status and housing tenure.
- Among **business customer** respondents, the primary firmographic factors used for both quotas and weighting were industry (SIC code list grouped into 5 'macro' groupings), business size (inclusive of 0-99 employees) and GDN region (determined by postcodes provided by GDNs). As the number of UK businesses is heavily biased towards very small companies, as is standard practice in business surveys, disproportionate sampling by size was used to ensure robust analysis could be conducted across different business size bands (sole trader, micro and small businesses). Further profiling data was collected to enable sub-group analysis, such as the extent to which business operations are dependent on gas.

Key findings

Given the scale of this research programme and the quantity of data it produced, we have organised the key findings into four sections that each address a different aspect of the trial design:

- **The scale of the challenge** section examines customers' current views towards low carbon technologies and the trial concept, which can be used to identify where support and resistance are likely to lie within communities
- **The role of environmentalism** section explores views on the Net Zero target and how these can be leveraged in the trial
- The **demonstrating the benefits of the trial and allaying concerns** section considers the perceived barriers to participation and advantages to taking part in customers' eyes
- The **communicating about the trial** section analyses the optimal channels, partnerships and strategies to employ when contacting customers about the trial

The scale of the challenge

As seen in the literature review and qualitative phase, it is unlikely that customers will organically adopt heat pumps or hydrogen boilers in the near future in the volume required to achieve the Net Zero target in the UK. Whilst awareness is relatively high (e.g. 62% of domestic customers claim to be aware of hydrogen boilers and 82% of heat pumps – numbers that were likely boosted by the survey taking place at the same time as COP26), customers indicated that they are unlikely to adopt these technologies in the next 5 to 10 years.

As demonstrated by figure 1, only around one in four businesses and one in seven domestic customers indicated that they would be likely to adopt a hydrogen boiler in the next 5 to 10 years, with nearly half of domestic customers indicating that they are unlikely to do so.

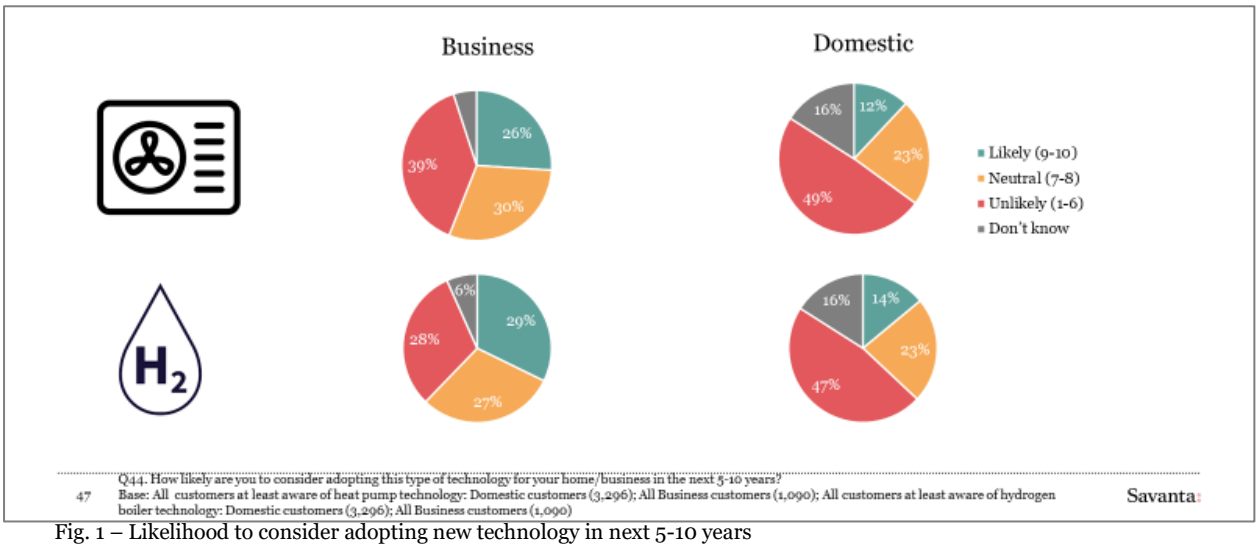


Fig. 1 – Likelihood to consider adopting new technology in next 5-10 years

This demonstrates both the broad challenge that the UK faces, and specifically the challenge faced by the hydrogen village trial: people are generally not intending to adopt alternative heat sources, meaning that the trial will need to generate behavioural change and will require a concerted effort to obtain buy-in.

This finding reenforced the need to use a behavioural framework both in the insight generation and the trial design, first highlighted in the literature review stage and carried through to both the qualitative and quantitative phase.

However, whilst the UK faces a challenge to get customers to adopt alternative heating sources, that is not to say the scale of the challenge is equal across all customer groups. During the survey, we introduced the concept of the trial to gauge initial reactions and enable us to explore more complex themes with respondents. This revealed that, among domestic customers, the 'low hanging fruit' for the trial are younger, more affluent and urban people. Among business customers, small businesses and those that rely on gas for their operations are more positive about participating. We can therefore surmise that these groups are more likely to react positively to hearing about the trial in their community.

On first glance, the group of business customers most reliant on gas (who therefore have the most to lose from disruption) being more supportive of the trial can seem counter intuitive. However, a strong story emerges about businesses that are unable to operate without gas in the wider dataset:

- This audience is more likely to feel well informed about how the energy and power they use in their business impacts climate change
- This audience is more likely to be positive towards replacing their natural gas appliances with greener alternatives
- They are more likely to see the publicity of being a sustainable business as a benefit of participating in the trial

Conversely, as demonstrated by figures 2 and 3, resistance is likely to be centered around sole traders and older, less affluent, and rural domestic customers. These groups might require additional support, information or even incentivisation, which will be explored in more detail later in this report.

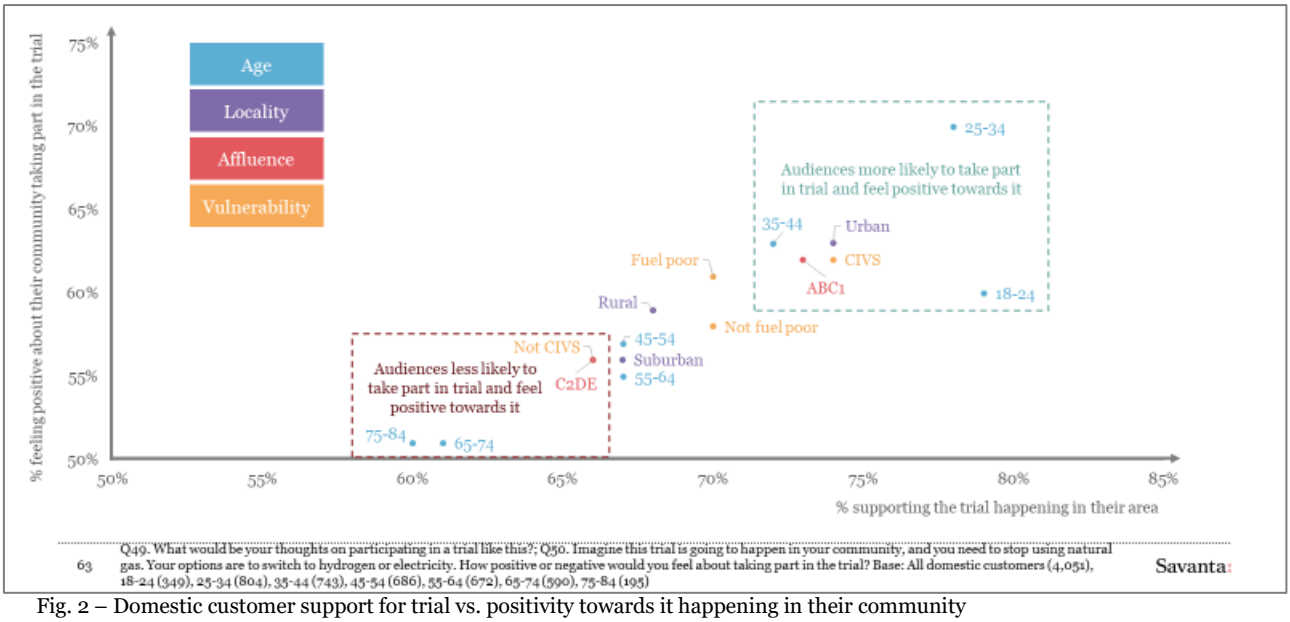


Fig. 2 – Domestic customer support for trial vs. positivity towards it happening in their community

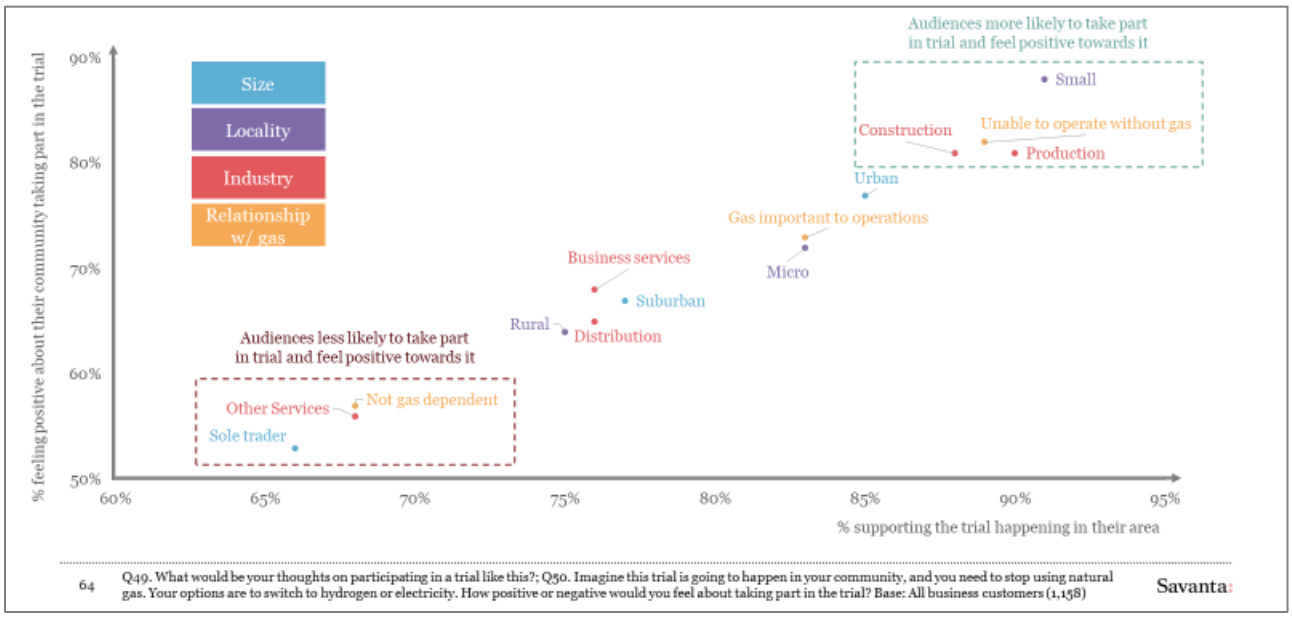


Fig. 3 – Business customer support for trial vs. positivity towards it happening in their community

When designing a trial, it is crucial to understand which audiences are likely to offer the most resistance to the project, so that their needs can be understood in greater depth and value propositions can be developed to target them (whilst not neglecting the more receptive audiences). As these audiences are likely to be particularly reticent, extra focus is required to make trial participation easy, attractive, social and timely.

The role of environmentalism

The hydrogen village trial sits within the Government's Ten Point Plan for a Green Industrial Revolution and is therefore intrinsically linked to the UK's Net Zero target. However, as seen in the inform stage, there is no guarantee that trial participants will view the project purely through this lens, and will instead draw conclusions about the benefits and costs to them and their local community.

A key part of the quantitative research focused on understanding the extent to which people are aware of the potential impact of the Net Zero target on how they use energy in their lives and whether it would be a key driver for positive participation in a hydrogen trial.

Positively, the data shows that the environmental benefits of trial participation can act as a strong 'pull factor'. As seen in figure 4, environmental benefits ranked highest of all the potential benefits that we tested. It should be noted though, as we will explore later, that a number of other benefits which can broadly be grouped together as 'financial' also score highly among both domestic and business customers.

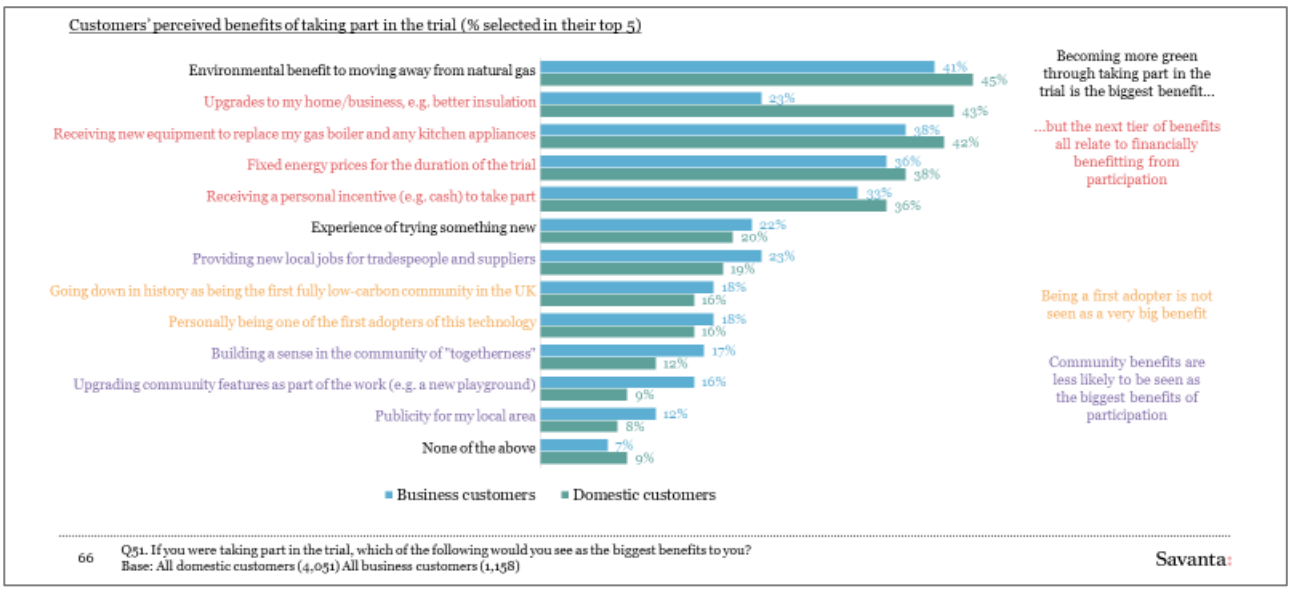


Fig. 4 – Customers' perceived benefits of taking part in the trial (% selected in their top 5)

As demonstrated by figure 5, three quarters of both domestic and business customers consider the UK's Net Zero target as a 'good idea' and 'essential'. This is identified using a semiotic pairing exercise, which is a question type in which respondents are presented with pairs of opposite statements and must select a point on a 7-point scale between the statements to signify how strongly they agree with one of the statements. This, coupled with both domestic and business customers seeing the environmental benefits of trial participations as having the strongest appeal, shows that tying in the effects of this trial with the Net Zero target would benefit its value in the eyes of customers. This aligns to the need to make it 'attractive' within the EAST framework.

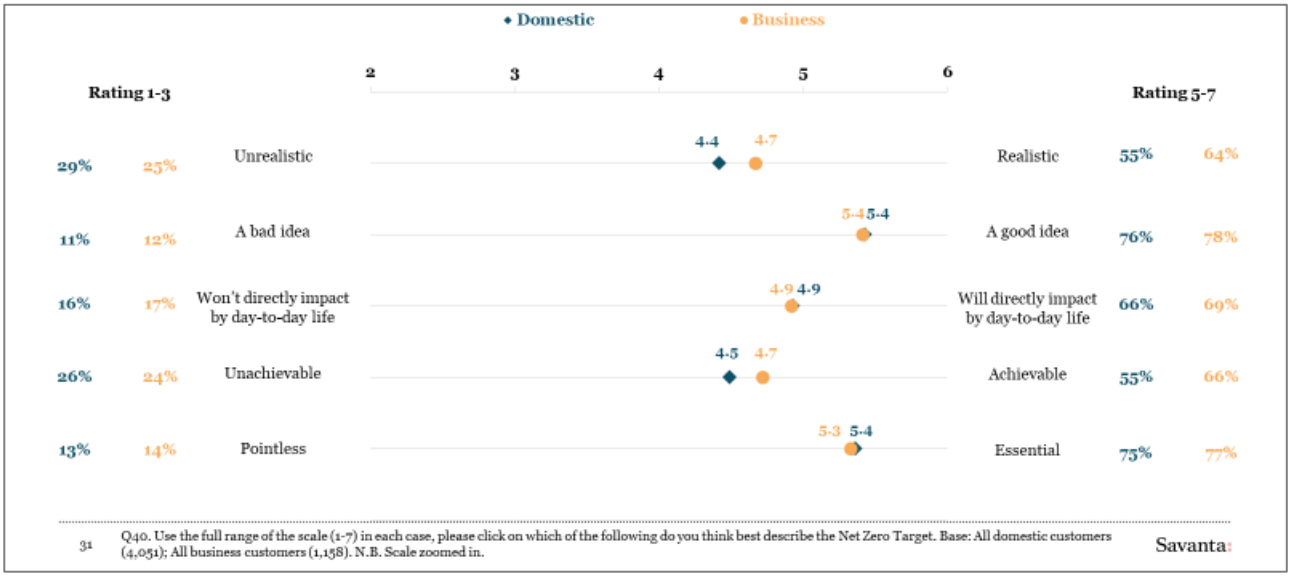


Fig. 5 – Customer attitudes towards UK's Net Zero target (a semiotic pairing exercise on a 7-point scale)

However, despite saying they are willing to make changes to their lives to combat climate change, many domestic customers feel less informed about how the energy they use impacts it. As figure 6 shows, this is particularly true of domestic customers, whereas businesses tend to feel more informed on this topic.

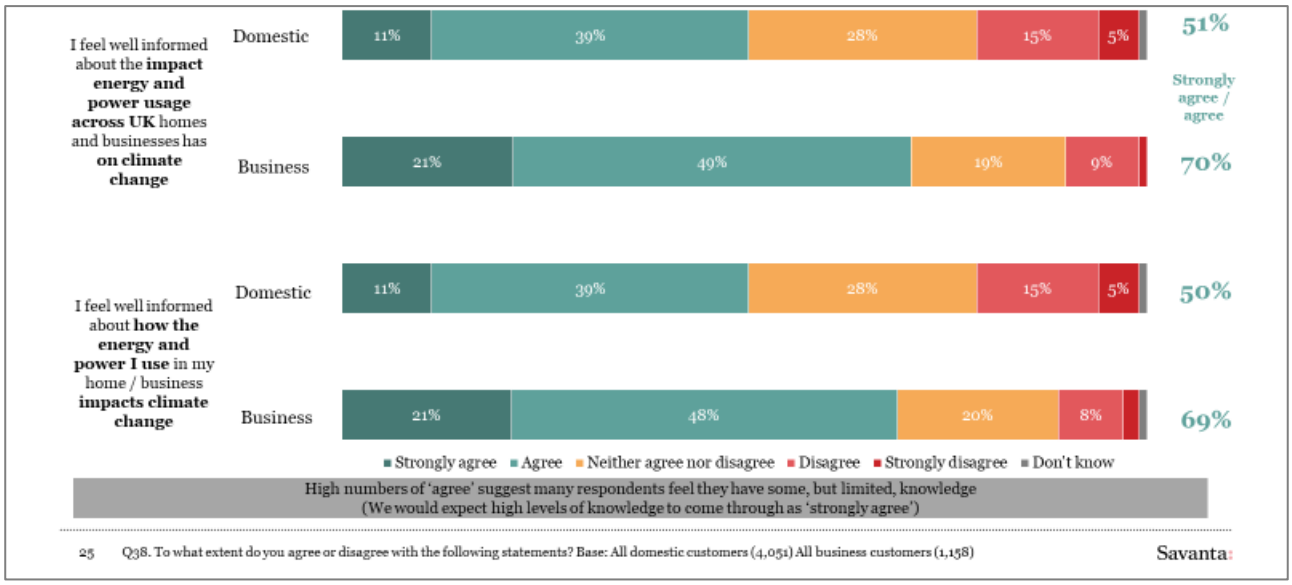


Fig. 6 – % agreement with statements on energy use and climate change

Furthermore, as highlighted in the previous section, there are different stories emerging from the data when the views of the different sub-groups are examined. Figure 7 explores the data from two of the semiotic pairs through the lens of age. It reveals that younger domestic customers are considerably more likely to feel the Net Zero target is both realistic and achievable, whereas more scepticism exists in older audiences. When communicating with all customers about the trial, but particularly younger ones, it is important to emphasise the trial's role in the UK achieving Net Zero as it is likely to result in greater positivity and support for it.

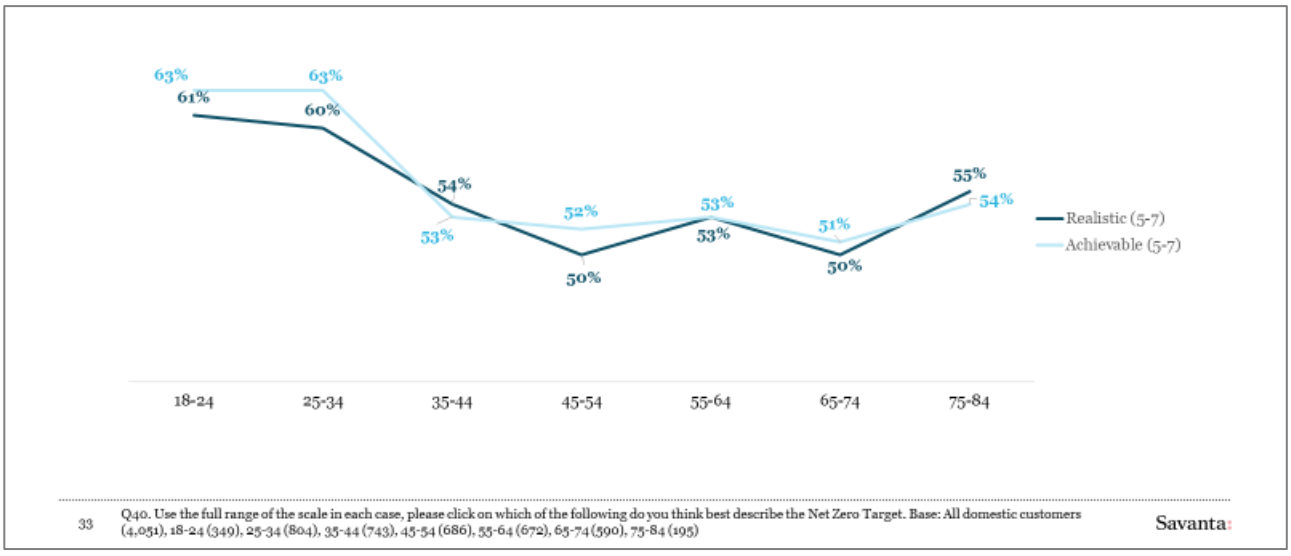


Fig. 7 – Domestic customers' attitudes towards UK's Net Zero target

The trial should therefore draw a direct line between the way that homes and businesses are heated, through to climate change and the UK's Net Zero target.

Demonstrating the benefits of the trial and allaying concerns

As seen in both the inform and qualitative phases, the trial needs to be positioned in terms of the benefits to the individuals, households and businesses taking part. The previous section explained the significant role that the environmental benefits of participation can play in encouraging support for the trial, but we must not forget that the primary lens through which people will view the project is the benefits and costs to them, their families and communities. Within the EAST framework, this corresponds to the need to make it 'easy' (i.e. without major barriers) and 'attractive' (i.e. generating more benefits than it does costs).

The most significant factor to consider in this is the financial aspect. The idea that no customer will be left out of pocket will be key to the success of the trial, removing what would otherwise be a key barrier to participation. As we saw earlier, a substantial proportion of both domestic and business customers believe they are unlikely to adopt heat pumps or hydrogen boilers in the next 5-10 years. When asked why, the perceived high price of these technologies emerged as the primary barrier. This is demonstrated by figures 8 (heat pumps) and 9 (hydrogen boilers).

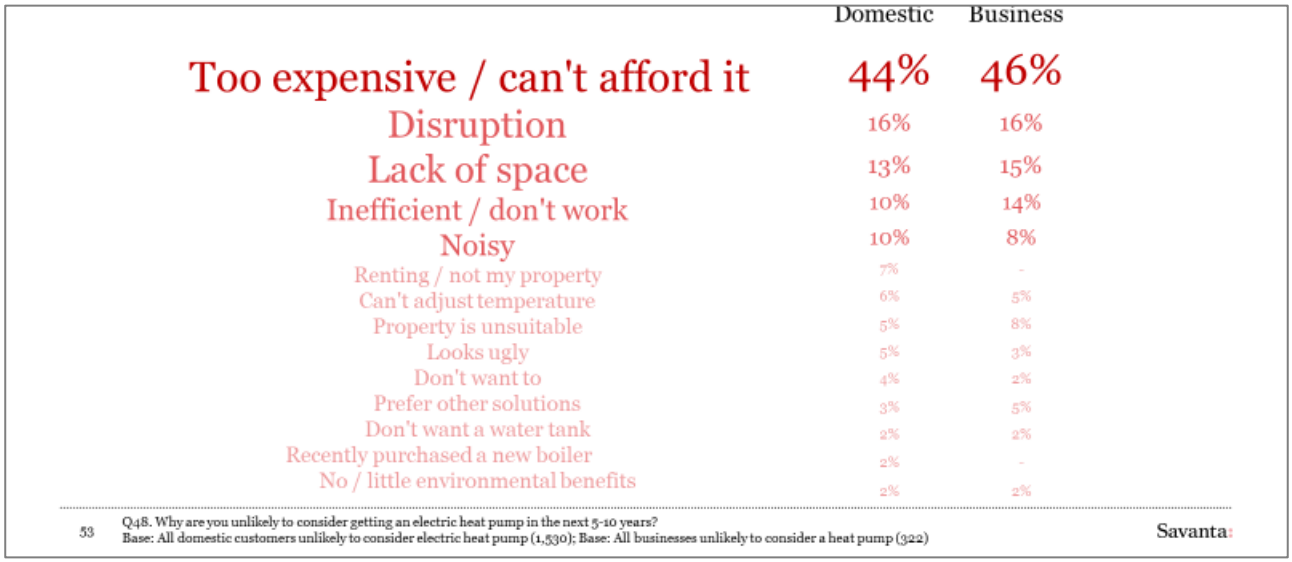


Fig. 8 – Reasons to be unlikely to consider a heat pump in the next 5-10 years

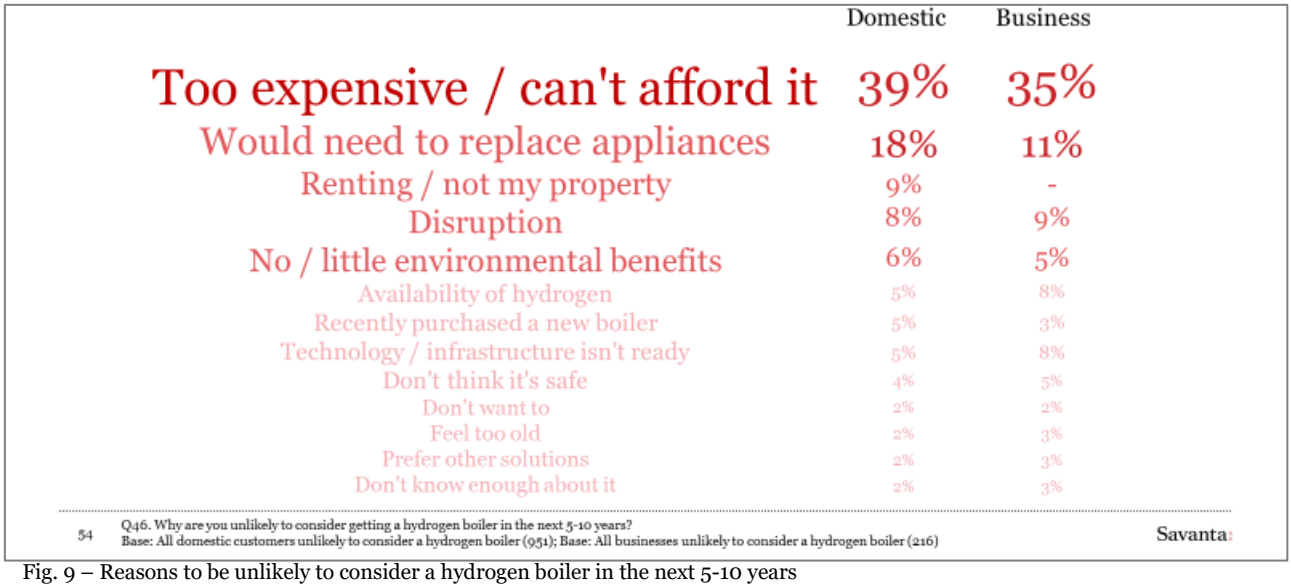


Fig. 9 – Reasons to be unlikely to consider a hydrogen boiler in the next 5-10 years

Whilst the perceived high cost of these technologies can act as a blocker to adoption, removing this barrier and other financial factors can act as a strong 'pull factor' to participating in the trial. After the environmental benefits of participation, the next four most appealing potential benefits to trial participation according to customers all relate to how households and business can save money or receive free upgrades to their appliances or property. For example, two in five domestic customers rank receiving new appliances (43%) and new insulation for free (42%) in their top five benefits to participating in the trial respectively, as is demonstrated in figure 10. Whilst the trial itself may not include all of these benefits, it is useful for its design to know which hold the greatest appeal among customers.

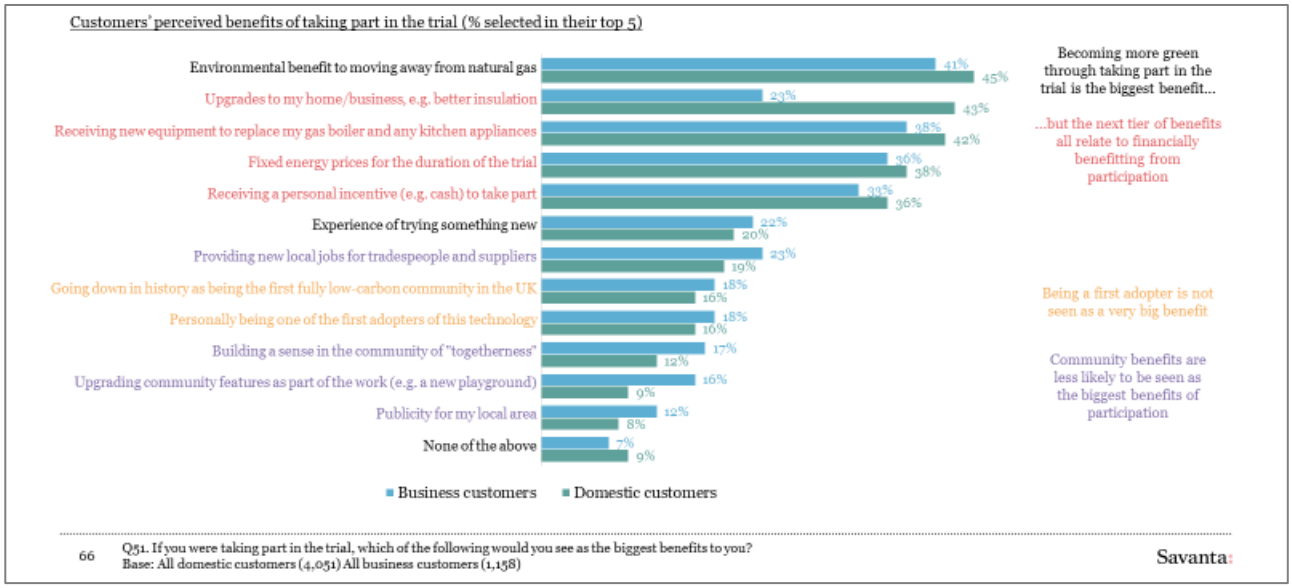


Fig. 10 – Customers' perceived benefits of taking part in the trial (% selected in their top 5)

As well as emphasising the benefits of participation and the technologies involved, messaging and education will need to allay customers' concerns. At the same time as seeing the appeal of financial benefits such as free insulation and appliance upgrades, customers' biggest concerns relate to being hit in the pocket (either during installation or through running costs).

Secondarily to this, and reflecting the hierarchy identified in the qualitative phase, customers are also concerned about:

- Disruption during the installation process and during a potential switch back to natural gas at the end of the trial
- The reliability, safety and compatibility of hydrogen appliances, reflecting a general lack of familiarity with the technology

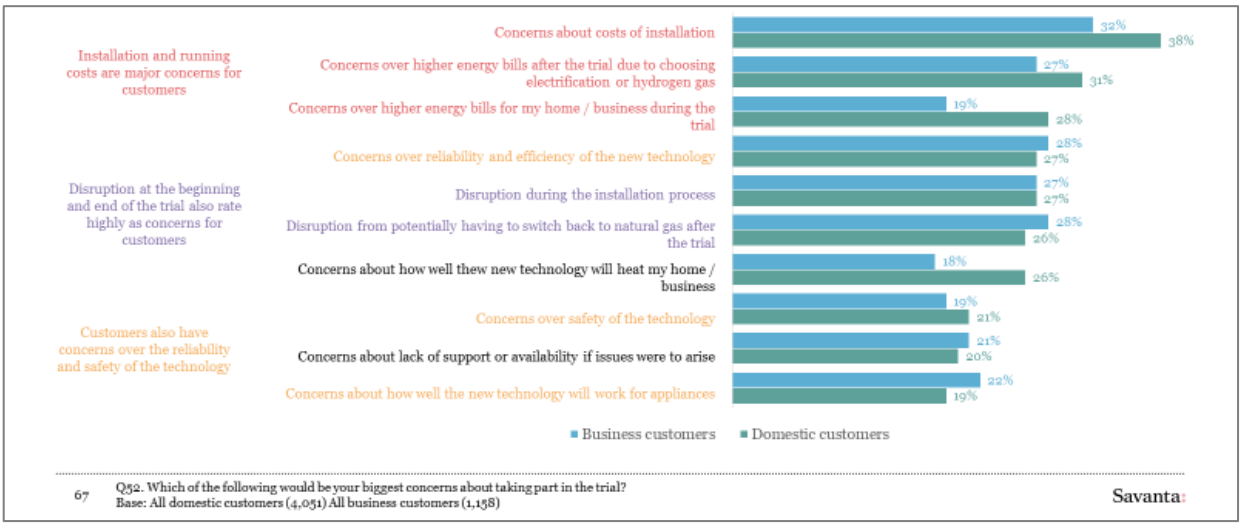


Fig. 11 – Customers' concerns around taking part in the trial (% selected in their top 5)

Messaging therefore needs to combat concerns around cost and disruption, as well as educating people on the reliability, safety and efficiency of hydrogen. It should also emphasise the benefits to the local community with particular focus, if possible, on providing local jobs through the trial. Among both domestic and business customers, this is the most appealing local community enhancement of those that we tested. It was also attractive to sole traders, who are otherwise a group that will potentially resist the trial in their area.

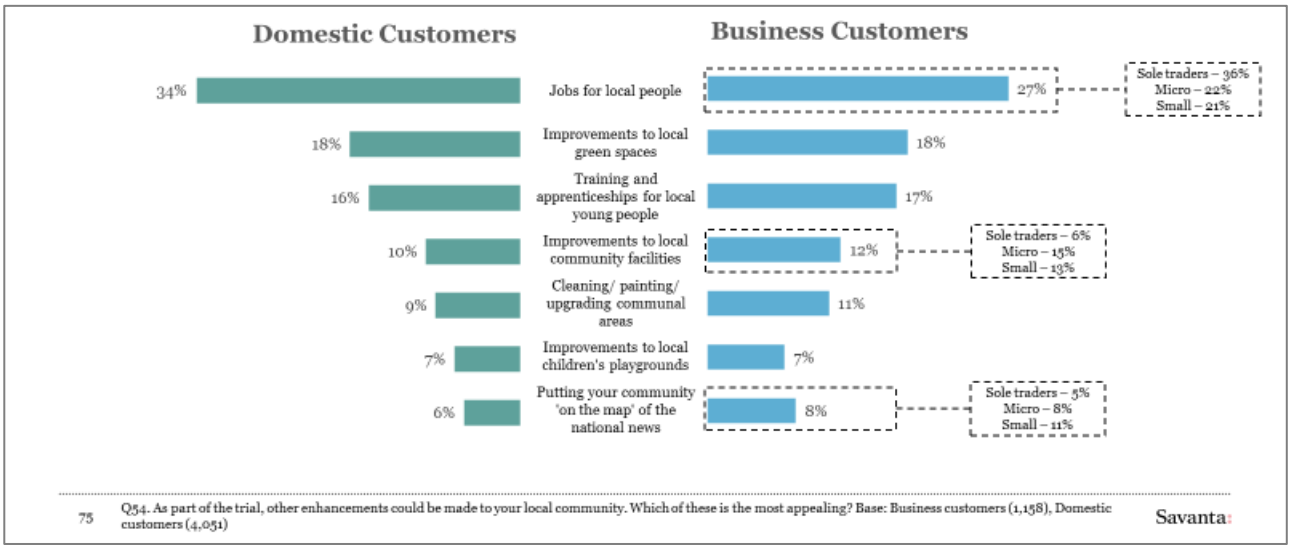


Fig. 12 – Most appealing enhancements to local community for the trial

Communicating about the trial

When communicating to participants about the trial, it is crucial that the information is trusted by the community. As part of the survey, we explored with respondents the extent to which they would trust information about the trial from the various theoretical institutions, individuals and bodies that could be involved. The data showed that regulator-endorsement and the involvement of both a GDN and scientists should improve the trust in the trial and related communications. The data also indicates that GDNs should be wary of visible national Government involvement as this brings a high level of mistrust. As figure 13 shows, the low levels of trust in national Government are consistent across all age groups, whereas older audiences are more likely to trust the regulator and scientists compared to younger people.

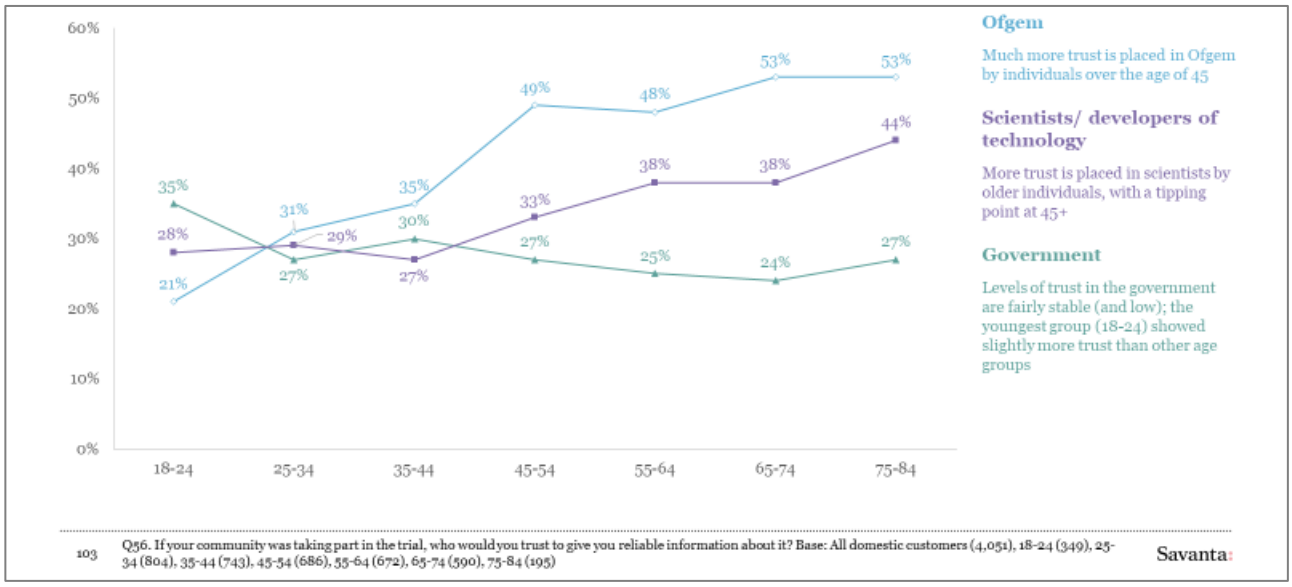


Fig. 13 – Domestic customers' preference on who they would trust to deliver information about the trial

Whilst we need to ensure that the source of information is trusted, we also need to ensure that the trial communication plan utilises the most effective channels for different audiences. Our data on this reveals that trial communications should include a combination of door-to-door and social media engagement. Door-to-door is especially important for older audiences, for whom word of mouth is the most important channel as is demonstrated by figure 14. Younger audiences are easier to target through online groups, local clubs, societies and social activities, which should be factored into the trial communication strategy. These channels are also important for ensuring that the trial participation is viewed as 'social', as this will improve its chances of success according to the EAST framework.

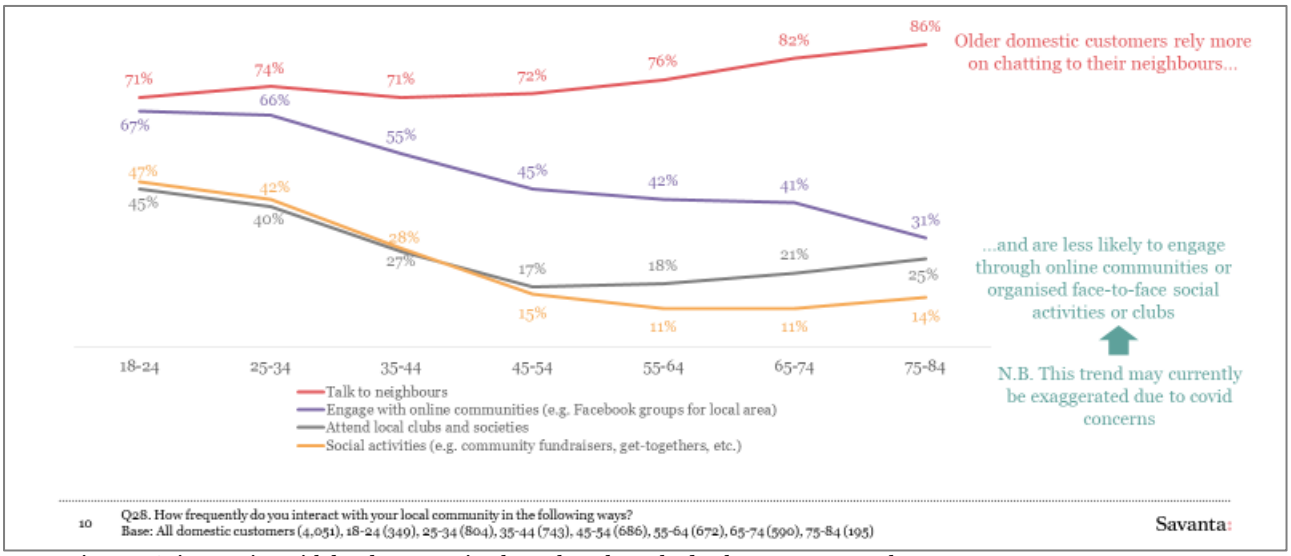


Fig. 14 – % interacting with local community through each method at least once a month

Providing sufficient forewarning should also form a key part of the communication plan. As highlighted in the inform stage, messages and education around the trial should be spread over an extended period, in order to educate, reassure and positively engage participants. In the quantitative stage, we tested how much advance warning both domestic and business customers would like if the trial was to happen in their local area. Across the two it was consistent, with a majority wanting between two months and one year in order for the communications to be 'timely' (within the EAST framework).

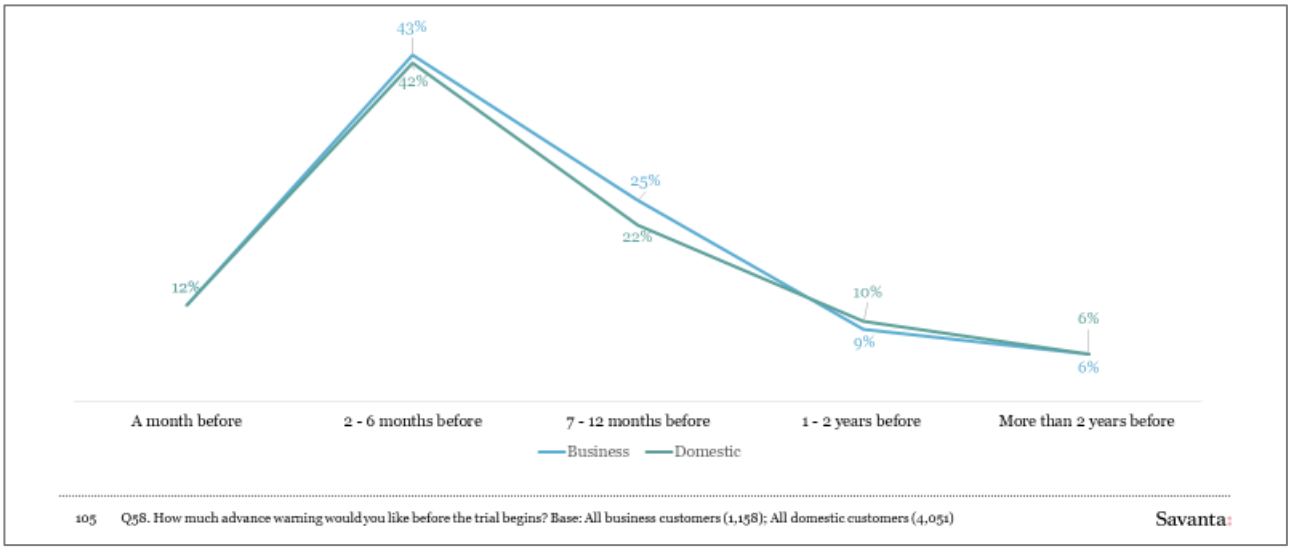


Fig. 15 – Amount of preferred time for warning before the trial

Conclusion

As the UK transitions to Net Zero, it is essential that our heating is decarbonised. This research programme has sought to aid the design of a highly effective hydrogen village trial by understanding the attitudes of potential participants, their motivations and concerns, and how best to positively engage customers in a trial.

The scale of the challenge in conducting a trial successfully with a diverse community within the UK is substantial. There are significant contextual barriers – such as a lack of knowledge of the impact of current heating habits on the environment, and low existing levels of intent to adopt alternative heating solutions – coupled with complex and multi-faceted concerns that people experience when presented with the trial concept.

Furthermore, different groups within the target population will react differently to the trial concept and communications. For example, older, less affluent and more rural domestic customers are less likely to be initially supportive, as are sole traders and businesses based in more rural areas.

Nonetheless, the challenge isn't insurmountable. As detailed in the inform and qualitative phases, and validated in the quantitative study, it is possible to clearly articulate customers' biggest concerns about the trial, together with the the 'pull-factors' that will encourage them to participate.

Whilst gaining the support of an entire community will ultimately be challenging, the insights generated by this research programme can enable the design of customer-centric trial propositions and communications, which put the views, opinions and existing behaviours of customers at the heart of business plans. As the research was based on the EAST framework, creating such customer-centric propositions based on the research findings will lead to trial participation being easier, more attractive, more timely and more social, which should in turn lead to a greater chance of positive participation and the ultimate success of the trial.

Note that further deliverables are available in addition to this Executive Summary to support the design of the trial design, including:

i. A report of full research findings, providing statistical evidence on a wide range of questions and audiences covered in the research
ii. Data tables, including the raw percentage answers to all questions in the quantitative research, split by key demographics and firmographics
iii. Proposition design simulators, built using the conjoint analysis, to enable the 'war-gaming' of propositions to observe how customer preference can be influenced by the inclusion of different factors in combination