Department for Business, Energy & Industrial Strategy

ofgem
Making a positive difference for energy consumers

Hydrogen Heating Village Trial Stage 2: Submission Application

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[14], 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.

Glossary:

Acronym	Term
ACoP	Approved Code of Practice
AGI	Above Ground Installations
ALARP	As Low as Reasonably Practicable
BEIS	Department for Business Energy and Industrial Strategy
CCO	Customer Care Officer
CEEH	The Clean Energy Education Hub
CIVS	Customers In Vulnerable Situations
COMAH	Control of Major Accident Hazard Regulations
CPB	Community Partners Board
CV	Calorific Value
ECV	Emergency Control Valve
ENA	Energy Networks Association

EPC	Energy Performance Certificate
EUS	Energy & Utility Skills
FEED	Front End Engineering Design
GDNs	Gas Distributions Networks
GS(M)R	Gas Safety (Management) Regulations
HE	Higher Education
HSE	Health and Safety Executive
HSE SD	Health and Safety Executive Science Division
HSWA	Health and Safety at Work Act
HVT	Hydrogen Village Trial
IGEM	Institution of Gas Engineers & Managers
InTEGRel	Integrated Transport Gas Electric Research Laboratory
LAD	Local Authority Delivery
LDZ	Local Distribution Zones
MOB	Multi-Occupancy Buildings
NEA	National Energy Action
NGN	Northern Gas Networks
NIA	Network Innovation Allowance
NUAR	National Underground Asset Register
NWL	Northumbrian Water Limited
NZARD	Net Zero Re-opener Development
PE	Polyethylene
PTP	Personalised Transition Plans
QRA	Quantitative Risk Assessment
R&CC	Redcar and Cleveland College
RIIO	Revenue Incentives Innovation Outputs
SME	Subject Matter Expert
SMR	Steam Methane Reforming
SOQ	Supply Offtake Quantity

STC	Safety and Technical Competency
TOTEX	Total Expenditure
TVCA	Tees Valley Combined Authority
UIOLIA	Use It Or Lose It Innovation Allowance
UNC	Uniform Network Code
VFM	Value for Money
W&WU	Wales & West Utilities

Figure 1: Indicative overview of the Redcar Hydrogen Community

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1. Project Summary

<table>
<tr><td>1.1 Project Title</td><td>Redcar Hydrogen Community</td></tr>
<tr><td>1.2 Project Explanation</td><td>Teesside is at the heart of the UK's green industrial revolution with significant hydrogen production facilities under development by major industrials, world-leading natural assets for storage and a range of industries seeking to decarbonise with hydrogen. With the announcement of the Track-1 sequencing process for East Coast Cluster and the vision for the development of a hydrogen economy through East Coast Hydrogen, Redcar is perfectly placed to deliver an effective and high impact HVT. The HVT area is strategically identified to support the UK Government's "levelling up" agenda.

<table>
<tr><th>Theme</th><th>Detail</th></tr>
<tr><td>Location</td><td>Redcar</td></tr>
<tr><td>Trial Duration</td><td>24 Months</td></tr>
<tr><td>Meter Points</td><td>1,845 Homes
194 Industrial or commercial properties
24 Care homes, schools, and hospitals</td></tr>
<tr><td>Hydrogen Supply Capacity</td><td>15,800 tonnes of hydrogen per year</td></tr>
<tr><td>Hydrogen Storage Capacity</td><td>120 tonnes of hydrogen</td></tr>
</table>

Since 2005, NGN has been consistently recognised by GEMA as the most efficient GDN (evidenced through the benchmarking process that Ofgem undertakes during the periodic review process) and has been a consistently high performing GDN based on metrics ranging from customer satisfaction, reliability and technical delivery. NGN has amassed a wealth of hydrogen knowledge through its industry leadership in the H21 Programme and NSIB work in collaboration with BEIS and Ofgem. NGN is currently the only GDN to introduce blended hydrogen into a public gas network through HyDeploy 2 and NGN has developed the internationally-renowned 100% Hydrogen Homes.</td></tr>
<tr><td>1.3 Funding Licensee</td><td>Northern Gas Networks Ltd</td></tr>
</table>

1.4 Project Description	1.4.1. The Problem(s) it is exploring Heat in buildings accounts for around 23% of national carbon emissions and ~85% of homes in the UK are supplied with natural gas for heating and other appliances. Ahead of a Strategic Decision, the UK Government has taken the decision to award a GDN with the authority to deliver a world-leading HVT with 100% hydrogen. 1.4.2. The Method(s) that it will use to solve the Problem(s) NGN's HVT is in Redcar in Teesside. NGN will deliver a customer-centric approach to a conversion to 100% hydrogen. NGN is the only GDN with experience of introducing hydrogen into a public gas network and the experience of HyDeploy 2 has informed the HVT strategy to consult and engage with consumers and vulnerable groups which is a priority at all Stages of the HVT. Residents and businesses participating in the HVT will be consulted during the Detailed Design Stage of the HVT. No consumers will be adversely impacted financially by the HVT and residents will have the choice to opt-out of the HVT and to choose an alternative heating solution. Further community support and engagement will be delivered through NGN's Customer Hub which will be located at the heart of the HVT in a local retail unit. NGN has partnered with NPG to ensure a whole systems approach is taken with the HVT. 1.4.3. The Solution(s) it is looking to reach by applying the Method(s) Following significant investment by NGN into research into network conversion to hydrogen, the HVT would provide the final evidence to support a Strategic Decision in 2026 and extension to a Hydrogen Town by 2030. NGN would be supportive of continuing the HVT. However, NGN has also developed scenarios for the HVT exit to convert the HVT network to natural gas once the HVT is completed. The conversion back to natural gas would likely cost similar to that of HVT continuation. NGN is looking at the efficient and effective use of funding for the HVT to then become a 100% Hydrogen Town. NGN estimates that there will be significant costs in exiting the HVT to an alternative low carbon heating solution due to network reinforcement, but it is technically possible. NGN will continue to collaborate with the ENA and other GDNs to understand the impact and costs of this scenario in the Detailed Design Stage. Health and safety is a priority for the HVT and the potential nation-wide conversion to hydrogen. NGN is working with the HSE, appliance manufacturers, gas engineers and the other GDNs to ensure safety standards of the HVT are at least equivalent to a natural gas network.

	The scope of the Case for Safety has been agreed with BEIS, HSE, ENA and GDNs to include the End User safety evidence. To upskill and train engineers to deliver the HVT, NGN has partnered with R&CC to support the world-leading CEEH in delivering hydrogen-specific training programmes. The CEEH is located within the HVT area will run training programmes for engineers to develop future skills requirements to undertake the conversion programme. 1.4.4. The Benefit(s) of the proposed Village Trial This HVT would provide UK Government with the evidence base that it is possible to convert an existing network to 100% hydrogen through a planned conversion programme. Teesside is a national hub for hydrogen development with the announcement of East Coast Cluster, the rapid development of multiple hydrogen production sites and an industrial skills base to support development. Teesside provides the blueprint for a national conversion to 100% hydrogen, supported by the East Coast Hydrogen Programme which is planned to grow from Teesside. The HVT aligns with NGN's strategic vision outlined in its RIIO-2 Business Plan to support a policy decision for heat. NGN plans to, where appropriate, access the re-openers funding mechanism, as opposed to stacking projects into its TOTEX allowance. This approach is supported by shareholders who will provide a direct 10% funding contribution to the Detailed Design Stage, which is in addition to further in-kind support NGN has received from partners and supporters.

1.5. Stage 2 Funding			
1.5.1. NZASP Funding Request (£k)	£5,972k	1.5.2. Network Licensee Contribution (£k)	£664k
1.5.3. External Funding(£k)	£24,000k (benefit in kind)	1.5.4. Other RIIO-2 funding (£k)	-
1.5.5. Additional funding required (£k)	-	1.5.6. Total Stage 2 Costs (£k)	£6,636k

1.6 Whole Life Costs	
1.6.1 Estimated trial Whole Life Costs (£k)	
1.6.2 Of which, anticipated private sector contribution (£k)	-
1.7 List of Project Partners, External Funders and Project Supporters[15]	

Project Partners: NGN has collaborated with its partner network W&WU to develop its HVT as it believes that the HVT opportunities for UK-wide learning will be enhanced through the specific capabilities of these two GDNs. NGN has also partnered with bp, TVCA, R&CBC, and R&CC who have provided formal support and guidance throughout this submission. TVCA and R&CBC are providing bid support, strategic political input, and direct engagement with the local community and will do so throughout the HVT process. R&CC are partnering to deliver the tailored, high-quality training needed for the HVT. bp are a key production partner who will be providing low carbon electrolytic hydrogen to the HVT and are expecting to be operational by 2025.

External Funders: As described in Section 1.5, NGN do not require external funding partners for the Detailed Design Stage and will be funding 10% through a Network licensee contribution and the remainder through the NZASP funding request.

Project Supporters: The HVT has secured 26 Letters of Support from stakeholders including Redcar Member of Parliament Jacob Young, hydrogen producers, NPG, EDF, Xoserve, and several appliance manufacturers (See Annexe A). Alongside bp, other hydrogen producers including BOC, HiiROC, Protium, and Ryze have all given support for the HVT allowing NGN to have appropriate resilience built into supply contracts. NWL have also been engaged and will provide biomethane into NGN's network for hydrogen production. NGN has also received support from Sembcorp, who have indicated that there will be at least one repurposed salt cavern on the south side of the Tees that can be used for inter-seasonal storage to build further resilience into the system. Navigator Terminals have also given support as a potential partner for above-ground storage. Several appliance manufacturers have been engaged including Baxi, Daikin, Enertek, Falcon, Fiorentini, Ideal, Vaillant, Viessmann, and Worcester Bosch who have indicated that the volumes and ranges of appliances required for the HVT can be available in the required timescale. NGN has also partnered with Enertek who have played a leading role in the Hy4Heat programme and other projects developing both 100% and blended hydrogen appliances. Additionally, NGN are working with Enertek to investigate SMART Appliances and Grid Resilience to benefit the networks, add value to the user, and increase safety margins when using hydrogen (See Chapter 4.3). NPG have also provided support to assess the potential infrastructure reinforcement required for other low carbon heating solutions. NGN has also engaged NEA and Communitas to assist the HVT to ensure that no consumers will be negatively affected or disadvantaged through the HVT process. NGN has assured that its HVT has the support of its supply chain and local industry to compliment the broad local political support.

1.8. Timescale / Project duration	Detailed Design Stage: 18 months Build and Prepare: 24 months Go-live and Operate: 24 months (to cover two winter periods) Exit Plan: 12 months

1.9. Project Manager Contact Details			
1.9.1. Contact Name and Job Title	Tim Harwood, Programme Management Director and H21 Project Director, Northern Gas Networks	1.9.2. Email and Telephone Number	
1.9.3. Contact Address	Northern Gas Networks, 1100 Century Way, Thorpe Park, Leeds, West Yorkshire, LS15 8TU		
1.10 Trial Project Summary (750 words)			
1.10.1 The population and geographical coverage of the potential trial location	This HVT consists of residential and commercial sites in the Warrenby and Coatham areas of Redcar, and an industrial site at Kirkleatham in Redcar. The total population of the HVT is 5,866. The HVT consists of diverse building stock including homes, shops, leisure facilities and light industrial units. The HVT has a robust Customer Engagement Strategy that includes appropriate support for the 441 PSR customers within the HVT area. The HVT is strongly endorsed by local and regional political leaders. There is wide recognition that the HVT represents an opportunity to build on Teesside's plan to be the leading hydrogen economy in the UK, whilst providing local residents with an opportunity to contribute to Net Zero with minimal disruption.		
1.10.2 The number and range of gas consumers in the trial area, and coverage of consumers and building types within the trial	The HVT area covers a total of 2,063 meter points across a wide range of building and consumer types. The Warrenby & Coatham areas of the HVT consist of 1,782 domestic properties, 22 large sites (hospitals, care homes, and schools), and 177 industrial/commercial sites which are made up of shops & offices, hotels, pubs & restaurants, and 2 light industrial users. Kirkleatham is a smaller area of the HVT and includes 63 domestic properties, 12 shops & offices, 1 hotel, and 4 industrial sites. The local housing stock covers a range of building types from Victorian terrace houses through to large detached homes. MOBs and very large industrial users are excluded from this HVT.		

1.10.3 The broad strategy for hydrogen supply, new infrastructure and network conversion.	The Teesside area is expected to have over 2.5GW by 2030, based on recent announcements and dependent on UK Government decisions. This provides competition in the supply of hydrogen within the region, resilience and reliability of supply, and sufficient optionality for the HVT, ranging in cost and carbon intensity. The NGN HVT is focussed on low carbon hydrogen for non-reserve production, aligning with UK Government's trajectory towards Net Zero. NGN has worked with suppliers to provide the HVT through: ▪ **Low carbon hydrogen – bp**: an electrolyser powered by renewables and the electricity grid. The facility will be developed and operated at Wilton. ▪ **Low carbon hydrogen – HiiROC**: a carbon negative hydrogen production facility through pyrolysis in Bran Sands. This will be supported by the injection of biomethane into the grid by Northumbrian Water Limited. ▪ **Low carbon hydrogen – Protium**: an electrolyser powered by renewables and the electricity grid. The facility will be developed and operated at Wilton. Resilience of hydrogen delivery throughout the HVT is paramount to the success and continuation of current industry-standards in network supply. NGN is therefore in advanced discussions with a range of additional hydrogen producers in the area who have expressed a strong willingness and ability to supply hydrogen for the HVT. NGN has been able to include multiple hydrogen storage options due to Teesside's existing industrial and geological assets - adding further competition and resillience to the HVT hydrogen supply: • **Above-ground high pressure storage tanks:** intra-day storage of 10 tonnes of hydrogen to meet short-term fluctuations in demand, which will be operated by NGN. • **Repurposed salt cavern:** inter-seasonal storage of 110 tonnes of hydrogen to meet longer-term demand. This salt cavern has a capacity of 39,000m^3 and is available to be repurposed for hydrogen use. The option to leach additional salt caverns also exists should the HVT continue and expand. While some new infrastructure will be needed to connect the production and storage facilities to the existing network, the proximity of these facilities to the HVT area means that NGN will be able to convert existing assets for the HVT. There are currently 24.2 km of existing pipeline in the HVT area of which 89% are already PE (See Table 9). This provides VFM leveraging NGN's lessons learnt –

	on network assessment, consumer engagement and system management - from the successful model demonstrated as part of the 20% hydrogen trial (HyDeploy 2) at Winlaton in Gateshead.

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 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.

NGN has set out how its HVT will build on the evidence base and address remaining gaps. NGN considered the Trials Evidence Framework in its location decision. NGN continues to work with SMEs in academia, research and development, networks and industry partners to deliver the necessary evidence to make the HVT successful.

NGN has provided an Evidence and Benefits table (See Annexe B) detailing the evidence gaps presented in the BEIS Trials Evidence Framework and sets out plans to address them. Below are the key areas of evidence and learning delivered by NGN's HVT.

2.1.1 Customer experience

NGN will present findings on how participants accept the choice of energy supply with a switch to hydrogen or a low carbon heating solution alternative. This will support future Government policy decisions for heat based on the views of diverse consumers within the HVT. Consumers will not have been faced with a choice such as this since the conversion from town gas to natural gas and NGN will harness the opportunity to evidence the experiences and attitudes of consumers. The HVT will be of benefit, as conversion scales up, by allowing learning from both trial successes and improvement areas. The HVT will provide evidence from domestic consumers reliant on gas for heating, and from industrial and commercial consumers who require an energy supply to operate. Consumer feedback will be shared throughout the HVT to enable Government and wider industry to understand future energy choices in homes and businesses.

2.1.2 Hydrogen production and storage

NGN's HVT integrates experienced partners to demonstrate a range of alternative low-carbon hydrogen production technology akin to the H100 Neighbourhood Trials. This includes a range of hydrogen production technologies. This will demonstrate resilience and

support the case for a wider-range of renewable solutions that can be deployed throughout the UK.

The HVT will demonstrate inter-seasonal storage via salt caverns, and intra-day via above-ground high-pressure tanks, to ensure consumers receive the same reliability as that of the natural gas network today.

NGN, together with Northern Powergrid, will seek opportunities to utilise hydrogen storage as an integrated solution with the electricity distribution network, demonstrating the benefits of a whole-systems approach. Installing volume, pressure and flow data monitoring, and recording technology on both the gas and electric networks including supply and storage, will provide evidence and assurance to the reliability and safety of the energy networks throughout the HVT. This will evidence the scalability of the technology as well as allowing NGN to react to any unexpected events on the network and take timely preventative action.

Data gathered will reveal downstream consumer demand profiles and behaviours. This data will identify consumers using unexpectedly high amounts of energy – NGN will support them to make their homes more energy efficient.

2.1.3 Diversity of properties and end users

The HVT area covers diverse properties, including a variety of building occupancy levels and end-user requirements. The HVT will evidence the suitability of hydrogen for heat for the following building types:

- Dwelling houses – bungalows, terraced, semi-detached, detached, and small flats built at various time-periods and to different standards – from the 19th Century to modern day regulations, with diverse energy efficiency performance.
- Housing stock – affordable, local authority rented and private.
- Commercial buildings – shops, catering establishments, entertainments venues and offices.
- Places of social and religious gatherings – public houses, churches and social venues.
- Community and learning establishments – schools, colleges, and libraries.
- Healthcare establishments – medical centres and residential institutions.
- Industrial buildings.
- Other buildings – fuel stations, taxi businesses and amusement arcades.

Should Government decide, the evidence gained will benefit the Hydrogen Town Trial by reducing uncertainties about the range of buildings suitable for hydrogen conversion or other low-carbon heating solutions.

Throughout Detailed Design, NGN will work with industry and manufacturers to accelerate the development of a range of hydrogen-ready domestic and non-domestic appliances and meters. NGN will deliver the required safety evidence to support conversion of non-domestic

buildings. Local housing stock covers a range of building types from Victorian terrace houses to large, detached homes. MOBs and very large industrial users are excluded from this HVT.

NGN is working with partners and GDNs to develop industrial and commercial industry regulations and standards and on training schemes with a partner, the R&CC to ensure deployment can proceed without delay.

Throughout Build and Prepare, NGN will harness additional evidence on the reliability and safety of newly developed domestic and non-domestic appliances, and the performance of hydrogen-specific safety devices and mitigations in a range of settings.

2.1.4 Practicalities of conversion

NGN is delivering 100% hydrogen trials through its pioneering H21 Programme, including Phase 2A (100% hydrogen micro-grid at Spadeadam – a DNV research site) and Phase 2B (100% hydrogen in an unoccupied network in Southbank, Redcar).

Furthermore, alongside BEIS and another GDN, NGN launched the Hydrogen Homes in Gateshead, inviting the public and industry to experience 100% hydrogen appliances in a real-world setting. This demonstrated NGN's experience in installation and ongoing maintenance.

NGN will develop and present comprehensive phased conversion plans in Detailed Design to ensure the transition causes minimal disruption to the public. This will be supported by extensive engagement and co-ordination with stakeholders and the community.

NGN will continually document, share and address the needs and concerns of the public on, using this learning to develop best practice for a range of relevant activities. Best practice will advance innovative ways of working and solutions to reduce the impact of conversion of consumers.

Diverse road types, streets, and end-users in the HVT area ensures learnings are representative and scalable for UK conversion.

Resource requirements and interruption times during conversion will vary depending on the network assets and buildings being converted. The HVT will evidence the impact for future rollout.

2.1.5 Diversity of network assets

The HVT will address evidence gaps in the Trials Safety Evidence Framework. Through monitoring of asset performance and condition both during and post-trial, NGN will determine suitability for hydrogen conversion – similarly to HyDeploy 2 for blending.

NGN has selected an area with diverse buried network assets including metallic and PE mains of various generations (Please see Table 9). This will allow the HVT to close out evidence gaps around material compatibility and performance. NGN will continue to deliver research-based evidence through projects such as the Hydrogen Ready Components[2] NIA project throughout Detailed Design – working with relevant technical experts to establish safe working parameters.

The diversity of assets in the NGN HVT provides greater VFM and learning opportunities than converting a limited range of material types or pressure tiers. Further validation of changes in asset condition following the HVT will be performed by testing the materials exposed to hydrogen following the HVT (if deemed appropriate).

NGN will assess historical performance of all assets proposed for conversion, before and during the HVT, to maintain or enhance the acceptable gas leakage levels and their impact on materials. NGN will document and share evidence of such events with industry to further determine any potential long-term material suitability issues.

2.1.6 Operational aspects of the HVT

NGN will expand the research to-date on hydrogen system operation. Before the HVT, new operational procedures will be produced that underpin the training and competency requirements responsible personnel.

NGN will work with Human Factors - building on the ongoing work with the HSE SD – to ensure that operatives currently working on natural gas systems transfer the practices to the hydrogen network.

NGN will work with suppliers, including those involved in Hy4Heat, to produce the hydrogen-specific equipment needed for safe operations.

Including larger, non-domestic properties and assets in the HVT presents maximum opportunity to evidence a broad range of operations including on multi-material and pressurised systems and downstream of the meter.

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.

As duty holder accountable for the HVT's network and storage aspects, NGN will ensure the public's and all operatives' safety. NGN will comply with relevant regulations and legislation including HSWA and COMAH [3,4]. Although 100% hydrogen is not covered by GS(M)R, NGN

will use GS(M)R as a template for a Hydrogen Trials Network Case for Safety to support compliance with HSWA [3,5].

NGN will work with experienced partners, such as HSE SD, to ensure the health and safety protection afforded to producers and end-users is managed in-line within all existing regulations, including PSSR and GSIUR [6,7].

NGN's priority is to ensure the HVT presents a safe, reliable and sustainable solution. NGN will engage industry experts in risk management throughout Detailed Design. NGN will embrace existing industry and academia evidence to ensure any evidence gaps are addressed.

Past projects, including H21, provide a strong evidence base[8]. NGN's HVT is scoped to ensure NGN closes the remaining gaps in the Trials Safety Evidence Framework through industry hydrogen steering groups.

2.2.1 Planned technical approach to modelling, risk assessment and mitigation

NGN will expand on work to-date under H21 and Hy4Heat, implementing the QRA to determine levels of societal risk that hydrogen distribution and end-use present to the public[8]. The QRA will be specific to the HVT and include network infrastructure and the diverse building types and downstream installations.

NGN will work with the Regulatory Working Group, chaired by the HSE, to agree the benchmark for safety which determines the required levels of risk mitigation control to be adopted to accomplish the benchmark or better. The updated CONIFER model for hydrogen developed in H21 will be utilised to calculate the effectiveness of risk mitigation controls[8].

The QRA relates to societal risk and will be applied to the upstream network and downstream installations. It will be further broken down to risks posed at network-level or at downstream-level and by end-user or building type.

NGN's hydrogen production partners will assume full responsibility for the safe design and construction of the production facility working to already established regulatory frameworks. The production and storage facilities serving the HVT are located within a COMAH registered area and consequently are not subjected to the QRA[4]. This provides further benefit utilising existing facilities rather than further developing additional sites.

2.2.2 Scope of activities included in assessment of risks

NGN will assess the consequence of failure on all aspects of the HVT and develop risk assessments throughout Detailed Design by ensuring all hazards to people or the environment are reduced to ALARP and adhering to existing good industry practice. NGN will work within the guiding principles set-out in the IGEM standard for risk assessment techniques IGEM/G/7 in addition to the QRA[12]. Areas to be included in the assessment of hazards and risk are as follows but not limited to:

Operations and maintenance

- Operation and maintenance of the hydrogen production and storage facility.
- Gas quality monitoring and assurance including odorisation.

- Operations and maintenance of network pressure control and management installations.
- Network operations – emergency, repair, replacement, extensions and purging.
- Network leakage control and risk monitoring and surveys.
- Site security of fixed hydrogen facilities.
- Human factors and failure assessment.
- Updated mapping to clearly identify the HVT area as 100% hydrogen.

Emergency response

- Handling public reported gas emergencies by emergency call centre.
- Management of gas emergencies in areas where both natural gas and hydrogen assets are present alongside on another.
- Emergency gas supply incident management plans and procedures.
- Managing third-party works near hydrogen containing assets.
- Interaction with other emergency service providers.

End user

- Installation and maintenance of downstream meters, pipework and appliances, both domestic and non-domestic.
- Existing ventilation, suitability of materials, meter, and appliance locations.
- Installation and suitability of alternative electrical domestic heat solutions including any impact on grid capacity.
- Isolation of existing gas supply arrangements for those opting out of hydrogen.
- Consumer familiarisation with operation of hydrogen appliances.

2.2.3 Risk Assessment Areas to Identify Hazards

The risk assessment considers all contributing factors and hazards from conversion to hydrogen.

NGN will focus on the physical properties and characteristics of hydrogen compared to natural gas and how it impacts on the trial area. Understanding the similarities and differences of the gases enables an accurate assessment of risk and ensures hazards are effectively managed.

The fundamental properties of hydrogen compared to natural gas will have a significant impact on the assessments such as the difference in ignition and burning characteristics of hydrogen, and its dispersion behaviour when released from containment. NGN will fully assess the impact hydrogen has on all the materials present within the HVT area to ensure any effect of degradation from exposure to hydrogen such as loss of containment or functionality is understood and managed.

Research, led by NGN through the NIA, is underway with the HSE SD to list the materials and components within the conversion of the network and buildings. NGN will assess the impact of the behaviour of materials when working with hydrogen systems.

NGN will assess the impact of changes to system operation and the implications of new ways of working for engineers transitioning from natural gas. NGN will consider hazards to

those not directly involved in the HVT who may find themselves exposed to hydrogen, such as blue-light services and third-party statutory undertakers, working near hydrogen-containing apparatus.

2.2.4 Approach to building on existing safety projects and working with others to build a collective understanding of hydrogen safety

NGN will continue to lead on network hydrogen steering groups like the "Network Safety and Impacts Board" and "End-User" groups. This provides the networks with a platform to build collective understanding of hydrogen safety and to map-out technical evidence gaps. NGN will engage with BEIS and the HSE throughout the HVT to ensure emerging technical evidence is realised with minimal delay or duplication, as is the ambition of the H21 Programme. This ensures further NIA and innovation projects can be expedited together with third-party technical experts and partners during Detailed Design. NGN will utilise innovation funding to close out any additional evidence gaps identified outside of the scope of the HVT. NGN will collaborate with GDNs and industry to share the outputs to support future conversion.

2.2.5 Plans to meet the requirements of relevant health and safety regulatory framework

NGN is perfectly placed to undertake a live hydrogen network conversion HVT based on the extensive research programme delivered to date and the deep capabilities and experience within the organisation. NGN has commenced the process for a HVT Case for Safety using GS(M)R[5] as a template. NGN's Case for Safety will be specific to the HVT area, but designed to support UK-wide conversion activities (i.e. future trials and/or eventual national conversion).

Assessment work carried out to-date reviewing NGN's existing Safety Case for Natural Gas identifies within the report PIE/R/21/514 the key areas for inclusion in a HVT's Case for Safety and provides an estimate of time and cost for addressing evidence gaps[13]. The assessment also identifies key SMEs and organisations to support with the development of the document to deliver it efficiently.

Additionally, NGN will work with R&CC, who is based within the HVT area, to deliver the training required for Gas Safe Registered engineers. NGN also benefits from the Spadeadam and Southbank, Redcar, demonstration hydrogen test grids. Network operatives will gain experience and competency on actual hydrogen networks prior to the HVT going live with the latter also located close to the HVT area. This represents VFM taking into consideration the c.£3m investment into these facilities under the H21 Phase 2 NIC project[9].

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 aim of the HVT is to gather evidence on the feasibility, costs, and convenience of transporting 100% hydrogen safely in the grid and using hydrogen for heating and cooking. There are 5 Stages to this HVT and NGN has developed a detailed plan for each. Please see the Gantt chart for Stage 2 Detailed Design in Annexe C and the plan for Stages 3-5 in Annexe D.

3.1.1 Stage 2 (Detailed Design)

Scope

Stage 2 will run from January 2022 until Q2 2023. The objective of this Stage is to develop a detailed plan to enable Government to make a go/no-go decision on whether to proceed with the Stage 3 of the HVT. To achieve this, a comprehensive plan has been developed which covers stakeholder engagement, detailed design, safety management and Case for Safety, and collaboration.

Plan

Stakeholder engagement: This begins in early January 2022 to develop the communication plan and Drop-in Hub, which will offer an opportunity for consumers to ask any questions about the HVT and experience the hydrogen appliances. Subsequent phases will build awareness of the HVT in the community, commence community engagement and conduct research. NGN will bring a blended approach to engagement through modern self-serve technology, in the form of an app, and traditional gas safety engineer visits. Further information can be found in Chapter 5.

Engineering design: This will focus on the detailed designs across Production and Storage, Network Design, Pre-conversion works, and Appliances. The plan covers the design and modelling of the production and storage infrastructure and negotiations with producers. Several long-lead processes are also covered, including planning permissions, pipeline easement agreements, land lease agreement for above ground storage, storage cavern agreements and upgrades, environmental consent for storage, and ensuring COMAH compliance. The long lead tasks will form the critical path of this stage.

The network area focuses on all the modelling, design, and upgrades of the gas network. The network must be designed to accommodate sectorisation. During the HVT conversion, NGN will utilise innovative techniques to sectorise the HVT area to minimise the use of sector valves, saving both time and money, and ensure natural gas can still be provided to sectors not yet converted to hydrogen.

Pre-Conversion Works ensures the required data is gathered before conversion to hydrogen can begin. This includes a review of the electrical supply reinforcement in the HVT area. NGN will work with consumers and Northern Powergrid to understand the grid reinforcement requirement.

The appliance and flow meter requirements for the HVT area will be confirmed and manufacturing partners will be engaged to secure procurement of appliances in Stage 3.

Safety management & Case for Safety: This covers the QRA requirements, Case for Safety, Training, and End User Evidence gathering for Stage 2 of the HVT. NGN has partnered with R&CC and will develop and implement effective training programmes for gas engineers and workforce. NGN also has several hydrogen test facilities which can be used for pre-trial training purposes (See Chapter 4.4).

Collaboration work: This covers all work that can be carried on in collaboration with other project partners and involves several legal and regulatory work streams. NGN will work with Xoserve in collaboration with other GDNs to finalise a robust and fair billing strategy.

Key deliverables and milestones

The critical path for Stage 2 follows the long lead processes described in the detailed design section. Additional key deliverables include the appliance and consumers surveys. These results will be used to inform all aspects of the HVT impacting consumers.

3.1.2 Stage 3 (Prepare & Build)

Scope

The programme for Stage 3 will run from January 2023 until Q2 2024. The overall objective of this Stage is to demonstrate that NGN is ready to begin installation in consumer properties and the conversion to hydrogen.

Plan, key deliverables, and milestones

The plan for Stage 3 is detailed in Annexe D. Three main areas are covered: Stakeholder Engagement, Safety Management, and the Build phase. The key milestones and critical path items for this Stage are:

- Hydrogen production commissioned (14/05/2024).
- Storage commissioned (14/05/2024).
- Stakeholder engagement and consumer agreements completed.
- Commissioning pipelines.
- Distribution network preparation.
- Procuring appliances and meters.
- Potential reinforcement of electricity grid.

3.1.3 Stage 4 (Go live and operate)

Scope

The programme for Stage 4 has been estimated to run for 38 months from March 2023 until April 2027, assuming a HVT period of 24 months. The overall objective of this Stage is to

complete the installation in consumer properties, conversion, and system implementation and to carry out the operation of the HVT, evidence collection and benefits realisation.

Plan, key deliverables, and milestones

The plan for Stage 4 covers three main areas: Pre-conversion works, Conversion, and Trial Period. The key milestones and critical path items for this Stage are:

- Install hydrogen-ready appliances and meters.
- Install electric appliances for non-hydrogen consumers.
- Ready to commence Purge and Relight (03/01/2025).
- Complete Purge and Relight for first section (08/05/2025).
- Complete Purge and Relight for multiple sections (05/08/2025).
- Complete Stage 4 (14/04/2027).

3.1.4 Stage 5 (Trial exit)

Scope

The aim of Stage 5 is to gather data and analyse evidence on the feasibility, costs, and the end use of hydrogen for heating to either prepare for the continuation of the project or decommissioning and exit of the HVT. Potential exit plan scenarios have been identified (See Chapter 3.4).

Plan, key deliverables, and milestones

All scenarios will require consumer engagement and data analysis to inform the next steps before the end of the HVT. Key activities will also need to be completed across network conversion, consumer conversions, decommissioning works, and other activities (See Chapter 3.4). However, as there is significant uncertainty around the potential timescales and requirements around these activities, the exit plan has been summarised as a single item.

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.

NGN has engaged with over 26 stakeholders across key stakeholder groups (the majority of which have an NDA with NGN and key partners have an MOU). to ensure that each aspect of the HVT integrates a diverse range of project partners to deliver a resilient and VFM project. NGN is currently at varying levels of discussion with each and expect more to join as the HVT progresses. Specifically, NGN has engaged with project partners in the hydrogen supply and storage, appliance manufacturing, and public and local engagement sectors of the hydrogen supply chain. NGN has clearly articulated the responsibilities and liabilities for each partner

such that NGN is confident that it can deliver a resilient, inclusive, and safe HVT. Stakeholders are grouped into key delivery partners and trial supporters.

3.2.1 Key delivery partners

Key delivery partners will be responsible for the ownership and delivery of the assets and services core to the HVT. These include partners across the value chain from production, appliance manufacture and installation, and consumer engagement. NGN has received a Letter of Support from each key deliver partner where each has expressed a strong willingness and capability to provide the key deliverables required for the HVT.

3.2.2 Trial Supporters

Supporting partners will also play an essential role in the delivery of the trial and will perform services across the value chain. NGN has received a Letter of Support from each of the Trial Supporters. Each has expressed a strong willingness and capability to provide services for the trial. There are no legal arrangements nor liabilities at this stage, however advanced conversations are ongoing.

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.

Several changes to existing regulatory frameworks are required to facilitate the HVTs. These have the potential to impact on the design, feasibility and delivery timescales of the trial. These include:

- HSE Exemption for 100% hydrogen (GS(M)R);
- Regulatory Framework for Security of Supply;
- UNC Derogations;
- Billing and Metering arrangements with Xoserve; and
- Other Legal and Regulatory License Requirements.

NGN, collaborating with other GDNs, has investigated these frameworks over several years. NGN can point to projects such as HyDeploy 2 and H100 as evidence that (with timely and targeted engagement) the regulatory frameworks can be adapted to deliver the HVT. Early and ongoing engagement with Stakeholders such as the HSE, local councils and Xoserve and shippers is essential. It will also be important to implement learnings from similar trial projects, such as HyDeploy 2 and H100.

Further work is required in the Stage 2 Engineering Design to determine the impact and timescales of the regulatory framework amendments. A separate submission from the ENA has been prepared collaboratively with other networks which outlines the further work that

is required in early 2022 to provide a firm agreement of the regulatory timelines. Outlined below are the key regulatory compliance activities including a description of any regulatory barriers where NGN is planning to seek an exemption or derogation.

3.3.1 HSE Exemption for 100% Hydrogen (GS(M)R)

The HVT aims to demonstrate that 100% Hydrogen can be conveyed safely through the distribution network and used in customer homes whilst maintaining current service levels and network performance. Part 1 of Schedule 3 of the GS(M)R stipulates a hydrogen limit of 0.1% vol. Therefore, an increase in hydrogen will require a derogation to this limit, in the form of seeking a formal Exemption to the requirements of GS(M)R.

Exemptions from any requirement imposed by the GS(M)R are provided for by Regulation 11 of the GS(M)R. The HSE shall not grant an Exemption "unless it is satisfied that the health and safety of persons likely to be affected by the Exemption will not be prejudiced in consequence of it". Exemptions may be granted subject to conditions and a limit in time and may be revoked at any time by a certificate in writing. The HSE decision, will be based on no additional risk or/and as low as reasonably practicable.

An evidence base has been developed by networks via the NSIB suite of projects, including assessment of the impact of 100% hydrogen on materials in the network, appliances, operation of the network, including gas detection as well as assessment of the equipment being used to produce the hydrogen. This has been used to develop a detailed Quantitative Risk Assessment. For any public network trial, the process must be developed for the wider network characteristics. The HSE has developed a comprehensive gap analysis of additional evidence required and NGN's trial will bridge this gap. This is outlined in Chapter 2.

3.3.2 Regulatory Framework for Security of Supply

NGN acknowledges that its security of supply obligations will continue to apply throughout the trial period. While running a discrete, separable and small-scale hydrogen network will inherently not benefit from the security of supply resilience provided by the current interconnected natural gas and transmission networks, NGN has sought at every step to design its trial to ensure that participants enjoy the same/similar high-levels of reliability. The collaborative Annexe K addresses how GDNs will collectively investigate the regulatory impact associated with this topic.

3.3.3 UNC Derogations

The UNC sets out the common terms of the transportation arrangements between licensed gas transporters and gas shippers. It manages issues like customer switching, demand and settlement. Currently, the UNC is limited to gas which is methane does not include arrangements for hydrogen. Therefore, specific derogations are required to deliver this project. Including:

- A derogation to allow NGN to transport hydrogen as current arrangements define gas as being a "mixture of hydrocarbons and other gases consisting primarily of methane".

- A derogation to maintain consumers' ability to change supplier means NGN will make specific arrangements in Xoserve systems. NGN notes that switching will be managed by the Retail Energy Code from September 2022, so further investigation will be needed to consider this as the arrangement under the Retail Energy Code are supplier driven rather than shipper driven.
- Investigate any potential requirements for a derogation regarding energy entry – either using equivalent to existing or having a virtual entry point with a shipper to enter the energy.

A process to allow timely derogations of the UNC has been prepared and submitted to Ofgem for approval. Once approved, the derogation provides the ability for network companies to apply for UNC derogation when undertaking Net Zero projects/trials subject to providing the pre-defined project paperwork

3.3.4 Billing and Metering

Changes will need to be made to the way consumers are billed as a part of the HVT to ensure they are not disadvantaged and an appropriate metering regime to support the HVT must be agreed. Currently consumers are billed on the basis of the volume of gas consumed during their charging period, determined at their meter, and the billing CV for their charging period, determined from the average of applicable daily Local Distribution Zone Flow Weighted Average CVs (LDZ FWACVs). During the trial, hydrogen will replace the natural gas, therefore the CV of delivered gas will be reduced. If the existing regime were to continue then the domestic consumers would be disadvantaged as they would receive less energy than they would be billed for.

Work on billing has been delivered collectively and NGN's proposed approach is outlined in the separate collaborative submission submitted by the ENA. NGN notes that this may also need direction against supplier licences depending on the solutions identified. The extent to which this applies will be investigated as a part of the collaborative work proposed by the GDNs for the Regulatory Plan.

3.3.5 Other Legal and Regulatory License Requirements

In delivering the HVT, NGN will need to ensure compliance with all legal and regulatory requirements to deliver the infrastructure required for the project. These will be investigated during the Detailed Design Stage and may or may not be applicable:

- Legal and competence aspects relating to downstream of the ECV specially relating to the Gas Safety (Installation and Use) Regulations 1998.
- Agreements for any land acquisition and pipeline wayleaves for network planning or assets.
- Environmental Impact assessment, if applicable and planning approvals in principle including consultation with statutory and non-statutory bodies.
- COMAH apply to a hydrogen storage site at a level above 5 tonnes. NGN has not yet been able to confirm if this will apply to the trial. For trials where the level of hydrogen stored is below 5 tonnes, duty holders can still use existing COMAH

regulations as a framework to evidence a 'Case for Safety', and compliance with HSWA.

- The Pipeline Safety Regulations – if new pipelines, currently not planned for are required as a part of the trial'.
- Operating Licence Changes - depending on whether NGN owns the hydrogen used in the trial, it might need D4, and potentially A6 and A7 for discrimination and operating outside UNC (depending on UNC derogation status).

The Engineering Design study will establish the technical engineering blueprint and regulatory framework for the detailed design and procurement activities. It is imperative that Engineering Design commences as early in 2022 because of the programme risks associated with planning and permitting requirements.

3.3.6 Indicative timeline of Regulatory Compliance Activities

NGN has developed an indicative regulatory compliance plan in collaboration with the other GDNs. This plan addresses the issues identified above and can be found in Annexe E.

3.4 Exit plan (1000 words)

Please outline your plans for two possible scenarios:

1. the continuation of the project;

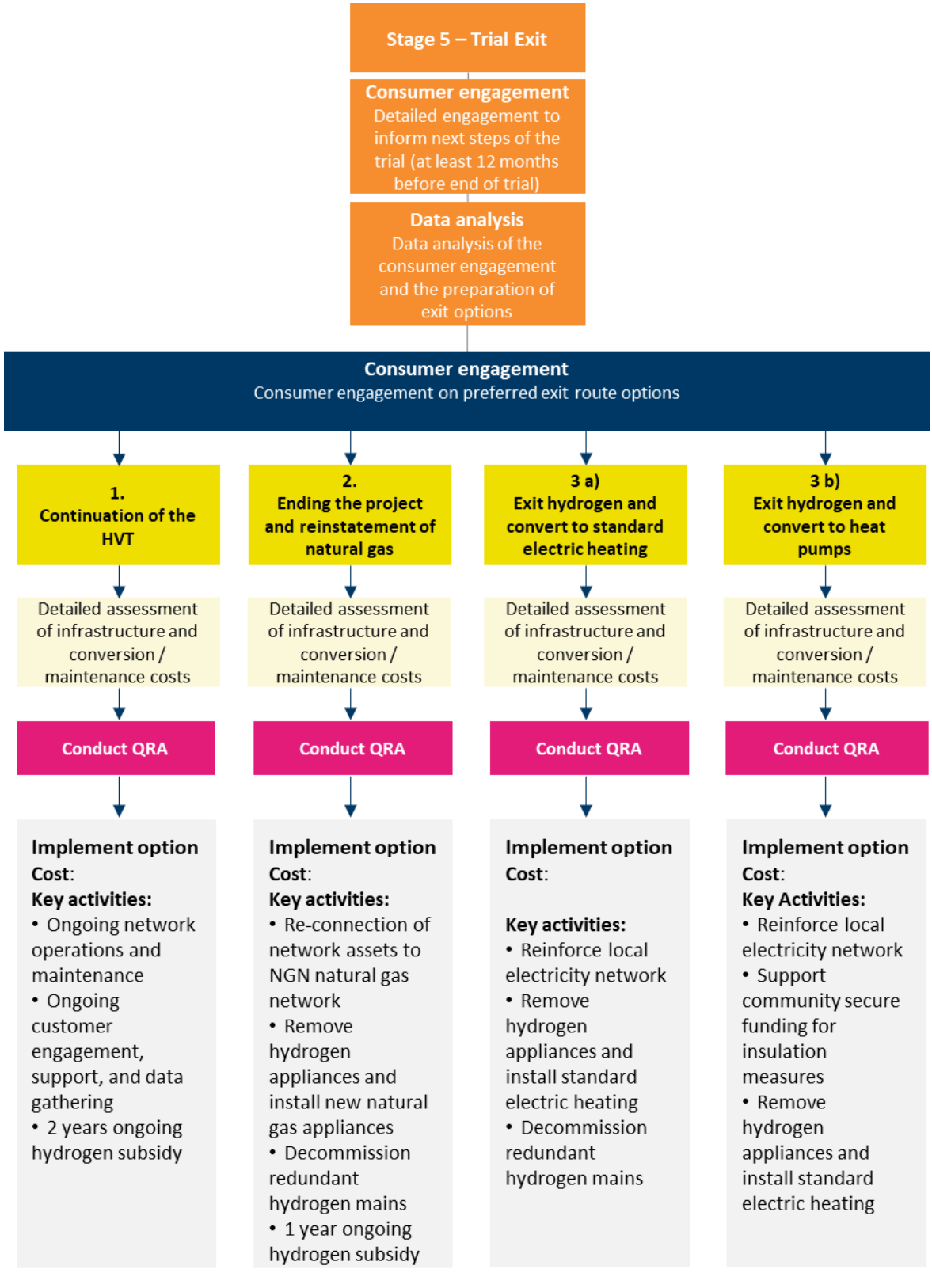
2. ending the project within 1-3 years of trial commencement and the reinstatement of natural gas supplies.

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

There is uncertainty regarding the outcome of the HVT, and significant learning will be gained through the project. This learning must inform the most appropriate exit strategy. Any exit strategy will be informed through extensive customer consultation and this will be iterative as the HVT progresses. It is also difficult to predict what legislative and regulatory changes will have been implemented as the Exit Strategy will be implemented six years from the point of this submission.

As a part of Stage 2, in collaboration with the GDNs, a detailed agreed exit strategy will be prepared to establish the engagement and data collection requirements that will inform the most appropriate approach. NGN's planned approach is outlined in Figure 2. These scenarios have been included based on feedback from stakeholders.

Figure 2: Flow diagram of the four potential exit plan scenarios.



Forecast costs for each scenario are outlined below. Exit costs have been considered for a 2-year period following the end of the HVT. Costs are in 2020/21 prices. Costs for scenario 1 and 2 have been included in the cost assurance template (Annexe J), however, costs for electric conversion under scenario 3a and 3b are not included in Annexe J but included here for comparison. There is uncertainty and final costs will be informed by the consumer engagement and investigative work in Stage 2.

3.4.1 Continuation of the HVT

NGN will seek to continue the HVT following extensive consultation with stakeholders. NGN is cognisant that the exit plan needs to consider the practicalities and consumer impacts of ending the trial and moving to hydrogen as an enduring energy source (i.e. cost implications for consumers).

The forecast costs and activity associated with continuing the trial of 100% hydrogen are outlined in Table 1.

Table 1: Key activities and costs for the continuation of the HVT.

Activity	Description	Cost
Network Conversion	▪ Ongoing opex for inspections and maintenance. ▪ Assessment of suitability of Hydrogen on network integrity. ▪ Extend UNC, Billing and HSE Exemptions.	
Consumer Conversions	▪ Ongoing consumer engagement, Data gathering and analysis. ▪ Agreement and cost of ongoing supply of hydrogen.	
Decommissioning Works	▪ Minimal Cost.	
Hydrogen production	▪ Ongoing subsidy to HVT customers for use of hydrogen. 2-year period (medium cost scenario).	
Other Activity	▪ Project management, legal and contractual support. ▪ Contingency.	
	Total	

3.4.2 Ending the project and reinstatement of natural gas

The forecast costs and activity associated with reinstating natural gas are outlined in Table 4.

Table 4: Key activities and costs for ending the project and the reinstatement of natural gas.

Activity	Description	Cost
Network Conversion	▪ Re-connection of natural gas network assets. ▪ Identify and reconnect mains isolated at start of project. ▪ Reconnection of natural gas supplies (those opting out of hydrogen). ▪ Removal of hydrogen network assets	

	▪ Covert district governors back to natural gas. ▪ Ensure complete removal of hydrogen from the gas mains prior to reinstating natural gas.	
Consumer Conversions	▪ Remove and dispose of hydrogen appliances. ▪ Undertake, pre-swap home appliance surveys. ▪ Install new natural gas appliances (cookers, hobs and fires) and modify hydrogen boilers to natural gas. ▪ Replace electric boiler with natural gas for opt out consumers. ▪ Remove trial electrical appliances. ▪ Return homes to prior state. ▪ Undertake stakeholder engagement.	
Decommissioning Works	▪ Decommission and purge redundant hydrogen. reinforcement mains. ▪ Decommission hydrogen specific district governors.	
Hydrogen production	▪ Ongoing subsidy to HVT customers for use of hydrogen. 1-year period during planning and delivery of re-conversion (medium cost scenario).	
Other activity	▪ Undertake project management activities, including on-going legal and contractual support. ▪ Ensure ongoing customer and stakeholder engagement throughout reconversion.	
	Total	

3.4.3 Exit Hydrogen and Convert to alternative low carbon heating solution

Stakeholder engagement indicates that if a decision is made not to progress with the HVT, then a low carbon alternative should be considered in addition to the option of reinstating natural gas. This is consistent with achieving Net Zero by 2050. Outlined in Table 5 and Table 6 are two potential electric options. NGN notes that either of these options would entail significant customer disruption and engagement would need to be progressed with the electricity distribution network operator, who would likely deliver the conversion activity.

a) Standard Electric (Option 3a)

Table 2: Key activities and costs for ending the HVT and converting to standard electric heating.

Activity	Description	Cost
Network Conversion	▪ Stakeholder and customer engagement on potential; conversion options. ▪ Upgrade of domestic electric supply for additional load and reinforcement of local electricity network, including substations.	
Consumer Conversions	▪ Property survey for appliances and swap out Hydrogen appliance for electric alternative.	

	▪ Upgrade of services and potential rewiring of property for additional load. ▪ Consumer engagement and data collection.
Decommissioning Works	▪ Disconnection of gas service and removal of redundant piping. ▪ Decommission and purge redundant hydrogen reinforcement mains and decommission, remove and remediate district governors. ▪ Decommission hydrogen specific district governor for the college in Redcar.
Other activity	▪ Undertake project management activities, including on-going legal and contractual support. ▪ Ensure ongoing customer and stakeholder engagement throughout reconversion.
	Total

b) Heat Pumps (Option 3b)

Table 3: Key activities and costs for ending the HVT and converting to heat pumps.

Activity	Description	Cost
Network Conversion	▪ Stakeholder and customer engagement on potential; conversion options. ▪ Upgrade of domestic electric supply for additional load and reinforcement of local electricity network including substations.	
Consumer Conversions	▪ Property survey for appliances and swap out Hydrogen appliance for heat pump. ▪ Upgrade of services and potential rewiring of property for additional load. ▪ Consumer engagement and data collection.	
Decommissioning Works	▪ Disconnection of gas service & removal of redundant piping. ▪ Decommission and purge redundant hydrogen reinforcement mains and decommission, remove and remediate district governors. ▪ Decommission hydrogen specific district governor for the college in Redcar.	
Other activity	▪ Undertake project management activities, including on-going legal and contractual support. ▪ Ensure ongoing customer and stakeholder engagement throughout reconversion.	
	Total	

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.

NGN has a Risk Register to understand risks that could prevent successful delivery of the HVT. The full Risk Register is attached as Annexe F. Below is NGN's approach to assessing risks, an overview of the highest priority risks, and the appropriate mitigations set in place to reduce the likelihood of the risk materialising.

3.5.1 Measuring Risk

NGN undertook a five-step process to develop its Risk Register, these steps included:

- **1: Risk Identification and Description:** All risks with the potential to impact the trial's delivery and cost were identified and a clear description provided.
- **2: Risk Assessment:** Each risk was assessed to understand the consequence and severity of impact if the risk materialised.
- **3: Risk Evaluation:** Each risk was scored using a combination of likelihood and impact. NGN's approach utilises a 5x5 matrix where both likelihood of the event occurring and impact that would materialise if the event occurred were scored on a scale of 1-5. The scores are multiplied together to derive a pre-risk rating for each risk. The higher the risk score, the more significant the risk is, allowing the identification of priority of risks within the trial. The scoring scale is shown in Annexe F.
- **4: Assign Mitigations for the Risk and Re-evaluate:** Mitigations for each risk were assessed to understand what action needed to be taken to reduce the likelihood of the risk occurring or reduce the impact if it materialised. Once mitigations had been considered the risks were re-evaluated to derive a post-risk rating that allowed risks to be prioritised.
- **5: Monitor and Review the Risk:** The Risk Register is a live document under continual review. It is understood that despite mitigations being in place, risk to the trial cannot be fully removed. NGN continues to monitor the Risk Register and amends mitigations and risk scores as appropriate to ensure risk is reduced as far as reasonably practicable. NGN will add any new risks found during the execution of the trial.

3.5.2 High Priority Risks

As summarised in Table 7, NGN's risk assessment identifies that, after mitigations are applied, no high-risk items and 15 medium risk items remain. In general, the mitigations focus on ensuring the appropriate upfront engagement, and policy and procedures are followed to reduce the likelihood of occurrence, rather than any significant intervention that would reduce the impact of the risk.

The most significant risks post mitigation for NGN are related to site access, which may result in vandalism or theft, the safe storage of Hydrogen, safe operational practices when purging the network of existing methane gas, and failure of assets leading to gas escapes. The

remainder of the identified medium risks are of moderate to significant impact but have been assessed as unlikely to occur.

3.5.3 Risk Mitigation Overview

NGN's comprehensive approach to risk, identification, assessment, and mitigation ensures that it's well-positioned to effectively manage HVT risk. This approach is underpinned by robust risk management mitigations demonstrated through the H21 research programme to-date and which will now transition into a live setting. NGN's experience in leading these projects on behalf of the industry demonstrates resilience and practicality in understanding and managing current and emerging risks involved in the supplementing hydrogen for methane as a part of the HVT.

4. Infrastructure and Delivery

4.1 A statement of the options identified for meeting requirements for hydrogen supply and resilience (1250 words)

identification of reliable and resilient hydrogen supply solution(s) for the proposed trial site. This should also include an assessment of the viability and cost of using a low carbon hydrogen supply; and evidence of support from any third parties who would be partners on the project and responsible for delivering hydrogen production.

NGN is confident that the HVT will have viable and resilient supplies of hydrogen, achieving the levels of availability today. Although contracts are yet to be finally concluded, there are multiple parties that are proactively working with NGN to develop production and storage assets. This creates a level of competition that allows NGN to get VFM propositions from the potential partners. Additionally, having multiple proximate suppliers brings the advantage of minimising infrastructure developments and transport costs.

NGN has received letters of support (Annexe A) and indicative hydrogen production data from bp, BOC, HiiROC, Protium and Ryze. A summary of key data from these production partners is shown in Table 8 below. These production partners have a combined production capacity of ~15,800 tH_2/year, almost 14 times the maximum hydrogen demand of the HVT area of just over 1,130 tH_2/year.

4.2 A statement of infrastructure requirements (1000 words)

This should include a description of any new infrastructure construction or existing infrastructure adaptation required to deliver the project; and an outline strategy and timeline for the design, procurement, construction and/or adaptation of infrastructure required.

Teesside was selected for several key reasons that differentiate it from other locations, including its proximity to an existing industrial cluster, existing and future hydrogen production, salt cavern storage, and large industrial redevelopment sites with COMAH

status. It also has strong local political support for the HVT. These factors result in logistical and cost benefits for the project infrastructure requirements.

4.2.1 Production and Storage

Several production facilities are available to meet the demand for the HVT area as described in Section 4.1 and are either already operating or being designed and commissioned independently of the HVT.

Teesside benefits from existing underground storage caverns on both north and south side of the Tees river. NGN has held discussions with Sembcorp which has indicated it can repurpose one of its caverns to accommodate hydrogen. NGN also engaged external consultants who have confirmed the suitability to convert the cavern to hydrogen. In Stage 2, NGN will assess the modifications required to enable this.

Initial modelling of the production and storage requirement for seasonal and intraday demand has been conducted. The salt cavern will help meet seasonal demand and provide resilient hydrogen supply. To meet intraday demand, new above ground storage bullets are required. In Stage 1, discussions have been ongoing with the TeesWorks regenerative project to repurpose existing brown field sites to build the bullets and pressure reduction equipment. Agreements will be confirmed in Stage 2 as well as completing the detailed design for the storage bullets and hydrogen infrastructure.

This HVT involves the design of new pipelines and associated AGIs to deliver hydrogen from production facilities via the network into storage. This will include routing design, completion of environmental studies and Environmental Impact Assessment, (if required) to meet the requirements of the Public Gas Transporter Pipe-line Works (Environmental Impact Assessment) Regulations 1999. Long lead items will be identified during the design stage for delivery during the construction phase.

The HVT will ensure reliable hydrogen supply, applying design criteria that prioritise resilience and peak load forecasts and utilising storage.

4.2.2 Network

The HVT is made up of Warrenby, Coatham, and the Kirkleatham industrial estate within the Redcar area. The area consists of 2,063 meter points with estimated hydrogen demand of ~1,130 tonnes of hydrogen per year. The current network in the area is approximately 24 km long and is predominantly made up of polyethylene (89% overall).

Table 4: Overview of the pipeline characteristic in the HVT area.

	Warrenby & Coatham		Kirkleatham	
	Length (m)	**Composition (%)**	**Length (m)**	**Composition (%)**
Cast iron	2,240	11	-	-
Spun iron	-	-	5	< 1
Ductile iron	167	< 1	23	< 1
Polyethylene (PE)	17,587	88	4,051	99

Steel	70	< 1	-	-
Total	20,064	100	4,079	100
Total length (m)			24,243	

With PE making up the majority of the network, the remaining 10% will be converted into hydrogen-ready pipelines through either the Iron Mains Risk Reduction Programme or the HVT. In Stage 2, modelling scenarios will be evaluated to address the challenges for converting the existing network. These models will be based on the 2021 Strategic Modelling NIA project, which included the Redcar area. Modelling will address:

- Capacity/demand requirements for spring, summer and winter.
- Low pressure points.
- Sections of high velocities.
- Sectorisation sizing for manageable sizes so that areas are only off gas for a day.
- Modelling each stage of sectorisation so that the natural grid can still be maintained which the first sectors are being converted. Some prior research has been conducted for the area in the Initial Hydrogen Strategy NIA. This has provided a good basis of the feasibility study in Stage 1.

Based on the output of the models, there may be design work for the existing gas network. This design work will review:

- Network operating pressures to address low pressure points and increase network pressures to account for any issues with service sizes.
- If any upsizing of pipelines to address velocity and low-pressure issues is required.
- Reinforcement requirements to address velocity and low-pressure issues for hydrogen as well as maintaining national gas pressures during the conversion process.

As well as modelling and designs for the existing network there will be some new design work required to connect the new infrastructure.

While modelling and design are being conducted, some physical surveys are required in the HVT area. These surveys include:

- Gas mains pressure testing.
- Service connections for condition, size and material.
- Location for network reinforcement.
- Proposed locations of the sectorisation valves.
- Pipeline route corridors.
- Proposed locations for the above ground infrastructure.

The selected area is also part of the NUAR project. The NUAR digital map will be accessible when and where it is needed by those planning and executing excavations and will enable enhanced communication between parties and improved data quality.

4.2.3 Design, Procurement and Construction

NGN has been securing sufficient production and storage capacity to meet the HVT hydrogen demand with resilient supply. The project will build the pipelines and associated AGI in parallel with the connecting the production facilities and storage so that it is delivered ready for commissioning in line with their programme.

The network modelling and design for Stage 2 will start at the beginning of January 2022 and take around 8.5 months to complete, with production and storage design running for 8 months also from early January 2022. The network modelling will support the design of works to be completed.

Procurement and construction will take place predominantly in Stage 3. NGN has already begun early-stage engagement with the supply chain. As detailed design progresses in Stage 2, NGN will finalise its procurement strategy. NGN expect to ensure all procurement is operated through open tenders following well-established processes for ensuring VFM (as described in Chapter 6).

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.

The HVT team will collaborate with key stakeholders across the supply chain to deliver this trial in the most efficient and effective way possible, and with regard for learnings across the supply chain. All procurement and supply chain activities throughout the HVT will be in accordance with the expected standards and delivery strategies.

4.3.1 Appliance requirements in the trial area

Based on the number of properties in the selected HVT area, the local building stock, and from NGN's experience in the H21 and Hydrogen Homes projects, the required range and volume of appliances has been estimated and shown in Table 10.

Table 10: Overview of the estimated range and volume of appliances required for the HVT.

Appliance	Expected uptake	Quantity
Boilers	90%	1,800
Hobs	60%	1,200
Cooker	40%	800
Fires	25%	500
Meters	90%	1,800
Smart Appliance	90%	1,800

Industrial/ Commercial Appliances	100%	6
Retail Appliances	75%	149
Alternative options (electric)	10%	200

These estimates are calculated assuming ~2,000 domestic properties and using the uptake for each appliance. Please note these quantities are indicative and subject to a detailed property survey.

As part of the Stakeholder Engagement phase of Stage 2 (Annexe C), each property in the HVT with be surveyed for their existing appliances. To assist with this, an app-based digital platform will be used for consumers to book appointments with CCOs, or to carry out the survey themselves online (assuming they already have had an EPC – see Chapter 5). Based on experience, customer uptake of self-service can be assumed to be around 40%. The data for the appliance survey will include:

- Heating – current boiler manufacturer, condition, type, output, and location in home.
- Cooking – freestanding, tower, hob, number of rings, manufacturer, model, single or dual fuel.
- Fire – manufacturer, model, configuration flue, chimney, open flame etc.
- Flow meter – type, size, and location.
- EPC rating.
- Property type and location.

NGN will get initial indications if they require any appliances replaced for hydrogen or electric. The information will also identify existing appliance manufacturers for the consumers' appliances, particularly for the boiler, who could assist with the installation of 100% hydrogen-ready boilers.

Due to the wide demographic of property types and ages, NGN expect a good cross-section of appliances, reflective of the exiting appliance stock in the UK. NGN are also expecting a range of industrial appliances in Kirkleatham.

NGN will record and plan for consumers that would like to change to an electric heating and cooking solution. This will include planning together with NPG for appliances and electrical upgrades required for the area or properties. NPG has provided a letter of support for the HVT and NGN will work closely with them to ensure no one will be financially disadvantaged. Any bespoke appliance, particularly I&C, would require an individual plan for conversion.

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).

NGN conducted an assessment of the skills required to deliver the HVT. In this section, NGN sets out what those skills are, how NGN plans to fill relevant roles, provide training, and ensure appropriate certifications are in place.

4.4.1 Required Skills

Table 11 provides an overview of the required roles, skills, and certifications required to deliver the HVT. This is based on experience gained following a similar process to develop an organisation to deliver the HyDeploy 2 trial. The HVT will benefit from the same leadership team as the HyDeploy 2 trial. The number of personnel required may change during the Detailed Design Stage as the scope and nature of certain activities are defined in greater detail.

Table 11: Summary of roles, personnel, and certification requirements required to deliver the trial.

Role	Number of personnel required	Certification
Hydrogen Production and Storage facility engineers and managers	10	• HNC In mechanical/civil/electrical or chemical engineering • TEM 1-4+ 10, EL6, SR25, Hazop
Designers	4	• impact of Hydrogen on NGN/SP/NP/14, NGN/PM/MSL/1 and NGN/PM/REP/2
Gas Quality Technician	3	• ONC or HNC in electrical engineering, TEM 1,2,4,5,9&10, EL6, TIM 4 + 5, Rhinology, EUSR Registration as NM) (G) Specialist Operations
Network Analyst and validation	3	• SynerGi Core competence DNV
Cadent call Handlers (National Emergency Call Centre)	125	-
Pipeline and Plant Maintenance operatives (both gas and electrical)	12 (8 x pressure maintenance craftspersons and 4 x E+I engineers)	• Maintenance Craftsperson NVQ Level 3 EUSR registration NMO (G) >+<7bar • E+I engineer NVQ Level 3 and National Certificate in Electrical or ONC
First Call Engineers	35	• NVQ level 3 + Gas Safe Register for escape locate and repair
Escape, Locate and Repair Teams	60	• Team Leader NVQ level 2 (escape locate and repair + mains and service laying) • General Operative NVQ Level 1 (assistants to team leader)

Gas Safe Registered Installation Engineers	62	• Gas Safe Registration with hydrogen competent work categories
Operational and Regulatory Managers and Senior Managers	6	• NVQ Level 3 Multi Utility supervisor award • SCO 1,2,4 +5 AE
Operational First Line Managers	15	• NVQ Level 3 as above + • EUSR NCO (G) Supervisor • SCO 1,2, 4 + 5 CP/AE
System Control Centre Personnel including Managers	21	• Internal qualification "Licence to Operate"
Emergency Dispatch Personnel including Managers	32	• Internal "Dispatch Applications Competencies"
Customer Liaison Officers	6	• EUSkills SHEA Gas Passport
Total	**394**	

4.4.2 Recruitment

NGN has an existing pool of highly experienced staff within NGN. NGN expects a majority of HVT roles will be filled through providing opportunities to internal staff. NGN employs >1,400 direct employees. The majority of these in operational roles. In addition to direct employees, NGN has ~1,000 service providers who are also operational and deliver the network risk reduction programme and can be utilised for the HVT, if required. Priority will be given to service providers within the local region of the HVT.

The NGN Chief Engineer will ensure staff deployed on HVT are suitably competent. They will identify the specifications for roles within the HVT including for management and operational staff with responsibility for the safe flow of hydrogen and provision of emergency response services.

As this will be the first time a gas network has been converted to 100% hydrogen, NGN expect sto seek additional external support from universities and technical consultancies. NGN has a diverse range of external suppliers under its Supplier Framework Agreement it can call upon to provide additional services such as complex infrastructure design and assurance as well as operational delivery. The Chief Engineer will ensure external suppliers are appropriately qualified.

NGN's existing resource level, supplier arrangements and project partnerships are more than adequate to deliver the trial safely and efficiently.

4.4.3 Training

In advance of the HVT, NGN will have in place robust training plans for specified individuals, teams, and the wider NGN business. Core HVT roles (identified in Table 11) will receive hydrogen-specific technical training due to the significant safety, health and engineering requirements of the roles. Other supporting HVT roles, such as CCOs, will receive general

hydrogen awareness training. All staff who encounter the public will receive training on how to answer questions the public may ask about hydrogen and the HVT.

NGN will collaborate with the GDNs and industry to develop a hydrogen training and competency framework. All HVT roles will have a STC documented and recorded centrally - underpinned by hydrogen site operating standards and procedures. Role specific and team training plans will be designed to reinforce these STC and procedures.

To deliver the tailored, high-quality training needed for the HVT, NGN is partnering with R&CC. CEEH, located at the College, will be a specialist industrial training facility, designed to meet the current and emerging skills needs of the clean energy sector, including hydrogen. The facility will be unique in Tees Valley, delivering a range of courses:

- For young people aged 16-18, including apprenticeships, industrial programmes and a HE offer, and
- For the existing workforce, enabling them to adapt current skills and develop new skills to support the adoption of clean energies for commercial, industrial, and domestic use.

Existing hydrogen test facilities at DNV Spadeadam, HSE SD in Buxton, Southbank (Redcar) and NGN's own Low Thornley Integrel at Winlaton in Gateshead provide excellent training facilities.

4.4.4 Certifications and competency assessment

Operations downstream of the ECV will be covered under the Hy4Heat Competency Framework for Hydrogen[10] which is supported by EUS.

Existing Gas Safe Registered engineers carrying out installation and maintenance on hydrogen downstream systems will be required to complete the Hydrogen Pathway Training Course recognised under the IGEM/IG/1 standard. A Hydrogen ACoP assessment module has been developed by EUS which all engineers and supervisors engaged in the HVT will have successfully completed.

Engineers will have been certificated as competent and have an endorsement added to their Gas Safe registration. Currently Gas Safe registration only applies to engineers working in domestic properties. NGN will work with industry and R&CC to develop the necessary skills and assessment criteria for engineers required to work on non-domestic installations.

Plans are already in place for EUS and the networks to develop certifications for non-domestic properties in 2022. NGN will – together with the other networks be a key partner to this. NGN's H21 Phase 2 research – which looked at the impact on operational procedures as networks transition towards hydrogen conversion – will be a key input.

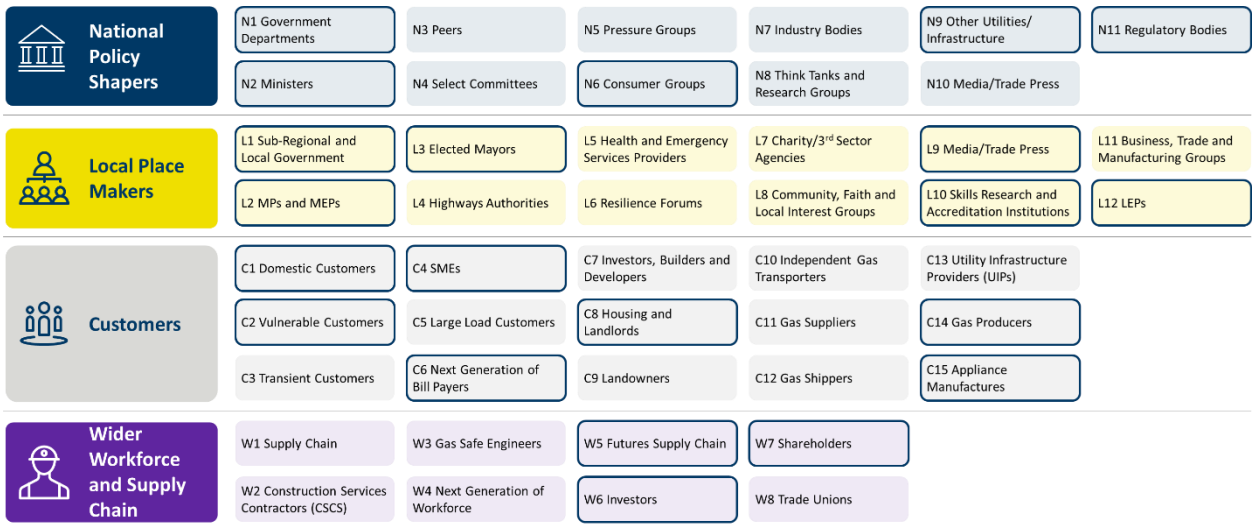
5. Public and Local Engagement

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.

The development of NGN's HVT proposal has been informed and shaped by its stakeholder community, as outlined in Figure 3. NGN provides further detail on its engagement strategy for Outline Design, including analysis of insights NGN has received so far in Annexes G and H.

Figure 3: Redcar Hydrogen Community Outline Design stakeholder map.



NGN has used a range of engagement mechanisms appropriate to the audience and objectives of the HVT, triangulating what what NGN has heard in engagement with research undertaken by others and relevant operational data.

All customer research NGN has drawn upon has been representative of either NGN's network or the UK as a whole. Wherever appropriate NGN has partnered with expert third parties, for example Leeds Beckett University. These partnerships have ensured all of NGN's research is objective, non-leading and ensures voices of hard-to-reach and vulnerable consumers are heard.

NGN's proposals have been designed with and are in partnership with Local Government, with letters of support from the Tees Valley Mayor, Leader of the Council and the MP for Redcar. NGN has partnered with R&CC, who will deliver all skills and training at their new renewables training centre. Finally, NGN has consulted with the customer advocates in the third sector, including Citizens Advice, NEA and Communitas Energy CIC.

5.1.1 Customer Acceptability & Insights

Through iterative engagement with NGN's consumers, local stakeholders and customer advocates NGN has refined and retested proposals for the HVT.

NGN has synthesised everything heard into 17 key insights that have shaped these HVT proposals. Detail on the insights and how NGN has used them are described in detail in Annexe H. Table 12 provides a summary.

Table 12: Summary of the key insights NGN has received from its consumers, local stakeholders and customer advocates and how NGN has incorporated these.

What NGN has heard	How NGN has used it
Overall acceptability of proposals is 77%	Committed to ongoing acceptability testing (5.2)
Most consumers would opt for hydrogen technologies	Used as a basis uptake projection (4.3) and engagement outputs (5.2)
79% consumers find NGN's customer offer acceptable	Refined and confirmed the customer offer (5.3), with commitments to further testing
Consumers expect to be protected from negative impacts on their bills at minimum	Incorporated into customer offer (5.3)
Consumers expect to be financially compensated for taking part in the trial	As above
Any other potential costs to be covered by the trial	As above
A whole house approach should be taken	As above
Disruption should be minimised	Addressed in 5.2 and 5.3, particularly through a streamlined appointment process with the ability to online self-serve
Trusted experts should be available to give a personalised service	5.3 – particularly the use of consistent CCOs and access to independent advice provided by NEA
Consumers want choice over their appliances	Addressed in the customer offer and data collection process (5.3)
Clarity on the exit strategy will drive acceptability	Addressed in the Exit Plan (3.4)
Consumers want clarity on the process well in advance	Designed into iterative communications and engagement plan (5.2)
Full, transparent communications will be required	All communications to be designed with consumers, local community and customer advocates (see 5.2 Phase 0)
Education will be required on climate change and hydrogen as a potential solution	This will be factored into all communications and specific provision has been included for community courses and educational programmes run through Redcar & Cleveland College (5.2)
A multichannel engagement programme will be required	Addressed throughout 5.2

A range of trusted voices will need to be heard	5.2 – particularly the creation of the Community Partners Board and early identification of formal project advocates.
All opportunities should be taken to maximise local economic and skills opportunities	Partnership with Redcar & Cleveland College and intention to establish and utilise the Community Partners Board to identify and deliver on opportunities.

Table 13: Summary of the key insights NGN has received from industry and how NGN has incorporated these.

What NGN has heard	How NGN has responded
A large volume of low carbon hydrogen production is planned within Teesside trial area to be online by between 2024 and 2026.	Proposed a diverse and reliable hydrogen supply strategy, which encompasses all the hydrogen production that is expected to be online in time for the HVT.
Both above ground and underground hydrogen storage assets are plentiful within the immediate vicinity and available for use during the HVT.	Partnered with both above ground and underground storage companies to ensure inter-seasonal and intra-day demand can be effectively met.
The investment required for production facilities is not commercially viable for a HVT period of less than 24 months.	HVT extended from 12 months to 24 months to ensure the costs for production facility build are commercially viable. This will also allow the trial to gather data during two full winter seasons.
It is key to ensure that timelines for meter and appliance production are realistic given the scale of the HVT.	Partnered with a total of 9 appliance/meter manufacturers and committed to allowing a realistic lead in time for appliances and meters, with all properties being surveyed during and customer appliance preferences being sought during the design stage.
Timelines to bring electrolytic production facilities online are quicker than blue production facilities due to the Track 1 timelines.	Commitment to ensuring the trial supplies low carbon hydrogen that satisfies the forthcoming Low Carbon Hydrogen Standard.

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.

NGN has a leading track record in stakeholder engagement in the sector. NGN has scored highest in Ofgem's annual engagement review 2-years running. NGN is the only GDN to be "double-green" rated by the national Consumer Challenge Group for high-quality stakeholder engagement during business planning. NGN has drawn on its HyDeploy

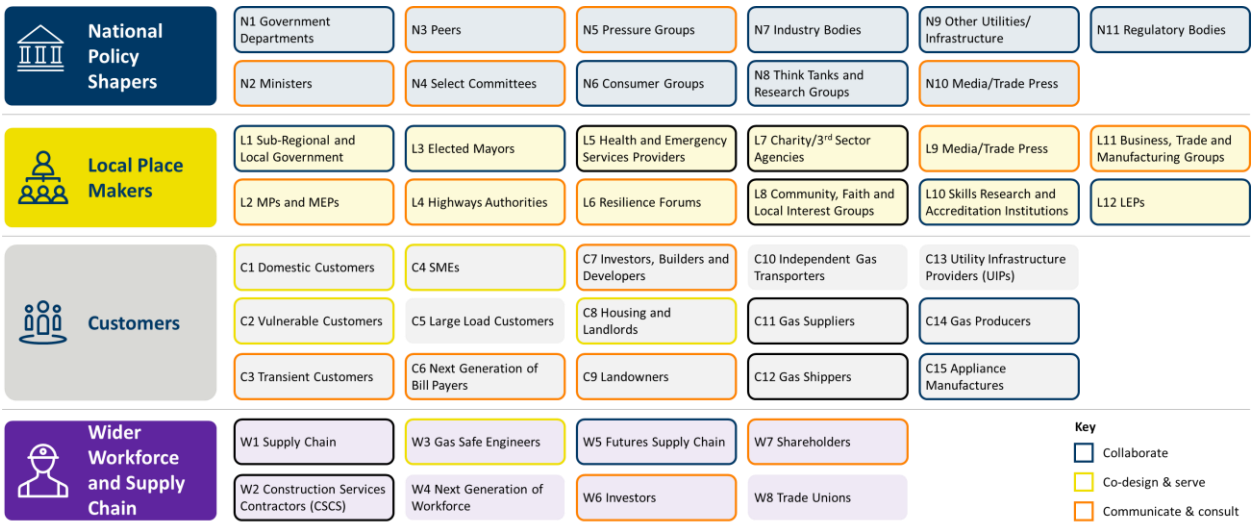
experience and the tried-and-test approach it will apply to the HVT is iterative, inclusive and makes every contact count.

This section sets out NGN's strategy for public engagement during Detailed Design. The objectives of NGN's strategy are:

- Build understanding, consensus and support
- Enable the collection of required data
- Codesign and refine the engagement and customer journey for subsequent stages

Figure 4 identifies the HVT's key stakeholder groups to be engaged in Detailed Design. This document covers public engagement. However, extensive engagement with producers, shippers and suppliers will continue, alongside communications with stakeholders.

Figure 4: Detailed Design Stakeholder Map



NGN will undertake a full engagement risk analysis. However, Table 14 outlines key risks:

Table 14: Outline of the key engagement risks for this Stage of the trial.

Risk	Mitigation
Failure to secure acceptance of local community for hydrogen conceptually or the HVT specifically	Strong cohort of community champions, drawing on extensive existing support among community. Multi-channel, community-led campaign with customer-friendly messages addressing environment, cost, disruption and safety concerns.
Failure to secure early support to collect required data	3-month period to generate interest and support pre-data collection. Data collection incentivised (see 5.3).
Engagement fatigue leads to concerns about future disruption	Single visit to homes/premises for data collection. Flexible appointments and online self-service.

Failure to engage with vulnerable and hard-to-reach groups	Plans to target hard-to-reach groups (Phase 0). Community partners support outreach to specific groups. Materials address language-based vulnerabilities.

The strategy consists of three phases.

Figure 5: Overview of Public Engagement Programme during Detailed Design.

5.2.1 Phase 0 (Plan & Prepare)

Purpose

Co-design detailed public engagement plans and materials for use throughout Detailed Design and build capacity in community champions.

Stakeholders

Local Place Maker cohort and representative groups of consumers from the HVT area.

Activities

- **Qualitative customer research** building upon NGN's existing Social Sciences research with Leeds Beckett University (LBU) – including 1-1 interviews and focus groups – to inform public education material on the hydrogen and the Net Zero transition.
- **Community Partners Board (CPB)** to convene Local Place Makers (see Figure 5) with particular emphasis on partners who understand the full range of local

stakeholders including hard-to-reach groups. During Phase 0, the CPB will co-design plans as well as engagement materials for the following Stages. The CPB will provide training and support to key local partners who can act as advocates (e.g. the Council and blue light services). Membership from BEIS and Ofgem would be welcomed in this group.

Outputs/Success Criteria

- Detailed engagement plans for Hard-to-Reach groups established
- Detailed communications and engagement plan for Detailed Design
- All resources in place, including Drop-in Centre fit out complete
- All engagement materials co-designed with consumers

5.2.2 Phase 1 (Build Awareness)

Purpose

Public launch of the HVT, delivered in partnership with community advocates. Raise understanding and awareness of the proposals amongst the community, provide an opportunity for the community to ask questions and raise concerns and begin to build support for the HVT amongst residents and businesses.

Stakeholders

Local Place Maker cohort, building owners, residents, and business owners within the HVT area, including young people and non-bill payers.

Activities

- **Trial introduction materials:** brochure, film, animations and website. Disseminated via post, Drop-in Hub, events and partners.
- **Drop-in Hub** in the town centre, will showcase the different technologies available during the HVT, be the base for customer care team and act as a focal point for the community, media and visitors to learn about the HVT.
- **Customer Open Days –** specific events at NGN's Drop-in Hub, within community assets, and via organised trips to the Hydrogen Homes**,** located an hour from Redcar
- **Community Net Zero and hydrogen courses and open evenings** in partnership with R&CC, will showcase hydrogen technologies
- **Iterative multi-channel communications campaign** including print advertising, cross platform social media, local media and on street signage
- **Collaborations with local business and community groups:** Dissemination in their newsletters, group meetings, websites and social media.

The CPB will continue to meet throughout Phase 1 to share insights, monitor engagement risks and establish mitigations.

Outputs/Success criteria

- 100% of bill payers and property owners engaged by at least one mechanism

5.2.3 Phase 2 (Doorstep Dialogue)

Purpose

Gather the data required to underpin Detailed Design and close any remaining engagement gaps with hard-to-reach groups.

Stakeholders

As for Phase 1.

Activities

Activities from Phase 1 continue during Phase 2. In addition:

- Multichannel communications to establish building survey slots, including letters, door-to-door visits, social and printed media
- Amplification through formally-identified local advocates
- Launch of an easy-to-use app, for digitally-engaged consumers who wish to self-serve to book appointments
- Household/building-level surveys via the digital app or in person by the HVT Customer Team
- Launch an independent advice service, provided by NEA

Section 5.3 details how this campaign will support NGN's customer data collection strategy. As with previous Stages, the CPB will have a central role in managing and monitoring engagement risks.

5.2.4 Phase 3 (Trial Co-design)

Purpose

Consult on and co-design the detailed customer journey for subsequent Stages of the HVT and get an up-to-date view of HVT acceptability.

Stakeholders

Specific to this phase: as per Phase 0.

Activities

Activities from Phase 1 and 2 continue. In addition, NGN will undertake research on customer journey, including workshops with local stakeholders and qualitative research with representative groups.

Research will test the overall acceptability of the HVT. If necessary, this will be iterative, refining proposals so that they reach minimum acceptability agreed with BEIS and Ofgem.

Outputs/Success criteria

- >60% acceptability (target 75%) of the HVT (as a minimum-to-proceed based on industry standards for business planning)

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.

5.3.1 Strategy for establishing all consumer's requirements

The majority of activity to establish consumers' requirements will be undertaken in Detailed Design. During this Stage, a survey of each property will be undertaken that will identify:

- The current appliances in the property
- Building fabric, with a focus on specific issues such as ventilation, meter location, internal pipework and access
- Energy efficiency, where an in-date EPC is not already in place

NGN anticipates the survey would be a 30–60-minute appointment, depending on whether a property already has an EPC in place. According to customer preference, the surveyor will either be accompanied by a CCO or a separate appointment (virtual or in person) set up with them. The CCO's role will be to talk through the HVT and customer offer, answer any questions, record any feedback and introduce the property owner to the different technology options available.

During the course of this meeting, the CCO will capture details of any factors of vulnerability that may need to be taken into account in subsequent Stages – including domestic customer, service-user vulnerability (e.g. care homes) or commercial vulnerability (e.g. businesses operations for which temporary interruption to supply would have a high impact).

Following this engagement, consumers will be provided with a personalised report that includes:

- their EPC report
- personalised recommendations on potential energy efficiency improvements and potential eligibility for financial support
- any information they have provided about vulnerabilities
- information on the range of hydrogen technologies available for their property, as well as the alternative heating solutions if they wish to 'opt out'

Consumers will then be asked to indicate if they wish to 'opt out' and take an alternative heating solution, such as electric boiler and immersion water heaters or heat pumps. All

consumers would be offered a 'zero cost' solution, but some financial contribution may be required if consumers wish to move to a heat pump (in line with current Government support and recognising the broader costs to upgrade buildings to suit heat pumps). To help consumers come to an informed decision, in addition to the information provided by the CCOs, all consumers will have access to independent, impartial advice through NGN's partner NEA.

For those consumers who wish to engage online, an app-based digital platform will be in place to allow them to carry out all or part of the customer journey online, specifically.

- Booking appointments (with non-surveyed appointments offered as an online if preferred)
- Self-surveying of the building (not including EPCs)
- Uploading customer information and preferences

The app will also be used by NGN's CCOs for consumers who prefer an in-person customer journey, allowing it to store and analyse customer data on a single system.

NGN acknowledges this activity represents disruption to consumers. In line with NGN's standard compensation for supporting research, NGN would propose an incentive of £30 per property (enhanced for MOBs).

5.3.2 Overview of the customer offer

NGN has based the customer offer on a range of research representative of its customer base (please read alongside Annexe G). Nevertheless, the proposed offer would be fully tested with local consumers during Detailed Design (5.2), with a particular focus on ensuring it is tuned for the needs of businesses, landlords and tenants.

A number of key principles have shaped the offer:

- Any payment compensates customer time spent supporting research (for example, sharing of data and monitoring) as opposed to the disruption that would normally occur in a change to Net Zero technologies
- Compensation offers VFM and does not skew findings of the trial
- The offer is the same, regardless of which technology is chosen; ensuring consumers do not feel coerced or that NGN indicates that one technology 'needs' incentivising

NGN's core proposed offer is:

- Energy bills tracked to the gas price during the trial period
- £500 shopping vouchers over the course of the trial, paid in monthly instalments
- A choice of brand new appliances provided and installed free of charge at the start and, in the event that the trial does not move into BAU, end of the trial (see exit strategy)
- A 'no footprint promise' that compensates any redecoration or remediation work required if existing appliance are moved.

- Annual boiler service and access to free maintenance throughout the trial including initial central heating clean and potentially upgrades where an existing system is poor quality.
- Compensation during the course of the trial for participants locked into an existing maintenance service agreement.
- Enhancements to NGN's SME disruption compensation scheme

The trial offers significant opportunities to address fuel poverty and energy efficiency of properties in the area as part of a fabric first approach. During Detailed Design, consumers will each have received a personalised energy efficiency report. Following this, NGN would explore with central and local Government the opportunities for expanding existing Government funded schemes (e.g. LAD) for non-fuel type specific home energy efficiency improvements.

5.3.3 Risks and approach to customers in vulnerable situations (CIVS)

Annexe H sets out the stakeholder insights and the detailed insights to support the outline design for the HVT. Table 15 outlines the key risks for CIVS in the HVT area.

Table 15: Outline risk and approach to CIVS for this Stage of the trial.

Risk	Mitigation
Vulnerable consumers are not identified	During Detailed Design, NGN will go beyond PSR to identify vulnerabilities. Repeated at key milestones recognising transient nature of vulnerability. All front line staff trained using NGN's Vulnerability Competency Framework to be able to spot the signs of vulnerability throughout.
Issues arising from disagreements between landlords and tenants	Early engagement through landlord forums.
Complexity and scope of vulnerabilities and support requirements	Where vulnerable consumers are identified, the CCO will work with them or their representative to put in place (PTP).
Higher risk of sensitivity to being off gas for a period of time.	CCO would check in a pre-agreed points before, during and after to ensure the PTP was working and agree any follow up actions.
Widening inequalities of consumers off gas grid (and therefore at hiof consumersvulnerability) in the trial area.	Identify properties eligible for Fuel Poor Network Extension Scheme and connect as part of the trial.

5.3.4 Billing solution

NGN has engaged with Xoserve and agreed a joint approach to billing. Xoserve has reviewed and assessed 6 different options looking to ensure that converting from natural gas to 100% hydrogen for the trial area will not adversely impact the end consumer. Consumers will still be able to switch shipper/supplier and industry processes in the main, will continue as they do in the current market. This is outlined in Annexe L. Furthermore, see Annexe K for the joint GDN collaborative approach.

6. Costs and funding

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.

6.1 Estimation of Costs and Contingencies

Costs have been calculated using a bottom-up approach focussed on key activities within the HVT. The costs of these activities have been used to populate the detailed Cost Assurance Spreadsheet attached as Annexe J.

To develop the cost estimates for the trial NGN defined four activity streams. Relevant business experts prepared cost estimations based on assumptions and uncertainties for each stream. A review of all costs was undertaken with an external third party to test and challenge assumptions and help NGN ensure estimated costs are robust and efficient. All costs included are in 2020/21 price base. A description of the process used to derive costs for each area is outlined below.

Network Costs

Network costs are derived from existing business-as-usual unit cost models. These same models were used to develop NGN's RIIO2 business plan, which was scrutinised by Ofgem and considered to be efficient[†]. These costs are well understood and based on actual unit costs from delivering similar activity across the network. An uncertainty band was applied for these costs as contingency as detailed in Annexe J. Uncertainty analysis was informed by SMEs who outlined high, medium and low scenarios. For hydrogen specific costs, actual costs experienced through previous innovation projects such as H21 and HyDeploy 2 were used.

Customer Engagement Costs

Customer engagement costs are based on a combination of the cost incurred from undertaking similar engagement activities for the development of the RIIO2 business plan and data from

[†] As detailed in Ofgem's Final Determination published December 2020.

live trial projects such as HyDeploy 2. Cost estimations were validated by a third-party consultant.

Production and storage costs

Cost estimations for production and storage were developed through targeted engagement with project partners. There is inherent uncertainty in these costs driven mainly by:

1) Uncertainty over the number and scale of production and storage facilities. NGN has identified multiple viable providers, details are still being finalised subject to external processes (such as cluster sequencing and hydrogen business model allocation);
2) Volume uncertainty due to demand variability in the trial area. NGN cannot predict the weather conditions for the 2-year period at this range. The total volume of hydrogen required over the period is highly dependent upon weather conditions. The energy use in the trial area can be ~4x higher in a cold (high demand) year compared with a mild (low demand) year.

The final unit cost for hydrogen will be the product of blended costs from multiple supply sources. NGN have used cost information provided by the potential producers to estimate blended unit costs under high, medium and low cost scenarios. NGN has used these to provide an indicative cost envelope which will narrow through the FEED.

At this stage, NGN has also assumed 5% VAT will be payable on the hydrogen procured (in line with the VAT paid on natural gas). If a full 20% rate is applied the hydrogen procurement costs would increase accordingly.

Appliances costs

Appliance costs are estimated based on manufacturers' estimates, including Worchester Bosch, which are based on bespoke production runs. The costs are variable depending on the number and type of appliances – this is uncertain until surveys and consumer engagement has been undertaken. For the base case, NGN assumes a 90% uptake of the Hydrogen (with 70% and 100% as upper and lower bounds).

6.2 Funding Options

A principles-based approach has been applied to the investigation and justification of proposed funding sources as outlined below:

- Shareholders have committed to a 10% cash contribution based on their firm belief that strong business support for developing the evidence required to demonstrate the case for Hydrogen is essential.
- Direct project costs will be sourced through the NZASP reopener, including appliances, consumer engagement, and augmentation of the network to deliver trial outcomes.
- Business-as-usual activities on the existing network like maintenance and asset/mains replacement will be funded through existing RIIO2 allowances.
- Stage 1 costs will be funded through the NZARD UIOLIA.
- Investment in specific projects to secure new or collaborative learning will be funded via innovation allowances or the UIOLIA. These projects have been

identified in a separate submission by the ENA and are not included in the cost assurance spreadsheet following agreement with other networks.

- Costs purchase of Hydrogen are included in the project costing on the basis that the costs of developing the learning should be socialised across all bill payers and not only those involved in the HVT.
- All network operators and National Grid have committed in-kind support to this trial. A collaborative approach has been taken to common areas as outlined in the separate submission by the ENA.

6.3 Efficient Costs

NGN has consistently benchmarked as the most efficient network in the gas distribution sector and has a track record of delivering projects on budget and on time. This was recognised by Ofgem through its RIIO2 Final Determination. NGN's efficiency is by design. Throughout RIIO1, flexible workforce arrangements and local service providers were implemented to increase productivity and efficiency. The costs and assumptions for this submission embed the delivered efficiency realised to-date and the further efficiencies within the unit cost models used for RIIO2.

6.4 Private Sector Contributions

NGN has engaged with several third-party organisations in the development of this bid. Costs sourced through the price control reopener should only be allocated for expenditure that is broadly within the current regulatory remit of NGN or via derogations specific to this project. Where funding is required for activity not solely intended for the HVT private sector contributions will be required to undertake the necessary Stage 2 investigations. The predominant area that this applies to is Hydrogen production where the producers will largely cover the costs of the Detailed Design work for the production assets. This is because these assets are not being established solely for the HVT and are part of private sectors own strategic plan to scale Hydrogen production.

7. Project deliverables

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.

The following project deliverables are based on project commencement January 2022.

Table 17: Proposed project deliverables for Stage 2.

Reference	Project Deliverable	Deadline	Evidence	Funding Request (%, must

				add to 100%)
1	Comms Plan	1/4/22	Completion and issue of the Communications Plan	5%
2	Preliminary Site Investigations	30/6/22	Report on the initial site surveys	5%
3	Network Modelling Complete	30/9/22	Sectorisation, pressure/velocity modelling completed	10%
4	Property Surveys Complete	31/12/22	Survey database updated with majority of required data	15%
5	Outline Case for Safety	31/1/23	Draft Case for Safety	10%
6	Training Plan	31/3/23	The outline training plan complete to allow the detail to be developed	10%
7	Network detailed design complete	31/12/22	Initial pipeline design complete, including reinforcement schemes	15%
8	QRA and modelling completion	31/12/22	QRA report issued incorporating Commercial consumers	10%
9	Stage 2 Report & Results	31/3/23	All technical reports complete and issued.	15%
10	Stage 2 Complete	31/5/23	Stage 2 close out report	5%

END OF SUBMISSION

References

No.	Reference Document Title	Type	Location
1	NGN/PM/EHS/76 Management Procedure for Selection and Management of Contractors	PDF	Available upon request from NGN
2	NIA_NGN_276 Hydrogen Ready Components	Website	https://smarter.energynetworks.org/projects/nia_ngn_276/
3	Health and safety at Work etc. Act 1974	Website	https://www.legislation.gov.uk/ukpga/1974/37/contents

4	The Control of Major Accident Hazards Regulation 2015	Website	https://www.hse.gov.uk/pubns/books/l111.htm
5	Gas Safety (Management) Regulations 1996	Website	https://www.legislation.gov.uk/uksi/1996/551/contents/made
6	The Pressure Systems Safety Regulations 2000	Website	https://www.legislation.gov.uk/uksi/2000/128/contents/made
7	The Gas Safety (Installation and Use) Regulations 1998	Website	https://www.legislation.gov.uk/uksi/1998/2451/contents/made
8	H21 (project)	Website	https://h21.green/
9	H21 Phase 2 NIC project	Website	https://h21.green/projects/h21-nic-phase-2/
10	Hy4Heat Competency Framework for Hydrogen	Website	https://www.euskills.co.uk/2020/05/11/beis-appoints-energy-utility-skills-to-develop-new-competency-framework-for-hydrogen/?utm_source=bambu&utm_medium=social&utm_campaign=advocacy
11	Gas Safe Register	Website	https://www.gassaferegister.co.uk/
12	IGEM/G/7 Risk assessment techniques	PDF	Available upon request from NGN
13	Review of NGN Safety Case PIE/21/514	PDF	Found in the 'References' folder
14	Hydrogen Consumer Trial - Open Letter to GDNs	PDF	Found in the 'References' folder
15	SIF Governance Document	PDF	Found in the 'References' folder
16	Project Brief - Smart Appliances and Grid Resilience	PDF	Found in the 'References' folder

END OF DOCUMENT