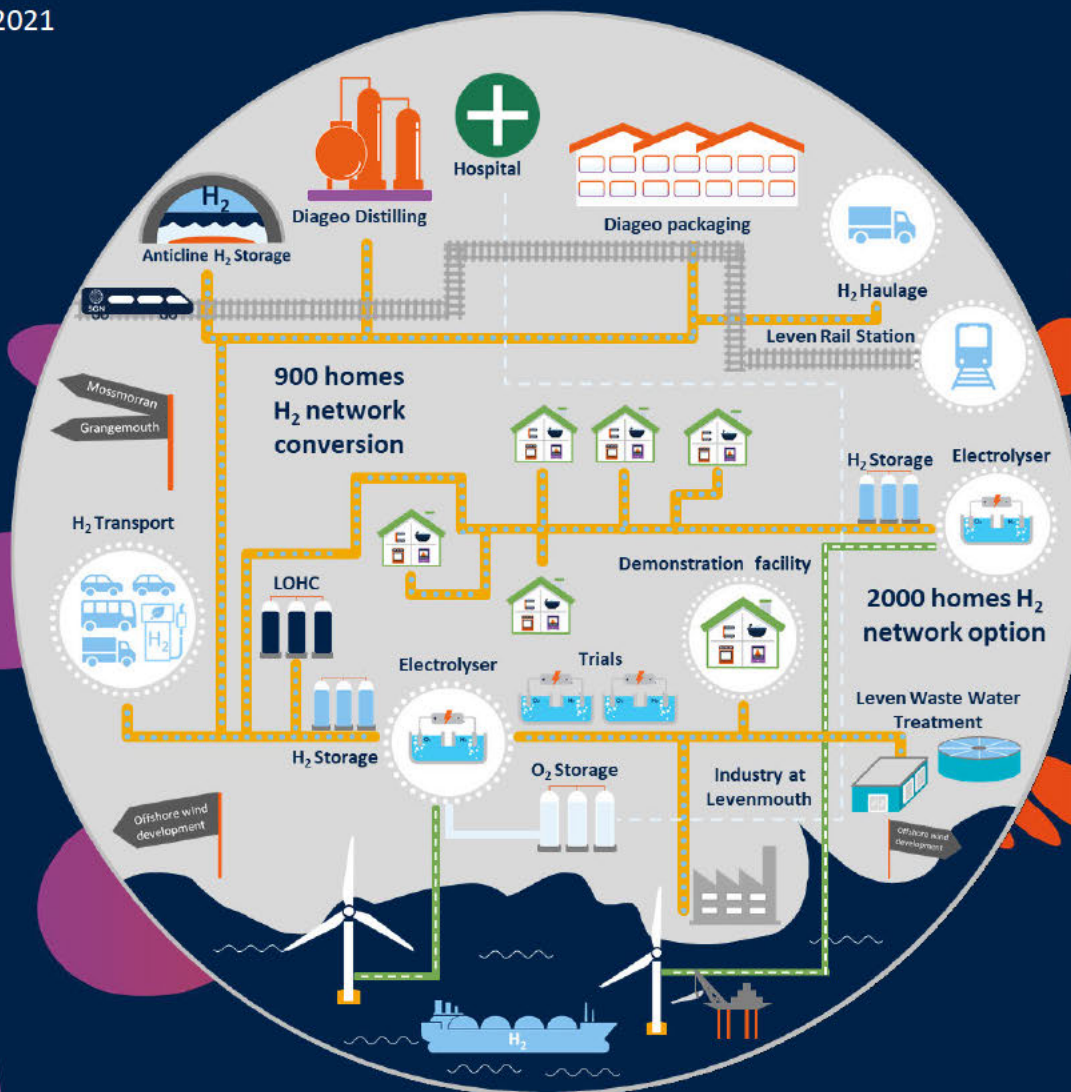


H100 Fife Village Trial

Hydrogen Heating Village Trial Stage 2: Submission Application

17/12/2021



SGN
Your gas. Our network.



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 2021¹, and have included all the information required in Annex A of that letter. Submissions must distinguish between plans, costs and benefits expected in Stage 2, and for the whole life of the project.

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

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

Please include diagrams, charts or tables where useful.

¹ <https://www.ofgem.gov.uk/publications/hydrogen-consumer-trial-open-letter-gdns>

2



1. Project Summary

1.1 Project Title	H100 Fife Village Trial (Stage 2)
1.2 Project Explanation	<p><u>Summary</u></p> <p>The H100 Village Stage 2 project aims to deliver a 'first of a kind' design for a conversion of an existing natural gas distribution network to hydrogen. This will include designing options for production, storage, distribution and fuel switching for between 900 and 2000 customers and applications in Fife. The H100 Village Stage 2 will support a final investment decision for a trial and demonstration to deliver best evidence for hydrogen system transformation at best value to customers.</p> <p>We have proposed 2 design options, 900 and 2000 homes. The 900 home option can maximise the existing electrolytic hydrogen production facility to full capacity with the addition of storage and power capacity to expand the neighbourhood into the village. The 2000 home option will include the expansion of the existing facility and design for new integrated source(s) into a wider network conversion and incorporate design of industrial and commercial premises, including a grain distillery and hospital.</p> <p>The activities undertaken in the H100 Fife Village Stage 2 project will be focused on de-risking the project for delivery by undertaking detailed design, progressing planning application/s, procurement design and key third-party agreements, including funding/delivery model, landowner and grid connections. The outcome of Stage 2 will be a 'shovel ready' project, with a clear strategy for funding, constructing and operating the Trial.</p>
1.3 Funding Licensee	Scotland Gas Networks PLC and Southern Gas Networks PLC



<p>1.4 Project Description</p>	<p><u>The Problem(s) it is exploring</u></p> <p>Decarbonisation of our energy systems is essential in order to arrest climate change and deliver on our Net zero ambitions. Hydrogen could offer a lower cost, lower disruption and resilient 'net zero' option for customers when compared with other decarbonisation methods. Decarbonisation of the gas network by replacing natural gas with hydrogen offers a credible and exciting opportunity to support the transition to net zero, but requires an energy system transformation in order to succeed. A safe, reliable demonstration of conversion of the gas network supplied by hydrogen sources to customers' homes and businesses representative of the GB housing stock is essential to evidence the role Hydrogen can play in the net zero solution, and the customers' preferences across the socio-economic and application spectrums.</p> <p><u>The Method(s) that it will use to solve the Problem(s)</u></p> <p>The H100 Village Trial Stage 2 will undertake design and development activities for either a 900 or 2000 home live village trial for hydrogen conversion in Fife. The project will comprise the following design and development elements that will incorporate the extensive research, technological development and learning from H100 Fife Neighbourhood, national evidence framework and parallel collaborative work:</p> <ul style="list-style-type: none"> • Design of an end to end hydrogen system including identification of preferred concepts for: <ul style="list-style-type: none"> ○ Hydrogen Supply options and design (electricity and grid connection points, production sites, land, planning and environmental impacts, maintenance requirements and strategy etc) ○ Hydrogen Storage options and design (preferred concept, sites, scale and resilience requirements, maintenance requirements and strategy) ○ Hydrogen entry system and design (pressure reduction system, odorisation etc) ○ Distribution options and design (conversion area, interventions, reuse and parallel network options, capacity, etc) ○ Downstream options and design (domestic, commercial and industrial users, property/user types, appliance availability, demand profiles etc) • Customer and Stakeholder Design (customer engagement, vulnerability, protection options, such as free appliances/commodity balancing/maintenance) • Regulatory Design (regulatory structure, engagement with HSE, Ofgem, BEIS, Business models, etc) • Funding and financing options • Quantified Risk Assessment for the trial and GB <p><u>The Solution(s) it is looking to reach by applying the Method(s)</u></p> <p>The project aims to design a trial and demonstration that delivers clear and robust technology readiness advancement, which is replicable and scalable, to inform hydrogen system transformation at best value to customers.</p>
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	<u>The Benefit(s) of the proposed Village Trial</u> The evidence, learnings and outcomes of this project will provide a blueprint for future hydrogen system transformation design towards a live trial that delivers critical technical, commercial, regulatory and social evidence of hydrogen's role in the pathway to decarbonisation.		
1.5. Stage 2 Funding			
1.5.1. NZASP Funding Request (£k)		1.5.2. Network Licensee Contribution (£k)	
1.5.3. External Funding (£k)	0	1.5.4. Other RIIO-2 funding (£k)	
1.5.5. Additional funding required (£k) 0			
1.6 Whole Life Costs			
1.6.1 Estimated trial Whole Life Costs (£k)	The proposed H100 Fife Village Trial is estimated to have a whole life cost of [REDACTED] for expansion to the 900-home option or [REDACTED] for the 2000 property scheme, based on an assumed trial length of 2/3 years. Further details can be found in Section 6 and Appendix 14.		
1.6.2 Of which, anticipated private sector contribution (£k) To be explored in stage 2			
1.7. List of Project Partners, External Funders and Project Supporters²			
Please include the value of their contribution and relevant experience.			
Project Partners: The project will be SGN led, with any additional partners to be defined during Stage 2.			
External Funders: other external funders to be identified in Stage 2.			
Project Supporters: [REDACTED]			

² For definitions see <https://www.ofgem.gov.uk/sites/default/files/2021-08/SIF%20Governance%20Document.pdf>



1.8. Timescale / Project duration

Initial timescale duration estimates indicate:

- Option 1: 900 properties
 - Stage 2 will take approximately 16 months to reach a financial investment decision (FID).
 - Stage 3 and 4 of the 900 property scheme can potentially commence in 2024, immediately following on from the H100 Neighbourhood.
- Option 2: 2000 properties
 - Stage 2 will take approximately 22 months to reach FID.
 - Stage 3 and 4 of the 2000 property scheme will see a extended construction period to allow for electrolyser lead time, with final consumer connections potentially in late 2025.

Pending the concept selection decision in Stage 2 an optimised programme will be developed for either option 1 or 2, or both (assuming a phased growth).

1.9. Project Manager Contact Details

1.9.1. Contact Name and Job Title

[REDACTED]
[REDACTED]
[REDACTED]

1.9.3. Contact Address

[REDACTED]
[REDACTED]
[REDACTED]

SGN
Axis House
5 Lonehead Drive
Newbridge
Edinburgh
EH28 8TG

1.10 Trial Project Summary (750 words)



**1.10.1 The
population
and
geographical
coverage of
the potential
trial location**

Geographic location and population

The H100 Fife Village Trial will be an extension of the H100 Neighbourhood Trial, located in Levenmouth Fife.

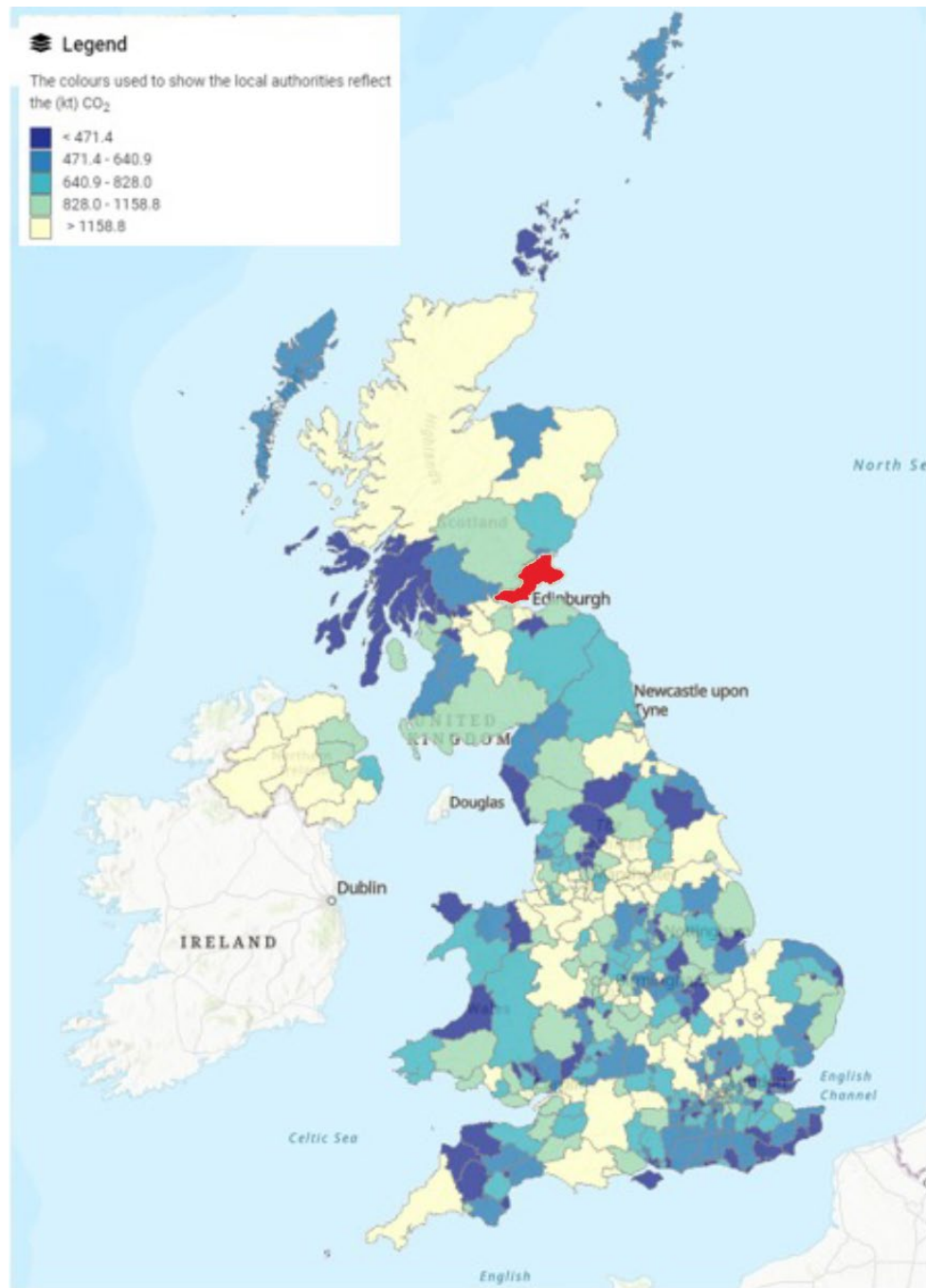


Figure 1 Geographical location of Fife within the wider United Kingdom



Levenmouth constitutes the seaside and coastal towns of Leven, Buckhaven, and Methil with a total population of approximately 30,000.

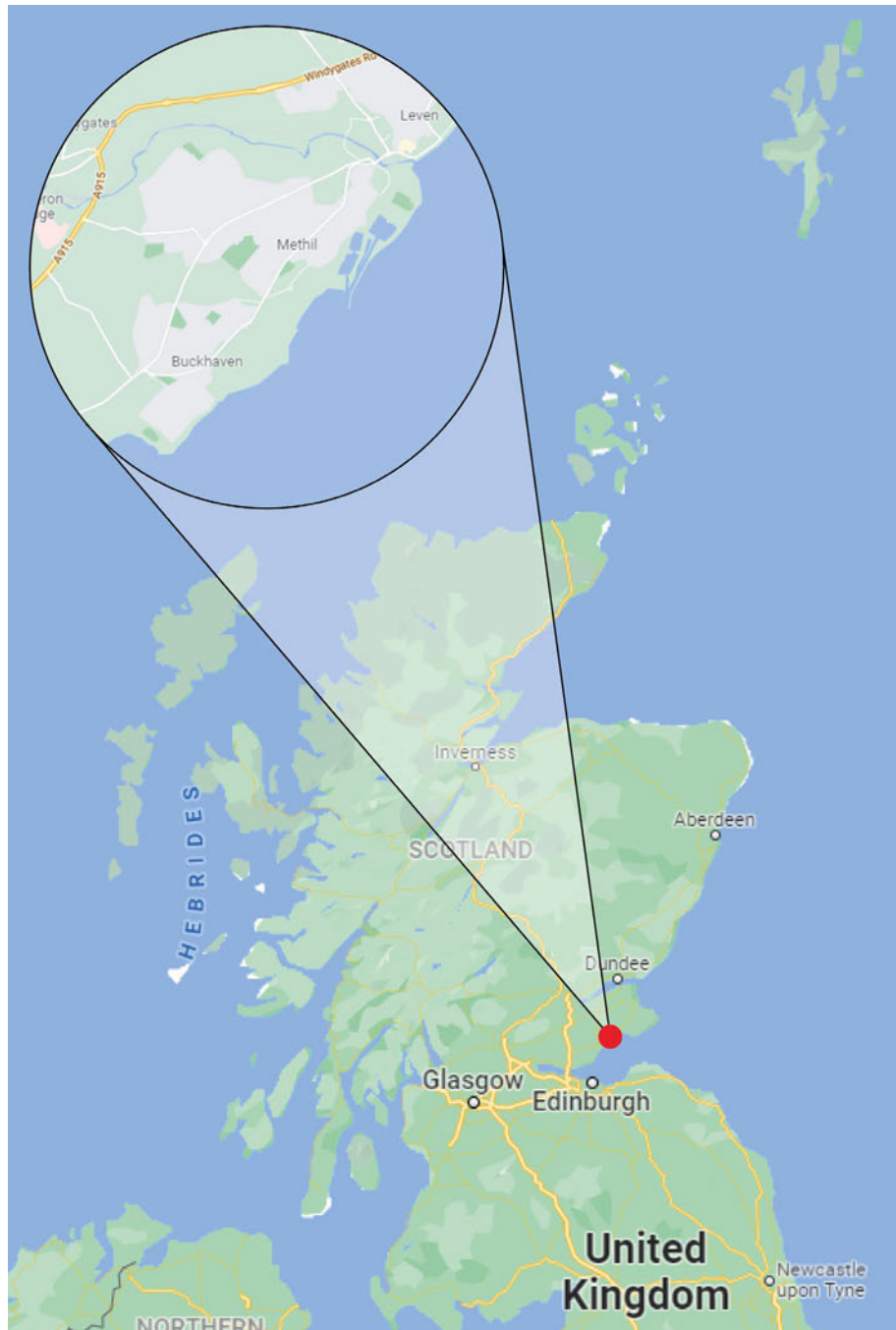


Figure 2 Buckhaven, Methil & Leven forming the wider Levenmouth area, identified within Scotland

Why this location for a trial?

Levenmouth has been selected as the best location for this trial:

- It has a diversity that is a statistically representative population (Appendix 1 – DNV Statistical Comparison of Fife against GB) sample



	<p>of the UK by; people per household, demographics, employment, residency status (e.g. owner occupied or tenant), gas supply use and demand profile, including winter peaking and typical building and property types</p> <ul style="list-style-type: none">• There is a broad range of commercial and industrial, and wider potential users that can be converted through the Village Trial or in subsequent phases, providing critical contribution to the evidence base.• It has access to an existing wind turbine which can provide the electricity for the production of electrolytic (green) hydrogen.• It is the location of the existing H100 Neighbourhood Trial, and by maximising the production capacity of the current production it offers a fast expansion for conversion opportunity.• Its central location in Scotland offers scaling potential to wider gas network decarbonisation connecting blue hydrogen production from the Scottish cluster and green hydrogen production from existing and proposed offshore wind in Fife waters.
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1.10.2 The number and range of gas consumers in the trial area, and coverage of consumers and building types within the trial

Gas Consumers

There are approximately 11,000 properties within Levenmouth, over 95% of which are connected to the gas network. A number of areas have been identified within Levenmouth that could form part of the trial, identified in Figure 3. There are over 2,936 domestic gas meter points in the cluster groups identified.



Figure 3 The 8 areas within Levenmouth identified for possible conversion

Building Types

A breakdown of the domestic property type can be seen in Figure 4, along with the location of commercial properties in Figure 5.

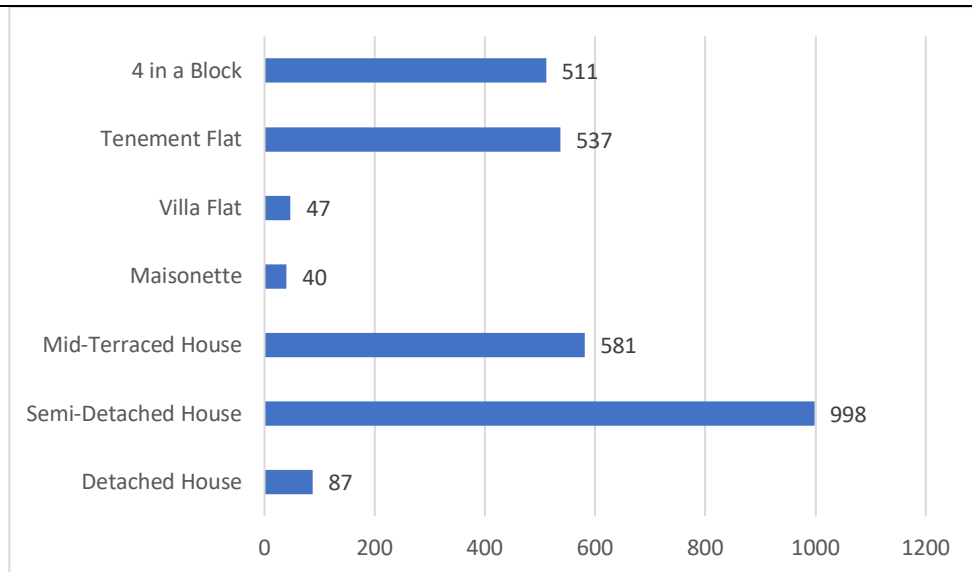


Figure 4 Domestic building types within Levenmouth

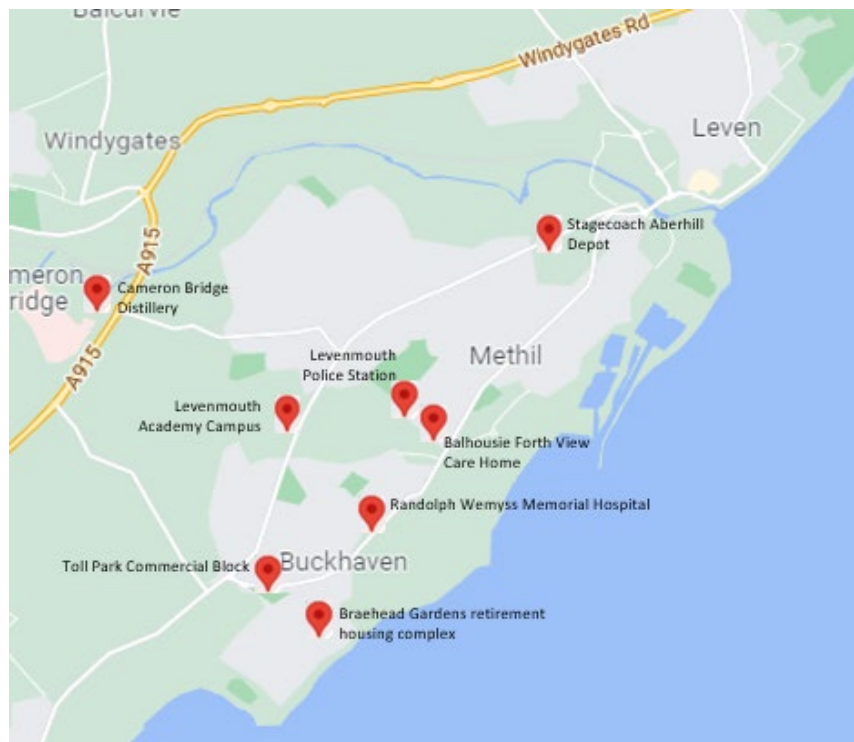


Figure 5 Commercial properties within Levenmouth



Figure 6 Randolph Wemyss Memorial Hospital (Left), Levenmouth Police Station (top-right) & Levenmouth Academy Campus (bottom-right)



Figure 7 Residential properties from within Levenmouth. Carlyle Crescent, NW Buckhaven (Top left), Whyte Rose Terrace, NE Methil (Right) & Pirnie St, Methilhill (Bottom left)

Diversity of property / building types

There is a wide range of building construction types in Levenmouth with typical representation to the UK.



1.10.3 The broad strategy for hydrogen supply, new infrastructure and network conversion.

Hydrogen supply and storage

The H100 Fife Village Trial will utilise green hydrogen. Building upon the Neighbourhood Trial, using the existing site for additional storage, and additional production capacity in the existing electrolyser the intention is to have enough supply to convert an additional 600 properties to a total of 900 properties. Further electrolytic supply will be designed in Stage 2 to allow for further conversion of ~1100 properties, either co-located or at a new site.

Gas distribution network conversion

One of the key drivers of the H100 Fife Village Trial is to demonstrate that network conversion is possible by reuse of the existing network pipelines. In Stage 2 the exact areas in Levenmouth will be identified for conversion. This will include identifying existing distribution mains that may be reused and any pipe sections or connectors that will need to be replaced in accordance with the Asset intervention protocol NIA project. Additionally, the sequencing and resourcing of conversion will be determined.

Consumer property conversion

The property conversion strategy will be determined in Stage 2 and will consider deliverability and minimising disruption to consumers. Advance installation of hydrogen-ready appliances and meters, in accordance with Hy4Heat safety guidance, will be considered to minimise conversion time for the consumers. An alternative approach that will be explored in Stage 2 is planning for a conversion of a mixture of pre-installed hydrogen-ready appliances and installation of appliances at the time of network conversion to enhance evidence and learnings. The strategy for conversion will be closely linked to the resourcing strategy.

New infrastructure

New infrastructure will include a new hydrogen production system (2000 homes) and new storage (900 and 2000), and discrete areas of the network that may require site specific upgrades in order to meet the required safety standards. It is anticipated that there may be some consumers who choose to no longer have gas, in which case alternative heating solutions will be required.



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.

This section should be read in conjunction with Appendix 2: H100 Fife Village Outcomes Table.

When looking at an energy system transformation at the scale considered, the greatest opportunity to influence success is at the R&D and design stage. This is true of any project or programme.

This requires a suite of evidentiary projects to remove as many uncertainties as possible towards a hydrogen system transformation, which is being co-ordinated nationally and monitored through the BEIS Programme Management Board and sub-Boards.

The difference between a Business-as-Usual (BAU) investment and an investment in new technology rests largely in the additional uncertainties. This uncertainty includes for example, technological (unproven first of a kind across many components/incomplete R&D), market (nascent/non-existent), legislative (immature/non-existent), and regulatory (incumbent not designed flexibly/non-existent).

These uncertainties can be managed within R&D projects using advanced management techniques, such as stage-gating, for key decision points (see Section 3.1). In the absence of underpinning R&D, the greater the uncertainty, the greater the cost, technical viability, deliverability and timeline risks for a system transformation. The H100 Fife project, the Village Stage 2, the Village trial and the overall hydrogen programme will seek to address/understand as many of these uncertainties as possible and measure against the Technology Readiness Level and Commercial Readiness Index (TRL and CRI) scales.

TRLs and CRIs are a recognised best practice scientific method for measuring evidentiary maturity.

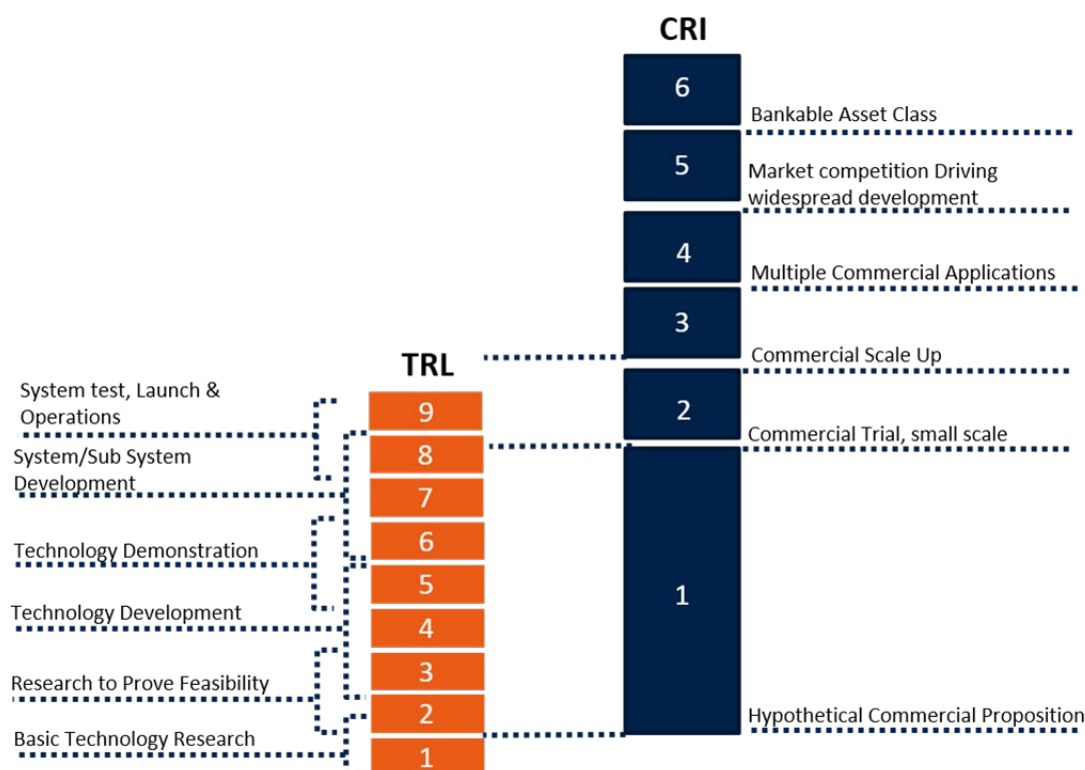


Figure 8 TRL and CRI scale

Technology development advances technology through the familiar Technology Readiness Level (TRL) scale, to the point where a 'first of a kind' (FOAK) technology is available to the market. This will be the case for H100 Fife, first operational end-end system, for first conversions H100 Fife Village and/or other Village projects. Further advancement to a commercially attractive offering typically comes as the technology is applied at a larger scale.

Scaling of technologies from single technical demonstrations, through small scale commercial trials, and eventually through large scale, multiple commercial applications and beyond, is associated with cost reduction. As technology becomes mature, competition arises, and costs are further driven down through market forces and through maturation and competition through the whole supply chain.

During the early stages of technology development, it can be difficult to accurately predict the real-life technical performance of a fully deployed technology within the correct operating environment. As a result, there is increased risk when investing and calculating Return on Investment (ROI) or Cost Benefit Analysis (CBA). A high maturity in technical performance is present when there are several full-scale commercial projects in secondary markets where externally verified performance data can be drawn upon. A lower commercial maturity exists where predictions are based on simulations (or) extrapolated from pilot tests. To secure investment and ensure bankability, site-specific data is required, project



performance warranties need to be defined, and evidence of output, reliability and operating costs proven, ideally based on similar projects.

CRI's are a useful indicator for nascent market support needs. Renewable obligations and incentive schemes, such as CFDs and RHIs are examples of support mechanisms that help balance the risk for investment, before investment is attractive on a merchant basis, however these mechanisms are generally employed once a product is proven to TRL 8/9 and full visibility of the end to end system operation and value chain is clear, due to the cross-chain risks between different parts of the supply chain, technical and regulatory uncertainties in delivery.

Following on from the H100 Fife Neighbourhood Trial, expanding the hydrogen evidence base to include grid conversion and diversifying the end user application is required to inform the gas networks' potential for a system transformation to hydrogen. The H100 Fife Village Trial has been designed in accordance with the TRL/CRI method to follow on to the H100 Fife Neighbourhood Trial, with both 900 and 2000-property options offering credible routes to providing the required evidence. The selection of preferred concept and option during Stage 2 will be based on the balance of ability to maximise delivery of the evidence base at best value for money.

The H100 Fife Village Trial as proposed will design to TRL 8/9 to provide the end-to-end transparency of learning across the system and value chain. This evidence can underpin the development of new regulatory and commercial frameworks, help shape mechanisms such as CFDs and other models to support the nascent hydrogen market at best value for customers.

Key unique features of H100 Village that enable this include:

- End to end process control for first-of-a-kind conversion
- Cross-chain risks are eliminated, i.e. security of supply, commissioning, emergency works
- Ability to manage stock realisation from storage (i.e. delayed payment) and maximise learning of storage operation and needs from green hydrogen source
- Ability to optimise hydrogen price from turbine with storage
- Existing parallel system to minimise customer disconnection/conversion risks and interruption.
- Dedicated Hydrogen demonstration and training facility

The following characteristics of the H100 Fife Village, or any Village Trial, are necessary:

- Diverse end user consumer base across domestic and commercial properties
- Housing type diversity
- Commercial property diversity
- Industrial users
- Expansion plans
- Community and local stakeholders engagement and enthusiasm
- A regulatory model development including hydrogen billing solution
- A social spectrum of customer, including deprivation and/or vulnerable customers.

During Stage 2 of the H100 Fife Village Trial, a detailed Evidence Management Plan (EMP) will be created which will be designed and structured around the BEIS Evidence Framework (Hydrogen Consumer Trials – BEIS Evidence Framework, 2021), the HSE gap analysis, the Networks' NSIB framework and our own assessment. We have drafted an evidence outcomes table that gives a detailed breakdown of the evidence we expect to generate



under the Village design and live trial and an assessment of the technology readiness progression. There will of course be a large amount of detail, evidence, reports and outcomes. This has been attached as Appendix 2: H100 Fife Village Outcomes Table.

Within the Stage 2 projects, evidence will take a myriad of forms, *inter alia*:

- Field observations
- Customer data (in accordance with GDPR)
- Property Data
- Geotechnical data
- Environmental data
- Desktop engineering design
- Literature review
- Experimental testing
- Connected R&D data and reports
- Audits
- Consultations/Surveys/Focus groups/interviews
- Communication media/Social media
- Resource intelligence
- Market intelligence
- System intelligence from H100 Neighbourhood
- Cost

All evidence collated will be comprehensively reviewed and maintained in the spirit of ISO 9000 and recognised industry standards. It will be assessed for statistical representativeness, subjected to 3rd party Peer review and selected academic papers into journals. This is similar to other major R&D projects we have delivered with successful outcomes, ranging from 'Opening up the Gas Market' to 'Robotics' and 'Real-time Networks' under the Ofgem NIC. We will tailor the evidence and updates for the various audiences and working groups and feed iteratively into the key projects, such as the Asset Intervention Protocol (NIA).

An example of a very detailed evidentiary report structure, with linked reports and evidence is detailed below. We can also generate higher level summaries for example at the BEIS PMB in a format consistent with other key projects, see H100 Fife (Neighbourhood) example below.

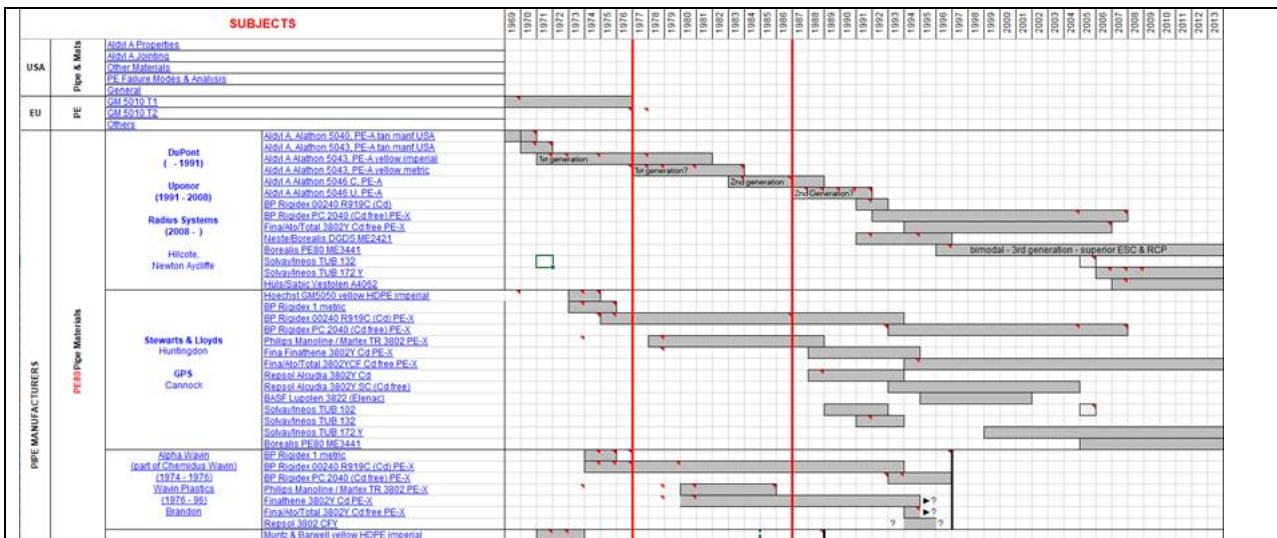


Figure 9 Snapshot of complete evidentiary project (PE Asset Life NIA)

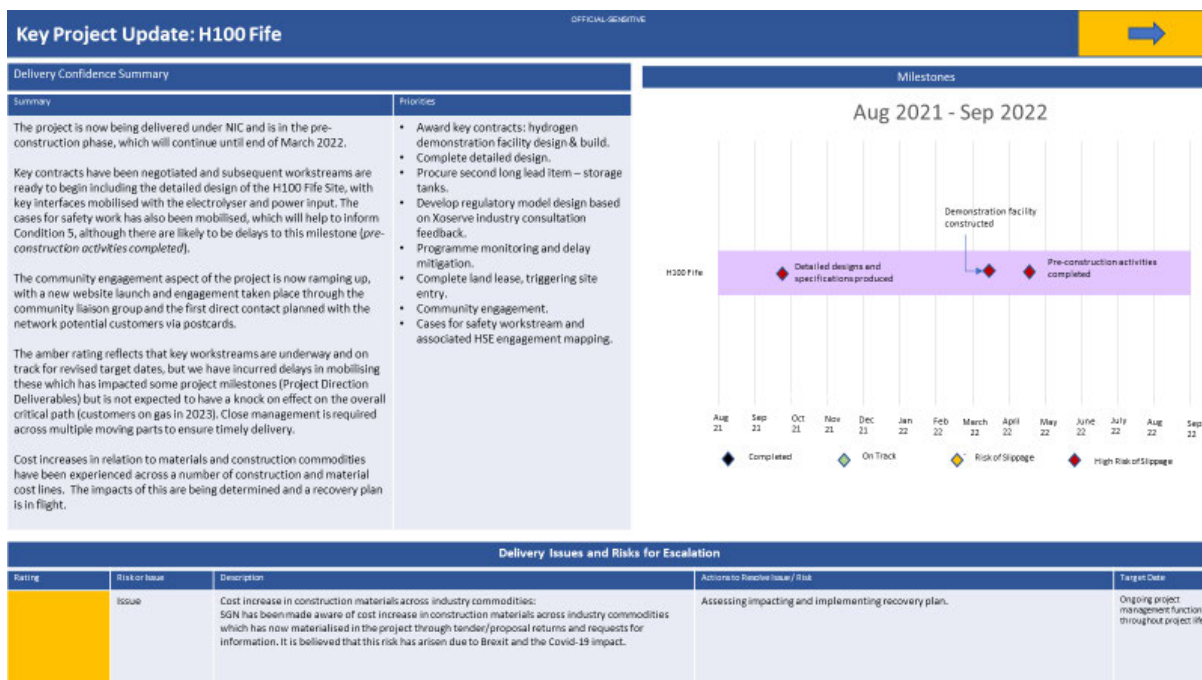


Figure 10 PMB critical project report example – H100 Fife



Hydrogen Heating Programme: Annex

Dashboard Key

RAG Rating: Delivery Confidence

Green

Successful delivery of the project/programme to time, cost and quality appears highly likely and there are no major outstanding issues that at this stage appear to threaten delivery.

Amber/Green

Successful delivery appears probable. However, constant attention will be needed to ensure risks do not materialise into major issues threatening delivery.

Amber

Successful delivery appears feasible but significant issues already exist that require management attention. Milestones are being delivered with some delays. Recovery actions being implemented. Limited impact to critical path.

Amber/Red

Successful delivery of the project/programme is in doubt with major risks or issues apparent in a number of key areas. Urgent action is needed to ensure these are addressed and establish whether resolution is feasible.

Red

Successful delivery of the project appears unlikely/unachievable. There are major issues which at this stage do not appear to be manageable or resolvable. The project/programme may need re-baselining and/or overall viability re-assessed.

Trend Status



Notable improvement in summary and RAG since the last entry into the Dashboard.



No notable improvement or decline in summary and RAG since the last entry into the Dashboard.



Decline in summary and RAG since the last entry into the Dashboard.

Figure 11 BEIS PMB RAG rating and update criteria

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.

The H100 Fife Neighbourhood project is developing a Case for Safety and Local Operating Procedures (LOPs), together known as the Safety Management Framework (SMF). This SMF is specific to the Neighbourhood phase operating parameters and is being delivered by competent third parties and subject to third party review and HSE scrutiny. As agreed with



the HSE, and in absence of a regulatory framework for the HSE to measure the majority of our SMF against, the neighbourhood Case for Safety is being delivered in three parts, each with a framework document covering specific areas of the project and each being assessed against an agreed principle.

Upstream: Production / Storage / Gas Treatment

Whilst the H100 Fife Neighbourhood phase falls below the lower limit for COMAH, we are producing documentation in the spirit of lower tier COMAH requirements to allow the HSE to assess the upstream system.

Midstream: Distribution Network

The Gas Safety (Management) Regulations (GSMR) do not apply to 100% Hydrogen and therefore there is no requirement to prepare a GSMR Safety Case for these trials. However, we have agreed with the HSE that we will use GSMR as a template to produce our Cases for Safety and help to evidence compliance with requirements under the Health and Safety at Work Act (HSWA).

Downstream: End user (downstream of the meter ECV)

For the purposes of H100 Fife Neighbourhood we are following the recommendations of the Hy4Heat Annex as well as the principles of GSIUR.

An overview of the H100 Fife SMF methodology and work to date can be found in Appendix 24.

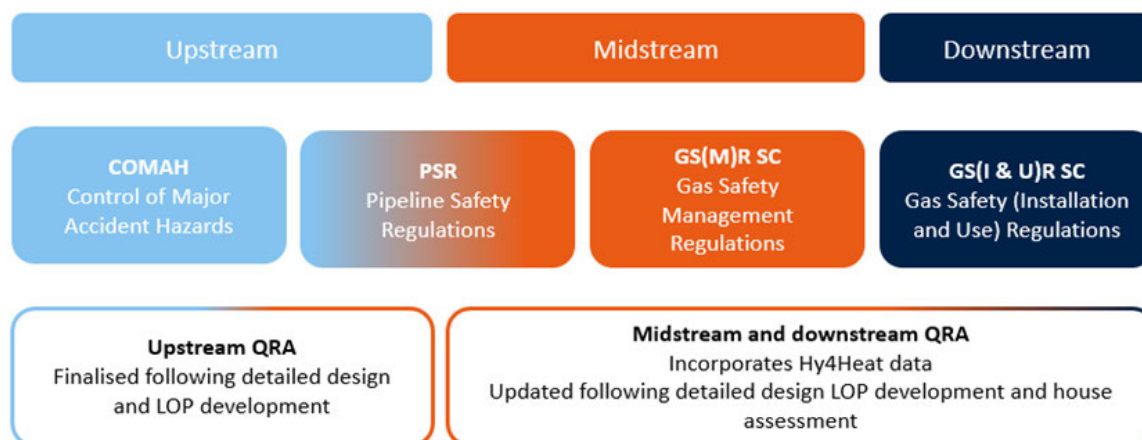


Figure 12 H100 Fife SMF Delivery Methodology

Following further engagement with the HSE in consultation with the other GDNs, BEIS and Ofgem, the HSE has issued guidance to SGN in relation to the village application covering:

- The capacity and legal duties that the HSE will provide regulatory oversight and advisory support for the trial.
- Documentation we need to provide for the Trial.
- The status the HSE's review of documentation will have.

The GDNs have also been provided with the HSE's 'consideration for trials' spreadsheet in relation to the village, referenced in the BEIS/Ofgem letter³. We have agreed with the HSE

³ <https://www.ofgem.gov.uk/publications/hydrogen-consumer-trial-open-letter-gdns>



that we will align our Neighbourhood SMF with this spreadsheet by referencing each item on the spreadsheet to it, ensuring all aspects have been considered.

As our Neighbourhood SMF, consisting of the three Cases for Safety and four LOPs (covering Emergency, Distribution, Storage & Treatment, Production) will align with the HSE approach for the Village, we will utilise the resource involved in developing the Neighbourhood SMF to update and amend it to meet the specific attributes of the Village. Details of this will be identified during stage 2 and as outputs of the relevant work packages described in the GDN's collaborative Annex. However, we expect the following updates will be required:

Scotland Gas Networks Plc's existing Safety Case

Unlike the Neighbourhood, which operates outside of GSMR due to the construction of a new distribution network, the network conversion aspects of the Village requires assets covered by our existing Safety Case to transport a gas that is not covered by the regulations, this will be considered in the development of our SMF. We will make any required amendments to our existing Cases for Safety, our Safety Case, our operating procedures, and our training and competency requirements.

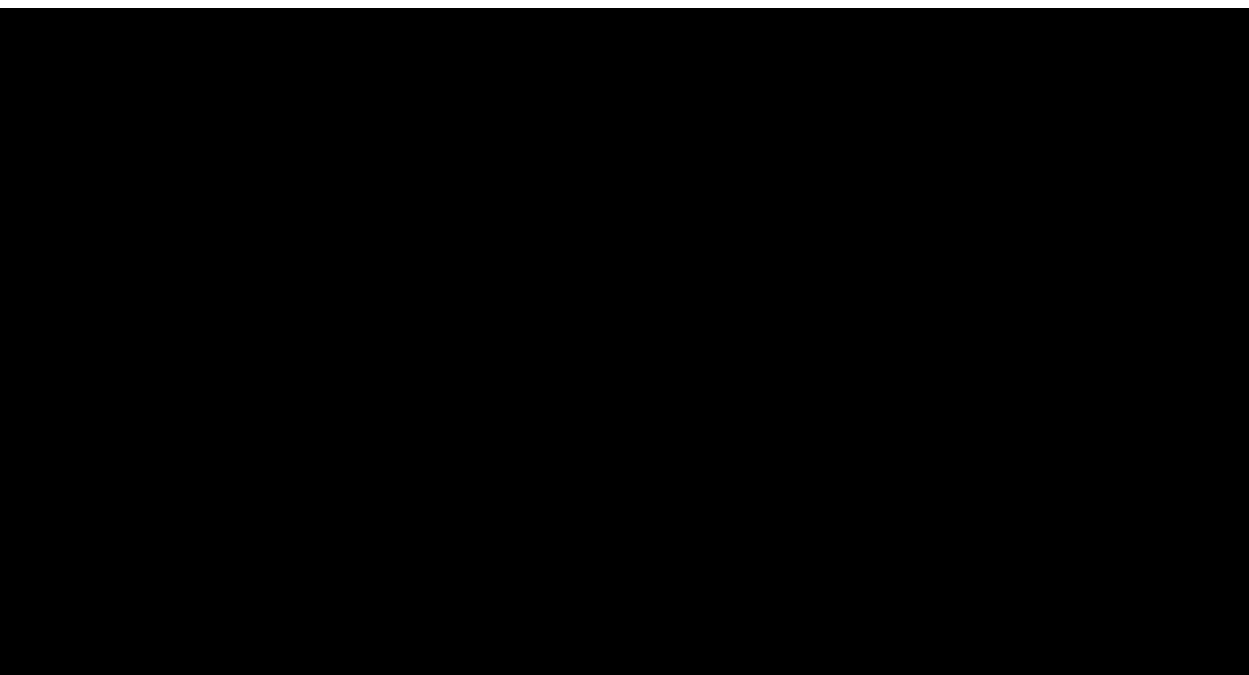
COMAH

The required storage volumes will move the production and storage site into the lower tier threshold of >5 tonnes as defined in COMAH. The necessary safety documentation will be produced and/or updated to meet this including Hazardous Substances Consent submission in line with planning requirements. The benefit of our agreed approach with the HSE for the Neighbourhood means that much of this information will have been produced.

Quantitative Risk Assessment Updates

Our Neighbourhood QRA, which directly feeds into the SMF will be reviewed following the completion of Village designs to assess and quantify risks and identify mitigations. We plan to revisit some principles and mitigations embedded in the Neighbourhood to identify efficiencies in relation to larger trials and mitigate against potential social or cost impact of some requirements, examples of this may include the ventilation recommendations of the BEIS Hy4Heat safety evaluation work or other mitigative measures identified by the Neighbourhood QRA, e.g. EFVs in the service pipe. Any deviation will be accompanied by a full risk assessment.





Collaborative GDN Annex

The collaborative annex submitted will explore workstreams identified in relation to the common aspects of any trial, including required network intervention activities. Any relevant outputs will feed into our overall SMF development activities and inform our QRA, Cases for Safety, Safety Case, and LOP updates as required.

Wherever possible we will retain the expertise and knowledge base of previous H100 phases, many of these organisations are also engaged on other hydrogen programmes which synergises efficiencies in the development of SMF. Project participants previously utilised and provisionally involved in our SMF development include:

Name	Project role
DNV	SMF Authorship
Arup	Detailed Designs, Safety documentation, Project Management
HSE SD	Third party review of SMF
ERM	QRA
Kiwa	Technical assurance
Steer Energy	Procedural development (e.g. purging)

We anticipate that by the end of Stage 2 we will be in a position to meet the requirements outlined by the HSE to SGN in relation to the village as summarised below:

- Collaborative development of the Safety Considerations for Trial (Annex C of BEIS/Ofgem letter) with industry during hydrogen trials and consideration of this document when producing our 'Case for Safety' for the Village
- Consideration of Sections 5-10 of the 'Safety Case Assessment Manual' (Guidance on the assessment and inspection of GSMR Safety Cases) when producing the 'Case for Safety' to assist HSE in its assessment.



- *Reference to the recommendations from the BEIS Hy4heat safety evaluation work (Annex to the Site Specific Safety Case for Hydrogen Community Demonstration – downstream of the ECV in Annex E)*

We will be cognisant of this guidance at all times when developing our SMF and we are actively working with the other GDNs on work packages outlined in the collaborative annex to support this aim. As detailed in this section, our existing Neighbourhood SMF is already being built on this basis and references both the SCAM and the 'Safety considerations for Trials' and we will expand on this for the Village.

As described above we plan to take account of the Hy4Heat annex whilst explore the potential to deviate where we can comfortably demonstrate using ALARP principles that safe alternatives can be achieved to mitigate potential cost/social impacts.

We understand that following submission of the required case for Safety documentation to the HSE and its assessment we will be provided with a 'letter of assistance' should the HSE be satisfied with our arrangements. And that if significant shortcomings are identified following the review that are not remedied the HSE may issue a notice under s22 of the HSWA to prohibit us bringing the system into use.

As requested in the Hy4Heat annex, downstream safety performance will be monitored to inform and improve the recommendations:

- Meter locations and building ventilation
- Ease of repair
- Leak occurrence and reporting
- Incidents and near misses.



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.

Stage 2 Plan

See Appendices 8 and 9 for the programmes for Stage 2 of the H100 Fife Village Trial options. Two separate programmes have been initially identified for 900 and 200 property options and subject to the concept selection output it is considered likely that either one (ie 900 or 200) or a phased 900 to 2000 scheme could be taken forward (Appendices 5 & 6).

A programme will be developed in Stage 2 that optimises the development and construction phasing of the project once the project concept has been selected. At this stage, the Stage 2 programme is broken down into 6 key work packages as shown in Figure 8 and Figure 9 and identified in level 3 of the Work Breakdown Structure (WBS) in Appendix 7.

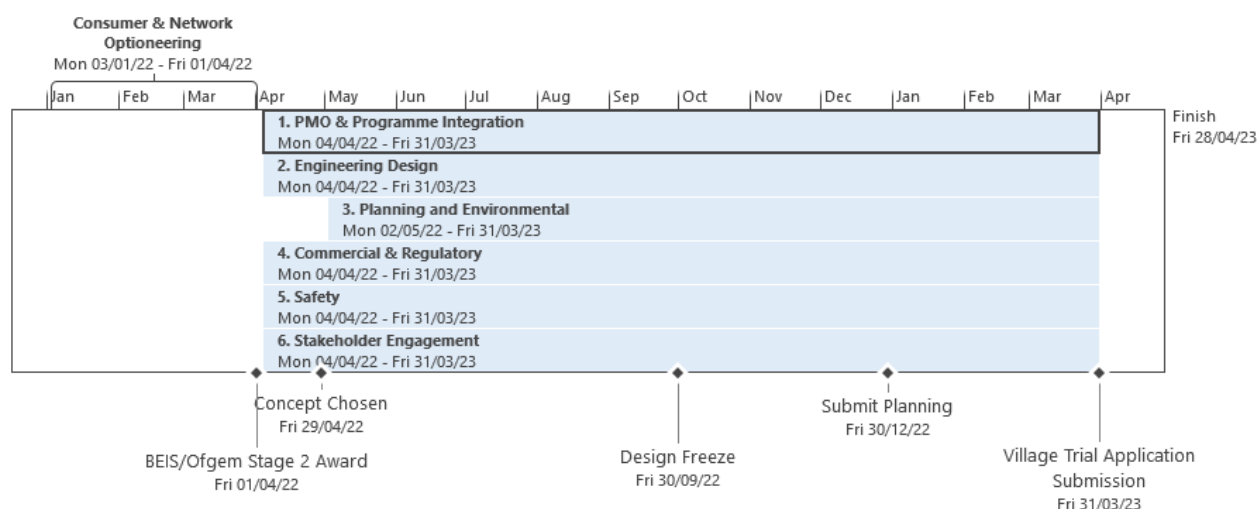


Figure 15 Key work package durations for 900-property concept.

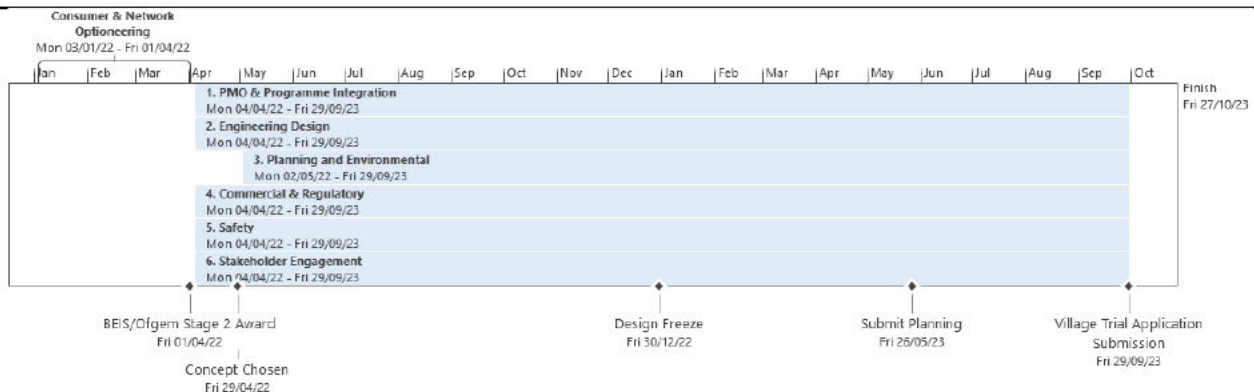


Figure 16 Key work package durations for 2000-property concept

Consumer and Network Options Identification	<ul style="list-style-type: none"> Assess network and consumer conversion options and viability
1. PMO & Programme Integration	<ul style="list-style-type: none"> Provide project-wide support in areas of Risk & Change, Cost Control, Programme and Information Management. Also houses Procurement and Evidence & Data functions. Develop procurement and contracting strategy to deliver procurement process for key contracts including electrolyser and main works contracts
2. Engineering Design	<ul style="list-style-type: none"> Concept Selection Development of reference outline design to support the planning approvals and procurement of the production site Design of network and consumer conversion
3. Planning and Environmental	<ul style="list-style-type: none"> Screening, Scoping and undertake environmental assessments as agreed with the planning authorities Consultation with key stakeholders Submit key consent applications
4. Commercial and Regulatory	<ul style="list-style-type: none"> Develop a business plan including delivery structure and funding Identification of delivery partners Negotiation of key third party agreements
5. Safety	<ul style="list-style-type: none"> Develop safety case Discharge responsibilities under CDM
6. Stakeholder Engagement	<ul style="list-style-type: none"> Develop Stakeholder Strategy and Plans and commence engagement with stakeholders including potential trial participants

Figure 17 High Level WBS Activities

Consumer and Network Options Identification

The initial phase of Stage 2 is centred around assessment of network and consumer conversion options and viability to inform a consumer conversion strategy, enabling the wider project programme. The end of this phase will be the first go/no-go stage gate, Stage Gate 1.

Engineering Design

The engineering design phase will commence with selection of a preferred project concept, building on information from Stage 1 and the consumer and network options identification work. This entails choosing preferred production and storage options and corresponding location for the 2000 homes option, plans for conversion of existing network and necessary tie-ins, and end-user plans to include a diverse range of both domestic and commercial properties.



Following this creating an outline design for the hydrogen production and storage system enables a number of follow-on activities including planning and procurement. Design freeze is go/no-go Stage Gate 2.

Another key design activity is progression of outline network design, to enable supply of hydrogen to identified areas and corresponding properties, likely to take 12 months. This will be started following concept selection and will run in parallel to production system outline design.

The area will likely need grid reinforcement to power additional electrolysis. [REDACTED]

Procurement and Supply Chain

The completion of concept design also signals the start of the main procurement development activities. The two main procurement packages are likely to be Electrolyser and Main Works Contractor. Functional specification and tender packages will be prepared for both, in line with procurement and contracting strategies developed during Stage 2. Completion of procurement packages is go/no-go Stage Gate 3. Contracts will be developed to a point where they are ready for signature in Stage 3, but will not be executed.

The current base case programme assumes a lead time consistent with experience through the H100 Fife Neighbourhood Trial.

Planning and Environmental

Planning and environmental team will progress their work packages once a preferred concept has been identified and a site selected. However, in order to complete assessments and submit an application, design freeze of the production system concept must be achieved. Planning and environmental work drives the critical path.

Two planning permissions will potentially be required if the existing site cannot be expanded to accommodate sufficient additional production and storage and an additional site is required. Potential requirements for seasonal surveys for any new sites driving the critical path. Seasonal surveys would likely need to be concluded in early 2023, for finalisation of planning and submission for approval in Q2 2023.

This will be the final no/no-go stage, Stage Gate 4. A 4-month determination period is assumed to follow, ending in Sep-2023, although that is subject to the planning authority processes.

Safety, Regulatory, Commercial and Consumer Engagement

In parallel key workstreams including safety case development, regulatory design, customer and stakeholder engagement, negotiation of key commercial agreements (landowner, power purchase agreement, utilities etc.), identifying project delivery partners, funding and business plan, and safety case development will all be sufficiently developed to de-risk the project construction.

At this point and in parallel with a Stage 3 submission the project will be sufficiently de-risked to enable a financial investment decision to be made.

Whole Project Lifecycle Plan



See Appendix 8 and Appendix 9 for programme of the whole project lifecycle, incorporating Stages 2 to 5. An optimised programme will be developed during Stage 2 including identification of key programme risk and mitigation.

It is anticipated that the project could conclude Stage 2 for the 900-property scheme by Q2 2023. Given the relatively modest nature of the construction works, a 12-month duration is assumed sufficient to extend the storage capacity. Dependent upon delivery timing of all other necessary evidence, and any necessary network interventions, consumer conversions could commence as early as mid-2024. It is assuming a scale up to 900 consumers is delivered over a 12-month period with an assumption that consumer connections are focused during the summer periods.

Availability of additional grid capacity is likely to be on the critical path and priority will be given to early engagement and commitment to grid connection capacity during Stage 2 to reduce any potential programme impacts.

The 2000-property scheme is anticipated to conclude Stage 2 by the end of Q3 2023 driven by extended design and planning durations. Driven by the electrolyser lead times construction works for the production site are anticipated to conclude in Q2 2025. Again, assuming scale up to 2000 consumers is delivered over a 12-month, with some properties having hydrogen-ready appliances installed in the previous summer for conversion the next.

Delivery to UK Government's Heat Policy Programme

Scottish Government's target is 50% of domestic properties supplied by decarbonised heat solutions by 2030, a significantly higher level of ambition than is reflected in the ambition of a hydrogen town by 2030. Delivery of the H100 Neighbourhood in phases from 2024 to 2025 provides the critical evidence base required to progress to the Hydrogen Town significantly earlier than 2030, enabling hydrogen to play a much more significant role in delivering against 2030 targets.



3.2 Organisation of responsibilities and liabilities (1000 words)

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

Our H100 Fife Village proposal benefits from the existing governance and project participant base already established for the Neighbourhood and wherever possible we will continue to utilise this whilst ensuring value for money and robust cost and risk controls via competitive activities and relevant contractual terms.

Following the detailed regulatory analysis undertaken for the Neighbourhood we identified that Scotland Gas Networks Plc (ScGN) as the network Licensee is unable to operate as a gas producer without deviating from its existing license conditions. We therefore established a new delivery entity, SGN Futures (H100) Ltd (SGNF), to whom the majority of the works under H100 Fife Neighbourhood are subcontracted to via a Project Agreement between ScGN and SGNF. We expect to continue with this delivery model for future phases and will undertake an assessment during Stage 2 to ensure that no barriers to this approach exist.

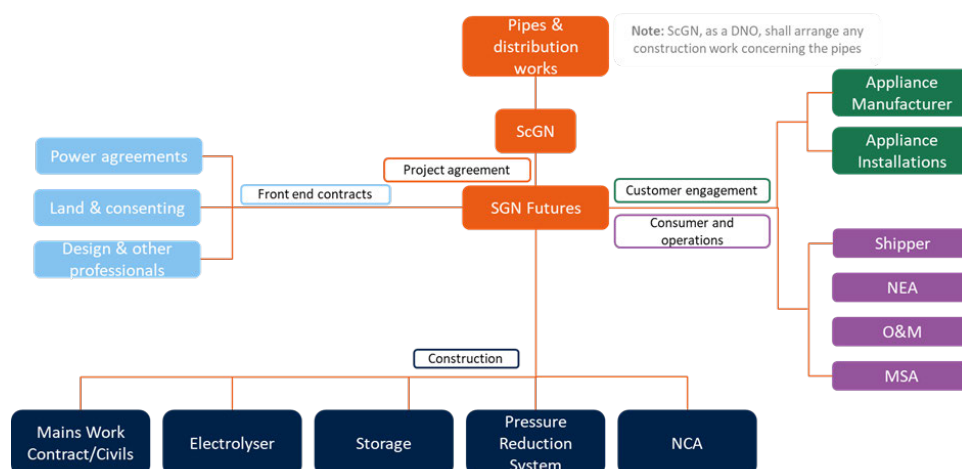


Figure 18 H100 Fife Village Organisational Delivery Model

Project funding structure will be as shown in Figure 16. We will ensure that all funding obligations flow down into project contract T&Cs to ensure funding compliance is de-risked.

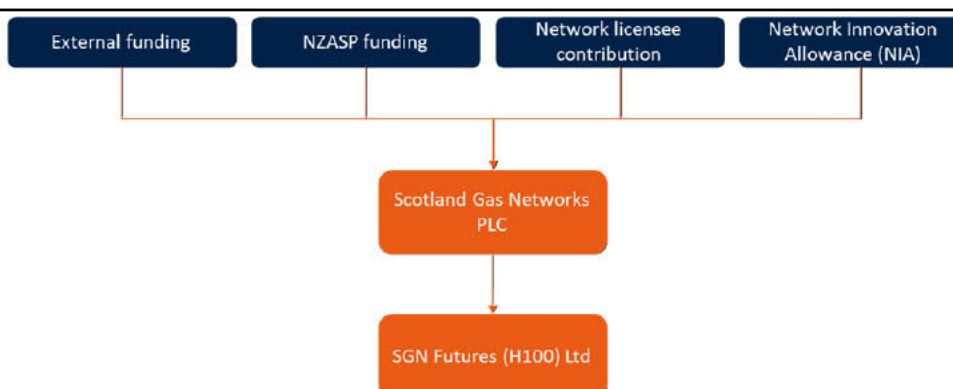


Figure 19 H100 Fife Village Funding Overview (Provisional; Stage 2 onwards)

[REDACTED] The details of all potential funding opportunities will be explored and progressed during Stage 2 with the aim of having agreements in principle in place in advance of the trial application for stage 3.

Ahead of Stage 2, we will continue work to explore and expand downstream design solutions and plan to fund this interim period between December 17 and the BEIS/Ofgem determination in spring 2022 with NIA (consistent with governance) before moving into NSASP funding [REDACTED]

Responsibility for assets and associated liabilities as part of the Village trial will be as per Figure 16 below. Consistent with the planned approach for the Neighbourhood, we expect to provide hydrogen-ready appliances to consumers in the trial, installed, maintained and serviced by Gas Safe registered engineers, at our cost. We will provide customers with a detailed brief and manufacturer's instructions such that upon installation responsibility for the safe operation, i.e. duty holder, will fall to the owner, as would be the case for natural gas.



Figure 20 Asset Responsibilities

During Stage 2, we will expand our portfolio of **Project Participants**, and where appropriate will leverage those that have gained knowledge and experience during the Neighbourhood trial.

Project Partners could include both Network Licensees and the Non-Network Licensees. We recognise and support opportunities for collaboration between the UK Network Licensees and as such embrace the opportunity to share knowledge and outcomes of H100 Fife with the other networks as Project Partners and Supporters, as we have done in previous projects.



Non-Network Licensee potential Partners could also include appliance manufacturers (as per Neighbourhood trial). We will continue to encourage their active engagement in the project, leveraging the opportunity for utilisation of the Hydrogen Demonstration Facility as marketing and customer engagement tool.

The majority of **Project Suppliers** will be defined in Stages 3. However, there are some key suppliers that we anticipate will be engaged during Stage 2, including:

[REDACTED]

We anticipate replicating our Neighbourhood trial end-user install strategy for work scopes including the property surveys, remediation and installation works. Benefits of maintaining supplier consistency across both projects will be weighed against value for money during the procurement process.

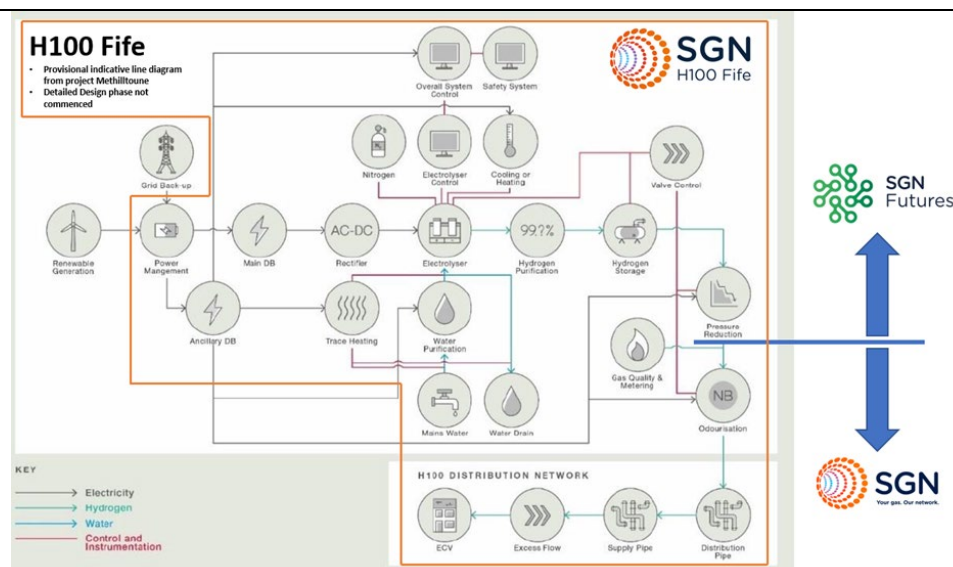


Figure 21 H100 Fife Village End to End Contracting Structure

Procurement strategies, and subsequent contractual terms will support risk management objectives, ensuring commercial protection and maximising cost certainty. Liability levels, insurances and key risk items will be drafted to ensure that not only are vendors appointed at the best price, but the outturn price of the deliverable is value for money to the end consumer.

We plan to engage [REDACTED] as our primary project supplier to deliver the stage 2 activities. This brings with it the benefit of a contractor that has been embedded in H100 programme from inception. The provisional organogram for the stage 2 delivery is provided in Appendix 10.



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.

Approach to Licence Conditions

The 'Annex on Collaborative Supporting Evidence' provided by the ENA and populated by the GDNs, sets out the joint approach to developing the regulatory plan for the hydrogen village trial(s), among other collaborative workstreams. Section 3: Planning & Risk Mitigation, Table 2 of the Annex identifies the number of regulatory challenges common to all GDNs including billing options, balancing regime, security of supply, metering and industry engagement. Table 3 then offers a provisional high-level timeline for developing the regulatory plan components. In Stage 2, the networks will work together to further define this timeline of regulatory compliance activities and associated milestones, with required regulatory and authority body activity and dependencies identified. We will continue to test assumptions associated with the regulatory plan and communicate programme progress.

We will ensure that the H100 Fife Village Trial is compliant with any bespoke hydrogen regulatory framework guidance where achievable. By combining the work done to date, what we plan to deliver under the Village Trial and the site-specific evidence, we will have a comprehensive regulatory understanding to support a transition to hydrogen networks. It is vital that there is a clear route for industry while ensuring consumers are protected in the energy transition; we believe that the learning from H100 Fife can go a long way to informing this hydrogen regulatory landscape.

We will leverage the work done to date under the H100 Fife Neighbourhood Trial to define the Village Trial regulatory model. The Neighbourhood model (the working of which has been shared with the other GDNs) presents an unregulated entity operating within a broader corporate group can take responsibility for the production of hydrogen which it sells to a third-party shipper who takes ownership of the hydrogen after production at the electrolyser. The shipper then transacts the energy input into the total system, in the same way as though it were natural gas and may sell the energy to the domestic supply market. Meanwhile the gas is transported by Scotland Gas Networks plc (ScGN) over the regulated network to domestic consumers' properties. These relationships are set out in the diagram below. The same principles will be considered for the H100 Fife Village Trial, which avoids the need for licence derogation, and avoids dependency on 3rd parties for production at this early stage of a hydrogen trial. SGN Futures (H100) Ltd is mobilised as a legal entity and could be further utilised to deliver hydrogen production activities under the Village Trial to maintain business separation from the regulated Gas Transporter licenced activities.



Figure 22 The H100 Fife neighbourhood Trial Structure

The regulatory solution for the H100 Fife Neighbourhood Trial is designed to be customer centric, ensuring it is simple and attractive for participation in the project by the end user and the appropriate consumer protection measures are upheld with consideration given to vulnerable customers. Similarly, the solution for customer metering and billing that we are developing with Xoserve is being designed to maintain customer participation and the supply switching process, allowing customers to retain the flexibility to stay with their existing supplier or switch. The proposal aims to reduce disproportional impact on industry and have cost protection mechanisms in place so that the retail supply chain and ultimately the end user is protected from the increased cost of hydrogen production compared to natural gas.

We have engaged extensively across industry forums and groups and carried out licence and code analysis to validate our regulatory proposal for the H100 Fife Neighbourhood Trial and we will submit our regulatory model in April 2022 with Ofgem.

Our plans for the Neighbourhood Trial have been peer-reviewed by [REDACTED] to understand the applicability for the hydrogen Village Trials. Their report *HyNet Homes WP4: Commercial & regulatory Final report* concludes that they are satisfied that the commercial and regulatory approach proposed for H100 Fife can be applied to the Village Trial.

Our approach to the Village Trial is to use this regulatory model as the baseline for the development of a village trial regulatory model in Stage 2. There are several documents and other sections of this proforma that underpin and document the significant work undertaken to develop the regulatory model for the Neighbourhood Trial, including:

- H100 Fife Condition 3 Report – evidence of a satisfactory regulatory model
- H100 Fife - Regulatory Analysis - 19 October 2020
- H100 Fife Condition 4 Report – presents our approach and philosophy for Security of Hydrogen Supply, which we will assess the suitability of for the Village Trial
- Section 5.3 of this proforma provides the detail of the work undertaken for the Neighbourhood to develop a billing solution Xoserve and our approach to this under the Village Trial, as well as information on our consumer offer



- Section 2.2 of this proforma elaborates on our Safety Case plans, aligning with the relevant regulations and our engagement with the HSE

Approach to environment and planning

In Stage 2, we will evaluate the site requirements under the planning and environmental workstream. Once the preferred site is established, we will benefit from the extensive engagement work completed with Fife Council, statutory consultees and the public to receive planning permission for the H100 Fife Neighbourhood Trial.

For the Village Trial we will benefit from our earlier engagement with planning departments, consultees and the community, having already developed their awareness and understanding of a green hydrogen production and storage system. We have already engaged and notified the necessary regulatory bodies regarding our hydrogen storage on site which falls just below the lower tier threshold and are confident we can secure our COMAH lower tier licence for the expanded site, along with other consents required.

If successful in progressing to FEED, we will endeavour to deliver the following in line with regulatory related activities associated with a hydrogen village trial:

- Assess applicability of previous work for Village Trial regulatory model
- Monitor development of H100 Fife Neighbourhood Trial regulatory and leverage applicable learning
- Deliver collaborative regulatory plan work as detailed in the 'Annex on Collaborative Supporting Evidence' supported by site specific regulatory activities
- Mobilise relevant regulatory workstreams to fill any evidence or knowledge gaps
- Develop case for safety using the GSMR Safety Case as a template
- Ensure licence compliance of security of supply arrangements
- Commence planning and environmental workstream (completion and determination under Stage 2 dependent on level of design required for the village scale, programme will be refined once optioneering exercise concluded)
- Commence consenting workstream e.g. COMAH
- Assess suitability of H100 Fife Neighbourhood Trial billing solution during Xoserve detailed design
- Identify risks and manage uncertainty associated with the regulatory plan using appropriate mitigations through a staged review and monitoring process
- Align with regulatory body and authority dependencies and input e.g. hydrogen trials framework
- Agree a regulatory model ready for implementation prior to go live

Approach to regulatory funding

The hydrogen village will be significant financial investment that will be of benefit to future consumers as well as those today. In Stage 2, we will undertake an assessment of the customer impacts of different funding options – [REDACTED]

[REDACTED] We will also assess the risk and how the balance of risk should be shared between different parties.



3.4 Exit plan (1000 words)

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

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

During Stage 2, we will work to further define our project exit plan. The strategy will consider both:

- continuation of the project where the Village becomes an integral part of the wider transitioned network, or
- ending the project within 1-3 years.

The ultimate goal is for continuation of the project by implementing an enduring solution to cover more homes, commercial buildings and include industrial assets from within the Levenmouth area and ultimately to form part of the wider North-East Network and Industrial Cluster project to deliver an East Coast Hydrogen Vision for Scotland.

However, we are cognizant of the varying factors that may result in ending the project therefore, an exit plan for either eventuality will be prepared.

Estimated costs for both scenarios have been referenced and explained in further detail in Appendix 14.

- Exit cost basis - A per-property cost has been calculated to revert to natural gas, covering back-conversion/replacement of appliances and components and corresponding network conversion.
- Continuation cost basis - is to conduct a study during Stages 3 and 4 to ensure security of supply, funding and ongoing arrangements for trial participants that continue to use hydrogen.

Production & Storage

Continuation of the Project

The power arrangements for the production of hydrogen will need to be extended or alternatives sought should the project continue. The design life of the production and storage components extends past the conclusion of the trial, and we would want to ensure that this asset is further utilised as a supply and storage solution for the trial participants. In the medium to longer term (2030-2045 onwards) it can be assumed that Levenmouth would be part of a wider hydrogen distribution network with supply from blue and green hydrogen injected at bulk supply points around Scotland. We will be repurposing the existing distribution network during the Village construction phase. Consequently, a continuation of the project would mean the existing network infrastructure would remain operational and in situ.

Ending the Project within 1-3 years

Even if the customer base of the Village Trial ends the hydrogen production and storage facility is likely to remain valuable as a green hydrogen supply solution. As we progress



through the latter stages of the project, alternative use cases for hydrogen will become clearer, with local industrial and transport assets providing viable options and will be built into our exit plan. This will give clarity to how the existing green hydrogen facility can be exploited in future, with consideration given to the corresponding ownership and operation structure. It should be noted that in both scenarios the production facility will be decommissioned at the end of its economically useful and design life.

Distribution

Continuation of the Project

To ensure that we maximise outcomes that differ from the parallel network in the H100 Fife Neighbourhood trial, the intention is for the Village Trial to utilise the existing distribution network. Consequently, a continuation of the project would mean the existing network infrastructure would remain operational and in situ.

Ending the Project within 1-3 years

Discontinuing the trial would involve switching the gas in the existing network infrastructure back from hydrogen to natural gas. Any new assets are likely to be left in situ, or repurposed. Since the PE pipe that makes up approximately 85% of the network and services are equally suitable for hydrogen and natural gas, the network asset intervention for reverting back to natural gas is minimal. An informed view will be taken on the viability of repurposing hydrogen services for natural gas once the evidence base has concluded this position. Work is to be done from a legislative and customer perspective to determine whether consumers that opt-out of a hydrogen supply and switch to an electric or other alternative, can then be reverted back to natural gas at the end of the project.

Downstream

Continuation of the Project

The trial scope stipulates that hydrogen prices will be kept in line with the cost of natural gas energy unit price for the consumer. If the project were to be continued, there is still an unknown as to what government policy and subsidies would be available for those early-adopters if hydrogen was to be mandated for heating on a wider scale. Consideration will be given on the impact of transition of supply agreements for consumers as well as an enduring regulatory model beyond the Village Trial scale.

Utilising experience from previous hydrogen projects, we understand appliance manufacturers would have progressed development from prototype models to full release models by the time of conversion for the Village Trial. This means that the appliances will have the industry standard installed life of ~15 years and could remain installed long-term if the trial were to be continued or transitioned into the wider network.

Ending the Project within 1-3 years

If the trial was to end, this would require the disconnection of customers from hydrogen and providing an alternative heating solution. For the purposes of this proposal, we have assumed customers are to be reverted to natural gas, but we will further assess our strategy for this when we develop our detailed exit plans based on the guidance and information available.



Appliance manufacturers have indicated their boilers may be back-convertible to natural gas, and there is potential for some dual gas appliances. This would mean that we would not be required to provide new appliances. As we progress through the latter stages of the project, the Government will take a decision on the preferred direction for heating homes, and an alternative heating option could be installed to reflect this policy decision. Additional detail is referenced in Section 4.3 - 'Supply Chain Strategy'.

There will be consumers who have appreciated the benefits that hydrogen has brought and will not want to switch away from hydrogen if the project were to end. These are some of the many factors for consideration in management and engagement with consumers. Consumer protections will be at the centre of our exit/continuation plans.



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.

The H100 Fife Neighbourhood Trial provides an excellent starting point for the creation of a Village trial risk register as there are numerous commonalities between the projects. Credit can be taken for improved understanding of the risks which were present during the early stages of the Neighbourhood trial and our subsequent observations of the effectiveness of the numerous mitigating actions that have been implemented. Clearly, key differences between the trials such as conversion of the distribution network (versus new parallel), customer impact (opt-in versus opt-out), and greater variety of end-user properties and appliances will introduce new risks that will need to be properly assessed.

Risk workshops involving the integrated project team and specialist advisors will identify and assess these risks and also differentiate between risks for the 900 homes and the 2000 homes solutions. Ongoing risk management processes will ensure emerging risks are identified as we progress through stage 2 and onwards, and appropriate mitigation measures will be implemented. Stage gates will be used throughout the project, including within stage 2, to ensure risks are being appropriately managed and mitigated ahead of any significant investment points.



Figure 23 Risk Management Process



An initial qualitative risk register has been completed during Stage 1 (see Appendix 12), and the primary inherent risks are explored below. This will be expanded during Stage 2 to become a fully quantitative register.

To support Risk Management, we will also operate the following tools and processes with our key contract partners:

- **Issue Management** to ensure a collective focus on resolving materialised risk.
- **Early Warning Process** to highlight emerging potentials for change.
- **Change Control Process** to measure impacts of issues and inform lessons.

Inherent Risks

At this early development stage of such a boundary-pushing project, unsurprisingly, cost and schedule predictability are key challenges and risks. With strong project management controls and an experienced project team, cost and schedule confidence will improve through the project stages. Additional project risks:

Hydrogen Supply Resilience

We need to demonstrate robust security of hydrogen supply. As owners and operators of our own hydrogen production facilities we are able to ensure hydrogen production and hence security of supply risks are exceptionally well managed.

The 900-property proposal will utilise the same wind turbine power supply (with grid back-up) and electrolyser infrastructure as the Neighbourhood trial (but with additional storage capacity). This will demand a higher utilisation of the twin-train electrolyser system, therefore necessitating expedient response to a reliability failure of one of the electrolyzers, and likely draw-down of hydrogen storage from inventory. Maintenance response agreements are in place as part of the Neighbourhood trials, along with equipment spares strategies and preventative maintenance strategies. However, the key mitigation development during stage 2 will be the rigorous assessment of appropriate, incremental storage capacity needs.

The 2000 property proposal will add additional electrolyser trains and additional hydrogen storage infrastructure, either as an extension of the existing site, or on a new site. As the electrolyzers are independent (no common, single point of failure) the overall network resilience to reliability failure of hydrogen production units will improve.

Safety Event

A safe trial is essential in demonstrating hydrogen's role as a safe alternative for natural gas.

The 900 home solution will leverage the production and storage facilities of the Neighbourhood trial (expanded by additional storage tanks), therefore limited change to safety risk is envisioned beyond that of higher on-site hydrogen inventories. The 2000 home solution is expected to utilise similar production and storage technology solutions, either on a new site, or via expansion of the Fife Energy Park site, and therefore the nature of safety risk elements (and mitigations) are likely to be similar, albeit on more assets.

Gas distribution in the Village trial presents new risks by repurposing the existing network. All risks associated with the conversion process will be assessed and mitigated in the form of a Quantified Risk Assessment (see Section 2.2), along with a new set of operating and maintenance procedures and following guidance provided by H21 findings.



In terms of downstream, end-user risks, we will leverage assessments from the Neighbourhood trial, expanded to incorporate the additional property types and appliances in the Village trial. In-property surveys will be performed and may trigger bespoke risk assessments for individual properties in line with the Hy4Heat Annex guidance and SGN's SMF⁵. We will leverage the GDN's collaborative annex work on end-user safety evidence (once complete) to update the risk register and mitigations where necessary.

Consumer Attitudes

Participation from a diverse set of consumers is critical to the success of the village trial. Insufficient participation in the hydrogen trial could compromise the quantity, diversity and potentially the statistical validity of trial evidence. Low participation would also increase project costs for electrification solutions and impose increased strain on the local power grid. The network conversion aspect of the trial will enforce change on consumers in the trial area, either to adopt a hydrogen supply, or change to an electrification solution. Unaddressed, the trial has the potential to generate consumer frustration, community discontent, and reputational issues.

As mitigation, during stage 2 we will develop a clear strategy for extensive investment into early and proactive engagement with the affected community. This should build on the engagement work that has been implemented in the Neighbourhood trial with the objective of demonstrating the benefits of hydrogen as a low disruption switch to a safe, carbon-free alternative fuel supply.

⁵ To Site Specific Safety Case for Hydrogen Community Demonstration (Arup, Kiwa) 2021
<https://static1.squarespace.com/static/5b8eae345cfd799896a803f4/t/60e48a3417ea3f41bc5d8153/1625590325963/ANNEX+Final.pdf>



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.

Infrastructure Hydrogen Supply Options

Following a high level review, two initial concept options have been identified for the Village Trial, which will be further refined and validated during Stage 2. The options are based on two different principles for the delivery of the village trial and they are not mutually exclusive:

- Option 1 – up to 900-properties – hydrogen is supplied by the Neighbourhood Trial electrolyser system which was designed for 900 properties. This is a lower risk, higher value for money option that can be delivered in 2024.
- Option 2 – up to 2000-properties – hydrogen supply from the Neighbourhood Trial electrolyser system is reinforced by a new supply produced from a second electrolyser, which will either be co-located with the existing infrastructure, or located on a new site. This has the potential to supply more evidence than the smaller scale option.

Further information on the designs can be found in Appendix 13 – H100 Village Location Concepts, and Appendix 21 – Production and Storage Basis of Design. Potential production sites, network conversion areas and key industrial sites are shown in Figure 24 below.



Figure 24 The potential 2000-property option area including large scale users (yellow), housing and commercial areas that could be converted (red) and the potential new production sites (green).

Resilience Philosophy

As with the Neighbourhood trial, the concept design will put resilience central to the philosophy ensuring that we can maintain our high standards and license requirements in relation to security of supply. A number of key considerations in the Neighbourhood resilience philosophy include:

- Redundancy - An 'N+1' philosophy is integral to the basis of design and this would be carried through to the Village. Redundancy will be supplied by ensuring multiple streams in the hydrogen production system, back up grid connections and a 24/7 onsite engineer presence.
- Reliability - The electrolyser procurement process put system reliability as key, suppliers were selected on the basis of operational histories with high system reliability. This was reinforced through commercial terms. Assessment of tenders applied a higher weighting to system and technology scores.
- Maintenance - The operational strategy ensures that high system availability can be achieved through critical spares strategy, preventative maintenance programmes and competent resources.



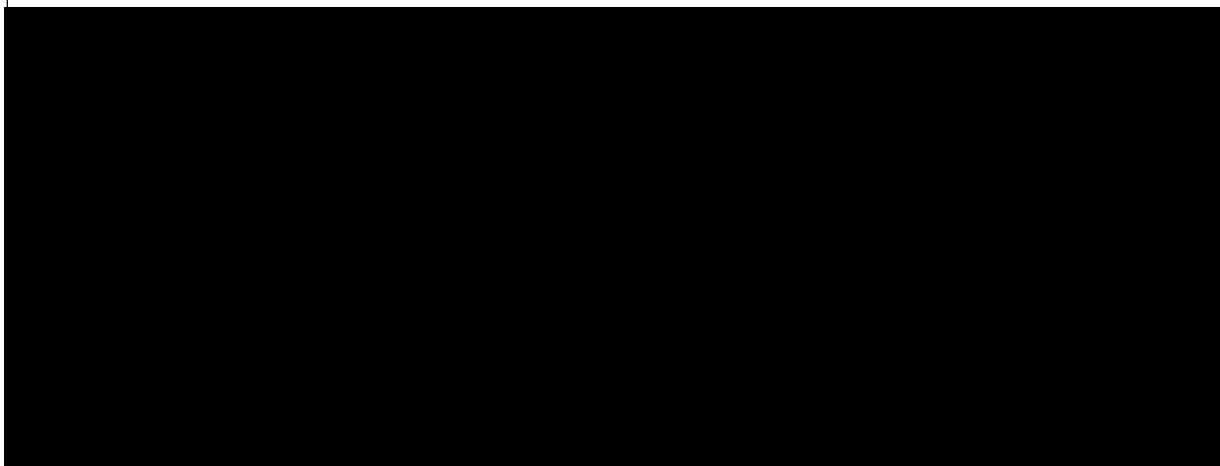
- Production and Storage Capacity – Key to compliance with our security of supply philosophy for H100 Fife is ensuring a sufficient supply of hydrogen is available in the event of production system interruption.

During Stage 2 we will explore cost effective opportunities to improve system resilience. For example, through expanding the electrolyser capacity or providing multiple network injection points, which may have the potential to build a more resilient system.

Hydrogen Sources and Resilience of Supply

A key feature to note is that both options proposed will be supplied by green/electrolytic hydrogen, supplied directly by existing renewable sources and low carbon intensity grid electricity. Scotland's electricity network is over 97% supplied by renewables⁶, and so either option will deliver low carbon hydrogen.

Analysis performed previously as part of the H100 NIA⁷ indicated relative hydrogen production costs as shown in figure below:



The two Village trial options proposed present a deliverability advantage, both because of the positive public perception of green/electrolytic hydrogen and the shorter development duration for green hydrogen projects when compared to grey or blue hydrogen. For this reason, hydrogen from natural gas is not considered within this trial.

The existing Neighbourhood production and storage site can be utilised to supply the 900 homes site and could support the supply for the 2000 home option if it is co-located at the existing site. As in the Neighbourhood, a grid connection from the local high voltage electricity network will also increase the resilience of electricity supply to the system.

6

<https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2018/10/quarterly-energy-statistics-bulletins/documents/energy-statistics-summary---march-2021/energy-statistics-summary---march-2021/govscot%3Adocument/Scotland%2BEnergy%2BStatistics%2BQ4%2B2020.pdf>

⁷ <https://www.sgn.co.uk/about-us/future-of-gas/hydrogen/h100-nia/hydrogen-logistics>



Designing for Resilience

During Stage 2 we will assess both options against a range of success criteria including resilience, cost, deliverability, learning and timeline to determine how the trial can deliver the evidence required in a way that is best value. This assessment will also include a review of the existing site to determine to what extent the Village could be achieved without the requirement for additional land.

System resilience potential and value for money opportunities will be central to the concept selection process to ensure that the selected option includes a production system and storage arrangement that meets the project's requirements. To assess the full lifetime costs of the two concepts for the trial project, a high-level techno-economic modelling exercise will be performed for each concept. This model will be the basis of further analysis in Stage 2 to optimise the system scale. During Stage 2, we will refine the model to reduce the uncertainties on the capex and opex of the system, to perform full discounted cashflow analysis considering fuel sale revenues and subsidies, and allowing economic performance metrics to be calculated such as Levelised Cost of Energy (LCOE) i.e. net present cost of hydrogen generation over its lifetime. This will give full transparency on the end to end system cost of hydrogen production, distribution and utilisation that will support the evidence base development with respect to the economics of hydrogen utilisation.

Consideration will be given to the opportunities for resilience in development of the network, and in particular the opportunities for multiple network injection points and utilising the Neighbourhood Trial parallel network.

Future Levelised Cost of Energy

The Village Trial reflects a system design that puts redundancy and reliability as central to its design. However, by its nature any demonstration at this scale is relatively high cost when compared to a commercial deployment.

Ultimately a cost effective hydrogen gas grid will be supplied by low cost bulk green and blue hydrogen with multiple grid injection points, and strategic geological storage. The Village Trial offers significant value for money by utilising the existing infrastructure from the Neighbourhood Trial. However, longer term value of a decarbonised energy system will be achieved by large scale conversion of the gas grid, which will complement increasing electrification and offer system wide resilience.

We have identified a clear pathway of growth from the Village as laid out in Appendix 11 – Expansion Opportunities, demonstrating how the gas grid can supply an increasingly diverse set of domestic, commercial and industrial users across the east coast of Scotland.



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.

Upstream Infrastructure

Infrastructure from the Neighbourhood trial can support both the Neighbourhood and the Village trials. The hydrogen production site includes an electrolyser system with hydrogen production capacity for up to 900 properties, storage for 300 properties, an injection point to the hydrogen distribution network for 1000 properties. The site contains a dedicated hydrogen demonstration facility, an enduring asset supporting engagement, education, training and upskilling for the trials. Additional onsite infrastructure includes an electrical centre, a management building and associated security, transport and drainage infrastructure.

The design strategy for Stage 2 will further define the infrastructure requirements for existing or repurposing assets. This outline design work will address both system (hydrogen production, storage, electrical, controls, utilities, process, structural, civil, mechanical and lighting) and the spatial (land ownership, geotechnical, environmental) considerations to analyse the existing site and any potential new sites. Further details on the infrastructure design requirements of these options can be found in Appendix 13.

900 Properties

The 900-property option should not require any additional hydrogen production due to the size of the existing electrolyser. A hydrogen security of supply assessment will dictate whether it is sufficient.

An increase in the amount of hydrogen storage on site will be required. The specifics of this storage will be calculated during Stage 2. There would be associated security, transport and drainage infrastructure required on site to accommodate the new tanks. There will be limited further large infrastructure required on the production site for this option.

The local electricity network will need reinforcement (by 10MVA) to ensure system resilience, which has a significant lead time of approximately 30 months.

2000 Properties

The 2000-property option will require significant new infrastructure including a larger electrolyser and increased storage. It will require a new grid connection with associated reinforcement through a new or existing substation. The new production system will require a version of all the balance of plant associated with such a facility including water connections, electrical plant room, electrolyser, hydrogen storage, pressure reduction, odourisation and metering.

In the event of potential issues with a large tank array, the preferred solution may be to install compressors and higher-pressure tanks. Optimal storage solutions will be further investigated in Stage 2.



The potential to fit the infrastructure required for the 2000-property option into the land utilised as part of the Neighbourhood Trial will be investigated further during Stage 2.

Procurement and Construction Strategy

The procurement and construction strategy will be determined in Stage 2. It is assumed that the additional storage, electrolyser and supporting infrastructure will be procured on an EPC basis. The electrolyser and the storage tanks have been identified as long-lead items (around 12 months), potentially driving the project construction critical path. Early engagement with the supply chain will be undertaken to mitigate programme risk. Design specification for these items will be completed during Stage 2 enabling tendering and order placement in early stage 3.

Midstream Infrastructure (Further detail in Appendix 16: Distribution Network Conversion)

The final conversion plan will be based on detailed understanding of the overall network configuration and operational activities with a targeted and phased approach and in line with the H21 safety findings and Asset Intervention Protocols. The speed of conversion and the number of properties that can be converted within a given timeframe will be partially dependent upon the resourcing strategy which will be developed in parallel.

Key changes required, subject to the overarching Quantified Risk Assessment:

- Replacement of any non-PE at risk pipes prior to conversion
- Replacement of steel services in advance of conversion
- A service excess flow valve (SEFV) developed under hydrogen excess flow valve (EFV) NIA project.⁸

⁸ https://smarter.energynetworks.org/projects/nia_sgn0154



Figure 26 Network map showing the composition of the current gas pipe material within the study area. CI = cast iron 2.1%, DI = ductile iron 1.5%, PE = polyethylene 85.1%, SI = spun iron 6.3%, ST = steel 5%

From the existing network material composition shown above, it is assumed at this stage that around 4km and 10km respectively (900/2000) of upgrade works may be required to replace metallic assets with PE. It should be noted that where replacement activity is compliant with the Iron Mains Risk Reduction Programme (IMRRP) [REDACTED]

Overall, the area is well positioned for a conversion trial with around 85% of the network assets upgraded to PE and therefore hydrogen ready from a composition basis.

Regarding network methodologies for conversion, the existing distribution system employs several techniques to enable the safe operation, maintenance, and repair of the network. An example on these is shown below.

- **Isolation:** PE pipework is generally isolated using the squeeze-off technique. For LP mains greater than 180mm a double squeeze-off is required to enable the pipe to be isolated. The squeeze-offs are applied in sequence as shown below and the gas flow is maintained by the installed bypass. This enables the section between the pair of squeeze-offs to be vented, cut and sectorised by the installation of a valve.

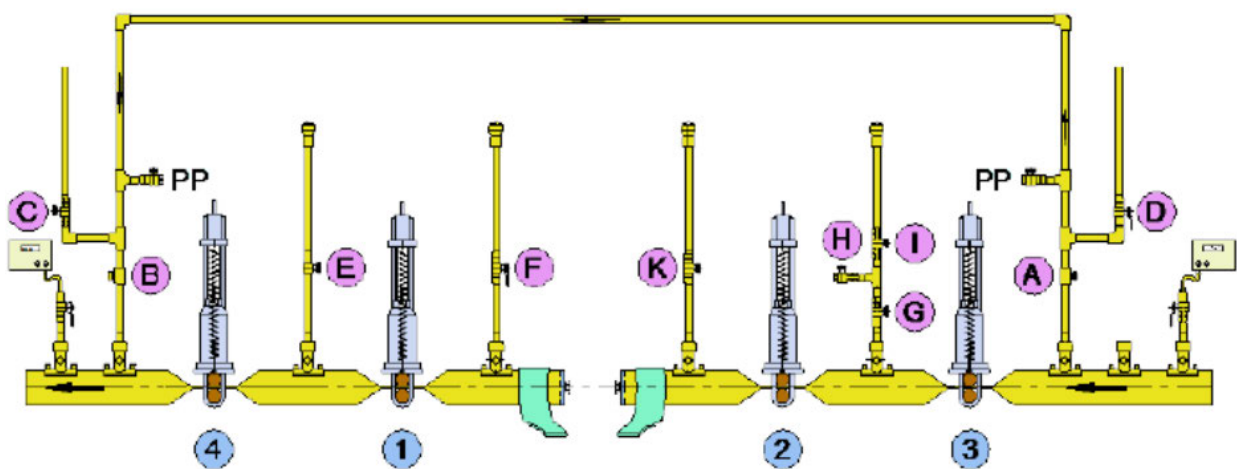


Figure 27 PE double squeeze-off

- **Sectorisation:** In areas where there is access to the parallel network from the Neighbourhood trial, the network may be converted in a phased manner. Customers can have their gas supply switched to hydrogen in less than 24 hours.

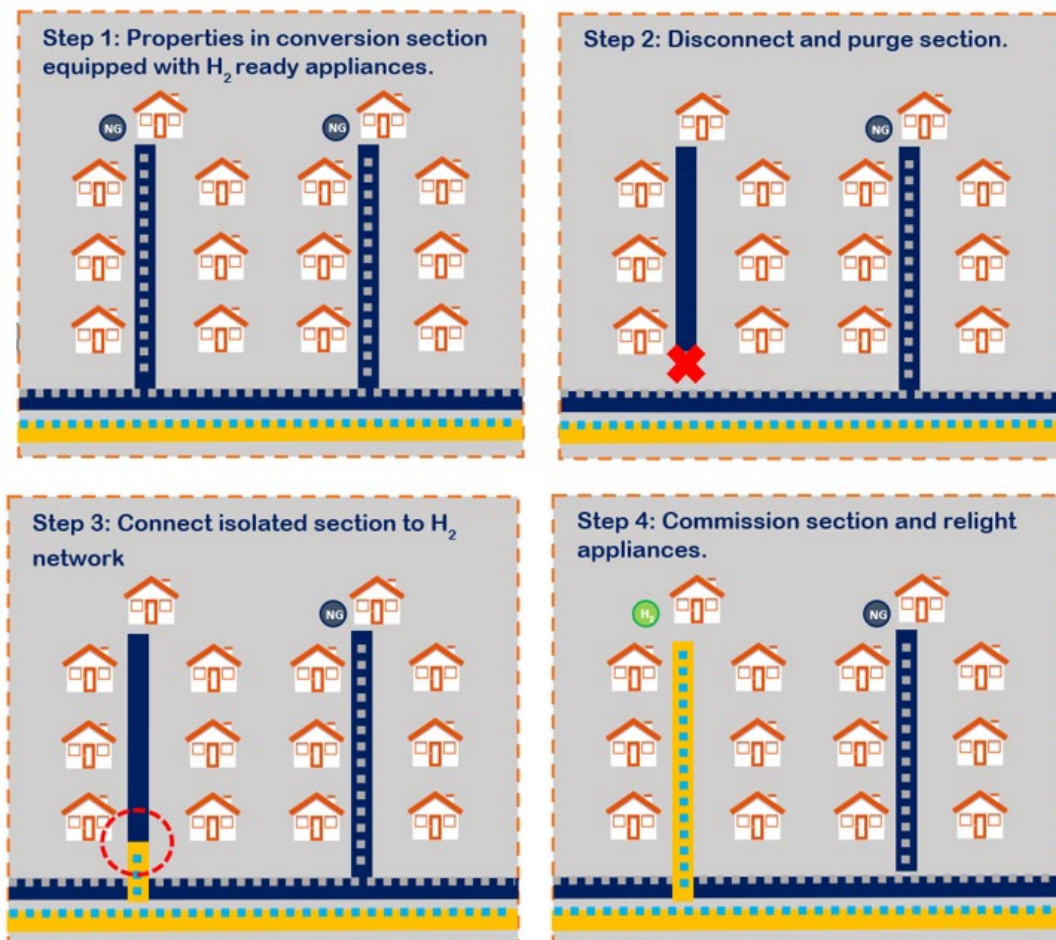


Figure 28 Step by step approach to phased conversion



- **Purging & commissioning:** In Stage 2, the risks associated with purging/commissioning will be reviewed and whether it can be completed by direct purging or indirectly. H21 Phase 2 established safe purging methodologies for commissioning and decommissioning distribution network assets by indirect methods, however SGN's NIA HyPurge project will look to expand on this to significantly reduce cost, vented gas and complexity by conducting research to deliver a safe means of direct purging natural gas to hydrogen, hydrogen to air and vice versa.

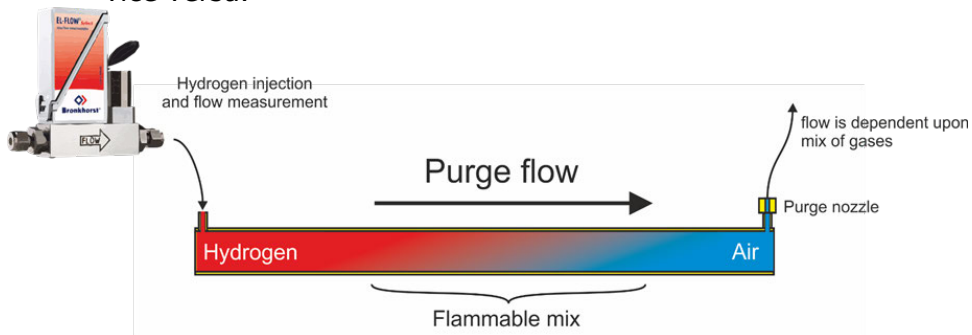


Figure 29 HyPurge project diagram

The in-property infrastructure requirements are described in Section 4.3.



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.

Asset Range and Volume

We have conducted an assessment of the range and number of domestic and commercial appliances required for the H100 Fife Village trial. In accordance with the relevant safety guidance and subject to individual risk assessment on asset condition, we will aim to repurpose existing components where possible and provide hydrogen replacements as required (Figure 26).

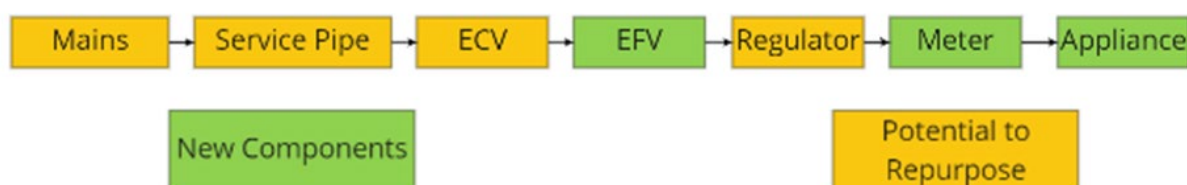


Figure 30 Domestic Gas Process Flow

Domestic Properties:

There are 3 main gas appliance categories in the home: boilers, cookers and fires. Each property will also require a new hydrogen gas meter and mechanical EFV (Excess Flow Valve).

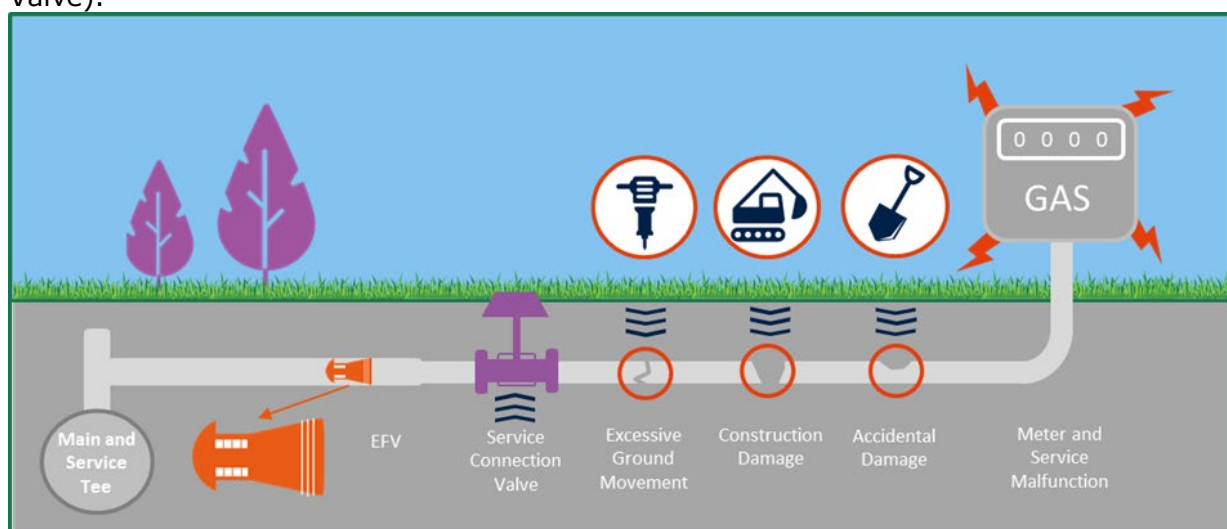


Figure 31 Domestic EFV in service



Table 1 Estimated appliance numbers based on 2,000 property trial

Appliance Type	Prevalence (%)	Households using Gas for this purpose (%)	Number required for H100 Village Trial
Boiler - combination	67	100	1,340
Boiler - standard	33	100	660
Cooker - Oven	100	17	340
Cooker - Hob	100	83	1,660
Cooker - Grill	80	30	480
Gas Fire	33	100	660
Meters	100	100	2,000
EFV (mechanical)	N/A	N/A	2,000
ECV	100	N/A	1,000*
Regulator	100	N/A	1,000*

*Numbers assume 50% repurpose rate

Estimates have been informed by previous project work in the area⁹ and nationally available data^{10,11}. During Stage 2, range and volume of appliances will be confirmed as part of our supply chain strategy.

- The nationwide trend is moving towards combination boilers and some households will simply not yet have reached end-of-life of their current standard boiler. However, given the opportunity to switch their boiler, we anticipate some consumers would opt for combination.
- The overall trend in ovens & grills is towards electric appliances – even for homes connected to the gas grid. This is especially true for grill burners, where gas grills are increasingly rare. Gas remains the preference for hobs among homes connected to the gas grid.
- We estimate up to 1 in 3 homes has a gas fire, predominately open-fronted conventional-flue fires (~90%), though glass-fronted fires with conventional and balanced flues are also present (~5% each).
- Considerations will be made to the conclusions of the Hy4Heat Safety Assessment, including ventilation in rooms with hydrogen appliances, installation of the gas meter external to the property, and inclusion of an EFV in the domestic gas carcass.

Within the potential areas of conversion, we have carried out walkabout surveys [REDACTED] and identified a variety of commercial buildings that present the opportunity to install a diverse range of commercial appliances, for example places of worship, schools, restaurants/takeaways, high-street convenience stores, community centres, warehouses and retirement living. We have estimated number of appliances required based on building type, for a section of the proposed trial area (Table 2).



⁹ Opening up the Gas Market (SGN) 2016

¹⁰ Energy Follow-Up Survey 2011 - Report 9: Domestic appliances, cooking & cooling equipment (BRE/DECC) 2013

¹¹ English Housing Survey (Ministry of Housing, Communities & Local Government) 2019

¹² Appendix 22: [REDACTED] Draft Report Walkaround Surveys



Table 2 Estimated number of commercial appliances required within South Buckhaven as an example

Commercial Appliance	Estimated Number of Appliances Required
Tube / Air / Cabinet Heating	15
Grill	3
Griddle	2
Chargrill	3
Fryer	4
Open Top Range	5
Cascade Heating	5
Meters	15

During Stage 2, we will conduct more thorough surveys to finalise commercial premises and corresponding appliances.

In restaurants and take-aways, we can assume fryers, grills, griddles, chargrills and oven/hob ranges are in use. All 5 of these appliances were developed under the Hy4Heat programme.

These and other commercial settings are likely to employ the use of space heating. Under the same work package of Hy4Heat, a range of commercial air heaters were developed—small (<50kW) and large (>50kW) forced draft cabinet heaters and suspended unit heaters, for a total of 4 appliances. A radiant tube heater (25kW) was also developed.

Other key buildings of interest are, for example, a shared retirement living building which could utilise a cascade central gas heating system.

Industrial users:

There is the potential to supply hydrogen to industrial users and we have already engaged with local industrial sites to understand the appetite for hydrogen. In Stage 2 we will assess the viability of this opportunity, which will ultimately form an integral component of our hydrogen town vision.

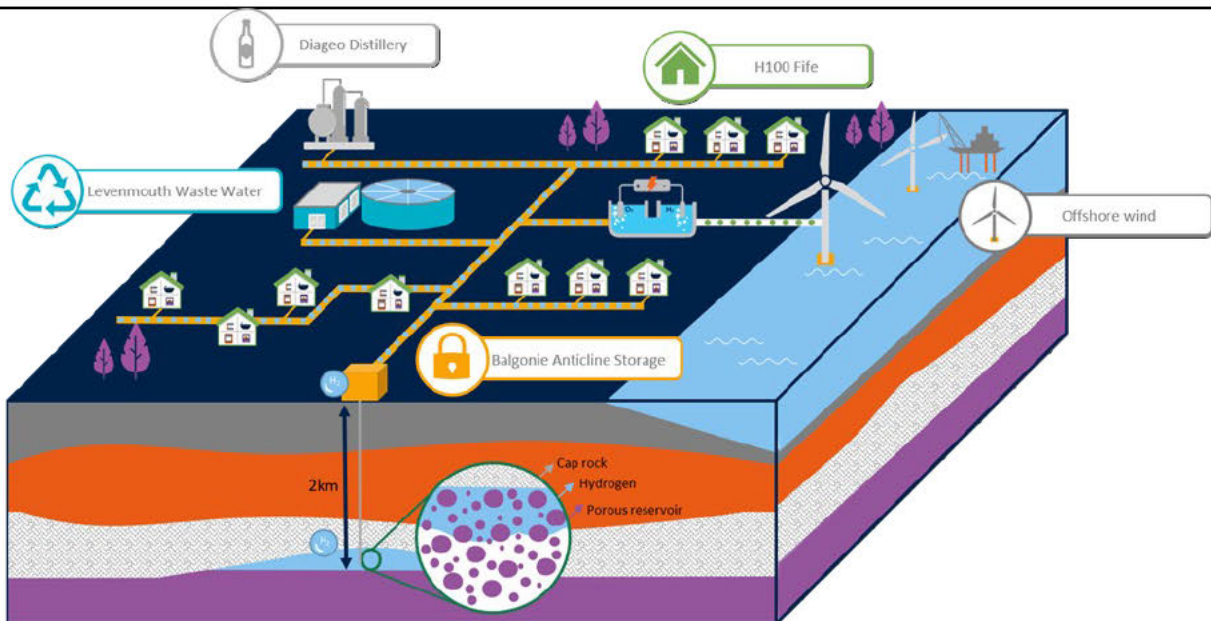


Figure 32 Demonstration of wider opportunities for hydrogen supply, storage and distribution at scale to industrial users

Supply Chain Support

We have been developing relationships with the supply chain and have a good knowledge and understanding of supply chain readiness and the current best cost estimates.

In addition, we are engaged with the supply chain of the upstream components. Extensive system component mapping has been undertaken to ensure each asset of the end-to-end hydrogen system is or will be available within the project timescales. This has allowed us to gain an informed view of the market capabilities, key players, asset cost and lead times to help us develop this proposal.

Further Development Areas

With the range of appliances, installations and components as outlined above, no further appliance development work is required to facilitate the proposed Village Trial. Nevertheless, further work could be conducted ahead of the trial to enable hydrogen-ready or dual-gas cookers, fires and commercial appliances, which are currently hydrogen only.



For those consumers that 'opt-out' of the trial, alternative conversion will be offered by electrification of their heating system. For the purpose of whole lifecycle cost estimation during Stage 1, this has been assumed to be heat pumps. This will be further explored during Stage 2 to assess other options in terms of user acceptability and economy. The primary purpose of the project remains to trial hydrogen, and residents will be engaged with through our stakeholder activities and educated on the relative merits of retaining their gas connection for a switch to hydrogen. It will be crucial to ensure that consumers are aware of the level of intervention required for both hydrogen and electric heating installations¹⁴ so that they can make an informed choice which they feel confident in (Figure 28).

Impact of technologies in the home

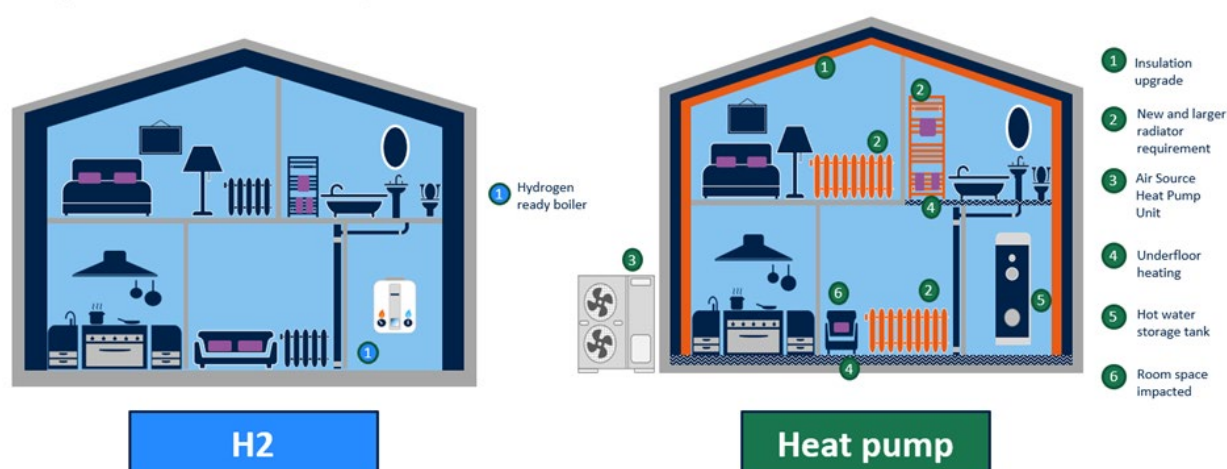


Figure 33 Comparison of hydrogen vs. heat pump technology in the home

¹³ Appendix 15: Letters of Support

¹⁴ Further information on the components and level of intervention required are found in Appendix 16: Distribution Network Conversion and Appendix 23: High level example interventions for converting domestic properties to hydrogen



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

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

Workforce capability, skills and training plans for the Village Trial will leverage the work completed and planned for the Neighbourhood Trial, [REDACTED]

Competency Frameworks and associated Training Plans will be developed to align and ensure compliance with the governing legislation for the applicable assets. They will be informed by our Cases for Safety and Local Operating Procedures (LOPs) for each element:

- Upstream (production & storage site)
- Midstream (distribution network)
- Downstream (consumer properties, downstream of the ECV)

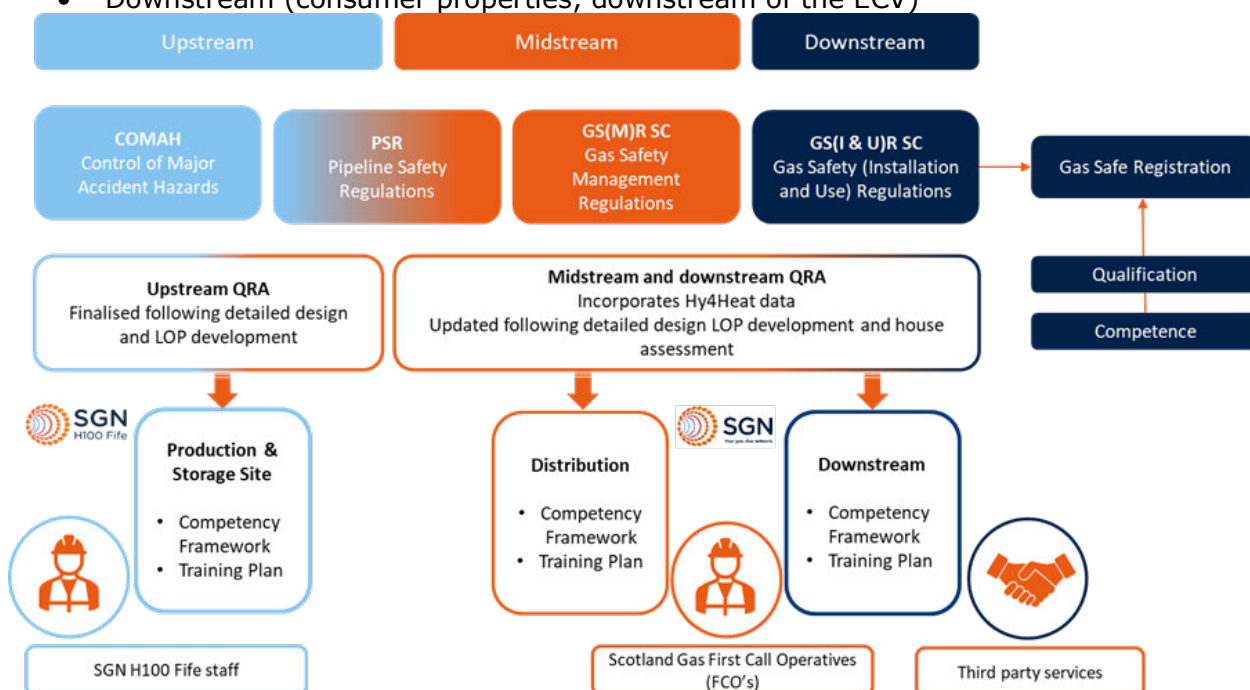


Figure 34 The route to competency frameworks and training plans across the end-to-end system, informed by the Cases for Safety, LOPs, the relevant regulations, the Quantified Risk Assessments (QRA) and resulting in hydrogen competent personnel.

The Cases for Safety and Local Operating Procedures for the Village Trials will be largely replicable from the hydrogen specific updates [REDACTED] as part of the H100 Fife Neighbourhood Trial. Further updates will be required to account for differences in the trials but it is anticipated that a significant quantity of competency framework and training plan effort will be complete by 2023.



The Village Trial will also benefit from the availability from 2023 of the H100 Fife Neighbourhood Hydrogen Demonstration Facility for training delivery purposes.

Remaining development of village-specific training content and training delivery plans will be completed in Stage 3 following final definition of project geographies and scale during Stage 2. This also aligns with completion timing of contributory projects [REDACTED]

[REDACTED] project is focused on training, assessment, and accreditation of Gas Safe registered engineers and is expected to be available by 2023. They have set key objectives to ensure that the Hydrogen Competence Framework is completed on time and ready for the first engineers to be trained, assessed and registered for working with hydrogen. These objectives include:

- Training Provider capability aligned to the trial locations, to include: facilities, appliances and hydrogen supply, competent hydrogen trainers
- Assessment Centres in place, aligned to trial locations
- UKAS accredited Certification Body able to certificate engineers
- Gas Safe Registered facility to add a hydrogen category
- Clear eligibility and entry criteria for engineers intending to work on hydrogen installations
- Matters of Gas Safety (MoGS) for hydrogen finalised

Matters of Gas Safety (MoGS) for hydrogen finalised



ENERGY &
UTILITY SKILLS

Stage 2 will also deliver initial proposals for a phased network conversion within the selected areas. Confirmation of the desired rate and pace of this phased conversion will enable quantification of the number of Gas Safe registered engineers required to deliver the downstream conversion work (appliances, meters etc). The strategy for appliance replacement and associated in-property work will be explored further during Stage 2 but we are minded to utilise third party service providers to deliver the full suite of works, thereby reducing interfaces and disruption for the consumers. Potential contracting partnerships and training service delivery partners [REDACTED] will be further explored during Stage 2 with a view to execute agreements during Stage 3.

First Call Operatives (FCO's)

As the operator of the gas networks in Scotland and Southern England, we are responsible for attending and making safe all gas related emergencies reported through the national gas emergency number 0800 111 999 that fall within the geographical boundary of the SGN network. The area that the H100 Fife project resides is covered by our North Region depot based out of Dundee as seen on the map illustrated.



Figure 35 Red area of map showing SGN North Region Depot patch

The coverage from this depot will allow the significant numbers of qualified emergency response resources within this region to be upskilled to ensure competence for hydrogen networks. These resources will be trained to respond to and make safe any reported escape within the H100 Fife project zone whilst still meeting its obligations for escape attendance.

Table 3 Numbers of SGN First Call Operatives and Repair Teams allocated in North Region Depot patch

Number of FCO's	Number of Repair Teams
59	35

Further information on the development of our Gas Escape Management protocols has been included in Appendix 4.

Production and Storage Site Staff

Comprehensive training plans will be required for Production Operators, Maintenance technicians, Asset Engineers and Asset Managers. This will be based upon existing SGN training requirements supplemented with hydrogen specific modules. Most of this training will be specified and delivered as part of the Neighbourhood Trial and should only require minimal updates for the existing site. Any new site may have different infrastructure and so training content likely to require further work. This will be progressed during Stage 3.

The range of applicable training will draw from Cases for Safety and LOPs and will focus on operational integrity elements such as:

- Risk Management



- Risk assessment; Register of Open Risks; Approval to Operate & risk acceptance protocols;
- Facilities Design & Construction
- Documentation & information
- Operating & Maintenance Procedures
 - Operating Envelopes; alarm management; structured rounds; Safety Critical Task Analysis (SCTA); handover logs; Abnormal & Non-Routine Operations (ANRO)
- Permit to Work System
 - Process clearing; Process isolation; Mechanical/Electrical isolation (LOTO)
- Safety Critical Equipment
- Emergency Preparedness
 - Response procedures; emergency equipment testing



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.

We are well underway with our engagement activities in H100 Fife Neighbourhood. By developing our hydrogen village from the same geographical location as our hydrogen neighbourhood, we have the considerable advantage of building on an existing platform of engagement directly related to participating in a hydrogen for heating trial. Similarly, we are able to benefit from relationships already established with key local stakeholders in which we have gained their support and buy-in for a hydrogen trial locally. We designed H100 Fife to support expansion into future phases, the second of which was increasing the number of customers supplied with hydrogen and including grid conversion elements. These future expansion phases have underpinned the narrative of our plans beyond H100 Fife Neighbourhood Trial and we're now in a position that H100 Fife Village Trial can align with the criteria of the hydrogen village as set out by BEIS and Ofgem. On this basis, we have had a head start on being able to set out our emerging plans for the hydrogen village with the local area in recent years and months, and are now updating our key stakeholders that there is a clear route to bring these plans to fruition, subject to our progression success.

Table 4 An example list of engagement undertaken that supports both the Neighbourhood and Village Trials for H100 Fife.

Example Engagement	Date	Outcome
Public meeting	March 2021	Meeting held to support enquiries around planning application. Public concerns alleviated and questions answered.
Community Liaison Group	Kicked off in August 2021, ~monthly meetings	Sounding board for engagement plans with local insight and opportunity for project advocacy from trusted partners
Conservation without Borders, Sacha Dench event	September 2021	Engagement with Levenmouth Academy and H100 Fife highlighted as flagship project in the run up to COP26
Project website created	November 2021	Dedicated resource to direct interested stakeholders and potential customers to
COP26 H100 Fife Exhibition	November 2021	Showcase of the H100 Fife programme, including plans for the hydrogen village at high profile event
Project FAQs and training packs	November 2021	Developed to support local stakeholder knowledge of project should they be approached by members of the public
Customer postcards	November & December 2021	Introducing customers in local area to the opportunity for green gas coming to Buckhaven and Methil. Next postcard planned for January 2022
Fife Council Officers Working Group	Monthly	Interface with key Council disciplines to support project delivery including planning, economic development, housing, building services, roads & transportation services, legal and procurement.
Fife Council Senior Management Meeting	Quarterly	Interface with senior management and local councillors to keep them informed on project progress
Regular engagement with key stakeholders	Ongoing	Supports project reporting and updates e.g. Scottish Enterprise, ORE Catapult



We have also mobilised our Community Liaison Group (CLG), made up of local representatives, organisations, charities, social enterprises and businesses that represent the community and individuals or have a direct consumer support role. A summary of the members involved in listed in the CLG letter of support provided with this submission. The initial role of this group has been to act as a sounding board for our engagement plans and as a window into the local community. This engagement has been two-way, where we set

out our plans for review and challenge. An example of this included our intention to issue a brochure to customers through the post to introduce the project and provide all the necessary project information. Feedback from this group suggested that we had a very short window of opportunity to capture the attention of a customer using postal mail and therefore we short opt for something short, simple and easy to digest. As such, we're delivering a series of postcards through the letterbox that raise awareness that green gas is coming to the area and teasing out some of the key project information. We have ensured validity of the postcards by linking through to the project website and providing details on next steps for engagement. Close working with Fife Council and the CLG has been key while our postcard series is in flight and we developed training packs and FAQ resources so that individuals were equipped with all the relevant project information should they be approached by members of the community.

Figure 36

Figure 37 CLG members



Green gas is coming to homes in Buckhaven and Methil

YOU can opt-in for a **brand-new free** gas boiler and appliances, while playing a key role in the battle against climate change.

We manage the network that distributes natural and green gas to almost six million homes and businesses across Scotland, Northern Ireland, and the south of England.

Small gas? 0800 111 999

SGN
Your gas. Our network.

Over 80% of homes across Great Britain use natural gas for heating, but in doing so, are responsible for a third of all greenhouse gas emissions. To help reduce these emissions to net zero by 2045, we want to safely decarbonise homes with green alternatives such as hydrogen gas which supply clean energy and don't produce any carbon.

Coming soon
a world-first happening right here in Buckhaven and Methil

In a world-first project co-funded by Ofgem and the Scottish Government, we're offering new free gas boilers and appliances powered by a green hydrogen gas supply to homes in Buckhaven and Methil.

Hydrogen gas heating systems, boilers and appliances work just the same as their natural gas equivalents. So if you opt-in, you can continue to enjoy the instant warmth and reliability of your gas supply with no change to how you use your energy.

If you decide to take part in the project, we'll install it all for free so you can make the switch to zero carbon energy quickly and easily with our support. Existing natural gas supplies will continue to be available for homes not participating in the project.

Look out for more information coming through your letterbox and your chance to make a difference.

Read more [ofgem.co.uk/h100fife](https://www.ofgem.gov.uk/h100fife) Follow us @SGNgas Find us on Facebook

Figure 38 First in a series of postcards issued to customers in the H100 Fife Neighbourhood Trial network area to raise opportunity awareness

In parallel to their role on the CLG, we have also engaged [REDACTED] a community-led charity and development trust working locally to deliver home energy advice within our project locality. As part of their first [REDACTED] survey, local households reported that they were most familiar, comfortable and confident with gas heating with 81% ranking it as their top preference compared to other technologies. The second [REDACTED] Survey asked households about their position on the importance of tackling climate change. All questions used a sliding scale - very strongly agree (1) to do not agree at all (10). A significant majority of participants reported that they agreed or strongly agreed with the following statements:

- I think climate change is a real and urgent problem
 - I think it is important that we reduce our own household carbon emissions
- The majority of households also reported that they would be interested in having a heating system that reduced their household carbon emissions.

The results of the household surveys carried out in the H100 Fife catchment area suggest that there is a high level of confidence in natural gas, there is an appetite within the project area to tackle climate change and reduce household emissions, but that the affordability of fuel remains the primary concern for householders.

We have been opportunistic in seeking out the exciting and unique engagement events. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

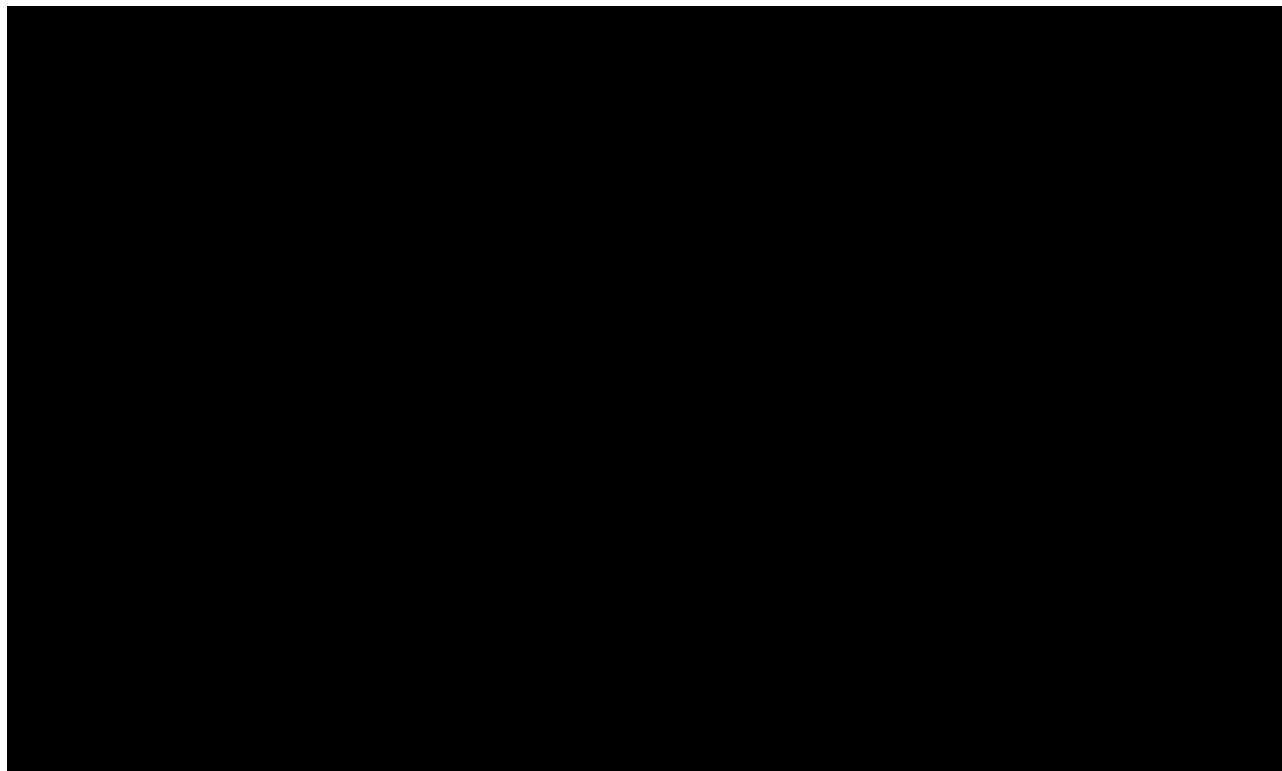


Figure 39 Climate change pioneer Sacha Dench visits Levenmouth Academy in support of the H100 Fife

We also hosted a successful H100 Fife exhibition at COP26 at Scotland's Climate Ambition Zone.

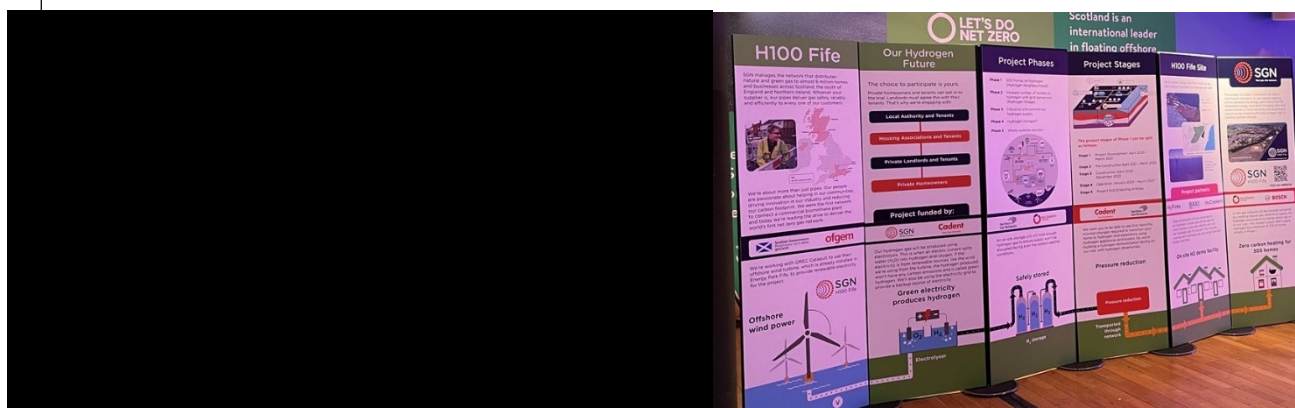


Figure 40 SGN presenting the H100 Fife programme at COP26 with supporting exhibition material.

Furthermore, we are looking at engagement events that have worked well in the past to incorporate into our H100 Fife engagement plans, such as our cooking with gas event for the Opening Up the Gas Market project. We're exploring a similar hydrogen cooking event and possibly even looking at new hydrogen BBQ technology.

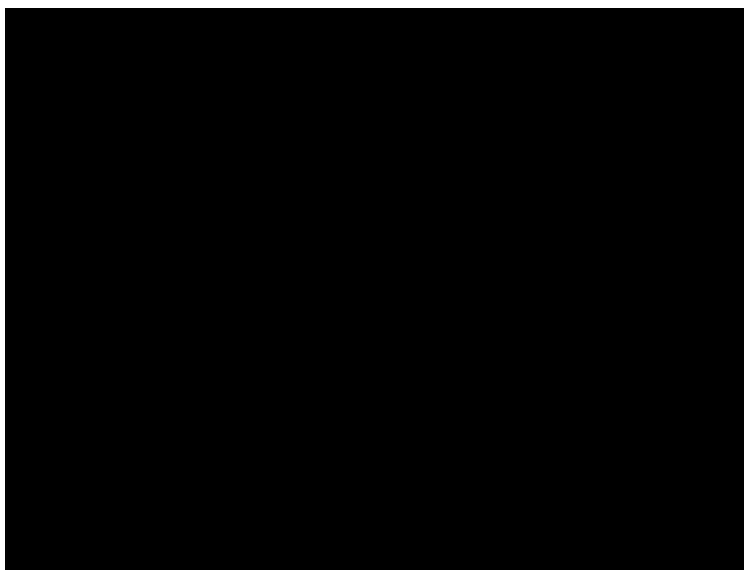


Figure 41 Chef demonstration for cooking with natural gas, Oban.

We have received letters of support from key local stakeholders that can be viewed in Appendix 15: Letters of Support.



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.

A priority for H100 Fife between the Neighbourhood and Village Trials will be to ensure clear lines of messaging and communications when engaging on both projects. This is due to the distinct differences between the trials, mainly the offer to opt-in for a hydrogen supply (Neighbourhood) vs the contrasting offer to opt-out of a hydrogen supply (Village). Similarly, the Neighbourhood Trial will be available to domestic customers only, whereas the Village Trial will seek to incorporate commercial customers in addition to homes. This will require two separate engagement strategies with defined plans to maximise consumer participation, while still aligning synergies so as not to be delivered in complete isolation of each other. The engagement plans and accompanying messaging will need to be tailored depending on the recipient stakeholder. [REDACTED]

[REDACTED] who are informed of our plans for both the Neighbourhood and the Village, however at a customer level, we need to be transparent on what is being offered to the trial location at the relevant time.

We plan to leverage the engagement platforms already established for the H100 Fife Neighbourhood Trial, as described in Section 5.1, to continue the positive relationships and support we have gained for a hydrogen trial. These stakeholders are aware of our plans for the hydrogen village and continue to offer a wealth of information and insight that will



support the development of our proposal for the H100 Fife Village Trial. The hydrogen demonstration facility planned to be delivered under the Neighbourhood Trial will be invaluable in delivering its legacy benefit, partly by providing a dedicated local space for engagement that is equipped with live hydrogen appliances in a home-like setting.

Figure 42 Hydrogen Demonstration Facility visualisation

We will continue to review and draw on the hydrogen consumer research evidence base that has been contributed to across industry to ensure our engagement strategy plans are current, effective and designed for success. Learnings from the Hydrogen Consumer Research collaborative NIA project, which is detailed in the GDN Annex of Supporting Collaborative Evidence, has provided key insight into attitudes, drivers and priorities for consumers in relation to changing their energy systems to hydrogen or electric. Once the outputs of this are fully analysed and understood, they will be used to inform our engagement plans. We also delivered a project [REDACTED] to better understand customer values to underpinning the transition to decarbonised domestic heat using 10 focus groups across Scotland. From our key outcome statements, we can see:



- Nearly three quarters of the Scottish public (73%) say they support replacing their boilers with a greener alternative
- But when asked if they would do and pay for this switch, support drops to 32%

This represents an 'action gap' that will be a focus of attention throughout the net-zero transition but will be something the H100 Fife Village can mitigate for the purposes of the trial.

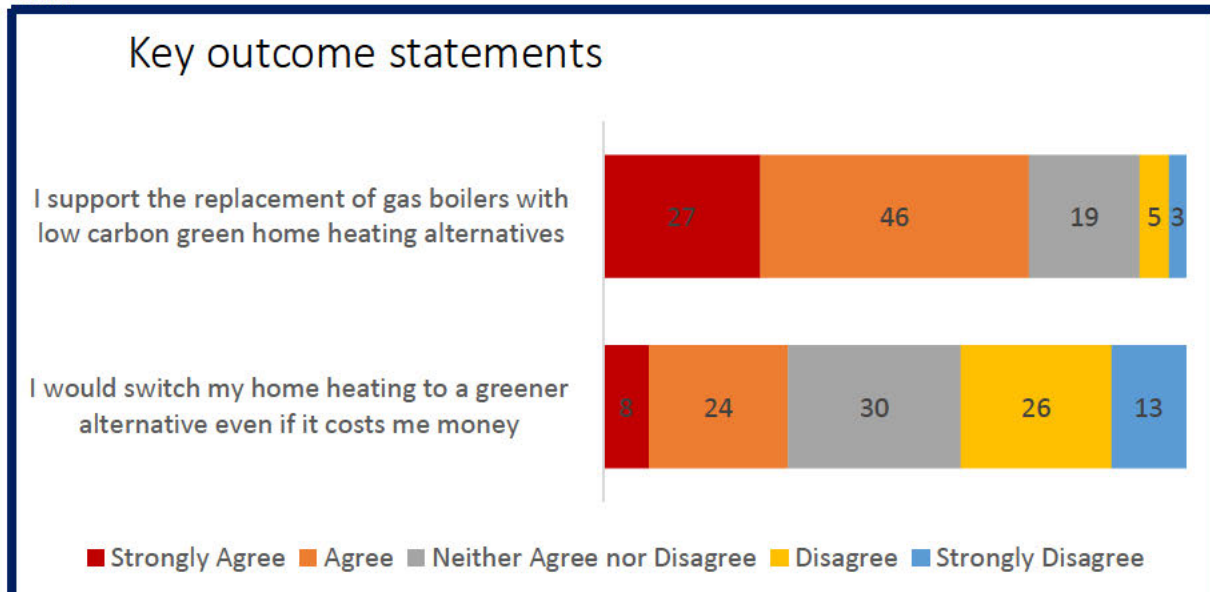


Figure 43 [REDACTED] showing the response split to two outcome statements. See Appendix 20: [REDACTED] for further details.

A successful public engagement strategy should accomplish the following objectives and success criteria:

- A clear strategy for engagement, with detailed plans for delivery and trackers of progress
- A vision of success and how this will be measured
- Timebound objectives that are managed and revised as needed
- A means of collating representative findings on the experiences, attitudes and behaviours of a diverse range of trial participants and building types during the conversion process, and of using hydrogen for heating and cooking when the trial is operational
- Flexibility to adapt plans based on engagement learning or feedback
- Methods to validate consumer acceptability of hydrogen and ways to improve consumer experience, including minimising disruption and inconvenience
- Plans for engagement that are inclusive and ensure fair treatment for all
- A multi-method approach for engagement across a range of platforms e.g. digital (websites, social media, newsletters), hard copy literature (letters, leaflets, brochures, information & training packs, signage), media (radio, adverts)
- Consider and incorporate learnings from similar work where appropriate e.g. H100 Fife (NIC), Hydrogen Consumer Research (NIA)
- Identify internal expertise and resource to support delivery and bring on partners as appropriate

This community is deeply rooted in the energy sector with a history in coal mining and export, more recently transitioning into offshore oil, gas and wind. There is now the



opportunity for this community to be at the forefront of the energy transition and we recognise the challenge of this as an area often described as difficult to engage.

[REDACTED]

[REDACTED]

[REDACTED]



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.

In Stage 2 and building on the connections already made under H100 Fife Neighbourhood Trial, engaging with local consumer groups will be crucial to identify consumer requirements as well as demographic trends and typical challenges of the local area. The Community Liaison Group already established will be a key touch point for this exercise. We'll endeavour to enrol further consumer stakeholders into this group to provide a comprehensive understanding of consumer requirements.

The consumer offer for the H100 Fife Village Trial will be built around the 'Consumer protection policy principles' set out for the Hydrogen Village Trial, in line with page 14 of the BEIS *Hydrogen for heat: facilitating a 'grid conversion' hydrogen heating trial* and specifically:

- Ensuring minimal disruption for consumers
- Safeguarding consumers from financial disadvantage by adopting a cost neutral model:
 - Providing hydrogen or electric appliances and associated install and maintain costs free of charge to the consumer
 - Implementing a billing solution that allows hydrogen to be billed at the energy unit price of natural gas
 - Supporting consumers through the project exit transition
- Enabling consumers to opt out of the demonstration – i.e. convert to electrification of their premises
- Dedicated support route for consumers whether transitioning to hydrogen or opting out
- Allowing consumer switching of their Shipper and/or Supplier
- Providing consumer support information, signposting to support services relating to home energy advice, fuel poverty, financial aid
- Conducting property visits and surveys to identify consumer needs and requirements, and where additional support may be required for vulnerable customers who can be identified through our Priority Services Register
- Careful consideration will need to be given to consumers who wish to participate but cannot for a number of reasons, including if hydrogen appliances for that particular end user application are not ready in time
- Identifying and securing funding mechanisms to protect consumers from financial disadvantage

Regarding the billing solutions for a hydrogen village, we are able to leverage the H100 Fife Neighbourhood Trial work with Xoserve and industry to identify a bespoke hydrogen billing solution that allows billing system to accurately charge a consumer as though natural gas were being consumed. This is required due to the calorific value (CV) differences between 100% hydrogen (~12) and natural gas (~39), which therefore requires circa three times the amount of hydrogen to produce the same amount of energy as natural gas.



Xoserve fully supports this submission and 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. The options reviewed have been based on the following assumptions:

- The Village trial geographical area will be excluded from the current Flow Weighted Average Caloric Value process
- The trial area will not include Class 1 meters (Annual Quantity > 58.6m kwh)
- The meters used in the trial will be hydrogen only

Xoserve have advised that costs are difficult to quantify at this stage and will be fully dependent upon the agreed solution, however, current estimates range between [REDACTED]. This will also be dependent on what other options are developed to support other hydrogen projects (i.e. Hydeploy/H100 Fife Neighbourhood Trial/Future Billing Methodology) which may be scoped and/or implemented, which may satisfy all or some elements needed to support Hydrogen Village Trial.

Through Xoserve's Change Management consultation for the H100 Fife Neighbourhood Trial, the Change Management Committee approved the development of the Multiplication Factor (Xoserve Option 2). This will be developed/defined specifically for hydrogen meters. When a valid read is received this value will be used in the calculation of consumption to account for the difference in volume that is required for hydrogen to deliver the equivalent energy of natural gas. Market Domain Data (MDD) will need to reflect the defined Multiplication Factor. This will be dependent on agreement from the meter manufacturer(s) that when updating the MDD with the hydrogen meter they will include the developed/defined Multiplication Factor. It is expected that the standard process for updating meter details in Central Data Service Provider (CDSP) systems will continue i.e. Meter Asset Managers installs the meter and provides details to the Supplier, Supplier provides the details to the Shipper and the Shipper provides the details to the CDSP.

The Xoserve team are entering the delivery stage of the project, currently working on an Evaluation Quotation report (EQR) which will go to Change Management Committee for review and approval. This document will confirm funding requirements for detailed design, meaning a timely start of this process. All industry participants will be invited to participate in the detailed design process and communication across industry parties will be co-ordinated via the Xoserve team, not just on the system and process changes but also in providing relevant supporting data and data visualisation tools as required. Full details of the Change Pack & Consultation are available online¹⁵.

[REDACTED] We are also engaging external expertise to support on mapping the billing solution interface with the metering requirements for hydrogen and will endeavour to continue a consistent and regular line of engagement with industry on the village trial billing solution. The detailed design stage of the H100 Fife Neighbourhood Trial billing solution will continue into 2022, targeting a Major Release date of November 2022 for system implementation. As such, we will continue to sense check the suitability and scalability of the neighbourhood solution to a Village Trial.

¹⁵ <https://www.xoserve.com/change/change-packs/2918-mt-po-change-pack-october-2021/?token=0f23ecc6-7fa1-4482-a8ac-80466fdb692>



One emerging issue that will need a resolution is the discrepancy between hydrogen and natural gas VAT. This is a significant risk to the delivery of the trials and the overall system transformation if not addressed. Further information is in Appendix 19: Hydrogen VAT Issue.



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.

Our costs provided in the submission spreadsheet for the delivery of the H100 Fife Village Trial (Stages 2 -5) for each option are as follows:

The whole life costs (WLC), and a cost breakdown for Stage 2, are included in our cost spreadsheet provided with the submission, the costs are derived from market intelligence, project experience and builds on the H100 Fife Neighbourhood where appropriate which provides accuracy assurance. These project costs will be managed by robust project management and control measures such as go no/go stage-gates and fixed price contracts mitigating against the risks of cost growth. During Stage 2, Stage 3-5 costs will be refined as options are finalised, achieving cost certainty.



A summary of key cost drivers for each option is below:

	900 properties – Option 1	2000 properties – Option 2
Stage 2	<ul style="list-style-type: none"> • Preparing procurement packages for Stage 3 for additional storage equipment and EPC main contractor, any other long lead items identified. • New planning application is required due to a change to intensity of use but assumed information from existing site will avoid need for EIA. • Design and Integration costs assumed minimal. • Electricity grid reinforcement design contribution costs included in Stage 2 to meet delivery timelines. 	<ul style="list-style-type: none"> • Preparing procurement packages for Stage 3 for a new electrolyser, storage for both sites, and main EPC contractor, and any other long lead items identified. • Potential for two planning applications required, one for existing site (amend existing) and one for the new site location. A full EIA required. • Significant design, planning, and project management costs required due to longer duration and complex infrastructure requirements. • Increased electricity grid reinforcement design contribution costs included in Stage 2 to meet delivery timelines. • Increased third party engagement for alternative new sites.
Stage 3 – 5	<ul style="list-style-type: none"> • Land expansion leveraging existing site. • Installation of storage • Network intervention and replacement works. • Customer engagement and property survey work. • Appliance supply volumes (gas/electric). • Customer gas works, service, pipe, mitigations and appliance installs. • Customer electrical works for those that opt-out. • Maintenance activities. • Commodity balancing. • Resource. • Xoserve billing solution. • Decommissioning costs. 	<ul style="list-style-type: none"> • Land acquisition of potentially new site. • Major construction activities required (expansion of existing site and new site). • Increased Network intervention and replacement works. • Customer engagement and property survey work across greater number of end users. • Greater appliance supply volumes (gas/electric). • Significant customer gas works, service, pipe, mitigations and appliance installs. • Customer electrical works for those that opt-out. • Maintenance activities. • Increased commodity balancing. • Resource. • Xoserve billing solution for increased number of sites. • Increased decommissioning costs.



Stage 2 Costs

For stage 2, we have presented broken down costs required in the submission spreadsheet and these are summarised below¹⁶:

A summary of each of these categories is provided below:

Contractors – Stage 2

¹⁶ NZASP only - For the purposes of this submission we have presented in the submission spreadsheet the costs associated with the 2000 home option. However, in this section we have also presented the alternative costs should we progress with the 900 home option only.



Labour – Stage 2

Other – Stage 2

Stage 3 - 5 Costs

For Stage 3 costs onwards, a preliminary techno-economic model was produced. The underlying assumptions utilised as inputs to this model were based on a number of sources including:

- Benchmarks from the H100 Fife Neighbourhood Trial were used where contracts have been procured, or where supplier quotations were provided
- [REDACTED] and SGN's wider database of industry benchmarks
- Engagement with potential suppliers.
- BEIS reference gas and electricity prices
- Energy usage data for the proposed conversion areas.

Whole Life Cycle Costs

A comparison with the H100 Fife Neighbourhood Trial against whole life cost for each option has been undertaken in terms of cost per home per year. A comparison of cost per home



per year shows value for money in this project's unique position to expand on the existing H100 Fife Neighbourhood Trial, accounting for the additional diversity of properties and evidence for the proposed H100 Fife Village Trial.

Contingency and Uncertainty

A [REDACTED] % contingency has been applied to all costs and a cost accuracy of +/- 50% has been applied for Stage 2 onwards. The overall [REDACTED] % contingency is considered good standard practice for this early stage of project development, this contingency will be revaluated and linked to project risks in Stage 2 as mitigations and designs are developed.

Similarly, the uncertainty range applied are reflective of the early stage of the project. The Stage 2 uncertainty range should decrease with design clarity (e.g., after preferred concept selection).

Funding Options

We propose funding stage 2 via the NZASP mechanism, commencing April 2022. In the interim we will continue to progress downstream design activities under the NIA, the learning from which will be relevant and valuable. This is reflected in the submission spreadsheet.

We will investigate third party funding opportunities in Stage 2. [REDACTED]

[REDACTED] We have also secured commitment from the [REDACTED] to explore its possible financial contributions to the H100 Fife Village phase as indicated in the letter of support signed by the [REDACTED] (Appendix 15).



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.

Reference	Project Deliverable	Deadline	Evidence	Funding requirements (%, must add to 100%)
1	Consumer and Network Options Identification	01 April 22	Consumer and Network Options Identification Downstream statistical representativeness	
2	Concept Selection	29 April 22	Preferred Concept Design Report	
2	Draft Procurement Strategy	27 June 22	Draft Procurement Strategy	
3	Final Procurement Strategy	06 Jan 23	Final Procurement Strategy	
4	Design Freeze	06 Jan 23	Design Report	
6	Pre Construction Activities	26 May 23	Planning application submitted to relevant authorities Safety case produced, regulatory model agreed, insurance agreed in principle, network design complete	
7	Third-party agreements in principle	23 Jun 23	Power Grid Gas network Water Land Appliances	
8	Procurement in principle complete	07 Jul 23	Technical/functional specification and tender pack	
9	Village Trial Stage 3 Application	29 Sep 23	Application to BEIS/Ofgem to continue into Stages 3 and beyond	

**Note: the first 3 months of the H100 Fife Village Trial programme funded by NIA*
The proposed Project Deliverables for Stage 2 in the above table is aligned for the 2000 home option. It is anticipated that the Project Deliverables, for the 900 home option will be the same as the 2000 home option, but with earlier deadline dates for several of the deliverables.



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