HyDeploy2 Project

Gas Network Innovation Competition // Cadent
2nd Project Progress Report (PPR) // December 2020

HyDeploy2

The HyDeploy2 project seeks to address a key issue for UK customers: how to reduce the carbon they emit in heating their homes. The UK has a world class gas grid delivering heat conveniently and safely to over 83% of homes.

Emissions can be reduced by lowering the carbon content of gas through blending with hydrogen. This delivers carbon savings, without customers requiring disruptive and expensive changes in their homes. It also provides the platform for deeper carbon savings by enabling wider adoption of hydrogen across the energy system.

This Network Innovation Competition (NIC) funded project seeks to develop the evidence base to allow roll-out of a 20 mol% blend of hydrogen within the UK local distribution network by running trials on the public network.

Before any hydrogen can be blended with natural gas in the network, the percentage of hydrogen to be delivered must be approved by the Health and Safety Executive (HSE). It must be satisfied that the approved blended gas will be as safe to use as natural gas.

Such approval is provided as an Exemption to the current hydrogen limit of 0.1 mol% within Schedule 3 of the Gas Safety (Management) Regulations (GS(M)R), 1996. These regulations ensure the safe use and management of gas through the gas network in the UK. Following such approval, hydrogen production and grid injection units are to be operated, and an extensive trial programme undertaken.

Blending hydrogen at 20 mol% with natural gas across the UK, would save around 6 million tonnes of carbon dioxide emissions every year, the equivalent of removing 2.5 million cars from the road.

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1.0 Executive summary

The HyDeploy2 project has had another successful year, primarily focused around the development of the UK's first application for an Exemption to use a hydrogen blend on a public gas network.

This has been supported by the design and engineering work relating to hydrogen delivery, necessary to support the Exemption application and ensure a smooth transition into installation and commissioning following the Exemption evaluation process.

The objective of the HyDeploy2 programme is to enable hydrogen blending to be rolled-out across the UK UK gas networks in material quantities including the use of hydrogen blended gas by industrial customers.

The Exemption application was submitted on 1st June 2020 along with a comprehensive set of technical reports and documents comprising the evidence base to justify the injection of blended hydrogen into the Winlaton trial network. Considerably more progress has been made in developing the evidence base for this Exemption application than had been anticipated in the original bid.

The application is based upon a detailed quantitative risk assessment, supported by rigorous assessments including experimental work, modelling, asset survey work and literature. The scientific evidence has successfully delivered deeper understanding of the gas characteristics of blended hydrogen gas, especially in the context of comparing its behaviour to natural gas. This has allowed the assessment of risk to be drawn more tightly, than was previously possible, resulting in broader technical arguments able to be made to justify the use of hydrogen blended natural gas.

To ensure a safe operation and a well-managed trial both network and domestic operational assets and procedures were assessed. A robust materials programme assessed the compatibility of assets and materials which will come into contact with the blended gas. The minimal changes to procedures that were identified formed the basis of the training that has been administered to all gas network engineers that will be involved in the safe operation and management of the trial network.

The assessment of downstream assets demonstrated combustion on hydrogen blended gas was as safe as natural gas. The accompanying review of appliance related industry procedures found no changes to industry guidelines was required. This knowledge was shared with over 700 participants from the Gas Safe community as well as guidance/standard developers. The project team has been in close engagement with officers at the HSE throughout the evidence development phase.

The trial area has been successfully isolated from the wider Winlaton gas network and the new pipeline from Low Thornley has been installed. Following contractor selection, the engineering and design work necessary for the physical works and to support the Exemption application has been undertaken. Equipment is being fabricated and is undergoing Factory Assessment Testing (FAT) with a view to be transported to site early in 2021. Physical works onsite are scheduled to commence early in 2021 to link in with the final exemption evaluation.

Ensuring consumers are not financially impacted during the trial is critical. The HyDeploy2 team have been engaged with Xoserve and the shipper/supplier community to develop a billing process which ensures consumers will not pay for any of the hydrogen gas they receive during the trial. The approach has been approved by Ofgem and is now being implemented ahead of the trial.

The objective of the HyDeploy2 programme is to enable hydrogen blending to be rolled-out across the UK gas networks in material quantities including the use of hydrogen blended gas by industrial customers. Therefore, a programme of work to understand the impact and compatibility of hydrogen blended gas to be used by industrial users has commenced, with three trials being delivered, the first of which will commence in December 2020.

The project has been in communication with local residents, industry stakeholders and policy makers. These activities have helped build momentum around hydrogen blending such that it has started to attract the attention of policy makers, including dedicated resource within BEIS focused on blending. The recently announced ten-point plan includes a key enabling role for hydrogen blending to unlock key targets for hydrogen production build out.

The project has had to contend with the impacts of Covid-19. The project has benefited from being a well-established team with all key participants highly experienced and with good working relationships with each other. This meant the transition to online working could be well managed. Overall commencement of the trial phase is likely to be slightly delayed, but not materially so, given the magnitude of the Covid-19 impact more generally.

Overall, 2020 has been a very successful and productive year for HyDeploy2. The evidence base developed to support the next stage of hydrogen blending is extensive, and subject to a successful evaluation of the Exemption application, should provide the basis for a successful public network pilot in 2021, alongside ground breaking industrial trials.

Photo taken pre-Covid-19

2.0 Project manager's report

The HyDeploy2 project has had a successful year, driving forward progress towards deployment of blending hydrogen into the gas grid.

Key achievements

The key achievement of 2020 has been the successful submission of an application to the HSE for an Exemption to the hydrogen limit within Schedule 3 of GS(M)R, accompanied by the supporting evidence base, to permit hydrogen blended gas to be injected into a public gas distribution network for the very first time.

The Exemption application was submitted on 1st June 2020 along with 46 technical reports and documents showcasing the evidence base to justify the injection of blended hydrogen into the Winlaton trial network. In general, considerably more progress has been made during this Exemption application than had been anticipated in the original bid.

The application is based upon a detailed quantitative risk assessment (QRA) and fault tree analysis with over 200 individual risk assessed gates/events. The data to support the QRA was based on scientific assessments including experimental work, information gathered from various sources including comprehensive literature searches and reviews, computational fluid dynamic modelling and carrying out asset surveys on the network, details of which are given below.

A house-to-house (H2H) survey was undertaken in the trial location and came to a successful conclusion early in 2020. The survey consisted of collecting Gas Safe compliance evidence of the appliances on the network and undertaking remedial work where needed to ensure the integrity of the installations, putting customers' safety first. By working with local Gas Safe organisations, the local council and dedicated Customer Care Officers, evidence has been collected on 89% of homes to demonstrate Gas Safe compliance of appliances.

This information has allowed a robust risk assessment to be made to ensure consumers safety is not prejudiced by the introduction of blended gas of up to 20 mol% hydrogen.

The scientific evidence, managed by the HSE Science Division (HSE SD) has successfully delivered deeper understanding of the gas characteristics of blended hydrogen gas, especially in the context of comparing its behaviour to natural gas. Therefore the assessment of risk has been drawn more tightly, reducing the inherent conservatism which necessitated physical mitigations in the previous HyDeploy trial.

One such example has been the review of actual natural gas incident reports which has provided valuable insights into real-world events. This work supported a number of key findings which allowed a more direct comparison between natural gas and hydrogen blended gas in the context of gas incident scenarios.

The historical gas incident literature review in conjunction with extensive modelling and experimental work was used to evaluate the characteristics of blended hydrogen gas within buildings. This data has been shared with the BEIS Hy4Heat programme to aid their engagement with the HSE, demonstrating cross-project collaboration and capturing synergies where possible to avoid replicated effort.

To ensure a safe operation and a well-managed trial, both network (upstream) and domestic (downstream) operational assets and procedures were assessed. A network asset survey accompanied by a robust materials programme assessed the compatibility of assets and materials which will come into contact with the blended gas. This identified no showstoppers to blending hydrogen on this network.

The Universities of Manchester and Sheffield were contracted to conduct mechanical tests to provide first hand data of materials performance of key materials after exposure to hydrogen environments reflective of those that will be experienced during the trial, the results of which showed no significant impact on the mechanical properties of these materials. Further work on materials is being carried out to support wider roll out, including further assessment of cast iron with DNV GL.

The minimal changes to procedures that were identified formed the basis of the training that has been administered to all gas network engineers who will be involved in the safe operation and management of the trial network. For downstream assets and procedures an extensive assessment on all currently available gas appliances certified under the Gas Appliance Directive (GAD) as well as appliances compliant with pre-GAD requirements was conducted. This resulted in identifying 13 generic burner types which represent the UK appliance population, the assessment of which found no safety or performance issues for hydrogen blended gas. Based on the results and assessments undertaken, it was identified that appliances using hydrogen blended gas will produce lower levels of CO in the flue gas and substantially lower levels of CO in the flue gas when operating in fault conditions. This mitigates the consequences of such fault conditions, making gas appliance operation inherently safer. The accompanying review of appliance related industry procedures found no substantial effect on operation and interpretation of industry guidelines, particularly the use of flue gas analysers to assess and detect poor appliance performance.

This knowledge was shared with the relevant standard bearers of; the Institution of Gas Engineers and Managers (IGEM) and; the British Standards Institution (BSI); as well as over 700 participants from the Gas Safe community, including those local to the Winlaton North East region.

The project team has been in close engagement with officers at the HSE throughout the evidence development phase. Following submission of the exemption application on the 1st June a process of challenge and review has been underway which has yielded over 200 clarification questions to date, the majority of which have been addressed and closed. A final determination is expected in Q1 2021 after which the site installation works can be completed and the trial commenced.

In preparation for site installation, the Winlaton trial network has been successfully isolated from the wider Winlaton gas network so that the hydrogen blended network can be well-managed and controlled. This also included installation of a new pipeline from the Low Thornley site (where the trial equipment will be located) to the isolated network.

The conclusion of a competitive tender process secured the Contractor for the Principal Designer to develop the engineering and design work necessary for the physical works and to support the Exemption application. Covid-19 disruptions has meant an extension to the HyDeploy trial at Keele University (Keele). NGN were keen to maintain momentum on the build at Winlaton, given the focus on hydrogen nationally.

A new hydrogen injection unit was separately procured by NGN with appropriate designs such that it can be provided with hydrogen trailered from existing industrial supplies, this ensured that HyDeploy2 would not suffer any delays due to the extension of the trial at Keele. This grid entry unit, and the gas unloading equipment have both been fabricated and are undergoing Factory Assessment Testing with a view to be transported to site early in 2021. Physical works onsite are scheduled to commence early in 2021 to link in with the final exemption evaluation.

Ensuring consumers are not financially impacted during the trial is of critical importance. As such, early work was undertaken to explore billing options for the trial. The HyDeploy2 team have been engaged successfully with key stakeholders such as Xoserve and the shipper/supplier community to develop a billing process which ensures consumers will not pay for any of the hydrogen gas they receive during the trial whilst minimising the disruption to the current billing mechanism. This has allowed for an appropriate billing approach for the trial to be agreed between all parties with the principles reviewed and approved by Ofgem. This is now being implemented ahead of the trial.

Alongside this, to support the roll-out of hydrogen blended gas across the gas networks, the National Engineering Laboratory (NEL) have commenced a programme of work to determine the fiscal accuracy of existing meters when operated with hydrogen blended gas with results expected in 2021.

The objective of the HyDeploy2 programme is to enable hydrogen blending to be rolled-out across the UK gas networks in material quantities, including the use of hydrogen blended gas by industrial customers as well as domestic customers. Therefore, a programme of work to understand the impact and compatibility of hydrogen blended gas to be used by industrial users has commenced.

A large-scale trial programme has been developed, which has leveraged a series of 100% hydrogen industrial trials under the BEIS funded Industrial Fuel Switching (IFS) programme, delivering valuable synergies and cost efficiencies. This commences with initial trials at Dunphy, a UK manufacturer of industrial burners, using a 1.2 MW test boiler representative of the majority of commercial/small industrial heating units. This provides the basis for Unilever to run hydrogen blend trials in one of their 7 MW steam-raising boilers in 2021. This boiler is typical of 100s of units across the UK. Similarly, a programme of work has been developed with Pilkingtons, one of the UK's leading glass manufacturers, looking at hydrogen blended gas combustion in their high temperature 55 MW glass furnace. Addressing the carbon impacts from such sectors are vital in reaching UK targets.

A dedicated effort has been made over the course of the year to communicate with local residents, industry stakeholders and policy makers. Although the UK has a Net-Zero target for 2050, the Committee on Climate Change's carbon budgets help focus on progress that is required much sooner than 2050 and so the importance of clear and concise communication regarding the opportunities of blended hydrogen gas development is paramount to enable decarbonisation of gas networks sooner.

Regular communications have been sent in writing to the customers on the trial network as well as engagement with the local school. A teach-in day at the school was scheduled for July but had to be postponed until 2021 due to Covid-19 restrictions.

In the absence of physical dissemination, the HyDeploy2 team have been able to successfully deliver a webinar which was attended by over 100 industry experts and key stakeholders and has since received over 1200 views online. This led to the production of a video which provides an overview of the HyDeploy2 trial in the North East and has since reached over 300 people online.

This outreach work has helped build momentum around hydrogen blending such that it has started to attract the attention of policy makers, including dedicated resource within BEIS focused on blending. The recently announced ten-point plan includes a key enabling role for hydrogen blending to unlock key targets for hydrogen production build out.

Outlook for next period

It is expected that the HSE will reach a conclusion on the exemption application early in 2021 which will then turn the focus of the project to completing the site installation, testing and commissioning within Q1 2021. Once the physical site works have been completed then the hydrogen blended gas can be injected into the Winlaton trial network commencing the UK's first public hydrogen blended gas network trial and providing a blend to 668 homes.

Learning from the HyDeploy trial will help ensure that a careful process to manage the hydrogen injection to the maximum achievable rate is undertaken and the strong customer relations built with local residents with customer care officers at NGN will continue to be used to monitor customer feedback.

In parallel to the Winlaton trial, the focus will be increased on the areas and barriers to rolling out hydrogen blending across the UK. This will be instrumental in defining the approach and scope of the next Exemption application and phase of the programme, looking to maximise the evidence that can be locked in to enable deployment.

In parallel successful delivery of the industrial trials programme will provide the necessary evidence regarding hydrogen blend operability for industrial gas users as well as widening the assessment of hydrogen blending to assets and procedures operating on higher pressure tier networks (above 2 barg). Being able to inject at various pressure tiers within the gas network will build resilience and flexibility for customers to receive hydrogen blended gas in their localities.

Key challenges

The biggest challenge has undoubtedly been the global pandemic caused by coronavirus. Although the project team and partners have been incredibly resilient to maintain progress and momentum, there has been some unavoidable challenges, primarily access to resources, labs and individuals.

At the height of the first lockdown delays were endured as life changed for many of the team and new ways of working and existing were being sought. Access to laboratories for the completion of testing was restricted and therefore alternate theoretical methods were identified. Physical engagements with residents and the local Winlaton school needed to be postponed and written communication relied upon to continue local engagement.

Despite this, the exemption application was submitted with a relatively limited delay, although other pieces of evidence were submitted retrospectively. A conclusion to the HSE's exemption assessment is likely to be early Q1 2021, slightly later than planned.

This, alongside similar delays arising on the physical works programme will have an impact on initial blending, but overall this delay is relatively limited given the magnitude of the potential impact from Covid-19, and does not impact the overall project schedule. The project also remains on budget. This is testament to the dedication of the project team.

Overall, it has been a successful year for the project; increasing knowledge concerning blended hydrogen gas networks; getting to the cusp of a successful exemption for the first ever hydrogen blended gas trial on a public network; and, for hydrogen blending technology being recognised as a credible and necessary technology for the UK to reach Net-Zero. This has been achieved through a competent, dedicated and engaged project team working collaboratively.

3.0 Business case update

Under the Climate Change Act, as modified in 2019, the UK is committed to achieving Net Zero emissions by 2050. This requires decarbonisation of all aspects of the energy sector.

The role of hydrogen in achieving this has received increased attention over the last few years. In its Net Zero report, the Committee on Climate Change (CCC)[1] identified that Hydrogen is a necessity and not just an option to meet Net Zero. For the UK to deliver on its commitments, it proposed a requirement for 270 TWh/yr of low carbon hydrogen, noting the areas where it was most likely to be required.

'In order to develop the hydrogen option, which is vital in our scenarios, significant volumes of low-carbon hydrogen must be produced for use in industry and in applications that would not require initially major infrastructure changes e.g. power generation, injection into the gas network and depot-based transport.'

More recently in the Prime Minister's 10 Point Plan, hydrogen was identified as one of the 10 key planks required on the journey to Net Zero. Importantly, this document set interim targets to unlock progress in the shorter term. Most notable aspects are shown in the call out box, with grid blending explicitly referenced.

The Energy Minister has recently set up the Hydrogen Advisory Council[2] "to inform the development of hydrogen as a strategic decarbonised energy carrier for the UK." Government is seeking to issue its hydrogen strategy in Spring 2021.

Blending provides the basis to establish and build out hydrogen production capacity, address regulatory hurdles, build the wider hydrogen supply chain and importantly provide an opportunity for customers to become accustomed to hydrogen being part of the energy mix.

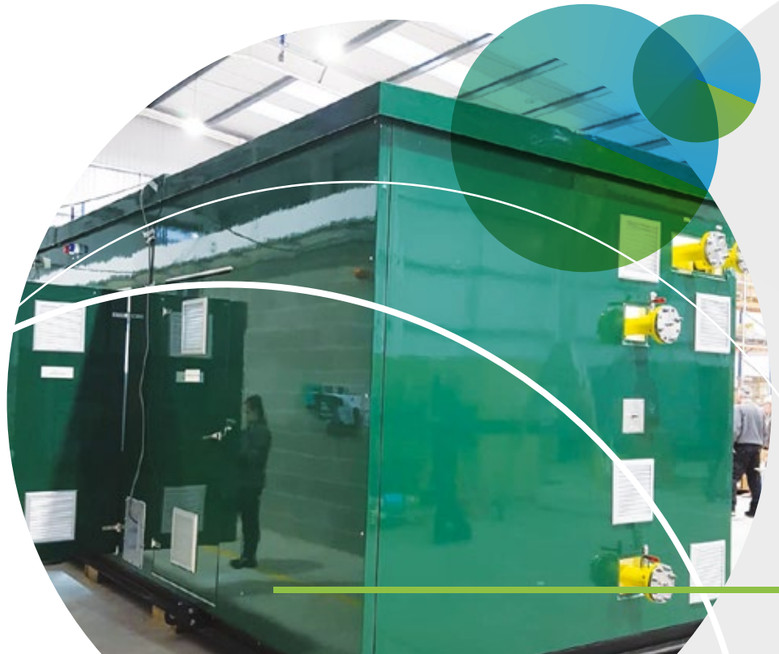
Over time, building on this platform, it is expected that parts of the gas system will migrate to full hydrogen. This will require resilient hydrogen supplies, the next level of regulatory and operational changes as well as suitable appliances. Programmes such as H21, H100 and Hy4Heat are designed to progress these network and appliance issues. Manufacturers such as Worcester Bosch and Baxi have both developed "hydrogen ready" boilers to facilitate that transition, as well as other appliance manufacturers developing hydrogen cookers and fires.

Delivering low carbon heat via gas capitalises on existing network assets cost effectively and means that customers do not require disruptive and expensive changes in their homes. Alternatives such as electrification using heat pumps will make a contribution; in reality to deliver Net Zero will require a combination of both. However, as recognised in BEIS Heat Strategy[3], in its RHI consultation, and in a 2018 report for the National Infrastructure Commission[4], this approach requires substantial consumer capital outlay and disruption, as well as substantial reinforcement of the electricity grid and additional generation capacity – recognising the combined implications of electrification on passenger vehicles.

The HyDeploy approach is to exploit the existing gas network by reducing the carbon intensity of heat delivered through blending of hydrogen, delivering up to 29 TWh per annum of low carbon heat. This approach requires no changes to appliances and the gas network, providing a non-disruptive solution to customers. It can operate seamlessly with a range of future heat scenarios, and provides a deliverable pathway.

The HyNet project[5] demonstrates how blending into the local distribution zone to decarbonise domestic heat can work in combination with higher blends and full hydrogen in industry to deliver deeper decarbonisation. It also provides a platform for flexible hydrogen fuelled power generation to balance intermittent renewables, as well as facilitating complementary zero carbon solutions for transport. NGN's InTEGReL project[6] demonstrates how hydrogen in the gas network can be integrated with operation of the electricity network to maximise the benefits to both.

To deliver hydrogen will require an appropriate policy regime. BEIS is undertaking work on business models to achieve this. This work has gathered pace in 2020. BEIS now have a dedicated team supported by contracted consultants. The objective is to issue a 'minded-to' consultation on hydrogen business models alongside the Hydrogen Strategy in Spring 2021. Such a business model is critical to transitioning from demonstration programmes such as HyDeploy into deployment, consistent with the new 10 point plan.



The 10 point plan for a green revolution

Policy impacts. Aiming for **5GW Hydrogen production capacity by 2030** in partnership with industry**. Lower carbon heating and cooking with no change in experience for domestic consumers through hydrogen blends and reducing the emissions of the gas used by up to 7%.**

Target milestones

- **2021** Publish our Hydrogen Strategy and begin consultation on Government's preferred business models for hydrogen
- **2022** Finalise hydrogen business models
- **2023** Work with industry to complete testing necessary to allow up to 20% blending of hydrogen into the gas distribution grid for all homes on the gas grid
- **2023** Support industry to begin hydrogen heating trials in a local neighbourhood
- **2025** We hope to see 1 GW of Hydrogen production capacity
- **2025** Will support industry to begin a large village hydrogen heating trial, and set out plans for a possible pilot hydrogen town before the end of the decade

[1] Net Zero - The UK's contribution to stopping global warming, CCC May 2019

[2] https://www.gov.uk/government/groups/hydrogen-advisory-council

[3] The Future of Heating, DECC 2016

[4] Cost analysis of future heat infrastructure options, Report for, National Infrastructure Commission, Element Energy Limited, E4Tech, March 2018

[5] www.hynet.co.uk

[6] https://www.northerngasnetworks.co.uk/ngn-you/the-future/integrel/

4.0 Progress against plan

The project is proceeding well against the original plan, with progress against each programme elements summarised below.

The evidence base to support the first public trial exemption has been concluded and the application to blend hydrogen gas into the Winlaton trial network has been submitted.

Much of the effort and resource used this year has been focused on concluding the evidence base and capturing this knowledge in 46 reports/documents. In parallel, collation of evidence required to support national roll-out has begun areas such as industrial users of gas. The Coronavirus pandemic introduced some delays in compiling the complete evidence for submission but the macro level timelines should not be to significantly implicated due to earlier successes when delivering the H2H survey 3 months earlier than scheduled in winter 2019. NGN separately procured an additional hydrogen injection unit which is to be supplied with hydrogen from industrial gas sources. This has enabled existing equipment to remain at Keele for an extended period to make up for time lost due to Covid-19 restrictions. Final design-work is complete and ready for site installation following the conclusion by the HSE of the exemption assessment.

Overall progress against the original plan has been largely maintained and, in some cases, exceeded, benefiting from some early work being delivered ahead of plan which mitigated some of the schedule risks associated with Covid-19.

Programme element	Progress
1. Exemption evidence - Materials	The University of Manchester and the University of Sheffield were selected as the winning bid to undertake the work. Experimental samples were machined from identified metallic materials (brass, steel and cast iron) and sent for 'soaking' where the samples were enclaved in large test tubes exposing the samples to a hydrogen environment, similar to the conditions these materials will experience during the trial. The samples were then removed and tested to determine the impact of the hydrogen exposure on their mechanical properties. No significant impact was observed on the materials' mechanical properties. Previous data from HyDeploy was able to be relied upon for the assessment of other non-metallic materials such as polymers and elastomers. The conclusions of which were documented and submitted to the HSE as part of the exemption application. A materials test programme has been developed to assess materials that will be exposed to pressure at tiers above that which the Winlaton trial network operates. This information will be necessary to support the roll-out of hydrogen blending on assets and materials operating at higher pressures.

Programme element	Progress
2. Exemption evidence – Appliances	The primary focus of the appliance workstream has been in extending the evidence base generated through HyDeploy to understand how unsafe appliances are impacted by the introduction of a blended gas. A comprehensive experimental design process was undertaken to allow all faults/maloperation situations to be understood by investigating the associated fundamental causality relating operation to combustion characteristics. 13 generic burner types were identified as being representative of the UK appliance population since 1976 and assessment of these burner types found no safety or performance issues up to 20 mol% hydrogen. Appliances using hydrogen blended gas were found to reduce the amount of CO produced in the flue gas, which was substantially reduced further when the appliances were operated in fault conditions. This evidence was captured, reported and submitted as part of the Exemption application to the HSE.

Programme element	Progress
3. Exemption evidence – Gas characteristics	Gas characteristics has been the largest workstream within the scientific programme. The two primary arms of this workstream has been the Accumulation and Consequences workstreams. The Accumulation workstream has consisted of developing three bespoke models, with increasing complexity and sophistication, to accurately characterise the accumulation characteristics of blended gas relative to natural gas under the full spectrum of conditions experienced in the real world. An experimental programme has been designed, consisting of a 'room in a room', to allow conditions to be controlled. The experimental programme has provided strong evidence to validate the models and allow confidence to be applied to modelling outputs. The results have demonstrated no material difference in the accumulation characteristics of the blended gas relative to natural gas, which supports the position taken for the HyDeploy1 exemption. The Consequences workstream has consisted of collecting incident data over the course of a decade, working collaboratively with industry stakeholders and utilising archives from both the HSE and DNV-GL. This dataset was used to understand the key variables to consider in the experimental design of ignition and combustion tests. An existing facility was repurposed to provide the ability to control leak rates and ventilation conditions to fully explore the resulting consequences following ignition of a blended gas relative to natural gas. This work is critical to exploring the holistic risk analysis supporting the public exemption to, as realistic and representative conditions as can be replicated to understand any marginal implications from the introduction of a blended gas.

Programme element	Progress
4. Exemption evidence – Gas Detection	Accurate gas detection is required to allow procedures to be utilised confidently by operatives to respond to incidents and manage risk. Collaborative work continued this year with the gas detection industry, who have been developing units capable of operating on both natural gas and the blend. One of the developed units has been undergoing tests on the network at Keele.
5. Exemption evidence – Procedures	A critical aspect of safe management of the gas network and installations is the correct application of operational procedures. The assessment of appropriate operational procedures formed a critical part of the Exemption. The review was broken down into two areas, procedures upstream of the emergency control valve (owned by NGN) and procedures downstream of the Emergency Control Valve (procedures which would be performed by Gas Safe registered individuals). Assessment of the upstream procedures was led by NGN and assessment of the downstream procedures was led by Blue Flame Associates (an industry expert on downstream gas procedures). Following initial screening, 56 downstream gas procedures required expert review, with 80 technical questions assessed by the project team, and for the upstream gas procedures a total of 80 gas procedures required expert review, and 266 technical questions for assessment. For upstream gas procedures the majority of operational procedures were unchanged, some required an increase in the frequency as to how often they are performed and some procedures which required a technical modification These were embodied in a set of supplementary guidance for NGN and formed the basis of an appropriate training package. For downstream domestic gas procedures all procedures applicable to a domestic gas installation were assessed not be detrimentally affected by the introduction of a 20 mol% hydrogen blend, and therefore required no change.

Programme element	Progress
6. Extension of evidence base required for wider deployment	In order to support wider roll out of blending, it is important to address higher tier network operation as well as a wider range of gas users, in particular industrial customers. In terms of higher pressure network tiers, the materials programme has included testing typical network materials at operational pressures up to 50 barg. These tests have commenced with results being expected in 2021. The wider evidence base for industrial users was largely scheduled to be undertaken in 2021 and 2022, however early progress has been made in this area. Collaborative work has been undertaken alongside a BEIS Industrial Fuel Switching programme which has leveraged a set of 100% hydrogen trials to deliver cost effective testing of a blend. Over the course of 2020 engineering work has been undertaken to prepare for the trials, as well as procurement activities in relation to hydrogen supply. The latter has proven quite challenging, given the quantities of hydrogen required, but delivery arrangements have now been put in place. Initial burner testing commenced in December 2020 on a 1.2 MW test boiler. This provides the basis for Unilever to run hydrogen blend trials in one of their 7 MW steam-raising boilers in 2021. A programme of work has been developed with Pilkingtons, one of the UK's leading glass manufacturers, to assess hydrogen blended gas combustion in their high temperature 55 MW glass furnace. A workshop was held with key industrials during the summer of 2020 as part of a gap analysis assessment.

Programme element	Progress
7. Generic activities applicable to all sites	An extensive site selection process was undertaken to review suitable opportunities for the subsequent Exemption application following Winlaton. The progress made in the safety case for Winlaton has exceeded expectations, which is being used to inform the most appropriate strategy for the next application. The HSE are clear that they would expect this to be a substantial step further than simply undertaking a similar trial to Winlaton, and provide a context to assess new evidence germane to wider roll out. This is being considered by the project team against the site opportunities identified.
8. Local engagement and evidence gathering	The project has maintained contact with the residents during the course of 2020, although Covid-19 has limited the opportunity for face to face engagement. Update letters have been sent out and questions have been received via the website and social media. These have been responded to by the team. A new video was launched featuring one of the customers in the trial area: **https://hydeploy.co.uk/winlaton/**
9. Develop and submit site specific exemption	This was the big achievement of 2020. The full exemption pack, comprising 46 individual reports was collated. The primary submission was made on 1st June with supplementary information provided subsequently. Over 200 technical questions have been raised during the evaluation process to date with a number of bilateral meetings arranged between the project team and the HSE inspectors and their scientific evaluation team.

Programme element	Progress
10. Pre-injection processes	Key activities have been undertaken in order to inform the Exemption application and to enable a smooth transition into final installation and commissioning once the Exemption determination has been made. The trial network has been successfully isolated from the wider Winlaton gas network and the new pipeline from Low Thornley has been installed. Following Contractor selection, the engineering and design work necessary for the physical works and to support the Exemption application has been undertaken. The new hydrogen injection unit, funded by NGN, as well as the gas unloading equipment, have been fabricated and are undergoing Factory Assessment Testing with a view to be transported to site early in 2021. Physical works onsite are scheduled commence early in 2021 to link in with the final exemption evaluation.
11. Live trial	Due to commence Q1 2021
12. Site reinstatement and engagement close out	Was not due to commence in 2020
13. Network models for deployment	Was not due to commence in 2020

Programme element	Progress
14. Regulatory and commercial basis for deployment	The billing arrangements for the Trial at Winlaton have been finalised and agreed with OFGEM. There has been extensive engagement with Xoserve to ensure that the processes and data handling necessary to support this can be put in place. With the support of Xoserve the project has been able to engage with the gas shipper and supplier community in order to prepare for the trial. A series of workshops have been planned for Q1 2021 to support this. Initial scoping work is underway to consider the most appropriate approaches for billing regimes for roll out. This is interfacing with other programmes, including the Future Billing Methodology project as well as work undertaken by Frontier into this area. BEIS have recently formed a gas blending group to provide a focal point to consider these issues. NGN, Cadent and Progressive are members of this group, and the project team is actively engaged and contributing to this.
15. Skills and training	Based on the extensive work in the Exemption, a training package has been developed by NGN for its operational staff. As at Keele, once the training is complete operators will be assessed and signed off to work on the trial network. This process has been made more challenging by the impacts of Covid-19, but NGN have found effective ways to manage the training. Whilst no changes are required to downstream processes, it was agreed that it was important to keep the downstream engineers informed. Therefore, a workshop was arranged for Gas Safe registered fitters. This was delivered in November 2020 with around 700 attendees. This was a very successful and popular event, and further follow up is planned to capitalise on this. Two articles have been published through the official Gas Safe Register magazine and a third is due in early 2021 ahead of the commencement of the Winlaton trial.

Programme element	Progress
16. Communications and dissemination	The communications strategy for 2020 has been largely focused on supporting delivery of the first public trial, along with national engagement with regard to the role for hydrogen blending. Due to Covid-19, face to face engagement with the local community has been more limited, but the project team has made the most of social media and the website to reach out where is required. There has been considerable engagement with key officials within BEIS regarding the role of gas blending. Over the course of 2020 there has been quite a change in view by government on blending, which is now seen as an important part of the transition to hydrogen. It provides a means by which material quantities of carbon can be saved in the short term without disruption to customers, but it also provides a basis to build up production capacity to prepare for the wider use of hydrogen. This has been recognised, with blending explicitly referred to in the 10 point plan, and BEIS forming an expert blending group to inform the transition to roll out. Once the Exemption has been granted, the plan is to lodge key evidence in the IGEM library such that this becomes a resource which can be drawn on by the wider industry.
17. Project management	Effective project management is necessary to deliver a project with 6 partners and multiple work streams. The governance structure is provided by the Steering group which meets quarterly. A well-managed system of monthly project meetings with associated programme and budget reporting is in place, and a comprehensive project risk register being used to manage the programme. Subsidiary working groups monitor and progress individual work streams.

5.0 Progress against budget

The table on page 25 shows the progress against budget to the end of November 2020. The programme is being managed for overall delivery within budget.

Progress this year has been delivered as per the original budget. The majority of spend has been focused on developing the exemption evidence, with site preparations and project management accounting for the remainder.

Due to a collaborative working approach with manufacturers and other hydrogen-related projects, budgeted spend for certain programme elements has been sufficient to cover actual spend with forecast funds remaining to allow further focus in other programme elements. Inevitably individual programme elements will vary compared with the original budget, but this is being actively managed with a process of monthly reporting and review, enabling proactive decisions to be made to deliver the project to plan.

Overall, the delivery of the programme has been stewarded in such a way to ensure cost effective progress towards programme objectives.

Programme element	Spend to date (£)	Budget to date (£)	Total budget (£)
1. Exemption evidence - Materials	503,608	811,825	934,031
2. Exemption evidence – Appliances	456,012	418,248	497,965
3. Exemption evidence – Gas Characteristics	1,489,138	1,396,563	1,486,829
4. Exemption evidence – Gas Detection	56,658	209,885	223,292
5. Exemption evidence – Procedures	131,461	226,450	299,170
6. Extension of evidence base required for wider deployment	78,279	1,213,834	2,191,524
7. Generic activities applicable to all sites	277,927	955,505	1,016,544
8. Local engagement and evidence gathering	160,313	1,127,795	1,428,912
9. Develop and submit site specific exemption	382,436	383,761	757,072
10. Site preparation, installation and commissioning	865,558	1,533,605	2,279,219
11. Live trial	5,625	481,358	1,771,399
12. Site reinstatement and engagement close out	6,000	10,500	168,403
13. Network models for deployment	950	32,450	34,523
14. Regulatory and commercial basis for deployment	18,915	95,720	205,244
15. Skills and training	2,794	24,300	68,940
16. Communications and dissemination	16,094	69,380	312,068
17. Project management	487,995	801,469	1,293,606
Total	**4,939,763**	**9,792,648**	**14,968,741**

6.0 Project bank account

Bank statements have been provided to Ofgem. Due to the confidential nature of the project bank statements, they have not been included in this report.

7.0 Successful delivery reward criteria

All scheduled Successful Delivery Reward Criteria were completed in full during this period, as tabulated below and as evidenced to OFGEM.

SDRC1: Communications plan
25th October 2019

SDRC2: Evidence Base for First Trial
30th June 2020

SDRC3: Exemption Submission
22nd September 2020

To date all required deliverables have been delivered on time. It is noted that there have been some impacts from Covid-19 and so it is expected that the next deliverable may be slightly delayed.

8.0 Data access details

No public network or consumption data has been collected on this project to date.

9.0 Learning outcomes

The following key learning points have been identified during this period, and provided the foundation for delivery of the ongoing programme, as well as informing national roll-out.

Persistent messaging

Since the start of the HyDeploy programme, the project team has been convinced of the value of hydrogen blending in its own right, as well as a pathway to greater hydrogen utilisation. However, this was not widely recognised. Through persistent engagement with key stakeholders and policy makers, the role of hydrogen blending has been much better understood. This has culminated with a prominent role in the recently released 10 point plan.

The importance of non-technical attributes of new technologies

The primary focus of the HyDeploy programme is to deliver the safety and technical work programmes to unlock hydrogen blending into the grid. Looking to the future it is recognised that addressing regulatory and commercial hurdles are likely to be key to enabling wider UK roll-out. Having physical, operating assets such as within the HyDeploy project, provides a tangible touch-stone for key stakeholders to grasp the merits of the approach, and therefore galvanise action.

Expect the unexpected

This time last year, no-one was expecting a global pandemic. However, a strong experienced team is able to address challenges successfully. Good people make all the difference.

The importance of collaboration

The project has been at its strongest when it is drawing on the widest possible range of expertise and creative & engaged parties. The supply chain, such as equipment manufacturers have valuable insights which should be incorporated at an early stage to improve outcomes.

10.0 Intellectual property rights

No registerable IPR has arisen during the period.

11.0 Risk management

Effective risk management is critical for successful project delivery. A risk register is being used as a project management tool.

Going into 2020 the key project delivery risks were associated with delivering the final Exemption evidence base, co-ordinating the application itself and the physical work.

Covid-19

A global pandemic was not a risk that had sat on the project risk register. However, the team structure and levels of co-ordination developed through three years of collaboration provided a bedrock for the team to manage the risks well. Most of the organisations transitioned to online working seamlessly, and the calibre of the individuals meant that where organisations were less well set-up, staff themselves found workarounds.

Some experimental work was delayed, and so some aspects of this Exemption had to be based on analytical assessment. However, this experimental work was progressed in the Autumn and will form a key part of the next Exemption. Acceleration of the H2H activities, meant there was no need to enter people's homes during the lock down. Other forms of engagement moved on line. There were some impacts on physical works. Overall, the adverse impact of Covid-19 has been measurable in a relatively few number weeks, although the team is looking forward to meeting again in person.

Exemption

This was successfully managed, navigating the Covid impacts with the main pack being delivered on 1st June 2020, supplemented by remaining key reporting elements over the following couple of months.

Physical works

Covid secure ways of working were identified. There were some impacts on timelines, particularly relating to site access. More generally contingent plans had to be put in place to manage budget and schedule, which resulted in an alternative delivery plan for installation using framework contractors which has been put in place.

Training and engagement

Online training was developed for network operatives, backed up by more limited physical training. For Gas Safe Engineers an online familiarisation event was developed with around 700 attendees, which was very well received.

Going forward the key risks being managed relate to:

Physical works

The final aspects of fabrication and construction. This is being addressed by tight management of contractors by NGN.

Operations

Resilient hydrogen supplies have been secured, designed to provide reliable hydrogen availability during the trials.

Industrial trials

These are scheduled primarily for 2021, with some limited burner trials taking place in December 2020. Costs and risks associated with this programme are being managed and mitigated through collaboration with 100% hydrogen Industrial Fuel Switching trials.

12.0 Accuracy assurance statement

This report has been prepared in accordance with the Gas Network Innovation Competition Governance Document published by Ofgem.

The project has been subject to review and challenge by the Cadent Project Manager and signed off by Damien Hawke, Cadent Safety & Network Strategy, who is Project Sponsor for this NIC project.

Damien Hawke has confirmed that the processes in place and steps taken to prepare this Project Progress Report are sufficiently robust, and that the information provided is accurate and complete.

13.0 The project team

HyDeploy2 is being delivered by the HyDeploy consortium, which has technical expertise and practical experience. The partners are:

Cadent Gas (formerly National Grid Gas Distribution) is leading HyDeploy. They own and operate four of the eight gas distribution networks in the UK, including the West Midlands.

Northern Gas Networks is partnered with Cadent to deliver HyDeploy. The project supports their other work exploring the future role of gas. They own and operate the gas network in the North East, Northern Cumbria and much of Yorkshire.

Keele University is hosting HyDeploy on its campus and the University's Materials Department are carrying out research on the impact of hydrogen on materials.

HSE Bespoke Research and Consultancy is the consulting arm of the Health & Safety Executive. They will be providing the scientific evidence which will support the safety case for the trial.

ITM Power manufacture integrated hydrogen energy solutions and will be supplying the hydrogen production unit for HyDeploy.

Progressive Energy is an independent UK clean energy company. It is undertaking the management of HyDeploy through its development and implementation.

In addition to the core project partners the project is supported by a number of key companies:

Kiwa specialise in gas testing. It is carrying out offsite testing on a range of common household appliances to inform the project, and will lead the gas safety appliance checks on the campus.

Dave Lander is an internationally recognised expert in gas quality and safety and is co-ordinating the Exemption application to the HSE.

HyDeploy

Visit **www.hydeploy.co.uk**
Send **info@hydeploy.co.uk**