HyDeploy2 Project

Gas Network Innovation Competition // Cadent

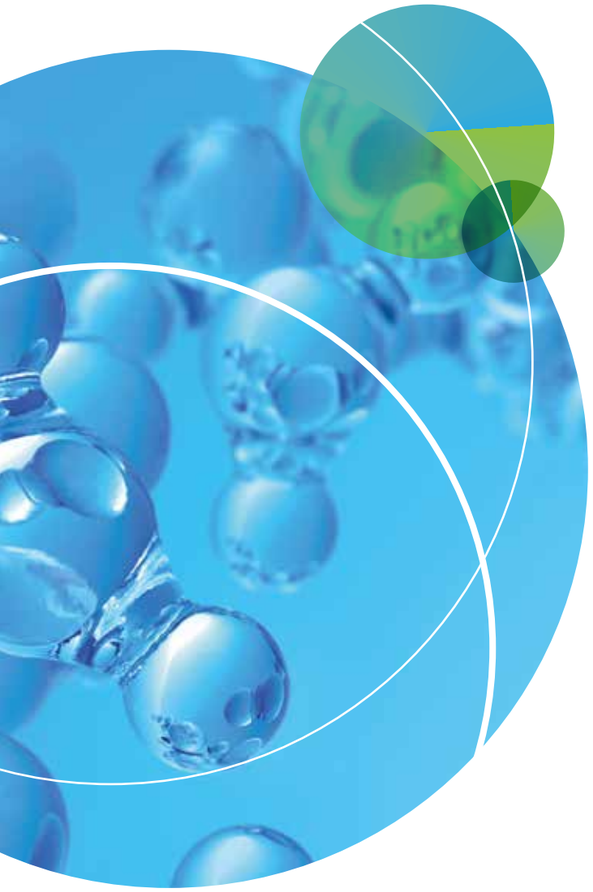
First Project Progress Report (PPR) // December 2019

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 %volume 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 normal gas. Such approval is provided as an Exemption to the Gas Safety (Management) Regulations. 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 installed, and an extensive trial programme undertaken.



Blending hydrogen at 20% volume 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.

Contents

1.0 Executive summary

The HyDeploy2 project has had a successful year, with formal commencement of the project in April 2019. The focus of the project this year has been:

1. Further developing the evidence base generated in HyDeploy to support the first public exemption,
2. Engaging with customers and stakeholders.

The work carried out over this year has built a foundational relationship with residents along with building sound evidence to support the first public exemption application in 2020.

The scientific programme, led by The Health & Safety Executive – Science Division, has made exemplary progress over the course of 2019. Building upon the programme architecture developed in HyDeploy, the scientific programme consists of work in gas characteristics, appliances, materials and gas detection. The overarching objective of the scientific programme is to develop the evidence base to allow the boundary of risk to be drawn tighter to understand the macro risk position of the introduction of hydrogen blended gas without any intervention and additional mitigations. The evidence generated through HyDeploy was sufficient to justify a year-long trial at Keele alongside physical mitigation such as leak tests. Mitigation was required, not to counter specific challenges, but to form a suitable risk margin in relation to the evidence. The purpose of the HyDeploy2 scientific programme is to increase confidence in the overall evidence base to draw the assessment of risk more tightly. This allows a more pragmatic position to be taken on required physical mitigations, with the ultimate objective of removing the need for any active additional mitigation within the home or on the network to accommodate the deployment of hydrogen blended natural gas containing up to 20 %volume hydrogen.

In preparation for the trials a rigorous site selection progress was undertaken, taking a holistic approach of understanding the physical deliverability of potential sites along with network implications of isolation and demographic information of the local region. Given the relative deliverability of the chosen sites across the Cadent and NGN networks, a project decision was taken to develop and execute the NGN site as the first public trial. The primary reason for this being that the NGN site has a secure NGN owned gas research facility to house the compound, rather than being contingent on land acquisition negotiations.

A successful and well managed customer engagement exercise was conducted to initiate formal preparations of the first public trial. The area of the NGN network that will receive the blended natural gas consists of 670 homes. Replicating the process undertaken in preparation for the HyDeploy trial, a house-to-house survey has been carried out to collect Gas Safe evidence of appliance integrity. Working collaboratively with the local housing authority Gas Safe evidence has been collected on 88% of homes to date, with external non-invasive information collected on the remaining houses. The original programme timeline scheduled the survey to take place in January 2020, however due to proactive and dedicated planning the project team were able to deliver the survey 3 months early. Expediting the survey has de-risked the project programme, allowed early engagement with consumers to build a strong working relationship with residents, and ensured appliances were safe and sound for the winter heating season.

Stakeholders have sat at the heart of the engagement and communications strategy of HyDeploy2. The primary stakeholders of the project being the residents of the trial location. Dedicated Customer Care Officers (CCOs) were deployed to the project to ensure there was a focused and responsive team of experienced customer liaisons to manage residents and ensure they were providing necessary information and support. Regular engagement has taken place throughout 2019 with policy makers, industry stakeholders and well-attended conferences. This formal engagement has provided bilateral forums to disseminate evidence and information about blended gas to key decisions makers, to the benefit of the industry at large and in facilitating hydrogen deployment.

Overall 2019 has been a very successful and productive year for HyDeploy2. The work carried out over this year has built a foundational relationship with residents along with building sound evidence to support the first public exemption application in 2020.

2.0 Project Manager's report

The HyDeploy2 project has had a very successful year, building on the early progress at the start of the project.

Key achievements

The work completed over the course of 2019 has been to lay the foundations for 2020 when the exemption application for the first public trial will be submitted as well as the commencement of the public trial itself.

The preparations for the trial started with a rigorous site selection process, involving network analysis of nearly 40 potential sites. A balanced picture of each potential location was developed, taking account of the local network dynamics, residential demographics, ease of utility connections and availability of land, to site the compound. Once all sites had been mapped in detail a formal review process was undertaken to refine the selection and agree primary site locations. On review of the relative delivery risks of the two chosen sites across Cadent and NGNs networks, a unanimous project decision was taken to use the NGN site for the first public trial. This was due to the site having a GDN owned gas research facility and known utility connections, therefore representing a lower risk of deliverability for the first public trial. The NGN site is also the same place the hydrogen grid entry unit was factory acceptance tested (FAT) during HyDeploy allowing cost savings with existing infrastructures being installed during the HyDeploy FAT.

Customer safety is the first priority of HyDeploy2. The primary sanctioning of the trials is via an agreed exemption to the hydrogen limit within the Gas Safety (Management) Regulations (GS(M)R), which requires an evidence base to be presented to the HSE demonstrating that consumers safety will not be prejudiced. To support the evidence base, a house-to-house (H2H) survey was undertaken in the trial location, building upon the experience and learning of the HyDeploy trial. The survey consisted of collecting Gas Safe compliance evidence of all the appliances on the network and undertaking remedial work where needed to ensure the integrity of the installations. By working with local Gas Safe organisations, the local council and dedicated Customer Care Officers evidence has been collected on 88% of homes to demonstrate Gas Safe compliance of appliances. Non-invasive external information was collected on the remaining homes, working with service providers as well.

The H2H survey provided the first opportunity to formally engage with consumers on the trial location, introduce them to the project and run local engagement events to inform the residents and ensure they were kept at the centre of project decision making. The data collected during the survey will aid in the mapping of the current 'base case' risk profile of the local region, to allow an accurate comparison with the 'blended gas' risk profile to be made. This will allow a robust risk assessment to be made to ensure consumers safety is not prejudiced by the introduction of blended gas of 20 %volume hydrogen.

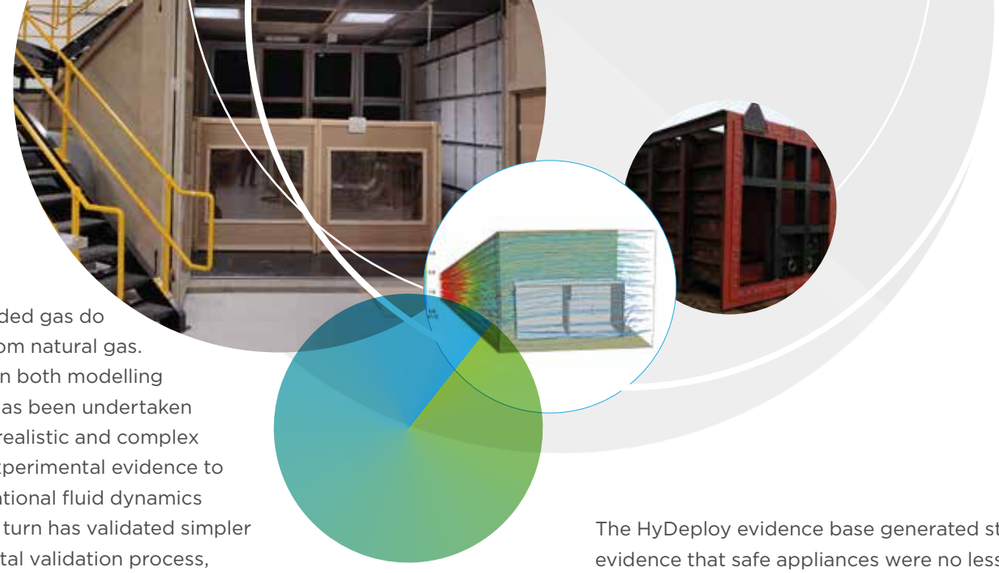
Alongside consumers safety, ensuring consumers are not financially disadvantaged by the project is a key priority for HyDeploy2. Therefore, early work was undertaken to explore billing options for the trial, to minimise disruption to the current billing process and guaranteeing consumers interests lay at the heart of the billing process. Utilising learning from the HyDeploy trial, along with engagement with Xoserve and the shipper/supplier community, a pragmatic billing approach was agreed between all parties with the principles reviewed and approved by Ofgem. This pragmatic approach will ensure consumers are not financially disadvantaged from the introduction of a blend of hydrogen whilst providing transparency to all stakeholders within the billing process.

To ensure a safe and well managed public trial both upstream (network) and downstream (domestic and commercial) procedures were reviewed. The overarching objective of HyDeploy2 is to launch the blended hydrogen industry and not all pressure tiers of the distribution network will naturally be exposed to a blend of hydrogen as part of the trial. Therefore, the philosophy of the procedures review was to understand the implications for procedures from NTS take off points through the distribution network and into homes and appliances, including installation and servicing of appliances. Over 800 network procedures were systematically reviewed, building upon the proven process of review and challenge developed through HyDeploy, to allow the extent of blended gas implications to be understood in its totality. The implications for blended gas were not found to be showstoppers, as less than 10% of procedures required further review.

Downstream of the emergency control valve, all procedures (BSI & IGEM) along with accepted industry guidance was reviewed for all domestic and commercial appliances types (over 100 appliance types identified) across all potential operations from installation through to decommissioning. Once again, the implications of blended gas were systematically overlaid on the procedures to understand any supplementary guidance requirements. Formal engagement with standard bodies will commence in 2020 to ensure the industry is adequately prepared for the first public trial.

Gas detection is critical to the safe and effective use of procedures. Following Gas Detection evidence generated as part of HyDeploy a pragmatic two-detector solution, using currently available detectors, was utilised for the HyDeploy trial. To support the first public trial the gas detection market was engaged with which led to a development programme of a gas detector that works seamlessly between a natural gas network and blended network, with automatic recalibration undertaken within the detector. This provides a user-friendly solution for operatives to respond to incidents across both natural gas and blended gas networks with the same detector and without procedural changes. The project team took receipt of the newly developed gas detector in December 2019.

The final physical preparation for the first public trial has been the scoping of the network modifications required to carry out the trial, and the commencement of competitive tender process to select the primary engineering contractor.



All network modifications to isolate the network and supply it with blended gas have been scoped and agreed between the project team and NGN, with all works planned in for mid-2020.

The engineering contractor will be selected in 1Q20 to allow work to commence on the design and installation of the existing hydrogen generation and gas mixing equipment at the trial location, utilising all of the learning and experience of the design and installation of the equipment for the HyDeploy trial.

The scientific evidence base is the core technical work that has been developed as part of HyDeploy2 over the course of 2019. The HyDeploy2 scientific programme is building upon the evidence base generated through HyDeploy to increase the confidence and direct applicability of the evidence, allowing a tighter profile of risk to be understood and reduce the need for inherent conservatism necessitating additional physical mitigations.

The materials programme has consisted of mapping a representative set of materials for the distribution network and associated appliances, followed by short and long term 'soaking' and mechanical testing. The results of the HyDeploy materials programme did not discover any showstoppers, however the evidence confidence was bound to the duration of the trial. The goal for the HyDeploy2 materials programme is to broaden the applicability of conclusions across other materials and provide a longer time horizon for conclusions to be drawn.

An accurate understanding of gas characteristics is fundamental to ensuring robust procedures are utilised and in mapping the risk profile of a given gas. The primary gas characteristic work being undertaken as part of HyDeploy2 is to further understand the accumulation and consequences characteristics of blended gas, following a potential leak and contact with an ignition source. The relative characteristics between the blended gas and natural gas are the primary output. It is broadly understood that the accumulation characteristics of blended gas do not materially differ from natural gas. To validate this position both modelling and experimentation has been undertaken to develop ever more realistic and complex analysis tools, using experimental evidence to validate a full computational fluid dynamics (CFD) model, which in turn has validated simpler models. This incremental validation process, from real world to modelling, has allowed a useable and powerful model to be developed to understand the full spectrum of real-world variability and their impacts on gas accumulation characteristics. Through early 2020 the full set of results will be known, to support the exemption application. Initial results are indicative of confirming the position that blended gas does not accumulate in a materially different manner to natural gas.

Alongside the accumulation work, the consequences of ignition have been studied by design and building room-sized containers with extensive monitoring equipment to allow controlled ignitions of natural gas and blended gas to be undertaken and the relative impact to be studied. Due to the scale and complexity of this experiment, 2019 has consisted of designing, building and commissioning the experiment along with developing the risk assessment and method statements. The experimental results will be understood in 1Q20.

Understanding the current risk profile of the gas network, and casualty of risk, is the first step in being able to confidentially understand the implications of changing the gas composition. To that end, the project team have worked collaboratively across all GDNs and informed entities to compile a consolidated dataset of incidents, allowing the profile and causality of risk to be understood to a greater degree. The incident dataset will inform the interpretation of the experimental results in aid of rigorous risk assessment, and will be made available for other programmes to use to ensure consistency of risk evaluation.

The HyDeploy evidence base generated strong evidence that safe appliances were no less safe following the introduction of a 20 %volume blended gas. The objective of the HyDeploy2 appliance workstream is to understand the implications of blended gas on malfunctioning appliances, to ultimately demonstrate that under all condition scenarios an appliance will not be less safe following the introduction of a 20 %volume hydrogen blend. Working in collaboration with appliance manufacturers and industry experts, such a Blue Flame Associates and Kiwa Gastec, a rigorous testing regime has been developed and deployed to explore the impact of blended gas on domestic and commercial appliances in their totality. Initial results have indicated promising results; however, the full data set will be available following the completion of the programme in 1Q20.

The ultimate destination for all of the scientific evidence generated is the Quantitative Risk Assessment (QRA) developed to allow all gas characteristics, causal events and mitigations to be aggregated together and the resultant overall risk profile of gas use to be understood. The structure of the QRA was reviewed and endorsed by the HSE as it underpinned the HyDeploy exemption. Throughout this year a robust review and challenge process was undertaken to utilise the project teams increased understanding of incident causality, following research and experimentation, to explore where the graduality and accuracy of the QRA could be improved. Additional functionality, primarily associated with the mapping of carbon monoxide risk, has been incorporated within the QRA to allow a more detailed risk profile to be understand.

The updated QRA will form the ultimate risk assessment tool to support the first public exemption application.

Much work has taken place over the course of this year to communicate with local residents, industry stakeholders and policy makers. Given the topicality of climate change and the supporting role heat policy has to play in ensuring the UK's recently updated Net-Zero target by 2050 is achieved, the importance of clear and concise communication about the opportunities and challenges of blended gas deployment has never been so important.

To help inform the project's local communications strategy and government stakeholders associated with community update, a formal social science research programme was commissioned through Newcastle University.

This highlighted the current attitudes and concerns of consumers and informed the messaging strategy that ultimately led to a very successful H2H engagement event with residents. The research found that 70% of consumers would be supportive of hydrogen blended gas deployment, and unsurprisingly potential cost implications resulting from any change were the primary concern of consumers. As a result of a successful engagement strategy regional media picked up the project and have reported positively on HyDeploy2.

A well-attended launch event was held in London in April 2019. The launch event consisted of formally introducing HyDeploy2 to industry stakeholders and policy makers, with useful and informative debate.

The project was received very positively by the invited stakeholders, will a full room. Following the launch event HyDeploy2 was cited in parliament as an example of the gas industry making positive and practical steps to decarbonising the UK's gas supply.

Outlook for next period

The activities of 2020 will consist of finalising the evidence base to being used to support the first public exemption application, alongside with submitting the application and undergoing the challenge and review process of the HSE. Running parallel to the scientific evidence the training and procedural development for the first public trial will be undertaken, utilising the learning and experience of the training undertaken to support the HyDeploy trial.

The design, installation and commissioning of the compound will take place. Following the transfer of the hydrogen generation and mixing equipment from Keele University to the NGN trial site, the equipment will be tested and installed followed by commissioning and ultimately the commencement of the first public trial.

Key Challenges

The key challenges over the past year have been associated with the ambitious delivery timeline of the project. The delivery timeline of the project is to have submitted the exemption application for the first public trial within 12 months of project commencement, in comparison with the HyDeploy1 project timeline which scheduled 2 years for exemption preparation. This compressed timeline has represented constraints concerning budgetary expenditure and resource availability; however, the project remains on budget and due to deliver within the specified time horizon of the original timeline.

The project will enter the construction phase of the programme and therefore challenges will inevitably emerge around logistical management and resource allocation. However, utilising the strong and dedicated team developed through HyDeploy, as well as learning from previous experience, no challenges are foreseen that will result in overall delivery risks. Customers will continue to be engaged with throughout the next phase of the project, ensuring they are kept at the heart of project decision making and building upon the productive relationship developed with the residents through the H2H survey.

Overall this has been a successful and productive year of delivery, making truly ground-breaking progress relevant not only to blending of hydrogen, but to the wider role of hydrogen in our energy system. This has been achieved through a competent, dedicated and engaged project team working collaboratively.

3.0 Business Case Update

The UK is committed to a pathway to carbon reductions through the Climate Change Act. The major change in 2019 was a revision to the Climate Change Act, committing the UK to achieving Net Zero rather than just an 80% reduction by 2050. This is a very significant change; now all parts of the energy sector will need to deliver. This has led to heightened awareness of the imperative of addressing climate change, and the pressing need to make progress.

The commitment to Net Zero followed a report by the Committee on Climate Change (CCC)[1]. In this report, the CCC identified that Hydrogen is a necessity and not just an option to meet Net Zero. For the UK to deliver on its commitments, it has explicitly identified the requirement for 270TWh/yr of low carbon hydrogen. It also identifies the need to make rapid progress in appropriate parts of the energy system where major changes are 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).'

In its subsequent 2019 Progress Report, the CCC reinforced that: 'In order to develop the hydrogen options, which are vital in our net-zero scenarios, significant volumes of low-carbon hydrogen must be produced.'

This recognises that blending of hydrogen is a vital part of the roadmap. 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 and Hy4Heat are designed to progress these network and appliance issues.

Manufacturers such as Worcester Bosch who have worked closely with HyDeploy team are developing hydrogen ready boilers to facilitate that transition. This could mitigate the impact of roll out by leveraging the natural replacement cycle. This transition has been mapped through work such as that undertaken by the ENA in its Pathways to Net-Zero Report[2]. 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 of 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 29TWh per annum of low carbon heat. This approach requires no changes to appliances and 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 InTegral 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. Initially this has been through its work on CCUS, building on work of the CCUS Advisory Group, and a recent consultation[7]. There is also an increased focus on hydrogen its own right. BEIS has supported early developments under its Hydrogen Supply programme and has recently announced the Clean Hydrogen Fund. These programmes enable early development and send strong signals to the market about government's intent. However, a firm policy regime is increasingly urgent to ensure that programmes such as HyDeploy can transition into roll out to make a positive contribution to 4th and 5th Carbon Budget shortfalls.

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

[2]Pathways to Net-Zero: Decarbonising the Gas Networks in Great Britain, ENA, October 2019

[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/

[7]https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-business-models

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 is progressing well. Much of the effort and resource used this year has been focused on defining the gaps of evidence necessary to support a specific public exemption whilst also structuring the scientific programme to generate the necessary evidence to support national roll out of hydrogen blending up to 20 %volume. Due to the broad objectives of the scientific programme agreed specification of experimentation took slightly longer than previously scheduled. However, following the progress in designing, commissioning and conducting experimentation has enabled the original programme timeline to be adhered to. Progress for trial preparations is ahead of the original plan as the H2H survey was designed and delivered 3 months earlier than originally scheduled, avoiding undertaking any remedial works over Christmas. Due to commercial sensitivities the contractual arrangements for undertaking and delivering the engineering requirements of the first public trial have been marginally delayed, however necessary information will still be delivered to support the exemption application and no delay to the physical delivery is forecast. Overall progress against the original plan has been maintained, and in some areas, progress has been delivered ahead of the plan. This has been achieved through the dedication and focus of the project team.

Programme element	Progress
1. Exemption evidence - Materials	An extensive asset survey was undertaken to map the full spectrum of materials that could be exposed to 20 %volume upon national roll out, including their likely operational mode and stress conditions. A process of review and refinement, supported by previous evidence generated and an extensive literature review, resulted in identification of the key materials necessary for further experimentation. A competitive tender process was undertaken to select a subcontractor(s) to undertake the actual experimentation, as this could allow specialist experimental equipment to be utilised within the project without needing to incur the expense of purchasing the equipment. The University of Manchester and the University of Sheffield were selected as the winning bid to undertake the work. The first round of materials experimentation, through sample preparation and controlled 'soaking' in blended gas has commenced with results expected December 2019. Experimental conditions are to be varied to allow necessary results to be made available to support exemption submission timelines, whilst also producing long-term evidence to support national roll-out.
2. Exemption evidence – Appliances	A rigorous selection process was undertaken to review all domestic and commercial appliance types in the UK and derive a defendable sample set representative of the full population for testing, the total population was found to be ca. 100 appliances with a sample set of less than 10. This process took slightly longer than initially anticipated, to provide sufficient time to review and challenge the sampling logic with a variety of appliance manufacturers and downstream industry experts. However, a high degree of confidence has now been attributed to the sample set to allow conclusions to be applicable to both the specific trial location and support a national roll-out argument. 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. An experimental design process was undertaken to allow all faults/maloperation situations to be understood by investigating the associated fundamental causality and directly manipulating the underlying combustion characteristics. Following experimental design and commissioning early data have demonstrated promising results with the full dataset due for early 2020 to support the public trial exemption.

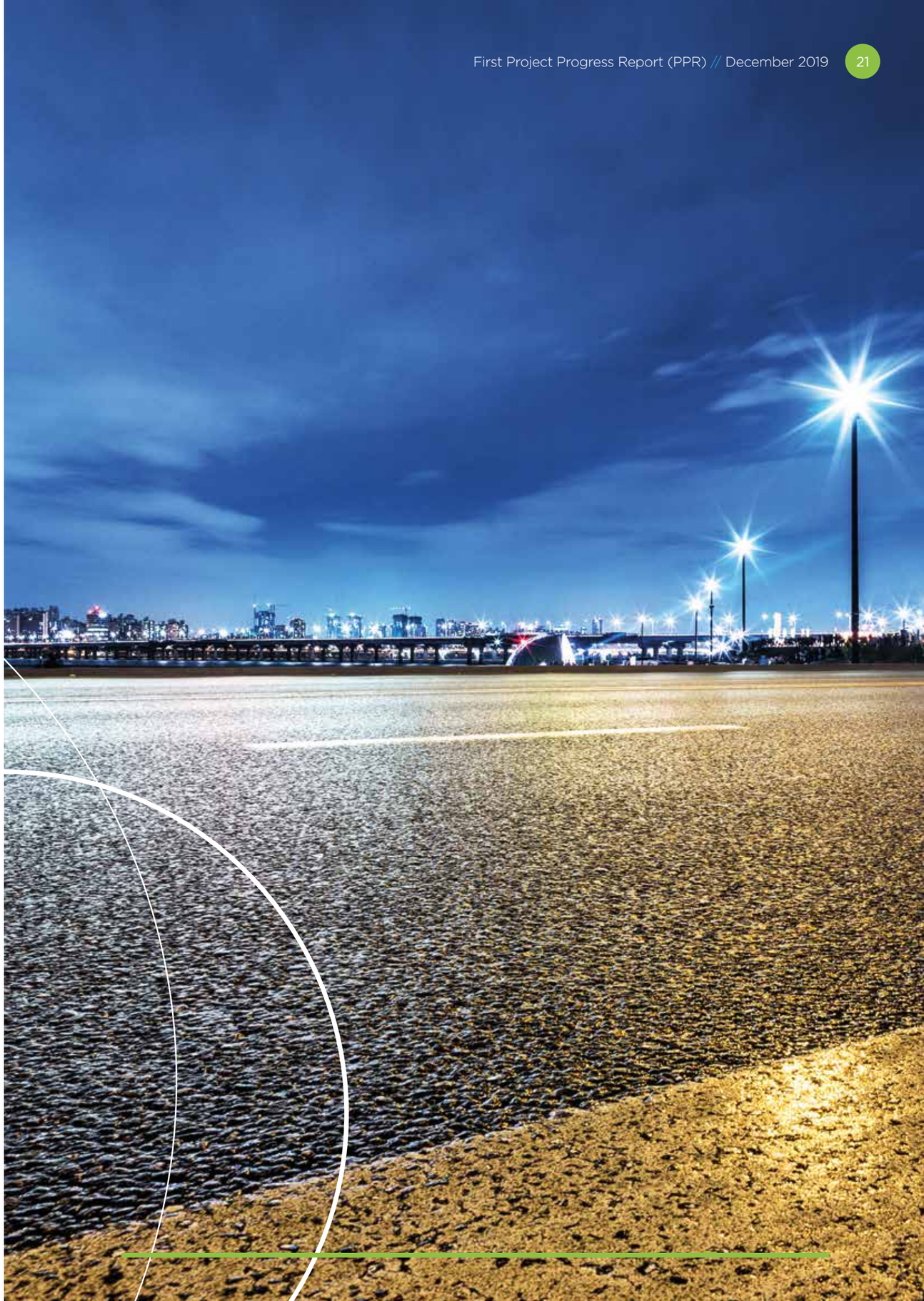
Programme element	Progress
3. Exemption evidence - Gas Characteristics	Gas characteristics has been the largest workstream within the scientific programme. The two primary arms of this workstream has been the Accumulation and Consequences workstreams. The Accumulation workstream has consisted of developing 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 variability 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 will provide strong evidence to validate the models and allow confidence to be applied to modelling outputs. Initial 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	Gas detection is critical to risk management of the network and dwellings. Accurate gas detection is required to allow procedures to be utilised confidently by operatives to respond to incidents and manage risk. The gas detection industry was engaged resulting in a collaborative relationship being developed and a product development programme carried out to redesign a currently widely used natural gas detector to detect up to 20 %volume hydrogen and automatically adjust settings accordingly. This allows operatives to utilise the detector across a natural gas and blended network without intervention or procedural change. The GDN validation and approval process (G23) has been initiated to conduct field trials of the detector, with the ambition to use it to manage the first public trial. The flue gas analysis industry has been engaged to understand and explore opinions to account for the implications of blended gas combustion, whilst minimising change to the current equipment. Technical solutions have been assessed in collaboration with manufacturers with the ambition to develop a software solution and therefore remove the need for new hardware for the appliance installation and service market to adopt blended natural gas.

Programme element	Progress
5. Exemption evidence – Procedures	Pragmatic and accurate procedures are essential to the governance of the gas network and appliances. A dedicated workstream was developed to assess both upstream (network) and downstream (dwelling) procedures. Building on the output of the HyDeploy1 procedures workstream, a team of network procedural experts have identified and assessed all network procedures, including those that will be impacted on roll-out but not for the trial. A process of technical evaluation and standards body engagement will follow to embody the changes identified into base procedures, to date no significant change has been identified to allow upstream procedures to be applicable to a blended gas network. A separate group of downstream experts, led by Blue Flame Associates, was formulated to review all downstream procedures – domestic and commercial for all appliance types. A similar process of technical review and recommendation has been undertaken, with formal standards body engagement to follow. Overall the procedures workstream required significant resource to ensure the implications of blended gas across the full suite of UK gas procedures are understood, in time for the first public trial.
6. Extension of evidence base required for wider deployment	The technical programme dedicated to assessing evidence gaps not covered by the core technical programme was originally scheduled to commence in 2020. To cost effectively deliver on the objectives of this programme, HyDeploy2 made a nominal contribution to a project exploring industrial fuel switching to run blended gas demonstration trials at industrial sites. By aligning objectives of two programmes and making a nominal contribution, one of the core deliverables of the 'wider evidence' technical programme will be delivered cost effectively to HyDeploy2. This programme is due to increase in delivery intensity in 2020. The core delivery of the HyDeploy2 wider evidence technical programme will be in late 2020 and 2021 – as originally scheduled.

Programme element	Progress
7. Generic activities applicable to all sites	A rigorous site selection process was undertaken to systematically assess all options for public trials. This holistic assessment took account of the network implications, physic deliverability of the site and regional demographics. This process concluded by identifying public trial locations that were deliverable and which will provide material benefit to the wider deployment of hydrogen. Following a risk identification and management exercise it was agreed by the project team to select the site on the NGN network to deliver the first public trial, due primarily to the compound siting land being owned by NGN in a secure gas research facility.
8. Local engagement and evidence gathering	A successful local engagement exercise was undertaken to engage with the residents of the first trial location and gather Gas Safe data on the appliances. A dedicated team of Customer Care Officers (CCOs) alongside local Gas Safe engineers engaged with the local community to provide free Gas Safe checks to residents in the area. Allowing remedial works to take place to ensure customers safety and provided an opportunity to gather evidence and develop a local relationship between the project and the residents. Working collaboratively with local housing authority, Gas Safe evidence was gathered on 88% of the 670 homes in the trial location, with external non-invasive information gathered on the remainder. It was only through careful planning and thoughtful customer-focused delivery that such a high rate of household evidence could be achieved.
9. Develop and submit site specific exemption.	Was not due to commence in 2019.
10. Site preparation, installation and commissioning	The majority of physical site preparations will take place in 2020. A competitive tender process was initiated this year to select the engineering contractor to undertake the design, installation and commissioning work. The process will conclude in early 2020 in time to have developed plans for review as part of the exemption application.
11. Live trial	Was not due to commence in 2019.
12. Site reinstatement and engagement close out	Was not due to commence in 2019.
13. Network models for deployment	Was not due to commence in 2019.

Programme element	Progress
14. Regulatory and commercial basis for deployment	For the purposes of the first public trial a pragmatic billing process has been agreed with Xoserve and industry stakeholders which will ensure customers are not disadvantaged in any way and minimises the administration burden of augmenting the billing process. The primary regulatory and commercial deployment work was always scheduled to take place after 2019, therefore only trial-related matters have been addressed over the course of 2019.
15. Skills and training	Once the procedural workstream has concluded a training package will be developed and delivered to operatives to ensure all effected operatives are competent to carry out their duties on a blended gas network.
16. Communications and dissemination	The communications strategy of 2019 was largely focused on supporting a successful delivery of the H2H survey. To support the strategy development a piece of social science research on the public acceptability of blended gas was undertaken with Newcastle University. This research informed the communications strategy by highlighting where consumers may have concerns and therefore allowing the communications strategy to address those concerns in a targeted manner. The research indicated that the majority of consumers would be supportive of blended gas being introduced in their local area. The primary dissemination activities planned are due for after the first public exemption process has been undertaken, to provide strong evidence for industry and policy maker engagement on the deliverability of blended natural gas. The project team is in regular contact with policy makers and influencers such as BEIS, CCC and IGEM to ensure stakeholders are being kept abreast of project progress.
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 the next page shows the progress against budget to the end of October 2019. 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 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	62,717	403,204	803,623
2. Exemption evidence – Appliances	196,995	555,494	751,017
3. Exemption evidence – Gas Characteristics	497,445	999,082	1,042,718
4. Exemption evidence – Gas Detection	14,779	264,768	264,768
5. Exemption evidence – Procedures	18,168	239,808	355,860
6. Extension of evidence base required for wider deployment	1,280	334,299	2,049,756
7. Generic activities applicable to all sites	104,238	1,097,770	1,097,770
8. Local engagement and evidence gathering	34,514	1,000,042	1,606,884
9. Develop and submit site specific exemption	28,806	194,280	862,840
10. Site preparation, installation and commissioning	9,819	834,098	2,216,196
11. Live trial	0	0	1,850,160
12. Site reinstatement and engagement close out	0	0	176,000
13. Network models for deployment	0	55,000	55,000
14. Regulatory and commercial basis for deployment	14,560	106,000	214,000
15. Skills and training	0	0	90,000
16. Communications and dissemination	10,052	93,618	373,490
17. Project management	190,650	378,373	1,158,660
Total	**1,184,023**	**6,555,836**	**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

SDRC 1 was completed on time.

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. These have been broken down into specific programme areas.

Evidence Base Generation.
The programme has developed a rigorous technical analysis process which allows the benefits of leveraging a variety of technical tools to be harnessed in support of evidence generation. By proactively designing technical workstreams to include both modelling and physical experimentation, the relative benefits of the two conceptual techniques can be captured to ensure robust evidence is generated in support of the exemption application and national roll out.

Technical Programme Integration.
Through developing each technical workstream within the scientific programme in parallel the interfaces and co-dependencies of workstreams can be clearly identified – allowing each workstream to be structured in a complimentary manner. This ensures the resultant evidence base, in its totality, will be a cohesive and consistent to deliver on the overall programme technical objectives.

Customer Engagement.
At the NGN trial location strong customer engagement based on evidenced social science enabled direct evidence to be collected on 88% of the 670 homes within the trial area. This was facilitated by developing a well-structured engagement plan and dedicating experienced Customer Care Officers to liaise with the residents – ensuring their questions were always addressed in full and making customers feel valued. Feedback was positive and good access was achieved.
Lessons learned:

- Don't underestimate the time and effort to communicate with customers. It is the critical few that require the majority of the effort,
- Often issues must be dealt with that are separate to the programme, but are important to the customer, and therefore important to address to build trust.
- Timing of engagement is important for customers.

Supply Chain Engagement.
The project has benefited from excellent support from manufacturers and service providers who have worked in a collaborative manner to contribute towards to the programme and often provided equipment and expertise free of charge. The knowledge and experience of supply chains cannot be underestimated, and leveraging that expertise through dedicated engagement has been found to be immensely valuable to the delivery of the project.

Regulatory.
An approach to billing has been agreed in principle, however given the number of stakeholders and regulatory frameworks governing the UK billing process much time and resource has been applied to ensuring the administration and logistics of the trial billing process is appropriate and keeps customers interests at the heart of decision making.
The key learning outcome is that the amount of time needed to formulate acceptable and fair solutions to complex regulatory problems cannot be underestimate.

Team and Project Delivery.
The team is well formulated, complementary and is delivering high quality work effectively.
Lessons learned:

- Combing scientific rigour with practical experience is extremely valuable.
- Communicating assessments of complex risk profiles effectively through organisations is important.
- Internal project reporting processes provide visibility to enable informed decisions, particularly when managing the budgets of development projects.
- Engagement with other projects enables sharing of information and best practice, avoiding duplication and improving 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.

Many of the key project delivery risks have been successfully addressed over the last year. Minimising delivery risk of the trials is key to the success of the project, this was achieved by selecting the NGN trial site as the first public trial location. Addressing scientific risks will be essential in a successful exemption application in 2020, this risk was managed through detailed experimental design and collaborative engagement with industry and manufactures. The trial preparations were de-risked by bringing the H2H survey for the first public trial ahead in the programme by 3 months, which was successfully delivered to avoid any remedial works over the Christmas period.

The key identified risks being managed going forward are:

Exemption Approval Risks.
The largest programme risk of 2020 is the successful application to deliver the UKs first public exemption to GSMR to inject 20 %volume in the gas grid. This risk will be managed by building upon the robust evidence base generated in HyDeploy to address evidence gaps and increase confidence in the available evidence.

Programme Construction Risks.
Physical preparations of the compound location, including installation of the equipment and network modifications, are due to complete in 2020. Like any build programme cost and timeline risks will need to be proactively managed by employing robust controls and governance of progress, leveraging learning from the HyDeploy build programme and undertaking works as soon as practically possible.

Operational Procedures Risks.
As the project will complete the preparations for the first public trial through 2020 a robust and appropriate training plan will be developed and delivered on to ensure all operatives are competent in the use of blended gas operational procedures. This process will involve overcoming logistical challenges to coordinate the appropriate number of operatives to be trained – however planning for training has already commenced and will be finalised during 2020.

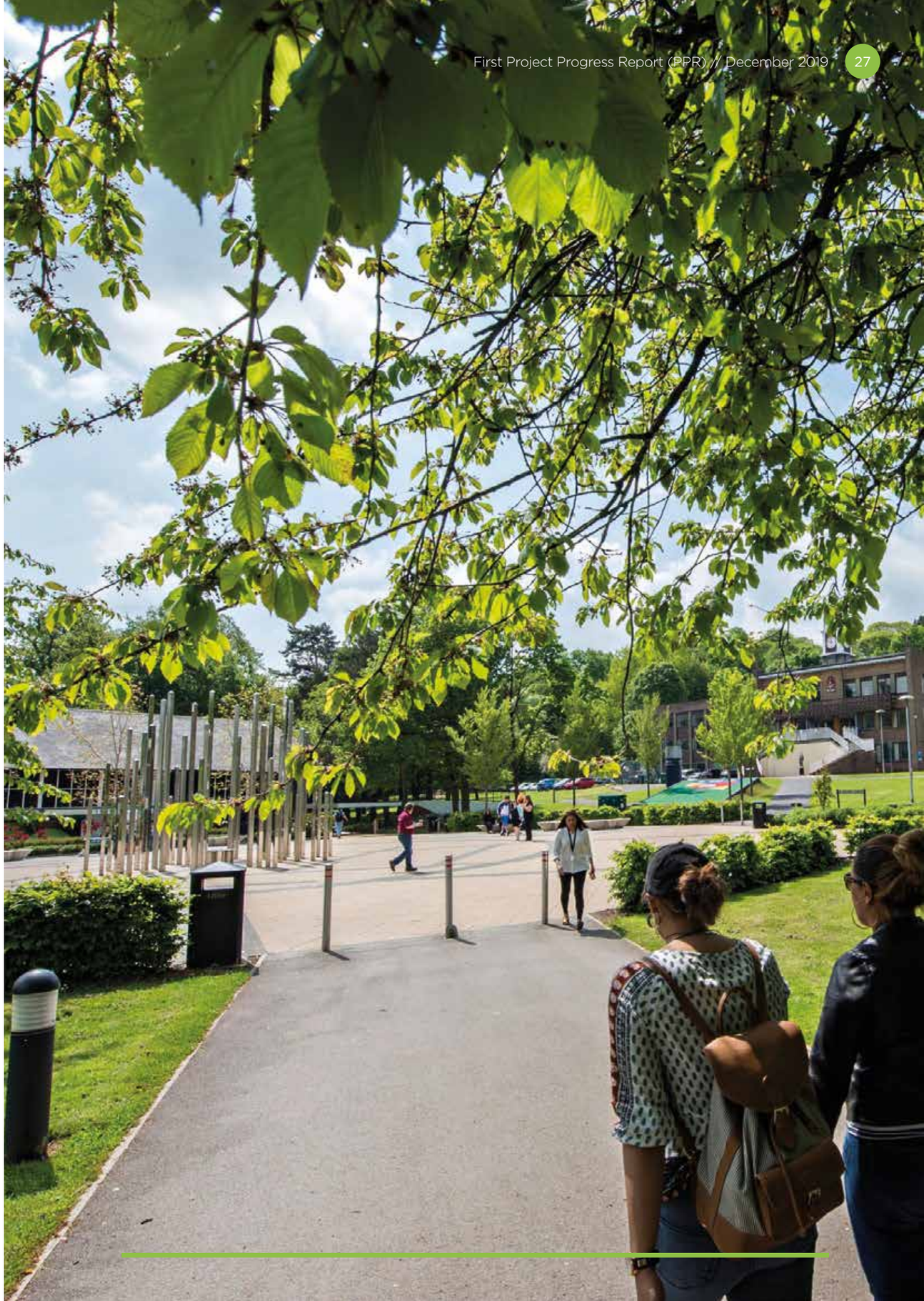
Business as usual risks.
Whilst the project is focused on delivering a blend of natural gas and hydrogen blend into a public UK network for the first time, much of the activities are 'business as usual' for gas networks. Both GDNs remain focused and vigilant to ensure that the network continues to operate safely as usual as we approach and then deliver the trial phase.

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 HyDeploy2. They own and operate four of the eight gas distribution networks in the UK, including the West Midlands..

Keele University is providing learning from the first HyDeploy trial and providing continuity of consortia through the HyDeploy2 trials.

ITM Power manufacture integrated hydrogen energy solutions. They will be supplying the hydrogen production unit for HyDeploy2.

Northern Gas Networks is partnered with Cadent to deliver HyDeploy2. They own and operate the gas network in the North East, Northern Cumbria and much of Yorkshire.

HSE Bespoke Research and Consultancy 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 public trials.

Progressive Energy Energy is an independent UK clean energy company. It will be supporting the management of HyDeploy2 through 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**
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