

# Hy4Heat Report

## Final Progress Report



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## Letter from Mark Taylor

As the Hy4Heat programme ends – its legacy continues. The Hydrogen Home in Gateshead with hydrogen-powered heating and cooking appliances is open to the public and has already welcomed many energy professionals, journalists and local citizens. Global CEOs, energy commentators and investors have seen the hydrogen appliances at COP26's innovation zone in Glasgow and the London Global Investment Summit. It's likely that the general public's understanding of hydrogen's potential to help overcome some of the trickiest decarbonisation challenges facing us will also increase as boiler manufacturers begin to market hydrogen-ready products in the coming years.

Hy4Heat has been a critical first step in establishing if it's technically possible, safe and convenient to replace natural gas with hydrogen in the gas network for residential and commercial buildings and gas appliances. Part of the programme involved considering the preparation required for a community trial with hydrogen. The government's Ten Point Plan for a Green Industrial Revolution and the subsequent Hydrogen Strategy highlight that a hydrogen neighbourhood and village trial are now planned, and the Hy4Heat programme helped lay the groundwork for this. It's exciting to consider that the Hy4Heat innovation programme that

started just a few years ago is having a direct impact on plans for trials, and that consumers in the H100 Fife neighbourhood should be using hydrogen for heating and cooking from as early as 2023.

While all the work packages are important, HSE independently reviewing the Hy4Heat safety assessment and providing a letter of assistance has been a significant milestone. The assessment indicates that the use of 100% hydrogen can be made as safe as natural gas in the limited range of scenarios described within the Annex where the additional risk control measures specified in the Annex are in place. This includes when used for heating and cooking in certain types of houses – the kind of detached, semi-detached and terraced houses that populate large swathes of the UK. This safety assessment provides an important foundation that the gas distribution network operators will use when planning community trials using hydrogen as a heating source.

Beyond Hy4Heat, the government published the UK's first ever Hydrogen Strategy in August 2021, putting the UK at the forefront of the race to develop a low carbon hydrogen future. BEIS, together with industry and the Hydrogen Advisory Council, is identifying and promoting

actions to enable low carbon hydrogen use at scale across the whole energy system. We know the UK is well-placed to draw upon its experienced gas-based manufacturing and consultancy to begin exporting products and expertise as well as to stimulate economic growth.

I'd like to thank the Hy4Heat team and all the companies and organisations that have played their part over the past few years in making it such a successful programme. Despite Covid-19's restrictions the Hy4Heat programme continued as a result of the programme team and contractors' professionalism and flexibility. I believe that a collaborative approach has been critical in achieving our aims, and am very grateful for the expert advice and support that has been given to the team by so many people. This kind of agility bodes well for the industry as it will need to adapt and change in order to ensure there is a cleaner, greener, energy system to help the UK meet net zero targets.



**Mark Taylor**  
Deputy Director for Energy Innovation  
Science and Innovation for Climate and Energy  
**BEIS**

The HSE's independent review of the Hy4Heat safety assessment has been a significant milestone



## Letter from Mark Neller

I'm very proud of what the Hy4Heat programme has achieved through the programme team and wider supplier teams collaborating to deliver all of its work packages. I'm also proud of the solid legacy and inheritance that Hy4Heat passes on to the next set of hydrogen innovation projects in the UK, and also in other nations with a significant gas distribution network.

It's also gratifying that Hy4Heat has been recognised by winning the Association of Project Management Programme of the Year Award 2021, meaning it was judged to have “demonstrated the most effective use of programme management techniques, achieved the greatest results, and provided evidence of innovation and lessons learned for the profession”.

The Hy4Heat programme made a great deal of progress in just a few years: from establishing hydrogen standards and a training framework for installers, through to the significant milestones of the safety assessment and the development of prototype hydrogen appliances, meters and components. The studies into commercial and industrial appliances and the market research into consumers' likely response to community trials are all foundation stones for the planned hydrogen community trials and potential future town pilot.

Since Hy4Heat began, the possibility and potential of hydrogen has become increasingly understood by industry, and by the general public, as having a key role to play in the decarbonisation of the energy system. It's clear that the challenges we face are not technical ones – as these can be overcome through innovation and engineering know-how – but rather they will be social issues. Great care needs to be taken to ensure that there is an informed and engaged population that understands that change to the way we heat our homes is needed which could include using hydrogen. People also need to be reassured that any transition will be managed fairly for all.

From a wider perspective there's also the opportunity that new hydrogen economies could bring in terms of jobs and skills from the production of low-carbon hydrogen through to development, manufacture, and installation of appliances for end users and consumers.

So, while the Hy4Heat programme has been successfully delivered, there's no time for resting on laurels. At the moment on a cold winter's day, about a sixth of the energy that we use, in the UK, is through the electricity network, about a third is through liquid fuels, and about half of all the energy that we use is through the gas grid. Decarbonising all these energy systems is important, and clearly decarbonising the gas grid is an imperative. The Hy4Heat programme is just one small, but important, piece of the jigsaw. There's still a very long way to go and there must be an even greater sense of urgency to accelerate the pace of change, in order to meet our net zero targets and reduce our impact on the environment.

Hy4Heat has: “demonstrated the most effective use of programme management techniques, achieved the greatest results, and provided evidence of innovation and lessons learned for the profession”.

**APM Award Winner 2021**



**Mark Neller**  
Hy4Heat Programme Director  
UKIMEA Energy Leader  
Arup



## Introduction & Programme Summary

Over the past few years, the BEIS Hy4Heat programme has played a significant role in the transformation in the mindset of industry towards a hydrogen future, and has helped to put the UK at the forefront of international efforts to develop safe, high-performance hydrogen technology for heating.

The UK is setting out its vision for transitioning to a net zero economy and, with around a third of UK emissions coming from households and some 80% of homes heated by natural gas, finding alternatives to natural gas as a domestic fuel is a high priority.

In 2017 BEIS committed £25m of its £505m Energy Innovation Fund to Hy4Heat. The programme has proved to be a critical foundation piece for Government's 2021 Hydrogen Strategy<sup>1</sup> and its Ten Point Plan for a Green Industrial Revolution<sup>2</sup> which includes hydrogen neighbourhood and village trials by the middle of the decade. These community trials will be possible as a result of the Hy4Heat programme.

Hy4Heat has achieved the technical, performance, usability, and safety evidence to demonstrate that hydrogen can be used for heat in some buildings. However the outcomes and benefits of the study are broader and more significant than expected at the start of the programme.

With a relatively small budget, the programme has unlocked hydrogen innovation across the gas industry. Consortia were encouraged to develop fully working prototypes within a constrained timeframe and lay the foundations of an entirely new customer-focused hydrogen appliance market. In a short time, the programme has moved UK hydrogen heating technology from a Technology Readiness Level (TRL) of one-to-two up to eight-to-nine on the scale: from a position of academic knowledge and understanding, to one of commercial market-readiness.

The programme encouraged the development of products that are like-for-like 'hydrogen-ready' replacements of existing appliances, maximising their convenience and acceptability for customers.

Innovation developments in this area include cooker hobs with burners that allow the pale blue, generally barely visible hydrogen flame to be easily seen by the naked eye. Something that it is thought will be important in shaping the public perception of hydrogen if it becomes part of the mix of technologies and options to decarbonise heat.

By adopting an evidence-based, stakeholder-led approach, Hy4Heat has mobilised manufacturers, supply chains and academic partners to collaborate on developing the boilers, meters, cookers, heaters and other appliances that will be central to a community-level trial – which will be essential for evaluating the practicalities of a potential conversion to hydrogen.

Unforeseen positive outcomes have arisen, too, in that emissions of NO<sub>x</sub> (Nitrogen Oxides - greenhouse gases) from burning hydrogen can be significantly lower than from methane with well optimised burner designs. This has helped stimulate new scientific research to investigate and explain these findings.

Another significant element of the programme was the completion of a first holistic safety assessment that shows the use of 100% hydrogen for heating and cooking can be made as safe as the use of natural gas in the most common domestic buildings (detached, semi-detached and terraced houses). This safety assessment is informing continuing work.

<sup>1</sup> UK Hydrogen Strategy, August 2021 - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1011283/UK-Hydrogen-Strategy\\_web.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf)

<sup>2</sup> The Ten Point Plan for a Green Industrial Revolution, November 2020 - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/936567/10\\_POINT\\_PLAN\\_BOOKLET.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf)

## Introduction & Programme Summary

In addition, the programme has supported the development of technical standards, certification guidance and a hydrogen competency framework for training, and has conducted market research studies on industrial and commercial appliances. Many of the programme's domestic appliances are showcased at the Hydrogen Home, developed in partnership with NGN and Cadent, and are also being used in other testing and display locations.

### The background

#### Getting the right team

In 2017 BEIS appointed Arup+, a team that brought together:

- Arup's programme management expertise and thought leadership in energy
- Leaders in the field of hydrogen Kiwa Gastec
- Energy specialists Progressive Energy and Yo Energy
- Appliance experts Embers

The Arup+ team's responsibility was to manage the programme on BEIS's behalf and together with BEIS oversee the procurement and delivery of all the work packages.

#### A clear mission

At the start a short mission statement was created to both guide the programme and to enable its large endeavours to be explained in a concise and precise way:

#### Hy4Heat's mission was:

"To establish if it is technically possible, safe and convenient to replace natural gas (methane) with hydrogen in residential and commercial buildings and gas appliances. This will enable the government to determine whether to proceed to a community trial."

The primary goal was to provide the technical, performance, usability, and safety evidence to de-risk the use of hydrogen and lay the groundwork for potential community trials.

Central to achieving this would be the critical safety assessment work and the development of a range of affordable hydrogen appliances, ready for use in homes and businesses.

#### A challenging start

Industry engagement research conducted at beginning of the programme identified that overcoming scepticism in the gas industry about the technical and commercial viability of hydrogen technology would be a challenge. Equally the manufacturing industry emphasised the timescales of the programme were unreasonably short in order to develop appliances.

Being a research and innovation programme there was a high level of uncertainty regarding the final outcomes, particularly about the timescales of appliance development. The overlapping nature of the work packages was complex and there were to be a large numbers of different stakeholder organisations involved. The success of the programme lay in the ability of Hy4Heat team to navigate these complexities and achieve results that last beyond the programme's lifetime.

The evidence-based, stakeholder-led approach saw leading manufacturers and their consortia team-up with academic partners to defy the odds and develop the appliances that will be central to a community trial within just three years. By creating a competitive environment for this surge of innovation, Hy4Heat laid the foundations for a consumer market of affordable, like-for-like, 'hydrogen-ready' appliances.

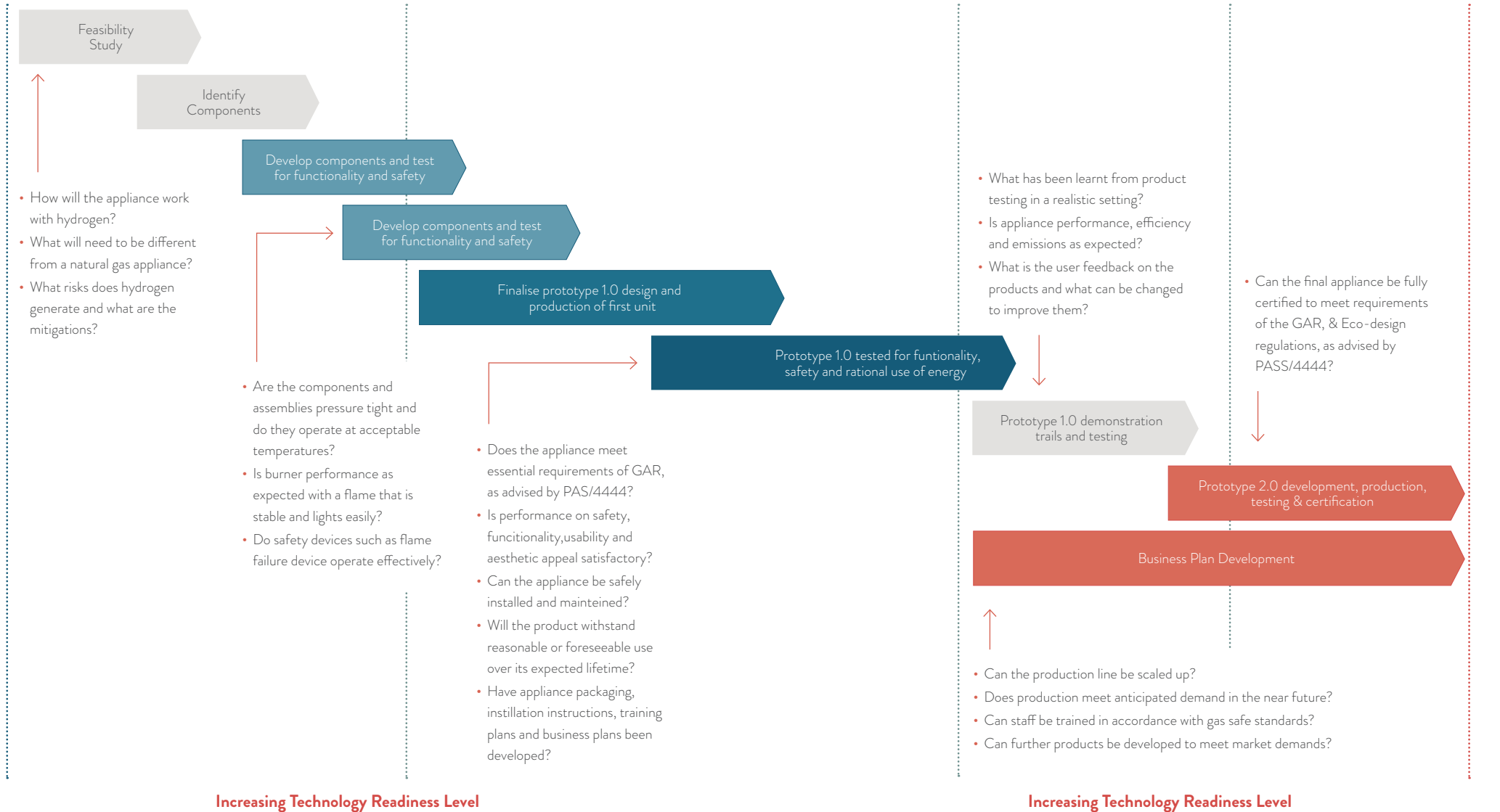
#### Building blocks for community trials

The appliances developed, alongside the safety assessment work and hydrogen standards, have all provided reassurance that progressing to the next stage of community trial is both feasible and plausible. This next stage is to be a hydrogen neighbourhood in 2023, a hydrogen village by 2025 and plans for a potential hydrogen town pilot before the end of the decade.

# Innovation Pathway

The Hy4Heat programme has supported the acceleration of the innovation pathway for hydrogen appliance development.

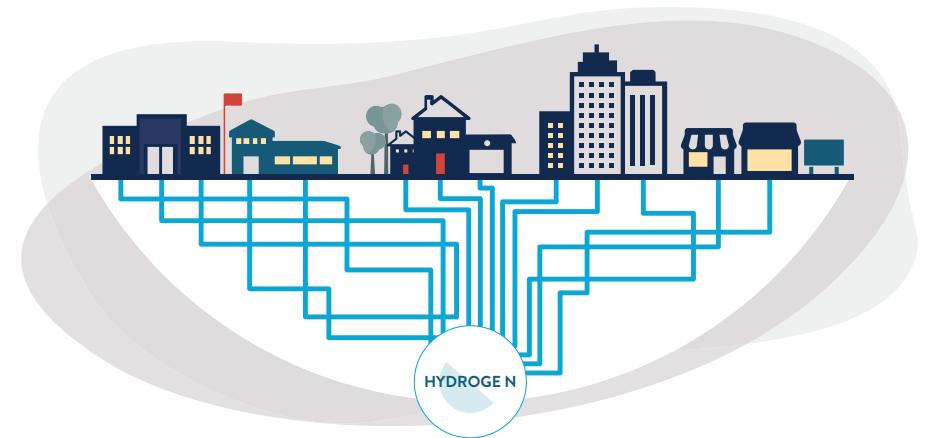
## Project Initiation



### Governance and programme structure

Stakeholder involvement in the governance structure, and throughout the whole programme, was an important part of ensuring key industry stakeholders could provide useful insight and inputs to support the programme delivery as well as provide challenge, oversight and scrutiny.

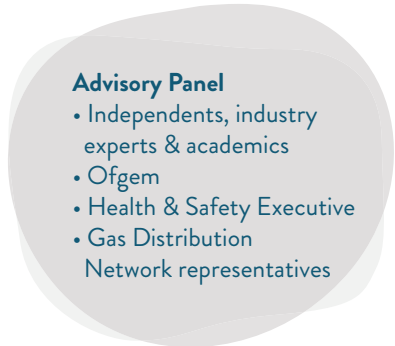
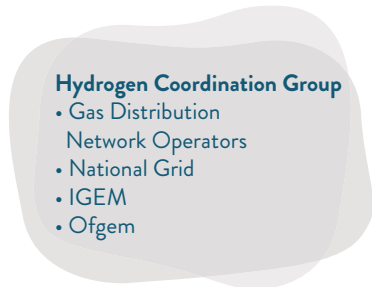
- The Programme Board was chaired by BEIS and composed of Arup+ and BEIS key programme team members, responsible for the strategic direction of the programme
- The Advisory Panel was composed to provide a diverse pool of knowledge from industry experts and academics, Ofgem, the Health and Safety Executive (HSE), and Gas Distribution Network Operators (GDNOs). It gave impartial advice, scrutiny and challenge, and peer review to the Programme
- The Hydrogen Coordination Group was composed of representatives from the GDNOs (Gas Distribution Network Operators), National Grid, IGEM, Ofgem and others and created to facilitate collaboration and learning across several projects and initiatives around hydrogen
- A Technopolis audit report into Hy4Heat commissioned by BEIS consulted stakeholders who stated that “both the Advisory Panel and Coordination Group included a good representation of the right expertise and skills needed”, and this resulted in “useful, comprehensive advice and challenge to the programme, in particular with reviewing outputs of the work packages”





# Hy4Heat Programme Governance Structure

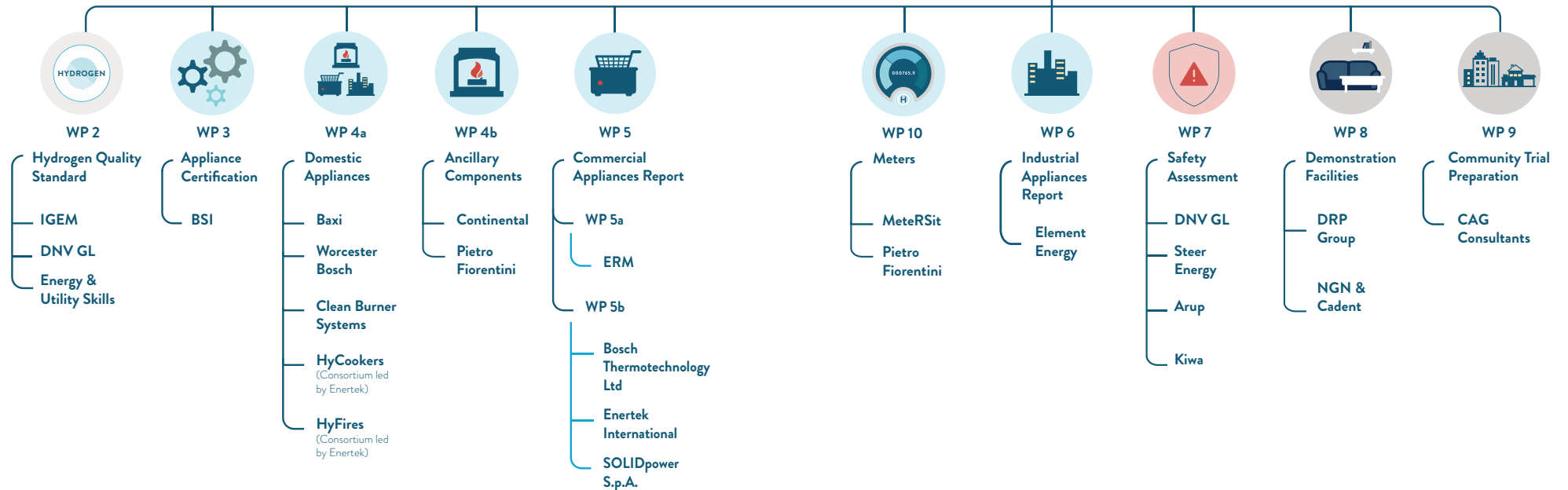
Hy4Heat's success has relied on collaboration of different companies and organisations. As well as the clear lines of accountability and responsibility to deliver the programme contractually, the Hydrogen Coordination Group and the Advisory Panel gave oversight, advice and guidance and were formed of different parts of the energy industry, academia, commercial sector and regulating bodies. The large number of suppliers, contractors and subcontractors delivering the various work packages undertook the majority of the programme's output.



Department for Business, Energy & Industrial Strategy



**ARUP**



## Stakeholder Engagement

At COP26 in Glasgow in November 2021, speakers from Hy4Heat organisations presented at the Hydrogen Transition Summit held in the Climate Action Innovation Zone and webcast globally. A display stand in the Innovation Zone enabled hundreds of senior business people and opinion-formers from across the world to see the hydrogen-burning stove, oven, boiler and meters up close. The exhibition stand was also displayed at the DIT Global Investment Summit in October, opened by the Prime Minister.

Throughout the programme Hy4Heat undertook extensive engagement with stakeholders. In part, this was conducted through links and relationships built with relevant trade bodies to drive programme awareness amongst its members but Hy4Heat also ran its own supplier events. These interactive sessions were to showcase the programme and also to gather insight and information from feedback in order to draft robust and relevant tenders for work package procurement purposes.

The number of attendees at the stakeholder event held in early March 2020 was double those at the first event in March 2018. More than 200 people attended from organisations including: appliance manufacturers and retailers, academics, energy industry consultants, trade bodies and associations, gas distribution network operators, exhibition agencies and the media.



## Effective Communication

An illustrative storyboard outlined the programme's mission in a simple way that could be understood by a non-technical audience. Throughout the programme this has been supplemented by the website, as well

as presentations, webinars and videos. The exhibition stand used at conferences in 2021 included video content featuring manufacturers and gas industry representatives demonstrating the household appliances.

### The Hy4Heat Programme

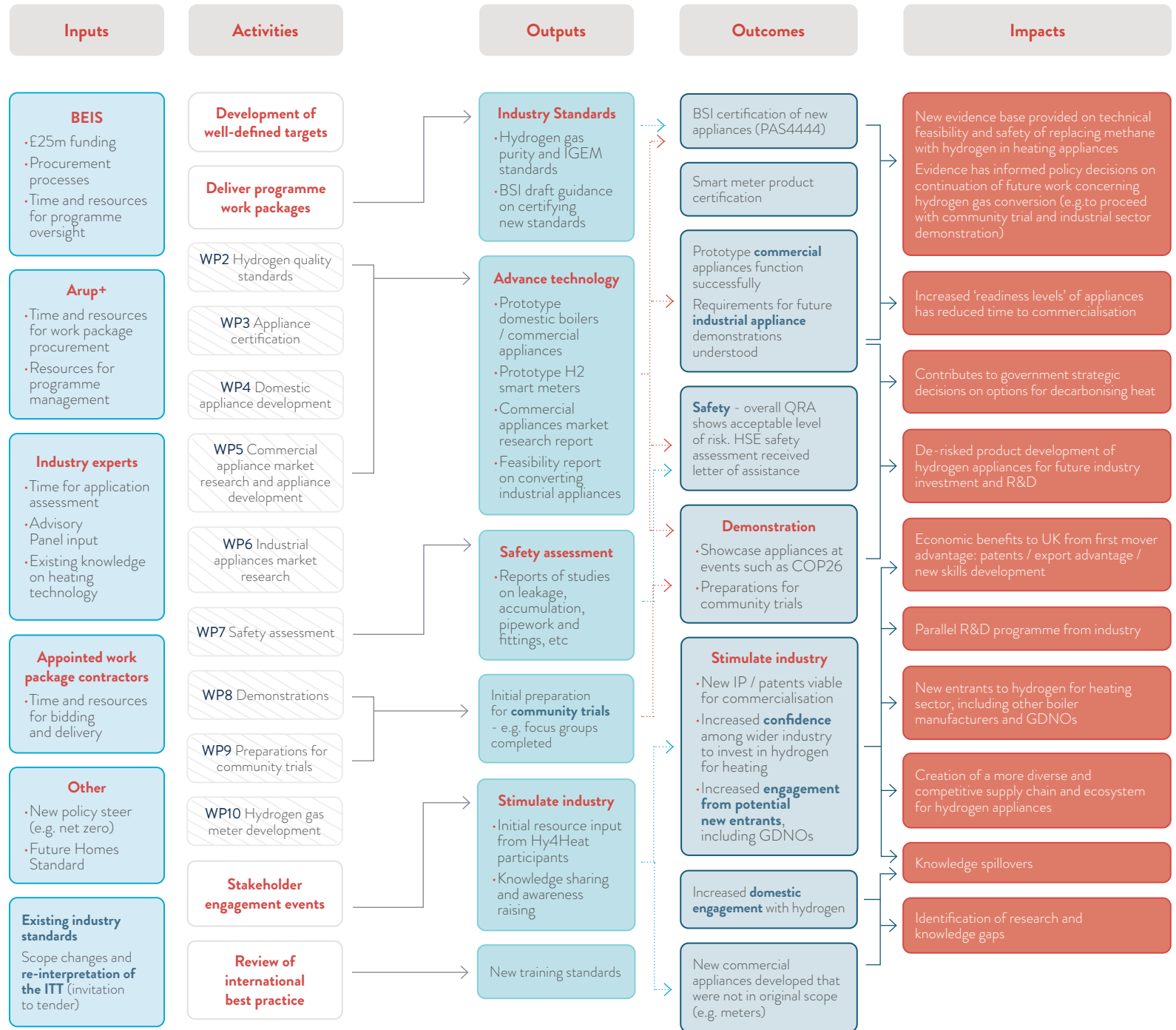


Storyboard used with focus groups, in 2019, researching potential responses by the public to a hypothetical in-home hydrogen heating trial

# Reviewing Outputs, Outcomes and Impacts

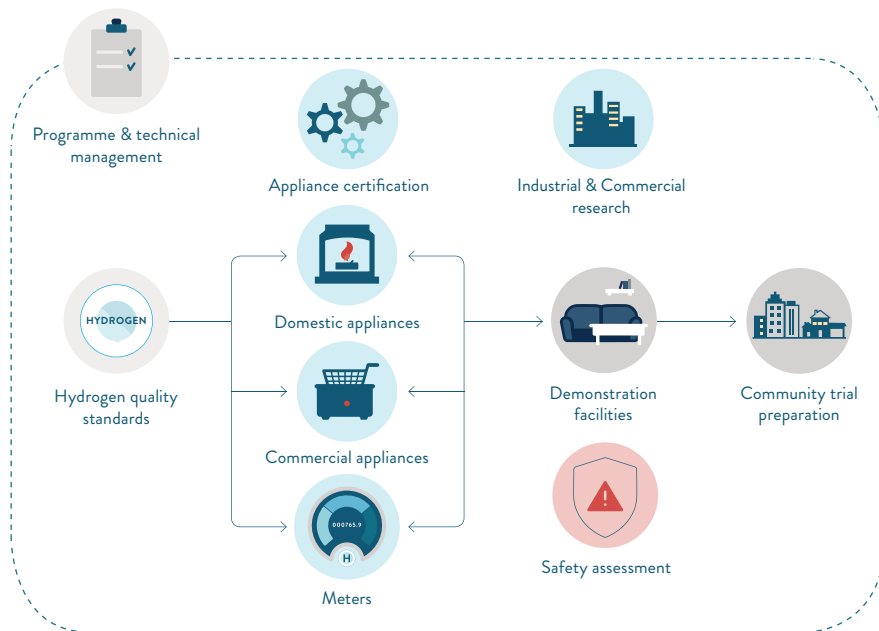
Hy4Heat was a multi-faceted programme with several work packages, several interconnected, running concurrently. Effective programme management and establishing a set of well-defined targets and outcomes at the start has ensured the programme delivered outcomes that support BEIS's decision-making around future hydrogen community trials.

Technopolis Ltd was commissioned by BEIS to conduct a process, impact and economic evaluation of the Hy4Heat programme and its interim report states that the Hy4Heat programme has delivered most of the intended outputs detailed in the 'Logic Chain' diagram shown here. The programme has successfully developed the intended domestic appliance prototypes, created the necessary standards, and undertaken safety testing to make a comparative risk assessment on the feasibility of using hydrogen for heating in certain common building types.



## Work Package Overview

The programme consisted of ten distinct but inter-linked work packages each of which operated to different procurement and delivery timescales. The Hy4Heat team oversaw the programme and technical management of the entire programme, coordinating the delivery of each work package. The team was able to respond to the changing needs of the programme as gaps were identified and new work packages added (for e.g. meter development and ancillary components) were added once the programme was underway.



### PROGRAMME MANAGEMENT

**WORK PACKAGE 1**  
Responsible for the overall delivery of the programme; oversight and governance duties including supporting procurement, managing delivery contracts, engaging with wider industry.

### STANDARDS, CERTIFICATION AND TRAINING

#### WORK PACKAGE 2

- Hydrogen gas standards
  - defined the purity of the gas and odorant to be added
  - determined if there's a requirement to add colourant to hydrogen
- Development of a competency framework for training, accreditation and registration of hydrogen gas engineers
- IGEM (Institution of Gas Engineers & Managers) has reviewed the relevant standards for hydrogen

#### WORK PACKAGE 3

- Hydrogen appliance certification of a new generation of appliances; new standard PAS4444 is to be used

### TECHNOLOGIES: APPLIANCE, METERS AND COMPONENT DEVELOPMENT

#### WORK PACKAGE 4a

- Development of domestic hydrogen appliances: including gas fires, cookers and boilers.

#### WORK PACKAGE 4b

- Development of ancillary equipment such as control valves and excess flow valves, needed for the safe installation of hydrogen appliances

#### WORK PACKAGE 10

- Development of smart hydrogen gas meters

#### WORK PACKAGE 5b

- Development of a number of commercial appliances such as catering equipment, space heating, fuel cell and boiler cascade system



### RESEARCH REPORTS

#### WORK PACKAGE 5a

- Research into the variety of commercial appliances and the issues to be addressed in their conversion or replacement with hydrogen appliances



#### WORK PACKAGE 6

- Research into the variety of industrial appliances and the issues to be addressed in their conversion or replacement with hydrogen appliances



### SAFETY ASSESSMENT AND EXPERIMENTAL TESTING

#### WORK PACKAGE 7

- Assess the safe use of hydrogen gas in domestic properties and buildings including ignition, gas leakage accumulation and ventilation of gas releases in different enclosed spaces within a typical domestic property



### DEMONSTRATIONS AND PLANNING FOR POTENTIAL COMMUNITY TRIALS

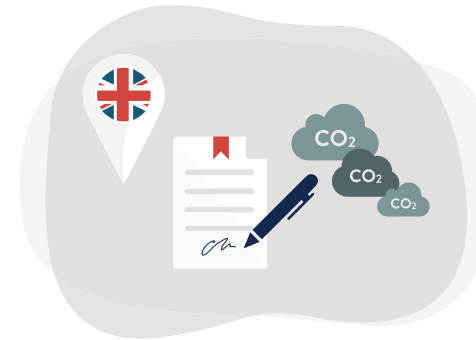
#### WORK PACKAGE 8

- Demonstration facilities to show prototype hydrogen appliances



#### WORK PACKAGE 9

- Planning and preparation for a potential community trial using hydrogen



## PROGRAMME MANAGEMENT

### WP1: Programme Management and Technical Oversight

As well as being responsible for the overall delivery of the programme, the Hy4Heat programme team oversaw and managed the other work packages. It performed oversight and governance duties such as:

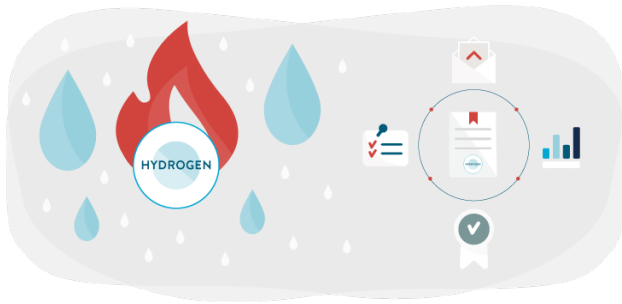
- supporting procurement activity and contractor appointments
- managing work package delivery contracts and checking milestone achievements
- identifying potential risks and putting in place mitigation measures where possible
- undertaking engagement activity with the established stakeholder group and wider industry and producing quarterly newsletters
- producing regular reports and updates for BEIS

From the start of the programme in late 2017, the programme management of Arup and technical management of Kiwa Gastec established a robust, transparent and evidence-based approach, giving regular industry updates, reports and presentations on progress.

Embers, Yo Energy and Progressive Energy played supporting roles, providing expert advice and insight throughout

#### WP1 | Public Communications

- Quarterly newsletters
- Annual reports
- Website and social media
- Stakeholder events, webinars and presentations



## STANDARDS, CERTIFICATION AND TRAINING

### WP2: Hydrogen Quality Standards

### WP3: Hydrogen Appliance Certification

Work package 2 oversaw an investigation and recommendations into hydrogen quality standards. DNV led a consortium to assess the options available for using hydrogen in relation to purity and colourant. Key deliverables are the Hydrogen Purity, Odorant and Colourant reports.

The Institution of Gas Engineers & Managers (IGEM) reviewed the relevant standards for use of hydrogen in heating appliances. This reference standard aims to identify and discuss the principles required for the safety and integrity of hydrogen installation and utilisation in premises.

Energy & Utility Skills has published a framework that will ensure installation and maintenance of

hydrogen appliances will be completed safely, to the highest standards, and be carried out by hydrogen competent, Gas Safe registered engineers.

A key achievement for work package 3 (Appliance Certification) is BSI's Publicly Available Specification (PAS 4444), created to be used primarily on the Hy4Heat programme but written so that it can form the basis for widescale standardisation of hydrogen-fuelled appliances. PAS 4444 is a guide to be followed by appliance manufacturers regarding functionality, safety, installation, operating and servicing requirements for their hydrogen-fuelled and hydrogen/natural gas dual-fuelled or converted appliances.

#### WP2 | Reports

- Hydrogen Purity
- Hydrogen Odorant
- Hydrogen Colourant
- IGEM Hydrogen Standards
- Hydrogen Engineers training framework

#### WP3 | Reports

- PAS4444 Hydrogen-fired gas appliances: guide



## TECHNOLOGIES: APPLIANCE, METERS AND COMPONENT DEVELOPMENT

### WP4: Domestic Hydrogen Gas Appliance Development

### WP4b: Ancillary Equipment Development

### WP5b: Commercial Appliances and Equipment Development

### WP10: Meter Development

These important work packages have seen the successful development of a range of hydrogen appliances, meters and ancillary components. The vast majority have already received certification, demonstrating how 'technology readiness levels' have risen in an accelerated time. It's expected that the successful development of the appliances, meters and components will stimulate the wider supply chain and create greater awareness of its potential.

The profile of the Hy4Heat programme has been raised by increasing media interest into hydrogen-ready boilers in national news reports. Newspaper articles and BBC consumer affairs programmes have highlighted that the boilers will, from the public's perspective, likely be almost the same as natural gas boilers.

Key achievements include:

- Baxi certifying boiler appliances, in preparation for wider domestic usage
- Worcester Bosch developing hydrogen-ready prototype boilers
- Both boiler prototypes have been installed in the HyStreet testing facility in Spadeadam as

well as in a hydrogen site open to the public near Gateshead

- Consortia led by Enertek are completing prototype cookers and gas fires
- Clean Burner Systems' work has shown that hydrogen is viable fuel for domestic fires.
- Continental and Pietro Fiorentini have demonstrated that existing ancillary system components can be viable for use with hydrogen
- MeteRSit's hydrogen meter has been certified enabling the organisation to move into production
- A smart meter developed by Pietro Fiorentini incorporates the latest ultrasonic measurement technology to measure both natural gas and 100% hydrogen



## TECHNOLOGIES: APPLIANCE, METERS AND COMPONENT DEVELOPMENT

As a result of its work on Hy4Heat, Bosch has already submitted 17 formal patent applications to date, with a further five in progress, and innovation still underway.

In its sustainability pledge, Baxi has made a commitment to only make heating products that are hydrogen-ready from 2025, in both domestic and commercial areas. It's aim is to make customers' lives easier and to support them through the energy transition by offering clever product choices.

### WP4 | Outputs

13 domestic appliance types including:

- Hydrogen-ready boilers
  - Four different models including combi boiler, system boiler and regular boiler
- Hydrogen gas fires
  - Six different models including standard open gas fires, glass-fronted balance flue fires, a glass-fronted conventional flue fire and a nonstandard executive range fire
- Hydrogen cookers have been developed covering three types of appliance, including
  - A four-burner gas hob
  - An inbuilt oven and grill
  - A single freestanding unit including all elements

### WP4b | Outputs

A number of components were developed and certified through WP4b to supply hydrogen suitable ancillary components to support with the safe installation of hydrogen appliances in any future potential demonstration and community trials.

The appliances procured through this work package included:

- Loose regulators
- Emergency Control Valves
- Full low-pressure regulator assembly kits
- Loose semi rigid connectors
- Compression fittings
- Brazed copper outlet assembly
- Excess flow valves



## TECHNOLOGIES: APPLIANCE, METERS AND COMPONENT DEVELOPMENT

A range of components, pipework and valves have been developed and tested for use with hydrogen gas. Commercial appliances including catering and heating appliances as well as smart hydrogen meters have also been developed.

### WP5b | Outputs

12 commercial appliance types developed including:

- Five types of catering appliances
  - open-top range, chargrill, grill, griddle and fryer
- Four types of air heating appliances
  - cabinet heating (above and below 50kW)
  - unit heater (above and below 50kW)
  - a radiant heater
- A radiant tube heater
- A boiler cascade controller (up to 480kW)
- A solid oxide fuel cell

### WP10 | Outputs

- Three smart meters developed
  - two new domestic hydrogen gas meters
  - a commercial hydrogen gas meter

#### Key difference

Flow valves are already present within natural gas SMART meters which are able to stop the supply of gas to a dwelling. In the developed hydrogen meters, these have extended functionality to detect excess flow and shut off the supply



## RESEARCH REPORTS

WP5a: Understanding Commercial Appliances

WP6: Understanding Industrial Appliances

Understanding Commercial Appliances and Understanding Industrial Appliances are both market research studies into the variety of commercial and industrial appliances and the issues to be addressed in their conversion or replacement with hydrogen appliances.

Both studies found that the technical challenges to developing hydrogen appliances for use in the commercial and industrial sectors are deemed to be surmountable.

### WP5a | Report

- Understanding Commercial Appliances Report

The commercial appliances study carried out by Environmental Resources Management (ERM) is thought to be the largest and most in depth consideration of natural gas appliances in the UK commercial sector to date.

### WP6 | Report

- Understanding Industrial Appliances Report



## SAFETY ASSESSMENT AND EXPERIMENTAL TESTING

WP7: Safety assessment and experimental testing

The safety assessment was a vitally important milestone on the pathway to the first community trials using hydrogen as a heating source.

HSE has independently reviewed the evidence provided in Version 1.0 of the “Annex to the Site Specific Safety Case for Hydrogen Community Demonstration – downstream of the ECV”, and has formally stated its view that the Annex provides an adequate basis, if applied

appropriately to the areas covered by the Annex by the relevant duty holder, for designing a trial, informing the risk assessment for a trial, and managing the risks from the trial in accordance with the risk assessment for the trial. HSE’s view ensures gas network operators can draw on these results to plan initial trials, such as the hydrogen villages outlined in the Government’s Ten-Point Plan and Hydrogen Strategy.

### WP7 | Reports

HSE Documents and Annex to support site specific cases for safety

- HSE letter of assistance 27 May 2021
- HSE Conclusions Memo – May 2021
- Annex to site specific cases for safety for hydrogen community demonstration

### Precis

- Precis summary and conclusions documents

### Assessments and Analysis documents

- Safety assessment: conclusions report (incorporating quantitative risk assessment)
- Safety assessment: consequence modelling assessment
- Safety assessment: gas ignition and explosion data analysis
- Safety assessment: gas dispersion modelling assessment
- Safety assessment: gas dispersion data analysis





## SAFETY ASSESSMENT AND EXPERIMENTAL TESTING

### WP7: Safety assessment and experimental testing

This assessment indicates that the use of 100% hydrogen can be made as safe as natural gas is when used for heating and cooking in certain types of houses (detached, semi-detached and terraced houses of standard construction), that were studied.

The findings of safety assessment have been shared with the organisations that form the Hy4Heat co-ordination group. The safety assessment has been presented at the International Hydrogen Safety Conference among other places and all the reports have been published online ([www.hy4heat.info](http://www.hy4heat.info)) in order to be available for future studies.

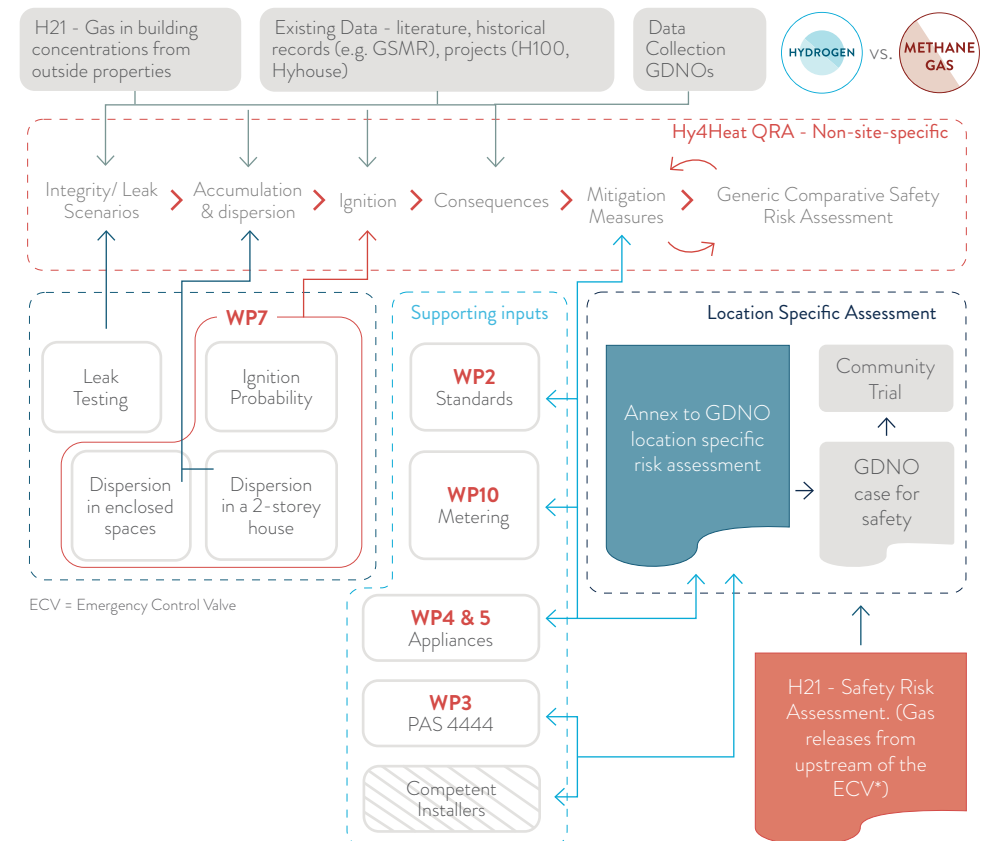
- Safety assessment: gas escape: frequency and magnitude assessment

#### Experimental Testing Documents

- Safety assessment; experimental testing – for the suitability of hydrogen in existing buildings – domestic pipework leakage
- Safety assessment: experimental testing – for the suitability of hydrogen in existing buildings – commercial pipework leakage

- Domestic hydrogen purge procedures
- Safety assessment: experimental testing – cupboard level leakage and accumulation data report
- Safety assessment: experimental testing – property level leakage and accumulation and data report
- Safety assessment: experimental testing – ignition potential testing with hydrogen and methane

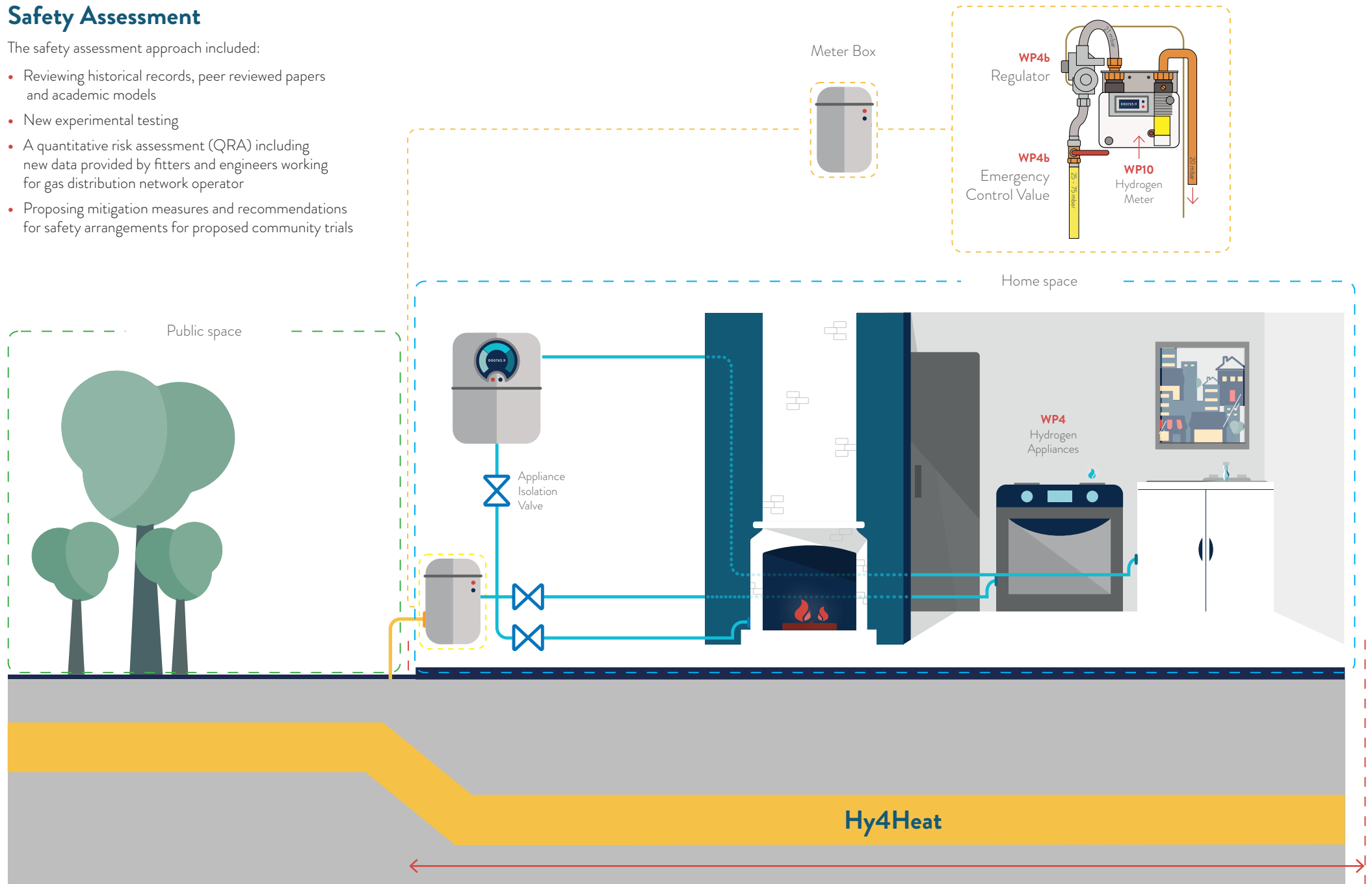
### Key areas within the safety assessment and experimental testing work package



## Safety Assessment

The safety assessment approach included:

- Reviewing historical records, peer reviewed papers and academic models
- New experimental testing
- A quantitative risk assessment (QRA) including new data provided by fitters and engineers working for gas distribution network operator
- Proposing mitigation measures and recommendations for safety arrangements for proposed community trials





## DEMONSTRATIONS AND PLANNING FOR COMMUNITY TRIALS

### WP8: Demonstration Facilities

### WP9: Planning for Potential Community Trials

Two homes have been built to display to the public the Hy4Heat hydrogen appliances and demonstrate them being used, using hydrogen.

The two semi-detached houses, in Low Thornley, near Gateshead, are a partnership between gas distributors Northern Gas Networks (NGN) and Cadent Gas and BEIS and part funded through the Hy4Heat Innovation Programme. These buildings provide people with the opportunity to experience a home of the future, fuelled with hydrogen, which does not create

carbon emissions at point of use. The houses are open to members of the public, who can view appliances and see how they compare to existing ones. Local schools, colleges and universities are also welcome to visit, to learn about the new technology, as well as potential careers in the emerging green economy and in science, technology, engineering and maths (STEM) subjects.

Anyone interested to visit the Homes can book visits by emailing, [hydrogenhome@northerngas.co.uk](mailto:hydrogenhome@northerngas.co.uk)

#### WP8 | Exhibitions

Fixed location

- From July 2021 Hydrogen Home - public demonstration homes

#### Showcase temporary exhibitions

- 19 October 2021, Global Investment Summit (GIS), London
- 8 – 11 November 2021, COP26 Innovation Zone, Glasgow



## DEMONSTRATIONS AND PLANNING FOR COMMUNITY TRIALS

### WP8: Demonstration Facilities

### WP9: Planning for Potential Community Trials

Appliances from Hy4Heat have been showcased at London's Global Investment Summit, 2021 - an event seeking to encourage foreign investment by showcasing the best of British innovation. More recently they've been on display as part of the Innovation Zone at COP26 in Glasgow in November 2021. COP is the United Nations summit that brings parties together to accelerate action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change. In previous years, the Hy4Heat programme has been presented and discussed at COP24 in Katowice and COP25 in Madrid.

#### WP9 | Report

- Focus Group and Literature Review



## Acknowledgements

Hy4Heat has been a flagship BEIS decarbonisation innovation programme. So much has been achieved in a short space of time - not least the acceleration of Technology Readiness Levels to a point where hydrogen-ready boilers will be commercially available sooner enabling a potential transformation in the way the UK powers its homes, as we build back greener. It's evident that across industry and among the wider public, there's an increasing awareness

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and understanding of hydrogen's potential strategic role as a decarbonised energy carrier. This is due, in part, to Hy4Heat and the positive response from the energy industry to meet the net zero by 2050 target.

As with any programme thanks goes to the many people who worked on it. Some of whom are listed below, but are only a fraction of the number that helped to deliver it successfully.

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### Wider team

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### Hy4Heat Coordination Group and Advisory Panel members:

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