HYDROGEN END USER SKILLS & STANDARDS SUPPORTING RESEARCH AND EVIDENCE STAKEHOLDER ENGAGEMENT DAY

The presentation will start at 10:00

This event will be recorded

Today's Agenda

Item	Subject	Timing	Presenter
1.	Objectives of the session	10:05	John Foyster
2.	Overview & objectives of innovation funding and precursor Hy4Heat	10:10	John Foyster
3.	Research & Evidence 1 Purging Domestic & Non-Domestic	10:20	Keith Howell
	2 Material & Component Suitability - Domestic and Non-domestic	10.30	
	3 Non-Domestic Piped Systems - Tightness & Material Compatibility	10.40	
	4 Installation Ventilation and Flues	10.50	
4.	Coffee Break	11.05	
5.	5 Pipe Sizing and pressure drop criteria	11.20	Keith Howell
	6 Meter Location and Ventilation Study	11.25	
	7 Excess flow valve (EFV)	11.30	
5.	General procurement procedure	11:40	Julie-Anne De Thomasis
8.	Next steps / Wrap up	11:50	John Foyster
	End	12:00	

Objectives

- Introduce Energy Innovation at BEIS
- Outline hydrogen standards supporting research and evidence
- Explain how to apply and how the competition will work
- Outline the next steps
- Collect questions

Feedback methods

1. MS Teams chat preferred, upvote!
2. Raise hands after each Lot
3. IdeaBoardz – anonymous feedback
4. Email NZIP Hydrogen following today

- Questions and answers will be distributed to attendees and published with the ITT.
- Questions which cannot be answered today will be clarified in the ITT.
- There will be opportunity for further questions following the publishing of the ITT.

Overview & objectives of innovation funding and the precursor, Hy4Heat

John Foyster

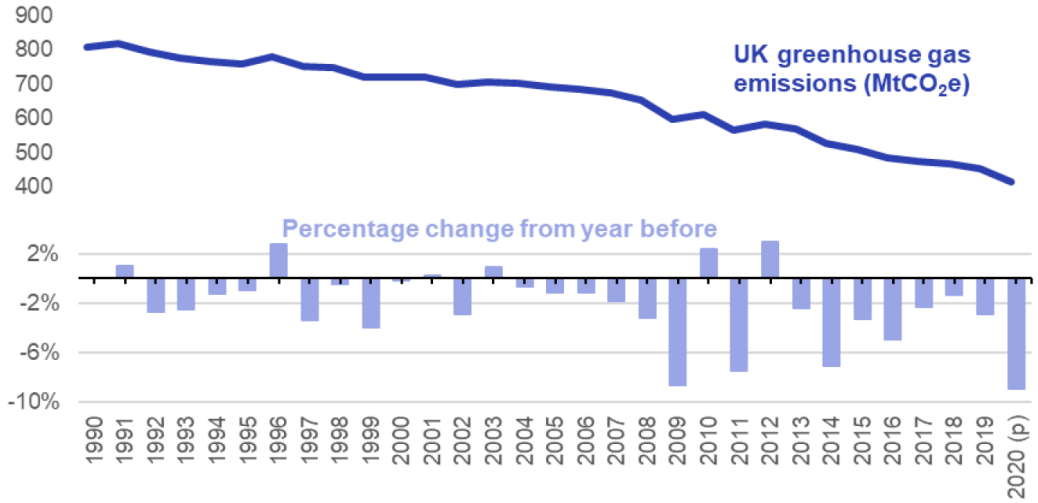
Innovation Programme Technical Lead - Hydrogen,
Science and Innovation for Climate and Energy (SICE)

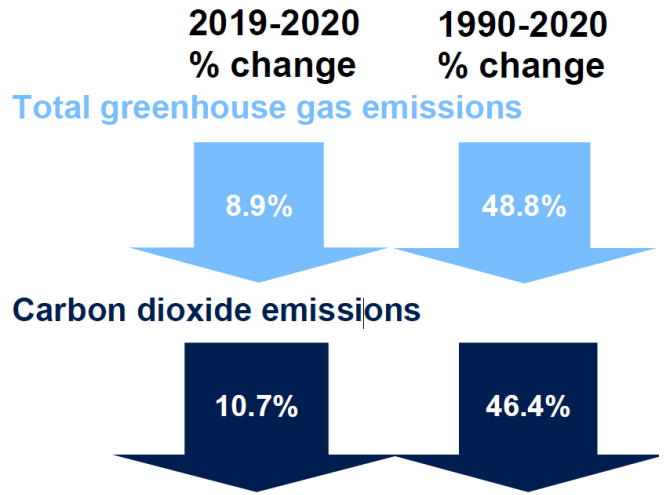
6th July 2021

The Net Zero Challenge

The UK passed into law to bring its GHG emissions to net zero by 2050. Last year we effectively brought forward the original 2050 (78% reduction) target by 15 years (Sixth Carbon Budget)

	2019-2020 % change	1990-2020 % change
Energy supply (including power sector)	↓ 11.9%	↓ 67.4%
Business	↓ 8.7%	↓ 46.8%
Transport	↓ 19.6%	↓ 22.5%
Residential	↑ 1.8%	↓ 13.5%
Public	↓ 2.0%	↓ 42.2%



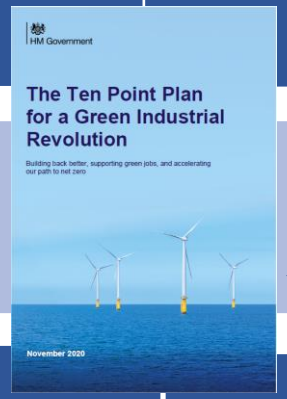


Department for Business, Energy & Industrial Strategy

Hydrogen and Net Zero

Low carbon hydrogen identified as key to achieving net zero

5GW ambition for low carbon hydrogen production capacity by 2030



Hydrogen Strategy – due out in summer 2021

Consultation on £240m Net Zero Hydrogen Fund and hydrogen business models due out in the summer 2021

Driving the growth of low carbon hydrogen could deliver...

Support for up to **8,000 jobs** by 2030, potentially unlocking up to **100,000 jobs** by 2050 in a high hydrogen net zero scenario	Over **£4bn** of private investment in the period up to 2030	Savings of **41MtCO$_2$e** between 2023 and 2032, or **9%** of 2018 UK emissions

"the difference [between existing targets and net zero] is striking. Low-carbon hydrogen moves from being a useful option to a key enabler. Updates to policy alongside adoption of our recommended target should reflect that"

CCC, Net Zero

Department for Business, Energy & Industrial Strategy

Hy4Heat

Up to **£25m**: “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 help enable the government to determine whether to proceed to a community trial of hydrogen.”

OUTPUTS

Appliances: Domestic and commercial including boilers, fires, meters and fuel cells

Skills and standards: including purity standard and PAS on safety certification of appliances

Safety: Studying safety of using hydrogen in some types of house, supporting preparation for first community trials

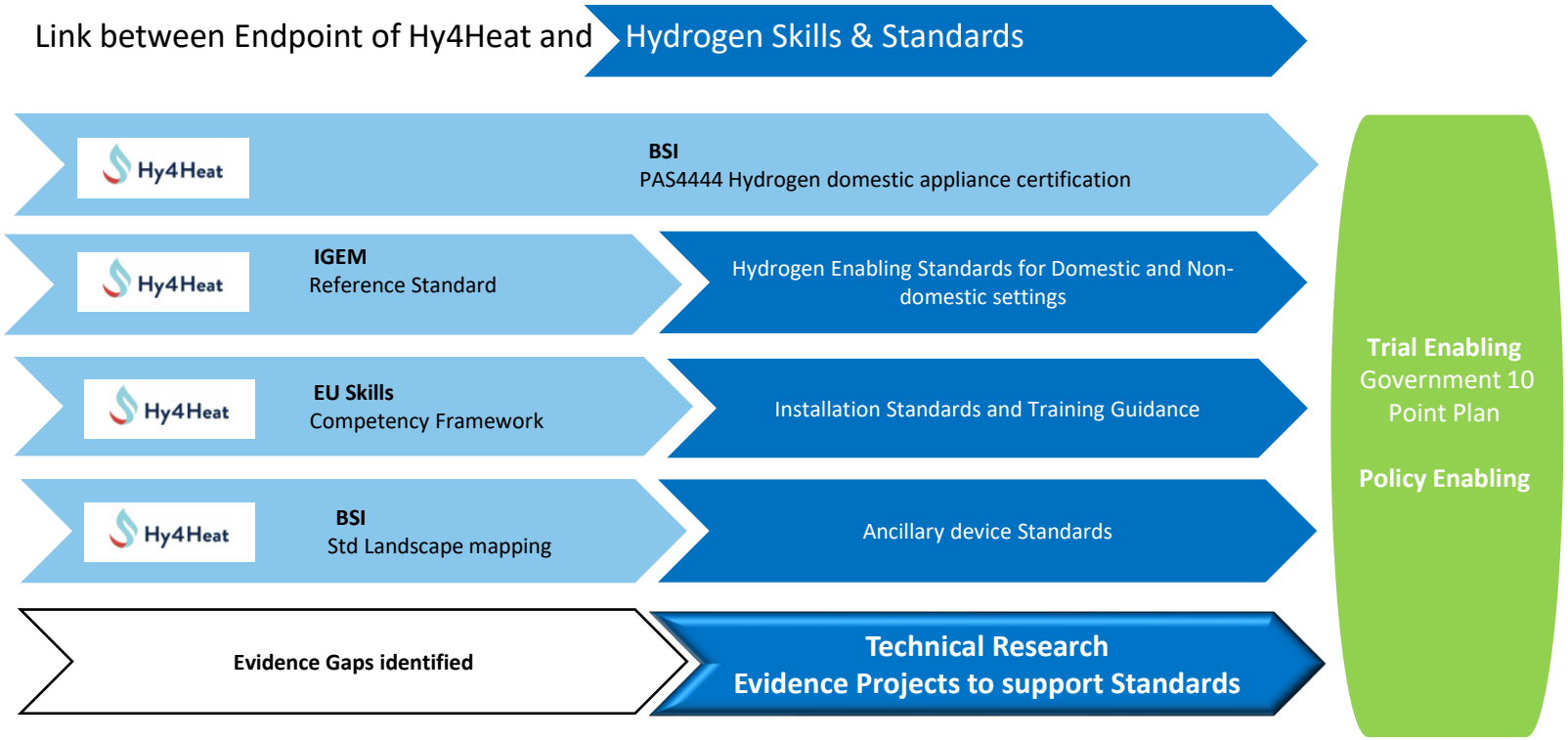
End Users Hydrogen Skills and Standards for Heat Programme

BEIS is funding the development of a targeted set of standards in domestic and non-domestic settings, downstream of the Emergency Control Valve which is the cut off point for the Gas Distribution Network Operators' (GDNOs) system asset responsibility.

There are four separate streams:

1. Hydrogen Enabling Standards – domestic & non-domestic
2. Hydrogen Installation/Training Standards
3. Hydrogen Ancillary Device Standards
   a) Ancillary component material specifications
   b) Ancillary component functional and test specifications
   c) Meter installation functional and test requirements
4. **Technical Evidence Research**

Links to Hy4Heat



Hydrogen standards supporting research and evidence

Keith Howell

End User Policy Lead

Hydrogen Heating Programme

6th July 2021

Department for Business, Energy & Industrial Strategy

Hydrogen standards supporting research and evidence

1. Purging Domestic & Non-Domestic
2. Material & Component Suitability - Domestic and Non-domestic
3. Non-Domestic Piped Systems - Tightness & Material Compatibility
4. Installation Ventilation and Flues

Coffee Break

5. Pipe Sizing and pressure drop criteria
6. Meter, Internal & External Ventilation Study
7. Excess flow valve (EFV)

1 Purging Domestic & Non-Domestic

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

This will include the development of an outline methodology and the trialling of this methodology in a test arrangement or test site to include monitoring of gas concentrations, equipment needed, safety measures, time taken, potential for direct or indirect purging

1 Purging Domestic & Non-Domestic

Current gaps

- Research to establish the purging parameters required for hydrogen
- Conclude any remaining evidence for domestic installations and provide new research to review if direct or indirect purging approach could be used for non-domestic installations.
- Work to test and validate the purging procedures identified above.
- Work to develop and test appropriate equipment for undertaking any indirect purging operations.
- Research to investigate the risk from potential ignition sources to hydrogen releases e.g., static during purging etc.
- Any implications on the use of specific tools during the purging operation (e.g brass)

1 Purging Domestic & Non-Domestic

Existing published work

- IGEM Framework for purging: IGEM/UP/1 Strength testing, tightness testing and direct purging of industrial and commercial gas installations
- Steer Energy report – Domestic hydrogen purge procedures: published 8TH June Hy4Heat
- IGEM H/1 - Reference Standard for low pressure hydrogen utilisation
- IGEM Interim Hydrogen Standard, IGEM/H/2 Section 10 addresses Purging

1 Purging Domestic & Non-Domestic

Stage 1a	**Literature search and assessment of existing evidence** A thorough review of the existing evidence and research information relating to the impact of hydrogen, whether pure or as a blend, on the purging of existing or new gas systems in domestic and commercial buildings. IGEM Interim Hydrogen Standard, IGEM/H/2 Section 10 addresses Purging
Stage 1b	**Physical testing** An extension of the work carried out by Steer Energy to include pipework sizes up to ~150mm, and to identify whether there are any additional or increased risks. This should identify whether there is a requirement to amend any of the purge criteria currently given in UP/1A. Identification of practical ignition sources within pipework, including static discharge, and review of the impact of ignition. This should include a representative range of pipework materials and jointing techniques. The detailed methodology of the physical testing programme is to be defined by the appointed testing house, with the over-riding requirement to demonstrate whether the risks are materially different from the current assumptions for Natural Gas

1 Purging Domestic & Non-Domestic

Estimated duration
9 months

Comments and Questions

2 Material & Component Suitability - Domestic and Non-domestic

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

This would address evidence gaps in terms of basic material and component compatibility. Initial step would be to characterise all of the materials that hydrogen could encounter in end user systems, considering the materials compatibility, longevity and modes of failure for components.

2 Material & Component Suitability - Domestic and Non-domestic

Primary areas

- Embrittlement - small changes in tensile strength, reduction in ductility (leading to brittle behaviour) and a reduction in fatigue life
- Permeability - the ability of hydrogen gas to dissociate into atomic hydrogen, pass through the metal structure and then recombine as hydrogen gas on the surface of the pipe.

2 Material & Component Suitability - Domestic and Non-domestic

Stage 1a	**Literature search and assessment of existing evidence** Fully relevant – the material can be regarded as being acceptable, or not acceptable as appropriate, for use in a 100% hydrogen gas system operating within a defined set of criteria. No further testing required. Partially relevant – focussed testing is required to address specific aspects before the material can be classified as acceptable or not acceptable No relevant evidence – full testing required to provide new evidence to allow classification as acceptable or not acceptable The work should also consider how an individual might be able to determine the type of materials installed in an existing setting (e.g visual, spark test etc..)

2 Material & Component Suitability - Domestic and Non-domestic

Stage 1b

Potential areas of physical testing

Preliminary list	New materials	Existing aged materials	
Pipework	Carbon Steel Stainless Steel Polyethylene Copper Corrugated Stainless Steel Tube (CSST)	Carbon Steel Stainless Steel Polyethylene Copper	Corrugated Stainless Steel Tube (CSST) Lead Aluminium Chrome Plated Carbon Steel
Equipment	Carbon Steel, Stainless Steel Brass Bronze	Carbon Steel, Stainless Steel Brass	Bronze/Gunmetal Cast Iron Chrome plated carbon steel
Components	PTFE Jointing Compound/Anaerobic Sealants/Tape Solder/Brazing Rod Soft body parts of valves (Elastomers/Polymers) Materials as above, but in different forms (ie springs)	PTFE Jointing Compound/Anaerobic Sealants/Tape Solder/Brazing Rod	Soft body parts of valves etc (Elastomers/Polymers) Materials as above, but in different forms (ie springs) Hemp

2 Material & Component Suitability - Domestic and Non-domestic

Estimated duration
15 months

Comments and Questions

3 Non-Domestic Piped Systems - Tightness & Material Compatibility

Objective

Primary Research to fill gaps in the existing Hydrogen evidence base

This would expand evidence gained from Hy4Heat in this area for end user systems, across the full possible range of piped systems converted, either demonstrating tightness or highlighting existing systems for which there will be risks. The work will feed into:

- The functional specifications (i.e which pipes & fittings could be used/re-used)
- The installation std (i.e how could the pipe & fittings be used/re-used and tested)

3 Non-Domestic Piped Systems - Tightness & Material Compatibility

Existing work from Hy4Heat

Domestic focussed research (yet to be published) with a remit of pipe / fittings ~22/32mm

Covering topics such as:

- Literature search & Leak flow theory examined
- Leakage Experiments
- Joints & Fittings
- Valves & Regulators
- Damage
- Flow investigations

3 Non-Domestic Piped Systems - Tightness & Material Compatibility

Stage 1a	**Literature search and assessment of existing evidence** Complete a literature review of existing hydrogen testing work already completed to gain a baseline understanding prior to commencing these works Identify pipework, fittings and jointing techniques downstream of the Emergency Control Valve (ECV) not tested through previous work (anticipated to be larger fittings / pipe) and compared for gas tightness for Hydrogen gas and Natural Gas/Methane.
Stage 1b	**Physical testing** Experimental results will be used to quantify the relative risk of using hydrogen in pipework, fittings and jointing systems to determine which are likely to be suitable for use / reuse while maintaining a safe gas system within the home/premises. Test the leak potential from a wide variety of pipework, fittings and joints at 20mbarg and 100mbarg – expectation is that the testing process will require parallel testing with natural gas as well as hydrogen to fully understand the applicability for the reuse of existing assets. Testing house to ensure the experiments are clearly designed to link back to pressure test (tightness) criteria as this work will inform the basis which could be used Testing may also consider longevity / operational Impacts (e.g impact of temperature cycling on joints / tightness) The test method should consider the use of a mock-up of a typical pipe system (downstream of the ECV).

3 Non-Domestic Piped Systems - Tightness & Material Compatibility

Estimated duration
12 months

Comments and Questions

4 Installation Ventilation and Flues

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

This work will undertake a set of scenario specific ventilation and flueing projects to address specific gaps in the evidence base. The work is not seeking to examine whole property ventilation and is intended to provide evidence to understand the requirements of specific sub-categories of installation work such as ventilation of inter floor piping/voids and flueing requirements of specific appliances such as hydrogen gas fires.

4 Installation Ventilation and Flues

Ventilation with respect to pipe work located within voids, shafts and ducts.

Stage 1a	**Literature search and assessment of existing evidence** Review relevant works such as BS9861 and the Advantica Research Project (Annex C of BS6891), Gas in intermediate floors, Report Number 6699 which provides a complete description of the research and testing carried out using natural gas. Review H4H outputs and any other relevant industry information.
Stage 1b	**Physical testing** Use the literature search to inform the design a testing methodology to address the evidence gap. The detailed methodology of the physical testing programme is to be defined by the appointed testing house. Undertake physical testing to provide the data to provide an understanding of hydrogen which is at least equivalent of the current NG Report Number 6699' including a summary Annex C of BS6891.

4 Installation Ventilation and Flues

Ventilation and flue requirements of open flued appliances such as hydrogen gas fires, water heaters, hobs and cookers for both domestic and non-domestic environments.

Stage 1a	**Literature search and assessment of existing evidence** Identify and review relevant standards covering combustion ventilation and flues for residential and small commercial. Assess evidence from Hy4Heat programme, and testing by Hydrogen appliance manufacturers Items to consider are the ventilation / flues criteria for air supply for combustion and to avoid mould / condensation
Stage 1b	**Physical testing** Use the literature search to inform the design of a testing methodology to address the evidence gap. The detailed methodology of the physical testing programme is to be defined by the appointed testing house. Testing will identify any specific measures which are necessary to prevent problems associated with appliance ventilation and flues from hydrogen combustion. For example - the endpoint of this project would include the evidence and testing which is sufficient to prescribe the installation basis for a flue system to be used / reused in a domestic setting if changing from an NG to H2 gas fire.

4 Installation Ventilation and Flues

Estimated duration
12 months

Comments and Questions

BREAK
Back at 11:20

5 Pipe Sizing and pressure drop criteria

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

To help understand whether pipes would have sufficient capacity with hydrogen, this would provide:

- a methodology by which existing pipes can be assessed and new pipes can be sized for the full range of domestic and non-domestic installation types;
- a criteria to specify or understand the extent by which existing natural gas operating pressures could be varied for hydrogen.

5 Pipe Sizing and pressure drop criteria

Aim

- To confirm an appropriate and standardised sizing methodology which can be applied to the installation of new or reused pipework (i.e. downstream of the ECV and meter). Sizing methodology output might take the form of ready reckoner table / app etc.
- To ensure that such pipework has adequate capacity to deliver necessary quantities of hydrogen gas at the required pressure to hydrogen burning appliances during conversion trials.
- Such methodology should be consistent with those prescribed for distribution mains and service pipes.

5 Pipe Sizing and pressure drop criteria

Current Natural Gas standards

- Design standards including flow formulae for sizing mains and service pipes
- Set pressure for meter regulators (noting that this also impacts billing systems through the pressure/ temperature correction factor used to calculate gas consumption)
- Minimum operating pressure at the appliance inlet connection – this recognising that there can be variation in pressure achieved at the meter outlet and consequently at the appliance itself
- Maximum allowable design pressure drop in installation pipework
- Pipe sizing tables for small diameter installation pipework and necessary allowances to be incorporated for the effects on pressure drop caused by pipe fittings

5 Pipe Sizing and pressure drop criteria

Stage 1a	**Existing Data & Information** There is already an extensive amount of pressure drop and flow formula available in science, academia and engineering and this should be assessed alongside any existing real world data (e.g Hy4Heat other industry projects)
Stage 1b	**Additional analysis, testing & confirmation** It is important that any empirically determined flow formula can be validated in terms of “reasonable accuracy range” by physical testing wherever possible. Undue conservatism on pressure drop estimations should be avoided as it may have a direct implication on the extent of any pipe replacement if moving from an NG to H2 system Opportunities may exist in the existing hydrogen projects being carried out by the to gather actual flow/ pressure drop data for various types and sizes of pipes in typical “installation” settings It is important that this data is collected and collated to provide the validatory evidence required.

5 Pipe Sizing and pressure drop criteria

Estimated duration
12 months

Comments and Questions

6 Meter, Internal & External Ventilation Study

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

Research would consider representative, internal and external, meter housing, design considerations including necessary clearances, ventilation requirements for gas and for the potential for humidity/water build up.

6 Meter, Internal & External Ventilation Study

Stage 1a	**Existing Data & Information** A thorough review of any existing evidence and research information Identify full range of meters to be considered in the study and the evidence required for different archetypes (e.g internal and external meter placement)
Stage 1b	**Study & Physical Testing** Study (possible desk) to assess the potential issues such as humidity/water and gas build up in external meter enclosures and then considerations for the requirements around ventilation Augmented with some physical trials and research and/or modelling. Report detailing conclusions on meter humidity/water and gas build up and the ventilation basis which can be used to address the identified issues.

6 Meter, Internal & External Ventilation Study

Estimated duration
9 months

Comments and Questions

7 Excess flow valve (EFV)

Objective
Primary Research to fill gaps in the existing Hydrogen evidence base

Research would consider items such as the installation and calibration of EFVs (Excess flow valve) to cover domestic and non-domestic supply. This will include what methodology and basis which will be used to set the shutoff point for the valves during operation, and understand how to check and test them.

7 Excess flow valve (EFV)

Stage 1a	**Background Data & Information** The study should consider Excess Flow Valves (EFV) either to be installed as a retrofit or as part of new installation for both domestic and non-domestic supply. The work will consider the methodology and basis used to set the shutoff point for the valves (if adjustable) during operation catering for the maximum usage of appliances installed within a full range of properties.
Stage 1b	**Study & Physical Testing** EFV prior to the meter The installation of a mechanical excess flow – assumed to be a hydrogen gas equivalent to ASTM F2138 - 12(2017). Considerations to take account of in the work include the ability to reset the valve (if required) with minimal cost and disruption. EFV integral to the meter Hydrogen gas meter containing an integrated Excess Flow Valve (EFV) to limit the flow rate to <20m3/hr or set at a value that is related and proportionate to the maximum usage of appliances installed within the individual property

7 Excess flow valve (EFV)

Estimated duration
12 months

Comments and Questions

Cost range expected & estimated durations

Lot	Title	Cost range expected	Estimated duration
1	Research and evidence gathering for purging domestic & non-domestic with respect to hydrogen.	£80,000 - £100,000	9 months
2	Research and evidence gathering material & component suitability - domestic and non-domestic for hydrogen.	£160,000 - £200,000	15 months
3	Research and evidence gathering for non-domestic piped systems - tightness & material compatibility for hydrogen.	£120,000 - £150,000	12 months
4	Research and evidence gathering for installation ventilation and flues.	£200,000 - £250,000	12 months
5	Research and evidence gathering for pipe sizing and pressure drop criteria with respect to hydrogen	£60,000 - £100,000	12 months
6	Research and evidence gathering for hydrogen meter and ventilation Study	£60,000 - £75,000	9 months
7	Research and evidence gathering for installation & set point of excess flow valve(s) (EFV)	£40,000 - £50,000	12 months

Department for Business, Energy & Industrial Strategy

PROCUREMENT OF THE HYDROGEN END USER SKILLS & STANDARDS SUPPORTING RESEARCH AND EVIDENCE CONTRACT

Julie-Anne De Thomasis

Commercial Lead
Science and Innovation for Climate and Energy
BEIS

Department for Business, Energy & Industrial Strategy

Procurement

Proposed Tender Timeline	Dates (may be subject to change)
Advert and full invitation to tender issued	9th August 2021
Deadline for questions relating to the tender	20th August 2021
Responses to questions published	6th September 2021
Deadline for receipt of tender	24th September 2021 (by 12.00pm)
[If needed] contract clarification process	w/c 4th October 2021
All suppliers alerted of outcome	8th October 2021
10 day Standstill period	11th - 21st October 2021
Contract award on signature by both parties	w/c 25th October 2021
Contract start date	1st November 2021

Transparency

- In the interests of fairness, today's information will be posted on the Contracts Finder/OJEU portal for all bidders, including those unable to attend today.

- Includes Q&A from today (published in an anonymised form).

Terms and conditions

- Although BEIS T&Cs are expected to form the basis of the contract, we will publish the final version of the T&Cs at the time of the ITT.

- They will be final and any bids submitted on condition that T&Cs are amended will be effectively submitting a non-compliant bid.

Questions and Answers

John Foyster

Innovation Programme Technical Lead - Hydrogen,
Science and Innovation for Climate and Energy (SICE)

6th July 2021

Questions

- The Q&A from this session will be published with the respective ITT.
- There will be a further opportunity to ask questions following the publication of the ITT on **9th /12th August 2021**.
- Please submit questions to **nzip.hydrogen@beis.gov.uk**. All questions should be submitted **by 12 noon BST, 27th July 2021.** Questions submitted after this date may not be answered.
- The questions submitted via email, which in our judgement, are of material significance will be addressed and published on the competition website.

Thank you for attending!