

# Work Package 4 Phase 2 kick-off



Dr. Steve Loades

BEIS Programme Manager, Hy4Heat

## Purpose of today

- Kick-off WP4 phase 2: development of prototype appliances
- Opportunity for discussions
- Update on other work packages – particularly ones relevant to WP4
- Informal industry networking / knowledge sharing

# Agenda

Welcome and introduction	Steve Loades
Opening remarks	Mark Taylor
Hy4Heat programme update	Heidi Genoni
WP7 update: safety assessment	Albert Law
WP2 update: standards, purity	Colin Heap, DNV GL
WP3 update: PAS 4444	Bob Walsh, for BSI
Discussion and Q&As	All
Lunch	

# Mark Taylor

Deputy Director: Energy Innovation  
BEIS (SICE)



**Hy4Heat**

Heidi Genoni

Hy4Heat Programme Manager

# Hy4Heat programme timeline overview

2018

2019

2020

2021

Hy4Heat ends



WP1&9 PMC Managing WPs in preparation for a Community Trial



WP2 Quality and standards



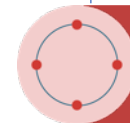
WP7 Safety and risk assessment



WP3 Development of appliance certification



WP4 Development of certified domestic appliances and WP10 Metering development



WP8 Demonstration trials



WP5 Commercial appliances  
Understanding the market

Potential commercial appliance development



WP6 Industrial appliances  
Understanding the market

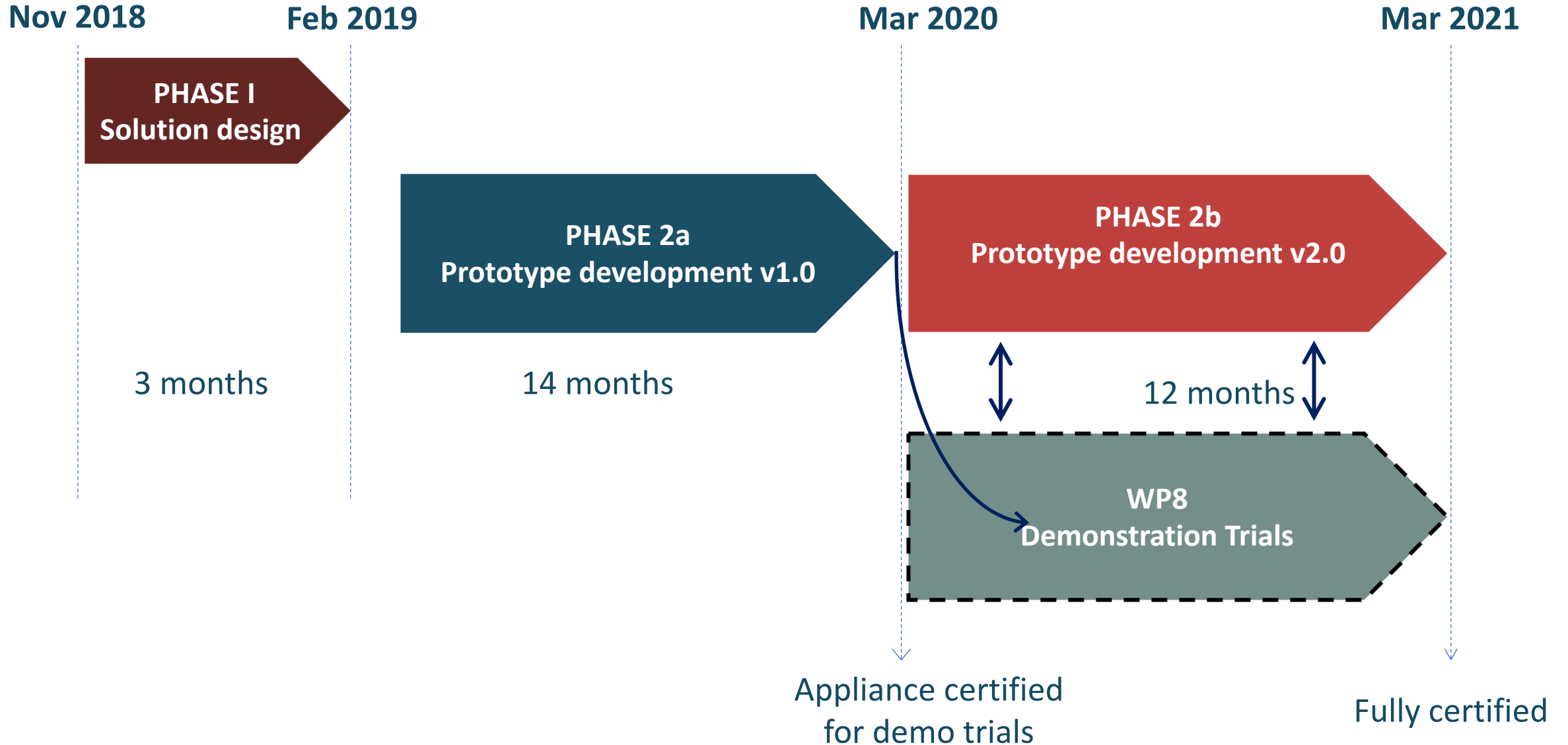
Potential industrial appliance development

Possible  
Community Trial





# Phased competition structure

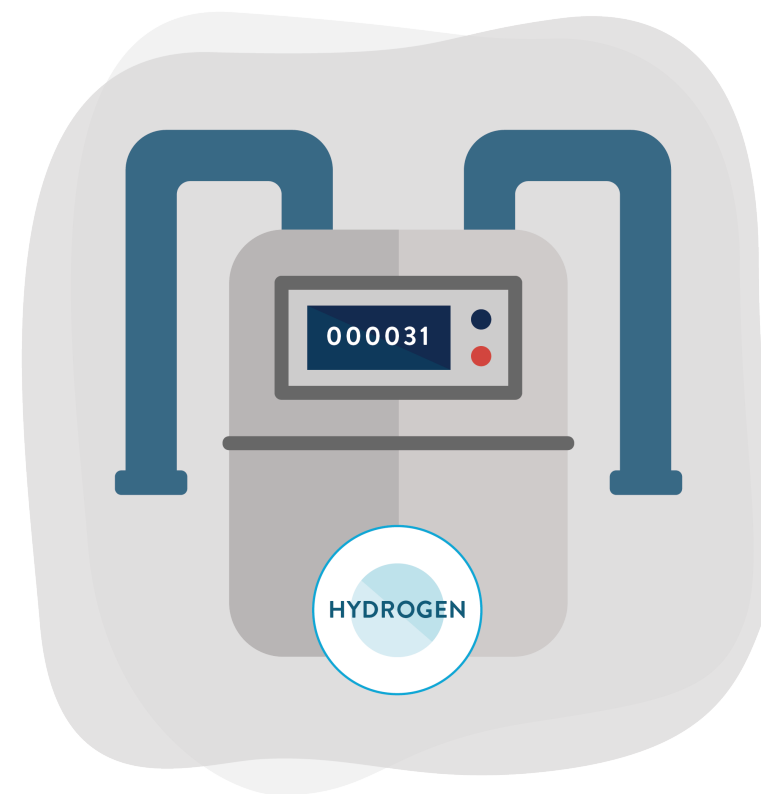


# WP8: Demonstration trials (unoccupied)



# WP10: hydrogen gas smart meters

- Procurement in progress
- Innovation partnership
- Will also be demonstrated as part of WP8



# WP5: Commercial appliances

- Industry stakeholder engagement event 21 May 2019
- We are considering procuring the development of:
  - Commercial space heating & hot water
  - Catering appliances
  - Commercial innovative appliances
  - Critical system components such as connectors, sensors, alarms, fittings and valves

# WP6: Industrial appliances



# Albert Law

WP7 Safety assessment

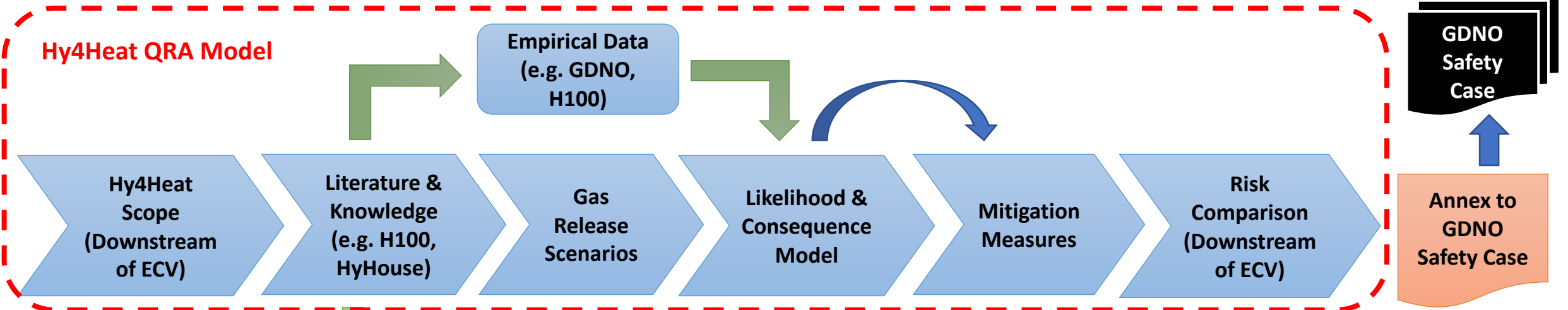
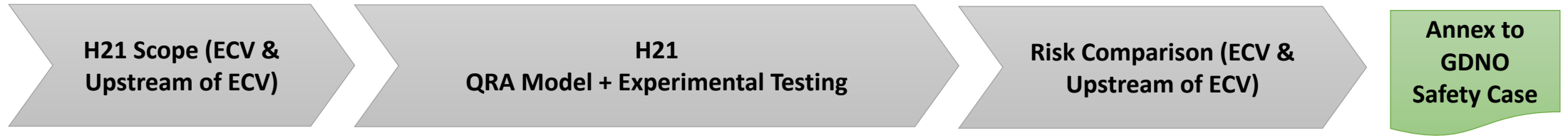
# Hy4Heat

## WP7 Safety Assessment

14 May 2019



# WP7 Safety Assessment - Overview



\*ECV = Emergency Control Valve

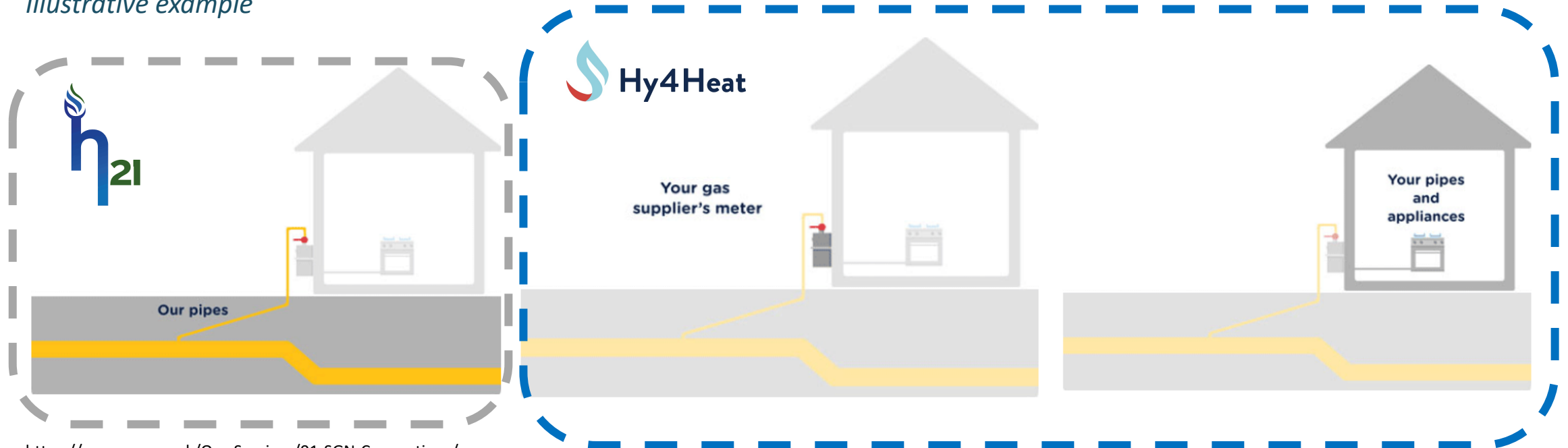




# WP7 Safety Assessment - Scope

Hy4Heat  
Scope  
(Downstream  
of ECV)

*Illustrative example*

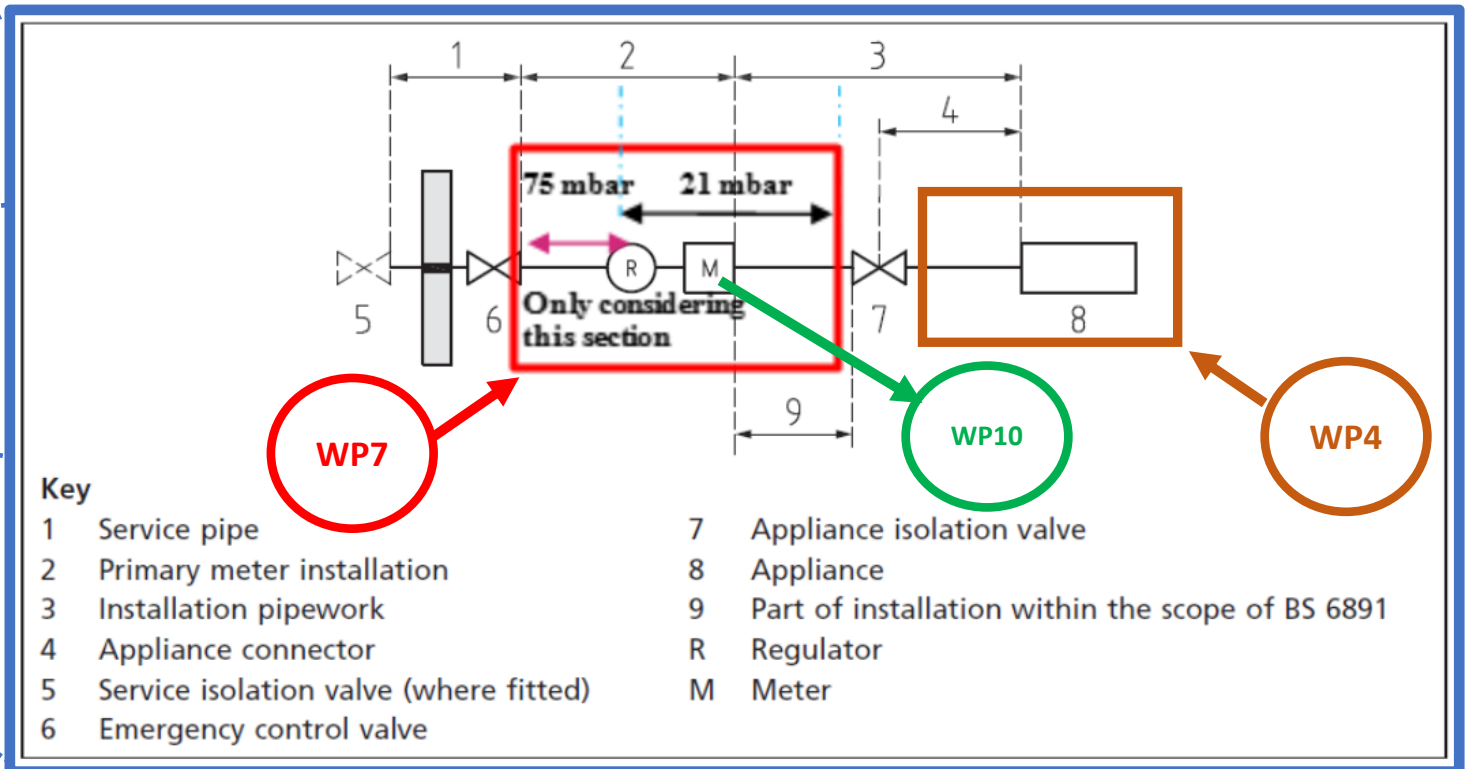
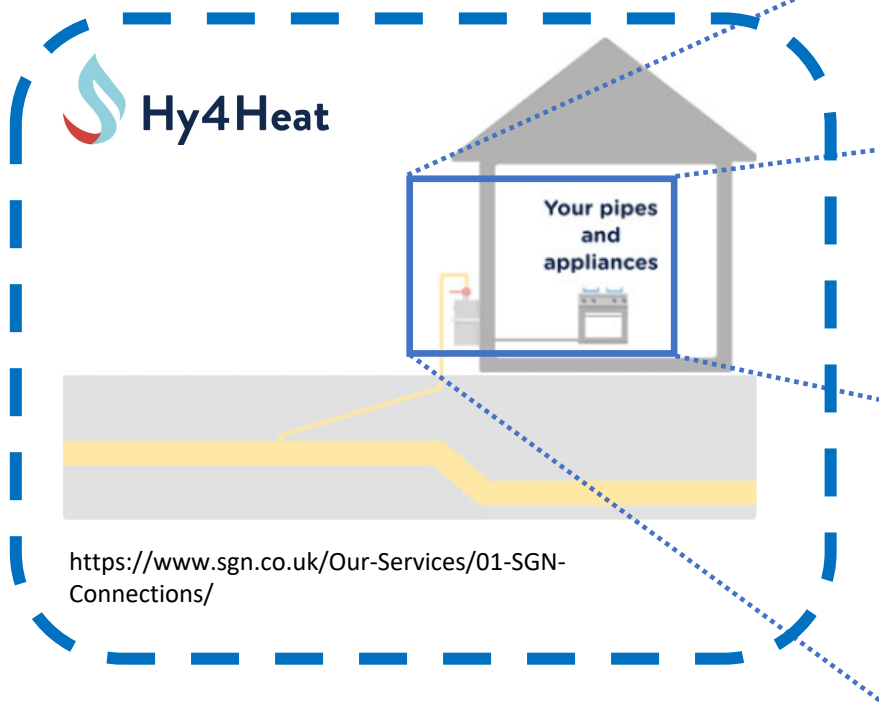


<https://www.sgn.co.uk/Our-Services/01-SGN-Connections/>

# WP7 Safety Assessment - Scope

Hy4Heat  
Scope  
(Downstream  
of ECV)

## Boundary & Pipework configuration (Downstream of ECV)



BS 6891:2015 Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm (R11/4) on premises

# WP7 Safety Assessment – Literature & Knowledge

Literature &  
Knowledge  
(e.g. H100,  
HyHouse)

## Natural Gas & Hydrogen:

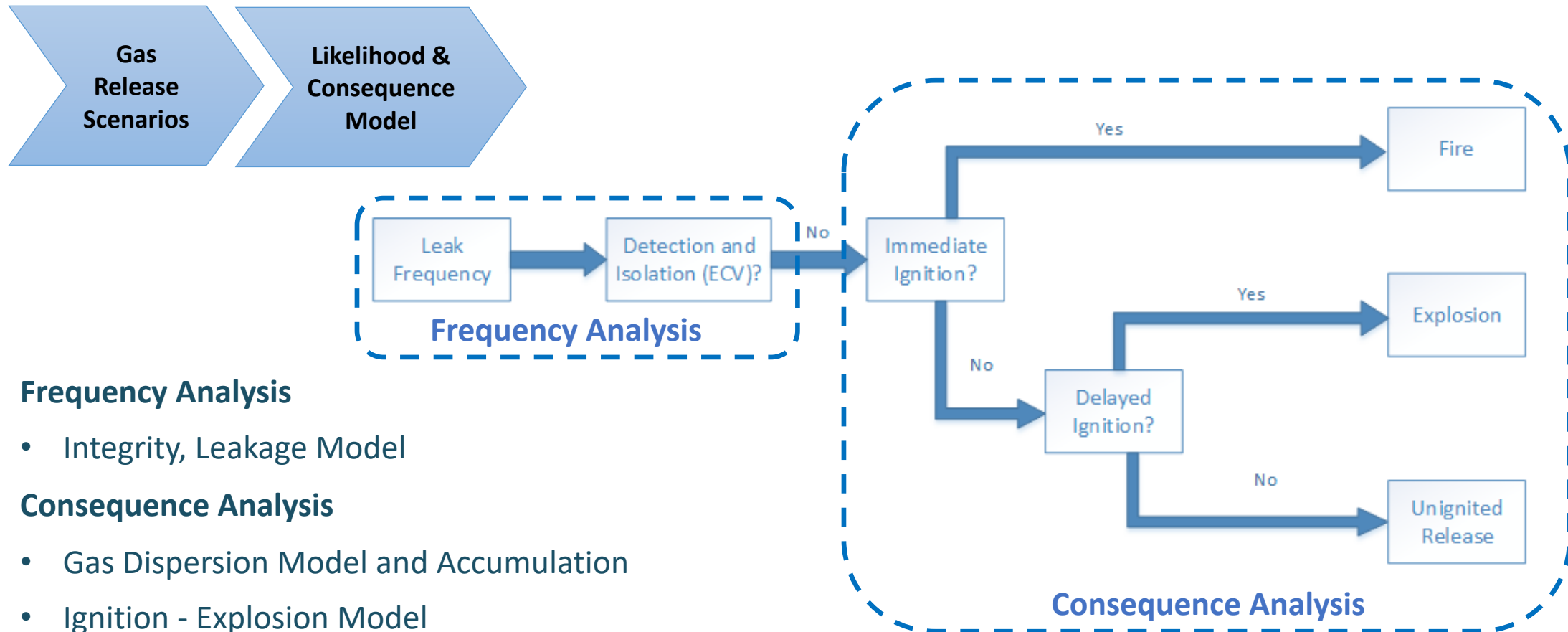
- Gas properties
- Ignition Energy
- Colourant and Odorant

## Literature & Knowledge:

- H100
- HyHouse
- HyDeploy
- Existing Pipework (Configuration, Material, Dimensions)
- Types of residential dwelling
- Air tightness (Building Regulations 2010)
- Historic gas incident events



# WP7 Safety Assessment – Gas Scenario, Likelihood & Consequence Model



## Frequency Analysis

- Integrity, Leakage Model

## Consequence Analysis

- Gas Dispersion Model and Accumulation
- Ignition - Explosion Model
- Consequence - Structural Damage Model
- Consequence - Fatality Model

*Illustrative example*

# WP7 Safety Assessment – Empirical Data

Empirical Data  
(e.g. GDNO,  
H100)

## Sources of Empirical Data

- GDNOs
- HSE
- H100
- HyDeploy
- HyHouse

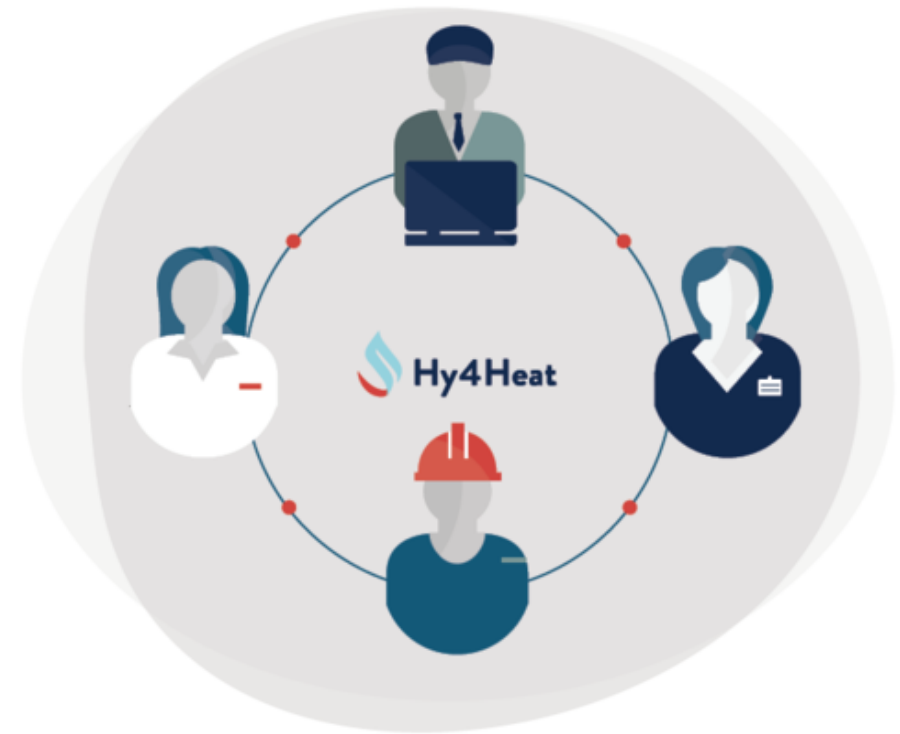


## Additional Data gathering:

- FCO Questionnaire

# WP7 Safety Assessment – Experimental Testing

- Focus on assessing the safe use of hydrogen gas in domestic properties and buildings
- Focus on providing experimental evidence to support the safety assessment
- Including gas leakage accumulation and ventilation of gas releases in different enclosed spaces within a typical domestic property
- Tender review in progress.
- Testing due to be completed by October 2019

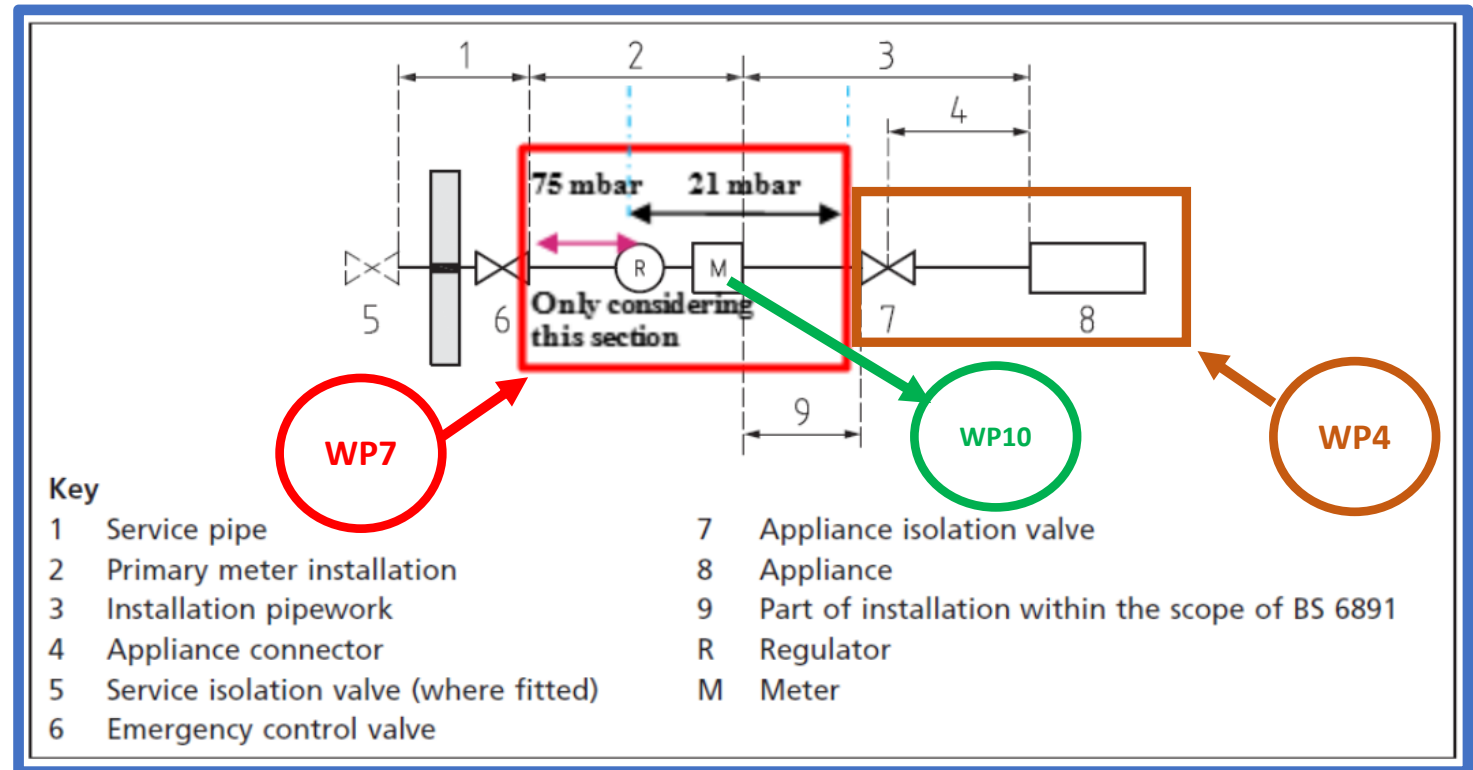


# WP7 Safety Assessment – Summary

- The overall WP7 Safety Assessment consist of:
  - 1) Existing Infrastructure safety assessment (WP7)
  - 2) Gas Meter - Developer Safety Assessment (WP10)
  - 3) Domestic Appliances – Developer Safety Assessment (WP4)
- Responsibility of the Safety Assessment downstream of the ECV (see diagram)
- WP7 is responsibility of the overall integrated safety assessment downstream of the ECV

\*ECV = Emergency Control Valve

## Boundary & Pipework configuration (Downstream of ECV)



BS 6891:2015 Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm (R11/4) on premises



**Hy4Heat**



# Hy4Heat (WP2) – Standards, Purity & Colourant

**Colin Heap**

**14<sup>th</sup> May 2019**

# Lot 1 – Hydrogen Standards

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- Objectives

- Assess current gas standards and their suitability for adoption for hydrogen
- Develop a hydrogen gas standard (new or adoption of an existing standard)
- Develop and update the relevant IGEM standards for use with hydrogen
- Develop robust evidence through research and testing
- Obtain IGEM committee approval for the updated standards
- Communicate to the gas industry prior to commencing the trial

- Deliverables

- To enable installers to construct and commission the pipe work and appliances required
- Support an unoccupied trial and/or demonstration zone
- The procedures in place for a potential occupied trial
- To produce a package of standards that provide a level of safety equivalent to that of natural gas.

## Lot 2 – Hydrogen Purity

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- This project focuses on hydrogen production and trace impurities to pull together a draft Purity Specification
- Draft Purity specification guided by literature review undertaken on existing quality recommendations for hydrogen used for heating
- Key stakeholder (hydrogen producers, network operators, equipment designers, appliance manufacturers and technical consultants) views sought to support the evaluation of the purity specification.
- Hydrogen production and clean-up options have undergone a cost benefit study using selected target scenarios to determine purity levels
- Significant uncertainties have been identified
  - the costs of purification at the point of use for PEMFC applications,
  - the future demands for hydrogen from the grid used in PEMFC applications and combustion applications.
- No firm conclusions can be drawn on the most cost-effective hydrogen purity level delivered through the grid.

## Draft Purity Standard

Content or characteristic	Value*	Rationale
Hydrogen fuel index (minimum mole fraction)	98 %	This value is a good compromise between hydrogen cost and effects on boiler.
Carbon monoxide	100 ppm (Safety Limit)	To meet health and safety limits, short and long term exposure (consideration being given to value nearer 10/20 ppm to permit the use of quick response PEM fuel cells)
Hydrogen sulphide content	$\leq 3.5$ ppm	These values are taken from GSMR1996 as any detrimental effects would be similar for hydrogen and natural gas.
Total sulphur content (including H <sub>2</sub> S)	$\leq 35$ ppm	
Oxygen content	$\leq 0.2$ %	
Hydrocarbon dewpoint	-2 °C	Complies with GSMR1996 and EASEE-gas
Water dewpoint	-10 °C	
Sum of methane, carbon dioxide and total hydrocarbons	$\leq 1\%$	No detrimental effects to boiler, this limit is to reduce carbon content of the exhaust
Sum of argon, nitrogen and helium	$\leq 2\%$	To avoid inerting the hydrogen gas (in agreement with ISO/FDIS 14687)
Wobbe Number range **	42 – 46 MJ m <sup>-3</sup>	Range and percentage variation based on natural gas range in GSMR1996
Other impurities	The gas shall not contain solid, liquid or gaseous material that might interfere with the integrity or operation of pipes or any gas appliance, within the meaning of regulation 2(1) of the Gas Safety (Installation and Use) Regulations 1998, that a consumer could reasonably be expected to operate	

## Lot 2 – Hydrogen Colourant

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- This project is considering the following hydrogen colourant options
  - Network addition / Appliance addition / No addition
- Implications of low visibility flames considered
- Appliance manufacturers consulted
- Risks to appliance performance considered
- Implications of odorant on flame colour investigated
- Work still to do
  - Leakage testing
  - Optimum colour solution
  - Concept and feasibility testing

# Questions and Answers

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**Hy4Heat**

Bob Walsh CEng.FIMechE

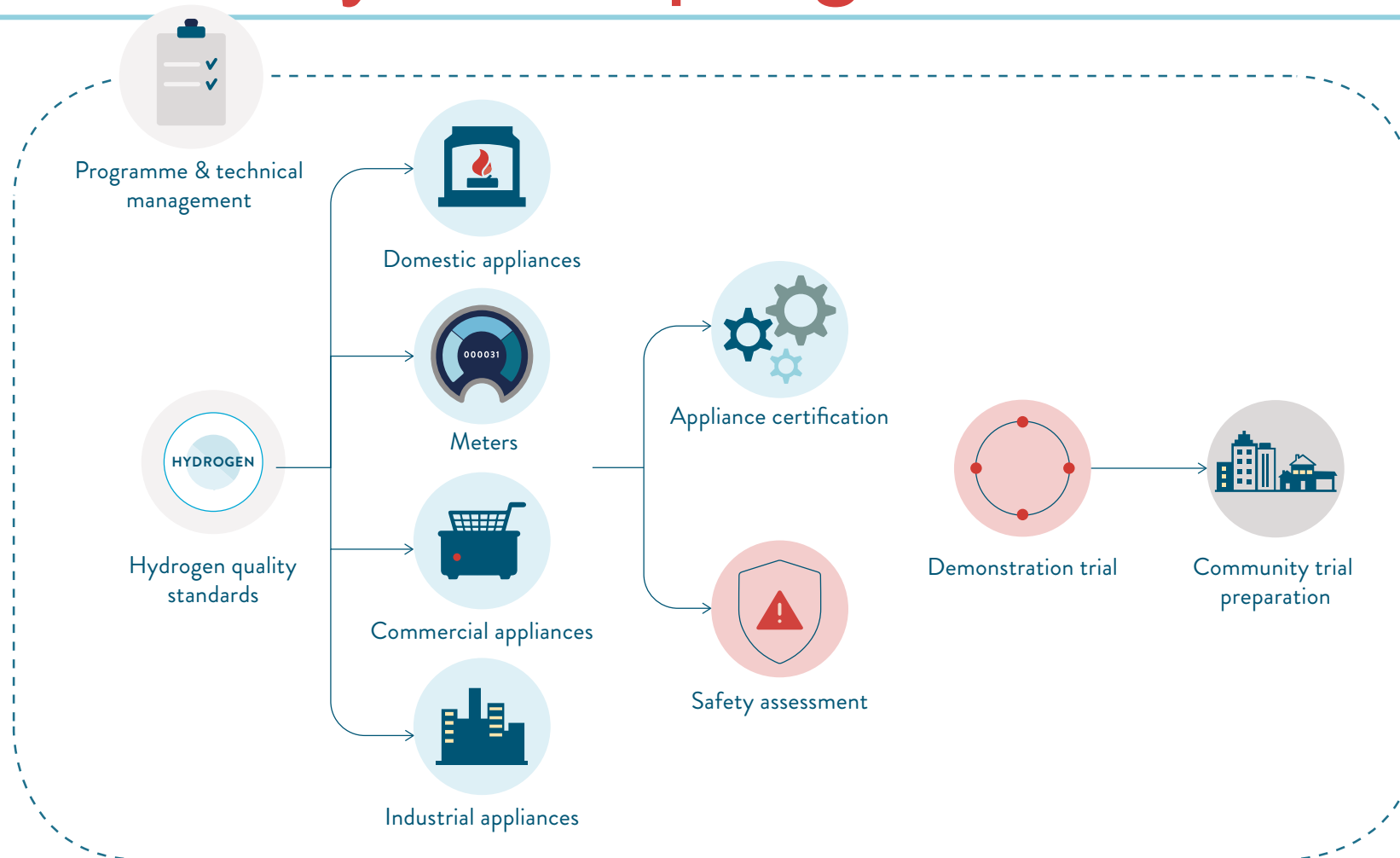
WP3: BSI PAS4444



Hydrogen Fired  
Gas Appliances  
Guide

**PAS 4444**

# Hy4heat programme



# Hy4Heat programme timeline overview

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Hy4Heat ends



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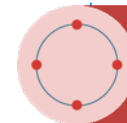
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## Work package 3

- Hydrogen appliances could be certified under the GAR
- The ability and/or capability to test and certify hydrogen appliances exists
- Currently no specific (harmonised) standards for testing hydrogen appliances but, like other unconventional gas appliances these are tested using a combination of standards or creating bespoke test methods to demonstrate compliance

**Consensus required on how existing standards will be used**

**There will be differences in how appliances need be tested**



# Why BSI and PAS?

- Need to develop some standardised guidance on how to apply current standards to ensure consistency across the industry
- BSI is the National Standards Body whose standards are widely used to test and certify gas appliances
- Developed by and in collaboration with industry stakeholders
- To support WP4 development and the wider industry
- Considered too early to revise existing standards due to limited experience and a PAS allows for guidance to be developed now

# PAS 4444 draft scope

- The PAS gives guidance on the development and construction of hydrogen-fired gas appliances which are either purpose-built to use hydrogen or might be converted to use hydrogen in the future
- The PAS covers the functional specification of the appliance, including specific advice on the demonstration of safety, including worst case conditions to stress the appliance in excess of that it is likely to experience in normal service. It also covers the setting of limits (upper and lower) hydrogen supply pressures and limit voltages. It discusses the possible arrangements of fittings and devices that might help demonstrate compliance with the Gas Appliance Regulations.

# PAS 4444 draft scope, *cont*

- The PAS also covers tests that manufacturers should consider adopting regarding both delayed ignition and unintended ignition of gas within the case of the appliance and / or its flue
- It also covers advice on manufacturer's instructions regarding installation of such appliances (including flues) and their servicing requirements
- The PAS generally assumes that any default performance requirements (for example noise or pressure rating) align with those of an equivalent 2<sup>nd</sup> family gas appliance, unless specifically stated otherwise

# PAS 4444 draft scope, *cont*

- The PAS is for use by the manufacturers of hydrogen fired gas appliances within the scope of the Gas Appliance Regulations and to manufacturers of conventional 2<sup>nd</sup> family gas appliances that might be converted to hydrogen at some date in the future
- The PAS is also of use to Notified Bodies

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# Indicative key dates

SG review (~2 weeks)	14/6 – 27/6/19
SG Meeting 1 (resolution of SG comments on Draft 1)	w/c 5/7/19
Review panel consultation (~4 weeks)	3/9 – 30/9/19
SG Meeting 2 resolution of public comments on Draft 2	w/c 10/10/19
SG editorial review	14/11 – 20/11/18
PAS publication	Jan 2020

# PAS4444

This PAS is specific to mainstream new gas appliances (cookers, gas fires, water heaters and boilers) flue type B and type C.

This PAS is not applicable to the conversion of installed gas appliances for use on hydrogen gas.

This PAS is currently not applicable to other types of gas fired appliances suitable for firing hydrogen firing:

- Flameless / catalytic burners
- Internal combustion engines
- Fuel cells - refer to EN 62282
- Gas turbines
- Industrial boilers
- Steam boilers

# PAS4444

The prime focus of the document is to consider residential appliances as these account for the volume of installed products. However due to the overlap of domestic/commercial products and standards, it is the intention that the PAS will be applicable to commercial products and will be developed to include those products currently outside of the scope.

# Normative references

BS EN 30 - Cookers

BSEN 203 - Catering equipment

BS EN 26 - Instantaneous water heaters

BS EN 89 - Storage water heaters

BS EN 509 - Decorative fuel effect gas appliances

BS EN 15502 - Gas fired central heating boilers

BS 7977 - Radiant convectors

BS EN 62282 - Fuel cell standard used for guidance



**Hy4Heat**

Round table discussions

# Q & A





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