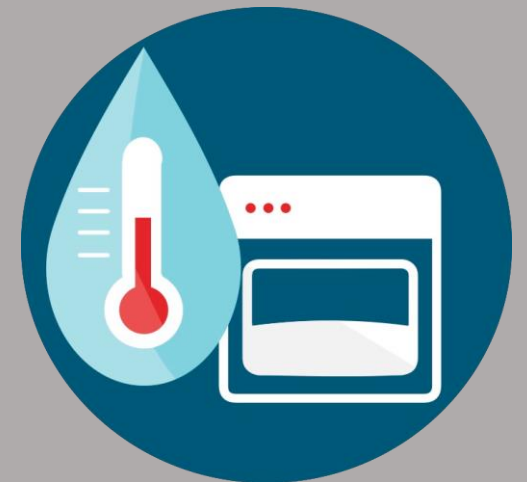


# Commercial Hydrogen Appliances & Equipement



# Jon Saltmarsh

Head of Built Environment  
Technology & Systems, BEIS

## Purpose of today

- An overview of the Hy4Heat programme
- An understanding of commercial appliance development opportunities
- Outline our innovation procurement approach
- A chance to give feedback to the Hy4Heat programme
- Opportunity to network with industry colleagues

# Agenda

Welcome and introduction	Jon Saltmarsh
Energy innovation	Mark Taylor
Hy4Heat programme overview	Jon Saltmarsh
Various Hy4Heat workstreams	Jeremy Few
Commercial appliances procurement approach & other Hy4Heat workstreams	Hannah Steedman
Q&A	All
Roundtable discussion	All
Feedback	All
Stalls & networking lunch	All

# Mark Taylor

Deputy Director: Energy Innovation  
BEIS (SICE)



**Hy4Heat**

# Jon Saltmarsh

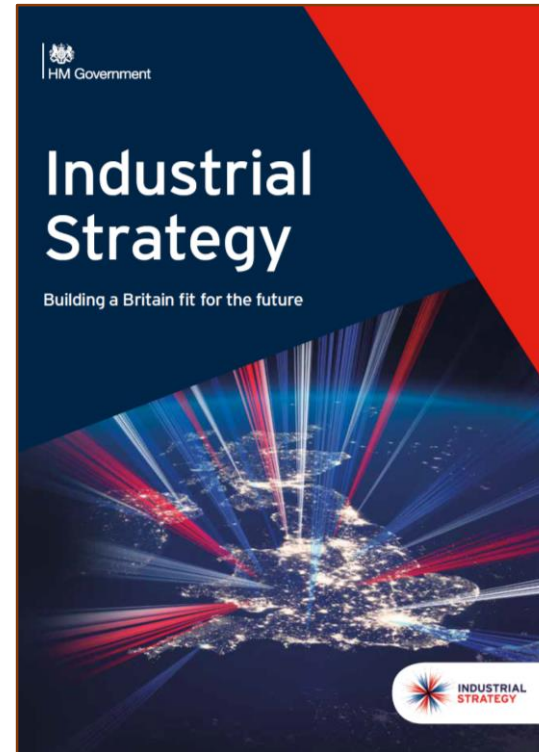
Head of Built Environment Technology  
& Systems, BEIS

# Policy is set out in two key documents

## **Clean Growth Innovation Challenges**

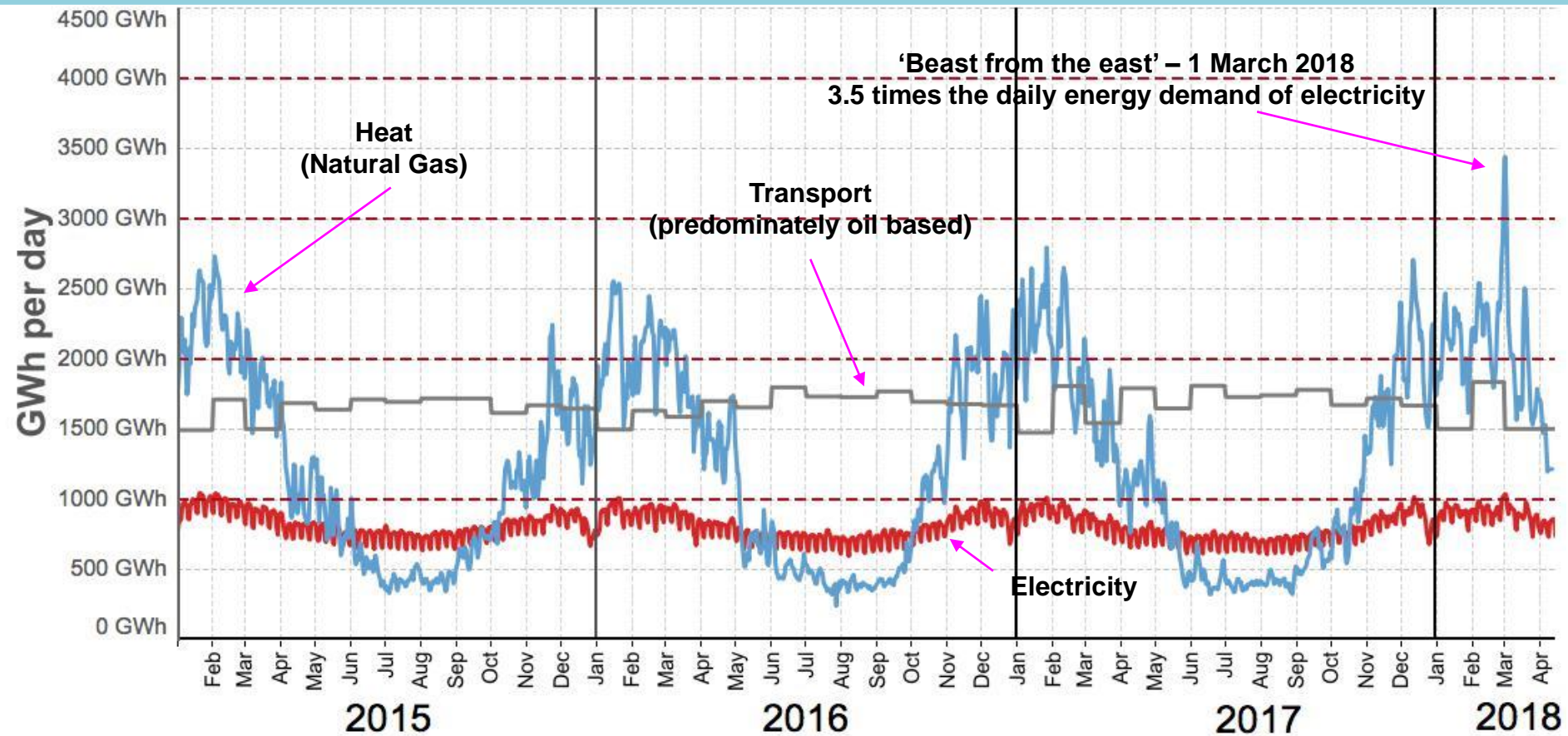
*“Clean fuels such as hydrogen and bioenergy could be used for transport, industry, and to heat our homes and businesses. We need to test how they work in the existing gas network, whether they can fire industrial processes, and how they could be used in domestic appliances.”*

Clean Growth Innovation Challenges - Clean Growth Strategy





# The challenge – UK energy demand



Data are from National Grid, Elexon and BEIS. Charts are licensed under an Attribution-NoDerivatives 4.0 International license  
Charts can be downloaded from <http://bit.ly/energycharts>

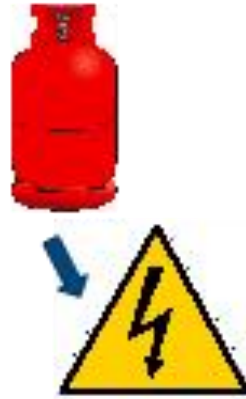


by Dr Grant Wilson grant.wilson@sheffield.ac.uk

# Decarbonisation pathways for heat

## Electrification

- conversion to electric heat pumps or other electric technologies
- particularly useful for buildings not on the gas grid



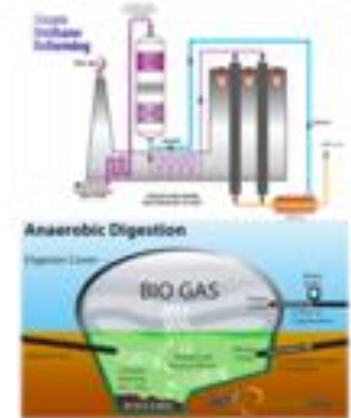
## District heat networks

- cost effective where there is sufficient density of heat demand
- likely to be an important part of the mix in the long term



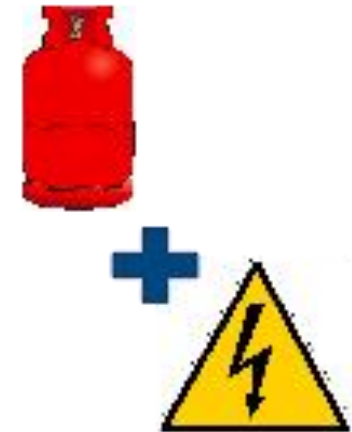
## Decarbonising the gas grid

- using hydrogen or biogas
- more work is needed to assess cost and feasibility

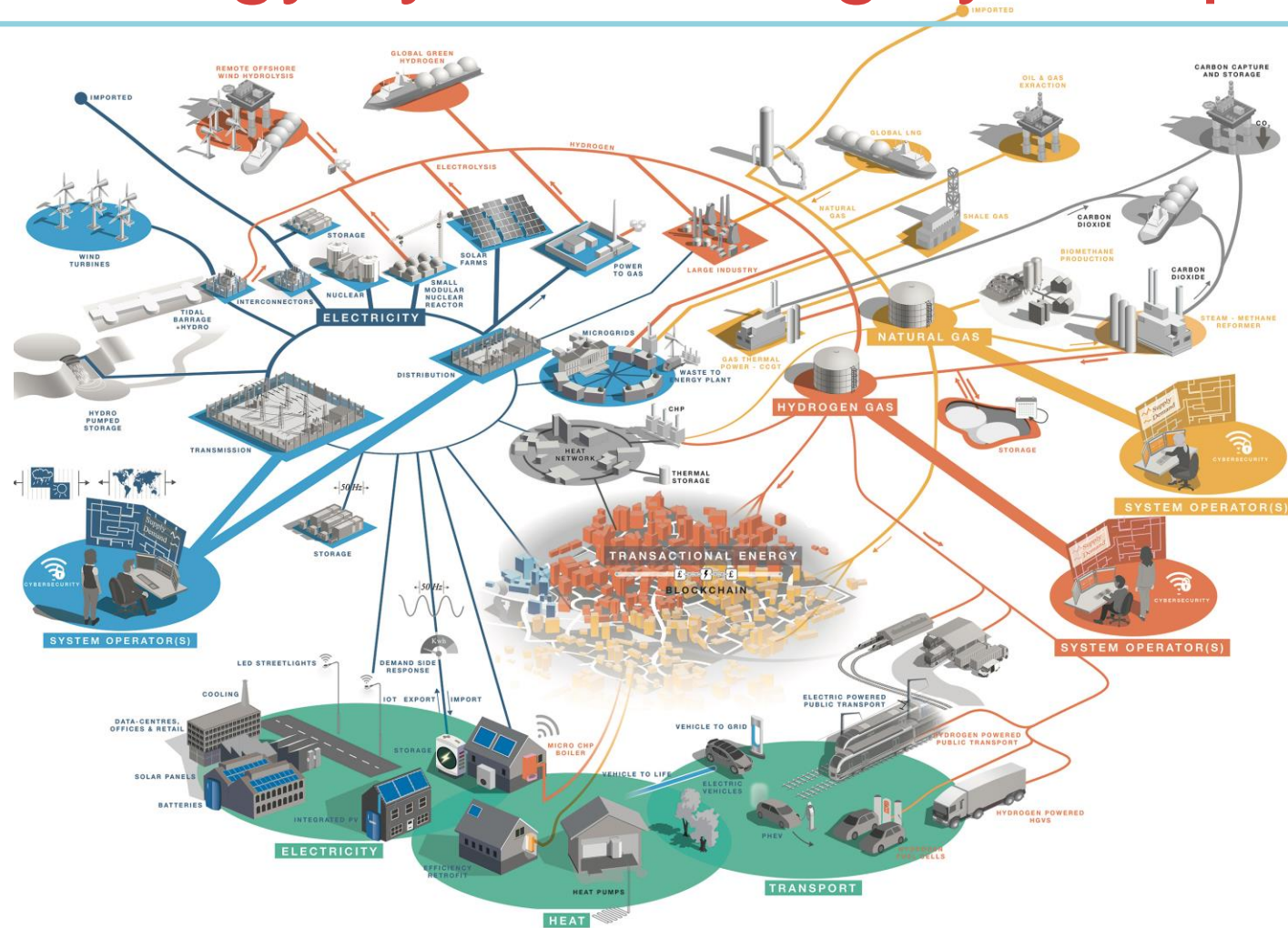


## Hybrid solutions

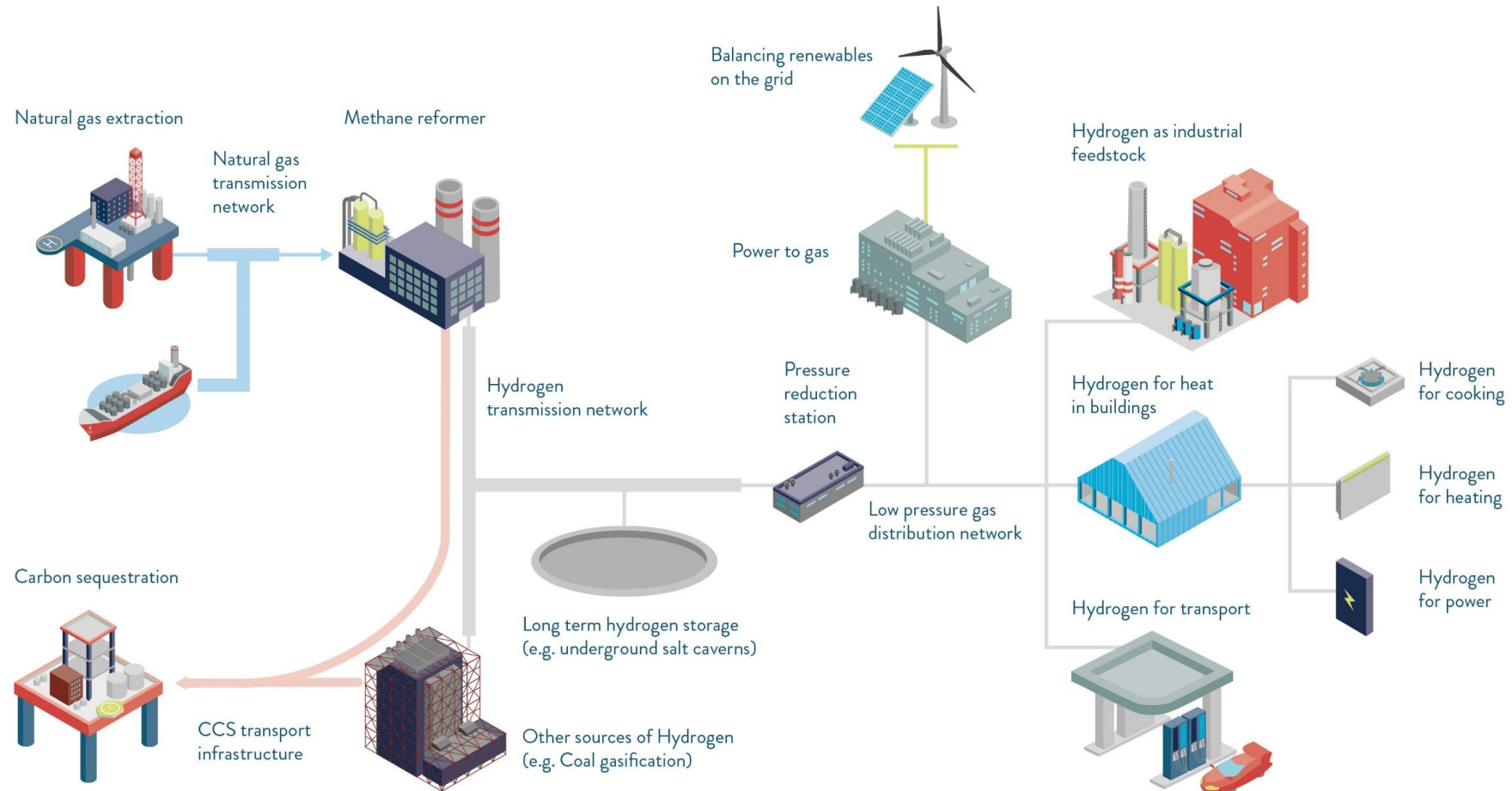
- two different heating technologies and energy sources working together



# The energy system is highly complex

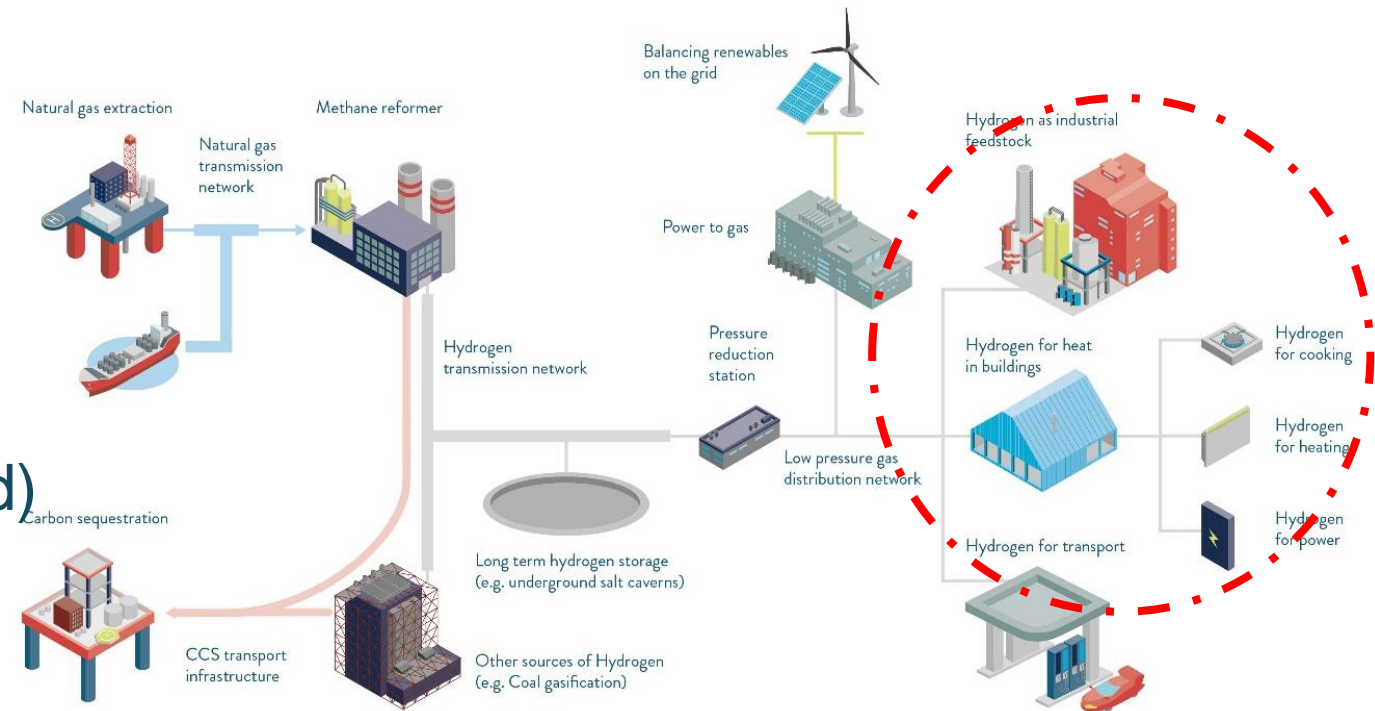


# Conceptual view of a hydrogen system



# Hydrogen innovation programmes

- BEIS Hy4Heat – hydrogen end use
- H21 – 100% hydrogen in the distribution network
- HyNet – end to end demonstration
- HyDeploy – hydrogen blending 20%
- H100 – hydrogen end use (new build)
- BEIS – hydrogen supply & storage
- BEIS – industrial fuel switching
- DfT – hydrogen for transport



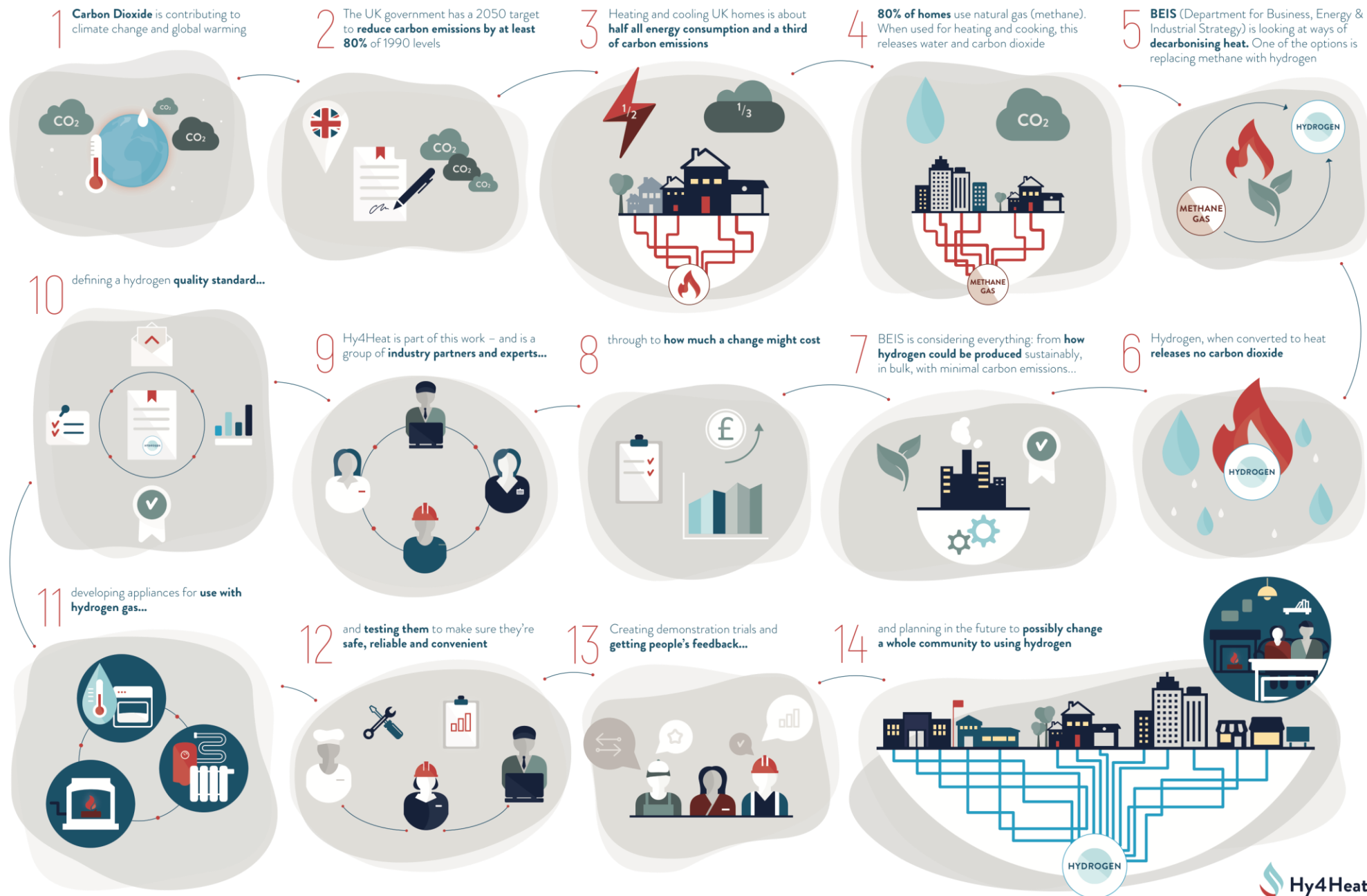
# Hy4Heat mission

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 Hy4Heat Programme



# 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



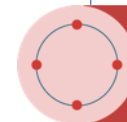
WP7 Safety and risk assessment



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





Jeremy Few

Hy4Heat work package manager

# Hydrogen quality & standards (WP2)

- **IGEM** review and revise existing relevant standards:
  - Overall safety (construction, quality, response)
  - combustion, flueing and ventilation
  - materials and components
  - design and installation of pipework
  - commissioning (purging and flaring)
  - metering
- **DNV GL** - purity & colourant
- **NPL** - odorant



# Draft hydrogen standard (purity)

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 $\mu\text{mol mol}^{-1}$	An absolute maximum value to meet health and safety limits, short term exposure
	20 $\mu\text{mol mol}^{-1}$	A practical engineering limit based on achievable production limits and to meet short term exposure limits
	1 $\mu\text{mol mol}^{-1}$	An aspirational limit to be a target for hydrogen purity to enable utilisation in fuel cells
Hydrogen sulphide content	$\leq 5 \text{ mg m}^{-3}$ (3.5 $\mu\text{mol mol}^{-1}$ )	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)	$\leq 50 \text{ mg m}^{-3}$ (35 $\mu\text{mol mol}^{-1}$ )	
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	

# Hydrogen appliance certification (WP3)

- Hydrogen appliances to be certified under GAR (Gas Appliance Regulation)
- BSI (British Standards Institute) developing PAS 4444



**bsi.**

# WP6: Industrial appliances



# Safety assessment (WP7)

- Comparing hydrogen with natural gas
- Building on knowledge and evidence that exists already e.g. collaborating with the GDNO's
- OJEU procurement underway further experimental testing
- HSE engagement



# Safety assessment overview



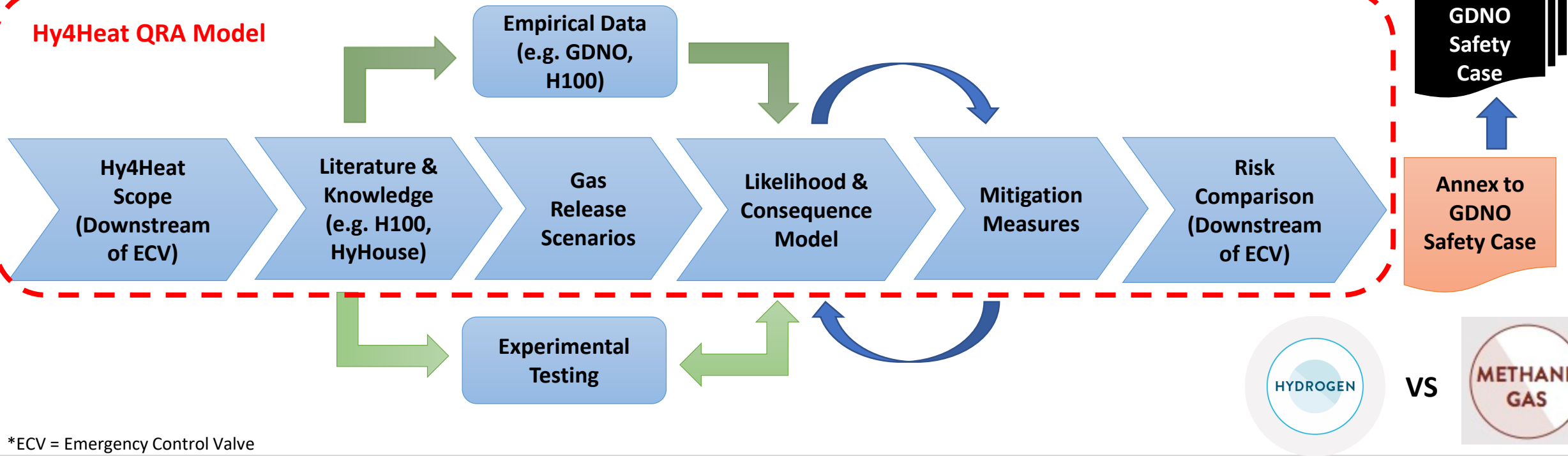
H21 Scope (ECV & Upstream of ECV)

H21  
QRA Model + Experimental Testing

Risk Comparison (ECV & Upstream of ECV)

Annex to  
GDNO  
Safety Case

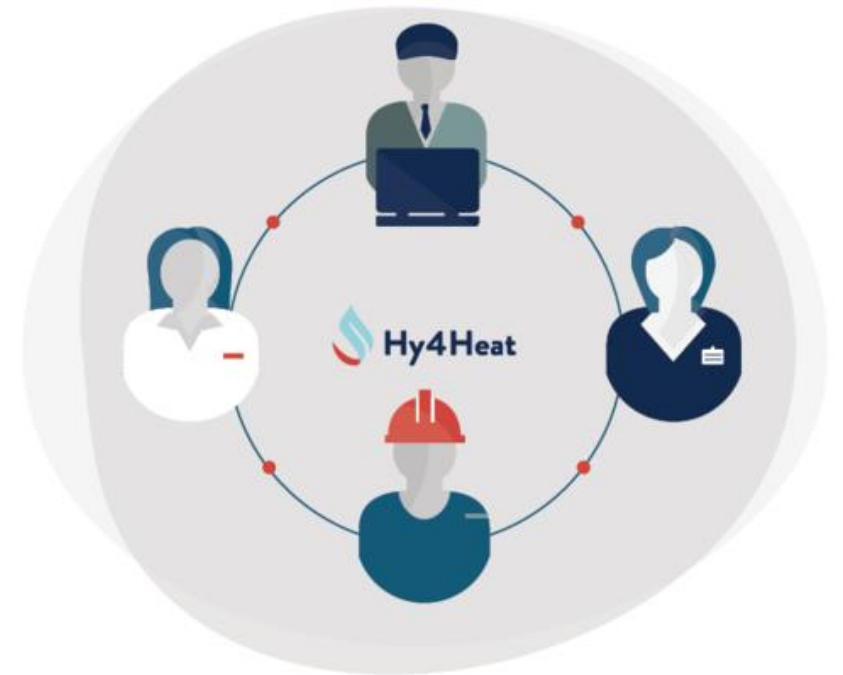
## Hy4Heat QRA Model



\*ECV = Emergency Control Valve

# 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

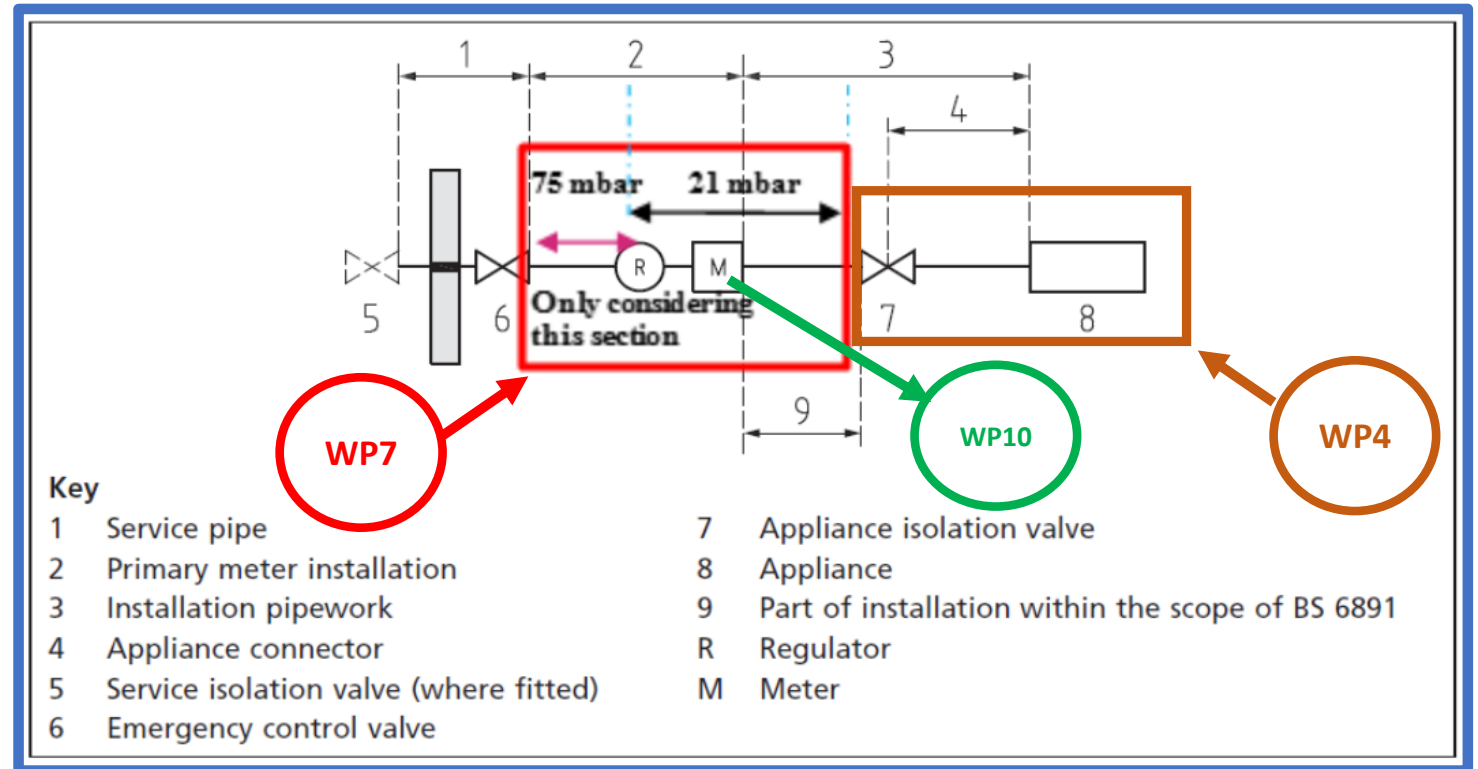




# Safety assessment: summary

- 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 responsible of the overall integrated safety assessment downstream of the 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

\*ECV = Emergency Control Valve

Hannah Steedman

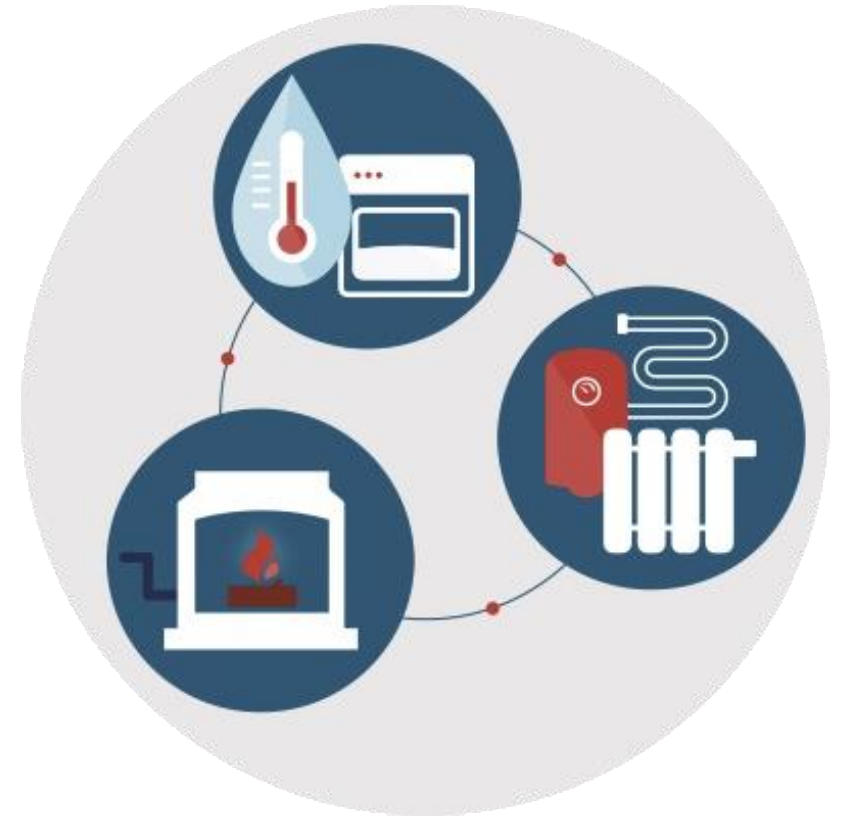
Hy4Heat work package manager

# Introduction

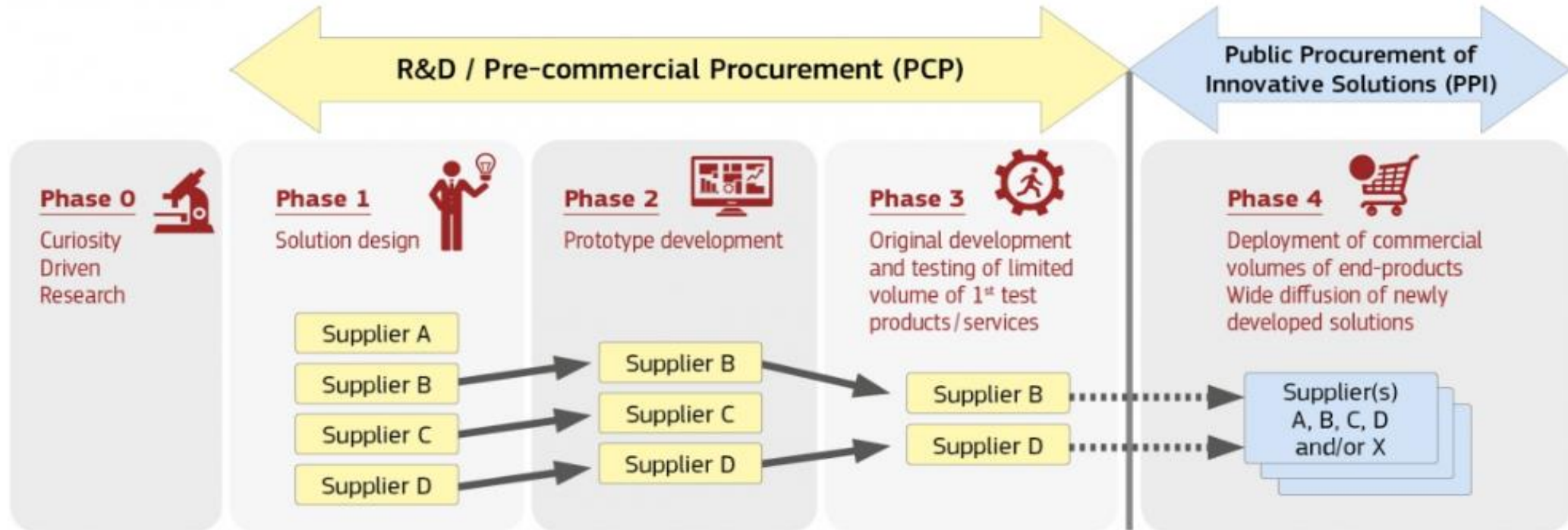
- Development of domestic hydrogen appliances (WP4)
  - Overview of pre-commercial procurement (PCP) approach
- Demonstration showrooms, unoccupied trials (WP8)
- Development of hydrogen smart meters (WP10)
- Commercial appliances research and development (WP5)

# Domestic hydrogen appliances (WP4)

- SBRI pre-commercial procurement innovation competition:
  - gas boilers
  - gas cookers
  - gas fires
  - innovative hydrogen appliances
- Phase 2 underway
- 14 development projects

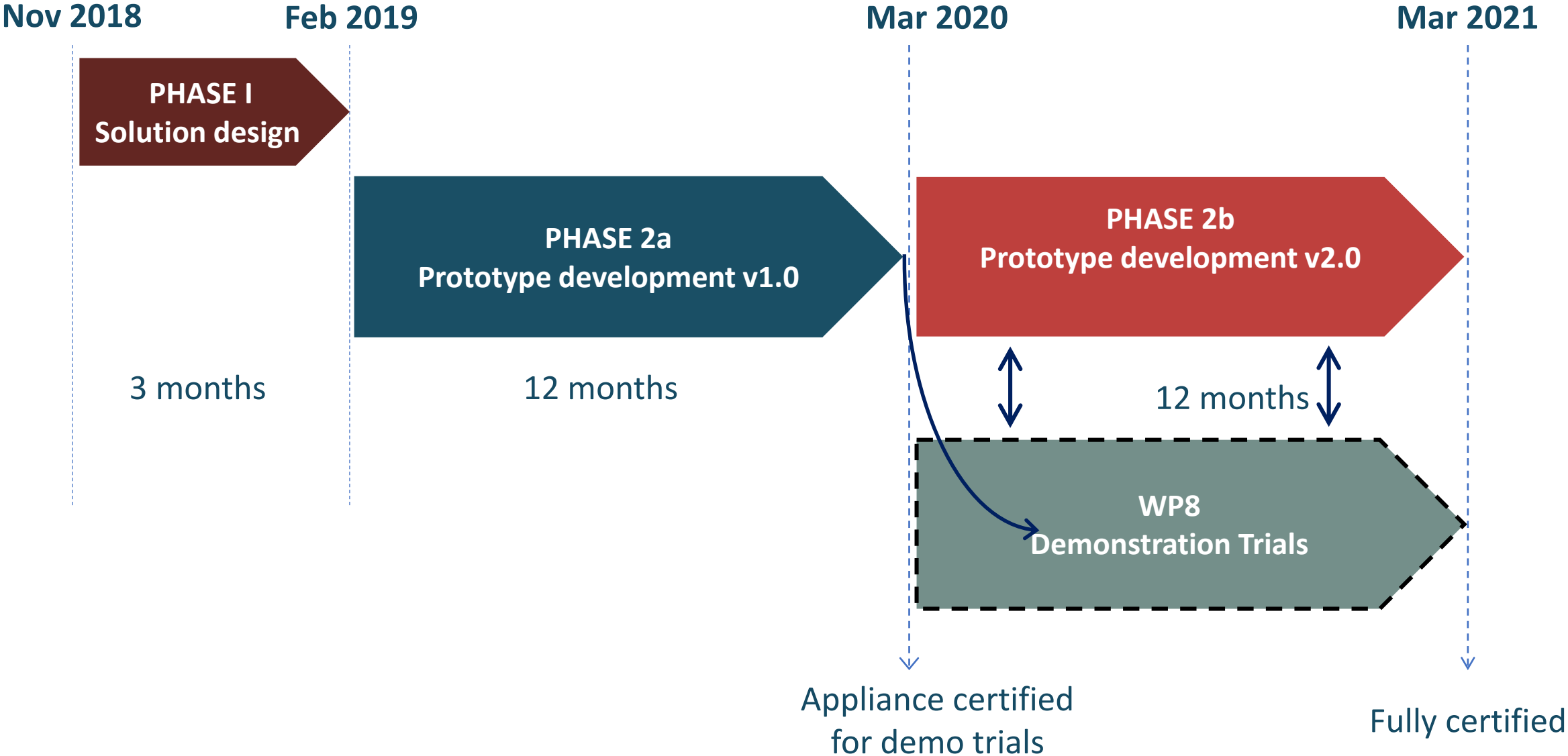


# Pre-commercial procurement approach



- SBRI is a UK implementation of PCP
- Competitions are open to all companies and across the EU
- It is an outcome-driven open, competitive tender procedure
- IPR approach allows for sharing of risk and reward between supplier and contracting authority

# WP4 Phased competition structure

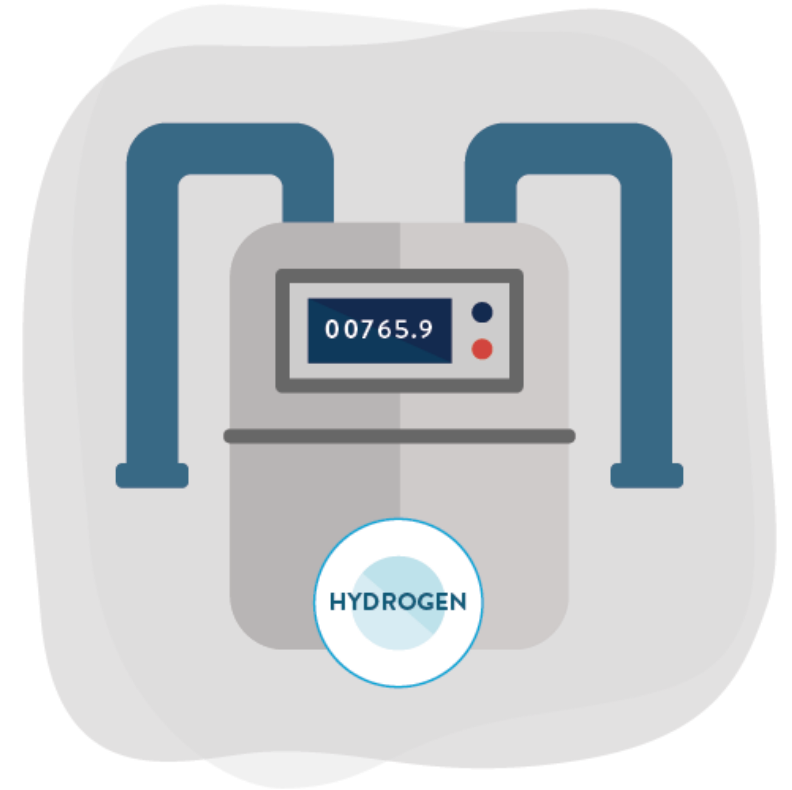


# Demonstration showroom WP8



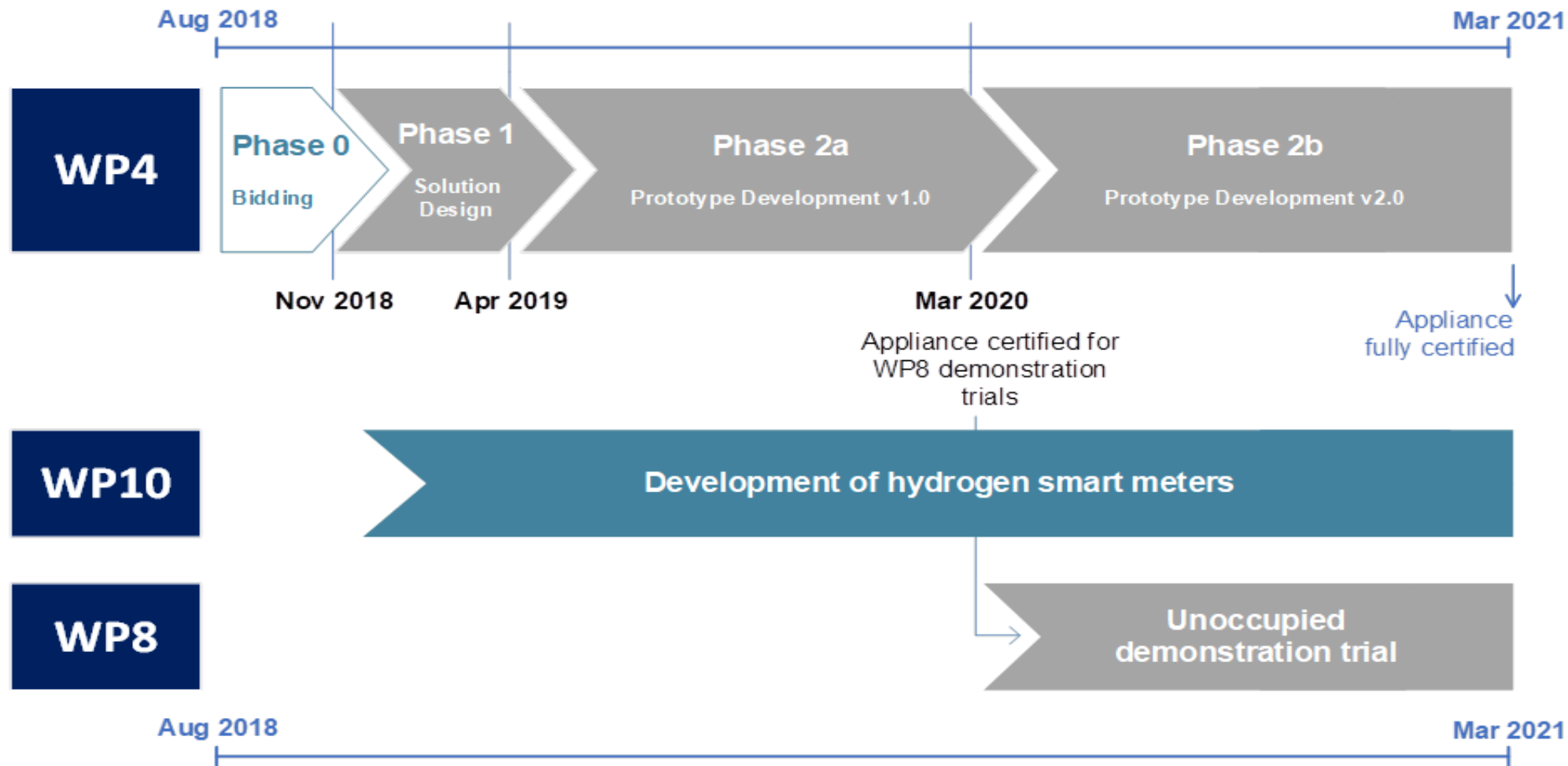
# Domestic hydrogen meters (WP10)

- Development of smart hydrogen meters that demonstrate safe and accurate measurement of hydrogen flow
- Procurement in progress
- Innovation partnership
- Will also be demonstrated in the demonstration showroom (WP8)





# Timescales



# Commercial appliances (WP5)

- ERM is conducting a study into the commercial sector
- We are considering procuring the development of:
  - Catering appliances
  - Commercial space heating & hot water
  - Commercial innovative appliances
  - Critical system components such as connectors, sensors, alarms, fittings and valves
- Expected competition value £4m

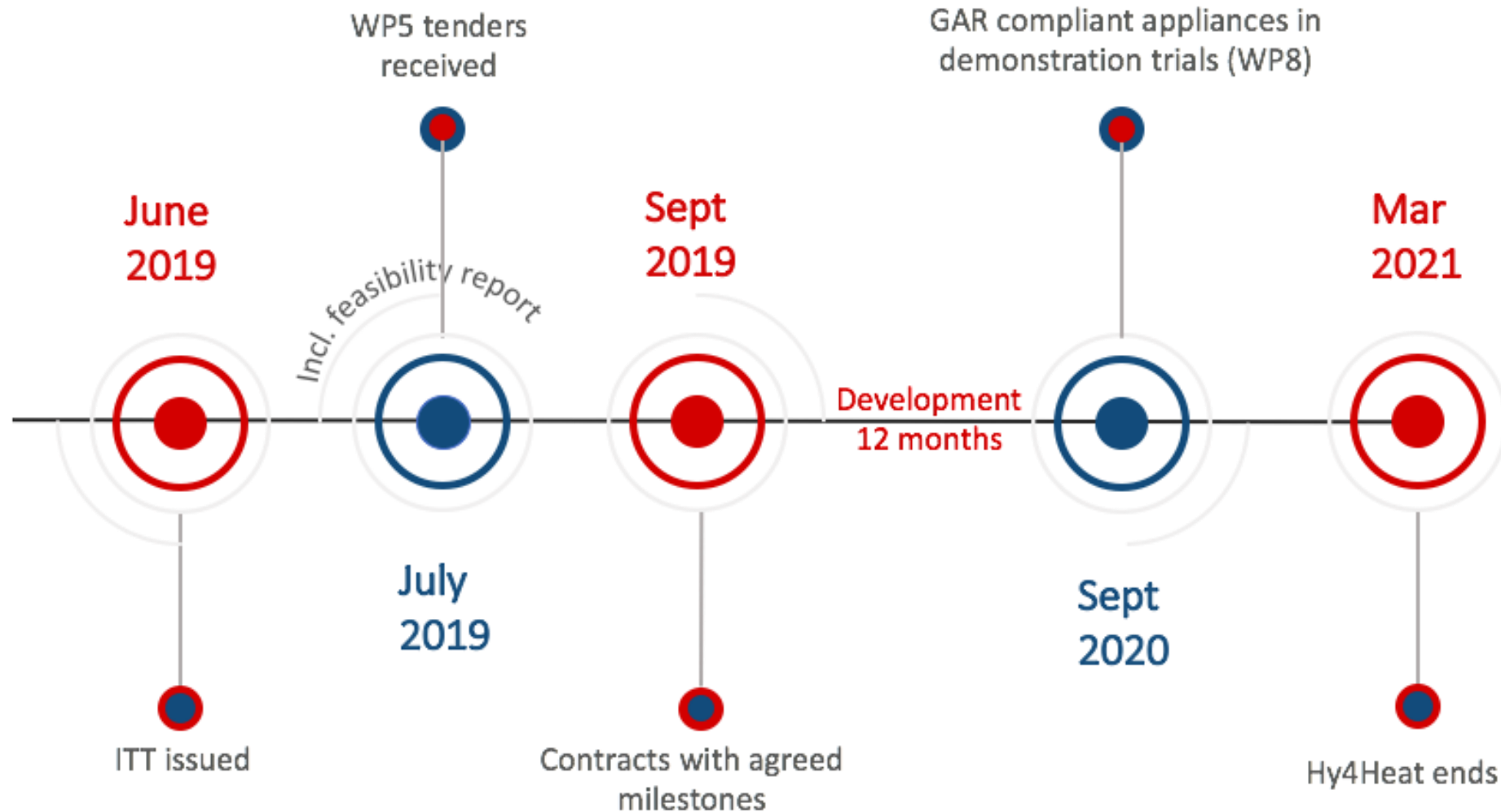
# Example categories (for discussion)

Category	Example appliance / equipment type
Catering / cooking	<ul style="list-style-type: none"><li>• Forced draught burner based indirect cooker</li><li>• Open / Enclosed atmospheric-burner based cooking equipment</li><li>• Catalytic / distributed flame radiant burner cooking equipment</li></ul>
Heating & hot water	<ul style="list-style-type: none"><li>• Forced draught burner based radiant / warm air heater</li><li>• Catalytic/distributed flame burner based radiant heater</li></ul>
Innovative / unconventional	<ul style="list-style-type: none"><li>• Gas driven heat pump</li><li>• Small laboratory or craft gas fired torch or burner</li></ul>
Auxiliary Items	<ul style="list-style-type: none"><li>• Valves</li><li>• Alarms / Sensors</li><li>• Pipework / Fittings</li><li>• Connectors</li></ul>

# Example support (for discussion)

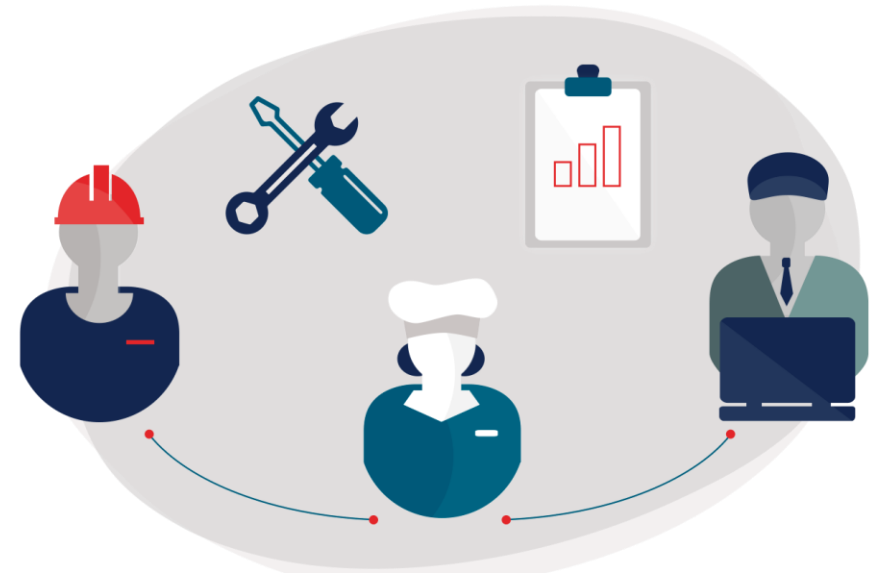
Category	Example appliance / equipment type	Target support
Catering / cooking	E.g. Forced draught burner based indirect cooker	c.£90,000 - £120,000
Heating & hot water	E.g. Forced draught burner based radiant heater	c.£90,000 - £120,000
Innovative	E.g. Gas driven heat pump	c. £100,000 - £150,000
	E.g. Bunsen burner	c. £40,000
Auxiliary items	E.g. Valves, alarms, etc	c. £50,000 - £100,000

# WP5 Phased competition structure

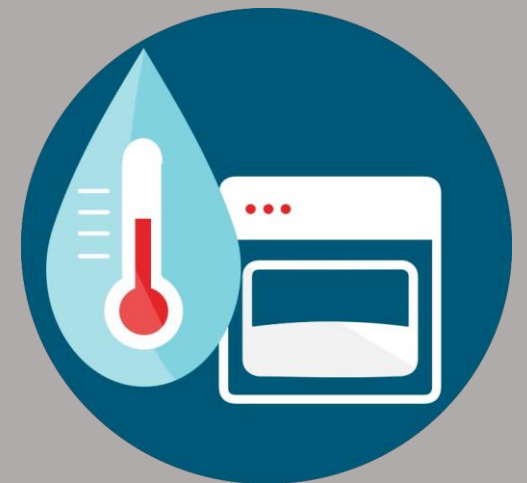


# Summary: commercial appliance development

- SBRI pre-commercial procurement
- Scope of appliances and funding across the commercial sector for discussion
- Competition launching in coming months



# Roundtable discussions

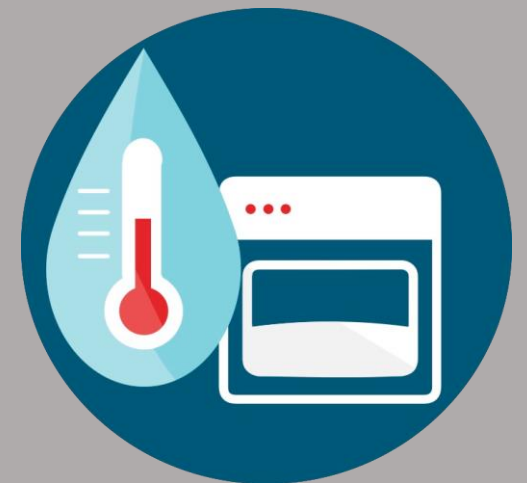




**Hy4Heat**



# Commercial Hydrogen Appliances & Equipment





**Hy4Heat**