

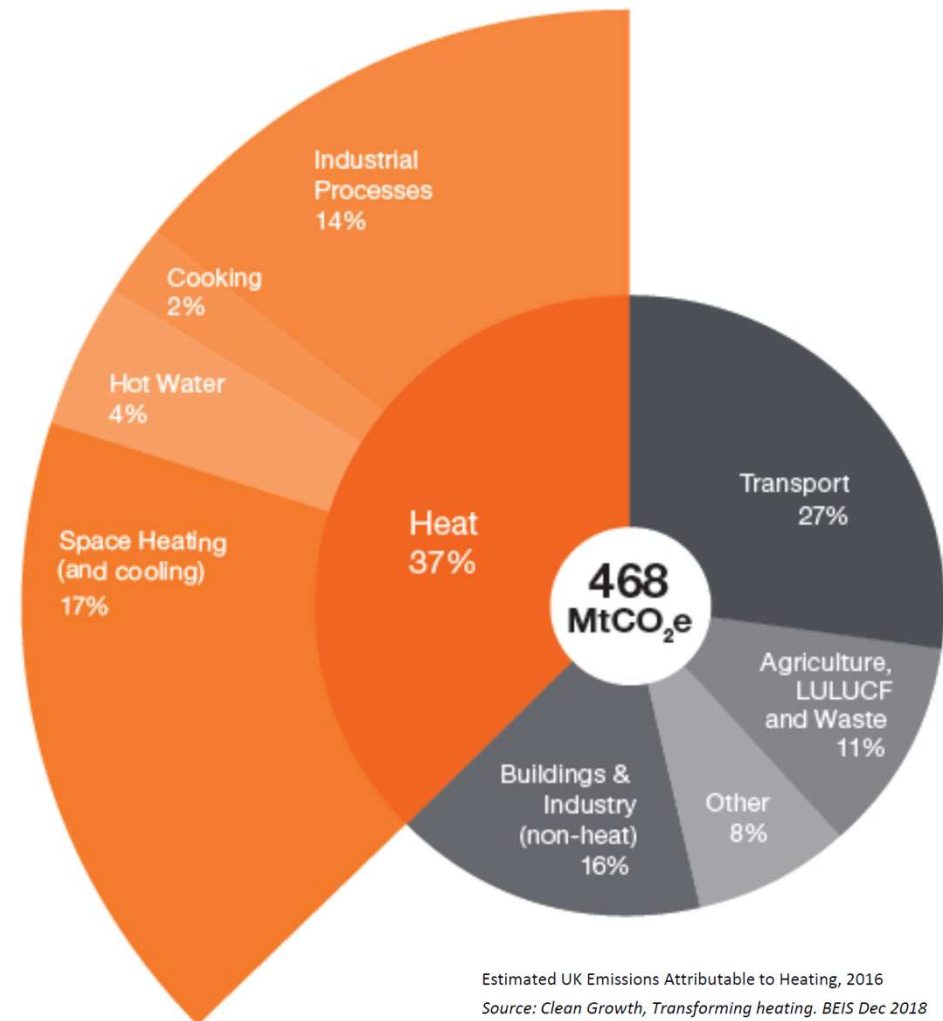


# Hydrogen for Heating Applications

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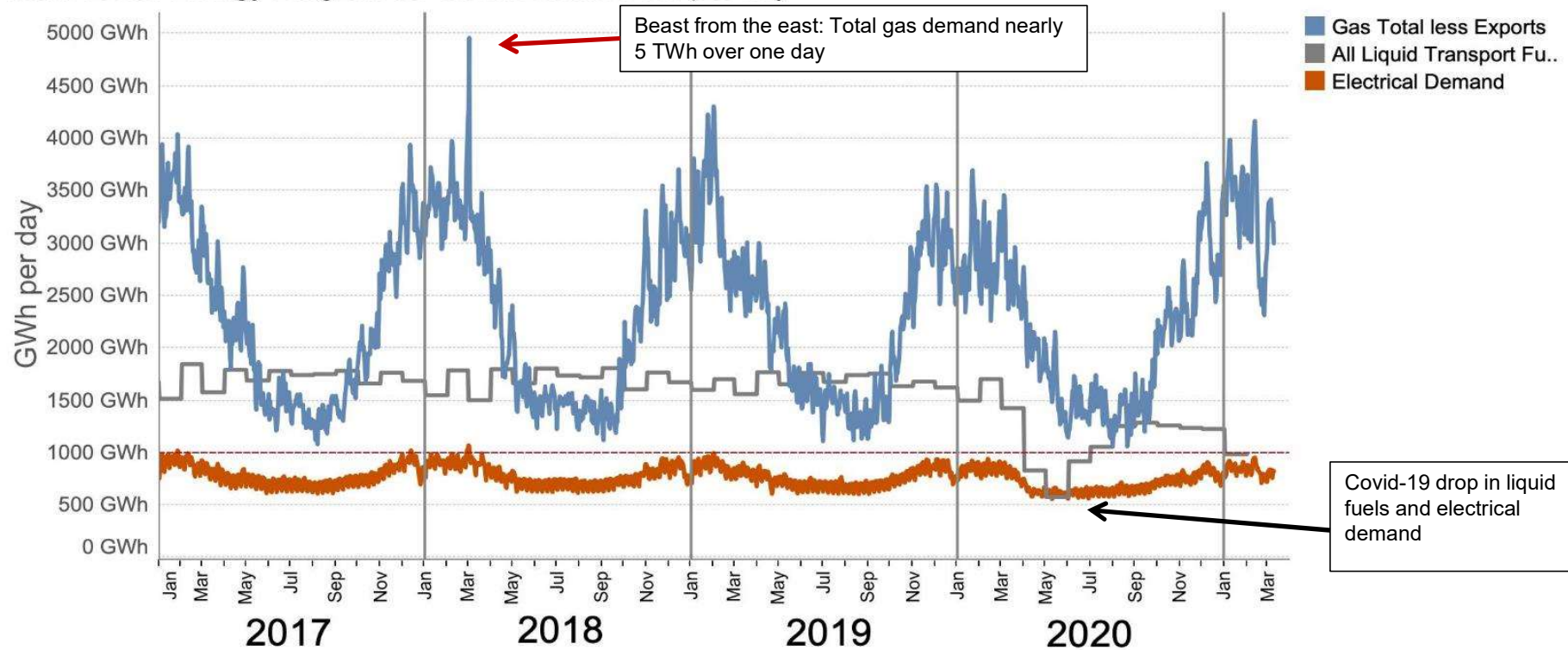
# The Net-Zero Challenge

- In 2019, the UK government set a legally binding-target to achieve net-zero greenhouse gas emissions from across the UK economy by 2050.
- Heating is responsible for over a third of our emissions. Meeting our net-zero target will require virtually all heat in buildings to be decarbonised by 2050, and heat in industry to be reduced to close to zero carbon emissions.

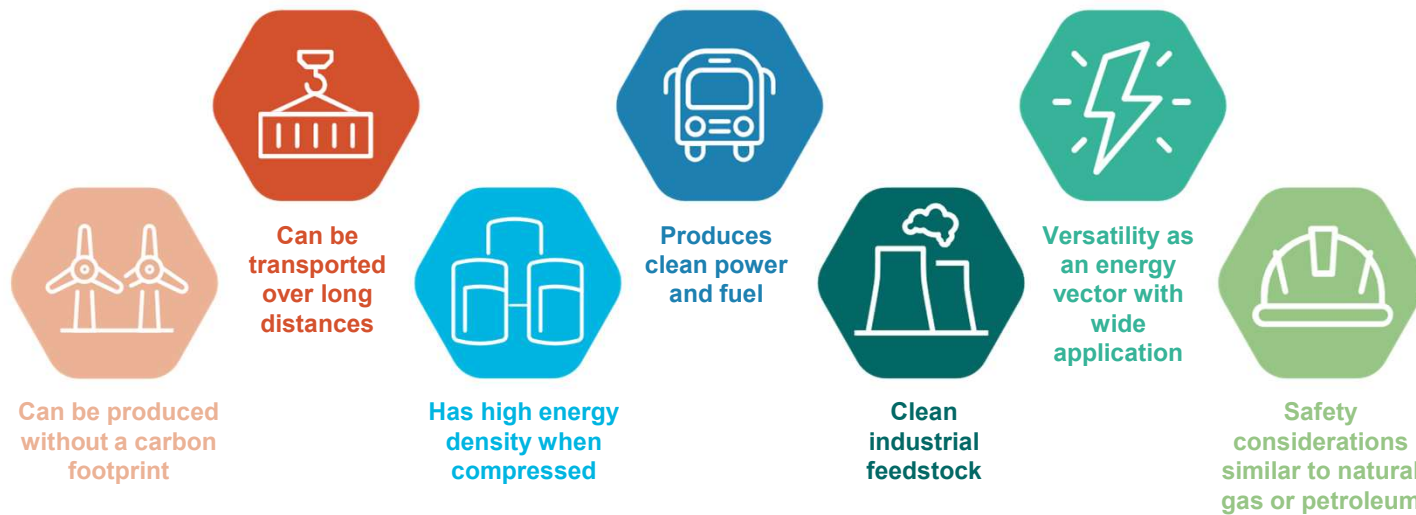


# The Energy System Challenge

Multi-vector Energy Diagram for Great Britain GWh per day



# Why Hydrogen?

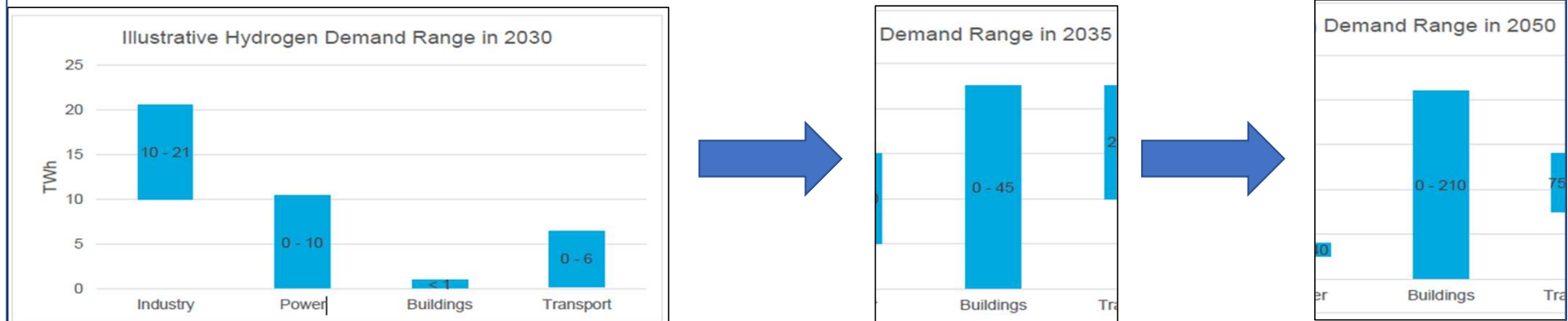


Source: ARUP

# UK Hydrogen Strategy

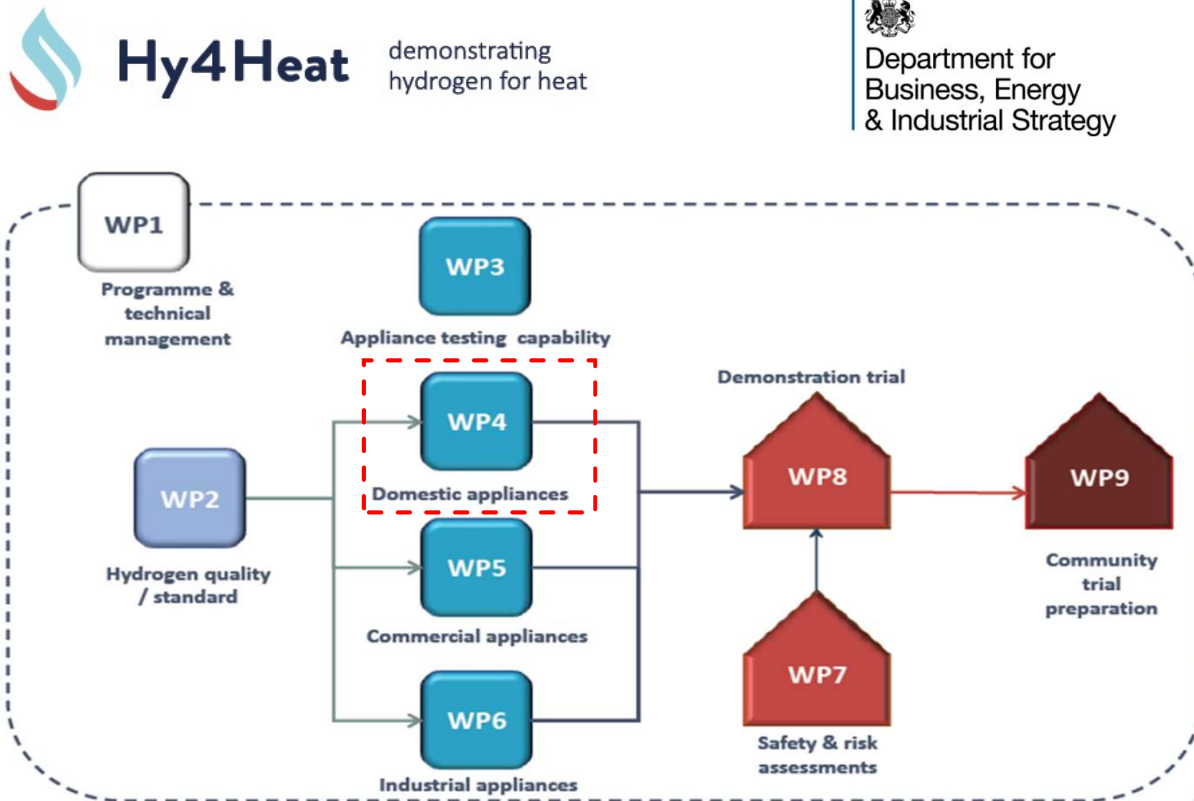


## Modelled hydrogen demand ranges (note total UK domestic building heat C. 434 TWh today)



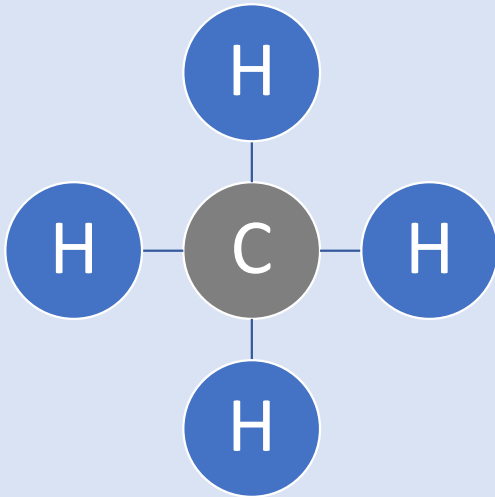
# Hy4Heat Programme

- UK Government funded project to establish if technically possible and safe to replace natural gas (methane) with hydrogen
- To provide technical, performance, usability and safety evidence to support policy decisions over future energy mix

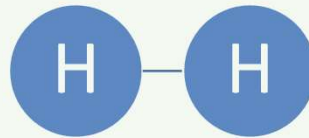


# NG (Methane) & Hydrogen Combustion

Natural Gas / Methane - CH<sub>4</sub>



Hydrogen - H<sub>2</sub>



Key Differences:

- Flame speed
- Flame temperature
- Flame detection
- Volumetric flow

# Hydrogen Boiler Development

- Prototype system and combination boilers based upon donor platform with adaptations to accommodate hydrogen combustion
- Identical size, comparable lift weight, efficiency and performance to NG appliance
- Performance and heat delivery as per NG counterparts
- No CO production potential; positive safety benefit
- Live demonstrations ongoing across the UK & EU



# NOx Emissions

- NOx production typically increases with temperature, levels of NOx are sometimes raised as a concern for hydrogen combustion as the flame temperature is elevated (2250°C) when compared to that of natural gas (1960°C).
- When discussing NOx emissions from gas fired boilers BSEN15502-1 refers. (in section 8.13, table 4)

Table 4 — NO<sub>x</sub> classes

NO <sub>x</sub> -Classes	Limit concentration mg/kWh based on NCV	Limit concentration mg/kWh based on GCV
1	260	
2	200	
3	150	
4	100	
5	70	
6		56

- The UK wide mandate in 2005 that all domestic boiler installations must be of condensing type means NOx emissions have been steadily reducing owing to efficiency gains and design changes.
- The EU EcoDesign Directive limit for NOx emissions from natural gas boilers is class 6, our current natural gas condensing boilers perform well below this limit.
- Knowledge acquired when developing natural gas boilers coupled with the sophisticated nature of the gas-air ratio valve have made it possible to ensure that our hydrogen boiler improves upon the extremely low NOx levels currently seen in our natural gas condensing boilers.

# Hydrogen Ready Concept

- Hydrogen ready boilers offer a simple and easy to implement option to help prepare a significant proportion of the UK housing stock for future conversion.



## Pure Hydrogen Boiler

*Installed at point of network conversion where replacing older non-ready boilers*

*Additional training required*



## Conversion Process

*Short intervention, parts kit changeover and recommission*

*Additional training required*



## Hydrogen Ready Boiler

*Works on NG up to a 20% blend of H<sub>2</sub> by volume – ready to convert*

*Current operative skillset for installation*



## Natural Gas Boiler

*Today's installed appliance park*

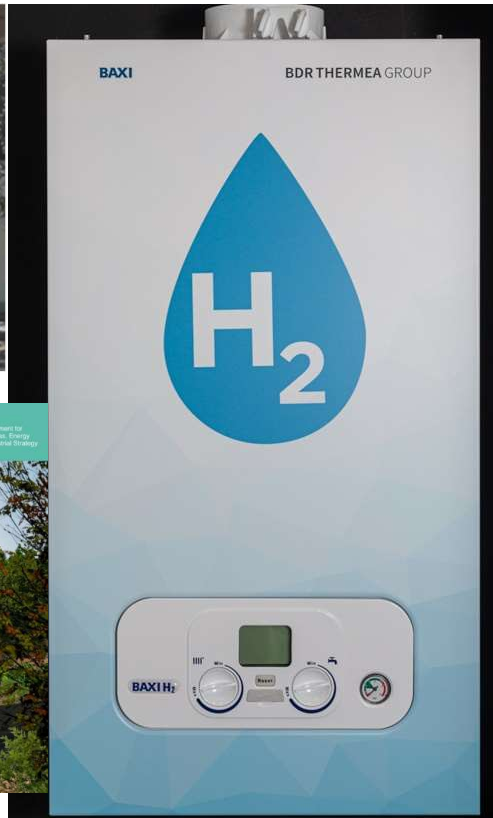
*HyDeploy project proving operation on NG up to a 20% blend of H<sub>2</sub> by volume*

*Current operative skillset for installation*

# Demonstration Sites

## • Demonstrations ongoing include:

- HyStreet Spadeadam, Cumbria
- Hydrogen Home, Low Thornley, Gateshead
- Rozenburg, NL
- Uithoorn, NL
- Apeldoorn, NL
- Bassano, IT



## Q&A