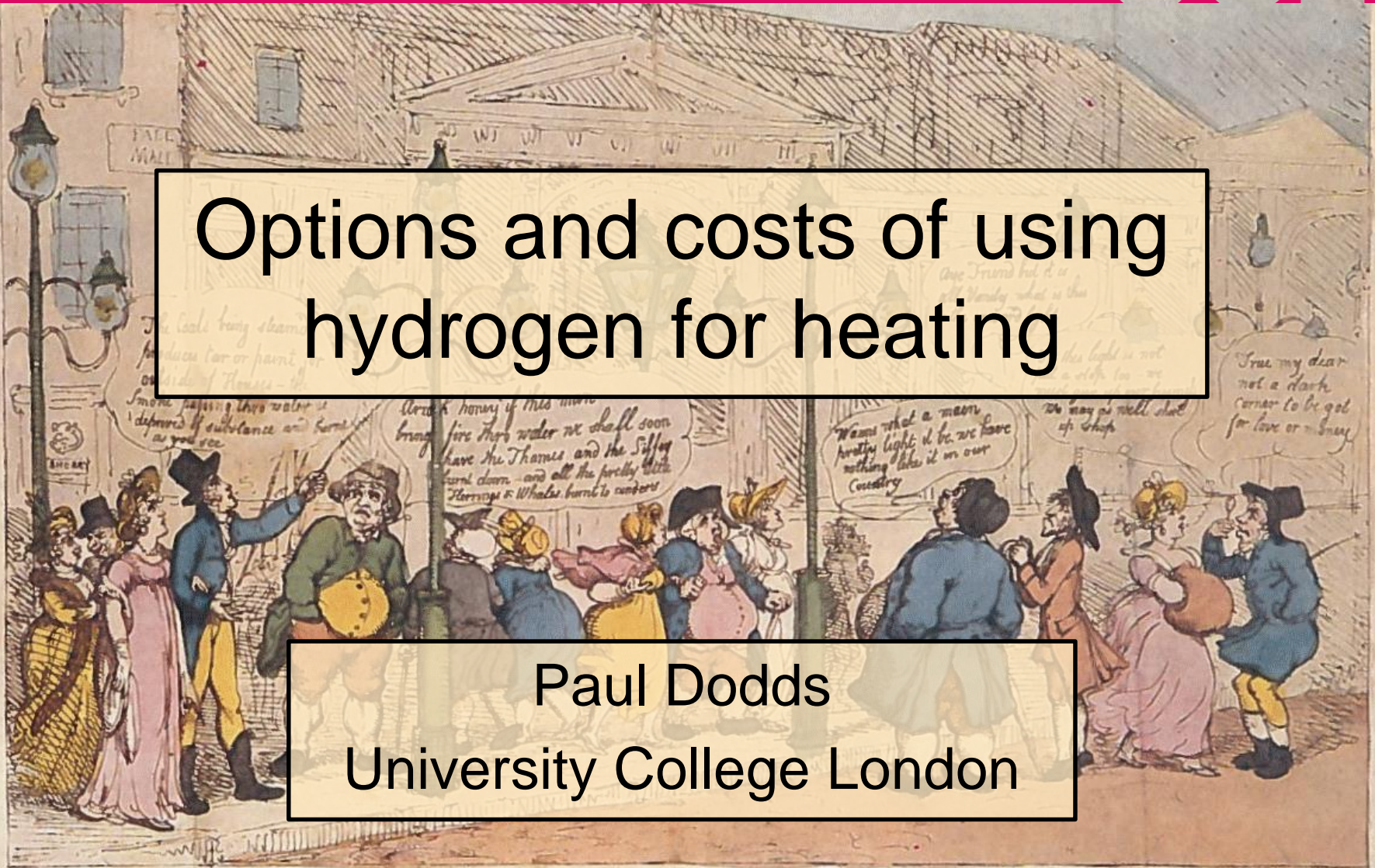


# Options and costs of using hydrogen for heating

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University College London



A PEEP AT THE GAS LIGHTS IN PALL-MALL. 13 September 2021

## 1812: The *Gas Light and Coke Company* is incorporated to provide gas lighting

Why town gas?

- Economic case: cheaper than whale oil.
- Quality of service: brighter, safer flame.

William Murdock.  
Chantler & Lacey (1949)



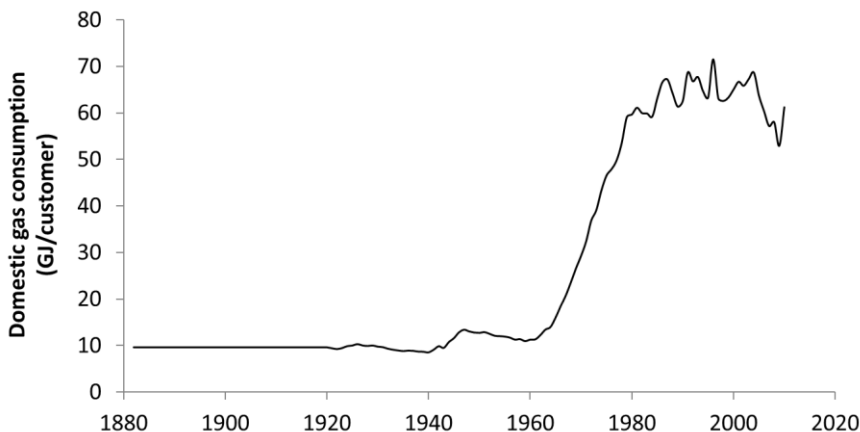


## Outline

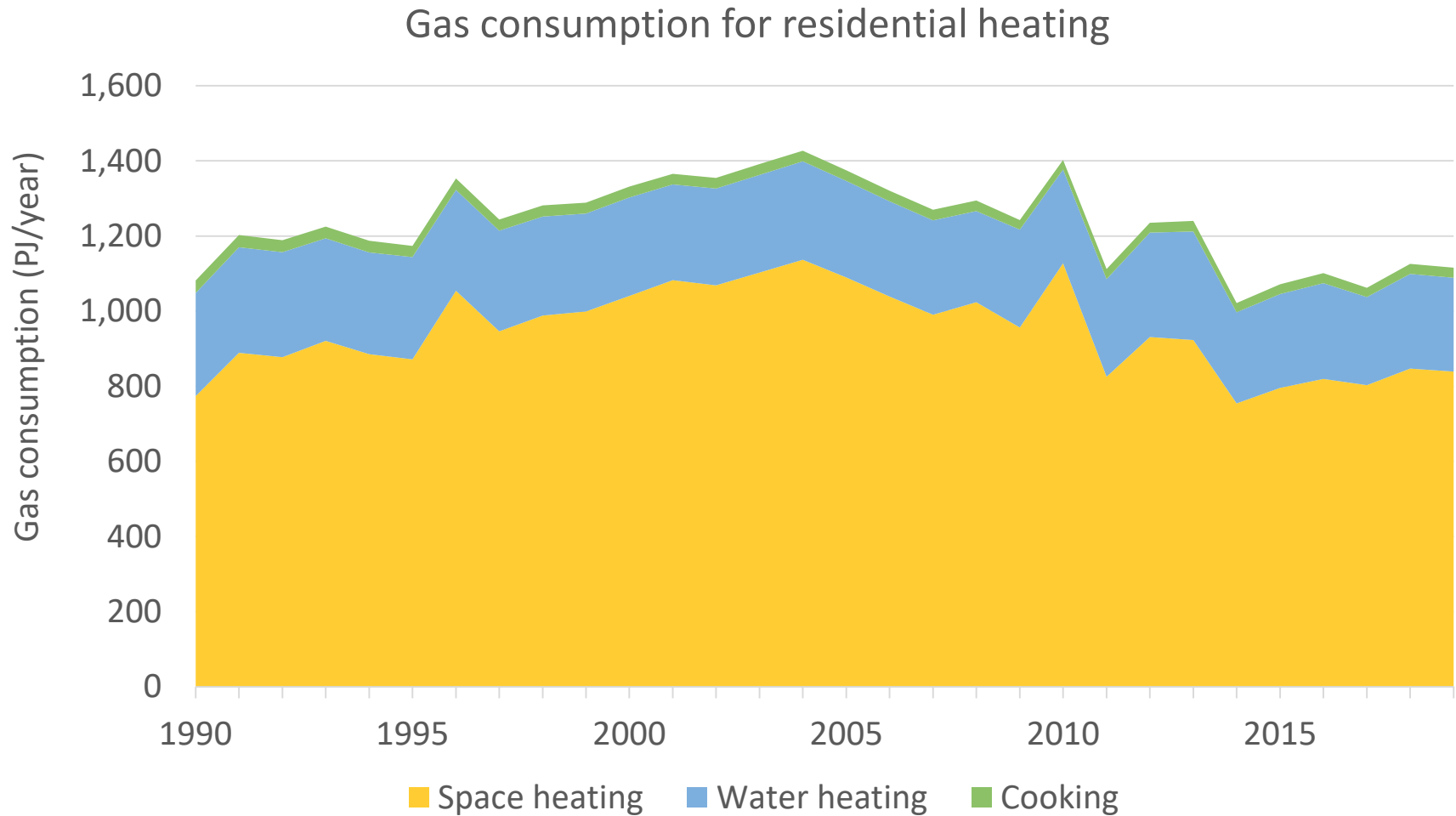
- Aim: to assess the implications, options and costs of gas network conversion to hydrogen
  - Would all of the gas networks be converted, as proposed, or only those parts where hydrogen is a competitive decarbonisation option?
  - Would customers be expected to use hydrogen boilers, or would it be better for them to instead use a different hydrogen-powered device, or a non-hydrogen option?
  - What are the decarbonisation costs of network conversion? Should we mandate “HyReady” boilers to prepare for conversion?
- We explore these aims using the UK TIMES energy system model

## The UK has experience of gas network conversion

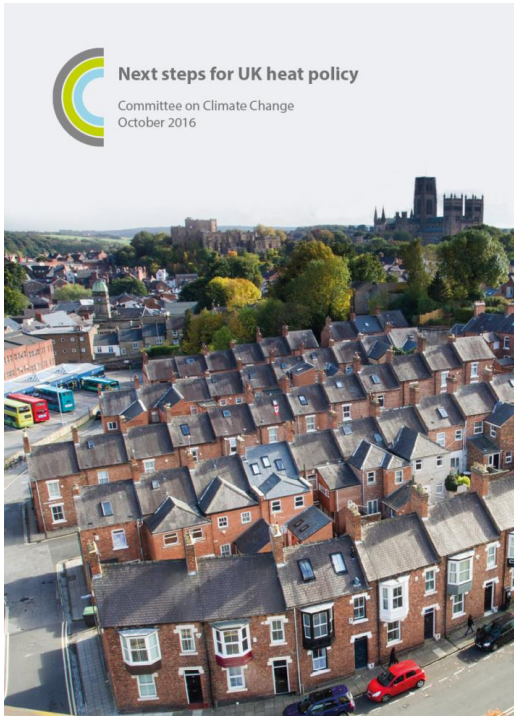
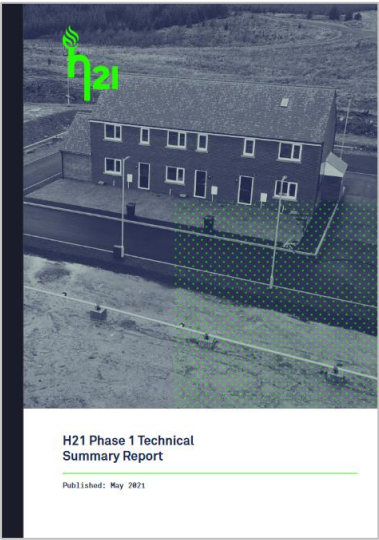
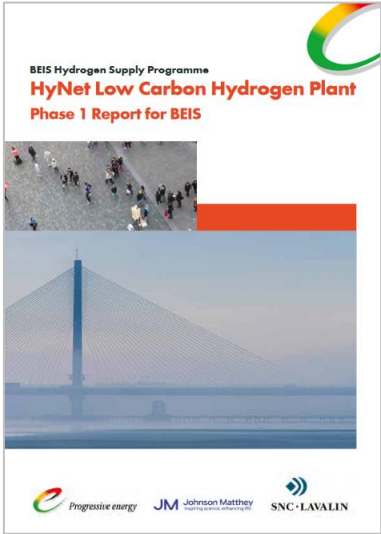
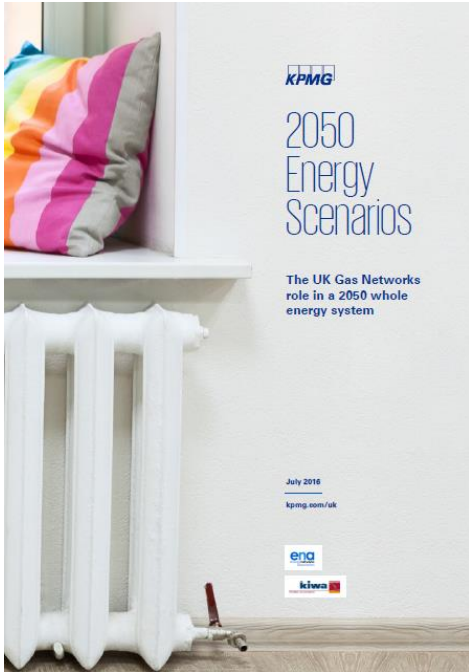
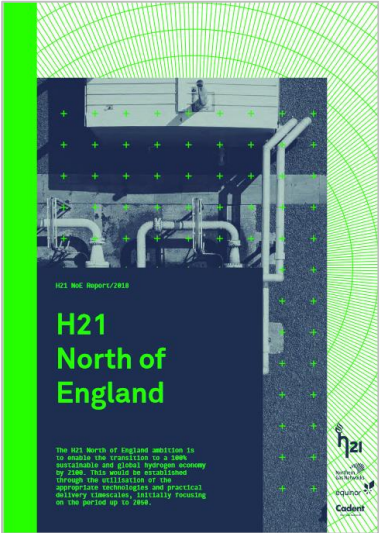
- Natural gas discovered in the North Sea in 1959.
- Conversion programme starts in 1967 and is completed in 1977.
- Many more houses connected as heating becomes the primary end-use.



# Natural gas remains a popular fuel for heating in UK homes



# The gas industry has invested much effort in conversion studies



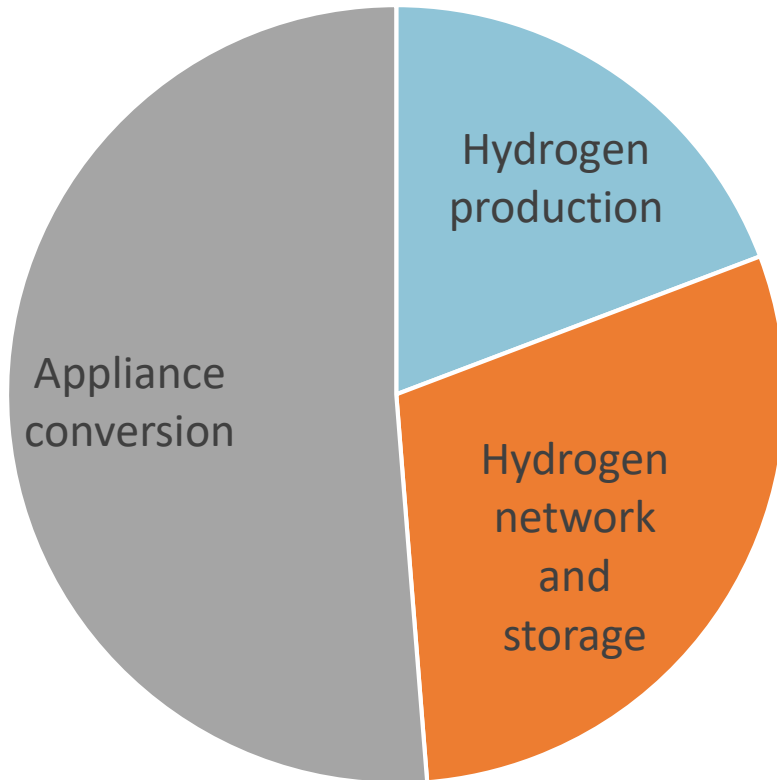
## The gas industry H21 vision is similar to the natural gas conversion programme

- Teams of gas fitters progressively convert all residences.
- Boilers and other gas appliances are replaced “for free”.
- Everyone that currently uses natural gas switches to using hydrogen boilers in the future.

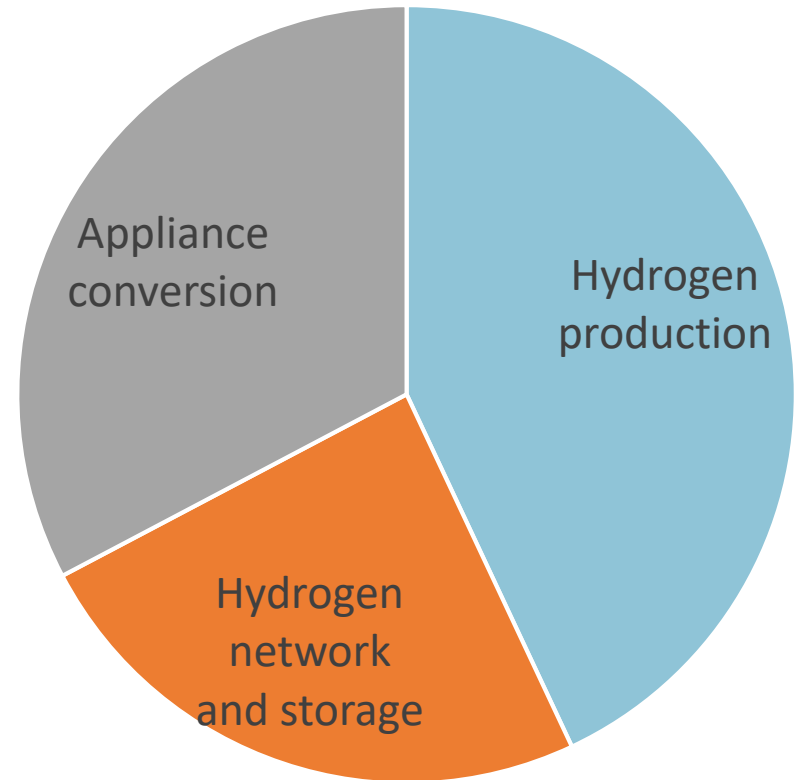
Strengths	Weaknesses
<ul style="list-style-type: none"><li>• Heating is fully decarbonised.</li><li>• Similar quality of service to what residents have had in the past.</li><li>• Economies of scale for purchasing and fitting new devices.</li></ul>	<ul style="list-style-type: none"><li>• Gas might not be the best or cheapest option for some households.</li><li>• No consumer choice – and possibly worse appliances.</li><li>• Fairness and equity issues.</li><li>• Residual GHG emissions and methane leakage.</li></ul>

## Transition cost estimates

NGN Leeds H21 costs



NGN H21 North of England costs





## Transition cost estimates

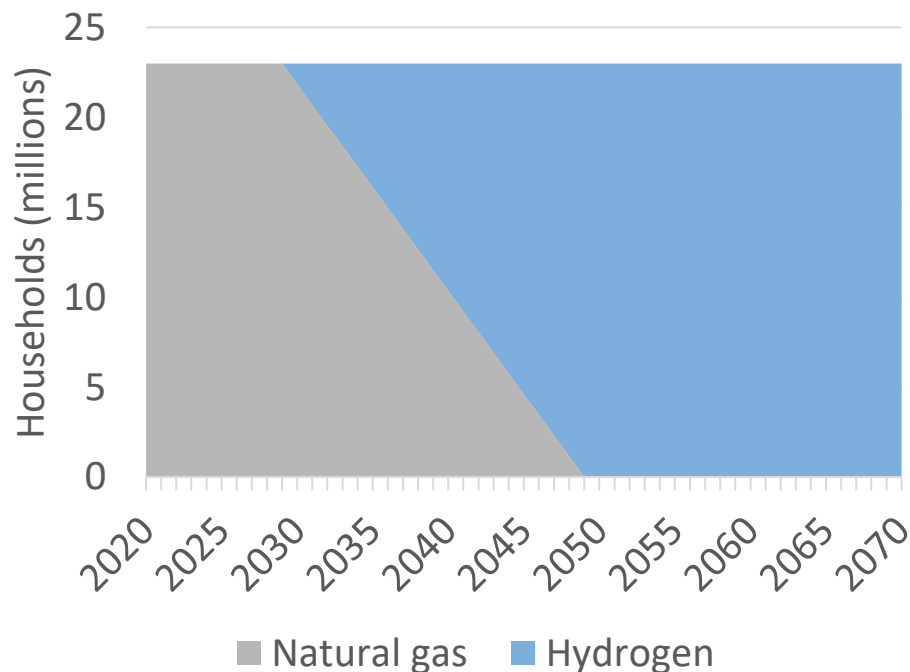
- Generally engineering appraisals are considered – the cost to carry out the conversion.
- An important accounting cost that is often not included is the early retirement of gas boilers across the country.
- Would a door-to-door approach by a dedicated workforce be much cheaper than the piecemeal replacements carried out today?

## Appliance conversion cost assumptions

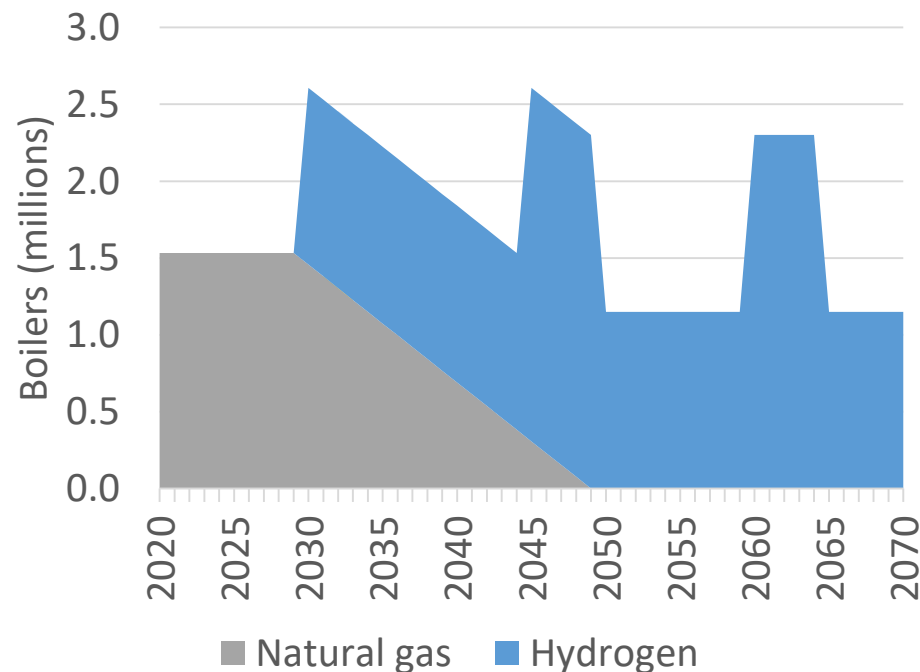
	NGN Leeds H21	NGN North of England	CCC	This study
Natural gas boiler replacement	£1,040	£500		£800
All appliances, gas pipes and meter	£1,723	£750	£1,500	£1626
In-house labour	£842	£572	£1,500	£588
<b>Total</b>	<b>£3,078</b>	<b>£2,066</b>	<b>£3,000</b>	<b>£2,214</b>

## A 20-year transition from 2030 to 2049

Total number of boilers



New boiler deployment



Total boiler years lost (millions)	154
Conversion programme cost (£bn)	51
Total undiscounted capital costs 2025-2050 (£bn)	180
Conversion programme cost per house (£)	2214

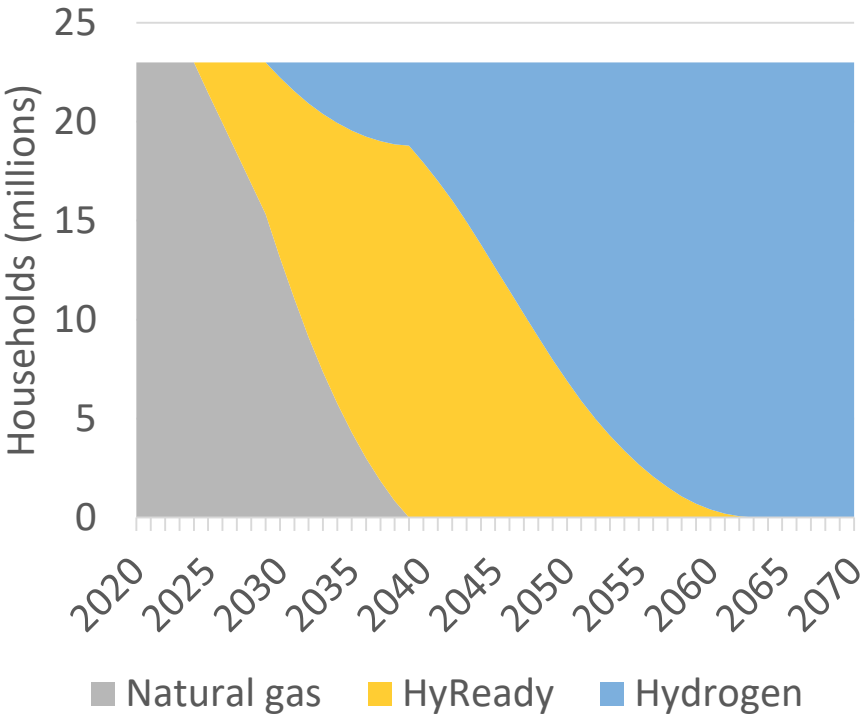
# Could we prepare for the transition with HyReady appliances?



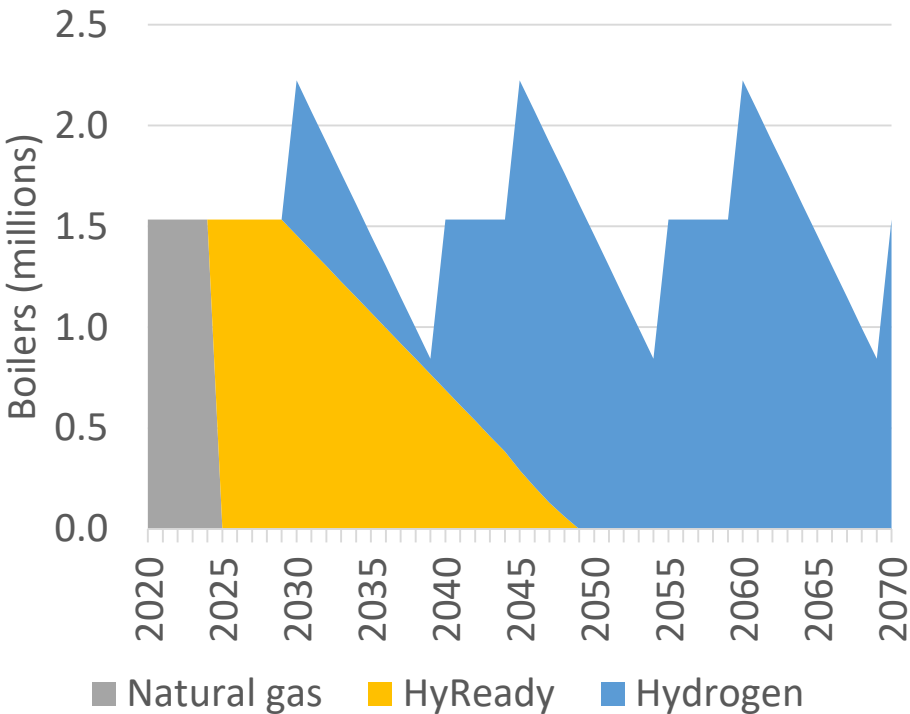


# 20-year transition; HyReady boilers mandated from 2025

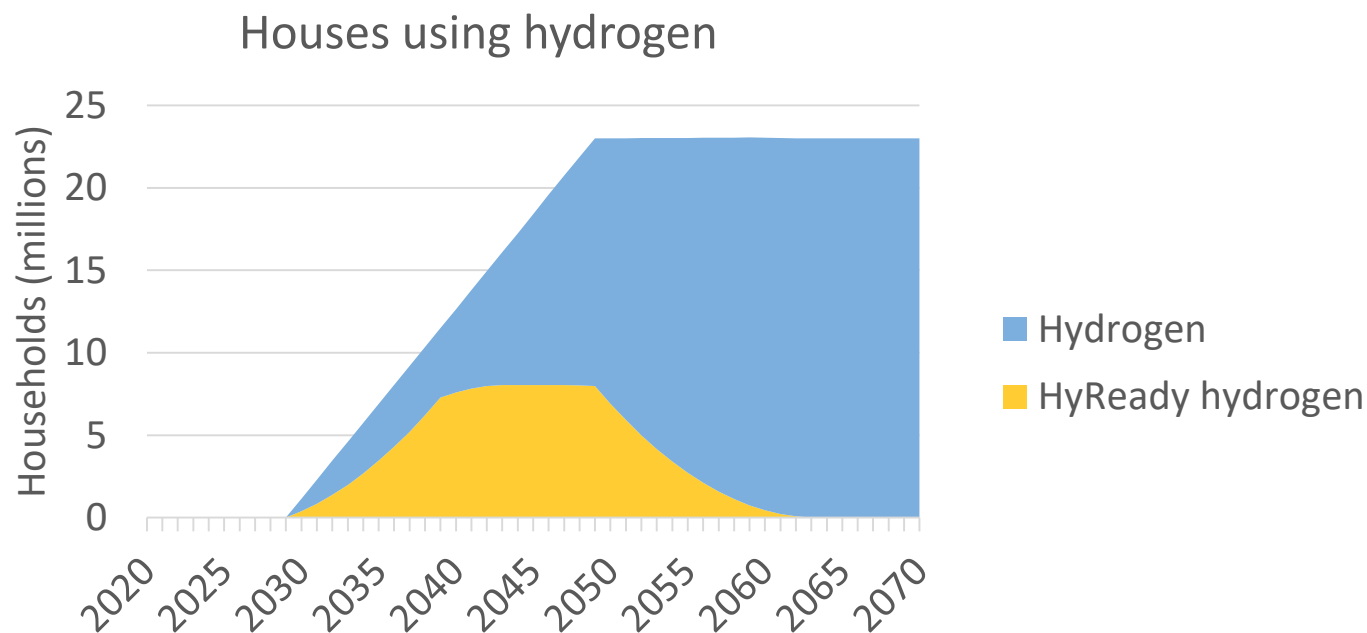
Total number of boilers



New boiler deployment



## 20-year transition; HyReady boilers mandated from 2025



	No HyReady	With HyReady
Total boiler years lost (millions)	154	13
Conversion programme cost (£bn)	51	28
Total undiscounted capital costs 2025-2050 (£bn)	175	188
Early gas boiler retirement costs (£bn)	28	2
Total cost (£bn)	203	190

# Can we reduce the appliance capital costs by changing the HyReady strategy?

Scenario			Undiscounted capital costs (£bn)				Peak boiler installations (mn/year)
HyReady mandated	Conv starts	Time to convert (years)	Conversion	Capital costs 2025-2050	Early retirement	Total*	
None	2030		51	175	28	203	2.6
2025	2030	20	28	188	2	190	2.2
2025	2030	15	30	188	3	191	2.5
2030	2030	20	34	181	8	189	2.6
2025	2035	10	25	188	0	188	1.9
2025	2040	10	23	191	0	191	1.5

\* Excludes fuel costs; does not account for HyReady boilers being less efficient than standard boilers

## Alternatives to the gas industry H21 vision

- Only parts or none of the gas networks are converted, with the remainder decommissioned.
- Consumers choose whether to continue using gas or to switch to another fuel.

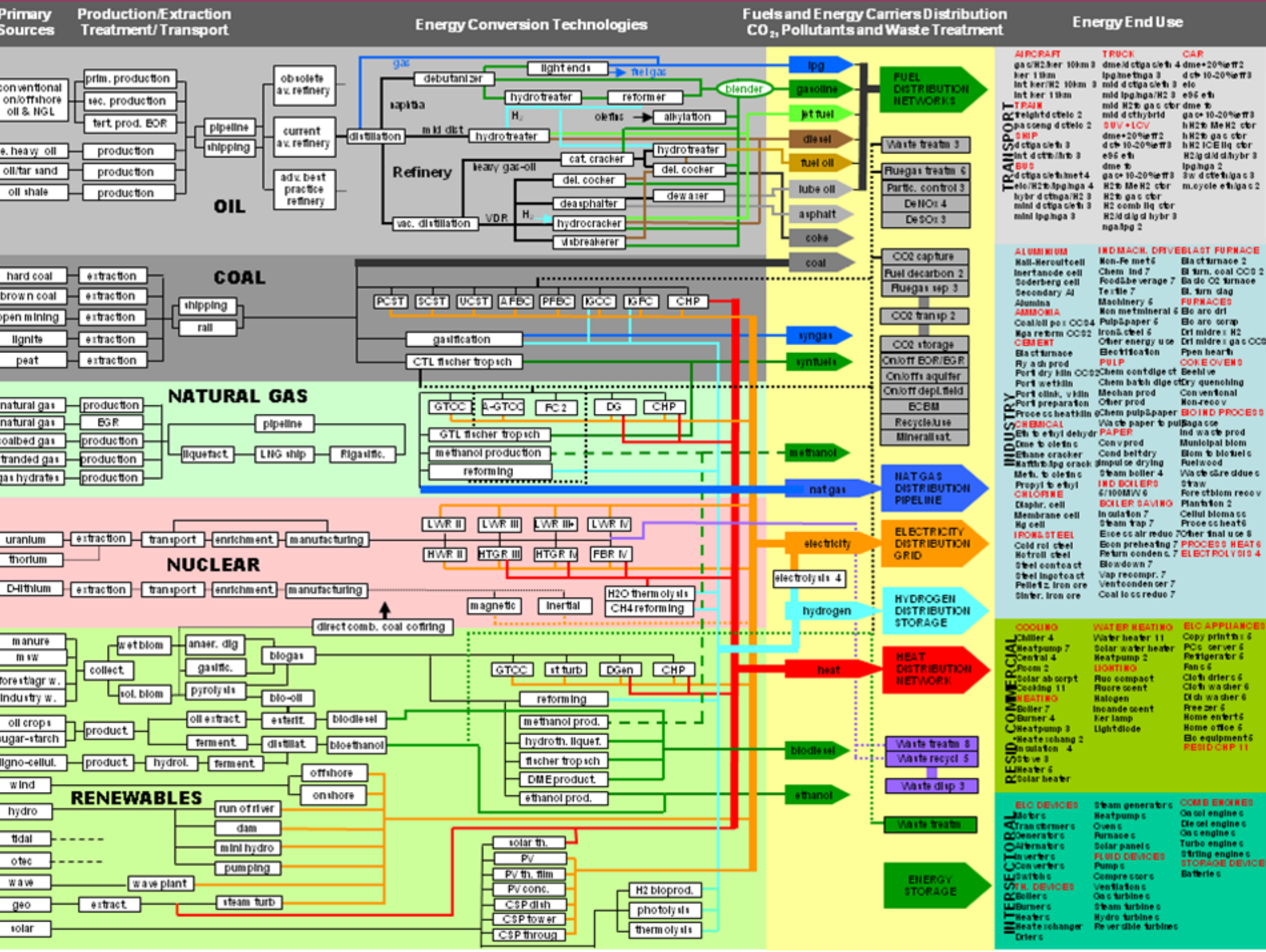
Strengths	Weaknesses
<ul style="list-style-type: none"><li>• Consumers can choose the best option for themselves in a fair playing field.</li><li>• Sidelining incumbents would create opportunities for other technologies to spur innovation.</li><li>• Fewer fossil fuels in the energy system.</li></ul>	<ul style="list-style-type: none"><li>• Switching off a gas supply without an affordable alternative is politically very difficult.</li><li>• Decommissioning is not necessarily cheap on a small scale.</li></ul>



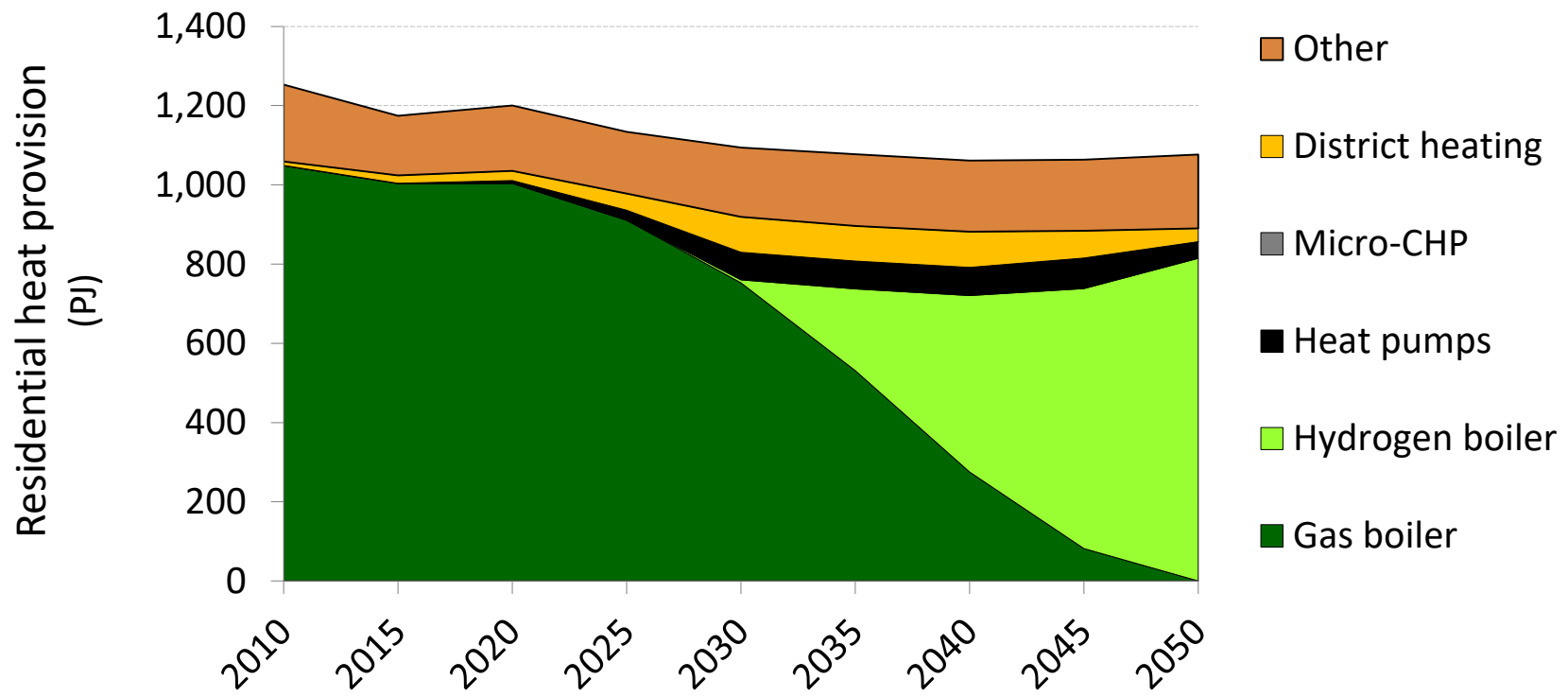
# UKTM – The UK TIMES Model

- *UK TIMES: Optimising energy system investment over the long term*
  - Identifies cost-optimal pathways to meet energy service demands in the long-term
- *Functionality of UK TIMES*
  - All GHG emissions (including non-energy)
  - Storage; flexibility; industrial sector
  - Linkages with European & global TIMES models
  - Assumptions explicit
  - QA protocol at the heart of development
- *History & future of policy analysis*
  - Predecessor model, UK MARKAL, has a strong policy heritage
  - UK TIMES provided underpinning evidence for BEIS's Clean Growth Strategy and the most recent Energy White Paper

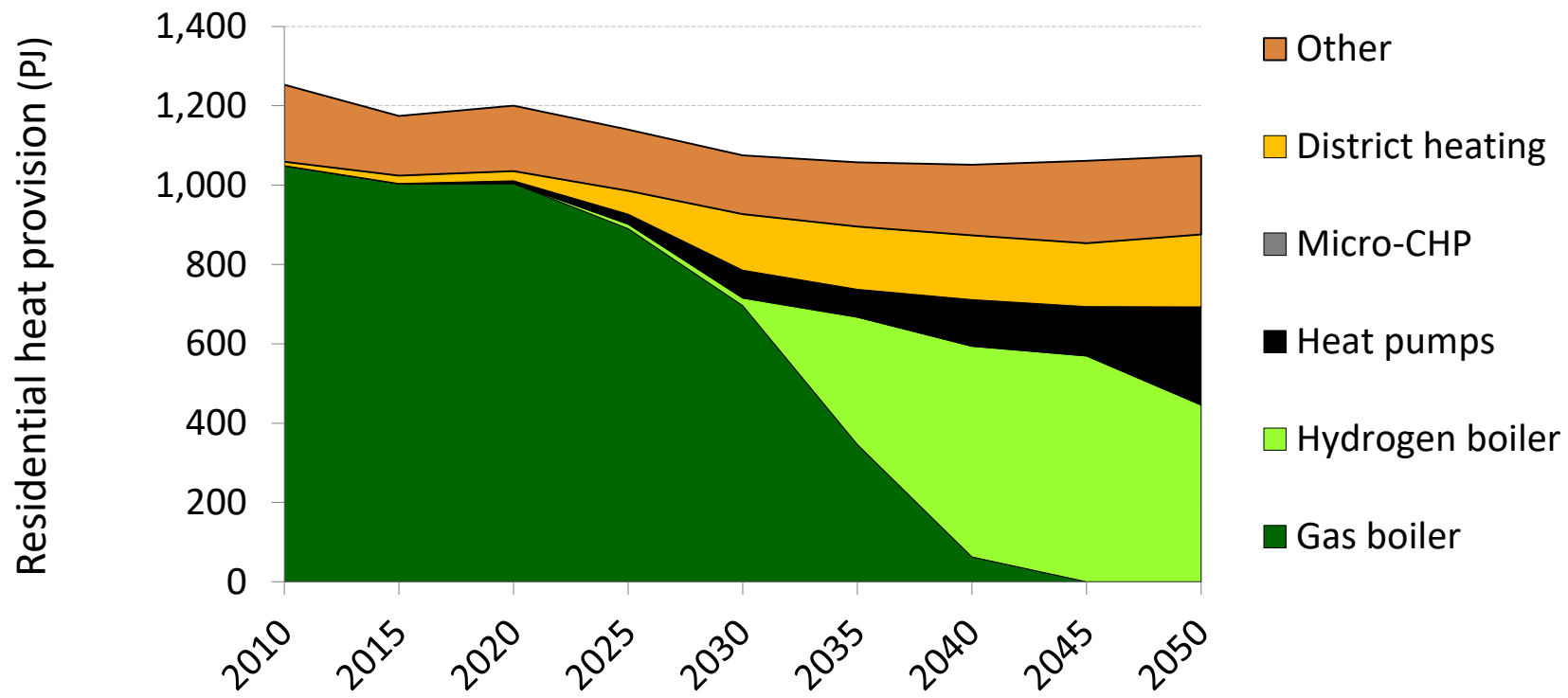




**In the “gas industry” scenario, there is a role for hybrid heat pumps and a small number of standard heat pumps**



## What if we make conversion and technology choice optional?

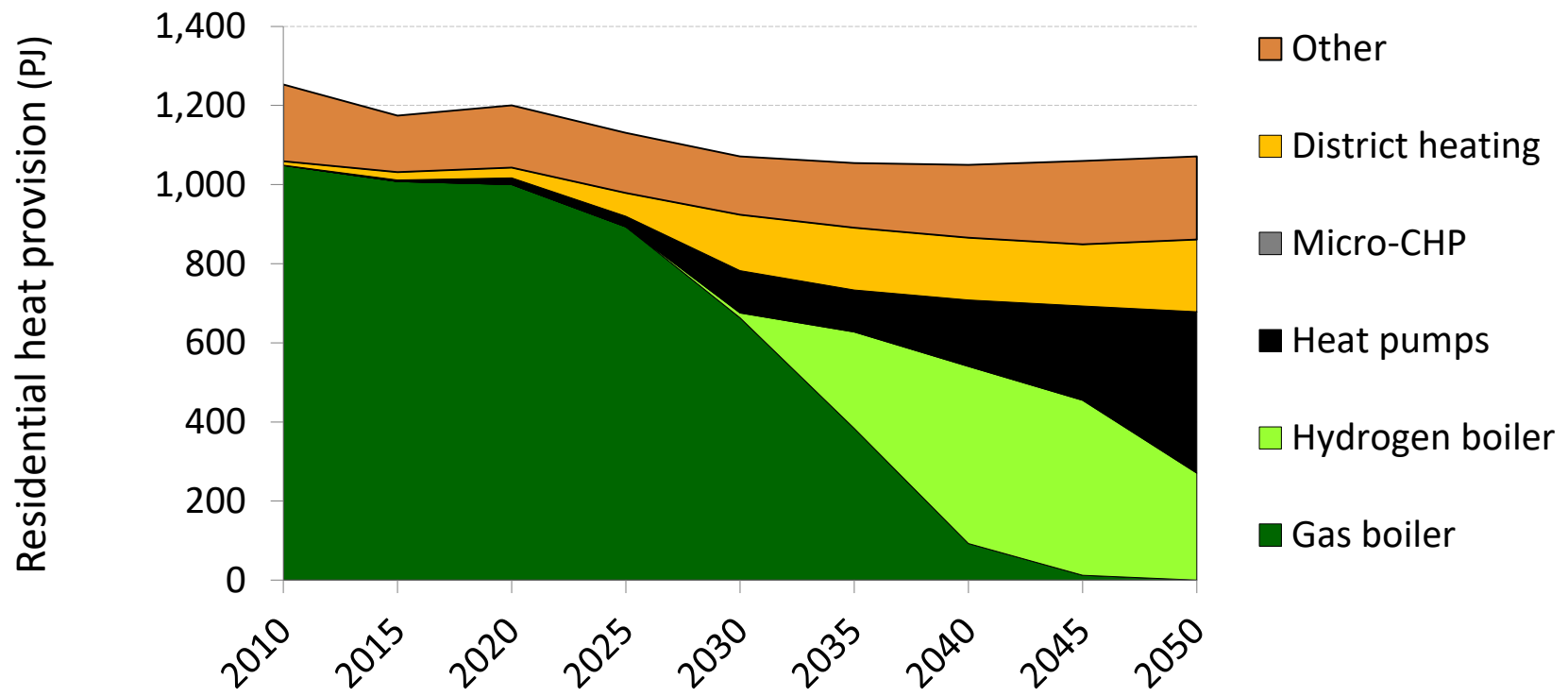




## Optional conversion programme

- Hydrogen is a temporary option in solid-wall houses, alongside heat pumps.
- Most cavity-wall houses use hydrogen, and some flats where a gas connection is available.
- Advanced night-storage heaters are most appropriate in highly energy efficient new houses.
- An optional programme reduces the discounted energy system cost by £22bn (0.5%).

## What if forecasts of a cheap conversion are incorrect?



## Further issues to consider

### 1. Consumer issues:

- Quality of heat service – cost is not necessarily the dominant factor
- Consumer choice

### 2. The politics:

- Controversial: “Incumbents option”
- More achievable than other options?
- Fair business models

### 3. Electricity and hydrogen system balancing:

- Future energy demand patterns will affect the potential role of hybrid devices – how do we trade-off system and personal preferences?

## Conclusions

1. Hydrogen conversion is the most cost-optimal option for at least part of the UK housing stock, but in many cases might be an intermediate option in the medium-term.
2. HyReady boilers do not look like an economic gamechanger.
3. The most appropriate long-term heating technology is unlikely to be boilers for all houses.
4. Capital costs are the most important factor between technologies. Any economies of scale in gas network conversion are important in the medium term.
5. Business model for gas network conversion should be chosen carefully to avoid locking in more expensive heating systems for householders than are necessary.





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and skills



Thank you for listening

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**HYVE** Hydrogen's Value in  
the Energy System