Committee on Climate Change

Independent advice to government on building a low-carbon economy and preparing for climate change

CCC Net Zero advice & Hydrogen Review

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- Net-Zero advice
- Key messages from the 2018 hydrogen report
- Sectoral uses of hydrogen
- Energy system impacts - CCS and electrification
- The need for strategy, action and demonstration

Net-zero Advice - Summary recommendations (1)

- **The UK should legislate as soon as possible to reach net-zero greenhouse gas emissions by 2050**. The target can be legislated as a 100% reduction in greenhouse gases (GHGs) from 1990 using the existing Climate Change Act procedures.
- The target should cover **all sectors of the economy, including international aviation and shipping**.
- The aim should be to meet the target **through UK domestic effort**, without relying on international carbon units (or 'credits').
- Now is the right time to set a net zero target. It is **technically possible, based on current consumer behaviours and known technologies**, with prudent assumptions over cost reduction.
- **An earlier date should not be set at this stage**. Some sectors could reach net zero earlier, but for most sectors 2050 appears to be the earliest credible date, to give time to develop speculative options as alternatives for any shortfalls. Avoiding the need for early capital scrappage or punitive policies.
- **The target is an appropriate contribution to the Paris Agreement**. The UK can benefit from the international influence of setting a bolder target, using it as an opportunity for further positive international collaboration.

Net-zero Advice - Summary recommendations (2)

- **Net zero target is only credible if policy to reduce emissions ramps up significantly**
  - The target can only be delivered with a strengthening of policy to deliver emissions reductions across all levels and departments of government. This will require strong leadership at the heart of Government. Delivery must progress with far greater urgency.
  - Policies must be designed with businesses and consumers in mind. They must be stable, long-term and investable. The public must be engaged, and other key barriers such as low availability of necessary skills must be addressed.
  - Report emphasises previous CCC recommendations for: Heating buildings; CCS; Electric vehicles; Agriculture; Waste; Low Carbon Power.
  - With new recommendations for stronger approaches to: Industry; land use; HGVs; aviation and shipping; and GHG removals.
- **Overall costs are manageable, but must be fairly distributed.** Rapid cost reductions during mass deployment for key technologies mean that net zero can be met an annual resource cost of up to 1-2% of GDP to 2050, the same cost as the previous expectation for an 80% reduction from 1990.
- **HM Treasury should undertake a review of how the transition will be funded and where the costs will fall**. It should develop a strategy to ensure this is, and is perceived to be, fair. A broader strategy will also be needed to ensure a '**just transition'** across society, with vulnerable workers and consumers protected.

Reaching net-zero emissions in the UK
How UK net-zero scenarios can be delivered

	2020s	2030s	2040s
Electricity	Largely decarbonise electricity: renewables, flexibility, coal phase-out	Expand electricity system, decarbonise mid-merit/peak generation (e.g. using hydrogen), deploy bioenergy with CCS	
Hydrogen	Start large-scale hydrogen production with CCS	Widespread deployment in industry, use in back-up electricity generation, heavier vehicles (e.g. HGVs, trains) and potentially heating on the coldest days	
Buildings	Efficiency, heat networks, heat pumps (new-build, off-gas, hybrids)	Widespread electrification, expand heat networks, gas grids potentially switch to hydrogen	
Road Transport	Ramp up EV market, decisions on HGVs	Turn over fleets to zero-emission vehicles, cars & vans before HGVs	
Industry	Initial CCS clusters, energy & resource efficiency	Further CCS, widespread use of hydrogen, some electrification	
Land Use / Agriculture	Afforestation, peatland restoration, healthier diets, reduced food waste, tree growing and efficiency on farms		
Aviation	Operational measures, new plane efficiency, constrained demand growth, limited sustainable biofuels		
Shipping	Operational measures, new ship fuel efficiency, use of ammonia		
Removals	Develop options & policy framework	Deployment of BECCS in various forms, demonstrate direct air capture of CO_2, other removals depending on progress	
Infra-structure	Industrial CCS clusters, decisions on gas grid & HGV infrastructure, expand vehicle charging & electricity grids	Hydrogen supply for industry & potentially buildings, roll-out of infrastructure for hydrogen/electric HGVs, more CCS infrastructure, electricity network expansion	

The impact of innovation on the costs of achieving carbon targets

- Overall, innovation and falling technology costs mean that we now estimate that the UK's 80% emissions target could be met at a lower cost than we estimated in 2008 – under 1% of GDP in 2050, rather than 1-2% of GDP.

Changes in cost estimates for long-term emissions goals		
GHG emissions reduction target (relative to 1990)	**Year and report**	**Cost range estimated for 2050**
60% reduction in CO_2 (~55% reduction in GHG)	2003 - *Energy White Paper*	0.5-2.0% of GDP
80% reduction in GHG	2008 - *Building a low-carbon economy – the UK's contribution to tackling climate change*	1-2% of GDP
100% reduction in GHG	**2019 - this report**	**1-2% of GDP**

Summary recommendation

Science and International context

- Global 2050 emissions aligned to the Paris Agreement: ~1 tCO_2e for 1.5C; ~2 tCO_2e for well below 2C
- The UK can and should go further than the world's average
- Other climate leaders are aiming for net-zero GHG emissions by 2050 or before

Reaching net-zero emissions in the UK

- Credible scenarios can reduce UK GHG emissions to net-zero by 2050
- The foundations for the change are in place, but a major ramp-up and acceleration in policy effort is required
- Expected cost of a net-zero target is the same as the cost accepted by Parliament when the existing 80% target was set

UK should target net-zero GHG emissions by 2050

Backed by significant policy strengthening

HM Treasury should review where the costs of the transition fall

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Hydrogen myth-busting

- The sunk costs of the gas grid do not mean that economically it's a no-brainer to switch it over to hydrogen and use it to serve boilers as we do at the moment
- There is not enough 'surplus' low-carbon electricity to meaningfully contribute to hydrogen supply at scale
- Gas reforming with CCS may well not be low-carbon enough for very large-scale use by 2050 (although it has an important role in the transition and at more moderate scales)
- An international market in hydrogen may well develop in time, but it is not a certainty and these imports may be no cheaper than domestic production
- Hydrogen is best used selectively, alongside mass electrification – it is not a silver bullet

Hydrogen can be a strong complement to electrification and efficiency

Low-carbon hydrogen is an important potential complement to electrification, especially in replacing natural gas (and potentially oil) in areas where electrification is not feasible:

- Buildings heat for colder winter days
- Industrial process heat
- Flexible power generation (e.g. for peaks)
- Heavy-duty / long-distance transport (e.g. HGVs)

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Hydrogen consumption and production in our Further Ambition scenario

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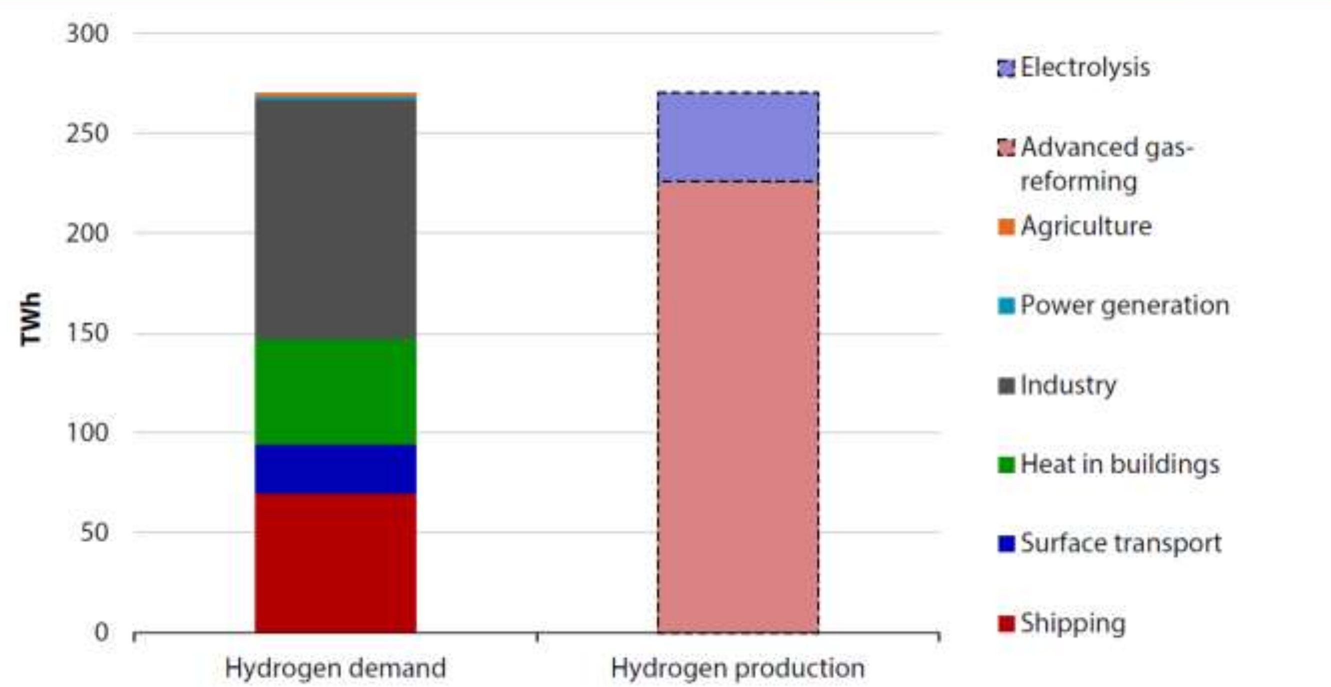
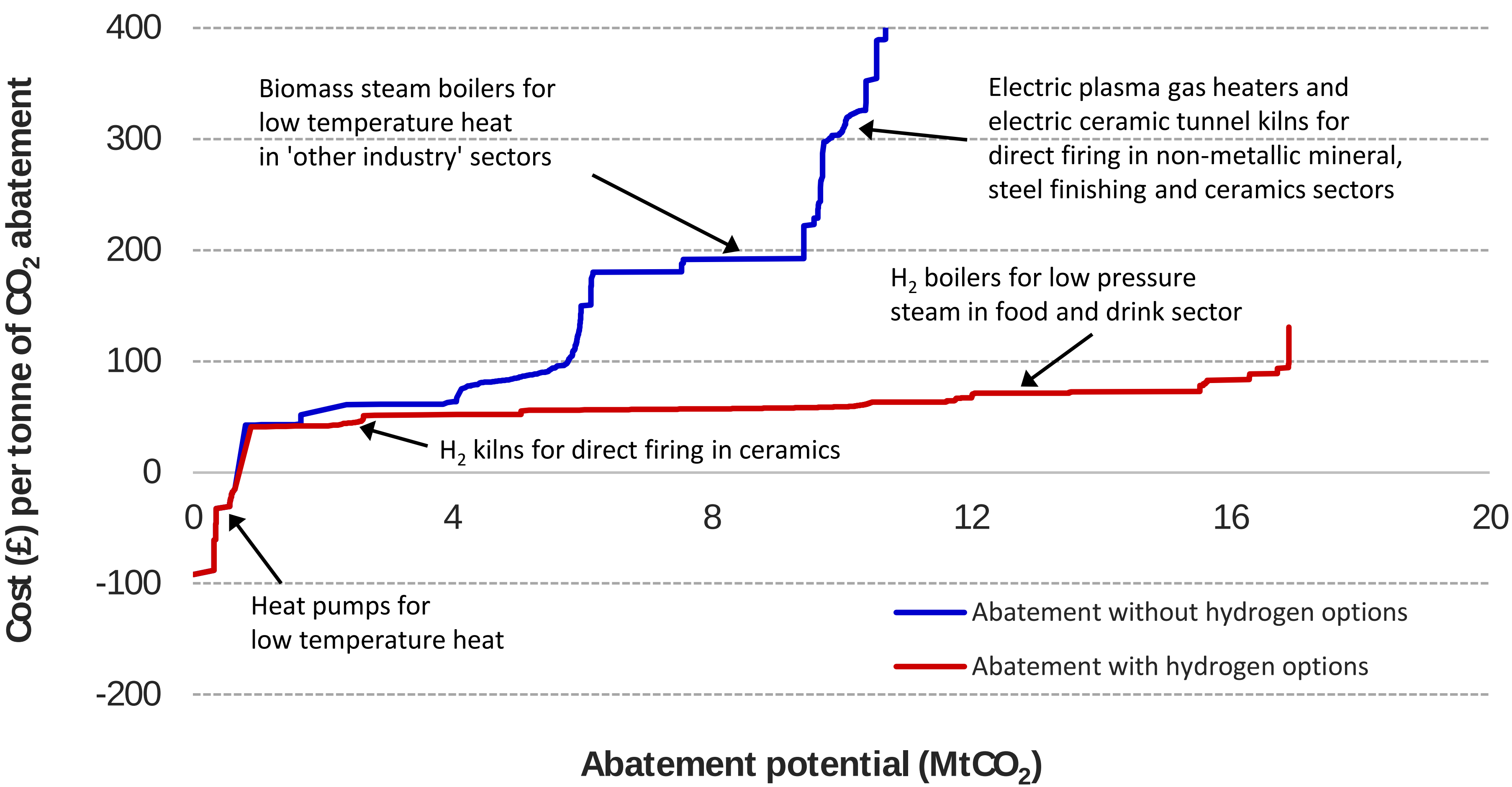
Figure 2.8. Use and production of hydrogen in the Further Ambition scenario (2050)



Source: CCC analysis.
Notes: Our analysis assumes the majority of future hydrogen production in the UK is from advanced methane reformation with CCS (225 TWh), with a limited contribution from electrolysis (44 TWh).

Source: Net Zero Technical Report

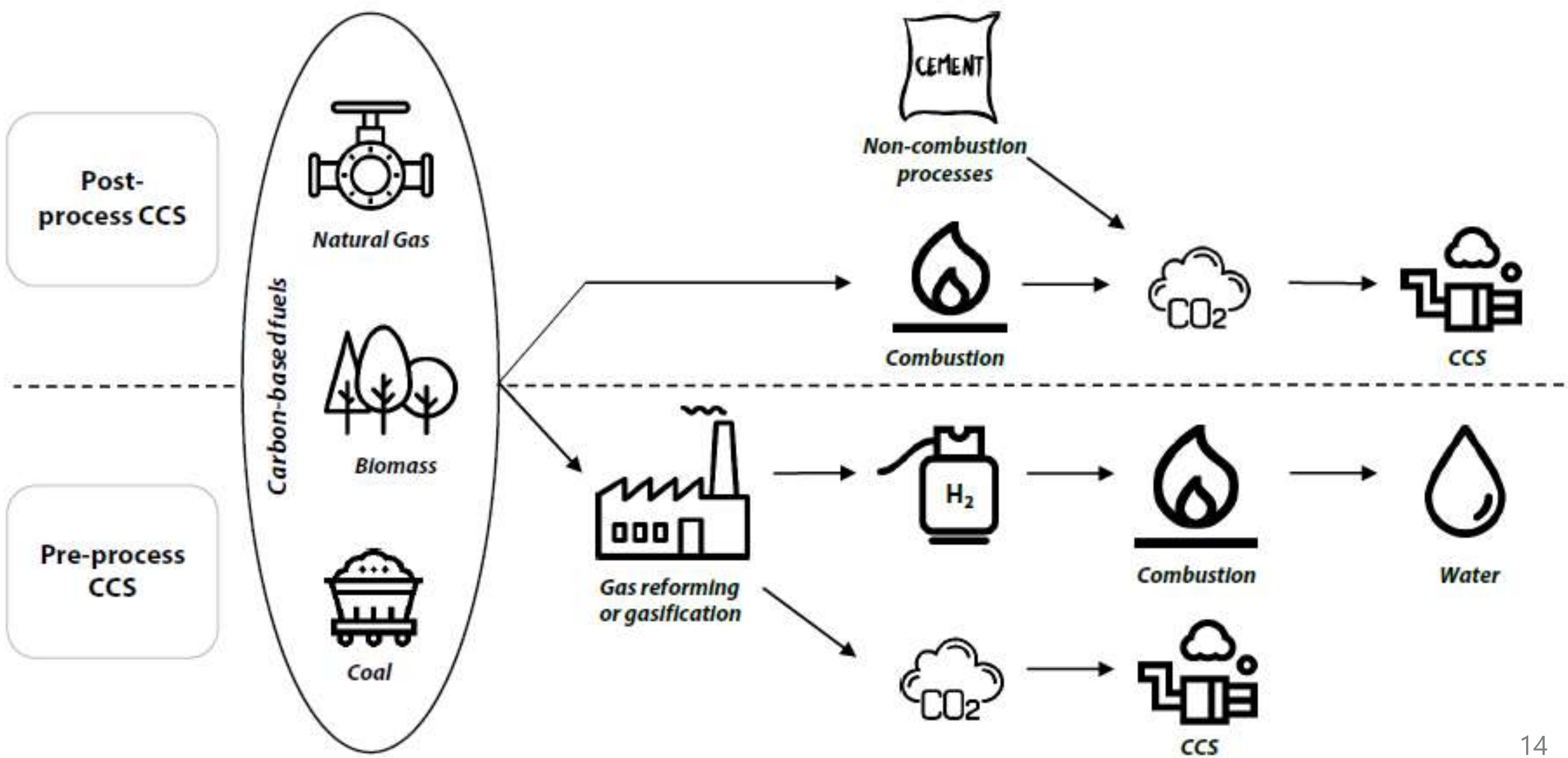
Use of hydrogen in industry can achieve greater emissions reductions at lower costs



Source: Element Energy/Jacobs Industrial Fuel Switching Market Engagement Study (2018)

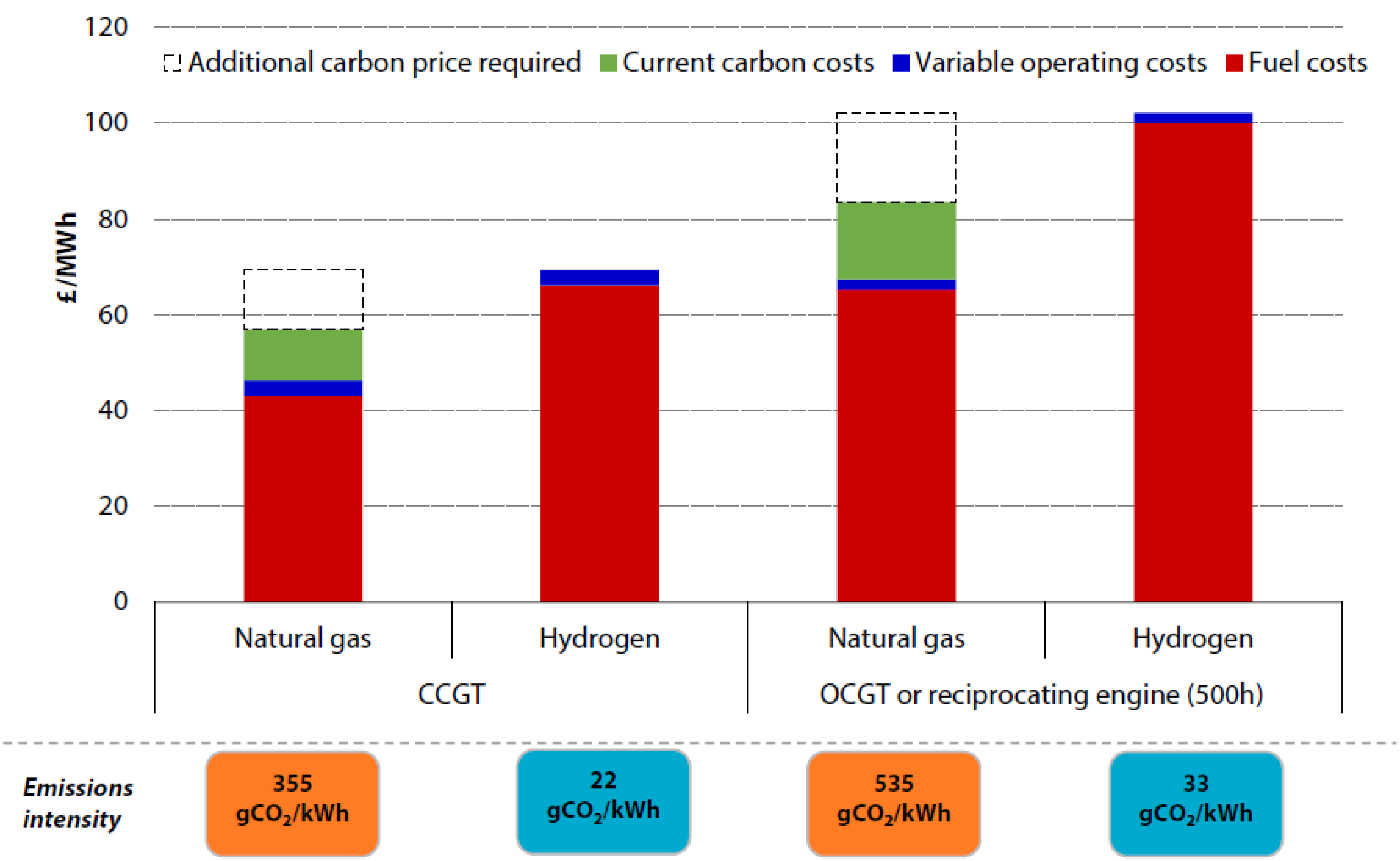
Some combination of hydrogen and direct use of CCS looks very valuable in industry

Figure 1.6. 'Pre-process' and 'post-process' forms of CCS for industry



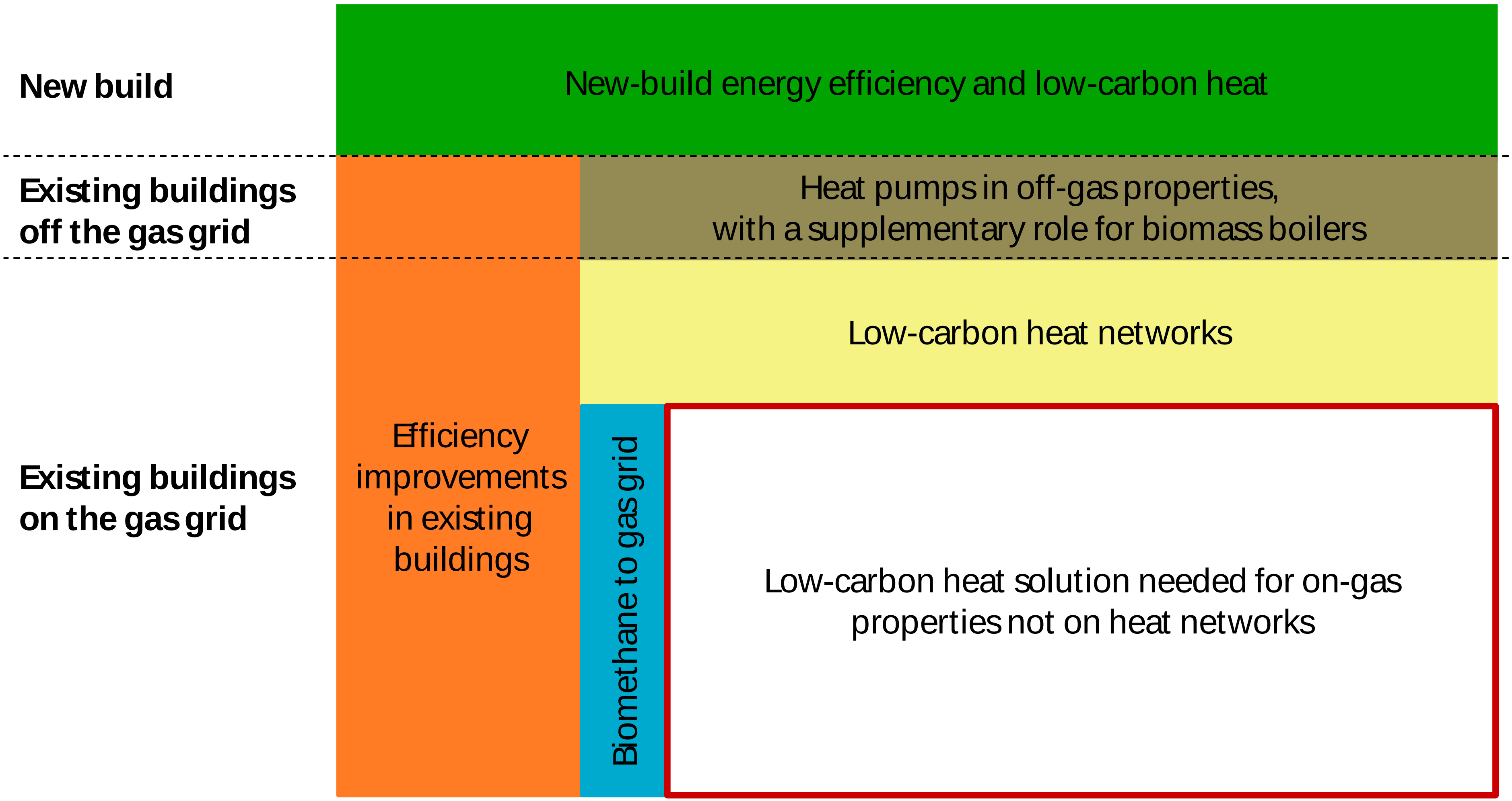
Hydrogen can cost-effectively replace natural gas for back-up power generation in the 2030s

Figure 2.1. Projected operating costs of gas plants in 2040

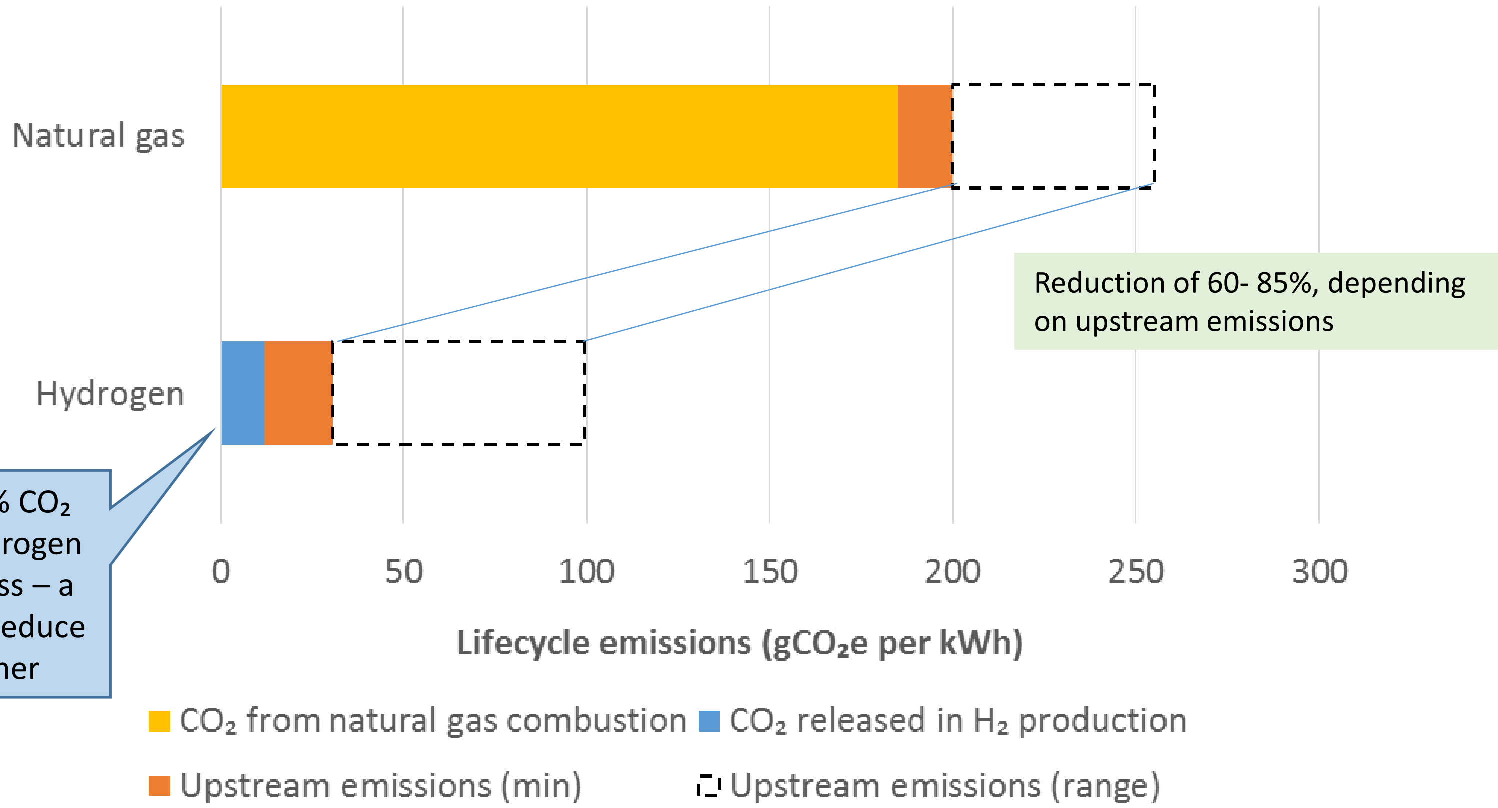


Switching from using natural gas to using hydrogen becomes cost-effective at carbon prices of between £70-100/tCO_2

Low-regret actions for buil decarbonisation (



Residual emissions of gas reforming are significant even with high CO_2 capture rates



This assumes 95% CO_2 capture in the hydrogen production process – a lower rate would reduce the saving further

The range of upstream emissions from natural gas production are 15-70 gCO_2e per kWh, which spans the range for LNG and shale in our 2016 shale report

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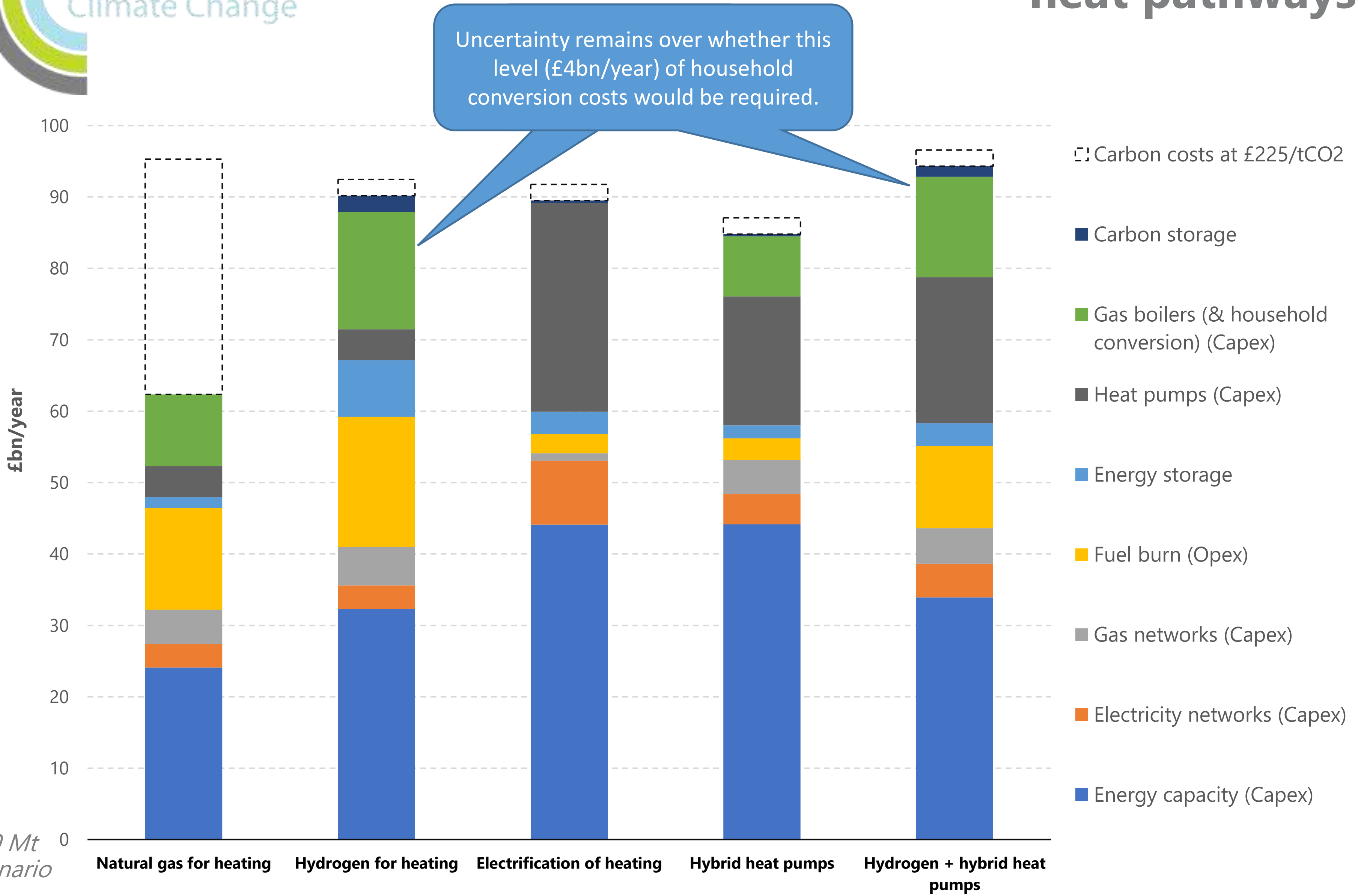
Costs of heat decarbonisation scenarios are within 10% of each other, across alternative heat pathways



10 Mt Scenario

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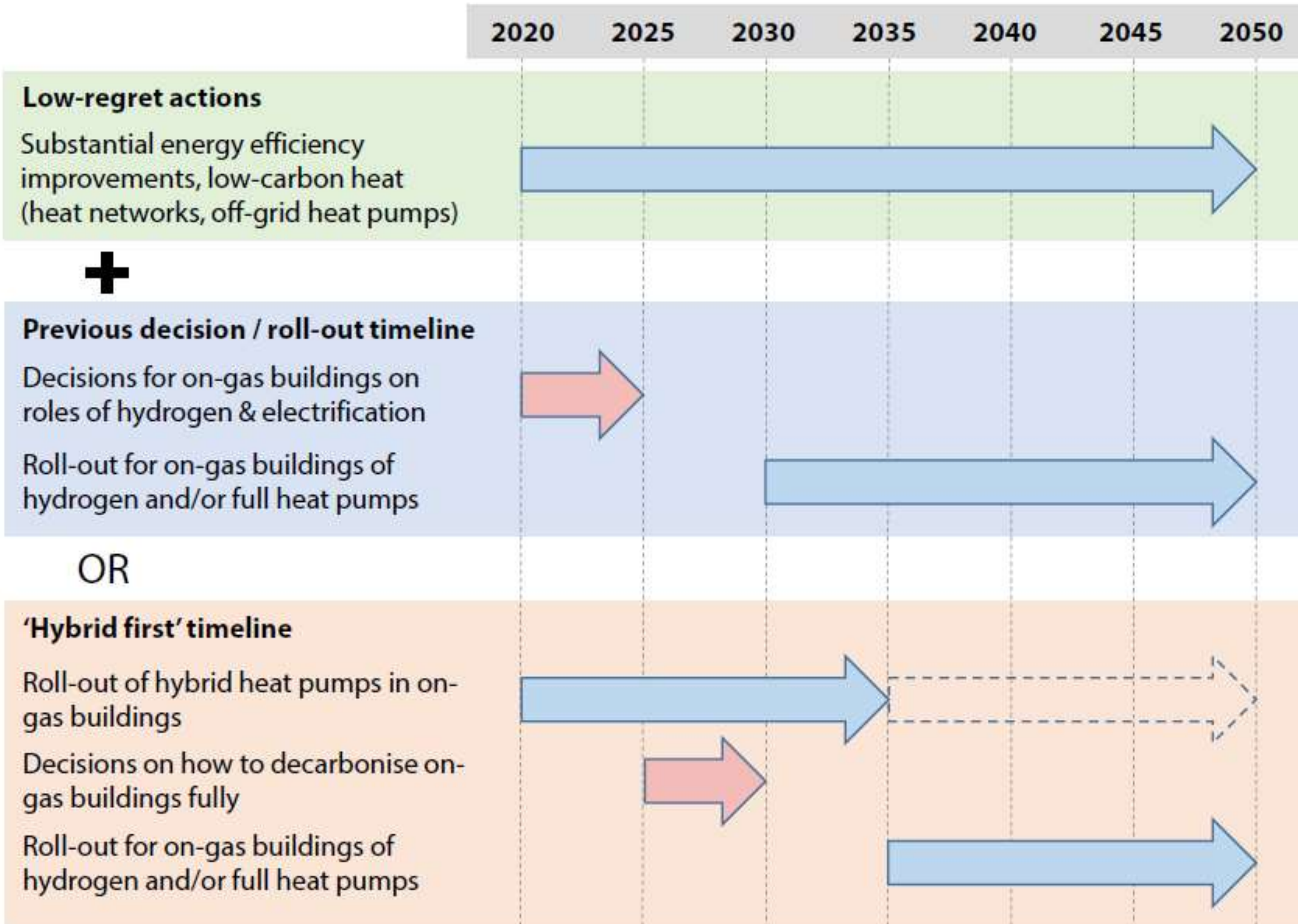
Widespread deployment of hybrid heat pumps can reduce the challenge in getting rid of natural gas and ensure we make the right decisions on what follows

Figure B2. Pursuing a 'hybrid first' approach alongside other low-regret actions



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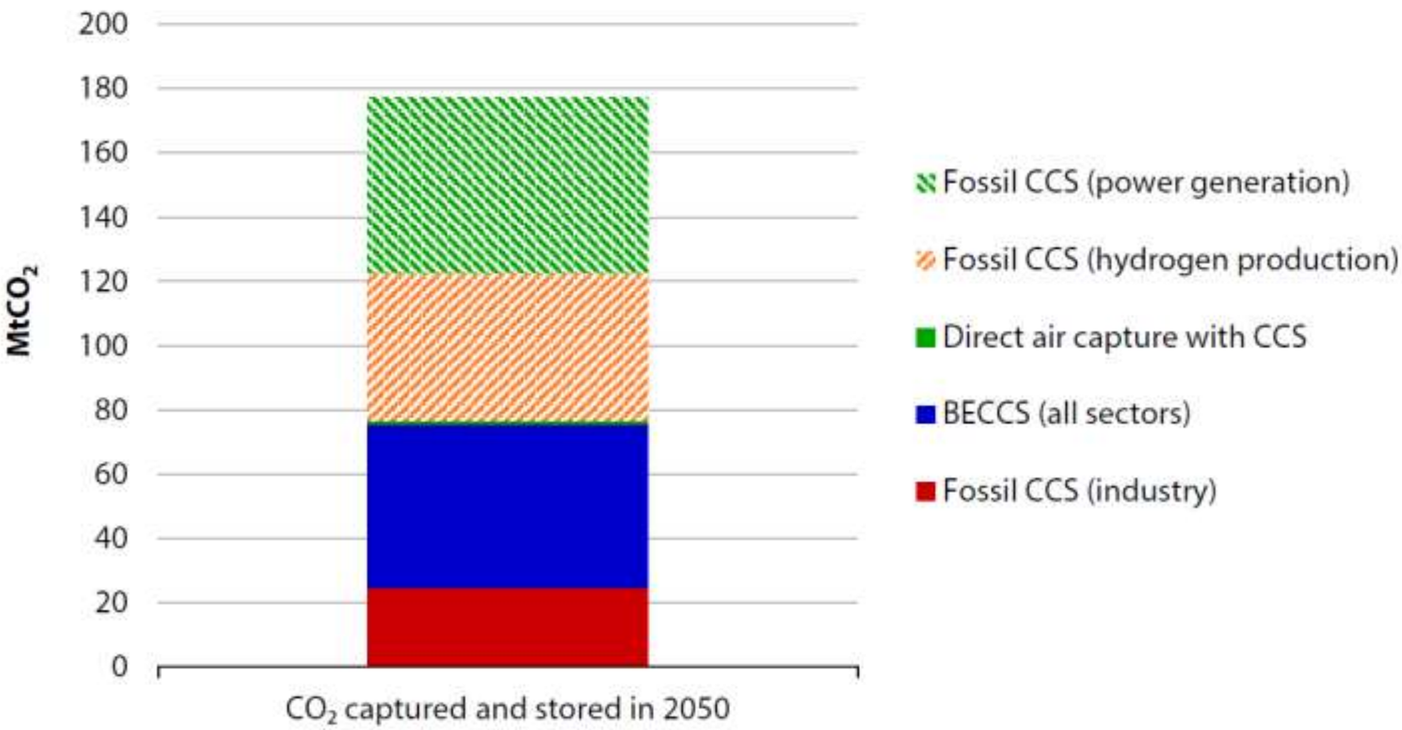
Our Further Ambition scenario requires a huge amount of CCS by 2050 – in practice it is likely to be possible to manage with less



A 'Full Hydrogen' scenario based on electrolysis is very expensive and extremely challenging to deliver

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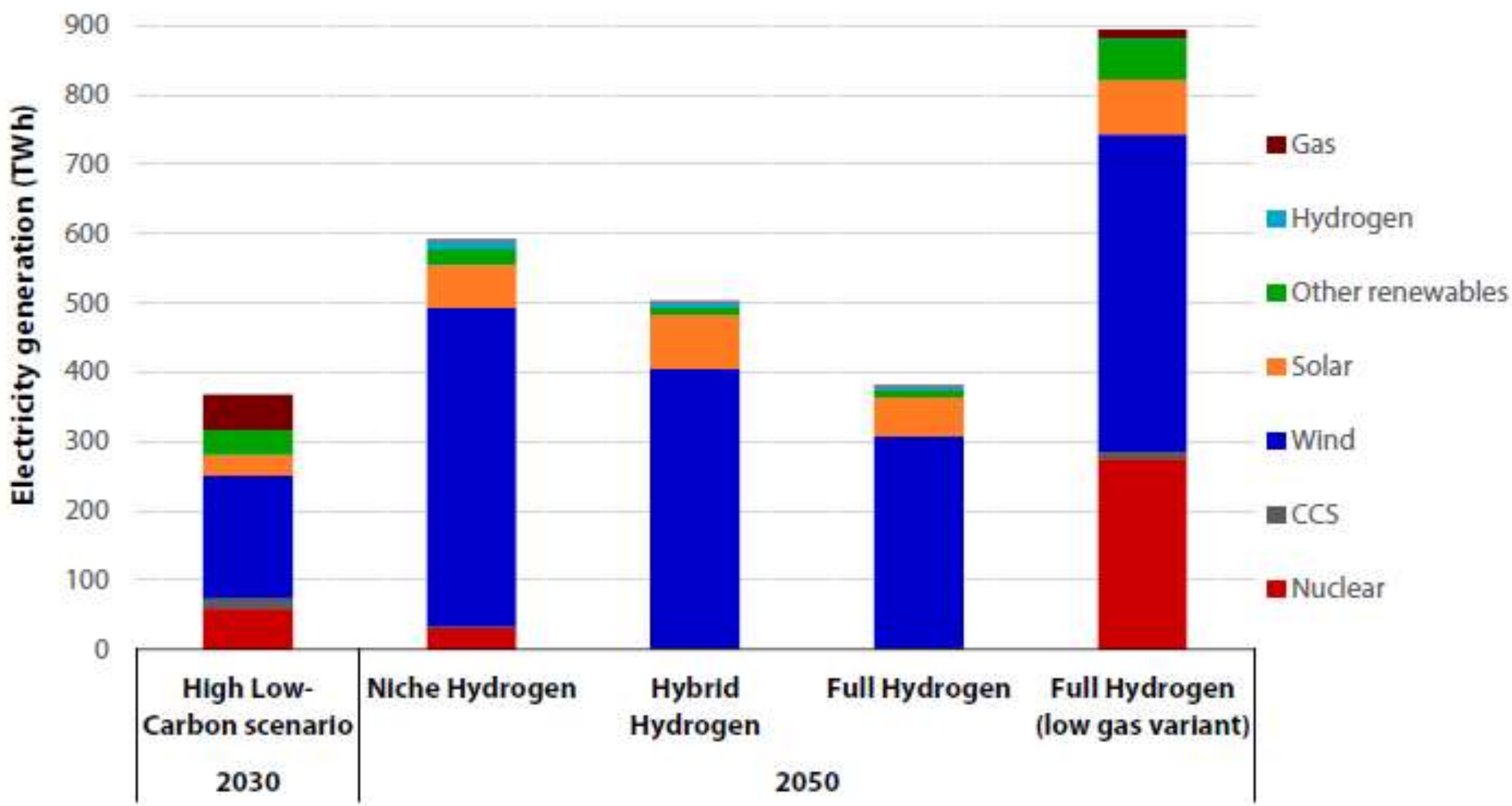
Figure 4.5. Electricity generation in the Niche, Hybrid and Full Hydrogen scenarios (2050)



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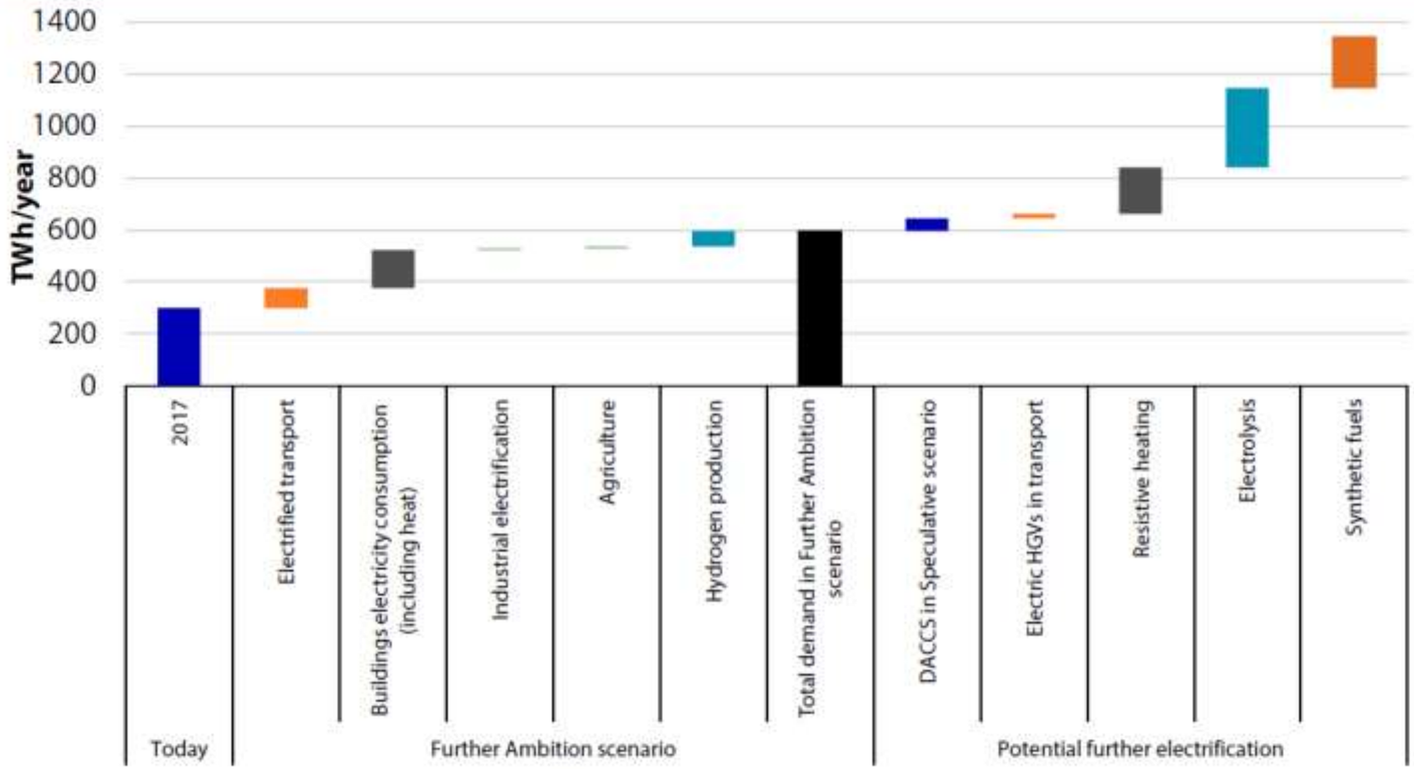
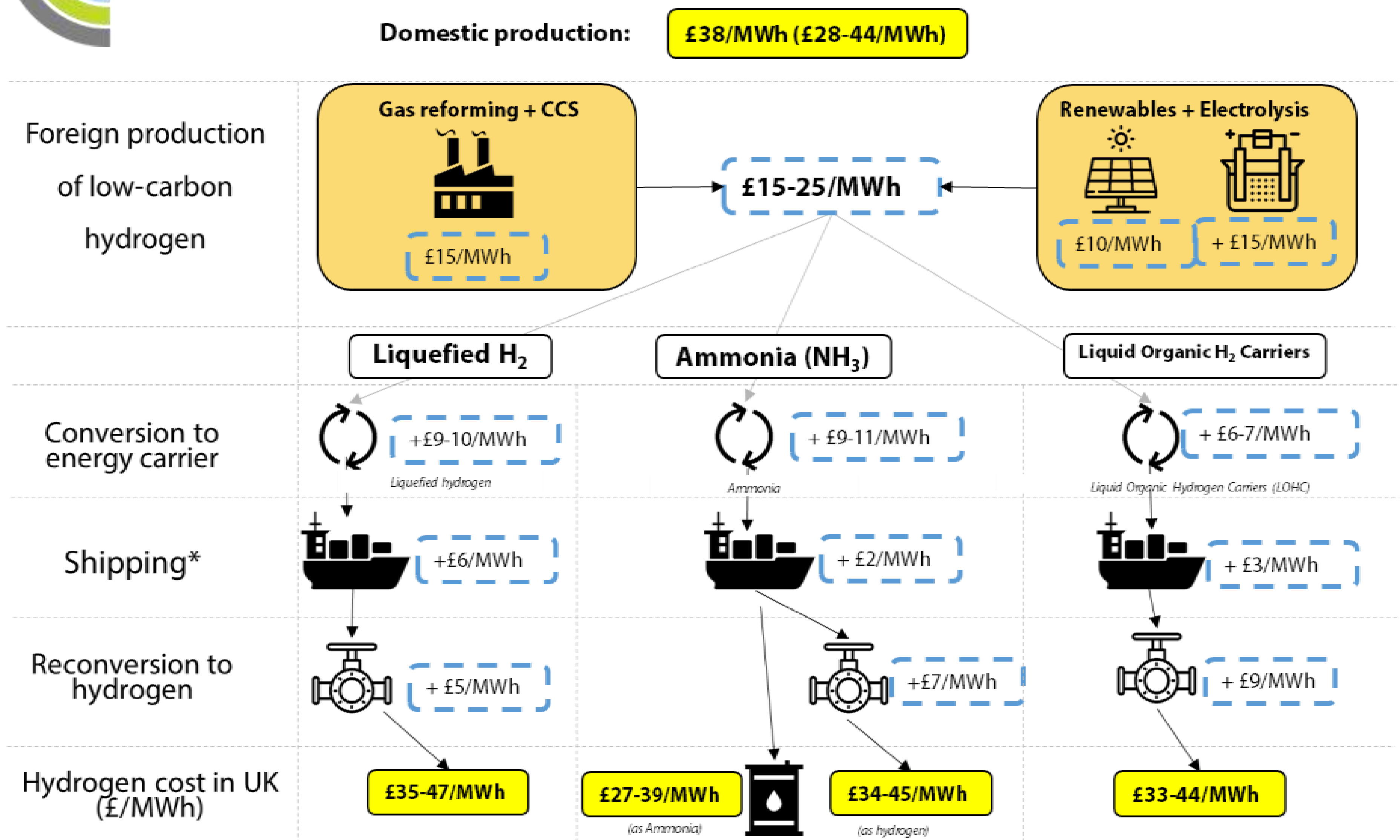
Our Net-Zero scenario entails doubling electricity generation by 2050, but further options could quadruple it

Figure 2.3. Potential new electricity demands from 2017 to 2050



Source: CCC analysis.
Notes: Electric HGVs in transport are hydrogen fuelled vehicles switching to electricity.

It may be possible to import electrolytic zero-carbon hydrogen but this is unlikely to be cheaper than domestic production



*including loading onto ship, assumed 10,000km journey from Middle East (via Suez Canal)

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The need for strategy

In order for hydrogen to become an established option for decarbonisation during the 2020s, we recommend:

- **Heat decarbonisation strategy.** A commitment should be made now to develop a fully-fledged UK strategy for decarbonised heat within the next three years, including clear signals on the future use of the gas grid and supporting requirements for carbon capture and storage (CCS) in the UK.
- **Strategy for decarbonising HGVs.** By 2050 it will be necessary for HGVs to move to a zero-emissions solution, requiring decisions in the second half of the 2020s.This will necessitate small-scale trial deployments of hydrogen HGVs in a variety of fleets prior to this, in the UK or elsewhere.

The need for action

Deployment of hydrogen should start in a 'low-regrets' way over the next decade, recognising that even an imperfect roll-out is likely to be better than a 'wait-and-see' approach that fails to develop the option properly

- Hydrogen production should start at scale as part of a CCS cluster, for use in a range of ways that would not initially require major infrastructure changes (e.g. use in buses, power generation, industry or blending at small proportions into the natural gas supply).
- Hydrogen-ready technologies (e.g. boilers, turbines) should be developed in parallel and their deployment supported by policy.

The need for demonstration

- Before any decision to repurpose gas grids to hydrogen for buildings heat, pilot schemes will be necessary to demonstrate the practical reality of such a switchover. These must be of sufficient scale and diversity to allow us to understand whether hydrogen can be a genuine option at large scale.
- Hydrogen use should be demonstrated in industrial 'direct firing' applications (e.g. furnaces and kilns).
- Depending on international progress in demonstrating hydrogen HGVs, DfT should consider running trials in the early 2020s, in order to feed into a decision in the second half of the 2020s on the best route to achieving a zero-emission HGVs.
- A substantial role for hydrogen produced from natural gas with CCS depends on delivering emissions savings towards the higher end of our estimated range of 60-85% on a lifecycle basis. This means demonstrating that it is feasible to achieve very high CO_2 capture rates (e.g. at least 90%) at reasonable cost from gas reforming.

Thank you