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Hydrogen in the Energy System

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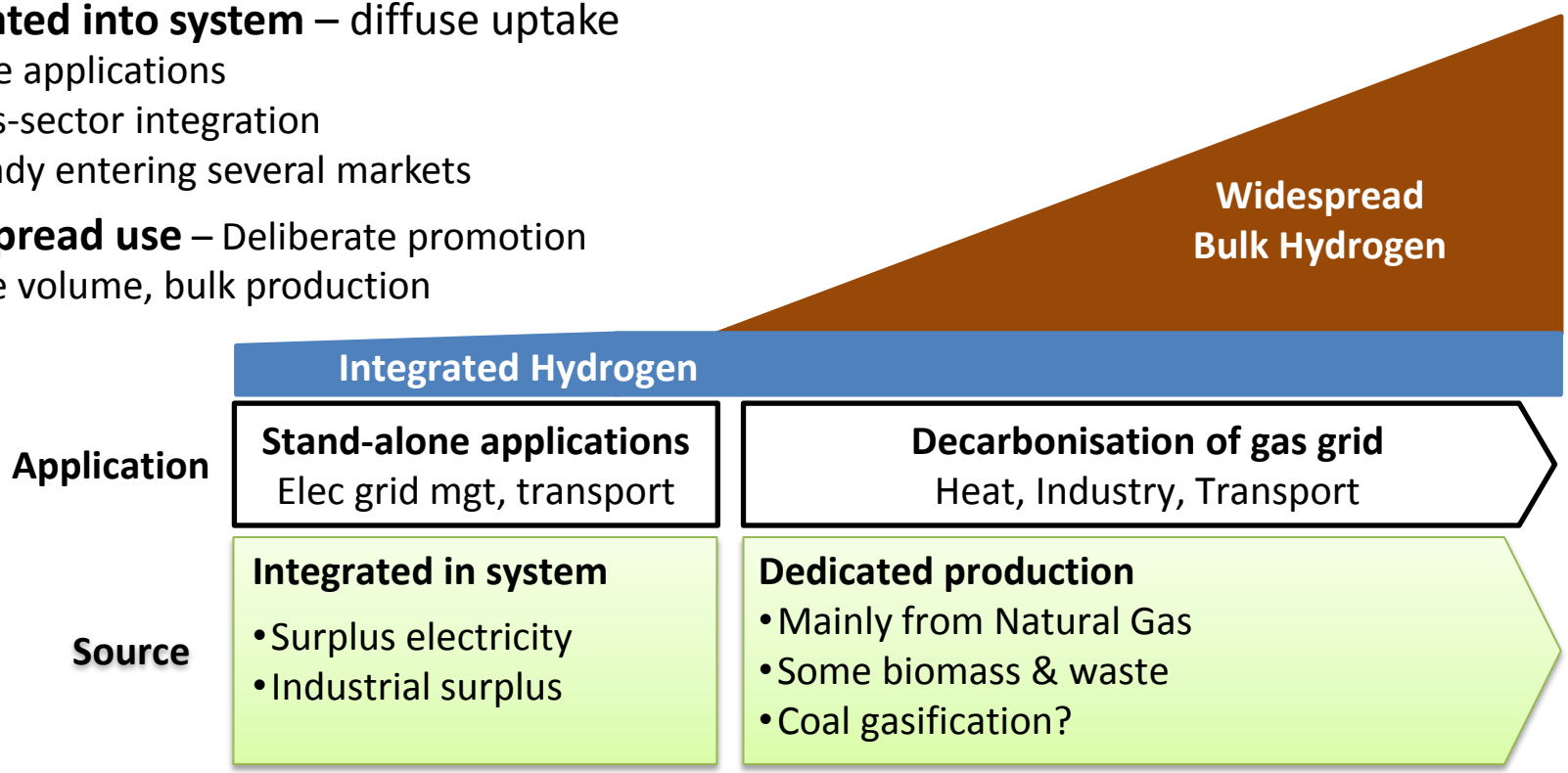
Potential roles for hydrogen

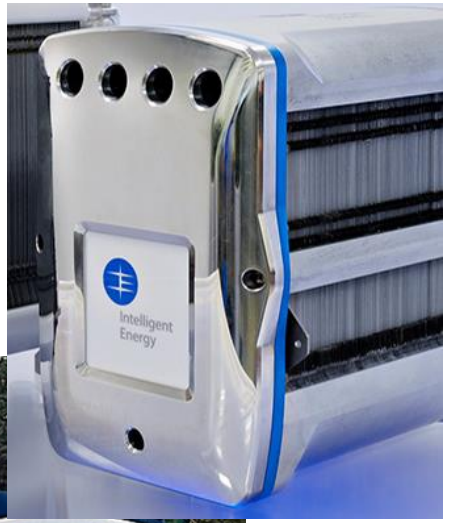
Integrated into system – diffuse uptake
- Niche applications
- Cross-sector integration
- Already entering several markets

Widespread use – Deliberate promotion
- Large volume, bulk production



Integrated role

- Potentially valuable opportunities
  - UK has some leading companies
- Barriers need addressing
  - Market
  - Technical
  - Regulatory
- Whole system / Cross-sector approach
  - to realise opportunities
- Source of hydrogen
  - ‘Surplus’ electricity
  - Industrial integration



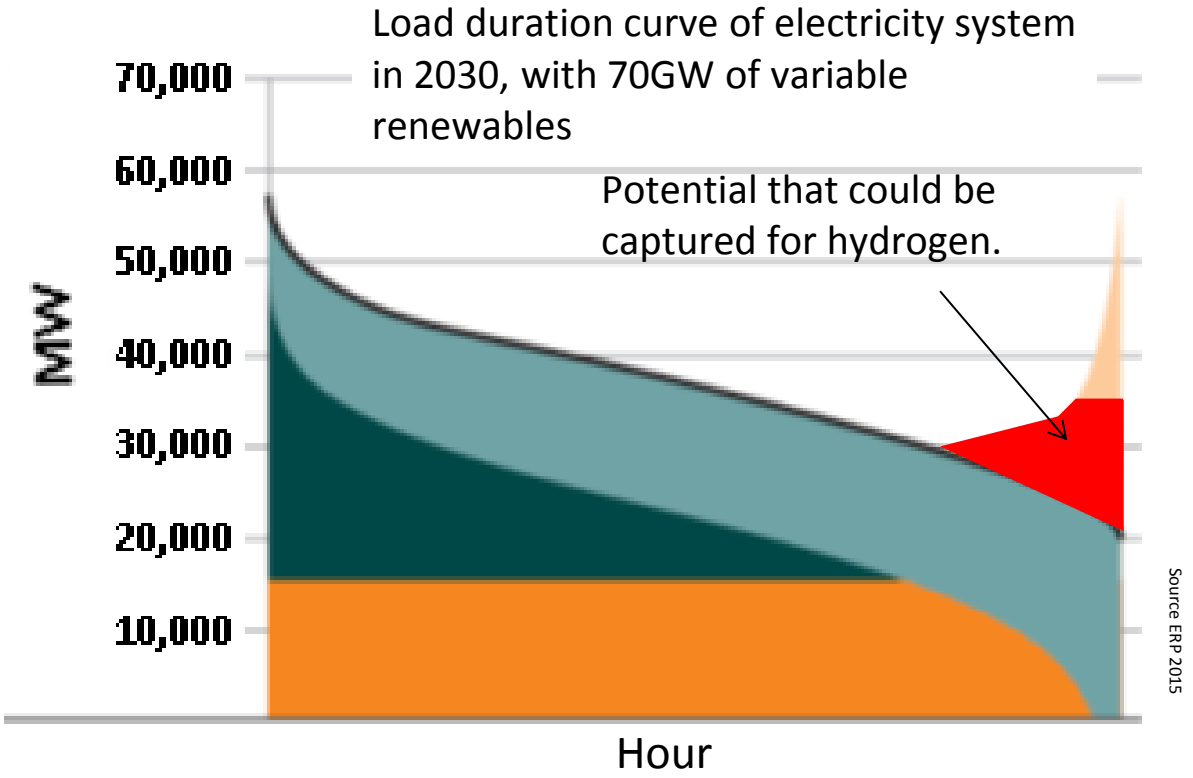
‘Surplus’ electricity

Depend on how electricity system is managed, as will compete with other options.

Various estimates in range of 10 - 32TWh of hydrogen could be produced from surplus electricity (~3-10% of future domestic heat demand).

Expensive to build electrolysers to capture all of the biggest peaks as load factor very low.

Any more would require building dedicated generation.



Widespread, bulk usage

Repurposing of the gas grid - Leeds H21 - report July 2016

Benefits

- Familiar customer experience
- Manage daily peaks and seasonal variations in heat demand

- Decarbonise metropolitan areas relatively quickly – after technical assessments
- Onus on single agent for delivery – contrast with electrification
- Could expand network to transport (with purifiers) and industry

- Requires dedicated production

Delivery

Early public engagement

- Needed to engender trust in process and in the delivery agent
- Understand attitudes towards hydrogen
  - How might its use be different to natural gas
  - Could people use it inappropriately?
  - Safety concerns

Bulk hydrogen production

- Primarily from natural gas
  - CCS will therefore be essential to reduce emissions
  - Basis for CCS development

Impact on domestic CO_2 emissions

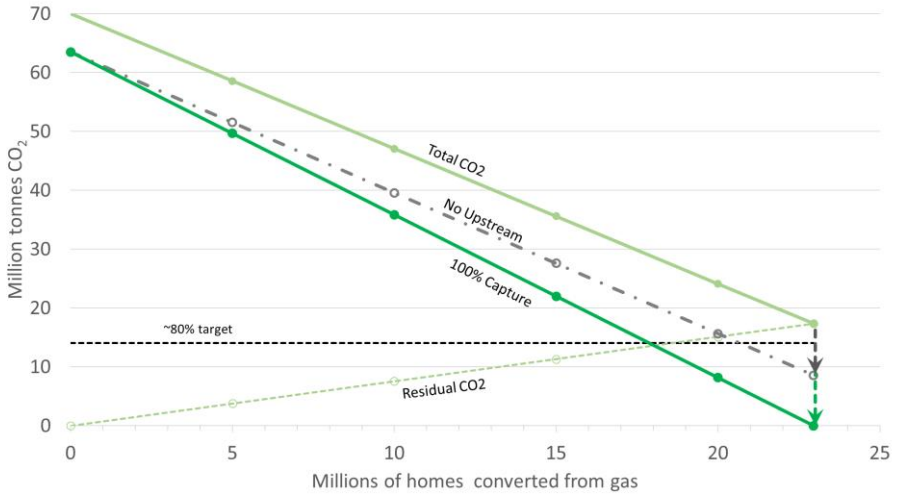
The 'Residual CO_2' line shows the emissions from hydrogen production from gas, with a CO_2 Capture rate of 90% and upstream emissions from gas extraction. Results in hydrogen at 50 gCO_2/kWh.

The 80% target is indicative - depending on how calculated. But may also want to consider what a post-2050 target might mean, which is likely to head towards zero.

If the gas is imported then the upstream emissions can be discounted – black line.

If CO_2 capture could achieve 100% then emissions would be reduced to zero.

This would lead to about 85 million tonnes of CO_2 going to storage per year.

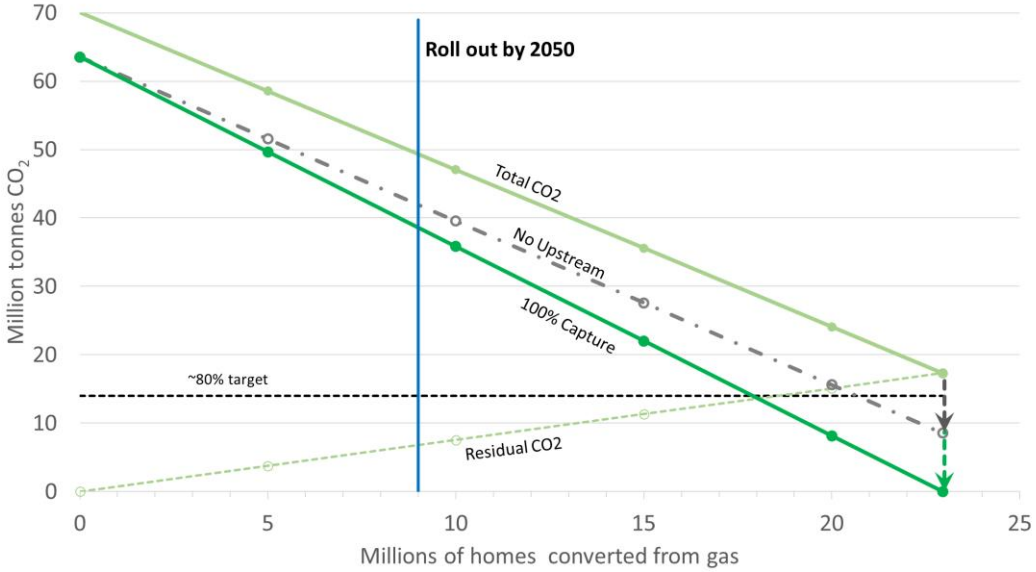


Roll out to 2050

Converting all the homes on the gas network would require three cities the size of Leeds to be converted every year from 2030-2050.

Leeds H21 mapped out a plan for 19 cities to be converted by 2050, approx 9 million homes – about 40% of the gas network. Doing so will put in place a national infrastructure for delivering hydrogen across the UK, which could expand to other areas.

So one question is what can we realistically expect from hydrogen?



Impact on primary energy consumption

Efficiency of hydrogen.

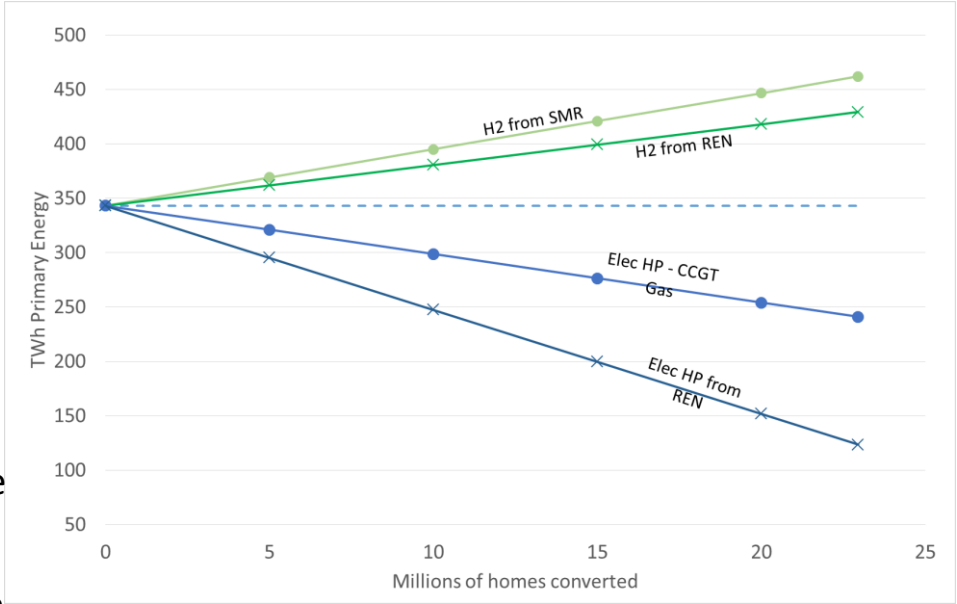
Gas to H2 conversion is about 74% inc CCS, which impacts on primary energy & means a continued dependence on imported gas.

Using only electrolysis would require over 50GW of nuclear or 150GW of offshore wind.

Alternatively hydrogen could be imported – which is still an energy security issue.

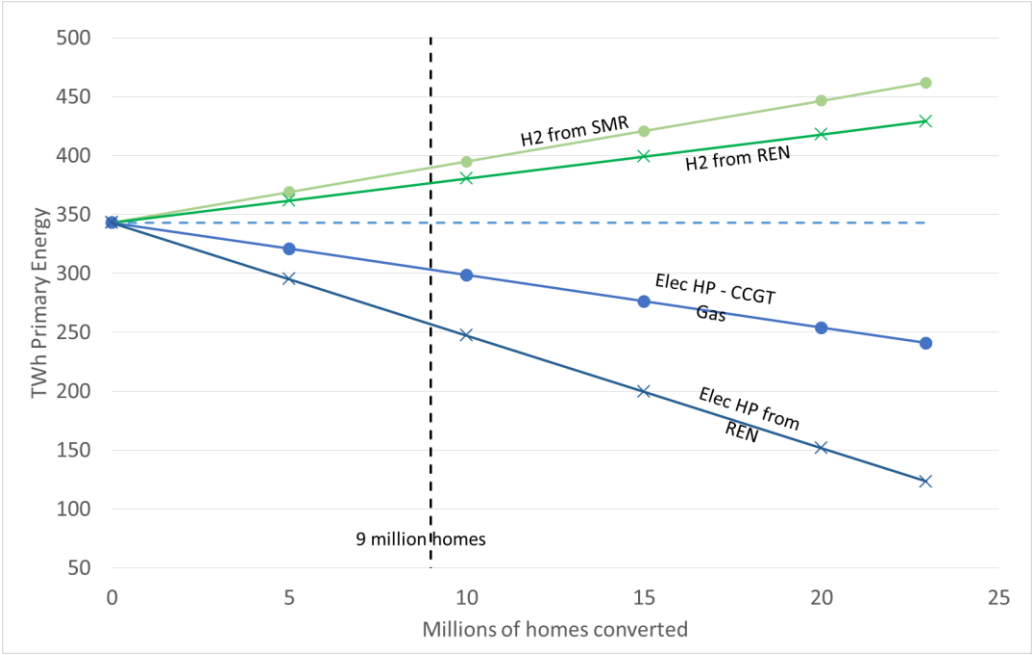
Heat pumps would reduce consumption, but challenge of peak heat and electrification.

Insulating homes could compensate this, but would be additional measures, as future heat scenarios already include demand reduction to compensate for increase in number of buildings.



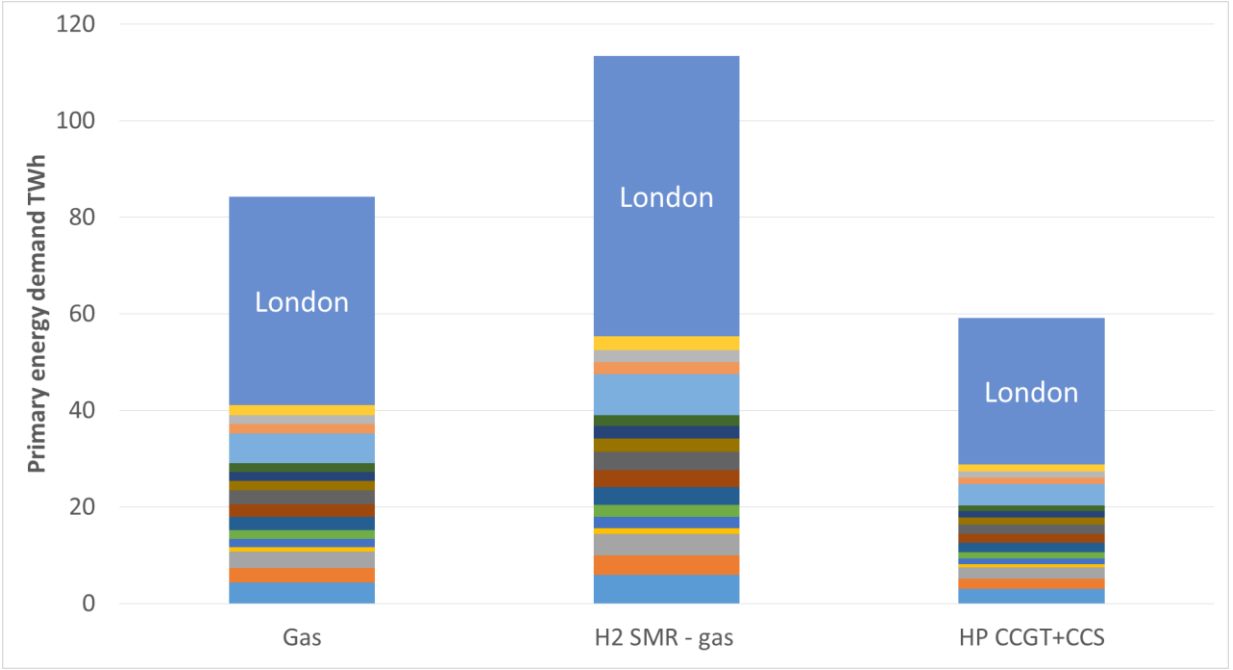
Potential by 2050

But if we only did hydrogen to 9 million homes, is primary energy a concern?



Gas for hydrogen by city

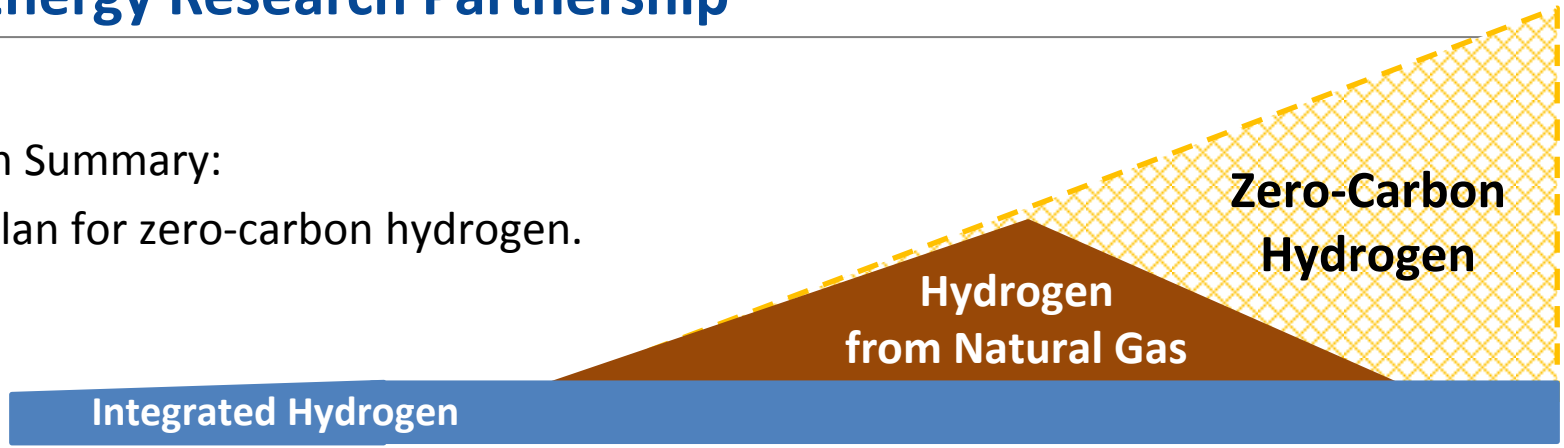
On a city by city basis, London dwarfs the other 17 cities.
Does this raise any issues for deployment of heat technologies?



Energy Research Partnership

In Summary:

Plan for zero-carbon hydrogen.



Stand-alone applications

Integrated in system

- Remove barriers
- Technology support
- Whole system approach

Decarbonisation of gas grid

Dedicated production

- Carbon Capture & Storage
- Public engagement
- Heat demand reduction

Zero-Carbon hydrogen

- Imports
- Negative-emission offsets

- Regulation for decarbonised hydrogen

- **Long-term strategy to decarbonise hydrogen**