Domestic Hydrogen Appliances for Decarbonising Heat in the UK

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SYSTEMS AND ENGINEERING TECHNOLOGY
1. Why hydrogen?

2. Are hydrogen appliances feasible?

3. Could the UK convert to 100% hydrogen?
Who we are

- Systems and Engineering Technology Consultancy
Contents

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2. Are hydrogen appliances feasible?
3. Could the UK convert to 100% hydrogen?
UK Electricity, Heat and Transport

Target Zero by 2050

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](http://bit.ly/energycharts) by Dr Grant Wilson grant.wilson@sheffield.ac.uk
Low regrets actions for decarbonising UK heat

Adapted from Committee on Climate Change, Next steps for UK heat policy (2016)
Relative cost of heat decarbonisation options

Source: Net Zero Report, Committee on Climate Change (2019)
Chemistry

**Natural Gas**
\[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{Energy} \]

**Hydrogen**
\[ 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{Energy} \]
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Domestic hob – with natural gas
Hydrogen hob – with hydrogen

- 4-75% flammability range compared with 4-17%
- Smaller detonation cell size
- Lower ignition energy

Less visible flame

7 x flame speed

Smaller molecular mass
Hydrogen hob – with hydrogen

Changes required:
- Remove primary airflow
- Reduce internal volume (void space)
- Ensure controlled ignition
- Fast acting flame failure device
- Develop new seals to avoid leakage
Domestic boiler – with natural gas
Domestic boiler – with hydrogen

- Replace pre-mix burner
- Reduce internal void spaces
- Develop new flame failure device
- Re-design heat exchanger for different heat transfer characteristics
- Increase size of sump (condensate)
Nationwide Conversion to Hydrogen

- Adaptation of Natural Gas Appliances
- New Hydrogen Appliances
- Hydrogen-Ready appliances
1. Why hydrogen?

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1967-1977 town gas conversion

- 14 million homes on gas supply (~18 million homes)
- 40 million gas appliances
- 10% of homes with gas central heating (further 30% heated by gas fires)

Now

- 23 million properties on gas supply (~27 million homes)
- 44 million gas appliances
- 80% of homes with gas central heating
How long would it take to convert the UK?

**Surveys and pipework updates**

There are approximately 23 million gas connected homes in the UK

- Initial survey – 3 properties per day
- Property updates (pipework and safety checks) – ½ day per property

### Gas Appliances

<table>
<thead>
<tr>
<th>Gas Appliance</th>
<th>Installed base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boilers</td>
<td>21.2 million</td>
</tr>
<tr>
<td>Fires</td>
<td>10.4 million</td>
</tr>
<tr>
<td>Hobs and ovens</td>
<td>12.7 million</td>
</tr>
</tbody>
</table>

52 million person-days

### Scenarios

**Scenario 1:** If the conversion was undertaken by the existing Gas Safe workforce of 130,000 (10% of their working time) a transition would take approx. **16 years**

**Scenario 2:** If a dedicated conversion workforce of 100,000 was developed (50% of their working time) then a conversion could take as little as **4 years**
Key differences to town gas conversion

- Benefit of hydrogen is not direct to home owner
- Attitudes to Health and Safety (including perception)
- Increased complexity of appliances – and more appliance variations
- Appliance warranties and insurance schemes – e.g. boiler cover
- Alternative options available – e.g. heat pumps for heating and induction hobs for cooking
Conclusions

- Domestic hydrogen appliances are feasible.
  Key issues:
  - Demonstrating safety
  - Consumer acceptance

- Appliances could be converted or exchanged at point of conversion – or Hydrogen-Ready appliances could be deployed in advance to ease burden at changeover

- Nationwide conversion could take between 4 and 16 years depending on size of taskforce
Further Reading

Search “BEIS hydrogen appliances”

Search “BEIS hydrogen logistics”

The Engineer magazine, February edition
Thankyou

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