Definition of a UK green hydrogen standard

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Government energy policy

- Secure
- Affordable
- Clean
  - Renewable
  - Low-carbon

How can we prove that our hydrogen is low-carbon or renewable?
Background to the project

• The lack of a UK definition of “green” hydrogen is an obstacle to policy support for hydrogen and fuel cells.
• DECC convened (but subsequently closed) a working group to develop a UK standard for green hydrogen.
• Aims of this project are to understand:
  – how could a green hydrogen standard could be defined?
  – what are the options and implications of different low-carbon thresholds?
  – how could a standard support the development of hydrogen and fuel cells through existing and new policy instruments in the future?
  – should other “green” factors, such as improved air quality, be reflected in the standard?
Review of hydrogen and similar schemes for other energy vectors

- TŰV SŰD and CEP – German
- AFHYPAC – French
- DECC – UK (on hold)
- CertifHy – EU certification scheme

These schemes tend to assume “Green” hydrogen is derived from renewable fuels (apart from DECC).

Some schemes try to incentivise only new renewables deployment for hydrogen production.
Lessons from electricity: Guarantees of Origin

• Electricity has had the same challenge for 20 years
  – Renewable electricity is tracked
  – Low-carbon electricity is tracked

• Consumers can buy certified renewable or low-carbon electricity

• Policy support exists for sustainable generation

• Some issues have still not been overcome (e.g. what does “green” mean?)
What are the challenges?

1. Defining the hydrogen system boundaries over which emissions are counted
2. Estimating the emissions for each production process
3. Deciding the appropriate emissions level(s) for processes to meet the standard for policy support
1. Hydrogen system boundaries

TUÜ SÜD

AFHYPAC / Certifhy / CEP / DECC

Feedstock Production  Transport  Hydrogen Generation  Transport  Point of Consumption

Cradle-to-Gate (Point of Production)  Well-to-Tank (Point of Use)
2. Estimating GHG emissions for each production/well-to-tank process

- Which LCA formulation? Or just feedstock emissions?
- Where do we get the data from?
- What is the balance between cost and accuracy?

- How do you stop people gaming the system?
Production emissions

Choice of unit: gCO$_2$e/kWh (similar to electricity)

- Considering only fuels is simpler
- However, feedstock emissions can vary over time
- LCA is much more complex (e.g. renewable generation 20–70 gCO2/kWh)
- Lifetime and capacity factor assumed for LCA
Hydrogen distribution emissions

- Loss of hydrogen during refuelling is (relatively) straightforward to estimate – but can be strongly geographically-dependent.
- Embodied emissions in infrastructure is much more difficult to assess. What is the extent of a UK hydrogen pipeline system?

<table>
<thead>
<tr>
<th>Delivery route</th>
<th>% H₂ loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralised delivery by HP pipeline, compression and refuelling</td>
<td>10%</td>
</tr>
<tr>
<td>Centralised transport by liquid H₂ road tanker + cryogenic refuelling</td>
<td>25%</td>
</tr>
<tr>
<td>Centralised transport by compressed H₂ tube trailer + refuelling</td>
<td>13%</td>
</tr>
<tr>
<td>Decentralised compressed H₂ Treatment and refuelling</td>
<td>8%</td>
</tr>
</tbody>
</table>
3. Defining the appropriate emission levels for low-carbon

• Should these change over time in line with carbon targets?
• Is there a balance to find between stifling innovation and having plausible thresholds?
• Different technologies use different amounts of hydrogen to provide the same service – e.g. FCEV vs ICE
3. Defining the appropriate emission levels for low-carbon
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Defining tighter thresholds: transport

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Year</th>
<th>Production emissions* (gCO₂e/kWh)</th>
<th>End-use emissions* (gCO₂e/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel ICE, bought today</td>
<td>2015</td>
<td>239</td>
<td>162</td>
</tr>
<tr>
<td>Diesel hybrid ICE, in 2050</td>
<td>2050</td>
<td>239</td>
<td>92</td>
</tr>
<tr>
<td>Hydrogen FCVs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMR</td>
<td>2020</td>
<td>248</td>
<td>99</td>
</tr>
<tr>
<td>SMR+CCS</td>
<td>2020</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>Electrolysis from grid</td>
<td>2020</td>
<td>467</td>
<td>186</td>
</tr>
<tr>
<td>Electrolysis from renewables</td>
<td>2020</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Excludes embodied emissions in infrastructure/devices
### Defining tighter thresholds: heat

<table>
<thead>
<tr>
<th>Technology</th>
<th>Year</th>
<th>Production emissions* (gCO₂e/kWh)</th>
<th>End-use emissions* (gCO₂e/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas boiler, bought today</td>
<td>2015</td>
<td>186</td>
<td>206</td>
</tr>
<tr>
<td>Hydrogen boilers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMR</td>
<td>2020</td>
<td>248</td>
<td>326</td>
</tr>
<tr>
<td>SMR+CCS</td>
<td>2020</td>
<td>27</td>
<td>35</td>
</tr>
</tbody>
</table>

* Excludes embodied emissions in infrastructure/devices
What have we been doing?

• Analysing responses to DECC’s green hydrogen standard consultation
• Understanding how such standards are being set up for hydrogen in other countries, and have been created for electricity and biofuels in the past
• Developing a framework for calculating hydrogen emissions for the UK
• Identifying UK low-carbon policies and considering how they might use a green hydrogen standard
• Identifying challenges for setting green hydrogen thresholds
How could a green hydrogen standard have a meaningful impact?

Where might a green hydrogen standard be introduced into existing UK energy policies?

• Transport policies
• Heat, energy demand and energy efficiency policies
• Electricity system policies

How do we avoid double-subsidies for hydrogen production?
Conclusions

• Defining green hydrogen is an important step towards supporting hydrogen-fuelled technologies
• Several initiatives are underway across Europe to produce certification schemes for hydrogen, including in the UK
• There are numerous difficulties to overcome, as demonstrated by the electricity schemes
Thank you for listening