Hydrogen’s Role in the Clean Energy Economy

Hydrogen Webinar, The Climate Center

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A voluntary group of independent academics, scientists and engineers who aim to bring an evidence-based viewpoint to the hydrogen debate.

Members

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Principles

- The only zero emissions hydrogen is renewable hydrogen
- Decarbonize existing hydrogen first
- Hydrogen shouldn’t delay efficiency and electrification solutions
- Blending hydrogen into the gas grid is a waste
- Prioritize locally produced hydrogen
Decarbonise grey hydrogen first...

1. Grey hydrogen is 2% of world CO₂ emissions... same as aviation.
2. Start where grey hydrogen is used today as a chemical feedstock:
   • Fertilizer
   • Petrochemical processing
   • Plate glass
   • Maybe steel
   • ....
Hydrogen should not be used to delay electrification

1. When electricity can be used instead of hydrogen, it is:
   - More efficient
   - Lower cost
   - Lower CO\textsubscript{2}
   - A more mature solution: quicker to deploy

2. Green hydrogen solutions need massive renewable energy generation.

3. Blue hydrogen solutions are not clean.
Electrify everything we can: Vehicles...

- **3x more renewable electricity** to power a hydrogen FCEV than a Battery EV: **3x cost!**
- The killer is the conversion from heat to work in the fuel cell
- Electrify everything you can!

![Diagram showing energy conversion and efficiency for FCEV and Battery EV](image)
Land Areas for Electrification of UK Road Freight

Battery Electric Vehicles:
- 11.9 GW
- 4,000 wind turbines
- Land Area=6,000 km²

‘Green’ Hydrogen:
- 35.6 GW
  (31 GW = UK average)
- 12,000 wind turbines
- Land Area=18,000 km²

Assumptions:
1. UK freight: 189b t.km per year
2. 0.19 kWh/t.km (44t), LF=0.75
3. Efficiencies:
   - 0.77 ERS
   - 0.23 H₂
4. Turbine power: 3MW
5. Wind power density: 2 W/m²
Blue hydrogen production emissions

Carbon capture and storage

Emissions from the energy used to manufacture hydrogen

Emissions from the energy used for carbon capture and storage

Natural gas production

Methane and other hydrocarbons

Methane, CO₂ (Supply chain)

Hydrogen manufacture

Methane, CO₂, NOX

Hydrogen storage

H₂ (H₂ leakage)

To end use

CO₂ (Leakage)
The only low emission hydrogen is green hydrogen...

1. Blue hydrogen:
   - Increases gas consumption by 45%
   - releases 10%-50% CO$_2$ of grey hydrogen
   - generates high fugitive methane emissions
   - requires large-scale, non-existent CCS
   - See HSC’s definition* of clean H$_2$

2. Using grey hydrogen generates significantly higher CO$_2$ emissions than burning fossil fuels.

3. Green hydrogen is much cleaner, but requires a lot of renewable electricity.

* https://h2sciencecoalition.com/briefings/clean-hydrogen-definition/
Why is this important?

1. Hydrogen for heating and road transport is inefficient and will increase costs and fuel poverty and damage economies.
2. Blue hydrogen will increase gas imports, create high emissions and damage energy security;
3. Generating green hydrogen will require massive renewable electricity and will prevent decarbonisation of electricity grid;
4. Hydrogen must only be used where there are no other alternatives...
   • Fertilizer, plastics, glass, maybe steel
   • Not heating, Not heavy vehicles, Not electricity storage ...
5. Confusion and uncertainty around hydrogen will delay international decarbonization.