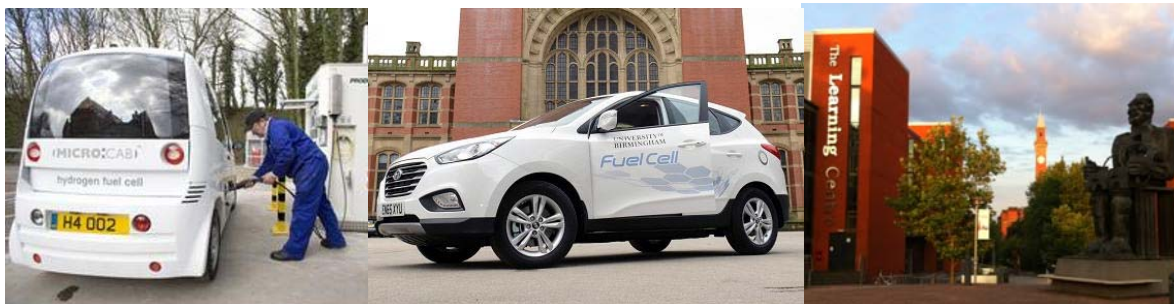


Decarbonising freight transport - The role of hydrogen-based fuels

Robert Steinberger-Wilckens, Prof Dr

**Centre for Fuel Cell & Hydrogen Research
School of Chemical Engineering**



Centre for Fuel Cell & Hydrogen Research Overview

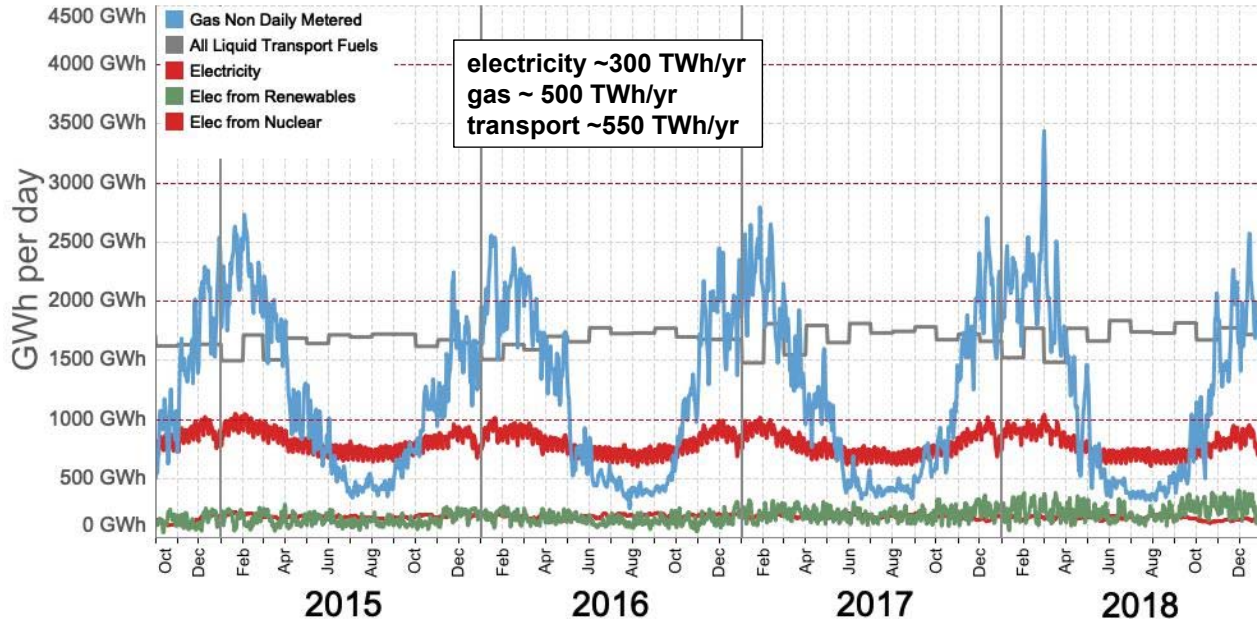
A group of 10 staff and ~35 PhD and MRes students working in:

- Hydrogen and Synthetic Fuel Production
- Low Temperature Fuel Cells & Electrolysis
- High Temperature Fuel Cells & Electrolysis
- Socio-economic topics
- Educational initiatives

The primary application is:

- Integration of fuel cell systems on vehicles

UK Energy Relationships



Decarbonisation = global costs

Emission reduction = local costs

Transport makes for

- > 35% of world primary energy use
- > 40% of global emissions
- ~ 50% of NOx in urban agglomerations
- .. and at the same time is closely linked to global economic growth and sustainability.

Extreme weather to cost UK billions and leave 2.5m homes at risk of flooding unless ministers take action, warns WWF

Report on the risks posed by climate change in 2050 warns there could be significant damage to the economy if it is not 'future-proofed'

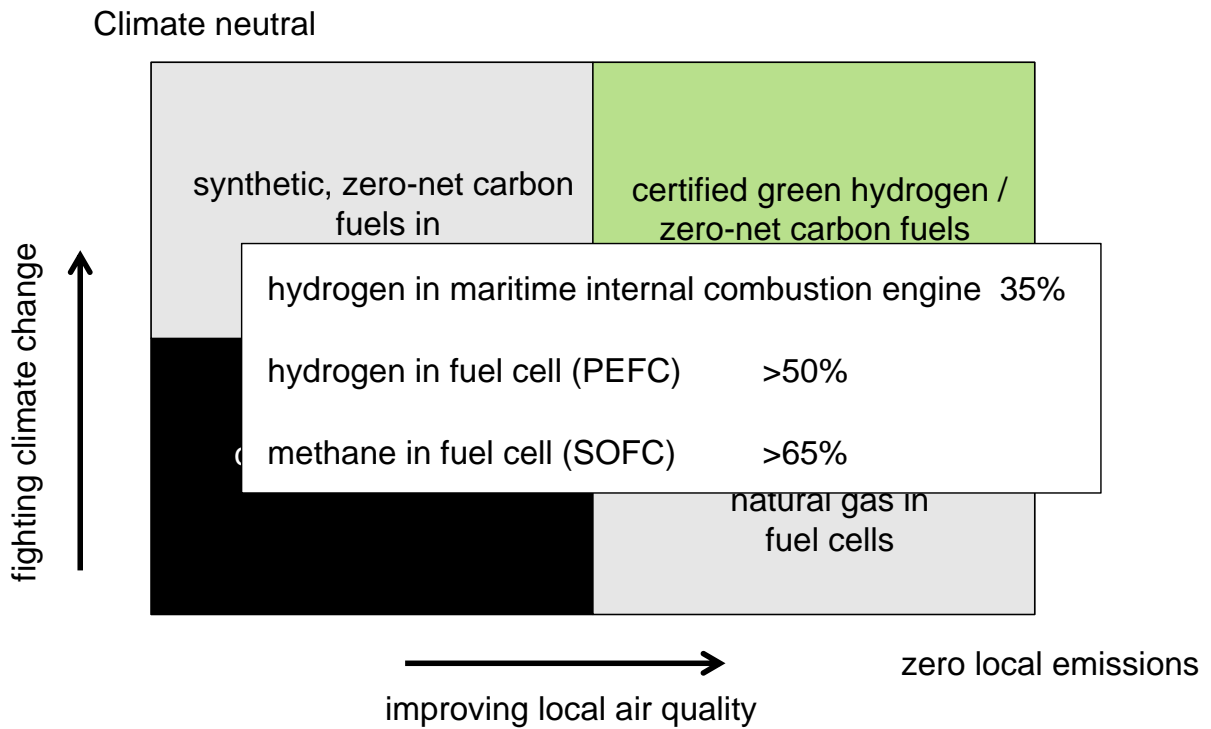
Each car in London costs NHS and society £8,000 due to air pollution, report finds

'We know the health impacts of air pollution, and now the economic case for cleaning up the air we breathe has been laid bare'

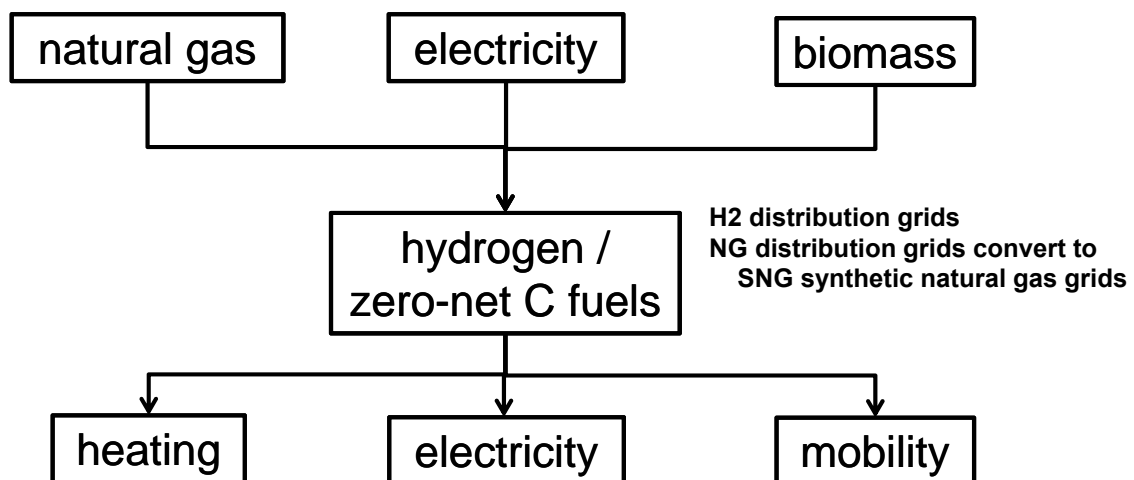
Toxic air a 'national health emergency' responsible for 40,000 early deaths and £20bn in costs each year, MPs warn

'It is unacceptable that successive governments have failed to protect the public from poisonous air'

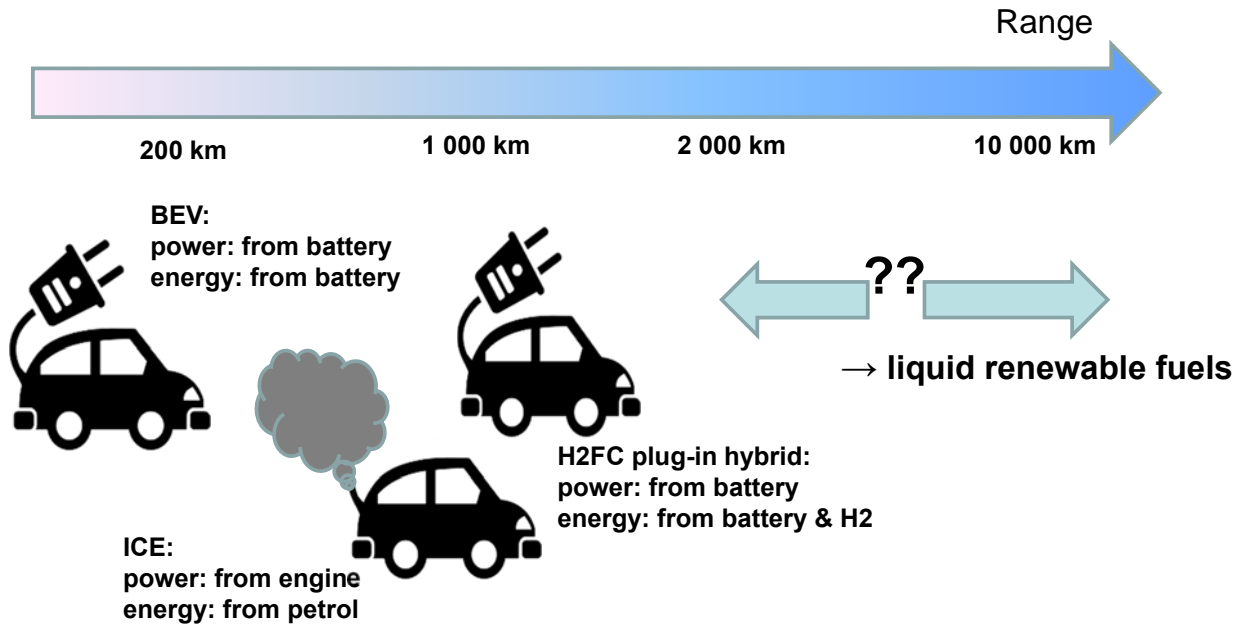
Global vs. Local Zero Emissions



Transforming the Energy Infrastructure

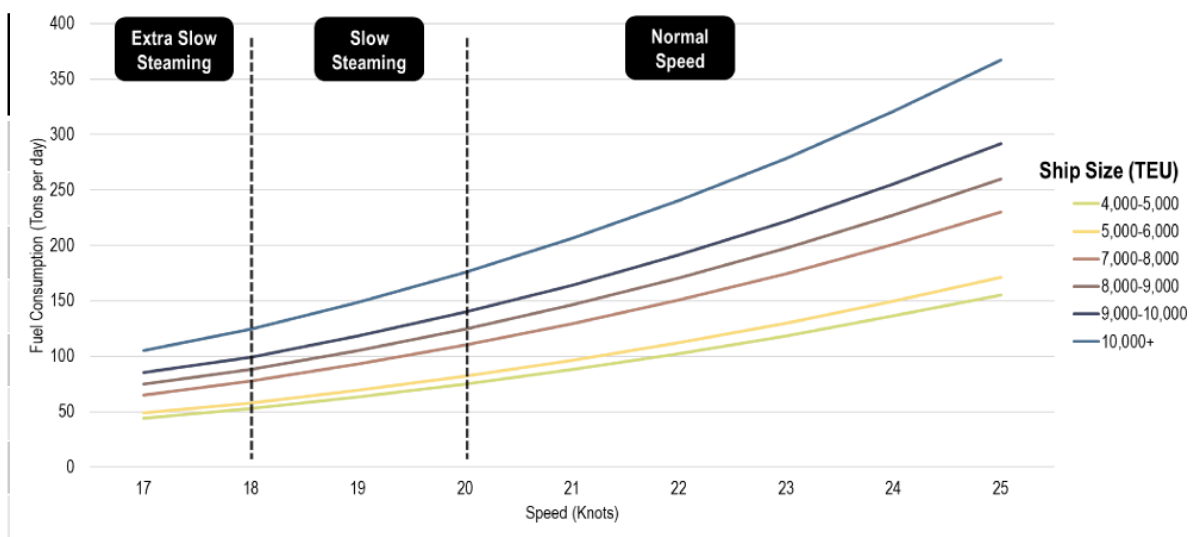


Zero Carbon Transport Solutions

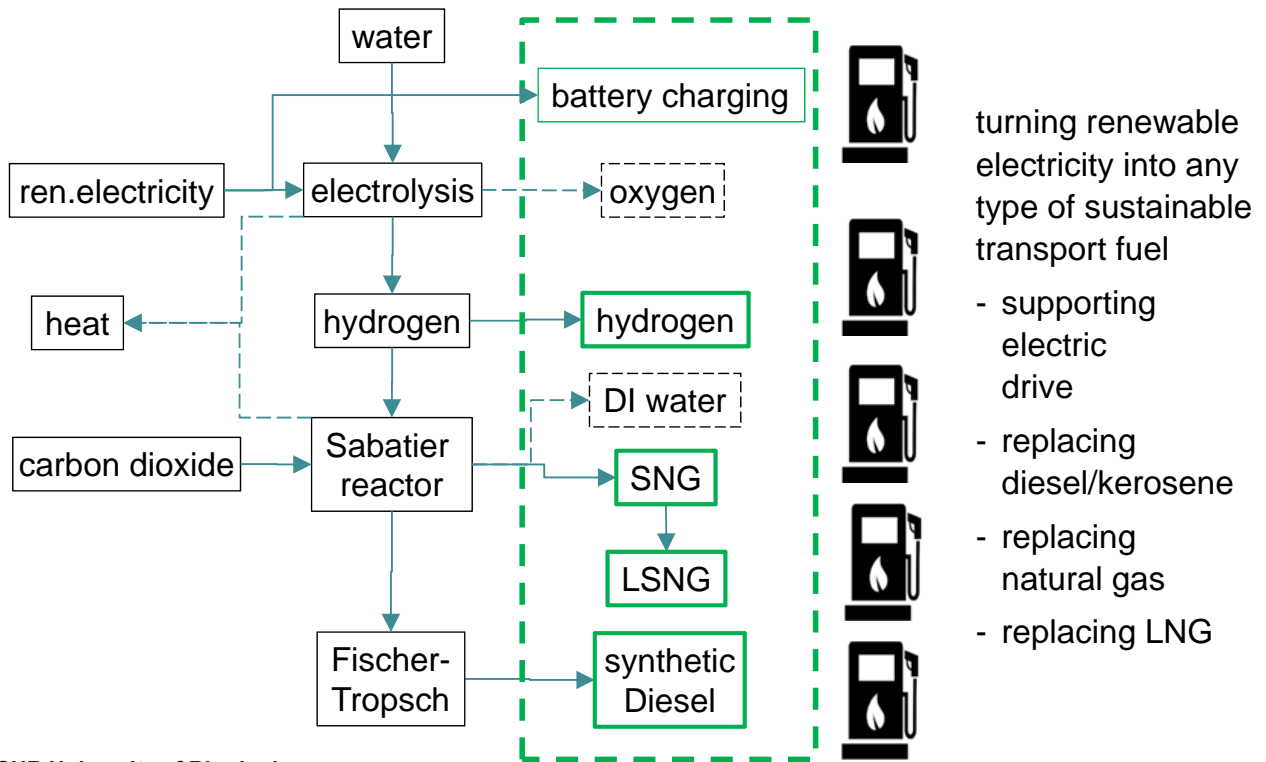


Comparison: Fuel Amounts

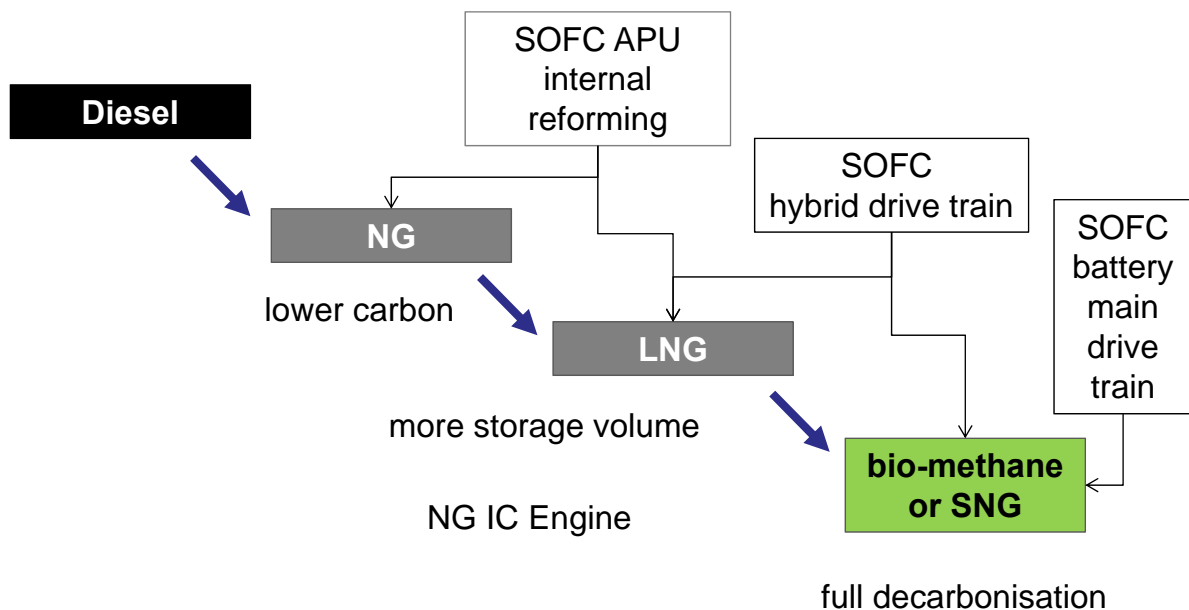
- steaming distance 10 days, 150 to/dy, 16 500 MWh



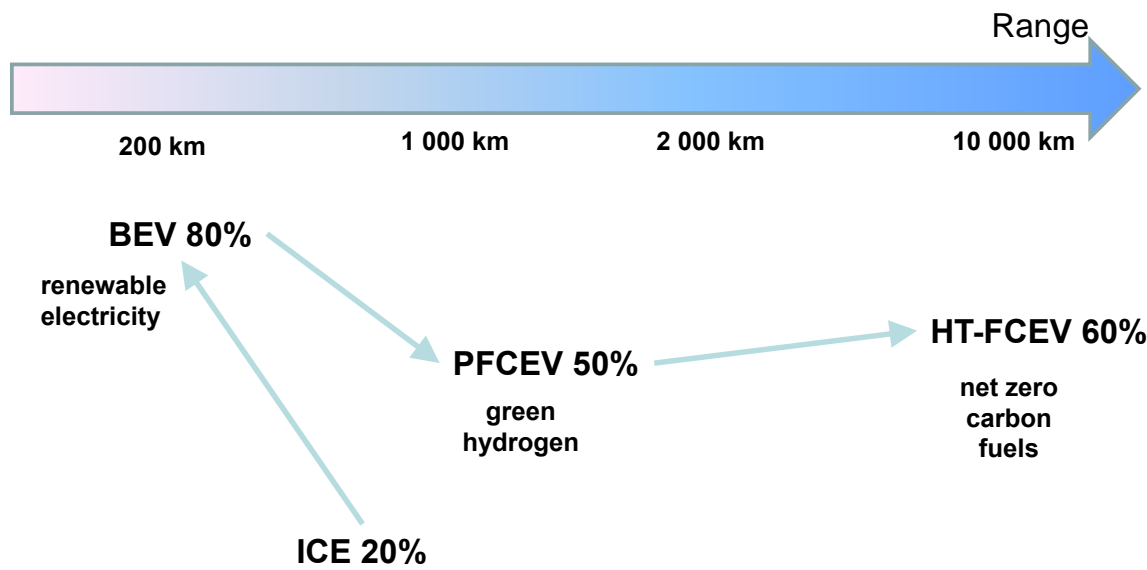
Complex P2G/P2L Product Chain



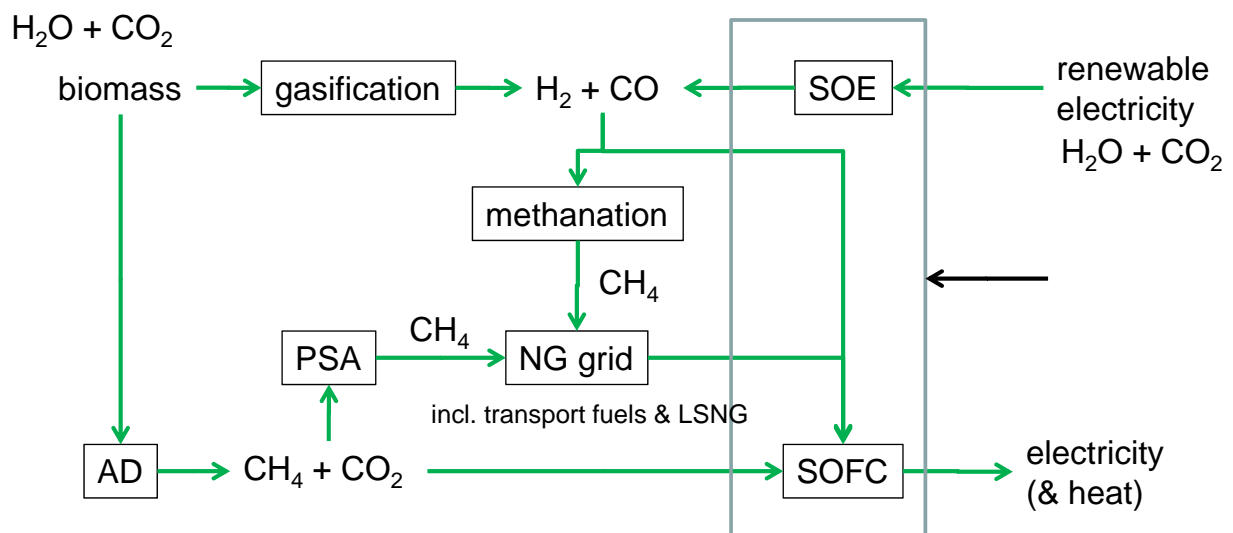
Fuel Cell Propulsion for Freight Road Transport (HDV/HGV), Rail, Aircraft, and Maritime Applications



Zero Carbon Efficiency



The Cycle of Zero-Carbon Methane



supplies synthetic natural gas for stationary applications and transport fuels without any fossil carbon conversion involved

Zero-Net Carbon Methane for Electrifying Large Vehicles

- ✓ from biomass and P2G (SNG)
- ✓ fully compatible with natural gas (NG) grid infrastructure
- ✓ compatible with NG/LNG trend for HDV, shipping etc.
- ✓ zero-carbon fuel with considerable reductions in CO, NO_x, SO₂, particle, and noise emissions even in ICE
- ✓ global zero emission scenario when used in fuel cells



Making Sense of the 'Hydrogen Economy'

issues

- conversion of distribution infrastructure, including organisational, asset destruction, and investment issues
- use of black hydrogen from NG/CCS schemes

Smart zero-carbon economy

- 'hybrid' system using hydrogen-based fuels from P2G
- making best use of existing infrastructure, adding new as appropriate
- use optional efficiency in conversion in PEFC & SOFC
- longer ranges for commercial vehicles
- CO₂ recycling economy



Thank you for listening and happy to answer any questions

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Chair in Fuel Cell & Hydrogen Research

Fuel Cell Systems Workshop – 26/27 May 2020, Bruges, Belgium.

EFCF 2020 – High Temperature Fuel Cells and Electrolysers

1 to 3 July 2020, Lucerne, Switzerland, www.efcf.com

JESS 2020 – Joint European Summer School,

07 to 11 & 14 to 18 Sept 2020, Athens

www.jess-summer-school.eu

