

THE ROLE OF HYDROGEN AND FUEL CELLS IN DELIVERING ENERGY SECURITY FOR THE UK

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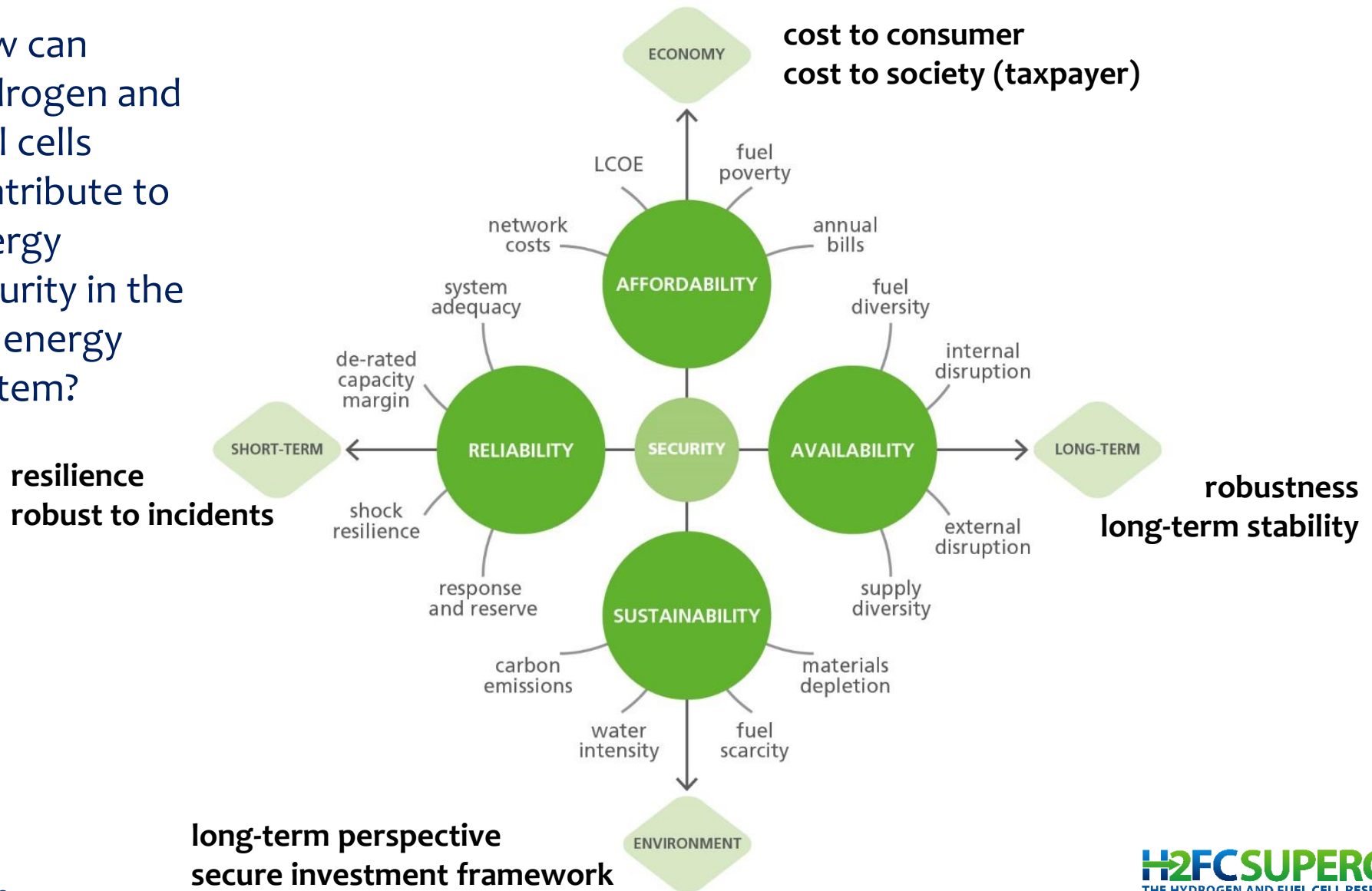
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H₂FC SUPERGEN
THE HYDROGEN AND FUEL CELL RESEARCH HUB

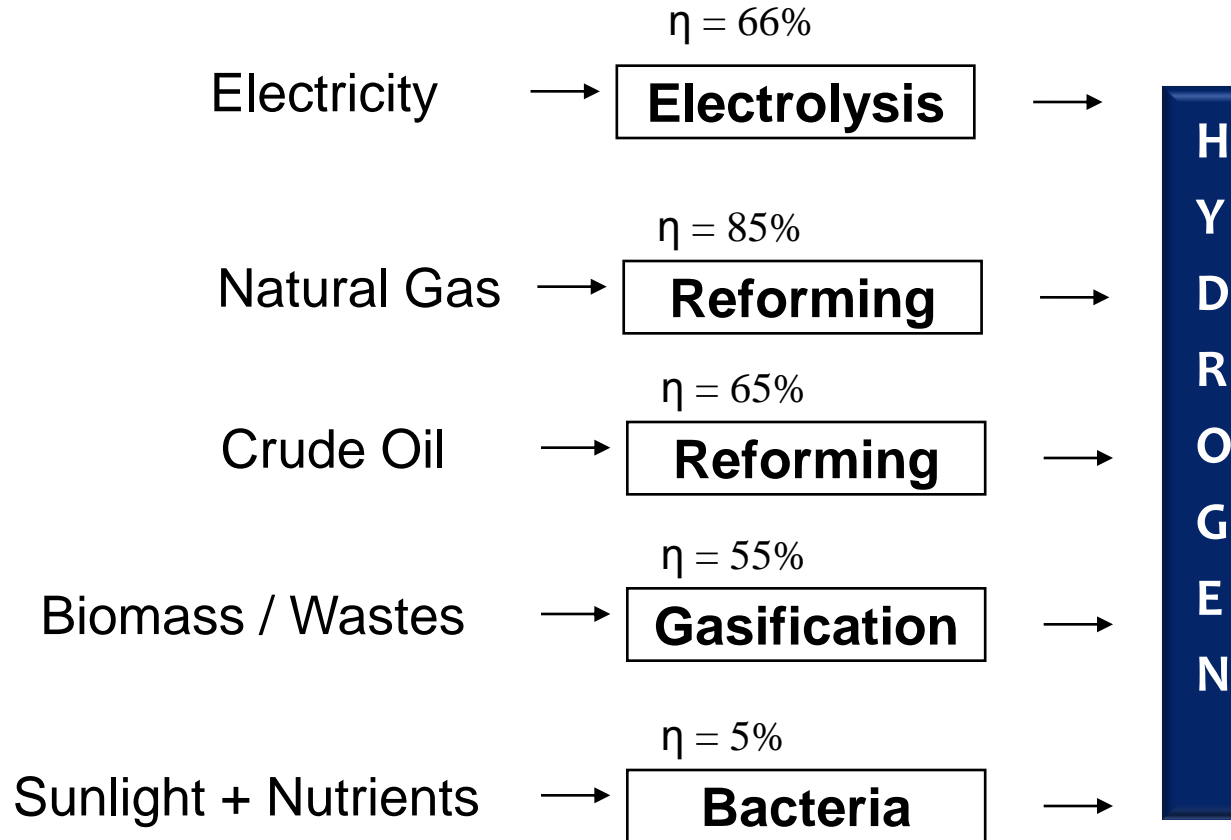
Energy Security Definition(s)

how can
hydrogen and
fuel cells
contribute to
energy
security in the
UK energy
system?



Hydrogen Production: Variety of Sources

Achievement: increase in choice of feedstock

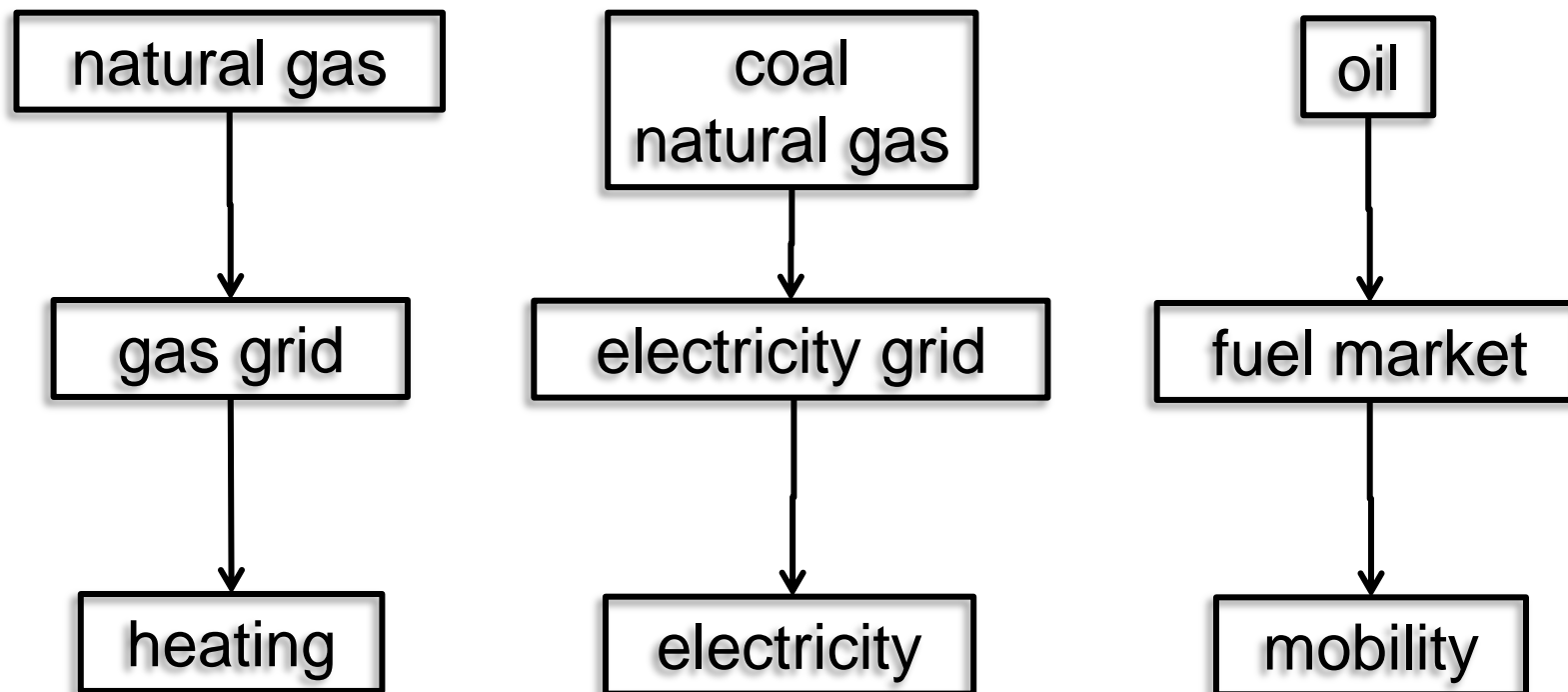


Energy Security – By Adding Flexibility

- * Adopting hydrogen increases UK energy diversity.
- * Hydrogen can be produced using a range of feedstocks/processes, including renewable electricity and biomass.
- * Price volatility of energy sources or supply disruptions can be ameliorated by switching to alternative feedstocks.
- * Energy imports can be reduced due to increased renewable energy employment, reducing political & economic dependence.
- * Scenario analyses show that the diversity of the UK energy system would improve compared to today's situation.

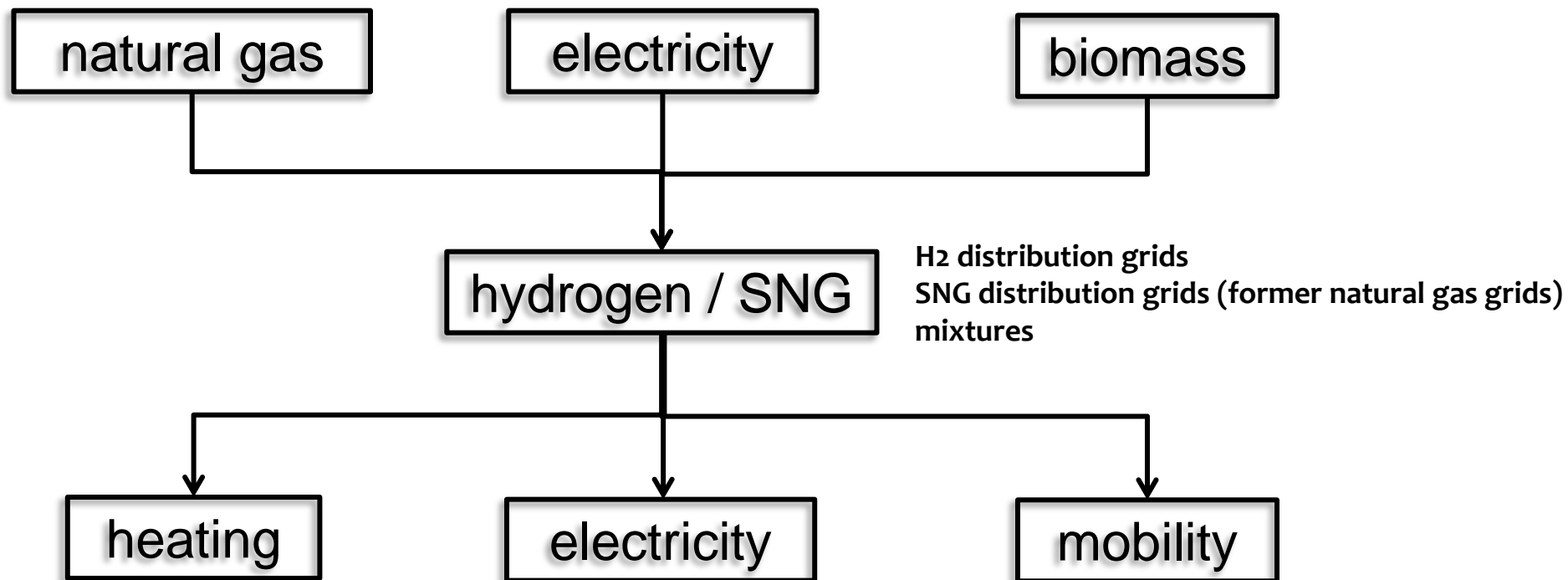
Conventional Energy Infrastructure

Risks: import dependence, loss of GDP to imports, political influencing



Future Hydrogen Energy Infrastructure

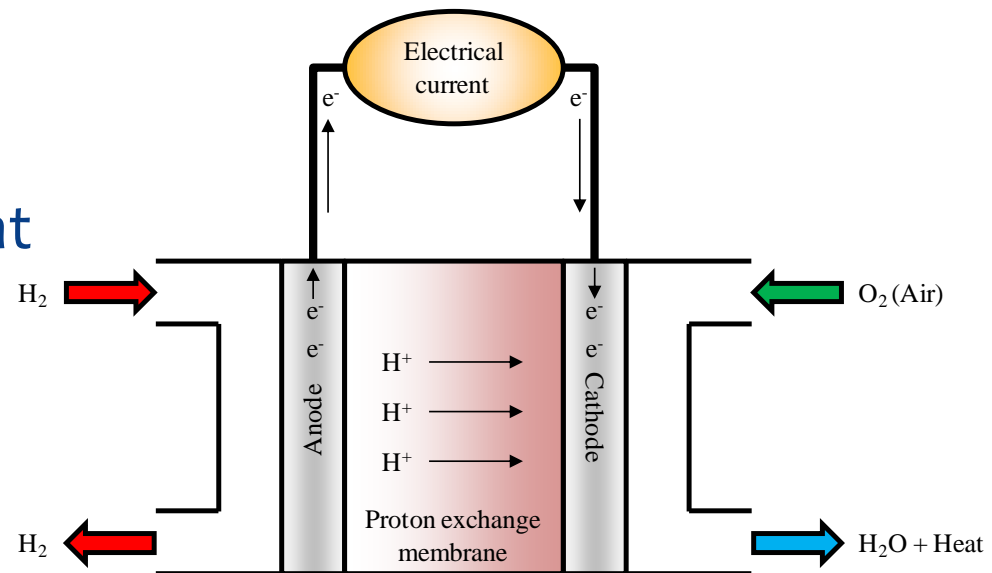
Achievements: increase in flexibility, reduction in import dependence, reduction of supply shortages



Hydrogen to Energy: Fuel Cells

Achievement: reduction in energy demand due to improved efficiency

- * fuel cells convert a range of fuels from hydrogen over methane (natural gas), town gas ($\text{H}_2 + \text{CO}$), propane, and methanol, up to ethanol
- * not limited by the Carnot efficiency: upper limit of the efficiency of (thermal) power plants
- * electrical efficiencies:
 - nuclear power station ► 33%
 - best coal fired power station at full power ► 52%
 - CCGT 400 MW ► 60%
 - fuel cell 2 kW ► 35 to 60%
 - fuel cell CCGT 100 kW ► 70%

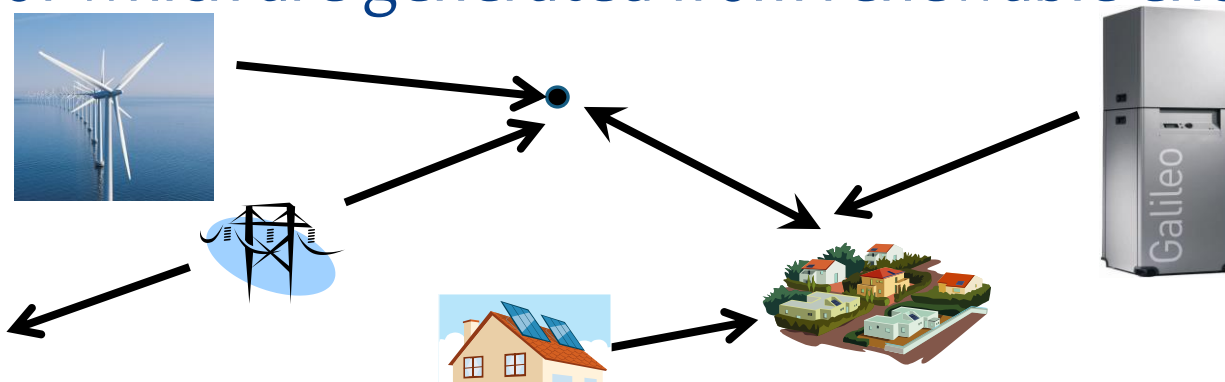


Decentralised Infrastructure

Achievements: increased resilience, reduction of grid failures, expanded fuel choice

Fuel cells support grid functions with respect to

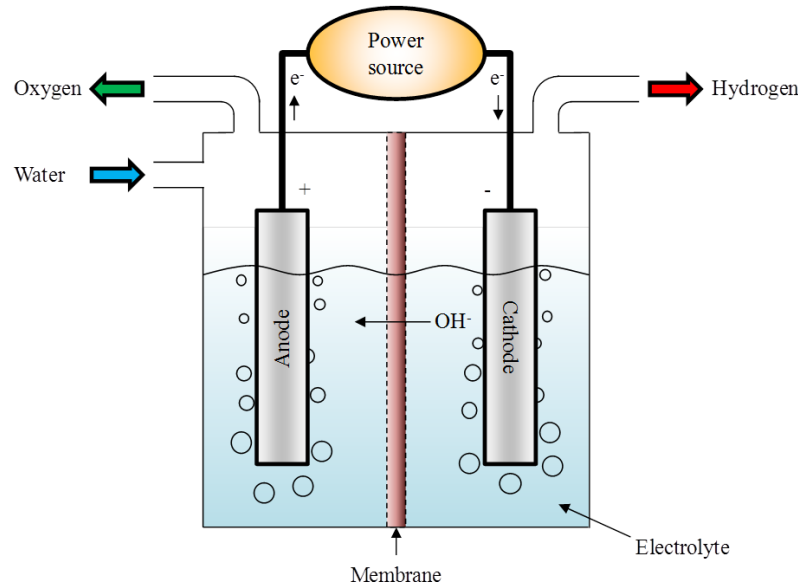
- * Reduced distribution losses,
- * Increased reliability due to lower probability of total disruption,
- * Blackstart capability and the option to ‘island’ parts of a grid that are still intact following an outage,
- * Increased fuel flexibility by allowing for a variety of fuels, many of which are generated from renewable energy sources.



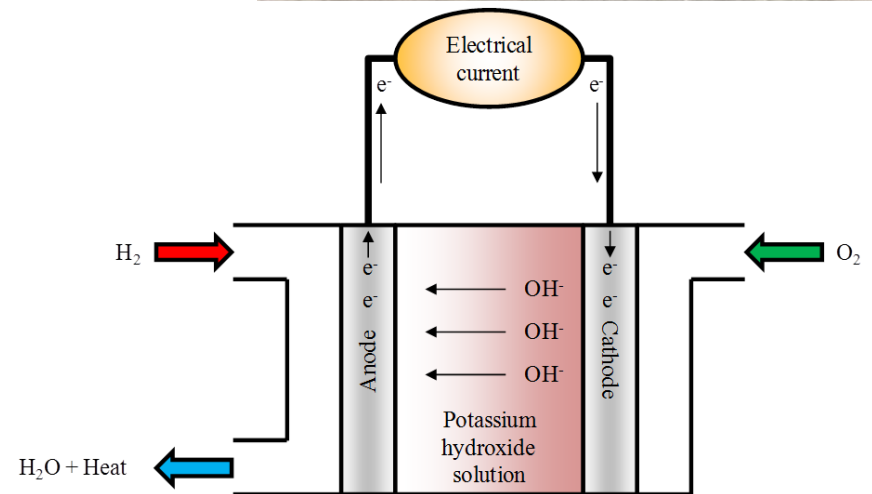
Enabling Technology

Achievement: novel options for safe operation of buildings and electricity grids

- * supply of grid support from Fuel Cell Electric Vehicles (FCEV)
- * building electricity backup from FCEV
- * linking electricity grid and gas grid



alkaline electrolyser converting electricity & water to hydrogen



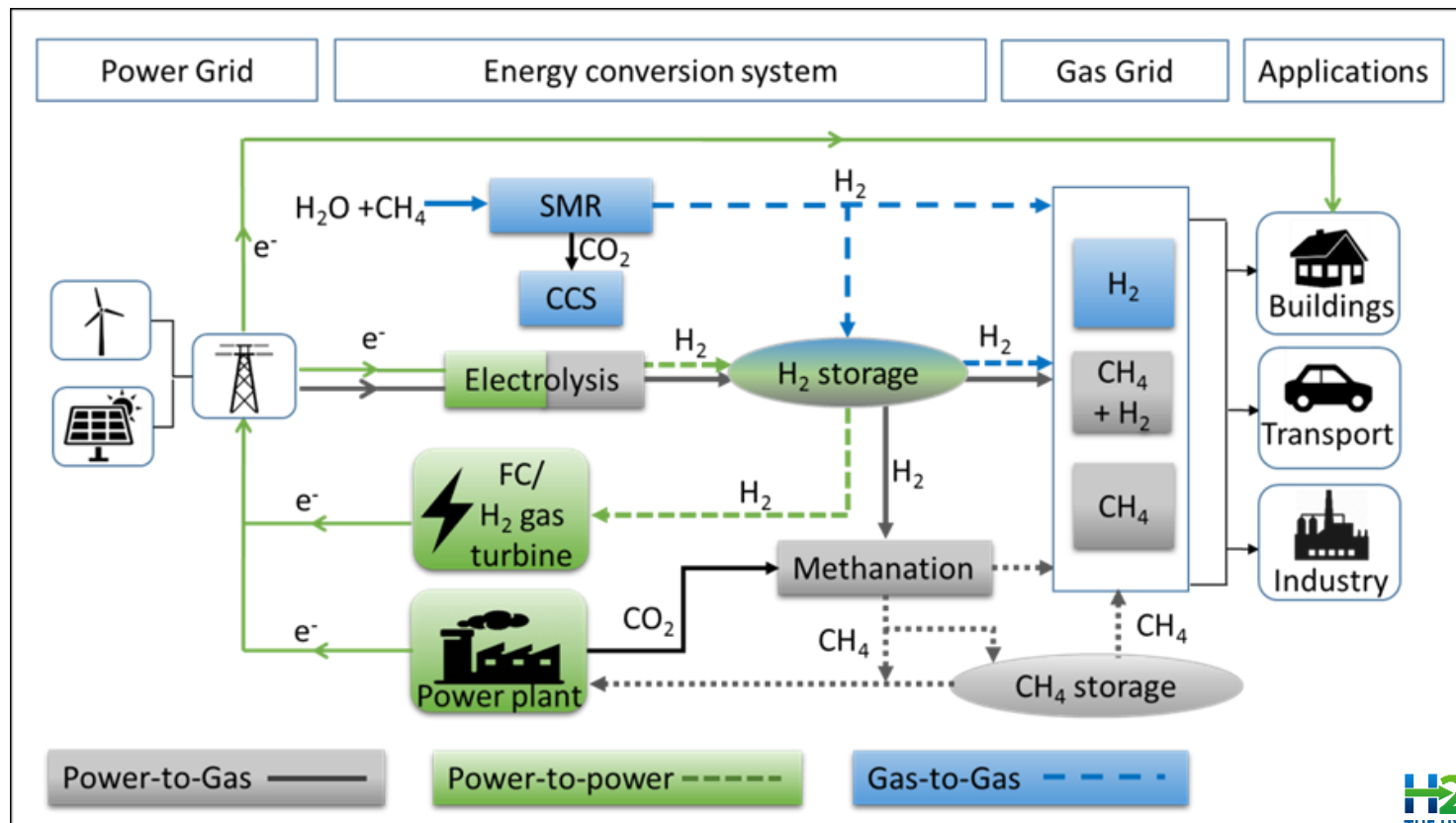
alkaline fuel cell converting hydrogen to electricity & heat

Linking Energy Sectors

Achievement: increasing flexibility and resilience of energy infrastructure

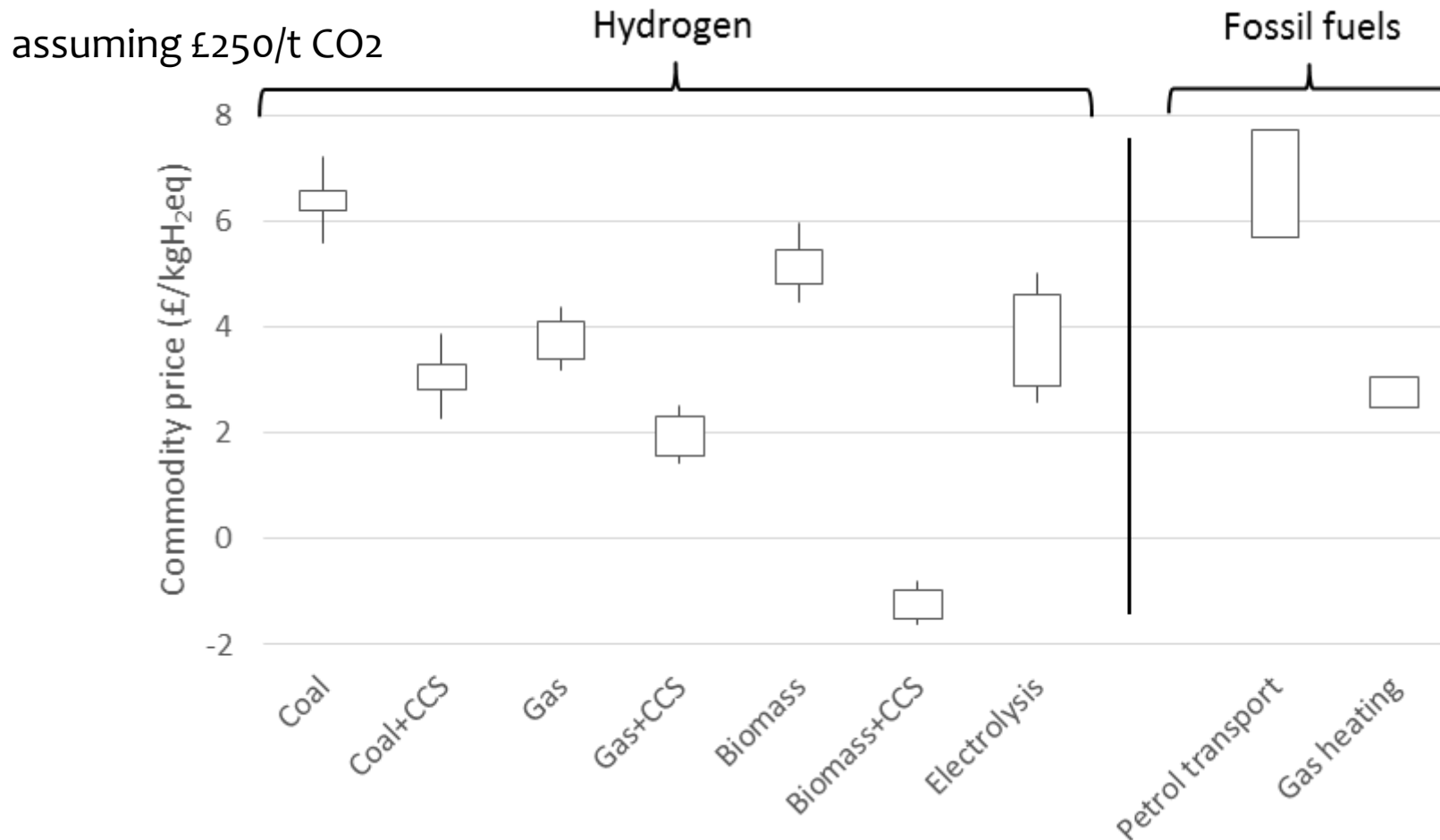
Fuel Cells and electrolysis as complementary technologies linking the electricity and gas markets (as well as transport fuels).

Provide balancing power for high renewable electricity systems.



Hydrogen Cost Development

Achievement: long-term reduction of cost of energy services



Pump Price vs. Societal Cost

Achievements: improvement of urban air quality, reduction of NHS cost

- * customer pricing of energy services largely excludes environmental and societal damages
- * externalities:
 - environmental damages
 - health impacts, incl. smog
 - corrosive urban air impact on buildings
 - limitations to human habitat
- * compensation for damages paid by state (taxpayer) or by the individual (health impacts)

Policy Support

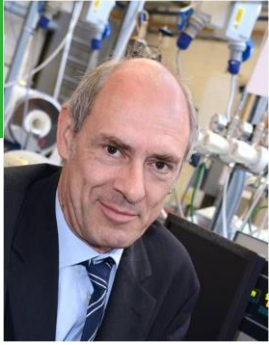
- * Holistic approach to energy systems to develop a low-carbon and flexible energy system, with hydrogen and fuel cells included in the Government's Energy Security Strategy.
- * Implementation of a 'system architect' or 'clearing house' as a coordination body for an increasingly complex energy infrastructure.
- * Policy incentives that create a level playing field for hydrogen and fuel cells.
- * Indication from the Government on the future strategy for supplying heat and power to homes, businesses and industry.
- * Retain funding for research on hydrogen and fuel cell technologies.

H2FC Potential Achievements

- * how can hydrogen and fuel cells contribute to energy security in the UK energy system?

Like this:

- * increasing the UK independence from fossil and imported energy sources,
- * increasing the stability of the UK economy by greatly reducing the risk induced by volatile energy import prices,
- * increasing the resilience of UK energy supply by reducing the risks from damage to the infrastructure (by natural incidents as well as malevolent interference).



Thanks for your Attention!

Any Questions?

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