



The benefits of integrating hydrogen and fuel cell technology into the UK economy

Global opportunity, with significant growth

- The global fuel cell market could be worth over \$26bn in 2020 and over \$180bn in 2050. The UK share of this market could be \$1bn in 2020 rising to \$19bn in 2050. [1]
- Overall fuel cell system shipments (excluding toys and education kits) in 2011 were 24,600 – growing by 39% compared to 2010, led by increases in stationary power generation. Annual megawatts shipped were over 100MW for the first time as commercialisation of the industry took hold. [2]
- In 2012, it is forecast that annual shipments of fuel cell systems will triple - reaching over 78,000 shipments for the full year. Annual megawatts shipped are expected to grow by over 60%, to around 176MW. Increases are expected across all applications. [2]
- By the end of 2011, 215 hydrogen refuelling stations were in operation worldwide with twelve new stations being added that year. [2]
- Hydrogen refuelling stations will continue to be added in 2012 as early markets gear up for the commercial release of fuel cell electric vehicles. Germany, California and Japan have announced plans for more than 200 stations between them by 2016. [2]

Delivering green jobs

- A recent survey by the UK Hydrogen and Fuel Cell Association and Energy Generation and Supply KTN revealed that UK fuel cell and hydrogen companies are expecting cumulative annual revenues to reach £1bn by 2020, bringing over 2,200 fuel cell and hydrogen related jobs to the UK. It is estimated that the European fuel cell and hydrogen industry already supports over 9,000 jobs. [3]
- A study commissioned by the US Department of Energy found that successful widespread market penetration by fuel cells could help to revitalize the
 1. http://www.carbontrust.co.uk/News/presscentre/091009_Polymer_fuelcell_challenge.htm
 2. http://www.fuelcelltoday.com/media/1713685/fct_review_2012.pdf
 3. <http://www.ukhfca.co.uk/wp-content/uploads/Hydrogen-and-fuel-cell-industry.pdf>

manufacturing sector and could add more than 180,000 net new jobs to the US economy by 2020, and more than 675,000 net new jobs by 2035. [4]

Contributing to carbon reduction targets

- A 2kW stationary fuel cell CHP unit can save up to 5 tonnes of CO₂ per household per annum depending on the installation [5] while fuel cells enable wider uptake of combined heat and power generation at 80-90% overall efficiency. [6]
- Fuel cell cars powered with renewable hydrogen have zero well-to-wheel emissions and produce between 0g (for hydrogen produced from renewable sources) and ~85g (for hydrogen produced from fossil fuels) of CO₂/km, compared to a gasoline internal combustion engine, which produces approximately ~170g of CO₂/km. [7]
- Results of a pioneering fact-based analysis of a portfolio of power-trains in Europe that compared fuel cell electric vehicles (FCEVs), battery electric vehicles (BEVs) and plug-in hybrids (PHEVs) to conventional vehicles with internal combustion engines (ICEs) showed that FCEVs are technologically ready and can be produced at much lower cost for an early commercial market over the next five years. [8]
- Hydrogen fuelled transport fuel cells improve general air quality by eliminating oxides of nitrogen and particulate matter from exhausts.
- 6,000 fuel cell CHP units, commercially available today, rated at 400kWe (sufficient to power a supermarket or school) would deliver the same level of CO₂ reductions as the proposed Severn Barrage, and could be in place in 5 years at more than 3 times lower capital cost [9]

4. http://www.hydrogen.energy.gov/pdfs/program_plan2011.pdf

5. www.cfcl.com.au , <http://cerespower.com/>

6. http://www.cfcl.com.au/Value_Proposition/

7. Well-to-Wheels analysis of future automotive fuels and powertrains in the European context Well-to-Wheels Report version 2b, May 2006

8. http://ec.europa.eu/research/fch/pdf/a_portfolio_of_power_trains_for_europe_a_fact_based_analysis.pdf

9. (Calculation compares the total power output from a 400kWe rated CHP fuel cell unit, operating at 80% efficiency, with 40% electrical efficiency, assuming a 40% efficiency saving over fossil fuel grid power. Cardiff- Weston crossing of the Severn Barrage is estimated at 17TWh, as determined by Parsons and Brinckerhoff and DECC, see <http://www.pbworld.co.uk/index.php?doc=627>; Assumes installed cost of single 400 kWe fuel cell CHP unit at \$1 million (currency exchange rate adopted at 1\$ = 0.62676 GBP, as on 09.10.2009 www.xe.com) and Severn Barrage costs at £15 billion)

- If 5.6 million homes had microCHP installed by 2020, the saved CO2 emissions would be equivalent to the emissions from eight new 750MW Combined Cycle Gas Turbine power stations [10]

Addressing renewable intermittency

- UK will face a 23% shortfall in energy supply at peak periods in 2015, and a 31.5% shortfall in 2020. By then, the costs of unplanned power cuts to the UK economy could reach £192bn. This would have a major impact on the UK's economic recovery and competitiveness in global markets. [11]
- Between January and mid-September 2011, 17 wind farm operators were paid almost £7 million to close down their operations to prevent the electricity network from becoming overloaded on almost 40 occasions. Looking ahead, it is expected that such incidents will become more common unless adequate energy storage technologies are deployed at greater scale. [11]
- Hydrogen represents an excellent storage option as it can act as both a short and long-term energy store to balance supply and demand at different scales, geographies and weather conditions. Hydrogen is a cost-effective and technically proven solution to: distribute energy between sectors, address intermittency in generation for wind, PV and marine renewables; and address variation in demand.

Energy Security

- Fuel cell systems can be fuelled using a variety of existing fuels, thus contributing to energy security and facilitating roll-out. They can be installed to operate on today's fuels, such as natural gas, as well as a wide range of other fuels such as biogas, bioethanol and future renewable fuels. [12]
- Linking fuel cell CHP installations to Anaerobic Digestion Biogas (ADG) via the gas grid (in analogous way to renewable electricity purchased on the electricity grid) would allow accelerated deployment of both technologies, assuming that the existing ADG-derived electricity feed-in tariff was available to such combinations. [12]

10. <http://www.centrica.co.uk/index.asp?pageid=39&newsid=1175>

11. <http://www.ukhfca.co.uk/wp-content/uploads/UK-HFCA-Energy-storage-final.pdf>

12. <http://www.ukhfca.co.uk/did-you-know/#factsheet2>