Managing renewable intermittency: the role of Hydrogen Energy Storage[i]

The need for energy storage

According to some predictions[1], the 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.

The UK Government has made a low carbon economy a central policy objective, with renewable energy as one of the key delivery mechanisms. Due to the intermittent nature of renewable energy generation, the UK's renewable energy targets will be difficult to meet without the deployment of energy storage technologies. 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.

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. As the UK moves to a low carbon economy, 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.

Intermittent generation

Because of its intermittent nature, increasing renewable electricity generation (e.g. from wind and solar) can cause:

- grid instability and difficulty in meeting peak demand;
- an increase in the costs of electricity network operation;
- disruptions in the electricity market through, for example, negative prices for electricity[2]; and
- disturbance across the whole generation portfolio - for example, by forcing gas-fired power plants to operate below maximum output.

In May 2011, the German Government announced that it would exclude nuclear energy from the future generation portfolio. The resulting expansion of renewable energy is envisaged to lead to a central role to hydrogen and fuel cells, and this is being facilitated by additional Federal funding of €200m provided exclusively for the deployment of these technologies. Early investment in energy storage in the UK will enable the shift to a low carbon economy without jeopardising the reliability of our electricity system.

Why hydrogen?

There are a number of technologies which enable, renewable energy generated during periods of low demand to be stored. The stored energy can be fed back into the grid when demand rises or used for other purposes. Thus, energy storage technologies can help to manage intermittent generation. The applicability of different technologies depends on geography, the amount of electricity they can store and storage duration. Hydrogen is the most flexible option, being immediately useful as renewable fuel for heat, transport and electricity generation, or as a chemical. The scale of storage can be intra- or inter-day, medium term and even inter seasonal, using a range of proven solutions.

[1] http://scag.ca.gov/rcp/ewg/documents/MindTheGapBrochure.pdf
[2] Negative electricity prices happen when supply outstrips demand.

Compared to other options, storing energy via hydrogen offers a range of key benefits:

- High responsiveness
- High energy density
- Flexibility in storage and release rates
- No deterioration due to severe weather conditions
- Long and short term storage (from days to months)
- Storage at different scales from a few to hundreds of GWh

Energy storage – key attributes

Energy storage through hydrogen is:

- **A near term commercial opportunity for the UK** that will assist in integrating greater amount of renewables within the UK electricity system therefore enabling the UK to meet its ambitious renewable targets and fill in the supply and demand gap
- **An optimal clean pathway to smart grid stabilization**
- **Proven and has been utilised for a number of years** in a number of locations, including: Shetland Islands, Utsira Island, Greenland, supplying a greater percentage of the community's overall power requirements with improved stability and reliability.

Hydrogen – a mean to distribute low-carbon energy among sectors:

- **Transport:** In addition to helping in the management of UK electricity networks, hydrogen produced from renewable sources offers the best opportunity to reduce GHG emissions in transport and eliminate dependence on fossil fuels. Use of zero carbon hydrogen in FCEVs is expected to lead to a 90%- 95% reduction in well-to-wheel emissions by 2020, when compared to current internal combustion engine vehicles[3]. The tank-to-wheel efficiencies of FCEV are also substantially greater than conventional internal combustion engine vehicles; on an energy equivalent basis, a typical FCEV can travel twice the distance of its petrol/diesel counterpart.

- **Heat and power:** Hydrogen can be used in stationary fuel cells, where it is typically converted to heat and power at 80-90% efficiency, or to electricity only at 40-50% efficiency, without incurring NOx, SOx or carbon emissions. It can also be utilised in highly dispatchable gas turbines for power generation or injected into a natural gas pipeline and used conventionally[4].

Generating 'green collar' jobs

Building on the UK's unique capability in hydrogen and fuel cells will allow the UK to secure future investment from global automotive OEM's which have announced plans for the launch of their commercial fuel cell and hydrogen vehicles in Germany, Japan and California in 2015. There is an opportunity for the UK to join these countries at the forefront of global developments, and the UK fuel cell and hydrogen industry is working hard to achieve this. A strong position will also help us to compete effectively with countries such as Korea, which has a goal of supplying 20% of the world's fuel cells, creating 560,000 Korean jobs and generating global sales of $126 billion[5]. Action now will also aid economic recovery through the creation of both direct hydrogen and fuel cell sector jobs and indirect jobs across the renewable, other low-carbon and automotive industries.

Note

Carbon neutral or zero carbon hydrogen can be produced from a range of sources. To learn more see the UK HFCA Position Paper on Hydrogen Production.

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[i] This paper is one of a series covering the various opportunities which hydrogen and fuel cells offer. Visit www.ukhfca.co.uk to find out more

[3] http://www.iphe.net/docs/Renewable_H2_Rpt_040411.pdf

[4] E.On is undertaking a €5m pilot project in Germany where around 360m^3 of hydrogen per hour will be produced from renewable electricity (wind) and fed into natural gas pipeline. http://www.eon.com/en/media/news-detail.jsp?id=10738&year=2011

[5] http://www.fuelcells.org/Fuel_Cell_Industry_Job_Estimates.pdf