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Stabilising the grid through use of Energy Storage

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Abstract:
A low carbon economy is now a central policy objective for the UK Government, 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 use of energy storage technologies.

It is projected in some market reports that the UK could potentially face up to a 23% shortfall in peak period energy supply by 2015, and 31.5% shortfall in 2020. It is estimated by then that the costs of unplanned power cuts to the UK economy could reach as much as £192bn [1].

In 2011 seventeen wind farm operators had paid almost £7 million to suspend generation, on almost 40 occasions, in order to prevent the electricity network from becoming overloaded [2]. Looking ahead, many industry experts expect that such incidents will become more common unless adequate energy storage technologies are strategically deployed at greater scale.

Hydrogen represents an excellent storage option as it can act as both a short and long-term energy store. The hydrogen energy storage can then be used to balance supply and demand at different scales, geographies and weather conditions. As the UK Government is strategically moving the UK towards a low carbon economy, hydrogen can play an important role as a cost-effective and technically proven solution to distribute energy between sectors through its injection into the natural gas networks and its use in transport.

In the transport sector, hydrogen produced from renewable sources offers one of the best opportunities to reduce green house gas emissions in transport and significantly reduce dependence on fossil fuels. Use of zero carbon hydrogen derived from renewable sources in Fuel Cell (FC) vehicles is expected to lead to a 90%- 95% reduction in well-to-wheel emissions by 2020, when compared to existing internal combustion engines [3].

In the natural gas network, hydrogen can be injected into a natural gas pipeline to be used conventionally. A number of European trials have indicated that up to 15% of pure H2 can be injected into the natural gas pipeline without the need for any modifications to existing equipment [4]. This offers the potential to utilise the green hydrogen produced from renewable generation to both reduce the CO2 emissions from the use of natural gas, and to act as a deferrable load on the electrical network.

This paper will build upon our previous findings from the "techno economic assessment of existing energy storage systems in comparison to Hydrogen energy storage technologies" presented at the IET RPG conference in 2012 [5], to develop an economic analysis of utilising hydrogen's ability to 'sector-shift'.
Based on the 2010 figures for UK gas consumption there is potential to absorb up to 162TWh of renewable energy into the natural gas grid in the form of hydrogen gas [6]. This paper will therefore explore opportunities where hydrogen can be deployed as a load balancing mechanism on the electrical transmission network. Using a levelised cost model the paper will show the economic analysis of utilising hydrogen's ability to 'sector-shift' to provide strategic energy storage capacity into the electrical network to enable the projected increase in renewable energy connections.

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[4] EU Commission Task Force for Smart Grids, Expert Group 4, “Smart Grid aspects related to Gas”, June 2006
[5] R.Gazey, Dr. D. Ali, Dr. D. Aklil, “Techno-Economic Assessment of Energy Storage Systems for Enabling Projected Increase of Renewables onto Electrical Power Grids”, IET RPG 2011.
[6] The European Union of the Natural Gas Industry, “Natural Gas Consumption in the EU27 and Switzerland in 2010”, Brussels 2011