analyst view

Hydrogen in Our Homes: A Daunting Prospect?

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Image source: Dan Carter

A current major topic of interest we have seen at a number of recent events is the potential to store surplus renewable energy in the form of hydrogen (via electrolysis) using existing natural gas infrastructure. This model has a number of benefits, including: increasing capacity utilisation of clean electricity generation assets; avoiding the need to curtail renewable electricity generation at times of low demand; less requirement for spinning reserve and stabilisation of the grid through demand-side management to name but a few. The question for consumers of natural gas however is: would we want hydrogen mixed into the natural gas pipelines and would it be safe?

Even as recently as 43 years ago (1969) this question would not have been an issue as coal gas containing up to 50% hydrogen was piped across the UK for lighting in homes, factories and for streetlights. To find out more about this history of hydrogen use in everyday life we spoke to Peter Hardy, Technical Services Manager at the Institute of Gas Engineers & Managers.

Hardy told us that the gas industry traces its origins back to 1792, when William Murdock used coal gas to light his home. He then went on to successfully light his employers' factory, the Soho Foundry, in 1802. The use of gas for lighting was seen as inherently safer than candles or oil lamps, both of which were notorious for causing fires when their wicks were trimmed.

The world's first gas company was formed in 1812 by Royal Charter, under the seal of King George III, and called the Gas Light and Coke Company. The company provided gas from coal gasification which contained up to 50% hydrogen, with the remainder being mostly carbon dioxide and carbon monoxide. This was used as naked flames for lighting until the invention of the incandescent gas mantle in 1887. The first gas fire was produced in 1856, meaning heat could also be produced from burning the hydrogen in coal gas. According to Hardy, even when natural gas began to be imported to the UK it was not used directly as fuel, but instead reformed to produce more hydrogen.

The eventual conversion of the UK gas infrastructure to methane began in 1969 and was completed five years later by 1974. This led to the consumer setup we have today where natural gas is used for heating, hot water provision and cooking, but it also allowed for electricity production using gas turbines. These generators offer a fast response and are currently seen by utilities as one of the best methods of balancing the national electricity grid which has an increasing contribution from variable renewables. While the fast response time of these generators is attractive to electricity grid managers, their efficiency and carbon emissions leave a lot to be desired. If we were able to use electrolysers to balance the grid by storing excess renewable electricity on a seasonal timescale, the resulting hydrogen could easily be used for heating, lighting, for distributed power generation or even as a transport fuel with minimal modifications to the current distribution infrastructure. Issues around leakage of hydrogen are not significantly more of a concern than those which surround methane. It is true that as a smaller molecule, hydrogen will diffuse through materials faster, but Enbridge (owner and operator of Canada's largest natural gas distribution company) recently reported at the 2012 World Hydrogen Energy Conference that leakage of hydrogen is not a concern on a gas-in to gas-out basis, i.e. it does not negatively affect the economics of running hydrogen pipelines.

Hardy also emphasised that in order for the UK government to meet its emissions reduction targets of 80% by 2050, reverting back to a piped hydrogen network would an ideal way to proceed. Using our existing natural gas supplies the centralised production of hydrogen could be achieved using carbon capture and storage. This would provide an ultra-low-carbon fuel which could be used in much the same way as our grandparents and great grandparents did for heating and lighting – only this time we could take advantage of fuel cells and benefit from higher efficiencies available with distributed cogeneration. In fact, a Danish demonstration project has been running since mid-2009, in the village of Vestenskov, part of which ran five 1.5 kW micro-combined heat and power fuel cells fuelled by an underground hydrogen supply network. The latest project report can be read here.

These end-user benefits are being demonstrated in Japan with the success of its Ene-Farm scheme known the world over, but the Japanese fuel cells still use natural gas and the fuel cell system is expensive, requiring significant government support. Having (relatively) pure hydrogen directly available would enable significant cost reduction for fuel cells by eliminating the need for reformers and the majority of the gas purification components. This balance of plant alone can comprise more than half the component cost of fuel cell systems, and results in parasitic load which reduces power output. If operated on a piped hydrogen infrastructure, these fuel cells could be made smaller, simpler and cheaper providing both heat and electricity with zero-carbon point-source emissions.

Going one step further and using electrolysers to generate the hydrogen could also lighten the load on the ever-expanding electricity grid while at the same time helping to accommodate the variability of increasing wind and solar contributions. If we were to follow this more holistic route, Hardy asks what would our ancestors think in the future? Will they look back in 2192 (the 400th anniversary of Murdock's discovery) and wonder what inspired the short-lived natural gas age?

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