AN ALTERNATIVE ENERGY STRATEGY

HYDROGEN IN THE HOME?

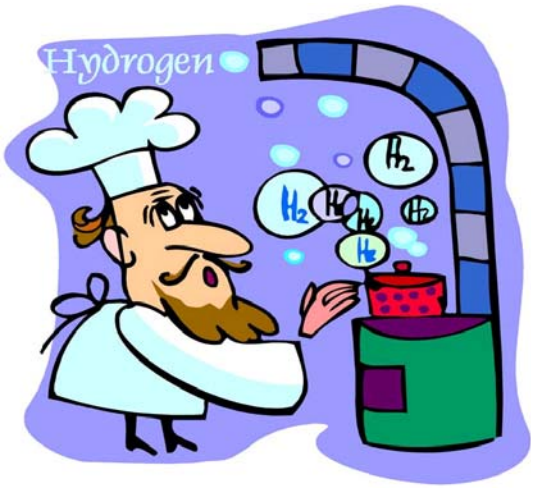
PRICE 30 P

Is hydrogen the answer to 'peak oil' and 'global warming'? Or should we just dismiss the idea as pie in the sky or at least 50 years away? Hydrogen after all can be used to heat one's house, generate electricity and fuel one's car, yet produces nothing more harmful than water vapour. What would such a future could look like and how fast could we get there?

Many looking at their gas and electricity bills will be surprised to see that the energy used in the gas is around 6 times that supplied in the electricity. Average annual household amounts are usually estimated at about 20,500 and 3,300 kilowatt hours respectively. Gas not only provides virtually all the heating for those houses with a gas supply but is used to generate up to 40% of UK electricity.

Could hydrogen be used in place of gas? The answer is yes. The old 'town gas' supplies contained 50% hydrogen. Hydrogen could replace gas and be pumped through the same pipelines we use now. In recent times the Gas Board has already made one conversion when North Sea gas became available: a change that took barely a year despite the need to modify all gas appliances in every home. As to danger the greater danger was and still is carbon monoxide, rather than hydrogen. The old town gas contained a mix of hydrogen, methane and other hydrocarbons, and carbon monoxide and dioxide. With 100% hydrogen there would be no carbon dioxide or deadly carbon monoxide at the consumer's end.

What about electricity? Would the hydrogen be burnt like coal and gas at power stations and distributed cross country through power lines on pylons? Preferably not. For a start power stations can not use all the heat they produce and though CCGT (combined cycle gas turbines) are over 60 % efficient (and even coal stations are getting better) and the old claim that 2/3rds of the energy was wasted is no longer quite true, much energy is still wasted at the station and a little more going down the power line.



This does mean of course that electricity must be generated in the home, but this is also possible now using fuel cells whose waste heat can help heat domestic hot water.

What of transport? Well, hydrogen can be used as an alternative to petrol or used in a fuel cell to produce electricity to power an electric car. The company ITM has established a 'hydrogen home' in its Sheffield factory in Nick Clegg's constituency. Their bi-fuel car can go 100 miles on hydrogen before having to switch over to petrol and might go 3 times further using a fuel cell. The bi-fuel concept would overcome the present lack of

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Based on a report compiled for ALDES by Bill Powell following his and Charles Purkiss's (ITM Power) presentation at a fringe meeting at the Spring Conference 2009. Comments to Bill, address: 53, Bury Road, Stapleford, Cambridge, CB22 5BP, email bill@vts16.fastmail.net would be welcomed

hydrogen filling stations and has obvious attractions for delivery and short distance commuting when the petrol would seldom be needed.

Nick Clegg and Vin Cable in the ITM bi-fuel car

Theoretically it would be possible to phase out both power stations and their distribution pylons. The current coal fed 'fluidised bed reactors' now used could be adapted to generate 'syngas' for the production of plastics, ammonia for fertilisers, and *hydrogen*. It is thought large facilities serving 300,000 population or more could achieve energy efficiencies of 90% although efficiency falls as size is reduced.

In principle any 'organic' material including plastics and biomass such as wood, miscanthus or silage could replace coal. Using biomass the whole cycle would be CO_2 neutral except for the energy used growing, harvesting and transporting the crop. On the other hand, if the CO_2 was captured, the process could become CO_2 negative! CO_2 would actually be removed from the atmosphere.

It is estimated that a highly efficient farm could grow 16 tonnes/hectare (t/ha) of dry biomass a year. That is about double the production of an immature miscanthus field near Lichfield. If 1 tonne contains 5000 kWh of energy an area of 15,000 ha - a circle say of 15 km diameter, would be needed for a town of 100,000 people (assuming 2.1 people/house). Scaled up for the UK as a whole this would take *half* of all agricultural land - and more would be needed to grow the energy for industry, commerce and so on. The cost however, assuming £60/t for biomass, could be less than 3p/kWh to the customer.

Biomass might contribute significantly in other countries but another benign source of hydrogen is needed in the UK . Fortunately this is available. The problem for renewable sources such as wind, wave and sun is their unreliability. Energy from a household wind turbine can fluctuate wildly over a 60 minute period from 0 to 6 kW. Even at a large scale the Danes have found there can be a serious mismatch in demand for electricity over a month. Using the power *when it is available but not needed by consumers* to generate hydrogen would make wind etc. more useful and more turbines could be installed.

There is a specific problem however relying on the gas main network to supply hydrogen: only 70% of properties have access to gas. The alternative is to supply energy via the electricity mains and use small electrolysers to convert it to hydrogen in the house. The problem with electricity is that its supply must, by and large, react to instantaneous demand which goes up and down through the year, the day and even from minute to minute. There are significant points in favour of electrolysers. They would allow energy to be *stored* at the house (as hydrogen) and be designed to take electricity at off-peak times or when strong winds, for example, were making extra renewable energy available. They would reduce the need for extra grid capacity and the number of times expensive (and often polluting) marginal power stations had to be switched on to cope with peaks. There is no reason why micro sources of electricity eg from solar panels or other local sources could not be used as well.

The issue of grid balance is important. Indeed *remote* control of selected appliances such as immersion heaters and freezers and the use of 'smart meters' to display real time costs and encourage householders to switch items off are both under active consideration. Electrolysers would leave control in householders' hands.

To produce electricity from the hydrogen once again requires a fuel cell. The good news is that 2 companies, Ceres Power (a commercial offshoot of Imperial College London) and Ceramic Fuel Cells Ltd, have made such good progress that British Gas and E.On UK have placed forward orders for sufficient units to conduct trials. Both use ceramic fuel cells operating at high temperatures. They can actually be fuelled by hydrogen, natural gas (methane), or liquid fuels.

Currently most work is being done using natural gas which is more readily available than hydrogen. Press releases from CFCL report its 'Gennex' fuel cell was designed for 1 kW but is delivering 2 kW on natural gas with 60% electrical efficiency. Because it would be in the home the remaining 40%, which would otherwise dissipate as waste heat, can be used to heat the household's hot water.

It would be wrong to contend that all the technical problems have been resolved and wrong to suggest that either of these 2 alternative approaches would be economic unless the price of fossil fuels or a tax on carbon, becomes very large. It is quite possible that a route using natural gas (methane) from biomass might prove more suitable than with hydrogen. Even so it is right to report that a great number of very interesting technologies are being considered by innovative engineers and scientists in an attempt to find ways to reconcile our current lifestyles with the need to slow and then stop global warming.

These efforts must be encouraged and supported. Our energy world could be looking very different in 20 years time.