Hydrogen - Another Con?

The following paragraph is lifted from a serious "alternative energy" website promoting development of hydrogen power for vehicles as a replacement for "fossil fuels" - and promoting it's suitability for massive investment.

- *"Hydrogen is one of two natural elements that combine to make water. Hydrogen is not an energy source, but an energy carrier because it takes a great deal of energy to extract it from water.*

- *It is useful as a compact energy source in fuel cells and batteries. Many companies are working hard to develop technologies that can efficiently exploit the potential of hydrogen energy. This page lists articles about hydrogen fuel as an alternative energy source."*

The first two lines tell a simple truth - the next lines completely contradict that truth and go ahead to expound the virtues of hydrogen as a replacement for fossil fuel as an energy source.

Here's another - taken from a Helsinki University page also expounding the virtues of hydrogen as a fuel - a very balanced presentation full of accurate facts about hydrogen and the difficulties of handling it.

Hydrogen Future

- *Hydrogen can be used to replace all gaseous and liquid energy carriers, for example gasoline, fuel oil and natural gas.*

- *Hydrogen makes an emissionless fuel cycle possible. If hydrogen is produced from biomass or by electrolysis using electricity from clean sources, there will be no emissions of greenhouse or toxic gases. Electricity for electrolysis can be produced using solar, wind, hydro, geothermal, or nuclear power.*

Well..... maybe balanced after we whip past the "*produced from biomass or by electrolysis using electricity from clean sources"* part. At least they call it an energy carrier and not an energy source! - one brownie point for honesty. Perhaps a little offset by the fact that suddenly liquid fuels that do occur naturally have been reclassified as mere energy carriers - also some truth, but a little too manipulative for our taste.

Hydrogen is the most abundant element there is - it however *never* occurs naturally in isolation. It is *always* securely atomically bonded to another element. Both the above pages concede it must be seperated from other elements to be of any use as an "energy carrier" - and therein lies the rub. There are three ways to seperate hydrogen from whatever it's bonded to - electrolysis is one - steam reforming is another - and nuclear is the third (either by powering electrolysis or direct cracking from steam).

Let's look at the numbers involved in the favoured process, electrolysis - the basic arithmetic - and let's use the USA as the "sample" - they are after all considered by most to be the biggest users of GHG producing fuels. (The source for these calculations is Donald Anthrop, Ph.D., professor emeritus of environmental studies at San Jose State University and they are presented by Patrick Bedard in the linked Car and Driver page).

In 2000, gasoline consumption in the US averaged 8.47 million barrels per day. Gasoline contains 5.15 million BTU of energy per barrel. For big numbers like this, it's customary to think in "quads," or quadrillion BTUs. So the gasoline energy used by motor vehicles in the year 2000 worked out to 16

quads - 1 quad is equal to 293 gigawatt-hours of electricity. That energy enabled American drivers to cover a distance of 2,526 billion miles.

The net energy needed per mile for a motor vehicle is about 0.46 kilowatt hours - so the above figures translate to an energy efficiency of about 25% for gasoline powered motor vehicles -"well to wheel".

Now let's do those same sums driving hydrogen vehicles.

Electrolysis is a 70% efficient process - so it takes 56 kwh to produce 1 kg of hydrogen which then has 39.4 kwh of available energy. Ideally our fuel cell would convert that to 6 kwh released as water vapour and 33.4 kwh as useable, however the best fuel cell is also about 70% efficient so our yield becomes 23.4 kwh. Hydrogen though is a gas - it takes up 3107 times the space of its gasoline equivalent. The energy needed in compressing it to fit in a tank will further reduce that energy yield to about 17 kwh.

So far we have no CO_2 emissions and all is clean and green - however that 56 kwh of electricity must come from somewhere. The US has an excellent supply of coal and many coal fired stations that are about 40% efficient - so starting with 140 kwh of energy from coal - we get 56 kwh to produce the hydrogen which then gives us 17 kWh from our hydrogen car. A well to wheel efficiency of about 12%.

Taking that figure back to the year 2000 sample at 0.46 kwh per mile we would need 1.16 trillion kwh, which - at 12% - calculates out to 32 quads of energy. Twice that used for gasoline powered cars and one third that of the entire energy consumption of the US - and giving an increase in CO_2 emission of about 270%.

OK... so few would accept coal as a viable option - but one fact sticks out like a sore thumb. The use of hydrogen gives about half the real efficiency of gasoline or other liquid fuels. However you cut it - that efficiency figure gives, on our year 2000 sample, an increase in the total energy that would need to be consumed of about 16 quads - a 16% increase in that total energy consumption of the US.

Steam reforming of methane to produce hydrogen has an efficiency of about 30 percent - giving more or less the same answer in total efficiency and emissions.

Renewables such as wind power and solar show the carbon payback and GHG contribtion from manufacture to also give more or less the same answer. A net 1.16 trillion kwh would also be quite a challenge to achieve from such sources.

Hydro power? .... not a likely option since science now points out the GHG contribution from the construction of Hydro dams can take decades to payback - and an entire "sample 2000" hydrogen fleet would require about 25 new dams.

Chemical extraction of hydrogen from aluminium alloys - our personal favourite! Eliminates the storage problems and produces hydrogen on demand - the only byproduct is aluminium oxide.

That though - is the stuff aluminium is made from with a process that takes vast amounts of electricity. Again - the numbers are the same!

This arithmetic is easily done by any first year student and anyone with a modicum of common sense would realise there is no accepted renewable or green source of energy that could fill in the extra demand created by the fundamental inefficiency inherent in the use of hydrogen as a transport fuel.

Guess that just leaves Nuclear