"The Hydrogen What?"

I guess I am just old-school, but frankly….I just don't get this "Hydrogen Economy" thing.

Don't get me wrong. The objectives of the Hydrogen Economy are both necessary and noble, but everything I have read contains the phrase "…in the mean time…" or its literary equivalent.

The advocates will state the fuel cell offers 2x conversion efficiencies over the internal combustion engine for vehicular applications, and that the exhaust product is water, both of which are true once the hydrogen is on board and available to the fuel cell stack.

They will also offer that hydrogen is a renewable fuel, which is only true if the hydrogen is produced by electrolyzing water with electricity supplied by wind turbines or other truly renewable source. It is certainly not true if the hydrogen is produced by reforming natural gas or other hydrocarbons. Most of these "…in the mean time…" scenarios feature the reforming of natural gas to provide the hydrogen.

What I don't get is why this "Hydrogen Economy" is any better than the Compressed Natural Gas (CNG) systems already available and deployed in vehicles to the extent that they are economically viable.

Natural gas has 1030 Btu/ft^3 while hydrogen has only 325 Btu/ft^3, so right off the bat, hydrogen requires three times the stored volume to deliver the same energy content to the engine/fuel cell. This is why all the discussion about a 10,000 psig hydrogen storage cylinder, vs. the 3500 psig CNG cylinders commonly supplied today.

It makes no sense that we would burn natural gas in a 55-58% efficient combined cycle gas turbine, distribute these electrons at 90-95% efficiency to a public fueling station, to electrolyze water and produce hydrogen at 60% efficiency, which would then need to be compressed to 10,000 psig to achieve a vehicle range of 170-300 miles depending on tank size and vehicle fuel economy.

Discharge temperatures on hydrogen compression are limited to 300ºF, resulting in something like an, 8-stage, 7-intercooler lubricated reciprocating compressor at 88-92% efficiency. Eight-throw recips are not exactly "off-the-shelf" items, and a solution of any size will probably be employ two-frames. Oil-free designs, typically required by the fuel cell, are generally limited to 1500 psig, and the hydrogen will embrittle Teflon wearing parts, resulting in unacceptably high maintenance requirements, if used. If such a compression solution does exist, it does not sound like your friendly neighborhood gas station variety equipment.

Despite the fact that a CNG based system already has a large portion of the fueling infrastructure in place, and that many these vehicles were dual-fuel equipped, deployment has generally been limited to local fleets because of the cost and critical mass to support the build out of the public refueling infrastructure. Does anyone really believe that compressed hydrogen systems will be any different? Or, for that matter even as good? Even on an interim basis?

There have been many studies on "well-to-wheel" efficiency, including one by Vägverket, the Swedish National Road Administration in October 2001. They concluded that using today's conventional gasoline engine at a relative efficiency of 1.000 (overall system efficiency 12.4%), a diesel-hybrid would be 1.507 (18.6%), a CNG-hybrid would be 1.281 (15.9%) and a fuel cell-hybrid supported by hydrogen produced locally through electrolysis would be 0.702 (8.7%). If the electricity for the fuel cell-hybrid alternative were produced from biomass, the relative efficiency would drop to 0.584 (7.2%). Go figure!

The development of the Hydrogen Economy is, more than anything, a storage problem. Critical development is needed to find suitable "hydrogen carriers" that can be handled at ambient pressure and temperature, preferably in a liquid form, to allow the use of the current fuel infrastructure safely.

There are a number of these initiatives currently in motion that range from sodium borohydride ($NaBH_4$) to carbon based nanotubes, but these efforts are still in their infancy and their potential for success unclear.

"In the meantime".....plan on a limited deployment of fleet-based compressed hydrogen systems that have the look and feel of "stunts", rather than of systems with a sustainable competitive advantage and commercial viability.

It also looks like there might be diesel-hybrid in your future as well.

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