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Hydrogen: Are production and storage technologies robust enough to deliver it?

5 January 2005

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Hydrogen has been slated to hold the key for a green future. Hydrogen derived from a renewable energy source, when fed to a fuel cell generates electricity without green house emissions. The energy community is very keen to exploit hydrogen for its advantages ranging from energy efficiency to air quality. Moreover the oil wells around the world are expected to fall short of their capacity and hence will not be able to meet the economy's growing energy needs in the coming years.

Though these factors could drive the energy companies and the researchers to consider hydrogen as a prospective green fuel, real benefit would be realized when hydrogen becomes an accessible fuel to everyone. The accessibility factor would materialize once the hydrogen production and storage technologies become commercially viable. The pace of the commercial viability decides the prospect of a "Hydrogen Economy."

It is estimated that more than 95% of generated hydrogen is produced by reforming conventional hydrocarbon fuels or from coal. Electrolysis – the splitting of water using electricity, accounting for the remaining 5%, is the oldest of the hydrogen production technologies. This technology has full blown commercial systems for industrial use. The chemical electrolyte used in the electrolysis is being replaced by proton exchange membrane (PEM). PEM eliminates the need for mechanical compression to achieve desirable pressure levels.

Unlike the conventional fuels, the inherent properties of hydrogen make it a difficult commodity to produce, store and handle on a large scale. However several companies and researchers at top Universities are inching ahead by proposing solutions to the problems in Hydrogen technologies. Today the technologies for hydrogen production and storage are at various stages of commercial development.

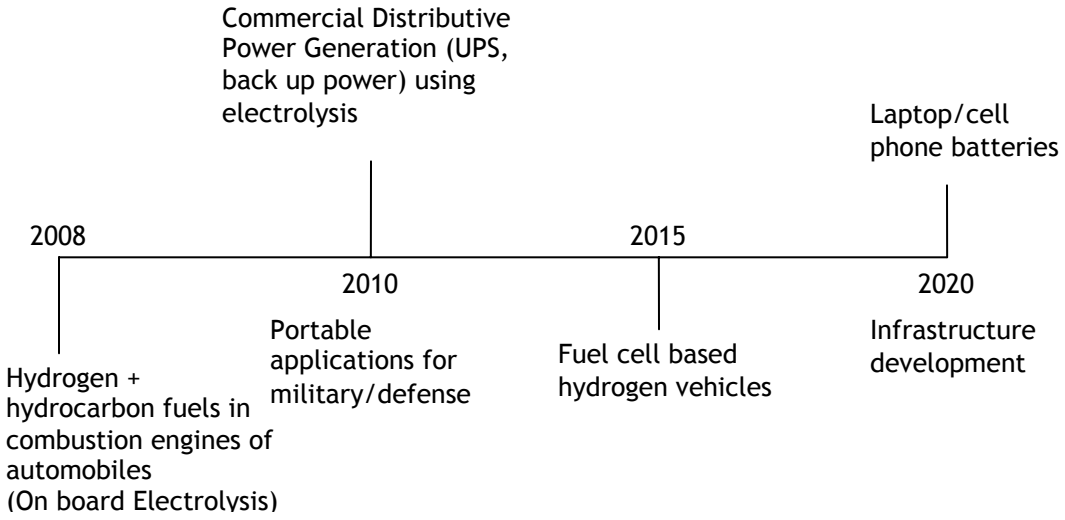
Some companies are contemplating on using solar power to break the water molecule to liberate hydrogen. PEM electrolysis and the solar hydrogen production are in the pathway to commercialization. These hydrogen production technologies find applications such as back up power sources and to power automobiles when used in concert with a fuel cell. There are technologies which produce hydrogen using electrolyzers in automobiles to feed internal combustion engines along with the conventional hydrocarbon fuels. This technology eliminates the need for fuel cells as hydrogen is generated as and when required by the automobiles.

Compressed and gaseous hydrogen storage technologies are anticipated to set trends in fueling stations or for on board vehicle storage. However, the success of these technologies depends on the development of hydrogen infrastructure and the development of internal combustion

engines for automobiles. Metal hydride and chemical hydride hydrogen storage technologies are proposed for portable applications like mobile phones, laptops personal digital assistants etc. The metal hydride technologies have to compete on the compactness and the chemical hydrides storage technologies have to prove its environment friendliness while recycling the reacted chemicals back as raw materials.

The research community is on its innovative path to propose solutions in hydrogen production such as solar reactors for co-producing hydrogen and carbon black, oxidative reforming of ethanol over platinum catalysts, solid state reactions, and solar energy. Hydrogen storage researchers are working on materials such as boron nitride, carbon nanotubes, dry sodium borohydride, nanoporous organic materials, nanoscale materials and nickel magnesium hydride batteries

By 2008, we should see a lot of automobiles using hydrogen (produced by electrolysis) along with the conventional hydrocarbon fuels in the internal combustion engines of vehicles. Backup power sources using electrolysis and military portable applications would become cost competitive by 2010. The following figure shows the time line of the evolution of various hydrogen powered applications.



Evolution of Hydrogen Powered Applications
Source: Frost & Sullivan

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Apart from the technological challenges, hydrogen has to compete on price with the conventional fuels in order to have a wide user base. The cost of hydrogen is proportional to the volume demand. If the demand has to be more, then the price has to be competitive. This gives rise to a catch 22 situation. However the technological advancements in hydrogen technologies and the fuel cells are expected to bring a balance between the above situations, and are likely to bring down the cost of these technologies.

Though the present state of hydrogen technologies might look bleak for commercialization in the near term, the future prospects are bright, as hydrogen's proposition as a fuel is unmatched by any conventional fuel. We have to accept the fact that the human kind has to be pushed to the brink to find an alternate fuel, which would drive the pace of commercialization of hydrogen technologies.

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