

HYDROGEN IS COMING

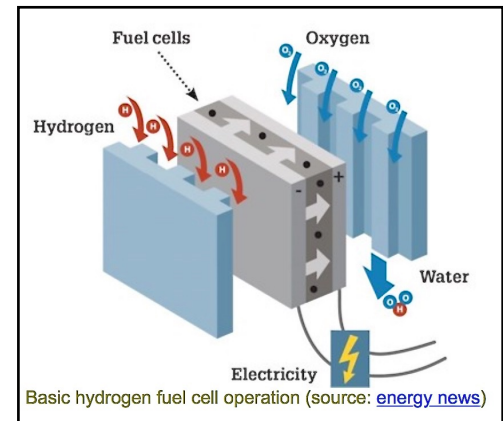
(And it won't be a Fly-by-Night Phenomenon)

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Hydrogen is the least dense of any element in the Periodic Table but among the most stable when combined with oxygen as a water molecule. Three fifths of the earth's surface is covered with salty ocean waters and the average depth is something like 12,000 feet.

Fresh water ice is retreating from temperate mountain glaciers and the high volume ice caps in Greenland and Antarctica. This is the result of changing climate. Ironically, melting these fresh water ice caps is raising the level of salty ocean water affecting millions of coastal residents and their infrastructure, while threatening many oceanic islands and other historic lowlands. Increased use of hydrogen could help slow this damage and various technologies are stepping in.

Increasingly, hydrogen has been used for both combustion and chemical purposes. It has been a combustion fuel substitute in cars that are specially-equipped. It has been added to methane gas lines experimentally up to 10% by volume, but current technology hasn't yet supported a higher percentage. It could be a valuable replacement at thermal power plants, but without a volume transported by pipeline, it's of limited feasibility. Hydrogen's next significant contribution may come from fuel cell technology. Since the earliest power needs of satellites and astronaut capsules, hydrogen has been used to supply fuel cells to make electricity (and oxygen).



Although there have been several aircraft that have flown without combusted fuels using Lithium-ion batteries to power an electric motor, there are exciting new developments. A larger, recognizable twin-engine DeHavilland Canada Dash 8 in the 50-passenger size has flown with one of its two props powered by a fuel cell electrically-driven engine. This soon to be approved FAA testing cycle in eastern Washington included post take-off operation on only the fuel celled

engine. The fuel cell 5-bladed engine is (above, left) and at right. And in the jet airliner category, Airbus Industries of Europe has promised a hydrogen combustion-fueled jet engine for one of three airliner prototypes by 2025.

This hydrogen conversion by aircraft will not be without significant challenges in both the combustion and fuel-celled uses. Hydrogen must be converted from other substances, and without pressurized pipelines to transport it and/or store it, the access



costs will be high, at least in the beginning. Liquid hydrogen is also a low density fuel, even when compressed. A pound of it will not yield the same thrust as a pound of Jet-A. Shorter flights operating with fuel cells or jet engines could see this compressed fuel occupying wing and center

fuselage locations. But longer range aircraft would have storage challenges that could affect weight and balance characteristics with limits for safe flight operation.

Whether moving toward the use of hydrogen for kinetic energy use is to reduce carbon emissions or just to be a bit greener with the earth—an important consideration will be just how green that fuel will be.

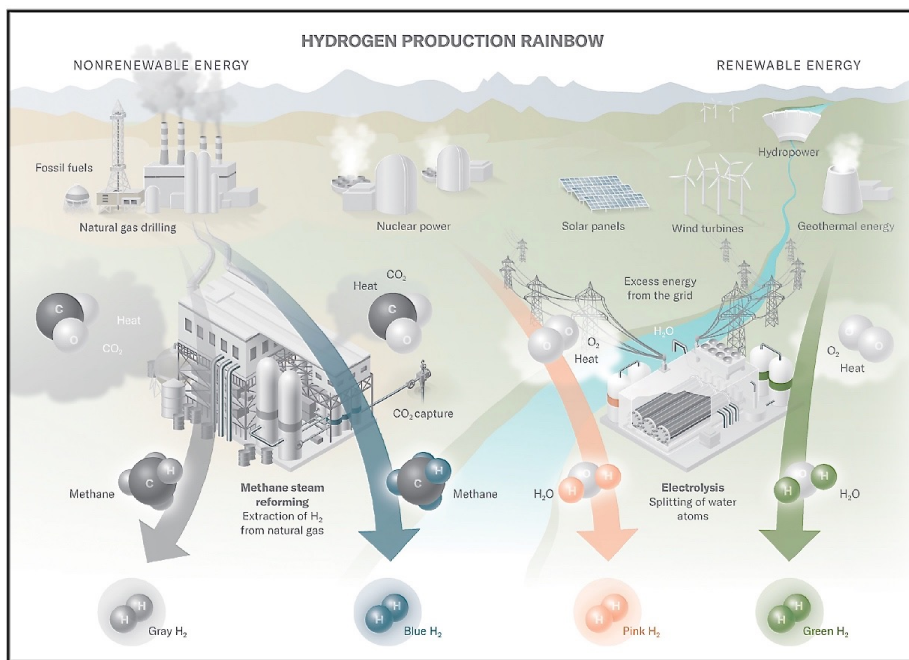
Hydrogen burned within engines or fed to fuel cells must be converted from something else. Will it be from refined or raw petroleum feedstock? Will it be by electrolysis (the separation of hydrogen and oxygen

from water using electricity)? And would that electricity come from petroleum feedstock, the Grid in general, from nuclear fission plants, or from solely renewable sources like wind and solar?

The choice of where and how hydrogen reaches its use points may come down to regulations by government entities or to cost, or both. How much shall we spend to be as green as possible? I will add this question, “How much is stopping the damage and dislocation from climate change worth to all of us?”

New technologies are the only way to maintain the standard of living we’ve enjoyed thus far, and hydrogen looks like a feasible path to improvement.

—Bill Martin



**Four paths to a non-carbon fuel.
Which one is the best choice?**

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