Fuel Cell Energy: Pros and Cons

http://www.triplepundit.com/2012/05/fuel-cell-energy-pros-cons/
http://www.greencarreports.com/news/1077558_hydrogen-fuel-cell-cars-still-important-automakers-say

There is no perfect energy source. Each and every one has its own advantages and compromises. This series will explore the pros and cons of various energy sources. Learn about other forms of energy generation here.

Although the idea of using fuel cells to power cars or provide electricity for buildings has popped up fairly recently, the fuel cell itself has been around for a long time. The principle was discovered by Sir William Grove in 1839, though practical devices did not appear until more than a century later. In the late 1950's Harry Karl Ihrig demonstrated a 20hp fuel cell powered tractor. Around the same time NASA began using fuel cells as a source of electricity for the space program, which led to significant improvements.

What exactly is a fuel cell? You can think of it as a battery that you add fuel to, in order to keep it going. The fuel, which is always combined with oxygen (or air) to produce electricity, can be as simple as hydrogen. This is the cleanest energy source we know of, since the only byproduct is distilled water. However, since neither of these two gases is found in nature in a pure state, they must be produced from some other source, such as air, water (through electrolysis), or hydrocarbon fuels (through reforming). Some fuel cells can run directly on hydrocarbon fuels. Hydrogen is not considered an energy source, but is instead called an energy carrier.

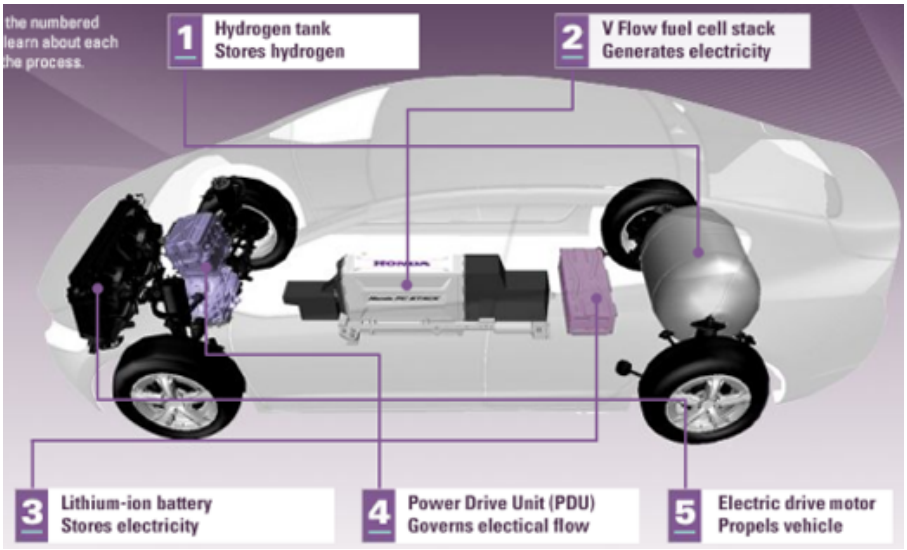
There are a variety of types of fuel cells, including: alkaline fuel cells (AFC), molten carbonate (MCFC), Proton exchange membrane (PEM) and solid oxide fuel cells (SOFC), phosphoric acid (PAFC), and direct methanol fuel cells (DMFC).

- AFCs were originally used in the space program, Performance is high, but so is cost.
- PAFCs were first generation fuel cells. Quite mature, they have been used to power buses as well as stationary applications. Cost is high and efficiency is relatively low.
- PEM fuel cells are often used in vehicle applications because of their fast response time. Cost is a factor as they use platinum catalysts.
- SOFCs used ceramics in their electrodes. They run at very high temperatures and do not require a catalyst. Efficiency is good but startup time is slow, making them unsuitable for vehicle applications. They are used in stationary power applications like the Bloom Box.
- DMFCs use liquid methanol as a fuel and is being developed for small applications like laptop and cell phone batteries.
- MCFCs are high efficiency, resistant to contamination and can run on hydrocarbon fuels. They run at high temperatures and are being developed for utility applications. Because of high temperatures, durability is often an issue.

Fuel cells that operate at high temperatures are well-suited for combined heat and power (CHP) applications, which increase their overall efficiency. This could be done at a large industrial scale, or at the residential level. Imagine having a fuel cell in your basement that would take in gas and use it to produce both electricity and heat, as well as hot water in a highly efficient manner.

Pros

- High efficiency
- Clean. Carbon free when using H_2 and O_2.
- Can use renewable fuels
- Do not need recharging.
- Can run continuously (as long as fuel is available)
- Provides base load power (good complement to renewables)
- No moving parts
- No noise
- Certain types are well suited to CHP applications
- Fuel can be made from water (which is abundant) or many other things
- Highly scalable–cell phones to power plants.
- Well suited for distributed generation, eliminating distribution losses.
- Can be run in reverse for energy storage, producing hydrogen from electricity and water
- Hydrogen fuel-cell vehicles vs. battery electrics: longer range (up to 500 miles vs. 300 miles) & quick refueling (5-10 minutes vs. 30-50 minutes for a quick charge to 80% of pack capacity).



Cons

- High cost due to expensive materials like platinum in Fuel Cells themselves
- Requires fuel
- Reliability still evolving.
- Durability, particularly at high temperatures.
- Robustness. Many are sensitive to temperature and contamination.
- Hydrogen fuel not readily available (costs $15/gge in Los Angeles area as of Dec. 2012)
- Little (but growing) infrastructure for hydrogen delivery
- Safety concerns with hydrogen (though it is less dangerous than gasoline)
- Low density of fuel, compared to gasoline
- Could become irrelevant if batteries got good enough
- Carbon footprint of hydrogen production itself
- Every U.S. citizen lives in a residence with electric power, meaning that battery recharging infrastructure is a solvable challenge rather than the million-dollar-plus cost of establishing a new hydrogen fueling facility from scratch
- Volume production isn't likely to arrive for a decade or so. By that time, will plug-in electric cars have become the established green technology or is there still a role to play for hydrogen fuel?

A great deal of research is still being done on fuel cells, so we can expect to see them continuing to improve, and quite possibly become a serious player in our overall energy mix.

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