Chasing Fuel Cell Advancements for Greater Competitiveness

Fuel cell vehicles have been a fascination of the environmental and automotive industries for some time now, with slow progress made in developing the right technologies for mass market, but nothing substantial has resulted from their efforts quite yet. There is hope, however, that current innovations in automotive fuel cell development may prove to be quite market-shifting as the costs for various components come down and the price of conventional fuels rise.

In fact, with the announcement of a strategic partnership between Daimler, Ford, and Nissan to develop hydrogen fuel cells, many have renewed excitement about bringing this technology to market. The goal of the partnership is to design a lower-cost vehicle in order to get the first vehicle into production by 2017, a very near-term goal.[i] Many other research projects are taking place, in particular with relation to creating lighter-weight chassis designs and adapting fuel cells to hybrid electric vehicles, as well.

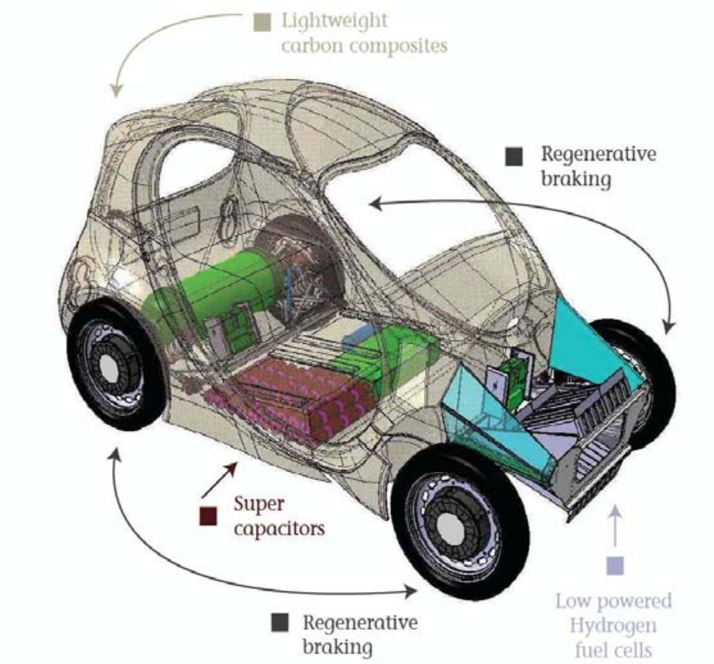
Better Chassis Design for Fuel Cell Integration

One of the challenges with fuel cell vehicles is that the conventional chassis design is too heavy and packaged around an internal combustion engine. Making a lighter-weight chassis that's a better fit for a fuel cell vehicle is one of the main initiatives in the industry today, and as such, there are many players working on developing a new design.

Microcab Industries Ltd. has been working on this problem for example. They have been in research mode for the past several years to produce a better design that is scalable for production. They've been focused on the design of a UK Royal Mail van, and have operational vehicles on the road since 2008, but are transferring what they've learned from that design to product a H2EV four seat car as well.

The design is based on a 65 kg Lotus bonded aluminum chassis that holds a 350 bar hydrogen store of 1.8 kg of hydrogen. The design also includes a 3 kW fuel cell, a 4 kWh lithium battery, and twin DC motors, each at 13 kW. The eight H2EVs that are road legal get top speeds of 55 mph and have a range of about 100 miles.[ii]

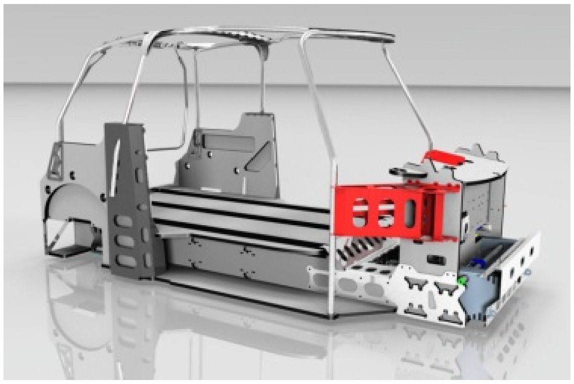
Another innovator in the field of chassis design for hydrogen fuel cell vehicles is Riversimple. They've developed a four-motor fuel cell vehicle (one motor per wheel) mounted on a lightweight chassis. They base their work around their concept of mass decompounding, which essentially refers to this process: a lightweight fuel cell engine needs a smaller chassis which means less power is needed which in turn means lighter components, and therefore a further chassis weight reduction.



Riversimple's hydrogen fuel cell vehicle

Riversimple's work has resulted in a chassis built with composite materials.[iii] Their current vehicle design applies lessons learned through the development of their concept LIFECar, which had a chassis design of the Morgan Aero 8produced by Qinetiq. In the long run, their goal is to produce a 34 kg chassis for a vehicle that gets 300 mpg (energy equivalent) and a 240 mile range.[iv]

The QBEAK, which is an electric car developed in Denmark by ECOmove, is already on sale and features a lightweight chassis made of 100% recyclable materials. This chassis is made with two aluminum sheets separated by a layer of ARPRO, a lightweight material already in use in other vehicles. This sandwich core provides high strength and high tensility to weight ratios.


ECOmove QBEAK electric vehicle with bio-methanol fuel cell

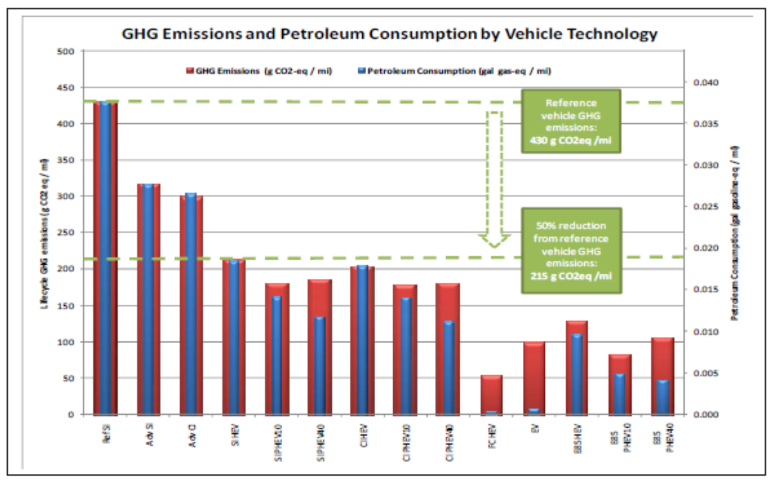
According to the company, not only are

these materials incredibly lightweight, they are also manufactured using less energy than conventional materials. And, with the addition of the ARPRO, the design has excellent insulation for heating/cooling energy savings and noise and vibration reduction. And in case anyone is worried that such a chassis would be unsafe, this combination of materials has been given a five-star safety rating by the National Car Assessment Programme (NCAP).[v]

The company touts the chassis as having isotropic energy absorption characteristics, intelligent inside design that can be reconfigured to seat up to six people, and an easily changeable design that allows for fast modifications for manufacturing.[vi]

There are big names working on the re-design of the fuel cell chassis as well. Consider Daimler, for instance. They have plans to put their third-generation F-CELL vehicle into commercialization and hope to start production on these new vehicles in 2017 using the improved chassis design employed in the B-Class vehicles of 2012.[vii]

Figure 1-1. Greenhouse Gas Emissions and Petroleum Consumption by Vehicle Technology



Source: http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/vt_mypp_2011-2015.pdf

Also of note is the world's first commercial FCEV by Honda, the Honda FCX Clarity. This vehicle has a custom designed chassis, though the company does not plan to mass produce this vehicle.[viii]

Advantages of Fuel Cells and On-Board Hydrogen Storage for Hybrid Electric Vehicles

Another angle being taken by many manufacturers and innovators is to create a way to apply fuel cell technology to hybrid electric vehicles as a way of achieving synergistic benefits. One of the major challenges of hybrid electric vehicles is range restriction; for fuel cell vehicles on the other hand, it's fueling stations. As such, combining the two technologies shows immense promise.

The advantages of marrying the two technologies are substantial. To start, fuel-cell hybrid electric vehicles (FC-HEVs) have a much higher fuel efficiency and lower emissions. This is due in large part to the way component sizes can be shrunk when the two technologies are combined. In hybrid electric vehicles, the higher range required the larger battery pack required. The weight of the larger battery back therefore drives down efficiency.

This close coupling of efficiency to weight makes electric and hybrid-electric vehicle design tricky. But if electricity produced by a fuel cell could be used to charge the battery of an electric vehicle, this could essentially decouple weight and efficiency.

Perhaps equally as important is the fact that FC-HEVs could run with virtually no restrictions on vehicle performance or driving range. As long as the fuel cell can continually recharge the battery, there's no limit to how far you can go. This removes the stress of driving range for the driver and creates a much more relaxed consumer experience.

Additionally, according to the US Department of Energy, fuel cell electric vehicles (FCEVs) have the lowest lifecycle carbon emissions of all the vehicles they have analyzed.[ix] As such, FCEVs could be the greenest vehicle technology possible, which is a notion that will gain importance as regulations for carbon emissions increase throughout the globe.

Though there is much more research that needs to be completed before FCEV technology comes to maturity and can be commercialized, many companies and organizations are optimistic about this type of vehicle. The US DOE, for instance, recently completed a seven year study to evaluate hydrogen fuel cell electric vehicles.

The study included tests that set a high level of technical performance for the 183 fuel cell electric vehicles deployed: 250 mile driving range; 2,000 hour fuel cell durability; and $3 per gallon gasoline equivalent for hydrogen production cost. In end, the high water marks were 2,521 hour durability for one team, and a driving range of 430 hours for another team.[x]

Yet this kind of work isn't only theoretical. A current example of how fuel cells and hybrid electric designs can be combined is ECOmove's QBEAK electric vehicle which uses a bio-methanol fuel cell that has a modular battery pack system. This allows the vehicle to be set up with between one and six modules for power each of which can hold 4.7 kWh of electricity for a total of 27 kWh of energy capacity. With six modules, the base QBEAK vehicle a 180 mile (300 km) driving range with top speeds of 120 kph (75 mph) with two 70 kW motors.

This range extender design, which is called the Modular Energy Carrier Concept (MECc) and is meant to be used with electric vehicles or hydrogen fuel cell vehicles, is based on the HTPEM fuel cell system with integrated methanol reformer. It runs on a methanol/water mix, with an onboard reformer that turns the methanol into a hydrogen rich gas. The methanol power system converts the fuel into electrical direct current charging the battery directly with very low conversion losses. It can also provide waste heat for cabin comfort.[xi] The end result is a very low total carbon footprint.

Conclusion

With the cost of fuel cell systems expected to fall by 90% by 2020, there is a real possibility that these vehicles will see rapid adoption worldwide in the not so distant future.[xii] Certainly advancements in chassis design and the combination of fuel cells with hybrid electric vehicles will go a long way to pushing the industry forward.

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A student of all things green, Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

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