HYDROGEN

THE FEASIBILITY OF HYDROGEN FUEL CELL POWER

When it comes to greener fuels, we know that hydrogen fuel cell technology is feasible, but is it commercially viable? Bernard Porter, director of low carbon vehicle programmes, Coventry University, investigates

Written by Bernard Porter, director of low carbon vehicle programmes, Coventry University

SWARM will put refuelling stations in Europe to support a fleet of more than 90 small and specially-designed fuel cell vehicles

Greener vehicle developments have been making good progress in the last few years, with improvements in both conventional and newer technologies providing meaningful benefits for users and the environment.

With many main vehicle manufacturers now adding electric or hybrid vehicles to their product ranges, and an increasing number of them aimed at commercial or fleet operation, there has been much reflection in government and elsewhere about the next steps in promoting their wider use. It will come as no surprise that fleet operations are seen as extremely important in this regard not only as a practical demonstration of their unique capabilities but also as a demonstration of their commercial effectiveness. Indeed, whilst general public acceptance remains a key objective for manufacturers and government, more can be done by showing green vehicles in actual use, and thus introducing them to a wider public.

ALTERNATIVE FUELS

So far, most of this attention has been either on hybrids using a combination of electric and conventional IC (internal combustion) engine propulsion, or on battery EVs. The plugged-in-places scheme has now arguably provided a base level of public charging points for EVs and whilst the EU may soon be pushing for more of these, there are a few other ways of using limited government resources to promote the use of cleaner vehicle propulsion.

Another contender is the use of hydrogen gas as a fuel. This has been much vaunted for a while now, and there are signs that things are about to become much more exciting. Hydrogen has many advantages as a fuel, and can even be used directly in an IC engine or, more intriguingly, in a fuel cell where it produces electricity. This sort of technology has been used in space and defence applications for some time. It was also (surprisingly) in common use as a combustible fuel for domestic heating and cooking, although not in transport applications, with 'town gas' being up to 60 per cent hydrogen, now replaced by natural gas of course.

In transport, the prospects for fuel cell vehicles appear to be gathering strength as governments in UK and the rest of Europe, particularly in Germany, see it as a good way to provide clean or zero emission vehicles. The UK government has repeated its expectation that vehicles will be available by 2015, and is committed to providing a growing infrastructure to support their use. Recently the industry-government partnership known as the UK H2 Mobility consortium published its first annual report with an upbeat message and plenty of recommendations.

These included a plan to roll out more refuelling stations to provide the necessary infrastructure. At present there are stations in some parts of the country, but many tend to be small scale and with limited access.

EUROPEAN HYDROGEN PROGRESS

Meanwhile a project funded by the European Industry group (Hydrogen Joint Undertaking) has started with partners across Northern Europe, including the UK. With the catchy acronym of SWARM, this project will put refuelling stations in Brussels, Bremen (North Germany) and Birmingham, to support a total fleet of more than 90 small, specially designed fuel cell vehicles, operating in local clusters. The UK end of this project involves two vehicle manufacturers, Microcab and Riversimple, two universities, Coventry University and University of Birmingham, as well as Birmingham City Council. French Industrial gas supplier Air Liquide is providing the refuelling stations, and the transport-grade hydrogen which will come from its existing industrial facilities. The project is now in the development and preparation phase and will see the deployment of the first of the trial vehicles from October 2013 and will last until October 2016, gathering data from many fleet users over 36 months. The main objectives of the project, which is classed as a large scale demonstration, are to establish and seek improvements in vehicle reliability, efficiency and cost effectiveness. Whilst the vehicle designs share some common characteristics, they are also sufficiently different to demonstrate a variety of powertrain architectures, and configurations. They are all however remarkably compact, lightweight and frugal in energy use.

Whilst the costs of fuel cells suitable for transport use remain relatively high, they are now on a steeply downward path, and ruggedness and durability are also improving. Engineers at the spin-out company Microcab and its associated research teams at Coventry University have been working with far-eastern fuel cell manufacturer Horizon and their UK distributors Arcola Energy to build their latest designs into the vehicle. With an eye on keeping the total weight down, maintaining high efficiency and providing a safe, controllable drive train, the work requires a wide range of technical skills. Indeed, providing trained technical staff and a service workshop will be part of the SWARM objectives too. ▶

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◀ DESIGN FROM SCRATCH

Many vehicle manufacturers have been running trials with hydrogen fuel cell cars for a while, and a few have been accumulating many hours of use. Mainly however these use a conventional base vehicle which has been adapted for the hydrogen system and electric drive. Although this can be made to work it is perhaps not the best way to approach the design of a low carbon vehicle. Microcab chief Professor John Jostins believes that there is a need to design and build a new class of vehicle around the fuel cell drivetrain. "This needs to embody the principles of lean weight technology in design and construction and keep the drivetrain as efficient as possible."

The current Microcab H2EV platform uses a bonded aluminium chassis built by Lotus which is light, strong and durable. This is married to a tough composite plastic body set. The drivetrain starts with a pressurised hydrogen gas storage system which then feeds the gas to the fuel cell, where it is converted (by reverse electrolysis) into electrical power and water, using oxygen from the air. This electrical power then turns the vehicle motors – hence in principle a fuel cell vehicle is an electric vehicle. A fuel cell is typically hybridised with a small lithium iron battery pack for dealing with the peaks of the drive cycle, allowing the fuel cell to be sized to provide average power over a duty cycle. The great advantage, of course, of the fuel cell powertrain is the speedy fill up time (typically three or four minutes). This allows for a compact tank, but with an estimated maximum range of over 180 miles.

Microcab has been designing fuel cell vehicles for more than a decade now and over that time refuelling infrastructure has grown but is still relatively scarce and, in many places, non-existent. For this reason in these early years Microcab has concentrated on urban vehicles, van and taxi fleet usage and back to base refuelling. It is highly feasible to set up a fleet of vehicles for a particular use (eg local delivery) in the vicinity of a hydrogen filling station. The users can then go about their business knowing that they will always be in range of their filling station. With a three minute fill time it is possible to return, fill up and go out again without the delay associated with long EV recharge. In that sense these vehicles are much more like conventional diesel vehicles. For the SWARM trial a key boost to hydrogen in the Midlands will be the installation of a forecourt-style hydrogen station in Birmingham. This will be able to dispense up to 200kg a day (the Microcab tank holds 1.8kg) so it can support over 100 fills each day and further fleets of vehicles around the station and the hydrogen economy will begin to emerge.

SERVICE AND MAINTENANCE

The other reason why fleets are important in the early stages is service and maintenance. There is a great shortage of low carbon vehicle engineers (be that EV or hydrogen) and when running these kinds of vehicle fleets, regular, good quality service and maintenance is a key issue to keep everything running smoothly. This requires skilled people and the government needs to support apprenticeships in this sector.

Coventry University is introducing training programs in these areas and the Microcab operation offers a live experience for trainees in getting to grips with what is essentially a very different engineering experience from conventional vehicles.

Prof. Jostins is also convinced that as we progress into the low carbon future, hydrogen and electric drives will become more commonplace but the changes we are seeing are not just about fuels and energy. The nature of mobility is changing, models of ownership are changing and attitudes to the car will not be the same as the last hundred years. He explains: "We buy a ticket for the train, we don't buy the train and elements of this relationship to our transport needs are shifting to the car with the advent of the 'pay by the hour' car clubs. Link this with the internet and digital systems and you end up with a very powerful system; 'the connected car' able to 'talk to its environment' and with increasing autonomy to decide what to do without the driver's input. This move towards Intelligent Mobility is surely destined to make a massive impact in the next hundred years of that fundamental need of human beings, to be mobile.' ■

FURTHER INFORMATION

www.swarm-project.eu

About the SWARM project

The European FCH JU funded project SWARM (Demonstration of Small 4-Wheel fuel cell passenger vehicle Applications in Regional and Municipal transport) will establish a large demonstration fleet of small passenger vehicles that builds on and expands existing hydrogen refuelling infrastructure. Three regions will be participating in this effort: the British Midlands, the Brussels area and Wallonia, and the Weser-Ems region in NorthWest Germany.

Each of these regions will deploy a new hydrogen refuelling site to close the gaps in a continuous 'hydrogen highway' that leads from Scotland via the Midlands to London, connecting to Brussels and on to Cologne and Hamburg/ Scandinavia/Berlin via Bremen.

The vehicles employed are low-cost, high fuel-efficiency, hybridised, light-weight passenger cars specifically designed for city and regional transport.

This project will deploy an unprecedented number of road vehicles for a demonstration project, with three OEMs contributing 30, 10 and 50 vehicles respectively. These will tested by real users in a variety of real-life operating

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