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Informing the fuel cell industry

2006 Light Duty Vehicle Survey

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Gemma Crawley, Fuel Cell Today

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Welcome to the first 2006 market survey from Fuel Cell Today. Since the first of the Light Duty Vehicle surveys, way back (!) in 2001, many things have changed, but some remain worryingly the same. There have been a number of very promising developments over the past twelve months but to put these in context we felt it was worthwhile starting with a quote from my predecessor, Mark Cropper.

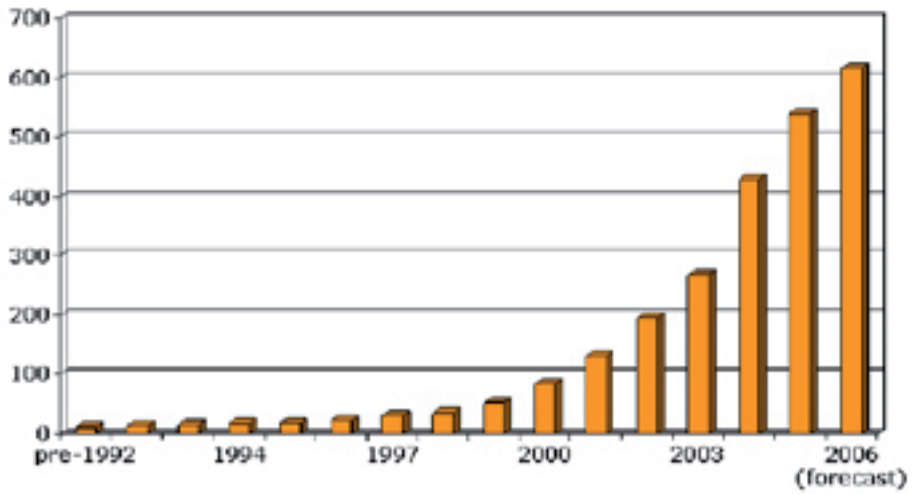
> "Activity in the sector has accelerated in the last few years,.... (since 1996)....the pace of development has accelerated rapidly, with more and more companies producing prototypes. This year, new prototype FCVs have been unveiled nearly every month, and automotive companies are also, notably, beginning to build prototypes in greater numbers for demonstration and testing."
>
> Mark Cropper, Fuel Cell Vehicle Survey, Fuel Cell Today, 19/12/2001

The aim of this is to remind the reader that although many good things have happened we cannot afford to take an increasing future market for granted.

As we predicted in the 2005 survey the actual number of new vehicles released over the last twelve months has slowed right down with slightly over 100 new vehicles appearing during 2005. This however, should not be viewed as a negative, but rather as an indication of the level of concentration on testing the fleets currently in action worldwide.

Picture 1: The good, the practical and interesting! Concepts cars from the 2005 Tokyo Motor Show. From left to right – Honda FCX, Toyota Fine-X and Suzuki Ionis

Figure 1: Cumulative Number of Fuel Cell Vehicles



Our forecast for the rest of 2006 reflects this with a fairly conservative prediction, based on our market information, which sees the total fuel cell vehicle parc by the end of 2006 sitting between 620-650 vehicles.

New vehicle releases have pretty much been limited to the concept cars at the Tokyo Motor Show. Honda was the first to announce its offering, with a concept version of its FCX fuel cell vehicle. The concept version uses the same fuel cell drive-train as the road certified version but sports advanced intelligent technologies, a low-floor and low-centre-of-gravity platform. More recently Honda has indicated that some of the concept car ideas are being further developed for its road FCX. Toyota opted for practicality whilst designing the Fine-X, which was designed with those of impaired mobility in mind, allowing easy entry and exit. Suzuki on the other end of the scale went for pure vision with the water inspired Ionis.

DaimlerChrysler joined in the fun and games to a certain extent by showing the F600 HyGenius (for ease of reading this is written in the rest of this report as HyGenius). Using Ballard stacks the fuel cell drive has an output of 86 KW (115 hp), consumes the equivalent of 0.4 litres per 100 km (97 mpg) and has an operating range in excess of 400 km (250 miles). The technical advances include a reduction in size by 40% and an improved cold start capability. The main change though has been the inclusion in the design of a lithium-ion battery, which stores surplus energy. The vehicle then chooses which is the optimal route to draw power, either the fuel cell and battery combined, as in for example acceleration, or just the fuel cell or battery.

Picture 2: the HyGenius B-Class FCV from DaimlerChrysler released at the 2005 Tokyo Motor Show

The main disappointment from this year has been the lack of obvious public development from GM. Another interesting example is the activity in Ford. Whilst we have seen some new vehicles from Ford there also has been no public development of the technology, at least for fuel cells.

Technology Type and Fuel Choice

This, unlike all of our other surveys, is still the area of least variation. Out of the total 2005 and 2006 new fuel cell vehicle parc we have identified only 1 vehicle that has not used a PEM stack with compressed hydrogen. The vehicle in question is from a company that we highlighted last year – Reva. The Indian medium sized enterprise is currently increasing its presence in the Electric Vehicle market and has been toying with fuel cell cars for the last few years. In 2005 they showcased a concept FCV with a Phosphoric Acid Fuel Cell that runs off methanol. The PAFC has been developed by Defence Research and Development Organisation (DRDO) and is intended for use in the Indian Armed Forces. It would not be a surprise if we see from this company a future two string development. One, mainstream with PEM units, as they have been until now, and another more specialist, such as the PAFC unit.

Interestingly one trend that appears to be slower than many first assumed is the uptake for trials of the high pressure storage tank. The 70 MPa (700 bar, 10,000 psi) tank was introduced in 2004 and since then has been seen in cars from DaimlerChrysler and Nissan, and surprisingly ThinkNordic.

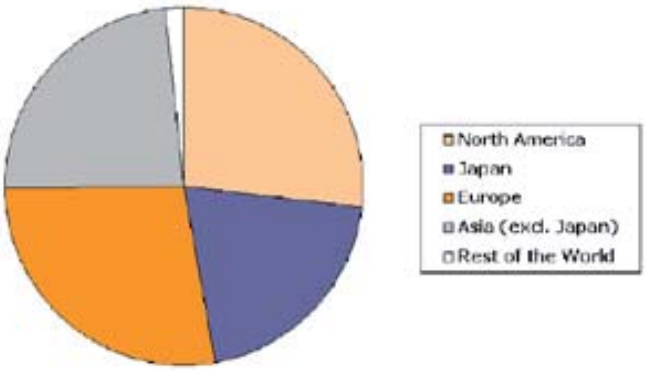
The project Th!nk hydrogen, which is supported by the Research Council of Norway, is a collaborative effort between Think Nordic, which is developing the vehicle and Raufoss Fuel Systems, a manufacturer of high-pressure storage systems. The production of the hybrid vehicle is scheduled for 5 this year and a further 15 in 2007. They will be used in various projects, including "Hynor" (more details on this later).

Region of Development and Use

As with each of our surveys we measure the region the units, here the vehicles and not the fuel cell stacks, are developed in and again where the vehicles are currently being used. That is increasingly becoming something of a detective chase as a number of the vehicles are either moved, scarped or basically re-launched. At this point we have to say thank you to our industry contacts for helping us keep track of the vehicles and assign the right number to each manufacturer.

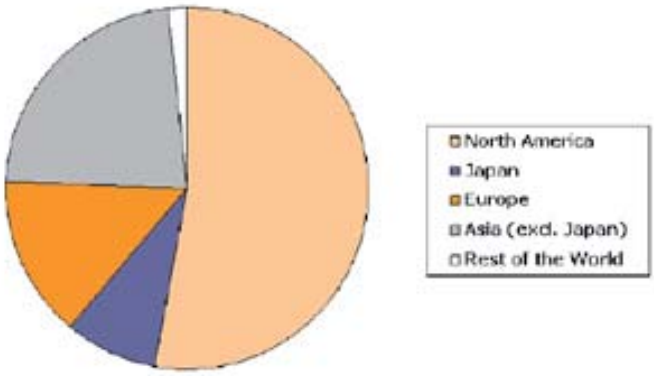
In development terms what is clear straight away from Figure 2, on the next page, is the fairly equal balance between Asia (not includin JSA and Canada together). This is certainly a shift fr hrysler dominated the market.

Figure 2: 2005 Region c



Turning to where the vehicles are currently in use then North America returns to dominance. This mirrors the chart we saw in 2004, for North America, but over the last twelve months we have seen the market share of both Europe and Japan decrease, with Asia increasing in strength. It is increasingly worrying that Europe seems to be strong in manufacture but weak in adoption of fuel cell vehicles. Apart from Berlin, and recently the HyPark project (both of which will be returned to l tration in Europe.

Figure 3: 2005 Region of



Regional Development

The 2005 survey introduced the idea of hotspot development. These are areas that have stopped waiting for the lead from central government and have instead taken the initiative to develop integrated fuel cell and hydrogen projects in their own back yards. Last year we focused on California and Berlin. Since this survey we have seen the launch of either plans or actual implementation of a range of other vehicle projects. Below is an outline of Hypark and Hychain, in the EU and the Vancouver Fuel Cell Vehicle Programme.

Hypark was an area set aside during the Turin Winter Olympics of 2006 in Italy to demonstrate the potential of hydrogen and fuel cells in Italy. Though it is unclear as to the longer term aims of the project, in the short term it seemed to have achieved an impressive amount. As well as demonstrating a fuel cell scooter fleet (which will be covered in the Niche Transport Survey Vol 1, due in July) it also attracted a small fleet of Fiat Pandas. The Panda fuel cell vehicle was first rel t been seen very often since. This year Fiat seem to have rejoined the f technology, with a new Andromeda II fuel cell stack, and announ ment with Nuvera.

Photograph 4: The Fiat Pa nter Olympics in 2006.

HyChain is another European Union project aimed at showcasing the entire hydrogen supply chain, from fuel production, distribution through to use. As well as other transport types the aim is to also include a small number of fuel cell vehicles.

Vancouver Fuel Cell Vehicle Programme

The Vancouver Fuel Cell Vehicle Programme (VFCVP) has attracted a lot of attention as the first Canadian demonstration project for fuel cell cars.

The VFCVP vehicles will be driven during a 3 year period by selected users in their everyday life. It is estimated that each vehicle will travel around 12,000-15,000 km per year. All the drivers will have to be trained by Ford, which will supply around 30 cars, on various issues including fuelling and basic operations. One of the fuelling stations fully equipped for fuel cell vehicles is at the Vancouver Fuel Cell Innovation Centre where these vehicles will also be serviced by a Ford-trained technician. Additional stations will be available on the Hydrogen Highway, a network of hydrogen production and refuelling facilities that is aimed at early deployment of the technology.

Although initially this programme was launched in 2004 it was not until summer 2005 that the first Ford fcv's arrived in the city.

The Competition

Included in this year's survey, for the first time, is this short section on the competition. In this respect we are not looking at increased efficiencies and the continued evolution of the current paradigm of petrol / diesel internal combustion engine (ICE), though this most certainly does represent competition. What we do cover is hybrids, batteries and hydrogen ICEs.

With any new technology it is all too easy to ignore the competition and assume the one you are backing is by-far-

and-away the best, and obvious, choice. For fuel cell vehicles not only is the current technological suite still continuously improving but a growing number of car manufacturers are looking at other options. For here the main two "others" are the continued adoption of hybrid technologies and the development of the hydrogen fuelled internal combustion engine.

Hybrids, depending on who you listen to, are rapidly becoming the consumers' darling, or fast falling out of favour with the very same consumer. What we do know is that sales of hybrids are continuing to grow and now all major automotive manufacturers have some form of hybrid programme. What seems to be becoming clear though is that hybrids are not, as first thought, a direct competitor to fuel cells but instead are a technological stop-gap until fuel cell vehicles. They may therefore in fact be buying time for companies to further develop the fuel cell product. If though you are of a more cynical bent you may also read into this a delaying tactic.

The internal combustion engine fuelled by hydrogen is also a tantalising option and one that could pose more of a threat to fuel cells than hybrids. The consumer, when adopting one of these cars, will only have to switch fuels, something that we have historically seen is possible with enough price incentive. BMW have released plans to put dual-fuel 7 Series vehicles on the road in two years time. Mazda are already leasing its version of a hydrogen ICE. Ford is also very active in this area but so far has given no dates for a commercial product.

With the development of high pressure hydrogen storage tanks the main barrier to adoption of these vehicles now is the refuelling question and this is being addressed across a number of countries (The Fuel Cell Today Hydrogen Infrastructure Survey will be published at the end of May).

For fuel cell vehicles though there is still a list of development issues, hence the 2015 – 2025 timeline currently given. Predictions though of the rate of adoption of fuel cell vehicles seem sometimes to be based on ignoring the competition – this could be foolish in the extreme.

Discussion

As with last year the discussion is split into three different aspects, the manufacturers, the political support and the consumer.

The Manufacturers

In the last 12 months many of the automotive manufacturers have been particularly verbose regarding alternative vehicle development and fuel cell programmes. Interestingly, most of the major players have cited 2015 as the breakthrough year for mass market fuel cell vehicles with full commercial potential being realised by 2020. This information is tabulated for ease of comparison below.

Table 1: Fuel Cell Vehicle Manufacturers' Current Timetable for Launch

Manufacturer	Year	Numbers	Notes
DaimlerChrysler (Germany)	2012		Initial launch,
	2015	10,000	Mass Market
Ford (USA)	2015		"commercial readiness"
GM (USA)	2010-2015		Commercial viability
	2025		Mass Market
Honda (Japan)	2010	12,000 (in USA)	Start production
	2020	50,000 (in USA)	
Hyundai (Korea)	2010		Road tests 2009
Toyota (Japan)	2015		Will cost US$50,000

It is however, not yet clear if this is a truly independent view from each individual organisation or a reflection of herd activity with one or two companies brave enough to name a date and the rest following suit. As such, statements concerning production dates should perhaps be treated with a certain amount of caution - again.

On a similar note, there remains a degree of uncertainty regarding the level of commitment to fuel cell vehicle development from some of the auto manufacturers. It is unclear which of the companies are pioneering the technology and which are simply following the crowd. In addition, the level of faith in fuel cells as a single answer to clean vehicle technology is also clouded. Ford, for example has been careful to hedge its bets as can be seen through the company's mixed approach of hybrids, hydrogen and fuel cell vehicles.

As anticipated, activity from the Korean manufacturers has been particularly strong. This is a reflection of robust government backing and strongly forged relationships between industry and government which are driving the fuel cell business forward in this region. Despite a very modest approach towards publicising research and development activities, we believe that going forward China will emerge as a particularly interesting area for growth and manufacture. In the next 2-3 years development in this region is anticipated to be very promising.

The profile of the fuel cell automotive sector has changed several times over the last year. As one company increases its activity and public profile another becomes more withdrawn from public arena. It is likely that this trend will continue throughout 2006 as development and demonstration programmes operate and the industry waits to see which company will become the market leader.

Political Support

Political support is becoming more and more of a complex issue with different reactions, caused by different drivers and funding mechanisms, in various geographical regions.

In Europe at first glance although support for fuel cells is gathering pace, support for fuel cell vehicles seem to be a bit hit and miss. We have a growing number of regions launching either high profile projects or grand plans but the majority of these seem to have either none, or very few fuel cell vehicles involved. The support though for other forms of vehicles, buses, scooters, wheelchairs etc is rapidly on the increase. One partial explanation seems to do with bottlenecks. Though it is easy for a government or state policymakers to declare a desire to have a fuel cell vehicle fleet, getting them appears to be harder. We have even heard remarks of waiting lists for a fuel cell car. This particular barrier to entry for other forms of fuel cell transport is significantly lower. That is not to say that they do not have other barriers, but the numbers bottleneck is a lot less. The other is purely financial. With the EU funding structure a total project budget is funded and has to include a serious amount of "bang-for-your-buck". Fuel cell vehicles, though good PR, eat up a lot funding Euros, whilst fuel cell scooters, boats and even buses not only earn the project good press coverage but gains a substantial amount of favour with local policy makers – their city, state etc being seen to be moving on sustainable development.

We fully expect to see a continuation of this trend at European Union level at least, for the foreseeable future with the launch of HyCom. This call aims to fund a small number of Hydrogen Communitues (HyCom) across Europe which build, adopt and use fuel cell products and hydrogen right across the spectrum. Here though it would be remiss of us not to mention the recently announced plans for the capital city of England, London. With the 2012 Olympics coming to over here plans for fuel cells (and hydrogen and renewables) in all there varied forms have been given a boost. Part of this was is the plan to bring 70 fuel cell vehicles to the city by 2010. Though we are not yet sure of the total breakdown of the 70 we do know that a proportion of these will be fuel cell vehicles. About time to!

In North America projects seem to be far more segregated between transport and stationary. Also transport projects are almost exclusively light duty vehicle driven, though now sometimes there is also an odd mention of buses. The prime example of this is the California Fuel Cell Vehicle Partnership which has recently announced plans to add another 300 vehicles (cars and buses) to its fleet by 2007. Support in the North America seems to see fuel cells in separate markets; fuel cell vehicles in one, stationary in another and portal, if at all, in another. This can be seen to be driven, at least partially, by the funding stream, where fuel cell vehicles fall under the Freedom Car funding stream, portable often is looked at by the Department of Defense and stationary by the Department of Energy.

This shows two extreme forms of political support with many other countries varying on a scale in between. There certainly does not appear to be one winning combination of political support but having larger than life champions cannot be a bad thing.

Consumers

It has certainly been a very interesting year for fuel cell vehicle development and the consumer. As well as the Spallino's being handed the very first public fuel cell vehicle, and the advert going out for a British counterpart, we have seen a JD Power survey being released which claims that consumers are openly considering fuel cell vehicles as the next option after hybrids.

What we cannot judge, as of yet, is the level of patience of the consumer until the mass market launch date. If it is pushed back any further we could risk seeing a market that is dominated by hybrids and hydrogen ICEs and not fuel cells.

In summary this past year has seen both positive and negative aspects of this market. Although numbers are down, as we predict will continue to stay low until at least the end of this year, we are seeing high profile success stories from the vehicles on the road. In a recent interview for NPR with Mr Spallino he commented that ""I get a lot of interested looks and comments from people not only at the office but at the soccer field and in the grocery market parking lot," he says. "I get people asking me to roll down the windows and saying, 'Are those for sale?' 'Can I buy one of those?'".

Other issues though are the 2012 debate. If this turns out to be another over hyped 2004 launch date then the backlash from consumers and policymakers could severely hamper, if not critically damage, the future of fuel cell vehicles.

Key Players

As with all of our surveys the following section provides an outline of the activity of the main players over the preceding twelve months.

During the last twelve months Agni (Malaysia) presented its Renewable Energy Automobile (REAL) fuel cell car. The vehicle runs on direct hydrogen and is the first Malaysian fuel cell powered vehicle ready for use. The company claims to have signed several Memorandums of Understanding in Europe, Asia and the USA to produce 50 cost effective fuel cell vehicles. It must be noted though that this claim has gone very quiet since it was made and we have seen, or heard, nothing on the MoUs signed or further development activity in this area by Agni.

Bajaj Auto (India) has worked with Energy Conversion Devices to produce a hydrogen powered autorickshaw. The three wheeled vehicle has been operating on roads in Michigan and is one of only two such vehicles in the world.

BMW (Germany) has hinted that the company will begin hybrid production by 2010 in addition to signing an agreement with General Motors and DaimlerChrysler to develop hybrid vehicles. BMW has a long standing arrangement with Delphi to develop SOFC auxiliary power units (APUs) for light duty vehicles. Recent results from Delphi indicate that this programme is still alive and show a multi-pronged development track by BMW.

Based on the Daihatsu Tanto vehicle, Daihatsu Motor (Japan) announced a fuel cell car with a range of 160km at the Tokyo Motor Show in Nove

Photograph 5: The new Daiha

In 2005, Clean-Tech (USA) ordered 150 units of Valence Technology's (USA) U24 and U27 U-Charge power systems for use in its electric fuel cell hybrid all-terrain vehicles. An initial fleet of vehicles is being used for tours of the North Carolina coast.

DaimlerChrysler (Germany/USA) has provided several F-Cell vehicles to various groups in the past 12 months. The company delivered one car to the University of Berkeley's California Partners for Advanced Transit and Highways Group, a further three vehicles to California's Air Resources Board and another five vehicles to Los Angeles Airport (LAX). The models at LAX make this the only US airport to participate in Daimler's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project which was awarded to the company by the DOE. LAX can also boast of its own hydrogen fuelling station on site to service the vehicles. Daimler also provided two F-Cell vehicles to the University of California, Los Angeles forming part of the 100 vehicle fuel cell fleet announced by the company in 2006. Furthermore, DaimlerChrysler presented two F-Cells to Sacramento Municipal Utility District and three models to the Pacific Gas and Electric Company in the US. The gas company expects to drive a minimum of 35 miles per day per vehicle.

Aside from adding vehicles to its ever expanding fleet, DaimlerChrysler has had a very active 12 months. The company announced plans to sell 100,000 fuel cell vehicles per annum by 2015 with full market penetration by 2020. To help achieve this goal, researchers at Daimler announced the capability to lower the engine fuel consumption by 10% in the F-Cell vehicles. This relates to the car requiring only 1Kg of hydrogen per 100Km (~3.4 litres of diesel). This development has consequently improved the range of the vehicle from 140Km to 230Km. The F-Cell vehicle employs Ballard fuel cell stacks. In the last 12 months Daimler, along with Ford, has purchased Ballard Power Systems, the German subsidiary of Ballard which integrates stacks into complete fuel cell systems.

Finally, DaimlerChrysler's Mercedes-Benz premiered the F 600 HYGENIUS fuel cell vehicle at the Tokyo Motor Show in October 2005. The vehicle uses 2.9 litres of hydrogen per 100Km, has a range of 400Km and is reported to be around 40% more compact than previous models. The fuel cell used for the HYGENIUS was developed in-house after previously having purchased stacks from Ballard. In addition, Mercedes has designed the vehicle to act as a mobile power source which can provide a total of 66kW of electric power to several homes.

Erdgenossische Technische Hochs[illegible]nt fuel cell vehicle was reported to have achieved a record 3[illegible]005 using 1.75g of hydrogen to travel 25.3Km. This performance[illegible] true.

Photograph 6: The sleek and futu[illegible]

Fiat (Italy), in conjunction with Nuvera, plans to begin demonstrating Panda Hydrogen fleets in 2006 and operate more extensive test programmes in conjunction with the European Union and Italian Ministries and Regions as the year goes on. As with many of the other auto companies, the hope is to achieve full market commercialisation in

15-20 years time.

In the past 12 months, Ford Motor Company (USA) has delivered a number of fuel cell vehicles across the USA. In September 2005 five hybrid hydrogen Ford Focus fuel cell vehicles were given to the Florida Department of Environmental Protection as part of a five city 30 car programme to demonstrate the real world applications of fuel cell vehicles. This was followed in October 2005 by the delivery of a further five cars to Michigan as part of the same scheme. Throughout 2005 Ford also delivered five of its fuel cell Focus cars to both Vancouver and California. In terms of technical development, Ford presented a motor designed to run on hydrogen, ethanol or petrol at the Detroit Auto Show in 2006. The engine can be switched between any of the three fuels at the push of a button. Ford has projected the company will aim to offer reasonable priced fuel-cell vehicles to customers after 2010.

In the early part of 2006, General Motors (USA) announced that the company visualises commercially viable hydrogen cars by 2010-2015 with mass market penetration by 2025. GM expects to get its first emission-free vehicles into dealerships in the next four to nine years. A spokesman for the company also announced that GM anticipates it will be able to "equal or better gas engines in terms of cost, durability and performance" once it is able to produce a volume of at least 500,000 vehicles a year.

Taking a step towards achieving this goal, the company has undertaken many demonstration and test projects over the last 12 months. During 2006, GM will provide 13 fuel cell powered vehicles to the New York City Metropolitan area for which Shell will provide the State's first hydrogen filling station. Under the US Department of Energy's Infrastructure Demonstration and Validation Project this programme will make GM and Shell the only companies providing fuel cell vehicles and fuelling stations to New York. The fleet of 13 vehicles will form part of the 40 vehicles GM has been commissioned to build under the DOE programme. Other fleets will be introduced to California and Detroit whilst the Washington D.C. fleet will be expanded from 6 HydroGen3 units.

Elsewhere, GM Daewoo will endorse the use of the HydroGen3 vehicle at the Korean APEC CEO summit for economic and business leaders to shuttle participants between venues. After the event has concluded the vehicle will remain in Korea and be [illegible] te fuel cell technology in this region. In addition, the [illegible] Russia to develop materials, catalysts and hydrogen [illegible]

Photograph 7: Genera [illegible]

On a more negative note, GM has decided to end its seven year joint research programme on fuel cell powered vehicles with Toyota as the technology moves from the research stage to propriety development and commercialisation levels. Both companies will continue to independently develop fuel cell vehicles and will continue to collaborate on such issues as safety and industry codes and standards.

Honda (Japan) has been leasing its FCX fuel cell vehicles since December 2002 and has announced plans to launch a fuel cell vehicle on the global market within three or four years. The vehicle is anticipated to be based on the FCX Concept, which was exhibited at the Tokyo Motor Show in October 2005. Furthermore, the company hopes to make its fuel cell vehicles commercially available to the general public within 10 years quoting potential sales

figures of 50,000 vehicles in the USA annually by 2020 with sales of 12,000 per year in this region in the early 2010s.

In order to achieve these goals, Honda has not only developed start up of its fuel cell system from below freezing but has increased the current range of the FCX to 270 miles. Elsewhere, the company has developed a way to expand the storage capacity of compact hydrogen by developing a new hydrogen absorption material which allows tank capacity to be doubled and is researching the possibility of system operation at temperatures as low as -300C. To demonstrate its fuel cell vehicle, Honda has been leasing a FCX car to a Californian family of four. As part of the automotive industry's first private test of fuel cell vehicles, the Spallino family use the FCX to get to work, school and anywhere else they wish to travel, providing feedback on the performance of the vehicle to Honda. Only 20 similar cars to the one involved in this trial exist in the United States and Japan. Following the successful US trial, Honda has announced plans to offer a British family the opportunity to run the FCX hatchback.

In Japan, the Honda FCX received motor type certification from the Japanese Ministry of Land, Infrastructure and Transport. The certificate is for vehicles intended for public sale and the award also marks the first time that a government body has enacted safety and environmental standards for a vehicle powered by pressurised hydrogen.

Together with Natural Resources Canada, Hydrogenics Corporation (Canada) sponsored a team of students who went on to win General Motors Challenge X competition in June 2005 with a fuel cell powered vehicle design. The students were the only team to use fuel cells for vehicle propulsion.

Working with Azure Dynamics, Industry Canada's Technology Partnerships Canada programme and Natural Resources Canada, Hydrogenics delivered a hydrogen fuel cell hybrid electric vehicle to Purolator Courier, Canada's largest overnight courier company. The fuel cell vehicle was presented along with 10 hybrid electric vehicles.

In the last 12 months, Hyundai (Korea) has revealed plans to release a fuel cell powered version of the company's Tucson sports utility vehicle by 2010 with road testing taking place in the USA in 2009. Hyundai has also forged a partnership with the Alameda-Contra Costa Transit District (AC Transit) whereby the company will provide 10 Hyundai-Kia fuel cell electric vehicles to the Californian public transport group which will then undertake a five year study to demonstrate, evaluate and validate the fuel cell technology. The first of the 10 vehicles have already been delivered to AC Transit and two additional Tucson FCEV models are expected in early 2006. The fleet will be completed when six Kia Sportage FCEVs are presented to California in late 2006/early 2007.

In February 2006, Mazda (Japan) received permission from Japan's Ministry of Land, Infrastructure and Transport to commence leasing its RX- both hydrogen and gasoline. Mazda has already s to add another eight vehicles to the fleet leasing t panies.

Photograph 8: Mazda's Hy

At the start of 2006 Nissan (Japan) announced that testing is to begin in Japan on the latest version of its company's X-Trail FCV. The vehicle is powered by a fuel cell stack which Nissan has developed to be approximately 60% smaller compared with the previous stack used with the 2003 FCV model. Testing will also take place in Canada around the Greater Vancouver area and it is anticipated that the vehicles will be tested in a number of environ-

ments and drive cycles. Nissan has given no indication as to when the company intends to produce mass market numbers of fuel cell vehicles.

This year has seen Nuvera Fuel Cells (Italy/USA) signing a multi-year agreement with Fiat Powertrain Technologies and Centro Ricerche Fiat to develop a hydrogen propulsion system for fuel cell vehicles. The agreement marks an exclusive supply deal between the partners and the Fiat Group for the new powertrain. Under the deal, the companies plan to combine the new Nuvera Andromeda II fuel cell stack with systems developed by the other partners. As a result of the research work, Fiat unveiled the Panda Hydrogen car at the Hydrogen Olympics in Turin (which ran simultaneously to the Winter Olympic Games). This is the first vehicle to incorporate Nuvera's Andromeda II stack. The vehicle has a range of approximately 200Km and it is reported that refueling takes less than 5 minutes.

Porsche (Italy) continues to work with Volkswagen and Audi and like many of the auto companies, looks towards 2010 as a production date for its hybrid vehicles.

PSA Peugeot Citroen (France) unveiled the Genepac fuel cell unit designed to be used in light duty municipal vehicles. The 80KW unit is roughly the size of a big suitcase and can run for approximately 500Km. PSA continues to work towards reducing the size of the system, tackling problems encountered with cold start-up and halving the cost of the unit by 2010. Also in the last 12 months, PSA Peugeot Citroen announced a development programme with Intelligent Energy (UK) to integrate Intelligent Energy's PEM fuel cell systems within PSA's electric vehicles. The vehicles are to undergo track and road testing in France and England. The collaboration is being supported by the UK's DTI under the New and Renewable Energy programme.

Quantum Fuel Systems Technologies (USA) continues to manufacture only Toyota Prius hybrid electric vehicles that can be individually converted to hydrogen electric power. Quantum has begun to sell fleets of vehicles including five cars to the City of Ontario as part of a US$7 million clean air programme. In addition, Quantum began operating a hydrogen vehicle fuelling station in the USA in January 2006. The hybrid vehicles cost between US$80,000 and US$100,000 each and hydrogen is charged at around US$4.50 per kilogram at the fueling station.

Reva Electric Car Company (India) and Indian Oil Corporation (IOC) are jointly working towards the production of two fuel cell vehicles. The hydrogen cars will be equipped with stacks from Hydrogenics Corporation of Canada and after the initial two vehicles have been produced a further 10-20 cars will be commissioned. IOC will provide the hydrogen fuelling infrastructure and test facilities for the vehicles. Reva is also developing hydrogen powered fuel cell hybrid vehicles with India's Defence Research and Development Organisation (DRDO). Reva is very active in developing and marketing alternative vehicles and has so far sold 2,000 of its electric cars in India and Europe.

Although Rolls-Royce (UK), owned by BMW, has not actively produced any fuel cell vehicles in the last 12 months, the company's CEO was reported as saying its engine technology is proven and as soon as fuel storage and distribution problems are overcome the company would not rule out the addition of a hydrogen powered vehicle to its fleet.

SAIC Motor (China) has announced plans to release 1,000 fuel cell vehicles into commercial operation in 2010 and is stepping up research of its models.

Sonalika Group (India) is a subsidiary of International Cars and Motors, this Indian based company has announced plans for a hydrogen hybrid vehicle for use in India by 2008. The company is working with Banaras Hindu University to develop the vehicle which should also be able to run on conventional fuel.

Targeting the year 2012, Suzuki (Japan) announced a next generation platform which can be used with either fuel cells or gasoline vehicles.

Think Nordic (Norway) received a grant from the Research Council of Norway to partly fund the production of a prototype fuel cell/electric hybrid vehicle with its partner Raufoss Fuel Systems. Raufoss Fuel systems will provide a 700 bar hydrogen storage system for the vehicle and the fuel cell stack will come from Hydrogenics. The companies plan to produce a further 5 vehicles in 2006 and another 15 in 2007.

Toyota (Japan) has had a very mixed 12 months in terms of fuel cell development. The company's hydrogen fuel cell powered Kluger V SUV became the first such vehicle in Japan to acquire motor type certification from the Japanese Ministry of Land, Infrastructure and Transport. Shortly before this award was made, the company announced plans to reduce the cost of its fuel cell vehicles from over US$1 million to US$50,000 by 2015. Furthermore, Toyota has been working towards apply d now has eight units operating on tourist routes across Japan. A further de City of Irving in California and the city has become the first in the US to test

Photograph 9: The Toyota FCH

However, Toyota insists that it will not be drawn in to a race to be the first company to mass produce fuel cell vehicles despite being the world's first auto manufacturer to market vehicles in 2002. The company has released no timescale indications but has stated that all of its vehicles will eventually be run on hybrid gasoline-electric motors. In the summer of 2005 Toyota had to recall 14 of its older FCHV models which were leased between December 2002 and June 2005 in Japan and the USA as one of them was found to be leaking hydrogen from its tank in August 2005.

. . . . . .

Other companies involved in fuel cell vehicle research but which have not been discussed here are: AvtoVaz (Russia), Morgan (UK) and Suzuki (Japan). Also BMW (Germany) which is working on fuel cells as APU units for the internal combustion engine.

About the authors

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