FuelCellToday®
Informing the fuel cell industry

2006 Bus Survey

Dr. Kerry-Ann Adamson, Gemma Crawley, Fuel Cell Today

- December 2006

Introduction

It has now been two years since the last Fuel Cell Today bus survey was produced. Although the numbers have not changed dramatically in this time (many of the buses currently in operation were introduced several years ago when demonstration programmes began and since this time very few new vehicles have been produced), there have been several press releases detailing forthcoming programmes and new projects in this sector.

Despite the numerous announcements from bus manufacturers and companies involved in this area, the Fuel Cell Today team can verify less than five new buses actually manufactured and placed on the roads in 2006. For this reason we have taken the decision to focus on announcements and forthcoming activity in this survey rather than looking at numerical developments and data from 2006.

The announcements which have been made in the past year have detailed some encouraging trends for the bus industry looking forward. There have been several press releases detailing forthcoming joint ventures and collaboration projects for the design and manufacture of fuel cell buses and the analysis of various demonstration projects (especially the Clean Urban Transport for Europe, CUTE, scheme) has proven the initial trails to be hugely successful. In fact, programmes like CUTE have provided not only excellent data regarding the performance and operation of fuel cell buses in real world situations but have also raised public awareness of the technology tenfold. For example, in London (one of the nine participating CUTE cities) commuters have been known to let a tradition bus pass and wait for the fuel cell bus to transport them across the city, preferring to ride on the fuel cell service.

One of the most notable trends in the past twelve months has been the increasingly global development of fuel cells for bus applications. Traditionally, fuel cell development and end use tends to be concentrated in one or two specified geographic locations (for example, North America and Europe). However, for bus development and use it would appear that this is a much more global sector. Announcements from Europe, North and South America and even locations as far a field as Bethlehem have dominated fuel cell bus news proving that this application is truly a global one.

In terms of demonstration programmes, 2006 saw the CUTE project come to a close. Thanks to the success of this scheme, the initiative will be extended in the form of HyFLEET:CUTE and this has been detailed at a later stage in the survey. Other demonstration projects continue to generate some excellent performance data and yield useful operational experience for drivers, maintenance workers, infrastructure provides and fuel cell and bus manufacturers.

Looking forward, although it may be easy to be disheartened by the lack of new vehicles on the road in 2006, the number of announcements made in the past year indicates that figures may be on the up in 2007-2008. Fuel cell buses have proven to be a successful and popular means of mass transport and have been demonstrated in many varied ways (from mass commuter transit in London to shuttling passengers around Germany during the football world cup). The importance of such projects and the data which can be obtained from them should not be underestimated.

Geographical Interest

It would seem that the appeal of the fuel cell bus is reaching further across the globe than ever before. Within Europe, it was announced by the European Commission in October 2006, that six regions and cities in the European Union and Canada are to purchase a number of hydrogen fuelled or fuel cell powered buses for local transport networks. The purchase comes following the success of the CUTE programme and cities including Amsterdam, Berlin

and the British Columbia province of Canada are expected to operate the buses following their purchase.

London seems to have attracted much attention over the past twelve months, participating in some high profile demonstration projects and with encouragement from London Mayor, Ken Livingstone, promising 70 fuel cell powered vehicles (including buses) on the city's roads by 2010.

Elsewhere in Europe, according to officials from Berlin's mass transit company BVG, every fifth bus in the city will be powered by hydrogen by 2009. According to media reports, BVG plans to order 250 hydrogen-powered buses and in doing so make Berlin the first European city with a significant proportion of emission free buses.

In South America, Brazil announced the development of five hydrogen fuel cell public buses which will be tested during 2007 in Sao Paulo and neighbouring cities. The four year programme requires a total travel distance of 1 million kilometres and if the buses prove to be successful the hydrogen bus fleet could be extended to 100 or 200 vehicles. The project has the backing of the United Nations Development Program (UNDP) and a similar scheme is expected to be launched in Rio de Janeiro in 2007.

In other Rest of the World regions, even Bethlehem is getting in on the act. In December 2005 the City of Bethlehem and the Economic Development Corporation launched a five month study on creating alternative transport means for residents, students, tourists and commuters to move around the city's South Side. One suggestion called for the introduction of a hydrogen powered shuttle bus to transport passengers around the city. The US$25,000 study is an initiative of the Keystone Innovation Zone.

Demonstration Programmes

The Clean Urban Transport for Europe (CUTE) programme was a large scale field trial of fuel cell buses and hydrogen infrastructure. CUTE began in November 2001 and continued until May 2006. During this time 27 fuel cell buses were operated in nine participating cities across Europe. In addition, a further six buses ran within the associated programmes Ecological City Transport System (ECTOS) based in Reykjavik, Iceland and funded by the EU, and the Sustainable Transport Energy Perth (STEP) programme in Perth, Western Australia.

The aim of the CUTE project was to develop and demonstrate an emission free and low noise transport system that would contribute to cleaner environmental conditions, increase public knowledge and acceptance of hydrogen and fuel cell technology and build a strong foundation for regulation and certification of fuel cell technology. All participants agreed that throughout the course of the programme, the fuel cell buses had performed beyond expectations and the project had been successful in demonstrating fuel cell technology as a solution to mass public transport requirements. In addition, the data set gathered as a result of fuel cell bus operation is especially valuable.

The success of the CUTE, ECTOS, and STEP bus demonstration projects led to a one year extension for the schemes. Cities participating in the contract extension included Amsterdam, Barcelona, London, Luxemburg, Madrid and Reykjavik and each of these locations continued to operate three fuel cell buses throughout 2006. Hamburg also participated in the extension, increasing its fleet size from three to nine and in doing so, making it the world's largest fuel cell bus fleet being operated by a single transit agency. Continued operation of the buses in to early 2007 and the ongoing operation of six more Mercedes-Benz Citaro buses in Perth and Beijing and three Gillig buses running in California is expected to provide valuable operating data.

The US Federal Transit Administration (FTA) announced in October 2006 that it is to provide US$12 million in funding to facilitate the development of major fuel cell bus projects across California. The projects will develop existing fuel cell bus demonstration programmes including those currently run by AC Transit, SunLine Transit and UTC.

At Hickham Air Force Base in the state of Hawaii, the US Air Force unveiled a hydrogen demonstration programme in November 2006. The base has its own generation and fuelling station and as part of the scheme a fuel cell powered shuttle bus will be used to move residents around the base.

The Hydrogen Fuel Cell Buses for Urban Transport in Brazil project marks the first hydrogen fuel cell demonstration

in South America. The programme includes a hydrogen refuelling station and a small fleet of hydrogen fuel cell powered buses which will be put in to service in Sao Mateus and Sao Paulo. The project was officially launched in November 2006 and is being led by the Brazilian Ministry of Mines and Energy and Sao Paulo Metropolitan Urban Transport Company. It is supported by the United Nations Development Programme and Global Environment Facility.

The HyFLEET:CUTE project was launched in January 2006 as a follow-up programme to the highly successful CUTE and ECTOS schemes. The goals of the project are to improve fuel cell technology by continuing the operation of the CUTE fuel cell buses over a period of 12 months in seven European and two non-European cities. In addition, HyFLEET:CUTE will develop design and production of fuel cell buses and build upon infrastructure developments. The programme will involve, amongst others, two bus manufacturers and eight transport companies.

The first phase of a wind/hydrogen village on the western tip of Prince Edward Island was planned to be launched in late summer/early autumn 2006. The project is being funded by Industry Canada. Transport will be the main focus of the project's second phase and the programme will eventually test the viability of a hydrogen powered shuttle bus.

Japan's Fuel Cell Bus Demonstration Programme has been executed in two phases. The first phase (JHFC1) ran from FY 2002 to FY 2005 whilst the second phase of the project (JHFC2) was introduced in 2006 and will continue for five years until 2010. Each of the two phases has clear objectives. In phase one the objectives were to show the effect on energy savings and the environmental impact of operating fuel cell vehicles compared with internal combustion engine vehicles, acquire data for codes and standards development, analyse the Japanese fuel cell vehicles and raise public awareness regarding fuel cell vehicles and hydrogen stations. Phase two has been designed to achieve similar goals with more detail and specific items to be investigated in each of the phase one objectives.

Phase one of the programme included the operation of a fuel cell bus service in Tokyo from August 2003 to December 2004. The bus travelled two routes of 15-20 km and completed 4-5 round trips per day of operation. After this time the fuel cell bus was operated at the Aichi Expo between March and September 2005 and then moved on to Centrair Airport to provide a shuttle service in July 2006. Phase two will see continued operation of the fuel cell buses.

The project is subsidised by The Ministry of Economy, Trade and Industry (METI), Japan Automobile Research Institute (JARI) and the Engineering Advancement Association of Japan (ENAA).

The Mayor of London announced plans to introduce 70 new hydrogen vehicles to London by 2010 as part of the London Hydrogen Transport Programme, run by the London Hydrogen Partnership. By February 2006, Transport for London had already begun the procurement process for ten new hydrogen fuelled buses.

The US Federal Transit Administration (FTA) announced in November 2006 that it had selected BAE Systems to develop advanced hydrogen fuel cell technology on a hybrid electric bus as part of the agency's National Fuel Cell Bus Technology Development Programme. The programme has been granted US$49 million over fiscal years 2006 – 2009 in order to facilitate the development of commercially viable fuel cell buses which will be demonstrated across the US. Fuel cell manufacturers involved in the project include Ballard, Hydrogenics, Nuvera and UTC.

Shell Hydrogen in partnership with Connexxion Holding and MAN Truck and Bus Company signed a Memorandum of Understanding to conduct an in-depth, economic and technical study for the creation of the world's largest hydrogen-fuelled public transportation operation to be located in Rotterdam, The Netherlands. The project aims to have the largest hydrogen bus fleet operational in a single region before the end of the decade and the partners will make a possible investment decision in 2007. If the proposal is accepted by the partners, more than 20 hydrogen buses and a re-fuelling station will be operational in Rotterdam by 2009 and will continue to run for a five year period.

Transport for London announced in July 2006 that the hydrogen fuel cell buses operating around the city would run on Saturdays as well as weekdays during the summer months. The reason cited was the impressive reliability and performance of the vehicles. The service life of the buses was extended until January 2007 as part of the CUTE

extension.

In February 2006, the California Air Resources Board (CARB) adopted a new regulation to reduce nitrogen oxide and particulate matter emitted by public transit buses. To comply with this regulation, Santa Clara Valley Transport Authority (VTA) elected to demonstrate fuel cell technology in a joint venture with SamTrans. Together, the companies operate three fuel cell buses as part of the Zero Emissions Bus Demonstration Programme. Funding has been supplied by the Federal Transit Administration (FTA), The Bay Area Air Quality Management District, Department of Energy, SamTrans and VTA. The buses were manufactured by Gillig whilst the fuel cells were produced by Ballard. With a total programme budget of approximately US$19 million the fuel cell buses were delivered in August 2004 and transit service began in February 2005.

Bus Manufacturers

The Advanced Vehicle Development programme at Georgetown University unveiled a 40 foot methanol fuel cell powered bus in September 2006. The vehicle is capable of covering 350 miles per tank of fuel and federal funding of US$1 million was provided for the project. To produce the bus, developers from the University worked with NuCellSys and have since begun work on a new model expected to be complete in 2008.

September 2006 saw the news that AC Transit had established a multimillion dollar programme to test fuel cell models in action. The firm will use the tests to gauge potential for commercialisation of its fuel cell and electric hybrid systems in three of its buses.

B.C. Transit, applied for funding for a project that would put around 20 fuel cell powered buses on the roads of Whistler starting in 2009. The application was supported by Whistler Council.

Hyundai Motor Company delivered the first of ten Hyundai and Kia fuel cell electric vehicles, including a bus, to AC Transit in December 2006. This marked the beginning of a five year demonstration programme to validate and evaluate the vehicles.

According to the Korea Herald, Hyundai-Kia and the Korean Government are planning to spend around 48 billion won (£26.4 million) on the development of fuel cell buses and cars by 2008. The initial bus is to operate in the Seoul metropolitan area as part of the public transport system.

Working closely with sister agency, AC Transit, Sunline Transit Agency received state and federal grants to purchase a hydrogen fuelled hybrid electric fuel cell bus in January 2006. The bus has a maximum speed of 65 mph and can travel 350 miles before refuelling is required.

In February 2006, Toyota and its subsidiary Hino Motors announced that a fuel cell bus developed by the two companies would be in operation at Centrair International Airport, Japan for two weeks in March 2006. Data concerning the durability and fuel economy of the vehicle was collected. In July 2006, operation was renewed this time including an expanded service to and within the airport. The effort is part of a fuel cell demonstration programme of the Ministry of Economy, Trade and Industry's (METI's) Japan Hydrogen and Fuel Cell Demonstration Project (JHFC).

Stack Manufacturers

In March 2006, Ballard Power Systems secured a US$8.3 million contract to service 27 Ballard powered Mercedes-Benz Citaro fuel cell buses that run on European roads throughout 2006 as a one year extension to the CUTE/ECTOS project.

Enova Systems confirmed its working relationship with IC Corporation in February 2006. Together, the two companies have developed a functional hybrid school bus and produced a prototype school bus incorporating Enova's 80 kW hybrid drive system. In October 2006, Enova announced that it will collaborate further with IC in the development of a new line of fuel cell hybrid buses. However, in October 2006, Enova also issued a trading update warning that demand for its systems had been less dramatic than anticipated despite developing relations with major firms in the school and commercial bus sectors. In December, the company entered in to a joint school bus programme with a major North American truck manufacturer.

In June 2006, Enova's Hybrid Drive components were used in a Hyundai fuel cell bus to transport several thousand football fans from the Tegel International Airport to the Olympic Stadium in Berlin to watch several FIFA Soccer World Cup games. Hyundai had 32 buses in use at the tournament, the flagship of which was the hybrid fuel cell bus.

First Auto Works in China, announced in December 2006 that it had produced one of Enova's "Hybrid City Bus" vehicles at its assembly plant. The vehicle is powered by Enova's 80kW parallel hybrid drive system.

October 2006 saw the formation of a research partnership between General Electric (GE), Ballard Power Systems, A123 Systems and the Federal Transit Administration (FTA) to develop a hybrid fuel cell bus. The companies will work together at GE's Global Research centre in Niskayuna and claim that the bus will have a range of 200 miles. The FTA will provide around half of the £13 million of funding required for the research.

Hydrogenics announced in December 2005 that Germany's TUV Rheinland Group awarded road certification to the company's fuel cell 'Midi Bus' allowing the vehicle to be put in to full public transit service in Germany. In April 2006, Hydrogenics successfully deployed a Midi Bus at the Hannover industrial fair. Over the course of five days, the bus travelled 405 kilometres, consumed 10.1 kg of hydrogen and transported 800 people between the event's 13 buildings. By July, the company had received a US $460,000 order for a fuel cell hybrid Midi Bus from Rheinbahn Rheinische Bahngesellschaft, the public transit authority of the greater metropolitan Dusseldorf area in Germany. The bus is intended to be used over a period of five years and can travel 200 km on one tank of hydrogen.

In November 2006, Hydrogenics announced that it will be supplying fuel cell systems for two bus projects in the US. The first is to be run by the Centre for Transport and the Environment in Atlanta, Georgia and the second in Weststart Calstart in San Francisco. Both schemes will receive funding from the Federal Transit Administration totalling an estimated US$11 million and the buses will use Hydrogenics' HyPM fuel cell power module. In November, the company also announced that it would provide a bus to Alchemy Enterprises.

In November 2006, Modine Manufacturing Company confirmed that it will supply fuel cell components for the first hydrogen buses in Brazil. The company will produce a fuel cell cooling system as well as electric drive train components for the project.

Nuvera Fuel Cells was awarded a US$4.875 million grant from the Federal Transit Administration (FTA) to develop a hydrogen fuel cell bus at Logan International Airport, Massachusetts. The grant was awarded as part of the Northeast Advanced Consortium (NAVC) and will be used to further the National Fuel Cell Bus Programme.

In September 2006, Proton Motor delivered a fuel cell hybrid bus to the City of Barth, Germany. The bus will be operated in urban and regional public transport.

Germany's Proton Power System stated in October 2006 that it was in talks with a UK bus manufacturer over plans to design and build more fuel cell powered buses to be operated in London.

Shenli High Tech Company in Shanghai is developing and manufacturing a hydrogen fuel cell bus in collaboration with Shanghai Jiaotong University and Chinese automaker Suzhou King Long.

UTC Power announced in March 2006 that it would work with Van Hool to deliver a fuel cell powered bus to DeLijn, the largest bus fleet operator in Belgium. The bus is expected to operate in Belgium for six months before being leased to other transit agencies in Europe. The UTC fuel cell system is capable of delivering up to 120 kW of power. In other news, a hybrid electric bus with a UTC fuel cell system was used to shuttle passengers on a route through Torino, Italy during the Winter Olympic Games in February 2006. The bus was originally developed in partnership with Irisbus (Iveco) and has been operating in Italy since 2001. It continued to operate in Torino in to the early summer of 2006.

More recently UTC Power was contracted by The Greater Hartford Transit District to provide a 40 foot hybrid electric fuel cell powered transit bus to be used in Hartford, New England. A US$2.9 million grant from the Federal Transit Administration (FTA) to the Greater Hartford Transit District will pay for the bus which will be operated by

CTTRANSIT once it arrives in Hartford.

Furthermore, in October 2006, UTC announced plans to participate in three fuel cell bus projects in Washington DC and California. As part of the US$8.35 million FTA funded project, UTC will provide the fuel cell power systems for the buses and participate in the development and design of new fuel cell buses in California as well as furthering development of buses currently being operated by AC Transit. The ultimate aim of the programme is to ensure that by 2015, 10% of all bus purchases in the US are fuel cell buses. In addition, UTC is due to receive a further US$8.4 million in Department of Energy funding to develop more durable and less costly seals and catalysts for transportation fuel cell stacks.

Other Companies Actively Involved in the Development of Fuel Cell Buses
The Pennsylvania Transport Institute (PTI) received two state grants amounting to around US$650,000 for the partial conversion of seven Centre Area Transportation Authority (CATA) buses to hydrogen. The grant money is expected to cover the costs of fuelling and operating the vehicles and other costs associated with the project and demonstrations will run for the next two to three years.

Quantum Fuel Systems Technologies Worldwide announced in August 2006 that it had delivered its new compressed hydrogen storage tanks to a fuel cell bus manufacturer for use in fuel cell buses to be operated on public routes.

Conclusions
Fuel Cell buses are a potential coming together of a number of social and technological strands. Not only are they a socially good thing, with both politicians and tax payers backing them, they provide a superb early adopter market for fuel cells. The Fuel Cell Bus Club, which comprised of the CUTE, ECTOS and STEP projects really lead the way showing what can be done in this area. HyFLEET:Cute has taken up the baton and from what we have heard this year the USA has also come online with its own large scale demonstration programme. In the developing countries it is hard not to get excited about the possibilities that could be generated by adoption of fuel cells, including in buses, in terms of reduced air pollution, reduced dependence on oil etc. Almost what is needed now is a concerted effort to buy large fleets of these of vehicles to help bring down the costs. Instead of purchasing 30 vehicles, organisations need to purchase 300. The traditional London bus fleet alone is over 8,000 vehicles. Makes you think, doesn't it?

About Us

Fuel Cell Today publishes free annual market surveys on different fuel cell applications including light duty vehicles, buses, automotive hydrogen infrastructure, portable, large and small stationary power generation.

About the authors

Kerry-Ann Adamson is the Editor of Fuel Cell Today and has interests in the socioeconomics of distributed generation and alternative fuels/technologies for vehicles. She can be contacted at kerry-annadamson@fuelcelltoday.com

Gemma Crawley works as a Senior Market Analyst for Fuel Cell Today. Her area of interest is the adoption of fuel cell technology in developing countries. Gemma can be contacted via gemmacrawley@fuelcelltoday.com.