Riding on hydrogen

London's hydrogen bus fleet has been running for more than 18 months now. David Yorke, future vehicle technology manager at First Group, talks about the experience to John Challen

In response to Mayor of London Boris Johnson's requirements to reduce carbon dioxide (CO_2) emissions in London by 60% by 2025, many alternatives to diesel power have been sought and introduced on the capital's public transport system. Transport for London (TfL) currently has 300 diesel-hybrid buses – with another 150 due to join the fleet by March 2013 – running on the city's streets, each claiming savings of 30%, in terms of pollutants and CO_2 emissions, versus conventional vehicles.

Meanwhile, thanks to its involvement in the CHIC (clean hydrogen in European cities) programme, as well as funding from TfL and DECC (the Department for Environment and Climate Change), London has, since 2011, been running hydrogen-powered buses. This fleet of zero-emission vehicles currently numbers five, with three more hydrogen buses completing the eight-strong fleet when they arrive later this year.

The buses, originally designed and built by North American company ISE, sit on Wrightbus VDL SB200 chassis and feature a 75kW Ballard fuel cell stack, as well as the FCvelocity-HD6 fuel cell module. That fuel cell is now into its sixth generation and features a new control unit, which, according to its developer, has "helped to advance durability, power density and fuel efficiency, compared with earlier generations".

First past the posts

"The first buses went into service in January 2011 and they will be running for more than four years," confirms David Yorke, First Group's future vehicle technology manager and project manager of the hydrogen bus scheme. He also reveals that this programme followed earlier trials with three hydrogen buses in London between 2003 and 2007, which, says Yorke, led to the decision to invest further in the technology as it evolved.

"The reason for running hydrogen buses, like hybrids, is down to environmental benefits: with these vehicles, there are no emissions," he explains. To make the programme practicable, a purpose-designed maintenance depot was built at First's Lea Interchange depot in Stratford to service and maintain the hydrogen fleet. Additionally, a

Fuel cell module specification

Gross Power	75kW
DC voltage	230–365V
Max current	300A
Weight (dry)	350kg
Dimensions	1530 x 871 x 495mm
Fuel	Gaseous hydrogen commercial grade (per SAE J2719)
Oxidant	Air
Coolant	50/50 pure ethylene glycol and water
Coolant temperature (nominal)	63°C
Fuel pressure (minimum):	16 barg
Air pressure (nominal):	1.2 barg
Control interface:	CANbus

Fuelling facts

The hydrogen refuelling station at Lea Interchange in Stratford comprises high-pressure (350 bar) hydrogen storage, which dispenses liquid hydrogen through two dispensers that service the buses.

The station is serviced by Air Products' fleet of dual-phase hydrogen tankers, which transport the hydrogen in liquid phase and can vaporise it into high pressure gas storage on site.

The dual-phase hydrogen tanker converts the hydrogen between states and pressures, and can supply medium- or high-pressure gas, in addition to liquid hydrogen. This means that large quantities of hydrogen can be transported, thereby reducing distribution costs and minimising the equipment required on site.

Above: The Lea Interchange hydrogen fuelling station
Below: One of the hydrogen buses running the RV1 route in London

bespoke fuelling facility was built by Air Products on the same site. The latter facility has recently completed 1,000 refuellings, as the fleet passed the 100,000 milestone on the RV1 Tower Gateway-to-Covent Garden route.

Looking at some of the detail, each of the buses completes around 120–130 miles a day, operating from 6.00am until after midnight. "We have managed to achieve good fuel economy (just over 8kg/100km), so have been able to adopt the normal refuelling schedule we would with a standard diesel bus – refuelling the vehicles every night," comments Yorke.

He also says that the maintenance schedule works in line with that of the rest of the First fleet. "Servicing of the buses fits into our standard 28-day cycle," he confirms. "That was one of the main aims – trying to normalise these hydrogen-powered buses into our standard bus service operations. There have been plenty of hydrogen bus projects before that haven't been so straightforward, but, with this one, we are trying to ensure minimum disruption to the maintenance regime."

Problem solving

Yorke is happy to report no major engineering problems with the vehicles, but concedes that the programme has introduced a new set of challenges in relation to fleet management. Time management, for example, has been one of the biggest headaches for Yorke and his team. "The biggest issue is that the technicians working on the hydrogen buses are a bit slower to solve problems than they would be on a diesel bus. They don't have the experience, so lots of little things take slightly too long to solve."

And that was in spite of a rigorous training schedule in preparation for the arrival of the new fleet. "We gave all the engineers an overview of the hydrogen buses, because, if you've got simple issues, you want them to be solved by the morning and any of our technicians should be able to handle these. But, for this project, the actual inspection and maintenance has been down to a more select group of engineers, who now have more experience with the overall workings of the bus."

Yorke also states that, as well as technician training, extra emphasis was put on making sure the drivers were competent. "All of the drivers completed a three-hour training session, which we would not normally do for a bus, as well as a two-hour driving session," he explains.

"The classroom session was taken up with safety and understanding the bus itself. If customers get on and ask about the bus, we wanted the drivers to be able to give some reasonable answers as to what is powering it, and why it is different and better. They can now give answers that we believe would satisfy the public," he explains.

"But the driving part was more about getting used to the vehicles and understanding the controls," continues Yorke. "It helped that much of the layout was the same as on a diesel bus. However, there are some extra controls and they needed to understand the different dashboard instrumentation."

Understanding how to use the regenerative energy procedure during braking to its greatest advantage for fuel economy was also vital, he adds. "Using this properly produces a smoother ride quality, because, when the fuel cell creates electricity, the torque curve is steadier," he asserts.