SILENT REVOLUTION

Richard Simpson examines the implications of switching from diesel to hydrogen fuel cell drivelines for the fleet engineer, using as an example a new bus fleet

The biggest hitters in the heavy vehicle market, including Daimler and Volvo Group, are backing hydrogen fuel cell technology as a replacement for diesel in the long-haul market. This is potentially the biggest change in road transport since the internal combustion engine replaced the horse, but UK companies First Bus and manufacturer Wrightbus and have stolen a march on the multinational giants.

In Aberdeen, the city council is working with incumbent bus operator First on the introduction of hydrogen-powered buses to the city's streets. First is also introducing 148 electric buses in Glasgow. Gary West, the engineering director of First Group Scotland, says that the twin-track operation will enable the operator to establish the cost-per-mile of each technology.

Hydrogen buses originally debuted in Aberdeen in 2015. A total of 10 single-deck Van Hools were run by First and Stagecoach. The city council facilitated construction of Scotland's first hydrogen refuelling station at Kittybrewster by BOC, as part of a long-term strategy of moving the city into the post-carbon age by 2035.

Kittybrewster produces hydrogen on-site by electrolysis: renewable electricity makes this a genuinely green fuel. Refilling a bus takes 10 minutes, and provides it with a range of up to 350km. The station was opened for the Van Hools in 2015. Fuelling for vans and cars was added in 2018, and it was upgraded to handle Wrights' double-decker buses the following year. Two shunters run the buses to Kittybrewster for refuelling.

UPGRADES

First upgraded its hydrogen fleet in late January 2021 with the arrival of 15 Wrightbus Streetdeck Hydroliner FCEVs (pictured above, and lower right). They are only a small part of an otherwise all-diesel fleet of 130 buses and 20 coaches, but changes have already been made to maintain them at First's Aberdeen premises.

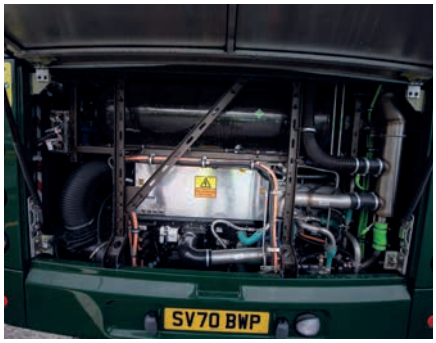
The workshop has two fuelling and washing lanes, one inspection lane and 15 maintenance bays.

Of these, the wash and inspection lines and one maintenance bay have been made 'hydrogen safe'. Hydrogen safety revolves around monitoring local concentrations of the flammable gas in the air. If hydrogen concentrations reach 10% of the gas's lower flammable limit, then a gas alarm sounds and ventilation through the walls (pictured top right) and roof is actuated. If concentrations rise to 20%, then the fire alarms are activated, electricals (apart from the ventilators) shut-down and the building is evacuated.

The workshop electrics themselves are protected, and the vehicles have vent pipes linking them directly with the outside atmosphere connected once they are in the workshop.

Although hydrogen has a formidable reputation as a fire hazard, thanks largely to the Hindenburg airship disaster, it may not be as hazardous as people think, West points out: "Unlike diesel, which pools on the ground and spreads fire fast horizontally, hydrogen disperses upwards and outwards, so it's not necessarily more dangerous, just different."

Manufacturer Wrightbus is working closely with First on supporting the new



technology. Ian Gillott, group director of parts and service at Wrightbus, explains: "We have had 70 years of experiencing continuing refinement of diesel technology and have perfected the processes and people needed, so service schedules are built around engine oil changes."

"That all changes with hydrogen, where the driveline is electrical, and there is no engine oil to change. It's a different experience for everyone; although the vehicles still look like their predecessors, everything has changed. Even for drivers: although we have tried to replicate the diesel driving experience to a certain extent, the hydrogen vehicles are far quieter and there are different lights to monitor on the dashboard. The start-up and shut-down procedures are different, too."

He warns: "Operators introducing hydrogen should not underestimate the challenges of the first six months. Training is critical: that's where the process begins. It is key to involve absolutely everyone who interfaces with the buses: drivers, maintenance-depot staff, support workers, and management. Training is where the battle is won or lost.

"We begin with in-factory training. Key technicians from the operator come and see the product being built: that way they know exactly what goes where. In-depth training must cover a broad range of specific vehicle systems, including high-voltage power, high-pressure gases and fuel cells. It takes five days to train a technician to Level Two, and a further eight days on top to train someone to master technician level.

"Upskilling people is critical to ensure as seamless a transition as possible, and we also take that opportunity to train them in our parts and warranty systems. All-in-all we are talking two weeks, then 'top-up' training is also required, so we come back after four weeks to deal with queries that may have arisen.

"It's all about uptime. There are 5,000 sensors on the vehicle, which enable predictive fault analysis." So, instead of a time-or-distance-based precautionary maintenance schedule, informed decisions can be made.

SERVICE WARNINGS

Gillott explains: "Any infringement of set parameters – major or minor – gives time for a decision to be made about when a component will be adjusted or replaced. With a conventional vehicle, the first that would be known would be a driver reporting a problem, and that usually means an unscheduled workshop visit. Now the operator can see a problem emerging before it actually appears."

Discovering exactly where these parameters should be set has been a key part of the Wright-First partnership.

West says: "Real-life operation of the buses has involved a lot of work adjusting the parameters at which sensors are triggered. We work not only with Wrightbus but also with second-tier suppliers such as fuel-cell manufacturer Ballard. We are confident that, ultimately, the maintenance burden will be less, but you need to run the vehicles to get the figures and the confidence to operate them."

Adds Gillott: "With First in Aberdeen, we are building a huge dataset from the buses of what happens when in hours and miles. The more data we have, the more uptime we can get. We have to make adjustments, and the customer has to make adjustments; we learn more as more vehicles roll out, and operations in Aberdeen have given us a proven record to take elsewhere. We now have buses going in to Belfast, Dublin, London and the West Midlands. Aberdeen has been a fantastic partner for us, and our suppliers, including ZF, Ballard, Siemens, Graysons, Luxfer, and Forsee Power."

Wrights is also rolling the WB Uptime 365 telemetry system across its full range: including diesel and battery-electric buses. TE

HOW THEY WORK

Robert Best, director of engineering at Wrightbus, explains the fundamentals of the fuel-cell bus: "The fuel cell produces electricity from hydrogen and air, but the bus has batteries too. These are charged by the fuel cell, and by over-run braking. The fuel cell has a maximum power output of 70kW: our equivalent diesel bus has a 170kW engine. Batteries provide extra energy when required: for acceleration and hill-climbing.

"Fuel cell output can be adjusted: the mixture of hydrogen and air is regulated like fuel and air with a petrol engine.

"Unlike a battery-electric, the powertrain is contained in almost the same envelope as a diesel: the rear of the bus is extended by 100mm to provide extra volume for hydrogen tanks."