Electrifying ENGINEERING

Battery-electric vehicles will play a key role in decarbonising many fleets. Richard Simpson talks to an engineer who has already travelled that road

Where London leads, the world follows. And this is very true in the field of public transport, where the UK capital opened the world's first underground passenger railway in 1863. More recently, London has been an enthusiastic early adopter of alternative drivelines for buses: first in the form of hybrids including the 'Borismaster,' and more recently in battery-electrics.

The terrible twins of global climate change and local air quality have been instrumental in driving this forward. While the higher capital cost of electric buses is universally acknowledged, the hope has always been that this can be recouped over the life of the vehicle by reduced energy and engineering costs. And, in any case, Transport for London aspires to make the entire bus fleet zero-emission by 2030, if funding allows.

The burden of implementing such ambitious plans falls on the shoulders of engineers such as Richard Harrington, the engineering director of Go-Ahead London, one of TfL's bus operators.

Harrington's career with the capital's buses began in 1984, when he joined London Transport as an engineering apprentice. His involvement with electric buses goes back to 2011, when, with TfL's ambitious air quality and climate change policies taking shape, he visited the Kortrijk Busworld Show with a view to organising electric bus trials in London.

To his dismay, the European manufacturers all wanted to include two years' research and development overheads in the cost of any trial.

"I was very relieved to find the BYD (Build Your Dreams) company in China," he recounts. "Although its major expertise is as a battery manufacturer, it already had 1,500 electric buses, built completely in-house, in operation in its home town. So there were no R&D costs to assimilate, and in December 2013 the first two Chinese-built buses arrived for us to trial.

"We put them into our Waterloo garage inside the ULEZ, and worked them on a variety of routes, starting at those covering just 75km a day and working up to see what their effective real-life range was. Some of the services operated from Waterloo are commuter routes, with an off-peak during the day which we could use to recharge buses. We were able to convert one route to 100% zero emissions in year one."

Successful TfL contract bids saw another 51 BYD buses, but with British ADL bodies built on Chinese running gear, join the fleet.

Spanish manufacturer Irizar, better known for luxury touring coaches in the UK, joined the party with a two-vehicle trial in 2015, and in 2016 more routes were won on the basis of electric operation. Go-Ahead's Waterloo depot became the first bus garage outside China to go all-electric.

"I've operated every electric bus that's available in right-hand drive; we trial them all. Our routes are all operated on competitive tender with TfL, and you have to take all operating costs into account, not just the front-end"

Richard Harrington

"We took delivery of 10 new ADL/BYD buses on the first day, and since then they have been arriving at a rate of five a week. The shortage of heavy low-loaders is a constraint on their introduction, as they have to be delivered from Scotland. Now we have 285 buses, with 300 more on the way."

Waterloo's role as a pioneer of electrics means that Harrington now has no difficulty in sourcing demonstrators.

"I've operated every electric bus that's available in right-hand drive," he recounts. "We trial them all. Our routes are all operated on competitive tender with TfL, and you have to take all operating costs into account, not just the front-end. This means that manufacturers must provide us with an extended warranty on the batteries, and a package on the cost of parts. We are in talks with all the manufacturers: you can't put all your eggs in one basket."

Currently, the Go-Ahead electric fleet includes 17 Switch Mobility buses and two Irizars, with the balance being BYD/ADL. But a further 20 Irizars, in the form of futuristic ie trams (buses styled like European trams but running on internal batteries and rubber-tyred road wheels) are to be introduced to route 385 in 2023.

RUNNING COSTS

While their lower fuel costs compared to diesel have been (hopefully temporarily) eroded by spikes in electricity prices, how do the other running costs of electrics compare to diesel?

"There are areas where there is more wear than on a diesel: suspension and steering. The battery-buses are heavier and carry that weight higher up, and that has consequences. On the other side, brakes last longer because regenerative braking is used, and there is no diesel engine or transmission, and in some cases no differential. Most significantly, there's no exhaust emissions control, which represents our biggest engineering cost on a diesel bus.

"There are fewer moving parts; there is less heat and vibration taking its toll on the vehicle, there is less oil, and there is no hydraulic fluid.

"These factors mean that routine maintenance costs are less, but the jury is still out, as the life of high-cost components has not been established yet. These include inverters, controllers and drive motors. You can offset some of the risk with extended warranties, but these too must be paid for.

"However, we can be sure that the maintenance costs will be lower than those of hybrid buses, which are the worst case as they combine two systems with the maintenance costs of both. They are too expensive to run, and those which are sold out of London end up being converted to pure diesel. In any case, TfL will only let us buy pure electric now."

TRANSITION

Go-Ahead's 15 years of experience in operating high-voltage hybrids has made the transition to pure battery relatively painless, Harrington adds.

"The technicians are already familiar with the safety processes with batteries, the high-voltage orange wires and so on," he says.

"The biggest change is in the maintenance of the battery temperature-control systems. We are now working at height with liquid-cooled battery packs on the bus roof, with the extra safety considerations that that entails. We have a crane to lift the batteries; people had to be trained and certified to use that, and the crane itself must be inspected twice yearly.

"But the transition to electrics has given technical staff an increased pride and interest in their job."

TRAINING

"The bigger training need is actually among drivers: battery regeneration is a key to successful EV operation," he says. As soon as the driver releases the accelerator, the regeneration starts, but when the brake pedal is engaged, it stops. They need to learn what is essentially a one-pedal driving technique, with the brakes only used to halt the vehicle or in emergencies.

"Weather is another engineering challenge. We are supposed to maintain a temperature of 17°C in the saloon, and that will deplete the batteries on a cold day by up to 40%, especially as passengers will dress for the weather, find the bus too hot at 17°C and open a window! My view is that 10°C in an ambient temperature of -3°C would seem warm enough.

"Keeping the drivers comfortable in hot and cold conditions is very important, especially now as the cab is sealed from the saloon post-COVID. We are looking at truck-style ventilated and heated seats, and heated steering-wheels to achieve this without wasting energy," Harrington explains.

"There's also the issue of wading height. There's increasing flash-flooding in London, and it's often difficult to judge how deep a puddle is." TE