FLAT(S) BATTERIES

Batteries represent a substantial part of the capital costs of electric buses, but, as Richard Simpson explains, their second-life value in static installations makes it possible to lease rather than buy

There can be few sectors of the automotive industry that have embraced battery-electric power with the enthusiasm of the city-bus market. Demand for buses that are zero-emission at point of use has risen in line with concerns about urban air quality. No one company is a better example of this than BYD (Build Your Dreams) which was founded in China in 1995. In 2010, it produced its first electric bus, and has now delivered over 50,000 such units throughout the world, with additional production facilities in North America, India and Europe.

Other manufacturers, both established and start-up, have followed suit. On the face of it, city buses are the ideal application for electric traction. Routes and schedules are known and predictable, the vehicles are back at base every night, and the reduction in noise and fumes are welcomed by passengers and public alike.

But the technology has issues; the first is cost. While modern single-deck diesel buses come in at comfortably under £250,000, the tag on a comparable electric bus can be at least twice that.

Then there's the cost of the infrastructure. Bus depots often need to be rearranged so buses can be left adjacent to charging stations for long enough to replenish their batteries, as opposed to the traditional model where they enter, are fuelled in a few minutes, and then checked, cleaned and parked (for example, see also *www.is.gd/ ehukid*).

In Munich, Germany, for instance, plans to electrify the city's bus fleet with 200 vehicles will necessitate the construction of an all-new depot over 36 hectares, with buses parked underground and a 25m high office block above. Fifty-six 150 kW charging stations will be supplied by Polish energy giant Ekoenergetyka, and waste heat from the chargers will be used to help heat the offices. It's an ambitious project, and indicative of the kind of investment required to make electric buses work on a large scale.

In contrast, harsh questions are being asked in Berlin, where electric buses were acquired without sufficient planning or infrastructure. Berlin's 1,400-strong bus fleet covers around 300,000 km a day in total, and is scheduled for diesel buses with a range of 700 km. The electric buses chosen by the city have a range of 140 km, and even this cannot be achieved on days of extreme ambient temperatures. In reality, electric buses operate during the morning peak, but by noon their batteries are exhausted and they have to be replaced by diesel buses. And, in a country where 38% of electricity is produced by coal-burning, the overall environmental benefit of electric buses may not be as great as it seems, either.

Yet successful electrification is possible on a smaller scale. Big

Newport Transport runs 15 Yutong electric buses with a ticket price of £340,000 each, but the £150,000 per-vehicle battery packs are owned by Zenobe and have a projected on-vehicle life of six years

Lemon, a community interest company founded in Brighton in 2006, is transitioning from running buses on biofuel to an electric fleet, with solar panels on the company's depot roof charging batteries during the day which then charge the fleet during the night. Currently, the company runs five Optare Solo Magtec electric midibuses (pictured below) and a converted Ford Transit electric minibus alongside conventional vehicles on its five routes.

One of the biggest up-front costs in electric bus operations is the vehicle batteries. The batteries may well have a shorter lifecycle than the vehicles themselves, and the question of whether to replace batteries at the end of their lifecycle with new when the vehicle itself is more than half-way through its intended life is a tricky one. For example, the hybrid New Routemasters required replacement batteries after just three years of London service.

One solution might be to decouple finance of the battery from finance of the vehicle. Owners of Renault Zoe passenger cars will be familiar with the concept: even cash buyers still lease the battery for a mileage-dependent monthly fee. Just as vehicle leasing companies finance the difference between the values of a vehicle at acquisition and disposal, so a battery leasing company can offer batteries on a pay-as-you-go basis underwritten by the residual value of the battery itself. That's because automotive traction batteries also have a further use as static power banks: once their capacity has dropped to 80% of new, they are no longer suitable for mobile applications but can still be used to provide back-up power in static applications such as off-grid sites.

For example, Volvo Bus is cascading second-life bus batteries into use as power banks in residential complexes in its home city of Gothenburg. The batteries store energy harvested from solar panels and are used to power communal laundries and lighting. When they are of no further use, they will be recycled, with material reclaimed, creating a circular economy in bus batteries.

Also, while Spanish vehicle OEM Irizar is best-known in the UK for its touring coaches, it is also a leader in electromobility, with a factory in Spain capable of producing 2,000 electric buses a year. It already has a joint venture with charging infrastructure provider Ibil, where old bus batteries will provide back-up power for car chargers in Repsol filling stations across Spain and Portugal.

A DIFFERENT PURCHASING MODEL

Back in the UK, Zenobe Energy, which specialises in energy storage solutions, is working with bus operators in London, Newport and Guildford. It can shoulder the burden of ownership and management of batteries and chargers in exchange for mileage or calendar-based fees, making a substantial reduction in the up-front capital costs of getting an electric fleet on the road. The offer includes second-life static batteries in the depot which can be replenished off-peak, and then used to recharge vehicles when they return to base without imposing a peak load on the local distribution grid.

Newport Transport, for example, runs 15 Yutong electric buses with a ticket price of £340,000 each, but the £150,000 per-vehicle battery packs are owned by Zenobe and have a projected on-vehicle life of six years. They give a maximum range between charges of 187 km, which is sufficient in the Welsh town to allow day-long operation with overnight charging (pictured, p31). In Leeds, First Group is rolling out nine new Yutong electric buses with Zenobe, supported by Ultra-Low Emission Bus Scheme public funding.

What's most important for customers to keep in mind is the big picture, contends Matt Horton, chief commercial officer of US electric bus manufacturer Proterra. He urges operators to see beyond the higher capital cost and look at the long-term saving from electrification. In terms of energy efficiency, electrics represent an 80% saving over diesels, in that the energy needed to power an electric bus to travel a certain distance is a fifth of that needed to move a diesel bus of similar size as far. Part of that is due to the greater overall mechanical efficiency of the electric driveline, compared to that of a diesel.

Finally, electric bus prices are falling all the time. Proterra's first had a price tag of $1.2 million apiece, but today come out at $700,000, with the bulk of the saving coming from reduced battery costs. TE