All-electric heavy trucks may seem a long way off, but Toby Clark discovers technology and pilot projects with potential to transform the timeline

Spark to flame

While hybrid systems of various types are often mooted for heavy vehicles, fully electric drivelines are rarely seen at anything more than 7.5 tonnes. Is this a question purely of battery technology?

Battery weight is typically blamed for limiting heavy electric vehicles to short-range operation at low speeds. But could range-extending motors or wireless charging in motion present solutions? Or is there also an issue around integration? Bringing together electrical, pneumatic, hydraulic and other systems that go together in already complex commercial vehicles is not without its difficulties.

Batteries are also expensive: a recent report suggested that li-ion units cost on average more than £400 per kWh. Meanwhile, new technologies, such as lithium-sulphur (LiS), lithium-air and nickel-metal hydride (NiMH) chemistries, have not yet been commercialised.

Doubtless, costs will be driven down by economies of scale: electric car manufacturer Tesla expects to open its Nevada-based Gigafactory 1 in 2017. "By 2020, the Gigafactory will produce more lithium-ion batteries annually than were produced worldwide in 2013… We expect to drive down the per-kWh cost of our battery pack by more than 30%," says the firm.

BMW has done much to promote electric vehicles – its i8 supercar has even made them glamorous – and has recently started using an electric 40-tonne artic on local distribution. The Terberg YT202-EV, operated by logistics firm Scherm Gruppe, supplies components to BMW plants around Munich. It completes eight trips a day on a single charge: three to four hours from an 80kW charger is good for 100km, it says.

NEGLIGIBLE EMISSIONS

The electricity used is also said to come from renewable sources, leading to a net annual saving of 11.8 tonnes of CO_2. The truck's negligible particulate emissions and quiet operation are equally important, according to BMW plant manager Hermann Bohrer. "We are sending another strong signal for sustainable urban mobility," he insists. This is, however, a one-year pilot, to be extended if the vehicle stacks up.

Terberg's YT202-EV is surprisingly conventional, but it illustrates the issues of integrating systems on board a heavy electric truck. Originally developed for yard operation, it has already proved itself in Berlin, transporting coffee from a multimodal terminal to a roasting plant 10km away.

The coffee is transported in tipper trailers, for which the tractor has an auxiliary 120-litre hydraulic tank. Its pneumatic brakes are operated by an electrically-driven Wabco compressor, controlled via a Lenze Schmidhauser inverter. Ten of these trucks are now in operation at distribution centres and container terminals in the Netherlands, Germany, Denmark and Switzerland, with a further four due by year end.

The truck itself looks the same as

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Terberg's offset-cab YT series distribution tractor, and uses a six-speed Allison 3000-series push-button automatic transmission. The liquid-cooled Siemens Elfa three-phase ac motor has a maximum power output of 138kW (185bhp) from 2,000–2,500 rpm, with peak torque of 780Nm from zero to 1,800 rpm.

Why no direct drive? As Terberg's senior project engineer Erik-Wim Vos says, the engineering issue is the same with an electric motor as an internal combustion engine: it needs the flexibility to operate at high torque and low speed on launch, with loads up to 65 tonnes, and to operate at higher speeds on the highway. "The Allison is a very good solution," says Vos, "and we use its PTO to drive the hydraulic pump, too. This saves us an additional drive and motor."

The maintenance-free batteries, supplied by US firm Valence Technology, operate at 614V and use LFMP (lithium iron magnesium phosphate) chemistry. This is "a little more robust" than other li-ion types, according to Vos. The batteries can handle up to 2,800 cycles from 0–100% charge, or 4,800 at 80% discharge. BMW's truck has two battery packs (113kWh capacity).

Low temperature is also "a challenge and a restriction" with batteries, says Vos. The LFMP batteries are not heated or cooled: they simply warm in operation, typically to 10°C above ambient. They can discharge at internal temperatures down to -10°C, but charging is only effective at internal temperatures down to -2°C – not an issue for 24-hour operations.

But charging solutions may change dramatically if a Highways England pilot for wireless inductive charging come in. The feasibility study 'Powering electric vehicles on England's major roads' has already led to £500 million funding for dynamic wireless power transfer (DWPT).

South Korea has one such system, supplying buses over a 24km route in Gumi since 2013.

OLEV (Online Electric Vehicle) buses can be charged while stationary or in motion, at a supply rate of 100kW. Despite having 17cm of ground clearance, the system delivers a power transmission efficiency from substation to vehicle of 85% (rising to 90% with reduced clearance) and the bus needs a battery only one third the size of an electric car's.

INTERNATIONAL COMPLIANCE

The technology, known as Shaped Magnetic Field in Resonance (SMFIR), has been tested at a supply rate of 180kW and complies with international electromagnetic emissions standards. Power strips cover 5–15% of the road length, and each section is only switched on when the OLEV vehicle passes over.

The UK feasibility study suggests that "a 40-tonne HGV requires 127kW traction at the wheel to maintain a speed of 55mph on the motorway". Obviously, peak power requirements are higher.

Though the study concludes that fully battery-electric HGVs are not feasible with present technology, it suggests that DWPT would need to be supplemented by static charging during rest breaks. However, given sufficient road coverage, with high-power DWPT systems (greater than 140kW), fully electric HGVs would become viable. TE

Regenerative semi-trailers

One solution that may help drivelines cope with periods of high power demand is Skeleton Technologies and Adgero's proposed KERS (kinetic energy recovery system) for semi-trailers. The UK and French firms are looking at a system using an electric drive motor/generator built into the axle of a trailer, and designed to harvest energy when descending and decelerating. Energy is then stored in ultracapacitors.

An intelligent management system tracks driver input to control the regenerative braking and acceleration boost, and the firms suggest that this system could reduce fuel consumption by 15–25%, depending on terrain and traffic profile, paying for itself "within three years". Road testing will begin next year with an unnamed French logistics company, the plan being to produce 8,000–10,000 units per year by 2020.