Advanced engineering

From range extenders for mid-range trucks to hybridised on-vehicle equipment, hybrid drivelines are seeing rapid engineering advances. Toby Clark examines some of the gains and the pains

Hybrid technologies are so diverse – from brake energy regeneration and stop-start systems in light commercials to hybridised on-vehicle systems for HGVs (driving, for example, mixer drums and waste compactors). And on again to gas turbine-charged electric systems on US highway trucks. So it's surprising that hybrid trucks aren't more mainstream. DAF, for example, launched its 12-tonne Hybrid LF distribution truck in 2010.

But the sheer variety of hybrids means they need to be specified very carefully. Mike Savage and Simon Shepherd, chief engineers at engineering consultancy Drive System Design (DSD), agree. "Lifecycle cost is important," explains Savage. "But because there is not a huge parc of hybrids out there, some costs are not well defined."

And he adds that the duty cycle is also key. "A good starting point is the velocity profile: how many stops and starts; average speed; and when there are chances to recharge." Analysis might then look at driveline torque data.

A full hybrid system, where engine-off running is possible, may not then be necessary. "There's a lot of value in lower-power mild hybrid systems for urban drive cycles," suggests Shepherd.

"It's surprising how little power you need in a secondary system," he adds. "If you're recovering brake energy and reusing it, you don't store much energy. You just need to recover the energy for each brake cycle. A 48V system for light duty would probably deliver a significant chunk [of the benefit] that a high-voltage system might do, and for a significantly lower cost."

Hydraulic hybrids are also making

Range extenders reach out to 26-tonners

Tevva Motors has been developing series-hybrid trucks – electrically-driven with a range-extending internal combustion engine – for a couple of years. It now has two proof-of-concept vehicles on chassis from partner JAC, China's second largest truck builder. The firm plans to move to series production of 7.5-tonners "within 24–36 months", but its retrofit conversions are already on stream.

"They are still at pre-production and very expensive [£75,000 plus battery lease]," concedes project manager Richard Lidstone-Scott. "So they will only be for early adopters." However, Tevva is now looking at 12-, 18- and possibly 26-tonners.

Telematics is vital for its trials, which are aimed particularly at validating Tevva's predictive range extender management system (PREMS). This previews a vehicle's daily route, in terms of road environment, and then operates the charging IC engine at optimum times, ensuring that the vehicle is emission-free in urban areas.

"Not only do we want to be totally transparent about the emissions we do generate, but also we can choose where we generate them," explains Lidstone-Scott. "Also, because we only run at three steady IC engine points – low noise, high efficiency and high power – we know that emissions measured on the dyno are the same as on the road."

But current emissions tests are not adequate. "There are no homologation rules that apply effectively," he says, reiterating that the range extender only runs at steady state and all drive cycles are transient. After VW's Dieselgate scandal, it is vital that emissions measurements are credible. "We are working with OLEV [the Office for Low Emission Vehicles] and LowCVP [Low Carbon Vehicle Partnership] to define a valid test cycle for this type of hybrid."

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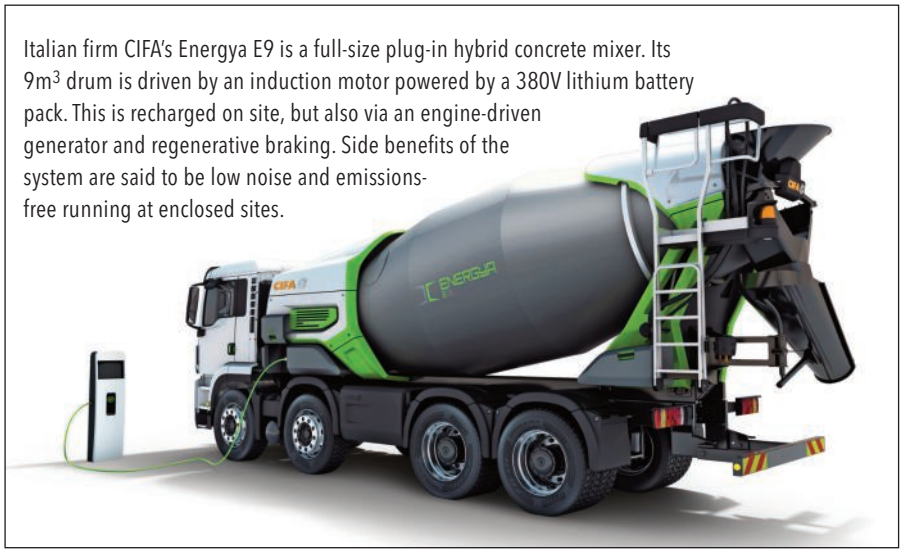
Simon Shepherd



Italian firm CIFA's Energya E9 is a full-size plug-in hybrid concrete mixer. Its 9m³ drum is driven by an induction motor powered by a 380V lithium battery pack. This is recharged on site, but also via an engine-driven generator and regenerative braking. Side benefits of the system are said to be low noise and emissions-free running at enclosed sites.

progress, particularly in municipal applications. Parker's RunWise transmission uses a PTO-driven hydraulic pump/motor to pressurise an accumulator under braking, which is then used to restart the vehicle. "Having a secondary system for auxiliary loads can be a very effective use of hybridisation, especially if they're electrical, because you're generating energy as it's going to be used," comments Shepherd. So hybridised container handlers, winches, etc, make a lot of sense.

Meanwhile, most electric and full-hybrid systems use single-speed transmissions, relying on the flexible torque characteristics of electric motors. But Savage believes there's also a future in multi-speed transmissions. "You're adding a little mechanical complexity, but saving energy overall," he says.

DSD's MSYS gearbox, for example, can handle high torque from a small package. "If you can use a small, high-speed machine and get the benefits of torque and speed from a gearbox, it can be 15% more efficient overall than a single-speed unit," explains Savage.

An electric motor may otherwise have to hit two or three extremes, adds Shepherd. "With a multi-speed gearbox, we're shrinking the operating envelope. So the motor can be smaller, meaning the cost of the motor and power inverter is significantly reduced."

SAFE MAINTENANCE

When hybrids go wrong, however, it is often ancillary systems that cause problems – and some may be down to the prototype nature of the vehicles. Last year, when Potter Logistics had been running two Mitsubishi Canter eco-Hybrid 7.5-tonners on delivery work for 18 months, fleet manager Colin Bamford said they were trouble-free. Since then, one of his trucks has seen repeated gearbox problems.

Nevertheless, it is possible that servicing hybrids may yet be easier and cheaper. "The electric motor, all of the power electronics and the battery packs are non-service items," comments Richard Lidstone-Scott, of Tevva. "And to change a motor out takes minutes and hours, rather than hours and days."

Conventional systems might also fare better. "We have to decide on a service schedule for our internal combustion engine, but it should be good," muses Lidstone-Scott. "We don't use a starter motor: we use the generator to turn the engine. And there should be much less wear and tear on the brakes because of the regenerative braking."

However, there remains the training issue. "When we take the Canter eco-Hybrid into the dealer, there's only one trained technician," says Bamford. That said, some training involves no more than electrical safety: with drive systems operating at 400V, and battery packs and capacitors retaining considerable energy, there is potential for lethal harm.

Additionally, high-voltage systems are usually fitted with a manual service disconnect (MSD) switch. This allows technicians to disconnect the power pack from the battery management system (BMS) and drive and control circuits. Also, an automatic high-voltage interlock loop (HVIL) cuts battery power and signals systems to shut down.

Tevva's technicians get several days' training. Perhaps surprisingly, 48V mild-hybrid systems are classified as ultra-low voltage so need less safety protocol. TE

The MSYS gearbox, developed by DSD sister company Evolute Drives, is a high-torque countershaft gearbox with an innovative cone clutch mechanism. Initially a three-speed unit, it can be packaged like a conventional front-drive transaxle and promises to improve the efficiency of electric and hybrid drivetrains by 15%.