

The future of hybrid engines

Electric vehicles have been around for more than a century (just as long as petrol, in fact), so the driveline technology is well-developed. Many manufacturers are using technology already proven in city bus applications. As far as urban and medium-range transport goes, all-electric trucks are certainly well on the way there, with most mainstream OEMs testing pre-production vehicles in commercial use with customers.

Long-haul maximum-weight remains the biggest challenge. Tesla claimed to have cracked that particular nut back in 2017 in a high-profile launch of its Class 8 (80,000-lb/36,300kg gross weight) semi which promised volume production and a network of dedicated chargers in place across North America by 2019. A range of 500 miles was projected, but no estimate of unladen weight was ever given. The truck's delayed market launch is now promised for this year.

Charging for long-haul is even more problematic than it is for other applications. Electric trucks have achieved the most penetration in the UK in the refuse collection application, where vehicles follow set routes, have predictable power requirements and spend long periods of time 'resting'

Internal combustion has a key role to play in the transition to zero carbon, argues Richard Simpson

back at the depot during which they can be recharged (Dutch example pictured above; for the UK, see www.is.gd/ibuhig).

In contrast, long-haul trucks can often be away from their bases for the best part of a week with the driver living in the cab, parking at the roadside overnight and drawing a 'hotel' load for creature comforts over night. Until there is a dense network of electrified truck stops around the strategic road network, electric trucks can only work on long haul if they can be fitted with some form of auxiliary power unit...or can charge on the go.

The latter is perhaps not quite so difficult as it first sounds. Scania has run a truck using overhead power lines like an old-school trolleybus (see also www.is.gd/ehijod). The idea being these would not only power the truck in motion, but also charge a small on-board battery pack enabling it to move on routes without the benefit of overhead power.

Ultimately it appears that the industry aims to move to hydrogen fuel cells: range and refuelling become less of a problem, but the creation, transportation

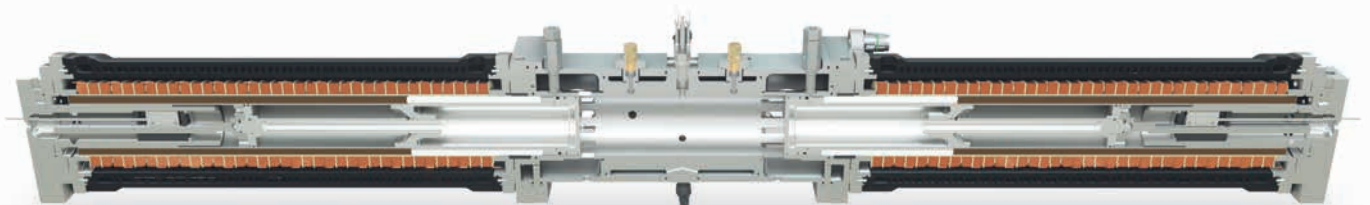


and storage of the gas remain fraught with practical difficulties. Currently most hydrogen is 'grey': made from methane; and this process releases more CO₂ into the atmosphere than burning methane directly in a combustion engine would.

GAS HYBRID

And that is a solution explored by US newcomer Hyliion, which has developed an electric truck powertrain that is supported by a natural-gas powered generator making a series hybrid (pictured, right). It is capable of travelling 25 miles on batteries alone (enabling it to enter zero-emissions zones), and up to 1,000 miles on gas power without refuelling.

Hyliion argues that its pure electric trucks can handle journeys of up to 250 miles, with the gas hybrid ERX running longer hauls. Unlike Tesla, which is developing a complete truck, Hyliion is offering its technologies - which use Dana motors and running gear - as bolt-in alternatives to conventional drivelines in trucks produced by mainstream manufacturers. It boasts that using biomethane, widely available in North America (and increasingly so here), as a road fuel makes the truck not just carbon-neutral, but carbon negative, and this may be of interest to European OEMs struggling with VECTO targets.





“Hybridisation with renewable fuels such as bioethanol could play an essential role in the rapid decarbonisation and electrification of transport”

Sam Cockerill

This solution is entirely feasible in the North American market, where Class 8 is dominated by bonneted trucks with long chassis, and buyers can exercise considerable control over driveline choice by, for instance specifying a Cummins engine and Eaton transmission in place of the OEM components. It might pose more of a challenge in Europe with its vertically-integrated drivelines.

Spanning both markets, Allison Transmission has an interest in hybrid drivelines, having produced its first hybrid bus transmission in 2003 and now has 9,000 diesel hybrid vehicles running in the transit bus market. Alexander Schey, its chief commercial officer, electrification, said: “Actually the industry appears to be moving away from this, and more towards hydrogen fuel cells as the range extender, at least for long-haul trucking. However, there is an interesting angle here for Allison’s eGen Flex, which allows electrical or internal combustion propulsion. There are some applications – for example mobile cranes – that have EV requirements, for example last mile on electric mode, or operating the crane electrically, but where a pure EV or hydrogen solution is not practical or effective enough. In these applications, eGen Flex could be a good stop-gap.”

Energy costs obviously vary between North America to the UK, but fuel

consumption reductions in the order of 25% have been recorded on city bus operations and overall cost per mile calculated at \$2.32 for the hybrid compared to \$3.29 for the all-electric equivalent bus.

Moving into the world of high-power haulage, Schey points out that Allison’s 100D e-axle has an output of 550kW; equivalent to 738bhp, and up there with the 16-litre diesel trucks. He points out that such technology is power-agnostic: the electricity can come from batteries, fuel cells or an engine-driven generator.

Packaging is obviously an issue. Different OEMs and end users will have varying requirements for power and range, and batteries, electrical components and independent power sources will all be competing for space.

ANOTHER WAY

A possible solution here is the crankless engine: a pair of unconnected opposed pistons generating electricity through reciprocating induction without the inconvenience of rotary motion

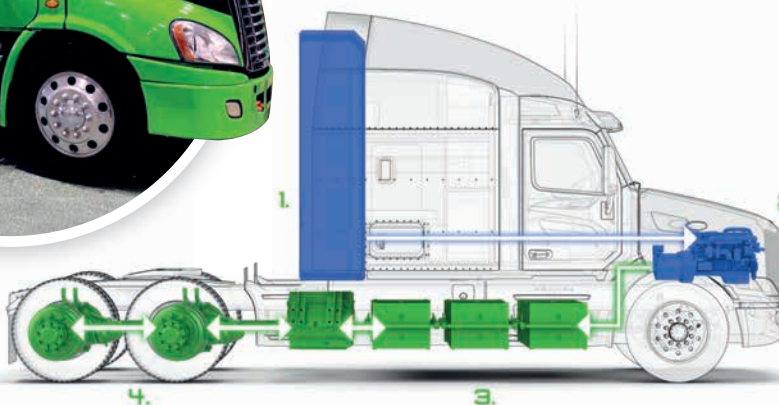
(pictured, below left). The introduction of a fuel mixture and a carefully timed spark drives the pistons down

the cylinder where they rebound off air springs, enabling the cycle to repeat. Sheffield-based Libertine has developed just such a free piston engine, which also benefits from a variable compression ratio, giving it a multi-fuel capability.

Libertine’s CEO Sam Cockerill said: “Hybridisation with renewable fuels such as bioethanol could play an essential role in the rapid decarbonisation and electrification of transport, especially in heavy-duty vehicles where battery technology and charging infrastructure could limit the pace of the transition to net zero.”

The slim design of the Libertine engine lends itself to modularisation; it could easily be slotted alongside the battery pack on a commercial vehicle, and dispenses with the need for a separate generator, allowing the end user to specify fewer cells (although at the cost of less ‘pure electric’ range) in exchange for the ability to recharge on the fly using a range of fossil or biofuels.

In March 2021, the company won £2.6m to develop a performance validation prototype. That involves integrating a Mahle Powertrain pre-chamber ignition system to form a multi-cylinder opposed free piston engine, optimised and calibrated to start and run cleanly on renewable alcohol fuels. **TE**



1. RNG FUELS GENERATOR 2. GENERATOR CHARGES BATTERIES 3. BATTERIES POWER E-MOTOR 4. E-MOTOR DRIVES REAR AXLES AND PROVIDES REGENERATIVE BRAKING