Hybrid highways

Hybrids are being suggested as our best route to preserve oil reserves, with application-specific solutions launching at an increasing rate. John Challen looks at some of the more promising engineering opportunities

Commercial vehicle operators should now be preparing themselves for the next generation of trucks and vans likely to be manufactured with electric motors and big battery packs onboard. It is no coincidence that the vehicle manufacturers are looking closer at hybrids now: fuel prices are rising and increasingly robust technologies are becoming more widely used in the high-volume passenger car market, meaning falling prices. Diesel hybrids, plug-in hybrids and fuel cells are all being evaluated but, just as in the automotive market, adoption in the commercial fleet world is likely to be slow, with operators understandably wary of the extra cost of any hybrid system, with its and novel componentry.

One of the most recent developments on electric and hybrid vehicle powertrains comes courtesy of Torotrak, whose Flybus uses flywheel hybrid technology connected to a KERS (kinetic energy recovery system) device, similar to that used in last season's Formula One Grand Prix series. Torotrak was key to developing that technology, and now seems set to transfer the knowledge to commercial vehicles, where it says fuel savings of more than 30% are possible.

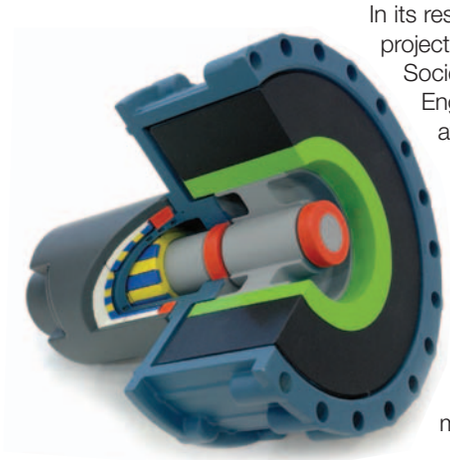
As revealed in the December issue of Transport Engineer, the Flybus project is headed by Torotrak, with additional participation from Optare (whose Solo midibus will provide the test vehicle) and Ricardo, the UK consultancy.

In its research ahead of the project, Torotrak addressed the Society of Automotive Engineers (SAE) in an attempt to shift thinking away from the traditional combustion engine. "Flywheel-based mechanical hybrid systems offer a much shorter payback time and do not reduce the number of passengers that can be carried [on a bus]," explains Chris Brockbank, Torotrak's business manager. "They are also a fundamentally more efficient approach, as energy remains in the mechanical state. With electrical regeneration there is an efficiency loss at each state change from mechanical to electrical to chemical and back again," he adds.

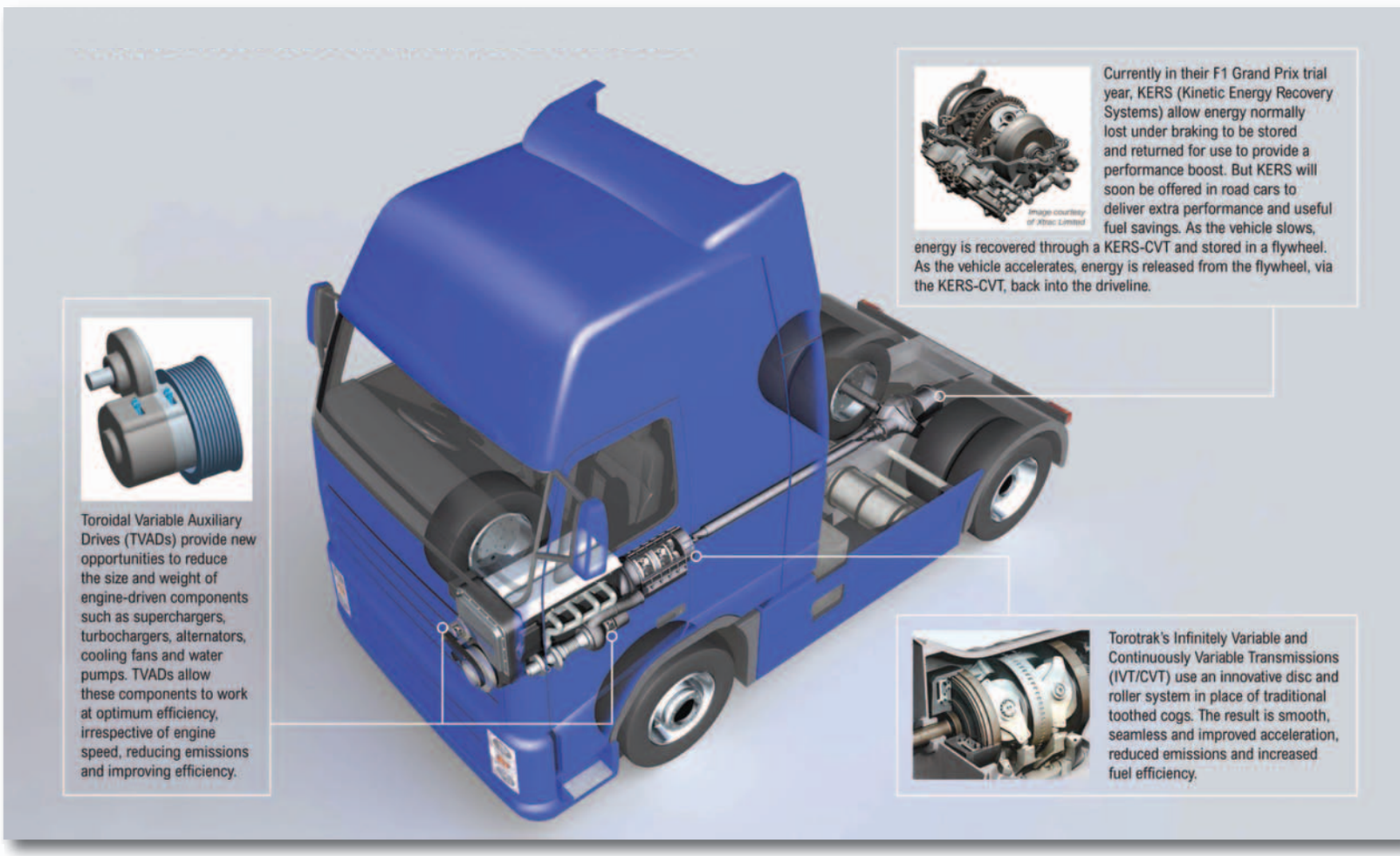
As well as Flybus, Ricardo is to head another project looking at the potential for flywheel efficiency savings in commercial vehicles, covering all areas from bearing design to materials. The company's KinerStor programme aims to demonstrate the viability of low-cost flywheel hybrids. At the heart of its work is research into flywheel subsystems that will then be used to build up two new approaches: a mechanical/magnetic coupled flywheel, developed by Ricardo (Kinergy), and an electrically-coupled unit, developed by Williams Hybrid Power.

Ricardo hopes that the results of KinerStor will make their way into propulsion systems from Torotrak and Williams Hybrid Power, which are both part of the KinerStor consortium, alongside CTG, JCB, Land Rover and SKF. When commercially available, one of the key markets for the systems will be low-cost, compact energy storage systems for heavy-duty vehicles. No less than 30% savings in fuel are expected from this system too, which should cost in the region of £1,000 a unit.

Meanwhile, another hybrid development, this from road cars initially in 2002, is Connaught Engineering's Hybrid+ system, which the company believes has huge potential in commercial vehicles. Last year, Connaught signed a deal with the RAC to run two Ford Transits, using its system. Contrasting

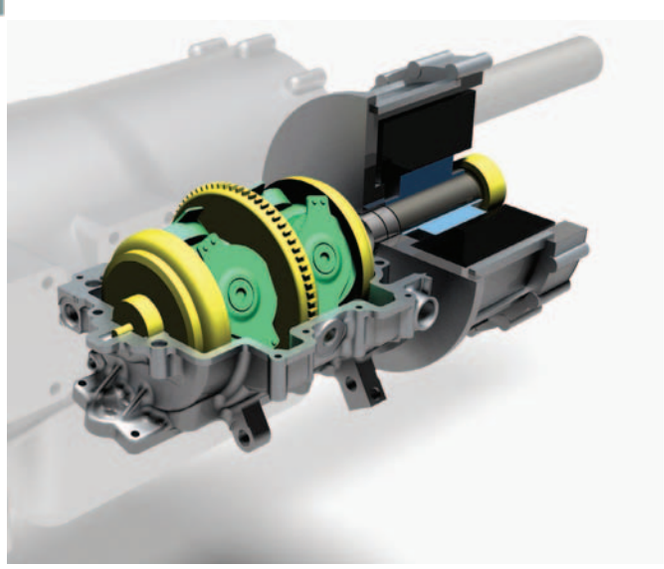


Below: The Kinergy high-speed, sealed flywheel energy storage system
Right: Transit equipped with Connaught's Hybrid+ electric motor powered by super-capacitor
Below right: Torotrak's flywheel hybrid technology



with the original version on Connaught's Type-D sports coupé V10 engine, Hybrid+ comprises an under-bonnet, belt-driven motor/generator, which feeds a bank of super-capacitors, instead of batteries, to save space and to eliminate problems with battery disposal. Connaught quotes prices from £2,750 and says the system can be fitted within a day. In return, operators see a claimed fuel economy improvement of more than 20% in town driving and 15% on the combined cycle.

Beyond the current engineering developments surrounding hybrid bus and truck powertrains, however, an increasing number of engineers believe there is potential in the long-term for vehicle propulsion via hydrogen fuel feeding fuel cell stacks.



In 2009, Proton Motor, a subsidiary of Proton Power Systems, announced the that it had developed the world's first fuel cell-driven street cleaning vehicle. Delivered to the Swiss city of Basle, the vehicle is currently undergoing field testing in the city and nearby towns. Measuring 3.5m-long and 1.28m-wide, the machine has a maximum laden weight of 4.5 tonnes.

Fuel cells clean up

Proton Motor's street cleaner replaces the diesel engine with a fuel cell and battery setup. It also swaps the hydraulic powertrain for electric drives. Core of the system is a 20kW fuel cell system, working in conjunction with lithium polymer batteries. Its nominal 27bhp output provides a maximum speed of 25mph and a range of more than seven hours on a full tank. The vehicle's tank can hold 6.5kg of gaseous hydrogen at 350bar, and from empty it takes 10 minutes to fill the pressure vessels, which are stowed behind the driver's cab.

Proton Motor says its emission-free approach to motoring enables energy savings of more than 50%,

Above: Torotrak highlights solutions for hybrid powertrain systems for trucks of the very near future

Above: World first fuel cell-driven street cleaner, from Proton Motor, now moving onto buses
Right: The fuel cell system exposed

compared with a standard diesel engine. One kilo of hydrogen equates to three litres of diesel, so, where a diesel-powered bus consumes around 55l/100km, Proton reckons vehicles fitted with its technology willl consume between 25-30l/100km.

Which brings us to last year's application of the company's triple hybrid fuel cell system in a bus. As with its street cleaner, Proton envisages halved energy usage, thanks to its 50kW PM Basic A 50 fuel cell system – also used in the world's first fuel cell-powered ferry, the FCS Alsterwasser. Despite using a much larger fuel tank than Basle's street cleaner (20kg, compared with 6.5kg), gaseous hydrogen can be filled in the same 10 minute timeframe, and gives a range of 155 miles (250km).

Range extender technology

Thomas Melczer, CEO of Proton Power Systems, believes that such projects are just the beginning for fuel cells: "There are currently some interesting discussions about electric mobility, and we see huge potential for our system to be used as a range extender for commercial vehicles, especially in the light-duty class." And he adds that, while the 50kW power pack is ideally suited to trucks, its starting point is on smaller vehicles, simply because that is where Proton Power Systems finds most demand.

"Our systems can also power auxiliary items, such as air conditioning, lights and entertainment systems. This is an important factor when you look at smaller electric vehicles that only provide an 87 mile (140km) range, and are limited in terms of the size of batteries that can be used," says Melczer.

Interestingly, Proton Power has also signed a framework collaboration deal with Deutsche Mechatronics, to help start volume production of the company's fuel cell systems in Germany, and Melczer says that his "small compact system, which is easy to fit, service and replace" could be used in as much as 50% of some operators' fleets.

That said, one of the problems surrounding the future for hydrogen remains the infrastructure. With both governments and OEMs not keen on making a financial commitment, there is a standoff. Melczer, however, thinks this can be overcome.

"In Germany, an initiative has been signed that involves companies such as Linde and Daimler, that will see the development of an infrastructure of hydrogen filling stations all over the country," he explains. "When industry sees what is happening in Germany, there will be developments elsewhere. It is important that industry has a sophisticated mix of alternative powertrains, and not just electric vehicles or fuel cell-powered transportation."

Elsewhere in Germany, refuse vehicles maker Haller has expanded its fleet of vehicles using the Rexroth hydrostatic regenerative braking (HRB) system, to 10, following a successful initial trial of one truck in Berlin in 2008. Its system captures kinetic energy when the truck stops, storing it as hydraulic pressure that is then released when the vehicles move off, so assisting acceleration. When its tanks are fully pressurised, the HRB motor can

deliver 335bhp and 2,500Nm of torque.

Haller's vehicles are in use as demonstrators and in-service by the company itself, and it reports excellent results. Rexroth has also supplied one system to the US – for New York City's Department of Sanitation. That authority is conducting a year-long trial with an HRB-equipped LET2 truck, from Crane Carrier Company, as part of a much larger investigation into the use of alternative drives.

Glenn Pochocki, vice-president of Crane Carrier, insists that hybrid drivetrains will become a "necessity in the near future" and says he was keen to provide the opportunity to improve the New York City fleet's performance and efficiency. TE

Bus stop-start

Research and development at Grayson Thermal Systems into hybrid systems for buses has resulted in a number of methods to increase efficiency, as well as passenger comfort. The company says it currently has a 30kW thermal resistor under evaluation by a hybrid drive manufacturer in a bid to eliminate conventional diesel-fuel heaters – with the resistor supplementing heat from the engine to boost the energy efficiency of interior heating.

Heat that was previously externally vented when the battery was fully charged, is now fed back into the heater. As well as more efficient running, benefits include faster warm-up times for the bus interior and overall increased heating for the bus' traditional water-to-air heater. Following the initial trial on one bus, the firm is now introducing 10 production units for trial with London Transport.

Grayson Thermal Systems managing director Stuart Hateley says the company is also considering a smaller unit for trucks and other commercial vehicles, as well as a pre-heating element to warm the bus cab prior to the driver entering the vehicle.

Hateley is also in talks with ComeSys Europe about an electric fan system that saves fuel, compared with the conventional hydraulic drive fan used by bus and coach operators. The fan uses Grayson's heat exchange technology, and is operated using ComeSys control systems. According to the company, operators have experienced fuel savings of between five and 10% using the new fan.