

# Injecting IDEAS

With 15 speakers and 150 delegates from all over the world, Delphi's CV powertrain conference turned the spotlight on upcoming emissions legislation and associated engine technologies.

Brian Weatherley reports



Every now and then *Transport Engineer* gets a glimpse into the future in the company of acknowledged experts. At Delphi's CV powertrain conference, held at its Gillingham technical centre, there were plenty on hand willing to share their predictions on the diesel engine technology that truck operators will be embracing as we head towards a notional Euro 7.

Setting the tone, Liam Butterworth, president of Delphi Powertrain Systems, declared: "Euro 6 emissions regulations came into force for all vehicles sold last year, but standards like these are only going to get tougher. They are driving developments throughout the vehicle and powertrain, and their impact will be felt especially in fuel injection and after-treatment systems."

But he continued: "It's becoming increasingly difficult to reduce emissions per unit of fuel consumed, which means the focus is turning towards fuel

efficiency." This, he said, is leading to new technological challenges, not only in terms of efficiency and CO<sub>2</sub>, but also NVH (noise, vibration and harshness), consistency, thermal management, stop-start and hybrid engine capability - as well as low-grade and alternative fuels.

Nevertheless, if you thought the heat was off diesel engine-makers now the dust around Euro 6 has settled, barring any final tweaks (*TE* March 2015, page

23), think again. While the emissions focus in the US and Europe has now turned to CO<sub>2</sub>, Delphi believes one of the biggest challenges will also be further reductions in NO<sub>x</sub>. So far, the most important projected regulations are the draft 2020 US standards, says the firm, adding that it expects levels between 0.1 and 0.02 g/hp-hr - compared with today's US Federal 2010 level of 0.2g/hp-hr. While Europe



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### Delphi pumping revolution

While Global FIE provider Delphi is playing its cards close to its chest, *Transport Engineer* understands that its MCA (modular concentric architecture) pump, currently under development, includes design innovations, particularly within the control valve and actuator assembly. Moreover, MCA is expected not only to be revolutionary in concept and operation, but also to drive new manufacturing techniques.

heavy-duty diesel engine standards are likely for Europe. For on-road vehicles, Carrasco talked initially of good news: "Euro 6 is already established and for 'Euro 7' no regulations or limits have yet been proposed." However, she also advised that further NOx reductions could be expected from the current 0.4g/kWh to 0.2g/kWh from 2020.

Importantly, she added: "An NO<sub>2</sub> limit will be introduced at about 45% of NOx emissions. And [on] particulate content, they are thinking of particulates down to 10 nanometres from 2025, so we will have to develop technology to measure that." Carrasco also reported that CO<sub>2</sub> monitoring and declaration are likely to be in place by 2018, with limits following between 2020 and 2023, though that timetable is uncertain.

That said, and while we wait to learn what Brussels will do in terms of emissions, Delphi is developing its next-generation fuel injection systems. Why? Global powertrain sales director Richard Green said Delphi believes that, just as Euro 6 brought Europe more into line with the US, future European regulations will follow North America, demanding reduced CO<sub>2</sub> and fuel consumption. "We all know that the major contributory factor here will be aerodynamics, but we can still show significant improvements ... with advanced fuel systems."

Incidentally, as vehicle manufacturers look to further enhance what Green described as the driving experience, he offered another thought. "From an NVH perspective, we see some of our heavy-duty customers looking to deeply integrate the fuel system into the

engine, rather than bolting equipment on the side. This gives them advantages in noise and other areas as well."

By way of example, Green suggested: "If you look at the current DAF MX 11 and 13 engines with [Delphi's] F2P injection system, they use a pump integrated into the block. While this isn't a new concept [it's the same as Delphi's EUP], it is unique for a common rail system. Most use remote HP pumps. Where we use the MCA pump concept [see above], the individual pumping elements - which are considerably smaller than an F2P unit - could be mounted into the block or cylinder head, driven by a lay shaft, overhead camshaft or conceivably crankshaft."

Back on emissions and fuel consumption, Green postulated: "We need to offer flexible injection characteristics and more injection events than manufacturers typically use today. We also need to offer multiple injection controls so there can be more small injections with closer separation." Control is the key word here: Delphi is

doesn't automatically follow, the rule-makers in Brussels will be watching.

So, what does the Delphi crystal ball show? Despite emissions reductions achieved through Euro 6, Richard Judge, chief engineer for medium duty at Delphi Diesel Systems, suggested that there is likely to be ongoing demand for further improvements. The result: "To go to lower NOx and PM [particulate matter], key tools will be fuel injection pressure, injection quantity and injection timing control."

Meanwhile, Maria Isabel Segura Carrasco, from AVL (the world's largest independent powertrain systems development firm), hinted that new



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clear that its customers want support for differing combustion strategies with selectable rate shaping.

Key to that, asserted Green, is closed-loop control – not only for monitoring and optimising real-time performance at each injector, but also for optimising performance over the life of the vehicle. That could also be useful, in terms of meeting future regulatory requirements around longer-term engine operation.

Real-time injector monitoring would also allow fuel quality to be tracked – an issue raised not only by Green but several speakers, particularly with regard to emerging markets. “We also see challenges from biofuels coming from a

When can we expect F3 medium- and heavy-duty common-rail systems and improved electronics? Delphi is aiming for 2019, allowing for OEM adoption as part of engine upgrades and new releases. So operators and workshops should start to see them from 2020.

That said, Delphi’s revolutionary MCA pumping concept should be available for several application types. “It can go directly into the engine; it can go into a remote pump... We are well advanced with the injector and on track with the pump,” reported Green. And looking ahead, he said there will be a clear upgrade path. “Our next generation of

Euro 5 and 6 haven’t changed. “The drive for more multiple injections with closer separations drives us to new injector technology – so smaller, lighter barrels, reducing leakages for improved efficiency and economy. In terms of pumping, that means smaller units, allowing better integration to the engine, improved NVH and increased efficiency. Those are the key elements.”

Delphi’s engineering director for CV FIE powertrain systems David Draper also predicted improvements in diesel engine and after-treatment controls. “Clearly, there will be more use of sensors, particularly around NOx and ammonia, to allow even better SCR [selective catalytic reduction] efficiency. Delphi is well positioned to provide some of these sensors, and we’re talking to customers now,” he said.

Beyond that, he pointed to electrification of engine ancillaries, such as water pumps, as a valuable mechanism to save energy and fuel. “The after-treatment structure – with an SCR catalyst and particulate filter – will remain. But over the next five to 10 years, it’s about providing inputs to control ancillary devices more efficiently. Beyond that we can see developments around, for example, variable valve trains to improve engine efficiencies.” **TE**



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multitude of feedstocks that can impact fuel system and engine performance. Our customers require us to cope with a range of fuels – not just diesel, but natural gas and DME [dimethyl ether].”

Meanwhile, Delphi is continuing to develop its range of CV powertrain components, including the medium- and heavy-duty fuel injection line-up, which now includes mechanical rotary systems, electronic unit injectors and electronic unit pumps, plus a plethora of common rail systems.

Green reassured delegates that the approach of supporting manufacturers’ existing engine designs continues. However, as the company moves from its F2 to F3 solutions, he also promised innovations, with smaller injector components that are lighter and faster, exhibit lower leakage and are more efficient. “We’ll also upgrade the electronics, so we’ll move from the current ETC3 to ETC4,” he asserted.

systems will be high performance, high efficiency and accommodate various fuel quality and lubricity issues.”

So which FIE features will follow next on diesel engines? James Kewley, Delphi’s chief engineer for CV FIE powertrain systems at its Stonehouse site, reckoned the challenges set by

### Tomorrow’s diesel engines

The following features were cited by a number of speakers at Delphi’s powertrain conference as likely to appear within eight to 10 years on heavy-duty engines, not least to meet future emissions legislation.

- Advanced turbocharging/compound-turbocharging
- Electrically-powered ancillaries
- Waste heat recovery, both electrically and mechanically
- Optimised air-handling

- Improved FIE control software and on-board diagnostics
- Variable valve timing and cylinder deactivation
- Reduced friction measures
- Engine down-speeding
- Mild-hybrid systems and stop-start on medium- and heavy-duty diesels
- Alternative fuels.

See future issues of *Transport Engineer* for more from the Delphi conference.