Euro 6 drivelines: whatever next?

from in association with Commercial Vehicle Engineer

September 2014
Always supporting

Support You Can Depend On.

For Euro 6, Cummins’ engineers are working as part of vehicle manufacturer’s teams to deliver both environmental and operational benefits. The result is optimum levels of performance and running costs with near-zero emissions. In service, our trained technicians will provide responsive support for all Cummins Euro 6 powered vehicles, maintaining the highest levels of availability. This makes Cummins your natural choice for Euro 6. Visit www.cumminseuro6.com for more information.
4 They think it’s all over
The main Euro 6 goals may have been met but the final
whistle on technology challenges for diesel engines is still a
long way off. Cummins product environmental
management director Pete Williams explains why
engineers’ attention is now turning more and more to the
detail of future European legislation on carbon dioxide
emissions from trucks and buses as it gradually emerges.

7 What next from Cummins?
Two years on from the launch of its ground-breaking Euro
6 range, the world’s biggest independent diesel engine
manufacturer is busy reconciling local demands for top-
notch fuel economy with global economies of
manufacturing scale and regional rules on greenhouse gas
emissions. Tim Blakemore hears from seasoned Cummins
engineers about how they do that.

10 Turbocharger technology
comes of age
As Cummins Turbo Technologies prepares to move into a
new, purpose-built Huddersfield manufacturing plant, the
company’s research and engineering boss reckons it is
“aligned for success” more than ever. Visitors to this year’s
IAA commercial vehicles show in Hannover can expect to
see exactly what he means.

12 Driving towards an uncertain future
Self-driving vehicles and forthcoming EU legislation on CO2
emissions from trucks and buses are sure to be among the
main talking points at the 2014 IAA show. And with Euro
6 technology starting to filter down into vans, it is shaping
up to be an event that no forward-looking commercial
vehicle engineer ought to miss. Tim Blakemore reports.

14 Proof of the pudding
Two years on from the launch of the first Euro 6 Cummins
engines we have been taking a look at who is using them
and why.
They think it’s all over

The main Euro VI goals may have been met but the final whistle on technology challenges for diesel engines is still a long way off. Tim Blakemore quizzes Cummins product environmental management director Pete Williams on the ways in which attention is turning to the nitty-gritty of future European legislation on carbon dioxide emissions from trucks and buses as it gradually emerges.

Two dates are linked most often and most intimately with European Union Regulation 595/2009. That’s Euro 6 to you and me, or Euro VI if you want to be strictly accurate and distinguish between emission limits for trucks, buses and coaches above 3.5 tonnes gvw and lighter commercial vehicles below this threshold. The first of these dates, 1 January 2013, was when Euro VI limits (let’s stick with the Roman numerals here for avoidance of doubt, as our learned friends might say) came into force throughout Europe for newly-type-approved vehicles. The second, 1 January 2014, applies to newly-registered vehicles. So with both these deadlines now well and truly behind us, a fair assumption would seem to be that the pressure is off for engineers at manufacturers of trucks, buses and their diesel engines. Not a bit of it. For one thing, the second of these two deadlines turned out to be not quite so immovable as it had seemed, at least so far as UK buses and coaches are concerned. And for another, as Pete Williams, product environmental management director at Cummins’ EMEA (Europe, Middle East and Africa) division, knows better than most, the 1 January 2014 was never going to be the final chapter of the whole Euro VI story anyway.

Buses and coaches in the UK

Let’s start with the PSV (passenger service vehicle) angle. The UK market for buses and coaches is much smaller than the truck market, barely a tenth of its size judging by registration figures from The Society of Motor Manufacturers and Traders (SMMT). Perhaps partly as a result of this, UK coach and bus operators have always seemed even less willing than their counterparts to embrace Euro VI technology until they had to. Small wonder then that a collective sigh of relief could be heard last year when it emerged that an anomaly in the British government’s application of European Union vehicle type approval rules (ECWVTA, European Community Whole Vehicle Type Approval, in the Brussels jargon) meant, in effect, that bus and coach manufacturers here would have as much as an extra year to carry on supplying Euro V vehicles.

This is because UK regulations on type approval through “small series” or “individual vehicle approval” (IVA) routes have not yet been updated. This is of far greater significance to bus and coach suppliers and operators than to their counterparts in the truck business simply because production numbers...
are generally smaller.

As their names suggest, the small-series and IVA type approval routes are designed for vehicle manufacturers with small production runs. The upper production limit to qualify for small-series type approval is 1,000 of any particular vehicle “type” per year across the whole of the EU. The cost per vehicle of type approval by small-series or IVA is higher than for the “Certificate of Conformity” (COC) large-scale route but not so high as to deter at least three of Britain’s top-selling bus-builders: Alexander Dennis (ADL), Wrightbus and Optare. They are all accustomed to using the small-series type approval processes and are now content to carry on doing so with Euro V vehicles until new UK rules on small-series and IVA type approval at Euro VI are in place. That seems unlikely before the end of this year.

Even high-volume multinational manufacturers such as Mercedes, Scania and Volvo, all of which are now fully geared up to building Euro VI drivelines in big numbers for trucks and buses, are happy to take advantage of Britain’s type approval loophole, it seems, for as long as their bus and coach customers continue to demand Euro V vehicles. “It gives us some wriggle room,” says an engineer at one of these manufacturers.

That is not to say that there is zero demand at present from UK operators for Euro VI buses and coaches. London, as usual, is a bit different from the rest of the country when it comes to bus specifications. The latest Transport for London (TfL) tenders demand Euro VI vehicles (diesel-only or diesel/electric hybrid). One reason why operators throughout the country are now far less wary about Euro VI than they have been in the past is that vehicle manufacturers have assiduously addressed concerns about weight and fuel economy, largely by engine “downsizing”.

Take the new Euro VI Enviro400 double-decker from ADL, for instance. It was unveiled in May, claiming to be 400kg lighter than its predecessor (also called Enviro400) and more fuel-efficient. The new Enviro400’s power unit is a 250hp 6.7-litre Cummins ISB6.7 six-cylinder engine, mounted transversely at the rear and driving through a fully automatic (epicyclic) gearbox to a ZF AV132 drive axle. Gearbox choice is between a six-speed ZF EcoLife 6HP1203 and four-speed Voith D854.6 W53. The old Enviro400’s Dana front axle is replaced by a ZF RL75 axle on the Euro VI ADL double-decker.

Not a single panel or piece of glass is said to have been carried over from the old model. Among the selling points of the new double-decker are an innovative heating and ventilation system, claimed to be exceptionally efficient, and a quick-release glass system which cuts window-replacement time dramatically. ADL chief executive Colin Robertson says that the new double-decker is the culmination of a three-year “customer engagement programme” involving around 70 operators and suppliers such as Cummins. The development project is claimed to have taken account of every fault reported on every ADL two-axle double-decker since 2006. “Every aspect has been meticulously thought out and built as part of this unique partnership involving customers from all walks of the industry, suppliers with unique, specialist skills, and drivers from up and down the country,” says Robertson.

Doubtless recognising operator concerns over Euro VI, ADL has focused sharply on whole-life operating costs with the new Enviro400, with particular emphasis on repair and maintenance costs. Evidence of this includes easier access to the wiper motor and fuel tank; wide-opening engine compartment tailgate and side doors; and a multiplex wiring system with short, modular sections that can be changed and clipped back into place with ease.

Initial operator reaction to the new ADL decker suggests this approach is well-judged with around 400 Euro VI Enviro400s said to be on order even before full-scale production started. Another 120 are thought to be due for delivery over the next twelve months to operators including Go-Ahead, Stagecoach and Reading Transport.

Where next and what next for Euro VI?

As boss of the product environmental management team at the Cummins engine manufacturing plant and technical centre in Darlington, County Durham, Pete Williams needs to keep fully up to date with Euro VI regulations as they affect not only buses and coaches in the UK but all vehicles in his EMEA (Europe, Middle East and Africa) patch. Indeed he also needs to maintain a weather eye on what is happening whatever next? Euro 6 drivelines
much further afield too, not least because of the global spread of customers for Darlington-built engines. It was clear from the start that Euro VI standards would be the first to employ “world harmonised” test cycles, he explains, pointing specifically to the World Harmonised Transient Cycle (WHTC), World Harmonised Steady State Cycle (WHSC) and World Harmonised Not To Exceed Zone (WHNTE). Much less clear initially, however, was how many regions of the globe outside Europe would choose to adopt Euro VI emissions standards in preference to those of Japan or the US Environmental Protection Agency. Now Williams reports that South Korea is expected to adopt Euro VI, albeit with some modifications, from 1 January 2015. Turkey is expected to be not far behind. Australia, which originally seemed undecided on whether to adopt EPA or Euro VI standards, now appears to have come down in favour of Euro regulations, probably coming into force in 2019.

Meanwhile, as always planned by European Union law-makers, the second and third phase of Euro VI regulations, focused on increasingly stringent on-board diagnostic monitoring, are set to come into force in Europe over the next two years. This month, 1 September, is the deadline for newly type-approved vehicles to meet “phase B” of the regulations, followed by the customary twelve-month breathing space for all vehicles to meet the same standard. Two completely new requirements in phase B are on-board diagnostics “threshold limits” (OTL) and particulate number limits for “positive ignition” (pi) engines, gas engines in other words, as distinct from compression ignition (ci) diesel engines.

Then comes the final phase of Euro VI, applicable to new vehicles from 31 December 2015 and all vehicles from 31 December 2016. The main effect will be to tighten oxides of nitrogen (nox) and particulate matter (pm) controls still further, not least by introducing an “in-use performance ratio” (IUPR) requirement for 600 equipment for the first time. This in effect will mean that the 600 equipment will have to work harder (sampling emissions more frequently) and be more precise, explains Williams. When it comes to accuracy of particulate sensors the legislation was in danger of being unrealistically ahead of available technology. No currently available sensors would have satisfied the phase B rules originally planned for introduction this month. Sensor manufacturers will be able to deliver what the Euro VI legislators want within the next two years.

**Where do we go from here?**

The short answer to this question is: towards legislation focusing on “greenhouse gas” emissions, carbon dioxide in particular, rather than on pollutants such as oxides of nitrogen (nox) and particulate matter (pm). It has been clear for several years that European Union legislation along these lines is on the way. Equally clear, however, is that the European Commission is loth to follow too closely in the footsteps of either Japan, which introduced legislation on truck and bus fuel consumption (and thus CO2 emissions) in 2007, or the US and Canada where broadly similar legislation, described rather uncharitably by some European engineers as “quick and dirty”, came into force first in 2011 and 2012. The expected effect is to force truck and bus-makers in North America to improve the fuel efficiency of their products on aggregate by minimum specified percentages against a 2010 baseline, in much the same way as the CAFE (Corporate Average Fuel Economy) legislation did with American cars long ago. The consensus among many engineers so far, even those surprised at the speed with which the US legislation has been introduced, is that it has been effective. Some are more than a little concerned that the European legislation could be too ambitious, too complex and risks getting bogged down in costly administration. There is also a more specific concern that, unlike the US legislation, the EU's may fail to take proper account of the distinct and separate influence on fuel economy of individual power units.

The EPA 2014 and 2017 regulations on greenhouse gas emissions from trucks employ two types of standard metrics: grams of CO2 per ton-mile for “vocational” vehicles (such as tipper and mixer rigid trucks) and tractive units, and payload-dependent grams of CO2 per mile for lighter vehicles such as pick-up trucks and vans.

The European Union certainly will not be following suit, though it is being urged to take at least one leaf out of the EPA book by including separate limits for engines as well as for complete vehicles. Since 2009 the European Commission has been working with ACEA (Association des Constructeurs Européens d'Automobiles), the European vehicle manufacturers association, on computer software to precisely simulate the fuel consumption of a vast range of heavy commercial vehicle types. The program is called VECTO (Vehicle Energy Consumption Calculation Tool). The ambitious aim is to make this the world’s first piece of software of its kind: capable of precisely simulating CO2 emissions of virtually any particular truck, bus or coach and thus encourage operators to specify the most fuel efficient. A “proof of concept” report on VECTO was published in April 2013. In May this year (2014) the European Commission’s “strategy for CO2 emissions from trucks and buses” was published, confirming that it centres on VECTO. It now seems likely that the first VECTO-based European Union legislation proposals making it mandatory for CO2 emissions from new trucks and buses to be “certified, reported and monitored” will be published next year. Precisely what data will be required to be input into the VECTO database from engine manufacturers remains unclear, however. ACEA meanwhile has welcomed what it sees as the “full transparency on fuel efficiency” promised to result from this EU certification system.

“This system will empower customers to compare and choose the most fuel-efficient vehicle combination adapted to their needs,” said ACEA secretary general Erik Jonnaert in response to the European Commission’s May announcement. “Customers are the best regulators for fuel efficiency.” The regulators themselves seem to disagree on that point. And exactly how those customers will take to being further “empowered” in this way remains to be seen.
What next from Cummins?

Two years on from the launch of its ground-breaking Euro 6 range, the world's biggest independent diesel engine manufacturer is busy reconciling local demands for top-notch fuel economy with global economies of manufacturing scale and regional rules on greenhouse gas emissions. Tim Blakemore hears from seasoned Cummins engineers about how they do that.

Two years ago Neil Pattison, Jonathan Atkinson and their fellow senior Cummins engineers in Europe were preparing to put the company’s first Euro 6 engines, the ISB4.5 and ISB6.7, on public display for the first time at the huge IAA (Internationale Automobil-Ausstellung) commercial vehicles show in Hannover, Germany. Who better then to turn to now for a snapshot of the latest developments from the world’s biggest independent diesel engine manufacturer and a preview of the Cummins technology set to be taking centre-stage at the 2014 IAA show?

Neil Pattison was promoted earlier this year from on-highway engine business director for the Europe, Middle East and Africa (EMEA) region to global integration account leader in charge of the substantial worldwide business Cummins does with the Volkswagen group, now including truck- and bus-makers Scania and MAN as wholly-owned group members. Also recently promoted is Jonathan Atkinson, former product development chief engineer now technical director at the Darlington, County Durham manufacturing and development base for “midrange” Cummins engines, with swept volumes from 3.9 to nine litres.

One new engine right in the middle of that range of swept volumes yet not part of Atkinson’s direct responsibilities (because it is designed primarily for North American pick-ups, schoolbuses and motorhomes) is the ISV5.0. Production of this 5.0-litre vee-eight diesel is due to start soon in Columbus, Indiana, with Nissan’s new Titan pick-up set to be its first application. Other early customers are likely to come from the US and Canada but the ISV5.0 is also expected to attract attention from a wide range of IAA visitors this year, if only because of the fuel-efficiency and exhaust emission technology it employs.

“Cummins has integrated the latest technologies in the ISV5.0 to deliver performance, fuel efficiency and durability in a highly sociable package,” says Jim Katzenmeyer, executive engineer in charge of vee-eight engine development. “Drivers will appreciate the smooth, quiet operation of the ISV5.0. And the fuel savings offered by this engine result in fewer greenhouse gas emissions – a great environmental benefit.” The ISV5.0 is promised from day one to satisfy the 2017 US Environmental Protection Agency legislation on CO₂ emissions cuts, the EPA “greenhouse gas (GHG) rules”.

Atkinson and Pattison have good reasons aplenty to be following the progress of Europe’s own greenhouse gas emissions legislation as attentively as anyone. It is thought that a legal requirement for manufacturers to make “declarations” on fuel economy (and/or carbon dioxide emissions) could be in force as early as 2016, but exactly what those declarations will entail and what legal limits will follow remains unclear (page 4). “There is a lot of discussion still going on,” says Atkinson. “There are some proposals out there, but the key word is ‘proposals’. As we sit here today we don’t actually know what the European GHG rules will be.”

In the US Cummins has been deeply involved in a five-year project called Supertruck, half-funded by the federal government, with the aim of establishing the most effective practical means of improving fuel economy from Class Eight (maximum weight) box-bodied articulated rigs. A Peterbilt (Paccar) tractive unit in the Supertruck project is powered by a Cummins ISX15 engine bristling with experimental waste heat recovery equipment. Fuel savings recorded to date by comparison with a standard truck of this type are as great as 54 per cent, according to Atkinson. The Supertruck project is due to end next year.

Cummins also contributed ideas on how best to regulate greenhouse gases from trucks in the run-up to publication of the EPA rules, not least though a 2009 paper on “Framework for the Regulation of Greenhouse Gases from Commercial Vehicles”, written at the request of the US National Academy of Sciences (NAS).

As recently as last month (August) Cummins put forward a detailed response to proposals for a second phase of US regulations on truck and bus fuel efficiency and greenhouse gas standards. “Phase 2 should maintain separate engine-based standards to account for the diversity of applications and duty cycles encompassed by the commercial vehicle market,” stresses Brian Mormino, Cummins’ worldwide environmental strategy and compliance executive director. Focusing on existing US regulations and how
they might influence European Commission thinking, Jonathan Atkinson notes that “two types of standard metrics have been adopted for EPA 2014 and 2017 regulations: grams of CO₂ per ton-mile standards for vocational vehicles and tractors; and payload-dependent grams of CO₂ per mile for pick-ups and vans.”

But there is no suggestion from anyone that the European Commission might be minded to adopt similar metrics to the EPA’s. Neil Pattison points to “historical differences” between Europe and North America, many stemming from much lower fuel prices at the pumps on the other side of the Atlantic. The better fuel efficiency of European vehicles in general means it can be argued that we have less need for big fuel economy improvements, suggests Pattison, echoing a point highlighted by Daimler truck and bus division boss Wolfgang Bernhard in a speech last December, delivered in his capacity as chairman of the commercial vehicles board of ACEA (Association des Constructeurs Européens d’Automobiles), the European vehicle manufacturers association. Bernhard reckons that when payload and overall average fuel economy is taken into account, European vans and trucks at present emit on average 32 grams of CO₂ per tonne-kilometre. This compares with 36 for China, 43 for Japan, and 41 for the US.

But the point underlined over and over by Jonathan Atkinson is that these averages count for little when it comes to developing truck and bus engines and drivelines. In the post-Euro 6 era it is real-world fuel economy that matters most, and that means understanding the huge and diverse range of duties in which European trucks are engaged, and developing the technology accordingly. “With or without legislation, our focus now is on increasing efficiency while maintaining low emissions,” he says. “Almost regardless of what the legislation says we are going to continue to go after real-world fuel economy as a very high priority.”

He underlines the point by drawing a parallel with the latest EU tyre-labelling regulations, including A to E categorisation according to rolling resistance and thus fuel-saving potential. “Some trucks with our four-cylinder engine cover a very low mileage at a really low average speed and with a really low daily run-time,” he says. “For trucks like this there is little difference between A- and E-rated tyres, whereas for a truck that is working on its road speed limiter all day long the tyres’ rolling resistance will make a heck of a difference. It’s the same with engine technologies. It’s how the engine operates that determines whether this thing or that thing is going to be successful in improving fuel economy.”

But how does a global manufacturer like Cummins reconcile such demands for power units tailored to specific, regional work patterns with the economies of manufacturing scale it needs to remain profitable? Anyone searching for definitive answers to this question surely need look no farther than the G-series, a new range of in-line six-cylinder engines which went on public display for the first time at the Bauma construction equipment show in Munich in April 2013. At least one on-highway version of the G-series engine, either a 10.5-litre ISG11 or 11.8-litre ISG12, is expected to be on show at the IAA in Hannover. Production of both started earlier this year at the same ultra-modern Beijing, China plant (owned by a long-standing joint venture between Cummins and Beiqi Foton, one of China’s biggest commercial vehicle manufacturers) where the Euro 6 ISB4.5 is built.

Design and development of the engine was led by a team of US-based engineers but with support from “global technical and marketing resources with deep knowledge of local market and customer needs,” according to Cummins vice president Steve Chapman. “The G-series global design approach is a vivid demonstration of how Cummins is transforming from a multinational to a truly global company,” he says. “This engine platform has been designed for diverse and global markets by utilising the expertise and local knowledge of our engineers from around the world.”

As with the Euro 6 ISB4.5, a key design objective for the G-series engines was to boost power-to-weight ratio by cutting engine weight. A carefully sculptured block has resulted in considerable weight-saving with no loss of rigidity. Again like the ISB4.5, more weight-saving comes from the use of lightweight composite materials for the sump and valve cover.

For on-road applications the ISG11 and ISG12 span maximum power ratings from 290 to 512hp. The first engines meet Euro 3, Euro 4 and China’s NS4 emissions limits, but Euro 5-, Euro 6- and Euro 6 drivelines whatever next? September 2014
EPA-compliant versions are under development, ready to greatly extend the potential global G-series reach. All G-series engines built so far are diesel-fuelled, using the latest XPI, ultra-high-pressure common-rail fuel injection equipment, but Cummins makes no secret of its intention to add gas-fuelled versions to the range in future.

Will we see the G-series in European trucks and buses, and if so when? Answers to such questions may well hinge on the progress of the European Union’s own greenhouse gas rules (page 4).

Will the VECTO computer simulation take proper account of the vast range of truck and bus specifications and duty cycles or will the law of unintended consequences kick in and the law-makers inadvertently end up hindering development of the most effective and efficient fuel economy options? Neil Pattison is inclined to give the law-makers the benefit of the doubt.

“They realise that they’ve gone as far as they can at Euro 6 with reduction of particulate matter and gaseous emissions,” he says. “But emissions reduction so far has not been market-driven. Cuts in CO₂ emissions will be market-driven.”

Certainly there is a less obvious clash between market forces and legislative power over CO₂ emissions than there has been over Euro 6. But that is not to say that everyone involved is now pulling in exactly the same direction. Local authorities and bus operators in particular are far more worried about local air quality at present than they are about any future limit on carbon dioxide emissions. And one inescapable and uncomfortable fact that should not be overlooked by the European Commission is that when exhaust after-treatment (especially a diesel particulate filter) is used to help improve local air quality the consequence is that fuel consumption and thus CO₂ goes up, not down, simply as a result of increased exhaust back-pressure.

Cummins’ Jonathan Atkinson is intrigued by some recent Transport for London (TfL) research revealing that more than half of vehicles operating in London at present are not fitted with DPFs, “So in five years from now maybe 50 per cent of London buses will have been replaced by new DPF-equipped vehicles then that proportion will change dramatically because really nothing comes out of the back of a modern DPF. One of the really successful parts of the Euro 6 legislation is the particle number, which in effect mandates for a very high efficiency DPF. The particle mass

**Citywide bus: first Scania powered by a Cummins engine, the ISB6.7.**

Jonathan Atkinson: “The fuel economy benefit of a stop/start system for trucks can range from almost nothing up to 15 per cent.”

**New Bus for London: hybrid Cummins/Siemens driveline based on ISB4.5 diesel engine.**

Now we are two: Euro 6 ISB4.5, two years on from its launch.

limit is there but it doesn’t really do anything because the number count is so much more stringent. It means that 99 per cent of particulate emissions have now been removed from the exhaust.”

No other diesel engine manufacturer has as much in-house control as Cummins over related components and systems such as exhaust after-treatment, turbochargers, fuel injection equipment and filters. “We have a huge toolbox at our disposal as we look at the next round of engine development,” says Atkinson. One tool in that box, engine stop/start systems, provides a good illustration of some of the crucial operational and engineering differences between cars and commercial vehicles, and of the risk of legislators failing to take them fully into account in their determination to be seen to be doing something to cut CO₂ emissions.

Automatic stop/start systems are now almost taken for granted on new cars and vans. Yet they remain virtually unheard of in heavier trucks and buses, though Mercedes has tried hard with its Atego at up to 12 tonnes gvw.

Some bus operators reckon that as much as 15 per cent of their total fuel bill is accounted for by engine idling, according to Atkinson.

“That’s an extreme, but it’s a real number,” he explains. “With trucks the benefit of a stop/start system to reduce engine idling time can range from almost nothing up to that 15 percent mark. Many are in the range of four to seven per cent.”

It is easy to imagine legislators and indeed operators being seduced by such figures. So what’s the problem? In a word: durability. Atkinson explains that though there is some scope for improving the robustness of the traditional starter motor and flywheel ring gear of heavy-duty diesel engines, “eventually you will come up against a durability limit, because of the mechanical interface.”

One radical engineering solution is an integrated starter/generator of the kind used by Volvo in some of its hybrid drivelines. Cummins has developed just such equipment too, but it is easy to see how the price and complexity will be likely to put off most truck and bus operators.

Atkinson also points out that the current type approval test cycles used to certify truck and bus engines do not allow for stop/start systems, though they do for cars. And anyway bus operators might well want to emphasise why bus engines do not allow for stop/start systems, provides a good illustration of some of the crucial operational and engineering differences between cars and commercial vehicles, and of the risk of legislators failing to take them fully into account in their determination to be seen to be doing something to cut CO₂ emissions.

A Cummins-led project promises to deliver solutions to these problems. The £9.9 million, 36-month FIRSTTM (Frequent Integrated Soft Stop Start Technology) project started in April, half funded by the government’s Technology Strategy Board. The aim of the project is to break down technology cost barriers by using a unique technical approach that will become a game-changer in the industry,” says project leader Neil Brown.
Your diesel engine is just the dumb thing that fuels my clever jet-engine. This is the gist of some banter overheard recently between a Cummins Turbo Technologies engineer and a friend of his who happens to work in the engine development and manufacturing side of the global Cummins business. Joking aside, there is a more serious point here, and it is becoming increasingly evident as the momentum in truck and bus engine development shifts rapidly towards still greater efficiency and CO₂ emissions cuts through minimising waste.

"More and more people are realising that the value isn’t in the crank, the cam and the cylinder any more," says Jonathan Wood, executive director research and engineering at the Huddersfield, West Yorkshire base of Cummins Turbo Technologies. "It’s in the fuel injection equipment, the exhaust after-treatment, the turbocharging and the control of all this, including combustion.” If proof were needed that Wood’s observations are spot-on and timely it can be found in spades among the exhibits at this year’s huge IAA commercial vehicles show, not least in the number of innovative Euro 6 drivelines depending on products of one sort or another from Cummins Components Group, encompassing Cummins Emission Solutions, Cummins Filtration and Cummins Fuel Systems as well as Cummins Turbo Technologies. Like all his colleagues in other parts of this group, Wood is the soul of discretion when it comes to the company’s customers and how they employ Cummins products and services. Of the 2.4 million turbochargers produced annually by Cummins, more than half end up on non-Cummins engines. More often than not, these truck and bus-makers are themselves happy to confirm the sources of their exhaust after-treatment or turbocharger. At this year’s IAA show Cummins turbochargers of various kinds can be found, for instance, on Euro 6 engines from DAF, Mercedes, Volvo, Scania and Hyundai. Two of the most notable recent applications are on high-power truck engines from Mercedes and Volvo.

Production of the 15.6-litre OM 473 Mercedes in-line six-cylinder engine began in Mannheim, Germany in September 2013. This is the European version of Daimler’s Detroit Diesel DD15 and DD16 engines, which have been powering Freightliner trucks in North America for the past six years. Now the...
The Holset power turbine and turbocharger on the OM 473 is described by Mercedes as one of the power unit’s “technical highlights” and “one of the main reasons for the engine’s high performance and economic efficiency.” A huge amount of torque, 2,500Nm, is on tap from little more than idle speed with all three versions of the engine, courtesy mainly of this turbo-compound system. This high-torque-at-low-speed characteristic is prized in particular by heavy-haulage operators when they are working with gross train weights up to 250 tonnes.

Operators like this are also among those Volvo has in mind with the new, Euro 6 version of its 16.1-litre in-line six engine in the FH16 truck range. Maximum power ratings here are 550, 650 and 750hp, with maximum torque now available from as low an engine speed as 900rpm. But in this case much of the credit should go not to any turbo-compound system but to one of the latest Holset two-stage VGT (variable geometry turbocharger) systems. A second turbo function in this application is to optimise operation of the cooled exhaust gas recirculation (cscr) which works in partnership with selective catalytic reduction (scr) to cut emissions of oxides of nitrogen (nox) to below stringent Euro 6 limits.

Another new Volvo’s Euro 6 16.1-litre truck engine: two-stage Holset v8 (variable geometry turbocharger).

Cummins two-stage turbocharger, the M2 with patented Rotary Turbine Control (RTC), provides an even better illustration, arguably, of the extent to which turbocharger technology has advanced lately. The M2 RTC has, in a nutshell, four operating modes.

In the first, high-pressure turbo mode, turbo lag is minimised and the engine’s transient performance improved.

The second, low-pressure turbo, mode is exclusively for high-power performance.

Power is then maximised in waste-gate mode.

And in the fourth mode, “regen”, exhaust gas recirculation performance is optimised.

The new five-litre vee-eight ISV5.0 Cummins diesel engine, designed primarily as a more fuel efficient option to big petrol engines, is the first to employ the M2 RTC. And Nissan’s new Titan pick-up, now on sale in North America, is the first ISV5.0-powered vehicle.

Cummins Turbo Technologies engineers are confident that growing interest in this two-stage system will be stimulated even more by their 2014 IAA show display as more and more truck, bus and light commercial vehicle manufacturers look way beyond Euro 6. Much the same can be said of the latest Cummins developments in waste-heat recovery, what Jonathan Wood likes to describe as “an adjacent technology” to the company’s mainstream activity of turbocharger design and manufacture.

Closely related technologies they may be, but when it comes to the serious business of durability and performance testing waste-heat turbine expanders like the one first revealed by Cummins a couple of years ago, conventional turbocharger test rigs are simply not up to the job. This is why around £1.4 million (including a £650,000 regional growth grant from the government) has been invested in the Cummins Turbo Technologies Huddersfield site to build a highly-specialised turbine expander test stand, believed to be the first of its kind anywhere.

Already this investment seems to be paying off handsomely as it looks increasingly likely that a mainstream truck diesel engine employing the Cummins waste heat recovery turbine expander could be in series production within about four years. Who might be the manufacturer of such an engine? That is the sort of question which everyone at Cummins naturally declines politely to answer.

There is no doubt, however, that Cummins Turbo Technologies is gearing up for expansion over the next few years. Last October plans to build an entirely new, multi-million-pound manufacturing plant in Huddersfield were announced. This is expected to mean further growth for the Huddersfield technical centre as well. The new plant, described as “state-of-the-art” could be up and running as early as 2016.

“We are extremely proud of our 60-year heritage in Huddersfield and believe we now have a once-in-a-generation opportunity to secure the future of the business by fully exploiting market opportunities,” said Jonathan Wood when the plans were revealed. “The new site will enable us to create a centre of excellence at St Andrew’s Road (the current site) serving our customers in north-west Europe and ensuring we continue to deliver our high standards of customer service. Holset turbochargers, which are at the heart of our business in Huddersfield, remain the component of choice for many international automotive customers - thanks to the expertise and experience of our highly-skilled workforce. This really is a fantastic opportunity for us. We've never been better aligned for success. Our current customer base in north-western Europe, our continuous improvement, our technologies, our market position – it is a once-in-a-lifetime chance.”

Turbocharger technology has come quite a way since a small, specialised Yorkshire company called Holset was bought by the Cummins engine company in 1973. The name was changed to Cummins Turbo Technologies in 2006. Nowadays turbocharging and its “adjacent technologies” are at the very heart not only of every truck and bus diesel engine development plan but also increasingly common on car and light commercial vehicle engines as the emphasis shifts more and more from exhaust emissions to fuel economy and low-carbon transport.

Waste heat recovery turbine expander: up and coming technology.
Visitors to this year’s IAA Hannover show can expect self-driving trucks and imminent EU legislation on CO₂ emissions from trucks and buses to be among the main talking points. Not to mention the Euro 6 technology that is now filtering down into vans.

Tim Blakemore reports.

Driving the future. This is the slogan that visitors can expect to see here, there and everywhere at the 65th IAA (Internationale Automobil-Ausstellung) commercial vehicles show, running from 25 September to 2 October in Hannover, Germany. Driving towards an uncertain future has a less catchy ring to it, for sure, but would be a rather more accurate reflection of the current state of Europe’s heavy commercial vehicle industry, especially so far as post-Euro 6 legislation is concerned. This at least is the picture painted at a pre-show seminar organised by VDA (Verband der Automobilindustrie), the German automotive industry trade association and organiser of this huge biennial show.

VDA president Matthias Wissmann was among several high-power speakers at the seminar to highlight how vehicle operators and manufacturers alike are struggling to make sense of what legislators are up to at present, not least in their still-fuzzy proposals for European Union rules on CO₂ emissions from trucks and buses (page 4). Truck- and bus-makers and their customers are as keen as anyone to cut these emissions, argued Wissmann. This was why a sense of frustration was building at various contradictory pieces of legislation, all of which could easily add up to more of a hindrance than a help. “The
commercial vehicle business is like a football team,” opined the VDA president, doubtless mindful of an event rather more important to most Germans even than the IAA show, the 2014 World Cup tournament in Brazil. “It has not only defenders but also midfielders and strikers. The variety of models among heavy trucks is so large that there cannot be any standard CO₂ value. The range goes from tipper trucks on construction sites to delivery vehicles and all the way to long-distance haulage trucks. And then there are also... more cautious line, seeing far more potential for using the latest communication technology in situations, such as low-speed manoeuvring on to loading bays, where no change in the law is required.

“Daimler has always been a pioneer in technology,” says Wolfgang Bernhard, the uncompromising boss of the group’s trucks and buses division, insisting that his target for self-driving “autonomous” trucks to be in service by 2025 is realistic. The Future Truck Actros is equipped with a system called Highway Pilot, encompassing radar sensors to the front and sides, a stereo camera behind the windscreen (where the mono camera for lane departure warning systems normally sits), and, at its heart, powerful electronic control units to handle “V2V” (vehicle to vehicle) and “V2I” (vehicle to infrastructure) communication systems. The upshot is that the truck drives itself on the autobahn, though Daimler emphasises that the driver can quickly and easily regain manual control from the Highway Pilot system at any time. This is crucial when it comes to the law, and in particular the 1968 Vienna convention on road traffic. This is what until now been the main hurdle blocking further development in Europe at least (the US is not a signatory to this convention) of autonomous vehicle systems. It demands, rather quaintly, that “every driver shall at all times be able to control his vehicle or guide his animals.” An amendment agreed recently by a United Nations working party allows for vehicles to drive themselves “provided the system can be overridden or switched off by the driver.”

But ZF engineers seem to be among those who see all this discussion about exactly what the law does or does not allow in autonomous driving of trucks to be less interesting than more practical applications of the latest communications technology. The ZF Innovation Truck is based on an old Daf XF 105 tractive unit, pulling both a semi-trailer and a drawbar trailer behind that, to form a 25.25-metre roadtrain of the kind that is difficult for even the most skilful driver to reverse, simply because of all the articulation points. But the ZF systems, all currently available or soon to go into production, allow the driver to stand outside the truck and control its movements precisely and easily from a tablet computer. “With this truck we illustrate the additional potential already present in our current technologies,” says Fredrik Staedtler, boss of ZF’s commercial vehicle division. “We have realised completely new assistant functions that are incredibly efficient and relatively simple to implement. They can also provide answers to many of the complex challenges that forwarding and logistics companies face on a daily basis. Be surprised at the innovative integration of advance transmission, steering and telematics systems.”

The three main elements in the ZF Innovation Truck are a hybrid version of the TraXon automated manual gearbox (full production of which starts next year); the latest ServoTwin electro-hydraulic...
steering system (already in use on Mercedes Arocs multi-wheelers; and ZF’s Openmatics telematics system. The TraXon hybrid module has a 120kW electric motor integrated into the gearbox’s bell-housing. The tablet computer communicates with the truck by means of Bluetooth (short wavelength radio waves) with a range of up to about 25 metres.

Voith, ZF’s arch-rival in bus and coach transmissions, seems to be taking a similarly pragmatic approach to the application of the latest information technology. At IAA Voith will be demonstrating how operational and maintenance data from its DIWA automatic gearboxes can now easily be downloaded to tablet computers, courtesy of a gadget called SmartCase.

Stands not to be missed by IAA visitors with as much interest in Euro 6 driveline hardware as in the software that goes with it include MAN, Mercedes-Benz Vans, Dongfeng and Iveco.

MAN is putting its new 15.2-litre, six-cylinder in-line D3876 engine (Euro 6, naturally) on public display for the first time.

Maximum power outputs in trucks go from 520 to 640hp. The all new Mercedes-Benz Vito van comes in front-wheel-drive, rear-wheel-drive and all-wheel-drive. The front wheel drive version’s 1.6-litre four-cylinder diesel engine comes from Renault and is claimed to be the first power unit for a van of this size to meet forthcoming Euro 6 limits.

Dongfeng is one of China’s biggest commercial vehicle manufacturers, surely making its global growth ambitions evident by a first appearance at a Hannover show. “By participating in the IAA, Dongfeng Trucks will reinforce the awareness of our brand and products and further develop partnerships around the world,” says the company’s president Gary Huang.

Among vehicles grabbing the limelight on Iveco’s stand are sure to be the new Daily light commercial vehicle range, unveiled a couple of months ago, and the latest versions of the Euro 6 Stralis heavy truck range, including one fuelled by liquefied natural gas (LNG). Stralis diesel engines employ the novel Iveco Hi-Scr exhaust aftertreatment system. It depends purely on selective catalytic reduction (SCR) to cut NOx emissions below Euro 6 limits, avoiding exhaust gas recirculation (EGR) entirely.

The pros and cons of this compared with the more conventional EGR-plus-SCR route to Euro 6 compliance are sure get a full airing in Hannover this year, especially when it comes to making those all-important total operating cost calculations.
Proof of the pudding

Two years on from the launch of the first Euro 6 Cummins engines we’ve been taking a look at who is using them and why.

On the face of it, there would seem to be scarcely anything in common between a new Alexander Dennis double-decker bus in service in London, a 12-tonnes-gvw DAF truck being used to paint white lines on British roads, and a VDL coach built in the Netherlands and operating in a remote corner of Finland. What connects these three vehicles is that they are all powered by Cummins Euro 6 engines. Two years ago the four-cylinder Euro 6 ISB4.5 and six-cylinder ISB6.7 were about to be put on public display for the first time at the 2012 IAA Hannover show. Exactly who would be buying these engines remained unclear, however, though Cummins engineers were even more quietly confident than usual. Now it is clear that this confidence was well-founded.

Britain’s top-selling truck-maker, the Paccar group’s DAF Trucks division, unveiled its new Euro 6 LF, CF and XF ranges at the Birmingham Commercial Vehicle show in April 2013. The LF range, with gross weights from 7.5 to 18 tonnes is powered by ISB4.5 and ISB6.7 engines (badged as PX-5 and PX-7) with maximum power ratings from 150 to 310hp. A combination of cgr (exhaust gas recirculation) and scr (selective catalytic reduction) is used throughout the entire Euro 6 DAF Trucks range, with all exhaust after-treatment equipment supplied by Cummins Emissions Solutions.

There is no such thing as a typical LF operator, but that road-marking truck mentioned above provides a good illustration as any of the vehicle’s strengths, with four- and six-cylinder Cummins engines at their heart. The truck is one of ten Euro 6 LFs ordered this June by the Staffordshire-based WJ LinkLine group, reckoned to be Britain’s biggest road-marking contractor.

“The new LF Euro 6 is proving more popular than ever across a huge range of customers as it can be tailored to anyone’s needs,” says DAF Trucks Ltd managing director Ray Ashworth. “It is agile for driving through a fully automatic (epicyclic) gearbox to a ZF AV132 drive axle. Gearbox choice is between a six-speed ZF EcoLife 6HP1203 and a four-speed Voith D854.6 W53.

ADL chief executive Colin Robertson says that the new bus is the culmination of a three-year “customer engagement programme” involving around 70 operators and suppliers. The development project is claimed to have taken account of every fault reported on every ADL two-axle double-decker since 2006. “Every aspect has been meticulously thought out and built as part of this unique partnership involving customers from all walks of the industry, suppliers with unique, specialist skills, and drivers from up and down the country,” says Robertson.

The new Enviro400 is claimed to be 400kg lighter than its predecessor and more fuel efficient. Not a single panel or piece of glass is said to have been carried over from the old model.

Around 400 Euro 6 Enviro400s are said to have been ordered already, with about 120 due for delivery over the next twelve months to operators including Go-Ahead, Stagecoach and Reading Transport.

ADL’s new double-decker: lower kerb weight and better fuel economy.
Products You Can Depend On.

Every Cummins Euro 6 engine comes with a pedigree of over 90 years of engineering expertise. They are adapted for each application, benefiting the operator and the environment. The engines deliver the best possible performance, reliability and fuel consumption whilst meeting near-zero emissions levels. This makes Cummins your natural choice for Euro 6. Visit www.cumminseuro6.com for more information.