Price

With the deadline for Euro 6 clean engines getting inexorably closer, operators need to understand the technology, cost and maintenance implications before it's too late. Brian Tinham reports

Over the past 12 months, informed commentators have become increasingly agitated about seemingly unavoidable and significant cost increases about to befall operators, when the Euro 6 engine emissions regulations come into force. Some even talk of an order of magnitude increase being inflicted by the European Commission and a disaster in the making. So, although the deadlines for trucks and buses may seem far distant – January 2013 for type approvals and January 2014 for new registrations – if these observers are right, the time for action is not then, but much, much sooner.

Still to be finalised

Not that Euro 6 has even been firmed up yet – despite Regulation EC 595/2009, concerning emissions from heavy duty vehicles, indicating that limits and procedures would be established by 1 April last year.

Word is that the large engine and truck manufacturers are arguing over several aspects, not least a note in a draft from last February, requiring OEMs to take responsibility for 'in-use compliance'. Under this clause, they would have to bring in Euro 6 trucks periodically to recheck emissions and, if found outside the limits, recall all vehicles of that type. Unsurprisingly, that isn't going down too well.

However, let's backtrack a moment. Since the advent of Euro 3, back in 2000, the EC has concentrated more or less exclusively on forcing down emissions of NO_x and particulates for diesel-engined vehicles greater than 3.5 tonne gvw (and, in fact, spark ignition gas engines – although these are inherently far cleaner).

Few would argue with the regulators' rationale, which is all about slashing the levels of pollutants known to be harmful to human health. However, achieving what are, by any standards, draconian cuts in allowed emission levels comes at a price. And, given other regulatory constraints on engine and truck builders (such as overall vehicle dimensions), as well as the commercial realities, available technologies and the timeframe, that price comes in several guises.

£1 billion investments

First, with manufacturers' R&D investments in taking Euro 5 engines up to Euro 6 estimated at £1 billion each, there's no escaping some pass-on cost. Secondly, however, with truck engines already

Technology balance

Manufacturers remain reluctant to give away detailed Euro 6 engine configuration information – and who can blame them? Martin Flach, Iveco UK product director, says simply that we can expect some mix of both EGR and SCR, "balanced to minimise cost", as well as turbochargers ("to regain any power we lose in other areas") and a DPF (diesel particulate trap).

Add to that larger radiators and ventilation grilles, to improve heat rejection, more attention to aerodynamics and, eventually (but not in time for Euro 6), some of the ideas from the Iveco Glider concept truck, launched at last year's Hannover IAA, and you're about there.

It's much the same at Scania – the only slight differences to Iveco's description being a single variable geometry turbocharger and its XPI high pressure, digitally-controlled, multiple injection common rail fuel injection, developed with Cummins. Jonas Hofstedt, senior vice president of powertrain development at Scania, gives the example of its Euro 6 16.4-litre V8, which, he says, runs at cylinder combustion pressures of 200bar, as compared to 165bar on the earlier 15.6-litre power plant. Also, XPI takes injection pressures up to 2,400bar, with multiple injections, although to date Scania is using only pilot and main fuel charges.

Interestingly, Hofstedt says that Scania's pre-production Euro 6 engines are currently in use, driving some of the company's own Transport Laboratory haulage fleet, which tests developments while trunking assemblies from the firm's Södertälje factory in Sweden to the Zwolle production plant in the Netherlands (Transport Engineer, July 2010, page 37).

As for MAN, the German giant reiterates its IAA statement: "MAN has developed the key technologies required for Euro 6: EGR, with MAN Pure Diesel; and SCR, with MAN AdBlue for Euro 5 or EEV [enhanced environmentally friendly vehicle]. These technologies are already being used in MAN's commercial vehicles [at Euro 5] with great success."

However, the devil, as always, is in the

# of perfection

Jonas Hofstedt, senior vice president of powertrain development at Scania, says that its pre-production Euro 6 engines are already being trialled, driving some of the company's own Transport Laboratory haulage fleet, which tests developments while trunking assemblies between Scania manufacturing and assembly plants

detail – and, for now, that is singularly lacking. Which is worrying.

As First Group's business improvement director Graham Belgum puts it: "The industry wants to improve emissions standards, but is concerned about costs and potential maintenance issues. We've been talking to Volvo and Cummins, for example, and it seems we can expect EGR on top of our existing SCR, as well as a variable geometry turbo. And we'll also have more complex exhaust systems, probably with more sensors and diesel injection for active regeneration of a DPF.

"We can also expect higher fuel injection pressures. We've been presented with the concept, not the detailed technology, but they could be in excess of 2,400bar, to help address any deficit in fuel consumption by improving the burn and adding multiple injections."

Belgum speaks for many fleet managers when he points to the obvious challenges, in terms of space and accessibility of additional componentry – as well as the impact of fuel quality (especially as biodiesel content increases), in the face of even more sophisticated fuel injection systems. "We need to know some detail, so we can see how much cost might have to be absorbed or mitigated by the business, what the additional training requirement is and what we might have to explain to passengers.

"For that, we need clarification on initial replacement and whole-life costs. OEMs need to be honest with us. Give us the worst case, compared against Euro 5, especially whole-life maintenance costs. We also want an early understanding of the systems, in terms of how they work, how to maintain them and how reliable they are likely to be. We need that so we can plan to look after our buses from day one and avoid any problems of powering down, for example, if the engine detects an emissions problem. That would have a serious impact on our operational performance. We must avoid the learning experience we had with SCR and AdBlue, which took a couple of years to address."

Practical problems on the run-up to Euro 6

When will we start to see Euro 6 compliant vehicles? If the experience with Euro 5 is anything to go by, then maybe fairly soon. Truck manufacturers have always been keen to broadcast their technical superiority and claiming early compliance is one sure way to do that.

However, in the absence of an equivalent to the old RPC (reduced pollution certificate), which meant up to £500 off the cost of a Euro 5 truck bought ahead of the deadline, operators aren't going to be interested. Indeed, even with a new RPC, no one will be rushing to get their hands on a new, off-green machine, if they save just £500, but incur a price hike of at least £5,000.

Martin Flach, Iveco UK product director, suggests that, perversely, the likelihood is a run on late registration Euro 5 trucks. "When the market wakes up to just how much Euro 6 trucks are going to cost – say, in the latter part of 2013 – I expect manufacturers to be inundated with requests for new Euro 5 vehicles ahead of the deadline," he says.

And, given the increased average age of the truck parc, caused by widespread cancellation of new truck orders during the recession, there is the potential for massive pent-up demand. In fact, Flach warns that, come 2013, the industry might not be able to fulfil orders. "Lead times might go out to 18 months or more over the next two or three years. Operators need to start planning their truck fleet replacements now."

extremely sophisticated – even compared with just five years ago – it has been difficult to see how engine designers could weave their NO_x- and particulates-busting magic, without making the engine work harder. That, of course, means increased fuel consumption – not only reversing hitherto welcome improvements, but also clearly impacting many fleets' greatest operational cost.

Indeed, the fear expressed early last year was that, to achieve the dictates of Euro 6, truck engines were likely to be 5–8% less fuel efficient than their Euro 5 counterparts. This despite the clearly damaging knock-on effect for the industry's costs in an already difficult economic climate and the perverse impact on greenhouse gas emissions. And, ironically, that was entirely plausible, since no element of EC legislation currently forces truck engine developers to further reduce CO_2 – quite unlike the laser focus for cars and car-derived vans.

So, should we be preparing for a forthcoming world of clean, but expensive and decidedly un-green, gas-guzzling Euro 6 trucks and buses? Well, yes and no. Yes, there is likely to be an on-cost and operational cost burden – although not the whole-life tenfold increase forecast by some. But also no, with best advice today stating that, if there is an increase in fuel consumption, it's going to be marginal.

"We'll all have done well, if there's no worsening of fuel consumption, but I don't believe any manufacturer will end up with a serious shortfall. That would be commercial suicide," Martin Flach, Iveco UK product director

Climate concerns beyond Euro 6

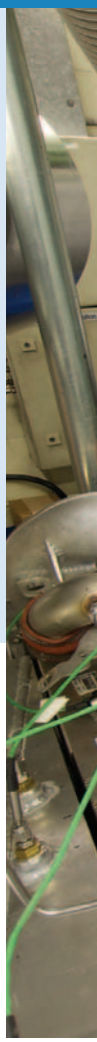
What about the future? Iveco's Martin Flach speaks for many when he insists that the EC needs to end its obsession with NO_x and particulates, and turn its attention back to greenhouse gases and fuel consumption.

"Unlike car and van manufacturers, we haven't had an opportunity to focus on CO_2, because we've spent the last 20 years keeping up with the NO_x and particulates rules. If that changes, we can bring in different approaches, including energy management for ancillaries, exhaust energy recovery, hybrids, aerodynamics etc.

"The technologies are there: it's mainly about developing them for high volume and low cost, rather than the current situation of low volume, high cost. For example, with hybrids the challenge is going to be coming in at £5,000–6,000 on-cost, which would mean a payback in 18 months. But if we can ride on some of the technologies being developed for cars, where the volumes are massive, this becomes a possibility."

Making that particular prospect fly is not just about technology or volumes, though. The transport industry will look to regulators for a little flexibility on payload and licensing to counter the inevitably greater weight of hybrid drives' batteries, even after downsizing the combustion engine.

As Flach comments: "Ourselves, DAF and others can all sell you a 7.5 tonne hybrid today, but there's not only the higher cost, but also the weight penalty, which is about 250kg. If government wants to stimulate low carbon vehicles, it needs to concede a payload bonus, allowing a 7.5 tonner to run at 7.8 tonnes, to carry the same weight, but stay in the C1 licence band."



As Iveco UK product director Martin Flach puts it: "We'll all have done well, if there's no worsening of fuel consumption, but I don't believe any manufacturer will end up with a serious shortfall. That would be commercial suicide." Nevertheless, he does concede that the additional cost for a like-for-like Euro 6 vehicle, compared to its Euro 5 predecessor, will be "something between £5,000 and £10,000".

Independent engineering experts agree. Andrew Nicol, technical specialist for performance and calibration at internationally renowned Ricardo, says of fuel usage that engineering understanding has moved beyond any fears of a 5–8% penalty. "I think manufacturers will achieve somewhere between equal [to Euro 5] and a very small penalty of 3% maximum," he says.

Why? "OEMs have been improving the balance between EGR [exhaust gas recirculation] and SCR [selective catalytic reduction] necessary to achieve Euro 6," he explains – indicating that SCR conversion efficiencies in the high eighties per cent mean that EGR rates can be backed off a little. "So they are now developing engines with, for example, more fuel-efficient timing – relying on SCR to handle more of the NO_x. Their difficulty will be compensating for additional back pressure from the new DPF [diesel particulates filter] and any active regeneration – which demands heat and hence fuel – but the fuel delta will still be marginal."

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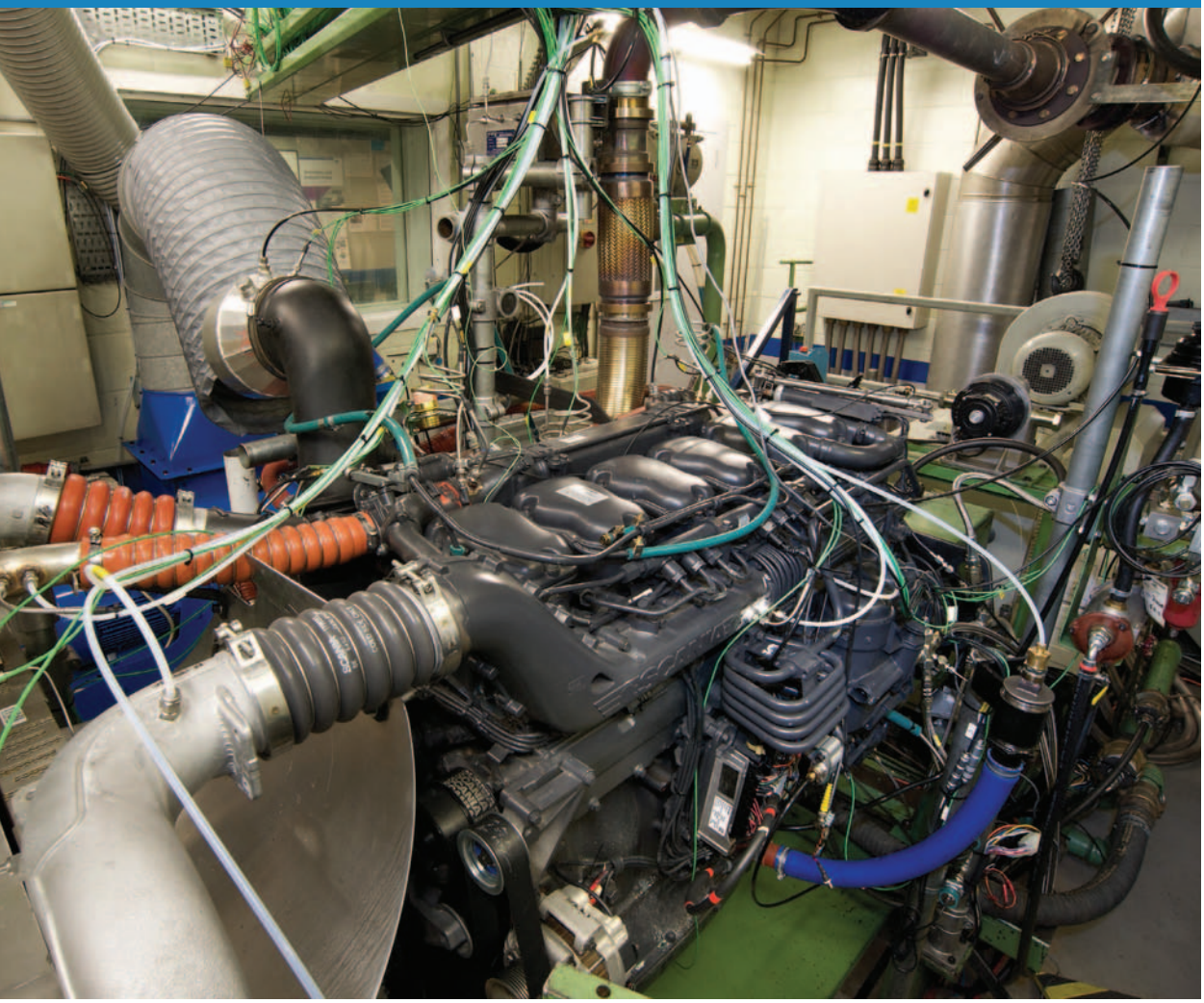
What about the on-cost? Nicol makes the point that, presently, manufacturers use only one of EGR or SCR to meet the Euro 5 emissions standard. However, since all Euro 6 engines will require both EGR and SCR, almost certainly with a DPF, in order to meet the proposed particle number (not just mass) limits, OEMs face adding two new systems.

Which two systems?

But the scale of on-cost, he says, depends on which two – and that, in turn, depends on the OEM's existing engine technology, simply because SCR systems are more expensive than EGR. Adding SCR for a big truck, including the dosing equipment and tank, comes in at around £3,000, whereas EGR is about £2,000, including the stainless steel cooler. Add a DOC (diesel oxidation catalyst) and a DPF, plus the extra hardware (inlet throttle and a seventh injector in the exhaust manifold, etc) for active re-generation, all of which costs around £3,000–4,000, and you're easily up to our Iveco man's forecast.

Exactly how much more a vehicle costs will also depend, in part, on the type and duty cycle. Flach makes the point that there is a trade-off between increasing on-cost and decreasing operating costs. "If an extra £1,000 on a Euro 6 heavy truck engine



Left: Euro 6 heavy-duty diesel engine testing at Ricardo

is going to save 1% on fuel, that means payback for the operator within a couple of years. But, if you translate that to a medium truck, the payback probably won't come within the life of the vehicle. So, in this case, there's no point."

Fair enough, but then there is also the weight (and space) penalty. EGR equipment adds about 50–100kg, while for SCR you're looking at around 25kg, plus 100kg for a tank full of Adblue – possibly lower, given that Euro 6 engines will consume less urea (because of the already reduced engine-out NOx), meaning a potential to reduce that tank capacity. And then there's the DPF, which, given that it's bound to be integrated into the exhaust box, is unlikely to add more than 25–50kg.

So what does all that add up to? Yes, there's that £5,000–10,000 on-cost, but also we're talking about a 75–150kg payload penalty. And there's the complexity factor: if operators in the early years find more amber warning lamps coming up on their dashboards, there are the service and downtime cost implications. Also, DPFs don't last forever and are likely to need replacing before a truck reaches its end of life. Similarly, on the fuel injection side, with greater sophistication and higher pressures, there may well be additional costs – albeit not necessarily huge, depending on the system selected and the competence of the technician using the diagnostics.

So, back-of-fag packet stuff, but allowing £1,000–2,000 per year extra on average, simply for kit going wrong earlier and at greater cost than is currently the case, we can reasonably expect the five-year additional cost to run out at a total of £20,000, including the additional equipment on-cost. Not what anyone wants, but that's worst case – and it certainly isn't an order of magnitude.

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