Mixing methane

Following last month's dual-fuel trucks investigation, Brian Tinham examines the technologies behind the conversion systems – and establishes exactly what transport operators really need to consider

If you want to get your head around the technologies used by the methane-and-diesel dual-fuel converters, you're probably in for a torrid time. You're likely to come up against what looks like smoke and mirrors. That's partly because each competitor wants to differentiate itself from the rest. But, to be fair, it's also because the worlds of software emulation, gas energy mapping and closed-loop control are a far cry from most transport engineers' experience, so hard to express.

One approach is to accept that, since all the better known CNG/LNG-diesel systems have either been proven on a range of transport duty cycles – so much so that some truck manufacturers now offer conversions as offline production, rather than retrofits – or are currently in advanced testing, whichever you choose you can't go wrong. However, if you want to go deeper, best advice is probably to focus on what matters: actual gas substitution rates; stated burn efficiency over your engine operating range; and the scale of optimisation available (or required).

These are the parameters most likely to influence cost savings and hence the payback period. Beyond those, it's about whether to go for LNG or CNG (see panel), and then maybe biomethane (liquefied or gasous), produced from biomass – clearly the most environmentally friendly source.

Nuanced technologies

That said, if you're determined to push further, you'll quickly come up against claims and counterclaims. These relate mostly to the benefits or otherwise of CAN-based approaches for amending ECU (engine control unit) inputs, versus ECU remapping or using emulation and translation of the injector controls.

Shimon Shapiro, who heads up R&D for G-Volution – which describes itself as a multi-fuelling, rather than dual-fuelling, specialist, having started with LPG (liquefied petroleum gas) – favours the latter approach. "Our patented Optimiser intercepts the signal between the ECU and the injectors, at the end of that control loop, to match gas/diesel rates to demand in real time," he explains. "We don't trick the ECU into reducing diesel by making it 'see' a lower demand, because of the knock-on risk for emissions. The ECU needs its speed-load setpoint to manage

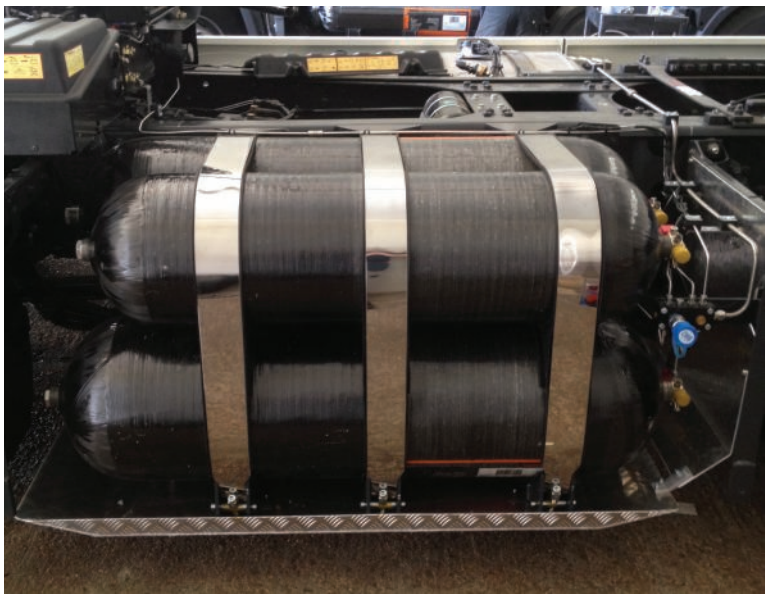
Dual-fuel at Euro 6

When it comes to Euro 6, Hardstaff's Trevor Fletcher reckons that dual-fuel conversion upgrades won't be easy. "Whereas at Euro 5 we have to keep non-methane hydrocarbons and methane within the 0.55gm/kWh limit, at Euro 6, the levels are 0.16gm/kWh for non-methane and 0.5gm/kWh methane." But there's slightly more to it, given the tighter controls on trucks' SCR and DPF after-treatment packages at Euro 6 – and the mandatory 700,000km, or seven years, operating requirement, verifiable via trucks' OBD (onboard diagnostics).

However, Fletcher is adamant this won't derail dual-fuel. "Will a methane catalyst do 700,000km? No it won't – so it will have to be a serviceable item. But this is not a problem, and the European GFV [Gaseous Fuelled Vehicles] working group won't be too proscriptive. If anything goes wrong with a dual-fuel system, the manufacturer's engine takes over anyway."

The truth is that EU regulators will be accommodating, because they don't want to stop dual-fuel in its tracks, given its importance, not only in terms of cutting emissions but also fuel diversity as diesel depletes.

Incidentally, Fletcher also suggests that the drive to bear down on atmospheric pollutants, through Euro 6, might be better served by encouraging operators to convert Euro 5, 4 and even 3 trucks to dual-fuel, where feasible. "Given that some operators have no choice but to keep their fleets running, moving to dual-fuel could save more emissions than Euro 6 will ever recover."



downstream after-treatment rates: EGR [exhaust gas recirculation] and SCR [selective catalytic reduction] systems need to work together."

His contention is that, if the ECU doesn't understand the engine's true operating status, it can't calculate sensible NOx and particulate levels. And although SCR systems are self-adapting, their closed-loop controls are based partly on NOx rates signalled by the ECU. It's a similar story for the DPF (diesel particulate filter), with regeneration triggered by exhaust back-pressure and the ECU.

Shapiro also argues that safety systems – engine controls are SIL (safety integrity level) 2 implementations – might be compromised. "You don't want to mess with the calculations," he says.

Off-road trials

So far, so good. But while G-Volution is working on two of the TSB (Technology Strategy Board) funded trials to develop its technology, there are, as yet, no on-road examples outside LPG-diesel (where there are plenty). To date, all its CNG work has been on MAN and DAF engines on a test rig in Huddersfield. It's promising – Shapiro talks of 50–60% substitution rates to match the original engine power and toque curves – but it's not there yet.

Prins Autogas, however, certainly is. Its systems are being used, for example, with Howard Tenens, as part of that haulier's TSB project, on a mix of Mercedes-Benz Actros 2544s and 2444s 6x2 tractors (with standard and small midlifts) and DAF 4x2 XF105, 6x2 XF105 with small midlifts and CF75 rigids – all delivered last month (*Transport Engineer*, Oct 2013, page 11).

Will Putter, Prins commercial director, reveals that its systems are also available for Iveco, MAN and Renault trucks. And he is happy to give prices, too (£17,500–£25,000, depending on configuration) with the caveat that moving tanks around on chassis is extra, provided by SB Components.

What about the technology? Although this firm shares a background in LPG-diesel conversions with G-Volution, there the similarity apparently ends. But this company is coy, stating only that its "system communicates with the ECU via CANbus to ensure fully computer-controlled injection of the correct amount of CNG, depending on the characteristics of the diesel engine". It goes on to indicate that the system monitors engine speed, turbo pressure, diesel injected, accelerator demand, engine torque and coolant temperature to derive the optimum balance.

Left: Brit European's JCB fleet is now running on diesel and CNG dual-fuel
Above: Howard Tenens' DAF XF 105 460 small midlift tank set, converted by Prins Autogas

To LNG or CNG?

If you're convinced by the methane dual-fuel argument, but not sure whether to go for LNG or CNG, the truth is there are few obvious choice criteria. Hardstaff's Trevor Fletcher suggests that operators think first about their payload issues and the range required, given the currently limited gas refuelling infrastructure. "CNG is compressed to 250bar, so that's 250 times, whereas with LNG it's 600 times," he explains.

So LNG offers much greater energy density – meaning that, if payload and/or range are issues, LNG is probably the way to go, because of its much lower containment weight. The tanks are also smaller, so easier to fit in the limited (and further reducing at Euro 6) space available on 6x2 tractor chassis.

And, although insulated LNG tanks are more expensive than their CNG equivalents, that is more than offset by the reduced installation costs of the former. The only remaining debate: the decidedly un-green energy required to compress LNG versus CNG, as against the reduced transportation costs and emissions required for its transportation to truck refuelling sites.

But for Putter, the issues that matter are reliability, efficiency and pounds and pence. So while he says that Prins' ECU technology is sophisticated, being born out of 25 years in the alternative fuels business, he also contends that it "doesn't push the envelope too far", sticking instead to a relatively low 45% average gas substitution rate. That's not just for safety, nor to avoid over-fuelling, important though both are. It's all about maintaining good, reliable efficiency, he says, to minimise overall fuel costs.

"Too many people get hung-up on the substitution rate. You can get 60—70%, but if that's at 15—20% efficiency slip [CNG litres versus pure diesel litres per km], then the real cost per mile is hit hard. With our system, the overall efficiency slip is just 4—8%."

Pragmatism rules – and so it should. But as part of that, it's also worth understanding that there's a horses for courses element with all systems. Talk to Hardstaff chairman Trevor Fletcher, for example, and you'll find that, while his company's system is now very well proven on Mercedes-Benz trucks, he accepts that there is always scope for improving performance. Indeed, that's part of the purpose of his TSB projects, designed variously to optimise the technology for a wider range of real-world operations and to complete R&D for Euro 6 compatibility.

"As a truck operator myself, I would be sat at 56mph on cruise," he explains, adding that his systems are optimised for gas substitution at that sweet spot. "But Tesco and John Lewis want to run at 50mph. Depending on the gearbox and diff ratio, they may be outside our optimum mapping. So we use our engine test cells not only to advance what we have for Euro 6 – given that Mercedes is discontinuing its OM501 v6 and changing to inline engines – but also to improve the system slightly for that duty cycle."