

Power struggles

Engine manufacturers are responding to various forces in the market with different strategies. Thomas Allen reports on how such companies are working to turn those challenges to their advantage

We are at a particularly interesting juncture in engine development for the construction industry. Faced with the disruptive forces of digital and electric technologies and the impending introduction of EU Stage V emissions regulations next year, all compounded by a technical skills shortage, engine manufacturers are being prompted, perhaps more than ever, to step back and assess their overall strategy.

SECTOR INSIGHTS

VOLVO PENTA – JOHAN INDEN

CHIEF TECHNOLOGY OFFICER

According to Johan Inden, chief technology officer at Volvo Penta, three trends are defining what the company is currently doing. They are connectivity, automation and electrification or hybridisation.

“Many of the opportunities going forward are in the integration of the engine with the full machine,” he said.

As machines become increasingly intelligent thanks to enhanced connectivity, automation and electrification, there is a sort of paradigm shift in which everything is affected. New safety features become available, pre-emptive servicing is made possible, and a machine’s features can be streamlined for greater efficiency and productivity.

Inden said, “By building a more integrated solution that adds both the connected side, in terms of uptime serviceability, and the

automated side, in terms of both safety and increased productivity, and then also moving to electric or hybrid, the next generation of productivity is opened up with all different types of machines.”

Without affecting the actual mechanics much, an engine can be fitted with a telematics system that interfaces with the telematics system on an OEM’s machine.

“So, you can start the preparation for the service process, for example, before you go out to the customer. Or, if the customer is asking something about a report they have got from the machine, you can always prepare beforehand what might need to be serviced, what parts are required, and so on,” Inden said.

By adding this predictability to the process, customers can be better supported and machine uptime can be increased.

Inden said, “We have over 700,000 connected machines – actually connected and operated by a Volvo group facility or a Volvo group company.”

With this number of connected machines, Volvo Penta believes it is important to keep its technology development in-house, including software development, in order to serve its customers best.

“It becomes an extended part of the product rather than something that should be done in a separate ecosystem,” Inden said.

This also allows for synergies within the Volvo group. Volvo Penta can draw upon technologies developed in other parts of the group, and vice versa – something that has been important for the development of hybrid systems.

With regard to electrification and hybridisation, Inden said, “You can say our strategy stands on two legs. One is understanding the application needs of our customers, and the other is reusing the technology that is developed in the group.

“So, matching the general technology development in the group, adapting it for our specific customer needs, and then understanding how we can deploy it into different types of machines.”

SHIFTING EMPHASIS

Volvo Penta is shifting the emphasis from its traditional diesel engine offering towards more tailored hybrid solutions.

Inden said, “You’ll of course see the continuation of the pure diesel offering, but you’ll also see that being combined into a hybrid solution, where you can use both the engine as the main propulsion or main producer, and you can also switch to electric, using it as a genset.”

He added, “Then you will also see serial hybrids, where you use the engine more as a producer of electricity, and then you drive an electrical engine that drives the machine.”

Inden predicted that over the next few decades, we will see the proliferation of these various types of solutions. The door is opening onto a platform approach, whereby customers are provided with tailored solutions that combine diesel and electric technologies to maximise productivity for their specific applications.

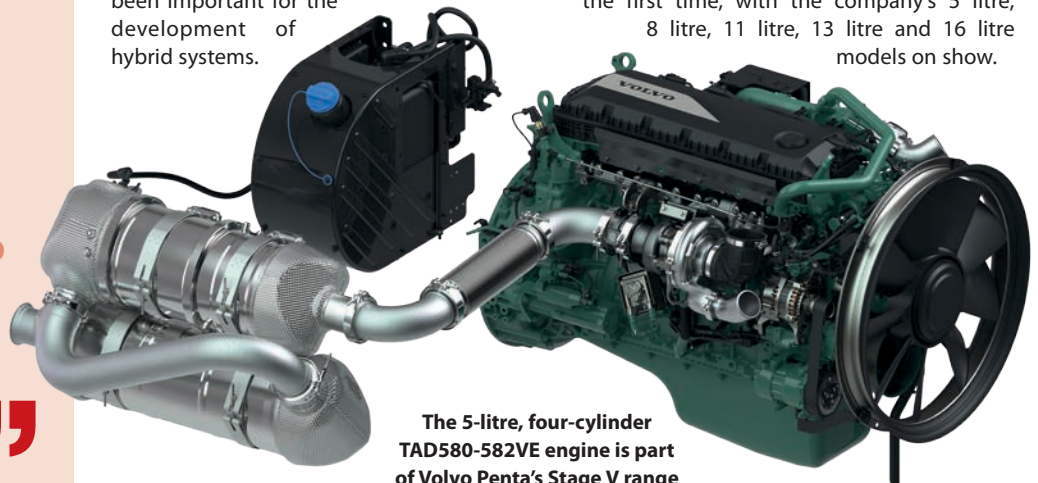
“Close customer dialogue and technology access – that’s kind of the mix that we are working with,” said Inden.

At Intermat 2018, Volvo Penta displayed its full range of Stage V engines for the first time, with the company’s 5 litre,

8 litre, 11 litre, 13 litre and 16 litre models on show.



“You’ll see the continuation of the pure diesel offering, but you’ll see that being combined into a hybrid solution where you can switch to electric”



The 5-litre, four-cylinder TAD580-582VE engine is part of Volvo Penta’s Stage V range

and client gains

“What we want to do is have a range of systems available because we know that it's not going to be a matter of one-size-fits-all”

CUMMINS – STEVE NENDICK

MARKETING COMMUNICATIONS DIRECTOR
Similarly to Volvo Penta, Cummins is putting more emphasis on hybrid solutions, having recently revealed its first electrified powertrain system for off-highway applications.

Speaking about the company's new range-extended electric vehicle driveline (REEV), Steve Nendick, Cummins' marketing communications director, said, "It'll probably be around 2020/2022 when we start to see these things on the market. I think there's a lot of learning for us to do with our customers and how to use this piece.

"Right now, the cost of battery power is pretty expensive, so we need the volume to start to increase to pull the battery price down."

RANGE-EXTENDER

The plan, though, is for Cummins to supply both full-battery and range-extender solutions. However, the range extender was said to be most relevant to construction and quarrying applications where there might not be the option to recharge on remote jobsites during the day. It offers the option of switching to diesel when the electric batteries run low.

As Cummins approaches its centenary next year, the company is looking ahead to what the next 100 years might bring, and its strategy is to develop a array of power solutions to reflect the alternative power needs of the future.

"What we want to do is have a range of systems available because we know that it's not going to be a matter of one-size-fits-all," Nendick said.

This means Cummins would collaborate with customers to provide a customised solution.



Cummins' new range-extended electric vehicle driveline (REEV), suitable for off-highway applications, was put on display at Intermat 2018

"Moving forward, we're not the diesel experts, we're the powertrain experts," Nendick said.

He also said the company's Stage V line-up was a pointer to the future because the engines' complexity, size and weight have been reduced, and yet they are more powerful. It is

expected that technological developments – including the increased use of hybrid solutions – will continue to drive that trend in downsizing.

PARTICULATE COUNT

Nendick said, "The real push from Stage IV to Stage V was the change to the particulate count. That drove everyone to have some sort of particulate filter.

"But because we have our own aftertreatment, our own company turbo, and we manage our own combustion process, we were able to look at it differently."

Whereas the engines had previously been fitted with two large units – a separate diesel particulate filter (DPF) and a selective catalytic reduction (SCR) system – it is all

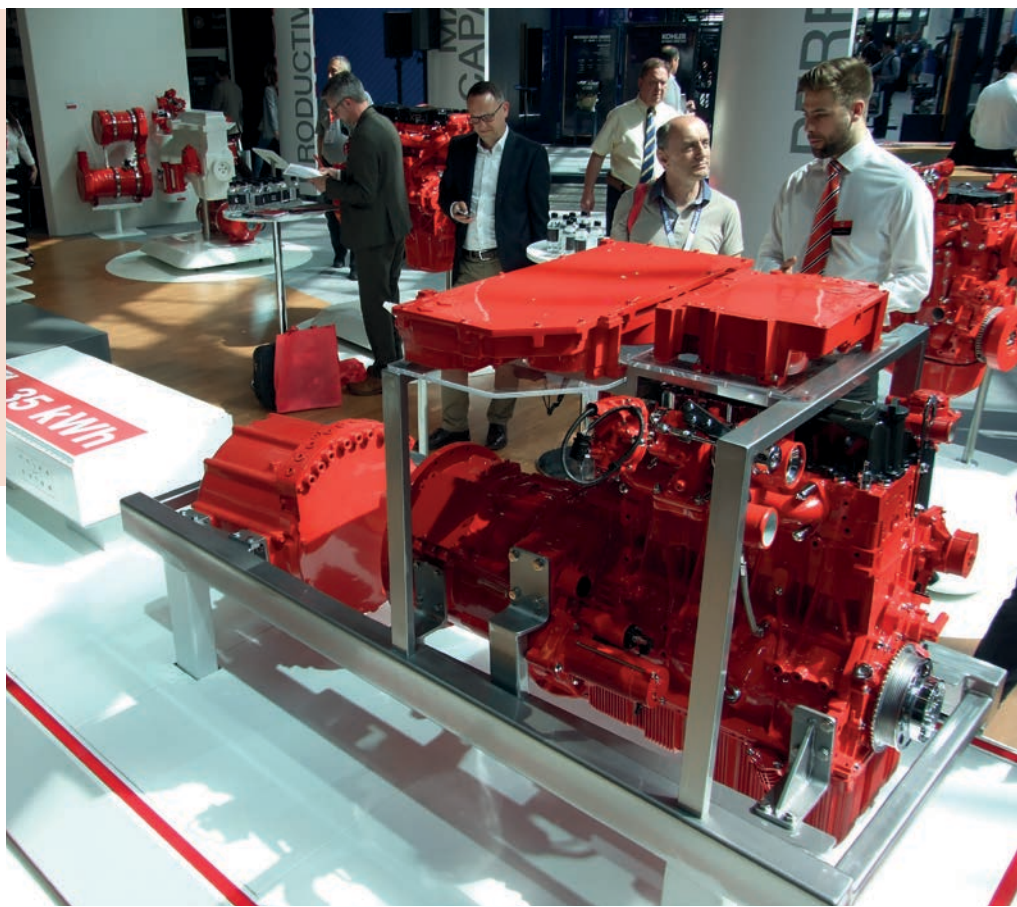
in a single unit now. Since the efficiency of conversion is higher, according to Nendick, more NOx (nitrogen oxide) emissions can be taken out through the aftertreatment system, meaning that exhaust gas recirculation (EGR) is no longer required. This has translated into improved power and torque.

"Particularly on the 6.7 litre, we've managed to push the torque up by about 30%," Nendick said.

"And that's given the manufacturers two opportunities to look at. One, can they increase the capability of the machine that the engine is fitted into or two, can they look at that and choose to move to a smaller engine with the higher performance capability and save money?"

Preparing for an emissions stage change is a time-consuming and costly process, according to Nendick – so Stage V is certainly nothing new. He said Cummins had been collaborating with customers to test prototype versions of its Stage V engines in various installations for the past two-to-three years.

"When the new regulations come through, it's quite a significant timeline to get everything ready."



PERKINS – OLIVER LYTHGOE
PRODUCT CONCEPT MARKETING MANAGER

Perkins does not seem to share quite the same enthusiasm for electrification – or at least, full-electric solutions – as Volvo Penta and Cummins, with Oliver Lythgoe, product concept marketing manager, saying, “Electrification is not so much a revolution – as it is being presented by some – but rather it’s just another tool”.

Speaking about full-electric solutions, he went on to say, “We’re out there, we know it, we have a route to provide it when OEMs ask for it. In reality, though, OEMs are not really demanding it much at the moment.”

It was suggested that it made sense to offer electric options at the bottom end, with small equipment that could effectively be powered off of a domestic plug; but it was not so viable for larger machines – especially those working in remote locations.

HYBRIDISATION

According to Secodi – Cummins’ distributor in France – there is a stronger trend in the market towards hybridisation, but at the moment it only applies to machine functions, rather than propulsion, because the infrastructure to charge batteries is not yet in place and the batteries themselves are not suitable for constant use.

Lythgoe also made the point that, “If a litre of diesel produces a certain amount of usable energy, to get the same out of the best lithium-ion battery today it would have to be 20 litres. And, of course, a diesel tank is made out of plastic and you can make it any shape you want.”

So, the diesel option is cheaper, more convenient and is, in fact, cleaner than might be assumed.

“Diesel particulate emissions have gone



down by 98% over the last 15 years,” Lythgoe said. “So, a modern fleet of engines at Stage V is pretty clean. If you wanted to improve the air quality, you’re probably better off doing something like a scrappage scheme and getting some of the old fleet out of the city centres.”

However, Perkins does recognise that the popularity of hybrid solutions is growing – partly due to the increasing number of low-emission zones in cities – and, along with the new Stage V emissions regulations, it is driving a trend towards engine downsizing.

Lythgoe said, “One of the trends that we’re seeing is just how much power density is increasing in our space. So, a 20 tonne excavator always used to take a 6 litre engine, and now most 20 tonne excavators are being fitted with a 4 or 4.5 litre engine. That’s really improving not only emissions but also fuel economy.”

For example, Perkins’ 4.4 litre 1204J-E44TTA engine was said to deliver 13% more power and 10% more torque than its predecessor.

These increases are part of an effort to

“ Diesel particulate emissions have gone down by 98% over the last 15 years ”

provide more value to the customer as the Stage V standards are phased in. The new regulations have been taken by Perkins as an opportunity to work on increasing engine efficiency.

The first of Perkins’ Stage V models to enter production is the 9.3 litre 1706J-E93TA, and it is one of 13 models that will be rolled out over the next year and a half. Perkins said that the range it was launching for Stage V was bigger than any it had launched for previous emissions stages, so it represented a particularly large and sustained investment.

In fact, Lythgoe said, “We believe this is the biggest emissions introduction ever in the industry of any manufacturer.”

Digital strategy

Rolls-Royce Power Systems has opened a new customer care centre in Friedrichshafen, Germany, marking the next step in the transformation of MTU’s global customer service.

Engine manufacturer MTU is owned by Rolls-Royce Power Systems and it is in the process of developing a new service and digital strategy, called Customer Service 4.0. The aim is to transform the company’s global customer support service so it becomes a complete solutions provider.

Andreas Schell, CEO of Rolls-Royce Power Systems, said, “With our service and digital strategy, we intend to deliver an exceptionally high customer-focused improvement in both our services and products.”

The new customer care centre in Friedrichshafen joins two other centres – one in Singapore and the other in Novi, US.

Digitalisation was said to play a key role in Customer Service 4.0, with an in-house digital solutions team driving the transformation.

The team of more than 40 people has been joined by employees from across the business, external experts, service providers from the start-up field, and app developers.

It was said that digitalisation was helping to link the company more closely with its customers, while also generating added value for customer support and product development by analysing additional information obtained from field engineers.

The first digital products – MTU-Go!Act and MTU Go!Manage – were designed specifically for individual applications and to meet customer needs, regardless of whether they are used for ships, trains, dump trucks or power generation.

With the system linked up to a data logger, MTU’s staff and customers are able to remotely monitor the performance of engines, schedule maintenance work, analyse operational data and determine what action is required.

However, Jürgen Winterholler, who is in charge of the digital solutions department at Rolls-Royce Power Systems, said the new products did not simply provide remote monitoring and error reporting.

“They provide the communications between the operator, service personnel and experts, collect the information at one location, and help the customer and our organisation to optimise the use and operation of our products,” he said.



Left to right: Jörn Lindstädt, head of global service; Marcus Wassenberg, CFO; Andreas Schell, CEO; and Jürgen Winterholler, head of digital solutions, in the new customer care centre in Friedrichshafen, Germany



The 1706J-E93TA is the first of Perkins’ Stage V models to enter production

“ There's an expectation that there will be a move to creating low-carbon fuels to address global warming ”

JCB – ALAN TOLLEY,
GROUP DIRECTOR OF ENGINES

The financial burden of changing to Stage V was also highlighted by JCB's group director of engines, Alan Tolley, "If you look at our engine R&D, the bulk of the resource we apply to it is to the emissions regulations."

Since the development of new technology for the Stage V regulations adds to the cost of the company's machines, Tolley said, "Every time we have an emissions step, we try to maintain and improve the other parameters of the engine – the performance and the efficiency – because that's what the customer values."

REDUCING OWNERSHIP COSTS

It is taken as an opportunity for the company to reduce the total cost of ownership by improving fuel consumption and engine serviceability.

The EU Stage V emissions regulations affect almost all of JCB's products because they cover such a wide power band – starting at 9kW and going above 560kW – and they also include some new applications, such as power generation. In addition, they have clarified and tightened the definition of non-road mobile machinery (NRMM).

"The technology does vary a bit with power. So, with the lowest power engines, it's not as stringent in terms of emissions compared to the higher-power ones, where it's very stringent. We pretty much say the high-powered engines are virtually zero emissions; whereas if you get down to between 9 and 18kW then the technology is not too different to what it was previously," Tolley said.

Since 2020, JCB has improved the fuel efficiency of its machinery by 43% on average, according to Tolley. Due to these efficiency gains, JCB has also noticed a trend towards engine downsizing. For example, the company recently introduced the 3 litre JCB430 Dieselmax engine to replace its 4.4 litre model.

With regard to reducing total cost of ownership through improved servicing, JCB has been providing LiveLink on all of



The recently introduced JCB430 Dieselmax engine on the production line

its emissions regulation-compliant machines since 2012.

Tolley said, "We have a whole space in our World Parts Centre where there's a room full of people and they're monitoring the output from LiveLink all the time. They can see how many machines are being operated, where they are, whether there are any codes coming through that the owner needs warning about, and so on."

He described it as a proactive approach to servicing, with customers being supported in an entirely new way, and it also offers security advantages with the option of geofencing.

New technologies like this were said to help attract young talent, but JCB is also actively cultivating a pool of fresh talent through the JCB Academy and various graduate schemes in an effort to tackle the skills shortage.

GETTING INVOLVED

In addition, new engineers are given the opportunity to get deeply involved in product development work at JCB. Tolley said, "With some of the bigger companies, young people can get a fairly small brief, whereas

here we tend to give people as much scope and responsibility as they can take."

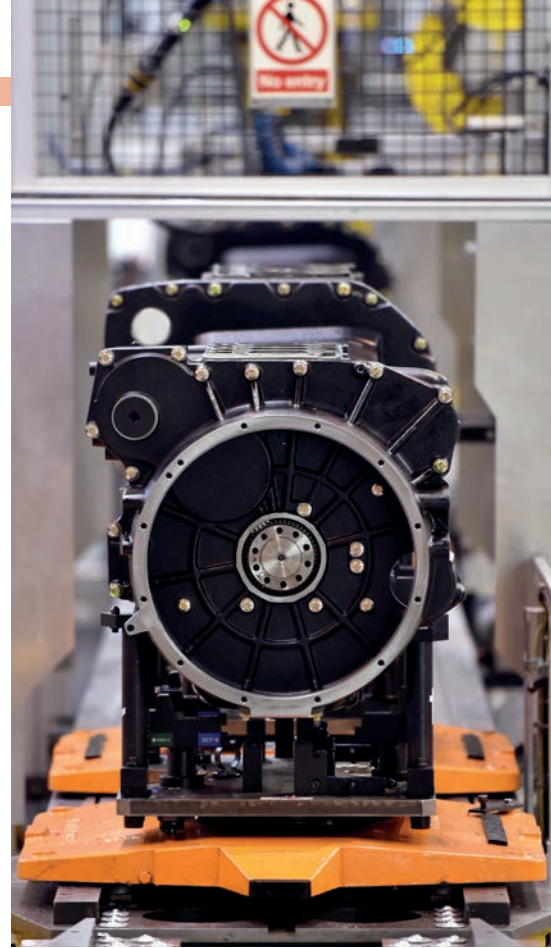
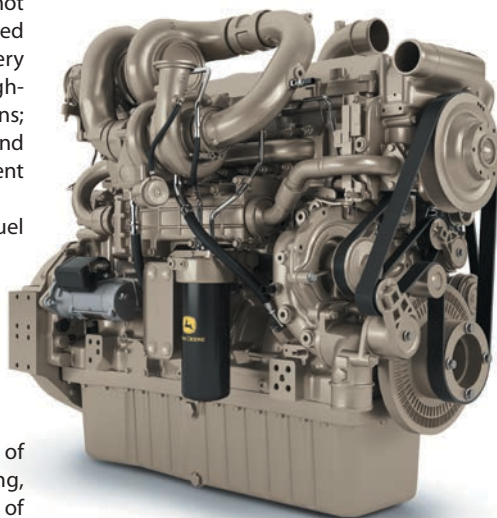
When asked about alternative fuels, Tolley said there are two aspects to consider.

"One is air quality, which is the NOx emissions and particulates, and the other is climate change from CO₂.

"So, there are some useful air quality improvements you can get by using some alternative fuels and what we have seen in Europe – in Scandinavia in particular – is the adoption of HVO type fuels," Tolley said.

HVO (hydrotreated vegetable oil) can offer some improvements in emissions without having to change the engine, though Tolley said those improvements were relatively small.

With regard to climate change, biodiesel is aimed at reducing CO₂ emissions because it is a renewable fuel. However, biodiesel suffered



something of a setback, according to Tolley, when incentives to produce biodiesel had the unintended consequence of encouraging farmers to substitute food crops for fuel crops.

"But I think there's an expectation that there will be a move to creating low-carbon fuels to address global warming – not necessarily in the short term but progressively in the long term," Tolley said.

HERE TO STAY

While engine manufacturers are facing various challenges, they are at least buoyed by favourable conditions in the market.

For example, Volvo Penta has enjoyed annual growth of about 30% in the industrial sector over the past three years, and over the past few months Cummins has gone from producing 200 engines per day at its plant in Darlington, UK, to producing 300 per day.

Indeed, internal combustion engines seem to be here to stay for the foreseeable future. Speaking at Kohler's stand during the Intermat 2018 exhibition, Peter Senecal of the University of Wisconsin-Madison, US, dismissed recent media reports that suggested electrification was going to take over as the premature burial of the internal combustion engine – especially with regard to off-highway applications.

Senecal said, "The diesel engine provides a unique combination of durability, performance and convenience that is unmatched by other technologies. With continued research and development, internal combustion will get even cleaner and should remain at the heart of off-road power systems for years to come."

The EU Stage V emissions standards have driven the latest advancements in clean

John Deere Power Systems' 13.6-litre engine, at the top end of the company's Stage V range

combustion technology, with Stage V line-ups being introduced by a whole host of manufacturers.

Among them is John Deere Power Systems, which has been working to provide OEMs and end users with a smooth transition to Stage V.

The US-based company's Stage V line-up ranges from 36 to above 500kW, with displacements of 2.9 through to 13.6 litres.

DIESEL PARTICULATE FILTER

Sandrine Couasnon, manager of marketing services and sales engineering for Europe, Africa and the Middle East, said, "For this stage, manufacturers will use DPF – a technology John Deere already has more than 900 million hours of experience using in the field."

It was suggested that this experience had led to the development of a DPF solution that, through its reliability and durability, offered increased uptime.

The range's aftertreatment technologies have also been optimised for flexible integration, with a reduction in packaging and weight compared to the previous Stage IV solutions. It was said that OEMs would only have to make minimal design changes when fitting John Deere's new engines because the technology has been built on the same engine platform as the current Stage IV DPF solutions.

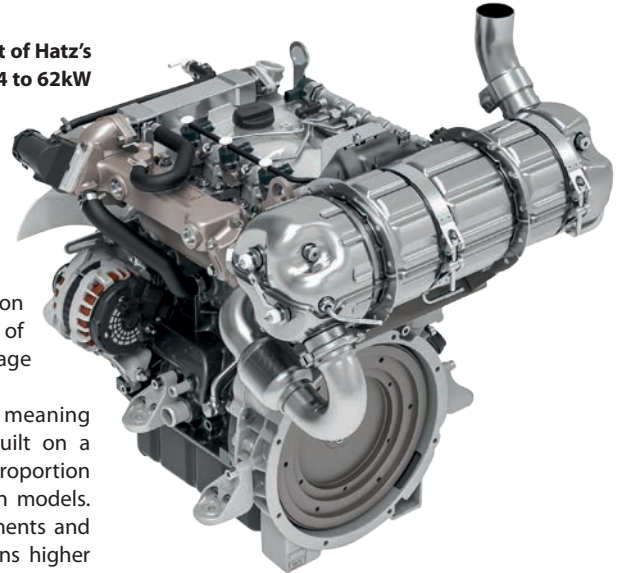
The three-cylinder 3H50TIC is part of Hatz's H-series, which ranges from 18.4 to 62kW

Meanwhile, Scania already delivers a complete range of engines that are compliant with Euro 6 on-highway emissions regulations, which are comparable to the Stage V standards for off-highway, so this has put the company in a good position to introduce the next generation of industrial engines that are Stage V-compliant, according to Scania.

A modular design is used, meaning that all of Scania's engines are built on a common platform with a large proportion of the components shared between models. The company said, "Shared components and systems for all of our engines means higher parts availability, minimised waste and easy servicing for a single technician."

The Stage V engines are based on SCR technology, along with Scania CPI fuel injection, the Scania Engine Management System, a variable-geometry turbocharger and a particulate filter. They were said to offer 500-hour oil change intervals.

Since the new Stage V standards are focused on reducing hydrocarbons, nitrogen oxides and particulates, Petro-Canada Lubricants has



suggested that we are likely to see a greater dependency on catalytic converters, DPFs, de-NOxing units and other forms of exhaust aftertreatments.

The company also said that for Stage V it has been proposed that in-use enforcement will be implemented to ensure continued compliance on a more frequent basis than an annual Ministry of Transport (MOT) test. In this way, heavy-duty equipment owners will be prompted to take a more proactive approach to maintenance and servicing, and so the performance of engine lubricants will become a more significant concern for them. They will be keen to ensure that a move to lower emissions does not compromise fuel economy or drain intervals.

Karl Rudman, business development manager at Petro-Canada Lubricants, said, "Careful consideration of lubricant choice should be a factor in a strategic approach to achieve gains in fuel efficiency, as well as the potential to extend drain intervals by using enhanced low-viscosity, heavy-duty oils."

PRODUCTION BEGINS

Hatz has started series production of its three-cylinder 3H50TIC engine as part of the company's seven-strong H-series range, which starts at 18.4kW and goes up to 62kW.

The H-series is being developed in accordance with the company's downsizing principle, so smaller engines that are lighter and consume less fuel while producing fewer emissions were said to be delivering higher power outputs and torque.

The new 3H50TIC has a power range of between 18.4 and 46kW, compared to the 37 to 55kW range of the four-cylinder 4H50TIC engine, which has been in production since 2014.

For EU Stage V, Hatz has designed the 3H50TICD and 4H50TICD versions, both of which are equipped with DPFs and have the same power outputs as their TIC equivalents.

The 3H50T is a special version that has been specifically developed for machinery that can be powered by a particularly high-torque engine with a power output of less than 19kW, meaning that they can fulfil the Stage V standards without a DPF.

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Yanmar Europe is going big

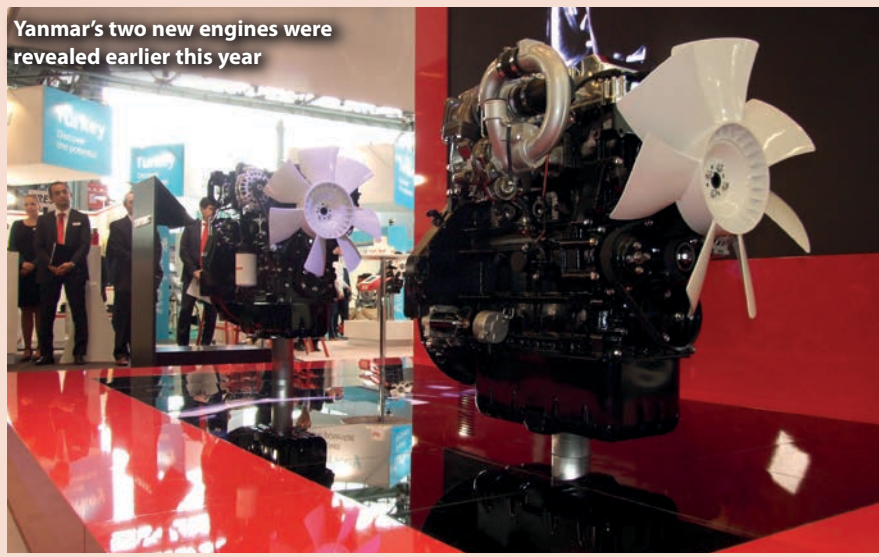
Yanmar Europe recently introduced two new high-power industrial diesel engines – the 4TN101, with a power range of between 55 and 105kW, and the 4TN107, with a range of between 90 and 155kW.

This expansion of Yanmar's line-up of diesel engines was said to place the company in the heart of the high-power diesel engine market.

Fitted with DPFs and SCR systems, both engines are Stage V-compliant and were also said to achieve reductions in fuel consumption of approximately 10% compared to similar-sized engines with the same output – based upon a comparison of average industry standards with the company's test results.

Yanmar also emphasised the high power density offered by the new engines. For example, the 4TN107, which features a two-stage turbocharger, has a power density of 34kW per litre. It also delivers maximum torque of 805Nm.

The compact size of the 4TN101 and 4TN107 was said to take into account the needs of OEMs. Yanmar's proprietary exhaust-gas reduction technology allows for a more compact exhaust-gas aftertreatment system, which was said to markedly improve the outward visibility and the comfort level for machine operators.



Yanmar's two new engines were revealed earlier this year