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'Alternative power' is a key theme influencing the design of engines for future mining equipment with incoming regulations and environmental pressures dictating the direction of product development. Dan Gleeson speaks to some of the key engine players to find out how far down the road they are with their clean energy efforts

Powering up

The ongoing need for 'clean' and 'green' power is currently dominating the mining engines sector.

Whether it is looking to build all-electric dump trucks, hybrid wheel loaders, hydrogen-powered mining equipment, trolley assist installations, or solutions to meet Tier 4 Final/EU Stage V emission regulations, the internal combustion engine that has dominated this space for decades is undergoing a period of massive change.

IM's Mining Trucks article in May went into detail on the electrification evolution taking place in the high horsepower side of the sector, but it is worth taking the pulse of the engine manufacturing segment in terms of potential widespread adoption.

Darren Almond, Manager of Drivetrain Product Planning, **John Deere Power Systems**, which claims to be one of the first companies to introduce electric drive technology in off-highway equipment – introducing its 644K hybrid loader, in 2013, and 944K hybrid loader, in 2015 – says many off-highway markets are in the early stages of electrification, with "immediate benefits to those specifically in the mining industry".

He told *IM*: "Exploring both completely electric and hybrid solutions as new technology becomes available could offer original equipment manufacturers (OEMs) cost and efficiency benefits."

He said general electrification components and systems were still in their early stages of

development for off-highway equipment, but this presented an opportunity to "create customised electrification solutions catered to mining applications". He remarked: "This is what makes electrification exciting right now.

"Plus, advances in battery, power electronics, drivetrain, generator and motor technology are being made every week," he added.

Niklas Thulin, Director Electromobility at **Volvo Penta**, agreed with Almond's assessment, saying electrification was in its early stages in the mining engine sector, explaining it was a "mixed picture" when it came to the pace and direction of the moves made by OEMs and miners.

"In some cases, electrification is driven by operators or even the operator's customers. In some cases, we see a technology push from progressive OEMs," he told *IM*.

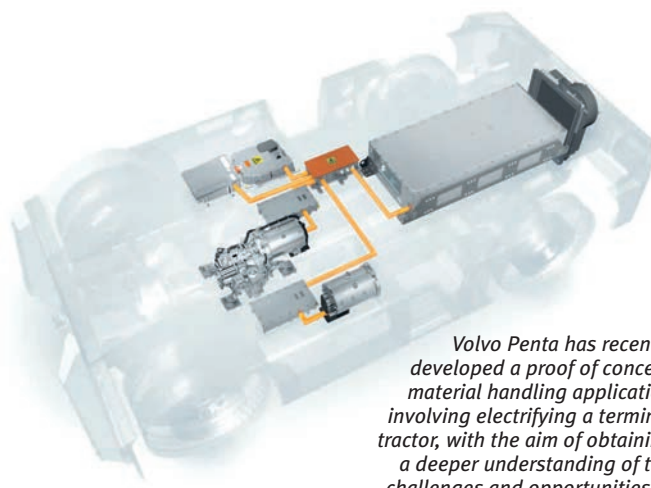
"For us, as a powertrain solutions provider, this means we interact with a wide range of stakeholders giving us a good view of different needs, challenges and opportunities with electrification."

Volvo Group's Electric Site project at the Skanska-owned Vikan

Kross quarry, which ran for 10 weeks using predominantly electric-powered construction equipment (*featured in a detailed write up in IM's January issue*), has given an indication of where the sector is heading, but Thulin said Volvo was building its electromobility offering across all parts of the group.

At Volvo Penta, this has recently seen the development of a proof of concept material handling application involving electrifying a terminal tractor, with the aim of obtaining a deeper understanding of the challenges and opportunities of going all-electric.

"At sea, Volvo Penta is engaging in the Electricity project providing the propulsion system for Gothenburg's first all-electric ferry," Thulin said. "Both projects demonstrate



Volvo Penta has recently developed a proof of concept material handling application involving electrifying a terminal tractor, with the aim of obtaining a deeper understanding of the challenges and opportunities of going all-electric

important steps in our journey to offer electrified power solutions for the future.”

Back with mining engines, Thulin had some encouraging things to say about just how quickly the transition was happening when compared with other sectors.

“We see that mining is one of the leading segments in electrification with a range of products now emerging from all leading OEMs,” he said.

Alternative power

There’s more to this discussion on ‘new technologies’ within the mining engines field than electrification.

This was made clear when **IM** spoke with **Cummins’** Executive Director, Power Systems, Mining and Aftermarket, Beau Lintereur, recently.

When asked about the potential for electrification in the company’s range of engines, Lintereur said: “Cummins wants to be a leader in all powertrains – whether that is electric, fuel cells, diesel, natural gas, you name it; that’s where Cummins wants to be.”

Cummins is already equipping some of its power generators to run on natural gas, **Caterpillar** has proven its Dynamic Gas Blending™ technology for LNG can provide savings on fuel costs and emissions while maintaining the same performance, payload and productivity in engines on its diesel 785C haul trucks in Mexico, and Anglo Platinum has continued to clock up the hours with fuel cell locos in South Africa.

One of the more recent developments has been in hydrogen, with the likes of Fortescue Metals Group and Anglo American talking up its use (*see this month’s High Profile interview on pages 8 & 9 to hear more from Anglo American*).

DEUTZ is one of the first engine manufacturers to invest in such technology after partnering with Munich-based start-up **KEYOU** to jointly develop commercially-viable, carbon-neutral hydrogen engines for off- and on-road applications.

DEUTZ, which has already established an electrification platform called E-DEUTZ, said: “As a leading global manufacturer of innovative drive systems, DEUTZ is seeking to play a pioneering role in the development of high-quality, eco-friendly and efficient engines.”

Dr Frank Hiller, DEUTZ CEO, said: “The use of alternative fuels such as hydrogen is growing in importance. We believe that this drive solution will be a valuable addition to our electrification strategy and play an integral role in the zero-emission vehicles of the future.”

The company’s expertise in combustion engines is being combined with KEYOU-inside technology, which can convert conventional production engines to run on hydrogen. “The technology is extremely scalable, both for on-

road and off-road applications, and it can be used in a range of hybrid configurations, including in combination with electric drives,” DEUTZ said.

KEYOU says it has developed a prototype for its KEYOU-inside technology that can turn a conventional diesel engine into a drive based on state-of-the-art hydrogen technology.

DEUTZ provided support as a development partner, supplying the engine – one of its standard six-cylinder models – and sharing its engineering expertise. The resulting hydrogen combustion engine is extremely cost-efficient, which makes it an attractive alternative to electric drives, fuel-cell drives and other zero-emission systems, the company said.

KEYOU’s first 7.8-litre hydrogen-ready prototype DEUTZ engine was unveiled to the public in 2018 and was also showcased at the recent Bauma fair, in Munich, Germany.

Specific pilot projects with vehicle manufacturers and end users are in the planning stage, with the appearance of the first prototype vehicles expected in the first half of 2020, DEUTZ said. The aim is to bring these prototypes to production readiness by 2021/22.

Stage V

It was a battle of the EU Stage V engines at Bauma, with major suppliers premiering new models or solutions that tick the regulatory box for use in off-highway machinery on the continent.

Cummins displayed the QSK60 Stage V engine for the first time at the show. The engine is part of a mining line-up that goes from 55 kW to 2,125 kW.

Available from 1,398-2,125 kW with a peak torque of 11,218 Nm, the QSK60 is ideal for excavators, dump trucks and wheel loaders, Cummins said.

“The proven QSK60 platform delivers high reliability and outstanding durability, with no loss of power or torque,” the company said. Heat rejection is similar to a US Tier 2 engine, so there is no need to re-engineer the cooling package, and the redesigned power cylinder, optimised wastegate turbocharge and improved crankcase breather system work to keep particulate matter (PM) levels low, Cummins added.

Cummins’ Lintereur said: “With single-stage and two-stage air handling configurations, this engine encompasses a wide range of ratings and altitude capabilities to meet the needs of the toughest mining applications.”

The engine is equipped to achieve an altitude capability of up to 3,500 metres above sea level (masl) without loss of power, plus the ability to go even further to 5,000 masl in certain instances.

“The projected life-to-overhaul exceeds 1.1

million gallons (3.8 million litres) of fuel burned, which makes it a great choice for repowers as well as new equipment,” the company said.

In a location not too far away, Caterpillar showcased a Stage V lineup that included the debut of the next generation C13B – shown as an industrial plug-and-play power unit solution at the event. This engine comes with multiple power ratings from 340 kW to 430 kW and a peak torque of 2,634 Nm, which fits into its underground mining engine range. It delivers 20% more power, 19% more torque and the aftertreatment is 65% smaller than EU Stage IV, according to Cat.

In addition, the company displayed a C18 engine on the stand, which featured engine-mounted aftertreatment enabling it to be dual-certified to EU Stage V and US Tier 4 Final.

The C18 was representing the newly regulated power category above 750 hp (560 kW), which also includes the C27 and C32 engines. The three engines are rated between 563-839 kW.

Steve Ferguson, Cat’s Vice President Industrial Power Systems, said: “With more than a billion hours of real-world, off-highway experience with diesel particulate filter (DPF) technologies at Stage IV, we’re extremely confident in the reliability and durability of our new Stage V engines.

“Furthermore, customers will see up to 20% increases in power density across our Stage V lineup, maximising productivity and reducing cost of ownership.”

And **Rolls-Royce Power Systems**-owned **MTU** also showcased EU Stage V engines for the construction equipment and industrial sectors at the show, explaining that MTU Series 2000 engines (567-970 kW) for construction equipment, industrial and mining applications would be available with EU Stage V certification from the end of 2022.

As well as reduced CO₂ emissions, the torque, performance and fuel consumption of the engines have all been improved, according to Rolls-Royce Power Systems.

Lars Kräft, Head of Industrial Business at Rolls-Royce Power Systems, said: “The first EU Stage V engines have been tested rigorously in numerous prototypes, at times under extreme weather and altitude conditions. This way, we’ve been able to evaluate a wealth of application data and operating experience, and the engines finally went into full production seven months before the new directive came into force.”

Bell Equipment recently took delivery of the first six EU Stage V certified MTU Series 1000-1500 engines from Rolls-Royce Power Systems. As early as 2016, Rolls-Royce Power Systems provided two EU Stage V prototypes for external testing at Bell, which were trialled in the hot, dusty climate of South Africa and endurance-tested at extreme altitudes of up to 3,000 masl.



Cat's recently launched R2900 underground loader is equipped with a six-cylinder, 305 kW-rated C15 engine, which uses the Cat Clean Emissions Module to limit both PM and NOx to near zero

These three companies went around their product development in similar fashions to deliver the emission-compliant engines.

As Cummins' Lintereur said: "Stage V in 2019 is the first time our mining products have been impacted by emissions regulations in Europe. Our proven solution for EPA Tier 4 Final using selective catalyst reduction (SCR) allows us to meet Stage V and provide installation consistency for original equipment manufacturers."

Cummins selected SCR for Tier 4 Final and Stage V because it delivers the best balance of installation, efficiency and total cost of ownership (TCO), the company said. The fully integrated after-treatment unit replaces the exhaust muffler, minimising design modifications, while reducing nitrous oxide (NOx) levels to Stage V requirements. The SCR system also features an integrated decomposition chamber and Cummins' airless dosing system, designed to last the life of the engine.

SCR reduces engine backpressure helping increase fuel economy and optimise temperature management, according to Cummins, while minimising Adblue/diesel exhaust fluid (DEF) consumption.

Sean Lynas, General Manager of Off-Highway OEM Accounts for Cummins, told *IM* the use of SCR on the company's Tier 4 Final engines in high horsepower applications for the US market had worked well, so it made sense to pursue a similar strategy in Europe for Stage V.

"Our ambitions for Tier 4 were essentially to be TCO and fluid neutral between US Tier 2 and Tier 4 Final, so the use of SCR wouldn't be a penalty in any way. I think we have been pretty successful in that," he said.

Lintereur concluded: "Having a common installation for Tier 4 Final/Stage V and

unregulated regions, with the exhaust system being the key difference, helps our OEMs build common chassis designs with one engine solution from us to meet the needs of all regions."

Cat, meanwhile, has leveraged a combined Tier 4 Final/Stage V solution across all its large mining truck engines to comply with the respective emission regulations. This has involved accumulating over 100,000 field hours, which included completing a planned engine rebuild.

Comparing its US EPA Tier 4 Final engines with its Tier 2 equivalent, Jeff Castleman, Business Development Manager, Large Mining Trucks, told attendees of a November Caterpillar event in Tucson, Arizona, that PM and NOx gas emissions had been reduced by 93% and 62%, respectively.

This is thanks to the use of an SCR system using DEF to remove NOx.

Castelman said the company went down this route on engines for its large mining trucks as it was a proven emission system with over 20 million hours of field operation, it offered a lower overall fluid and fuel consumption – lowering TCO – had a long life to overhaul (as well as multiple lives), involved common designs and processes, and facilitated ease of service and operation.

He went on to show how TCO had fallen on these new engines in a trial comparing a Tier 2-equipped Cat 793F haul truck with a Tier 4 Final-equipped Cat 793F haul truck.

Overall, the TCO came down 2.2% in this study, which factored in DEF use, repair and maintenance and diesel use. At the same time as this, the 793F with Tier 4 Final engine maintained its payload performance.

The results were similar across the large mining truck range, Castelman added, with those Tier 4 Final field hours coming from 785G trucks working in cold weather climates on coal operations, to 794 ACs running around deep pit copper mines and 797s operating in Canada's oil sands.

When it comes to machines more likely to end up in underground mines, Cat uses a similar approach.

In Cat's more compact range of engines (C3.6-C18 (560 kW and below)), it uses a mix of exhaust gas recirculation and SCR, which also requires diesel oxidation catalyst (DOC) aftertreatment and a DEF system, to meet Tier 4 Final/Stage V emission criteria. The exhaust aftertreatment devices are packaged in a Cat Clean Emissions Module (CEM).

For example, its recently launched R2900 underground loader, which is equipped with a six-cylinder, 305 kW-rated C15 engine, uses SCR, DOC and a DEF system to limit both PM and NOx to near zero, allowing the machine to meet EU Stage V and Canada's CANMET standards.

MTU, meanwhile, based its Stage V engines on Daimler commercial vehicle engines, with the new limits achieved by internal engine enhancements and adding an SCR system and DPF.

Rolls-Royce Power Systems offers a one-box solution featuring SCR, DOC and DPF to integrate all components into the limited installation space of the machines. "This exhaust gas aftertreatment system is both compact and robust," the company said, adding that the box meets the requirements of vehicle manufacturers and operators by being simple to install, operate and maintain.

Fuelling the emission compliance

Fuel is a major cost for truck haulage, representing 30-40% of equipment operating costs, according to vertically integrated fuel filtration company **Donaldson**. As a result, fuel savings of even just a few percentage points can save thousands of dollars per year in even the smallest fleets. At the other end of the scale, if the fleet for a large mining operation uses 1% less fuel, it can mean millions of dollars in annual savings.

Tier 4 and Stage V emissions regulations have compelled engine manufacturers to improve the efficiency of their engines, with the challenge being achieving this while also needing to burn more fuel to achieve production levels.

Jason DeGuelle, Product Manager – Engine Filtration, Donaldson, said: "Changes to the way engines are built have, in turn, brought changes in the standards for acceptable diesel fuel cleanliness.

"High-pressure common rail engines have been designed to improve fuel economy as well as reduce emissions," he said. "As a result, injectors run at much higher pressures, requiring tighter tolerances and clearances – which is why they need much cleaner fuel to operate at an optimal level."

On major mining sites, unplanned downtime for any reason is a significant problem. "Effective

fuel filtration is essential for maintaining engine efficiency and helping to drive economic fleet operation by minimising that downtime,” Donaldson says.

With good filtration and water separation, fuel cleanliness at the injector remains high and engine performance and efficiency will remain at consistent levels, according to the company. Poor filtration will lead to excessive wear and damage of injectors, reducing efficiency and putting equipment at high risk of downtime.

“When we talk about fuel filtration and jobsite efficiency, it’s important to discuss bulk filtration as well as onboard filtration,” DeGuelle said. “By pumping fuel through a high-efficiency bulk tank filter, any problems with fuel can be dealt with before being pumped into the equipment. Also, removing contaminants allows onboard filtration systems to do their job better and remain problem-free until regularly scheduled maintenance can be performed.”

Donaldson recommends a four-tiered approach for this:

- Use of high-efficiency filtration at the inlet of a



bulk tank will protect against taking delivery of dirty fuel;

- An effective breather filter on the tank will then help combat ambient dirt and moisture;

“Effective fuel filtration is essential for maintaining engine efficiency and helping to drive economic fleet operation,” Donaldson says

- Filtering fuel as it is being dispensed into the equipment is the final failsafe against contamination that happens within the tank;
- And, use effective onboard filtration as your final line of defence against injector and fuel system problems.

Repowering and retrofits

Komatsu and Cummins recently celebrated the delivery of the 100th modular common-rail system (MCRS) repower engine module to partner Rio Tinto.

This program is aimed at delivering major savings in fuel efficiency, more engine horsepower and lower service costs.

Since mid-2017, Rio Tinto, Cummins and Komatsu have been working together on a new technology roadmap that will see Komatsu 830E and 930E haul trucks – including autonomous trucks operating in the Pilbara region of Western Australia – upgraded with the latest Cummins QSK60 MCRS Advantage Plus engines.

“This new technology allows the engines to achieve higher horsepower with fewer turbochargers, while service life between repowers is predicted to be 36,000-40,000 hours, up from 28,000-36,000 hours, delivering lower lifecycle costs,” Komatsu Australia said.

According to Glenn Swift, Komatsu’s GM Western Region, the project reflects Komatsu’s philosophy of advancing, through technology and continuous improvement, the safety and operational efficiency of its product lines.

“It demonstrates how we aim to continually support our customers with their specific and ever-changing requirements. This highly successful project is testament to the approach and technical ability of key people from each company, working together initially to demonstrate their faith in the product capabilities – and which has been borne out by the results achieved so far,” he said.

According to Andrew Hardy, Komatsu’s Project Support Manager for Rio Tinto’s engine module program, the delivery of the 100th repower module is a significant milestone for a number of reasons. “Apart from being the 100th MCRS module delivered, the date of the installation, May 27, is exactly 560 days since we delivered the first MCRS module in November 2017,” he said.

“And, from the installation of the first MCRS engine module, Rio Tinto’s dump trucks have been in service with this new engine configuration for more than 26,500 days cumulatively across the fleet, with the first truck being in service for 555 days as of May 27, 2019

Rolls-Royce Power Systems and XCMG, the multinational heavy machinery manufacturing company based in Jiangsu, China, just last month formed a strategic cooperation alliance to further develop the Chinese domestic and export mining equipment markets, providing optimised solutions to customers worldwide.

A strategic cooperation agreement was recently signed in Xuzhou, headquarters of XCMG, by senior executives of the both companies. According to the agreement, Rolls-Royce Power Systems and XCMG will commit to joint efforts in exploring opportunities to integrate Rolls-Royce Power Systems’ MTU power and propulsion systems, including MTU Series 2000 and 4000 engines, into XCMG equipment for Chinese local and international mining projects. This brings together both parties’ technical strengths and business insights, in order to enhance product competitiveness and gain market share, Rolls-Royce Power Systems said.

With annual revenue of \$7.5 billion in 2018, XCMG is currently the largest market player in the Chinese construction and industrial sector, and ranks sixth in the world’s construction machinery industry, according to Rolls-Royce Power Systems. Rolls-Royce Power Systems has, since 2012, supplied MTU S2000 and S4000 diesel engines to power XCMG’s XDE series mining trucks ranging from 120-400 ton (109-363 t).

Both parties see great potential in further exploring the market with mining equipment built in China powered by high performing, reliable MTU diesel engines that meet Chinese and global emission standards today and in the future, according to Rolls-Royce Power Systems.

Andreas Schell, CEO, Rolls-Royce Power Systems, said: “It is a great pleasure to strengthen our partnership with XCMG, a valued customer with a strong market position and business ambition. The agreement demonstrates commitment of both our companies to deliver world-class solutions to the world’s mining industry.”

Tobias Ostermaier, President, Rolls-Royce Power Systems, Greater China, said: “I am confident that the agreement will allow better integration of MTU products and services into XCMG equipment, to achieve higher efficiency and optimised support to customers. It will also enable collaboration at different levels across each of our organisations to deliver highly complete and compelling offers to the market.”

Li Zong, XCMG Mining Machinery, General Manager, said: “The win-win cooperation is aligned with our development strategy to continue to enhance technology and market leadership at home and abroad. The combined force of MTU and XCMG will allow us to leverage synergies and create shared value.”

The two companies also agreed to collaborate on the validation and testing of new power and propulsion technologies, including gas engines and hybrid solutions, as well as applications of digital technologies, to drive low-carbon, sustainable development of the mining industry.

The field of preventative maintenance has been growing in the mining engines sector as equipment manufacturers, service providers and analytics companies continue to realise the impact unexpected downtime has on an operation and the financial benefit miners can receive by keeping components, systems and machines running for longer.

Notable related announcements at the recent Bauma fair came from Cummins, which used the event and its 100-year anniversary celebration to, among other things, launch its PrevenTech™ for Mining digital monitoring and reporting solution; and Rolls-Royce Power Systems, which launched its MTU Go! Act and MTU Go! Manage digital engine monitoring systems for Series 2000 and Series 4000 MTU engines used in mining vehicles.

Aimed at providing advanced detection of potential equipment health issues, Cummins PrevenTech “applies connectivity, big data, and advanced analytics to engine hardware, to help identify and diagnose performance issues faster and more accurately using the latest internet-of-things (IoT) technology and global security standards”, the company said.

IM spoke with Cummins’ Lintereur on the side lines of the fair to find out how the solution differed from other platforms on the market.

“This digital technology uses the best IoT technology in the marketplace,” Lintereur told IM. “We have developed a proprietary solution that is secure – it takes the data off the engine into a secured cloud-based environment. Then we have data scientists and engineers work...to use the data to find out what might be wrong or predict a failure.”

Lintereur said the specialists could look at how to extend the period engines run before operators must remove it from operation for routine scheduled maintenance – ranging from the next oil and air filter change, to the need for a major rebuild.

In order to increase the take-up of the new solution, Cummins is offering PrevenTech in three different tiers, to be priced accordingly.

The entry level provides fault codes, basic engine data and a filtration solution that will “allow you to move your maintenance practice to condition-based maintenance”, Lintereur said.

“The next level you have is a plus-product,” he said. “It is more of a DIY package; rather than feeding the customer data, we provide a portal that allows the customer to program logic where, if an event occurs to the engine, a fault code is sent over. The customer may want to trigger a message sooner than when a typical fault code occurs based on their own experience. This allows them to set specific triggers for things like

oil pressure and temperature.”

The third, premium level leverages Cummins Care in-house team of “engine analysts” to monitor the data coming off the system, Lintereur said. “In the premium package, you get 24x7 coverage from Cummins Care where we send you the recommendations directly.”

This tiered approach is likely to improve the platform’s predictive maintenance abilities with future algorithms constantly updated with real-life data from thousands of engines.

Lintereur was quick to point out the PrevenTech differentiators: “There are a lot of really good programmers and data scientists out there, but they lack the engine expertise. We have paired the data scientists and programmers with engineers that designed the engine or turbo, or control systems operating the engine.”

He continued: “Engines have been ‘smart’ for a while – we have been able to do some level of diagnostics on them – but they haven’t been connected. We haven’t been transmitting the data regularly, and certainly not in real-time. That data just lived on the engine. We have now taken a smart engine and connected it.”

The mining industry is one of the first sectors to have these tools at its fingertips – Cummins launched the solution in April for the QSK50, QSK60 and QSK78 engines – but the company sees it being rolled out across marine, oil & gas, power generation and rail applications before too long.

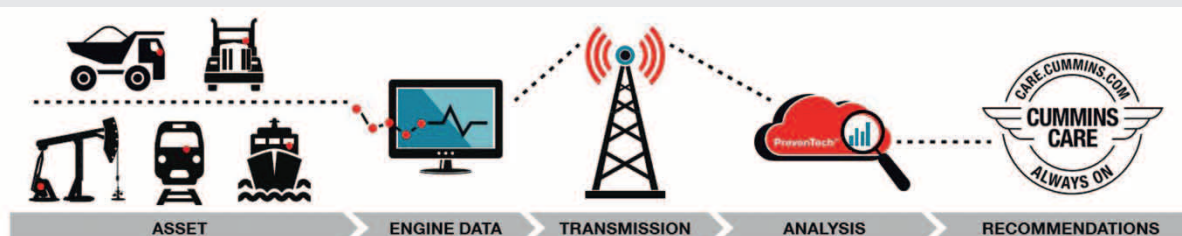
Cummins is acutely aware its new IoT solution will be used within a network of other maintenance platforms at mine sites, with Lintereur explaining that PrevenTech has been designed to interface with other providers’ solutions.

“We have realised that, if you’re a miner, for example, you may already have a platform to run your mine and we need to have a platform that can talk to it,” he said.

Cummins’ investment in digitalisation and connectivity is a wise one, according to Lintereur, with customers able to retrofit PrevenTech to their existing engines. This means the company’s return on investment will not be contingent on new engine purchases – investments likely to be pushed out further into the future with the IoT solution’s ability to keep engines operating for longer.

“PrevenTech is a product that can continue to grow even in a non-growth market,” he said, adding that the company may also consider offering the solution for engines from other manufacturers.

Lintereur summed up the benefits of the new solution: “A longer life to engine overhaul is what could eventually happen with PrevenTech. The engine will effectively become your maintenance manager.”



The PrevenTech solution “uses the best IoT technology in the marketplace”, Cummins’ Beau Lintereur says

– the day this 100th module is installed in the truck.”

Cummins’s Africa Middle East division has been strengthening its mining company ties in Africa, in recent months, with OCP Group and the engine company announcing the signing of a strategic partnership related to the implementation of a Master Rebuild Centre

(MRC) for Cummins high horsepower engines in Khouribga, Morocco.

The new facility will serve both North and West Africa and the scope of the agreement includes on-site maintenance of Cummins engines, Cummins said.

The building of the new MRC is a result of a feasibility study conducted by Cummins in

several countries in Africa, with the final decision zeroing in on Morocco where OCP operates a large fleet of mining trucks at its phosphate mines. This includes 186 t capacity Komatsu 730E-7s with 2,000 hp (1,491 kW) SDA16V159 Cummins-built engines.

OCP operates four mining sites in Khouribga (Sidi Daoui, Merah El Ahrach, Sidi Chennane and



In December 2018 and March 2019, MTU staff from South Africa and Zambia worked at FQM's Sentinel copper mine, in Zambia, to repower two of three 960-2KT Komatsu trucks. Photo courtesy of MTU

this purpose. “These are pre-assembled drive modules consisting of an engine, a generator and a radiator all mounted on a base frame. They also come with an electronic engine management and monitoring system,” MTU said.

In December 2018 and March 2019, MTU staff from South Africa and Zambia worked at FQM's Sentinel copper mine, in Zambia, to

reporting. This included the need for a cooling package that could adapt or change when a new MTU engine was placed in a vehicle, improved airflow for high altitudes, and increased performance and decreased noise of machinery.

The company offers a variety of mining equipment and support to customers spanning repowers for mines, mining haul trucks, off-road vehicles and power generators.

To help it better serve its customers, Horton worked closely with Detroit SA to determine how it could best support the company on its quest.

Given the mining environment and extreme operating conditions in Chile, the Horton teams worked with Detroit SA and recommended Horton HTEC Fans, which are engineered to tackle environments where durability and airflow requirements can prove challenging. Designed to maximise efficiency while minimising parasitic loss, Horton HTEC fans provide increased efficiency and durability with significant noise reduction in comparison to metal fans.

HTEC fans are also versatile, with configurations of five to 15 blades and standard and customisable hub mountings, including straight and tapered bores. As they are not a thermoplastic, but a patent-pending structural thermoset, they also deliver increased efficiency and higher speed ratings when compared with traditional metal fans, along with higher temperature ratings than nylon fans.

After switching to HTEC, Detroit SA saw an increase in efficiency and reduced noise from the lighter fan material, according to Horton. The distributor also noted that HTEC absorbs less power from the engine and is more resistant against the impacts of the uneven mine terrain, helping its customers more easily complete their jobs.

Detroit SA first installed HTEC in 2017 with its mine repowers. After seeing the success of those projects, it expanded the use of the fan to other machinery and recently installed a HTEC fan in a mining drill application. It is also exploring other options for this technology, including implementing it in wheel loaders and power generators. 



Horton HTEC fans are engineered to tackle environments where durability and airflow requirements can prove challenging, the company says

Béni Amir), three in Gantour (Benguérir, Bouchane and M'Zinda) and one in Boucraâ. The MRC will be based at the heart of OCP Group's industrial ecosystem, within the Fertiparc of the Oued Zem complex, Cummins said.

“This partnership is the first investment in this new industrial area, which offers an attractive environment for investors (connectivity, rental model, etc), thus boosting the regional economy and stimulating job creation,” it said.

The MRC will be operational by 2021 and will have an area of 14,000 m² and the capacity to complete 100 engine rebuilds per year. Cummins' investment in equipment is estimated to be around \$4.2 million.

The Khouribga facility will be Cummins 16th MRC globally; its second in Africa and the first in the North and West Africa region.

“The MRC consists of an industrial platform intended to receive Cummins high horsepower engines at the end of their lives, which will be brought in from 20 countries in the North and West Africa regions,” Cummins explained. “These engines, once delivered to the MRC, will be completely disassembled and inspected for defective components. They will then be re-assembled using Cummins genuine new or reconditioned parts and tested on an engine dynamometer in order to ensure that they have reached a new life performance.” The rebuilt engines will be finally returned to customers in the 20 countries in North and West Africa, guaranteed as new, Cummins said.

MTU Africa is not short of engine retrofit experience and it recently increased its number of successful engine installations with another eight projects.

The company converted three Komatsu 960-2KT and five Hitachi EH3500-AC2 mining vehicles at First Quantum Minerals-owned mines in Zambia. The Komatsu and Hitachi installations were first-time retrofits on both types of vehicle, MTU Africa said.

Mine trucks usually require new engines after three to five years, according to MTU, with Rolls-Royce Power Systems supplying Repower Kits for

repower two of three 960-2KT Komatsu trucks.

“In the rebuild, a competitor engine that had reached the end of its service life was replaced by a new 20-cylinder Series 4000 engine,” the company said, adding that the third 960-2KT repower project was to follow in May.

“The results of the first project once again confirm the classic virtues of MTU products: ‘all truck operators at the mine now prefer to drive the repowered truck,’ which boasts outstandingly fast response characteristics at lower engine revolutions per minute,” the company said.

The repowering project also led to greater engine reliability and robustness, longer maintenance intervals and lower fuel consumption, MTU added.

While this retrofit was a first on this type of Komatsu truck, MTU Africa has previously repowered Komatsu 730E, 860E-1K and 930E-4 trucks with MTU Series 4000 engines.

The truck fleet at the Sentinel mine includes not only the Komatsu trucks but eight Liebherr T284 mining trucks, also powered by MTU's 20-cylinder Series 4000 units, and two LeTourneau wheel loaders.

MTU Africa was also engaged by FQM at its Kansanshi copper mine to replace the competitors' engine on a Hitachi EH3500-AC2 mining truck with a MTU 12-cylinder Series 4000. This replacement is one of five trucks to be repowered at Africa's biggest copper mine over the next few months, the company said, adding that its MTU 12-cylinder Series 4000 engine is already powering two of the Hitachi EH3500-AC3 trucks at the mine.

Since the launch of MTU's Series 2000 and Series 4000 engines, they have been fitted to over 800 mine trucks as well as excavators, wheel loaders and surface blasthole drilling rigs worldwide, with the Series 4000 accounting for the lion's share, MTU says.

Keeping cool

Detroit SA, a **Horton** distributor located in Chile, has recently been on the lookout for solutions to a few problems its customers had been