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The MTU 16-cylinder Series 4000 natural gas engine for commercial marine applications.



A Rolls-Royce solution



# MTUreport

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## Connected

Integrated solutions deliver reliable power

## Cleverly networked

The MTU Microgrid connects

## At the heart of the data

Emergency power generators ensure Australia's data flow



A Rolls-Royce solution





Andreas Schell is CEO of Rolls-Royce Power Systems AG and Chairman of the Board of Directors of its subsidiary MTU in Friedrichshafen.

Dear Readers,

No experience in recent years has changed our everyday lives as profoundly as the Covid-19 pandemic. The changes are taking place globally, regionally and on an individual level and, in addition to the economic component, they also have an impact on our daily life and work together. With each we are becoming more adept at handling this situation. We are constantly re-organizing to keep our operations up and running. We've pulled together to protect those to whom the pandemic represents a serious threat. And we're exceeding our own standards by doing more for society at large, for our customers, for our company. We are being guided by two ground-rules in particular: to shield our employees and to be there for you, our customers.

Our production and assembly staff are working tirelessly to build and ship the power delivery systems you have ordered. Furthermore, we're still sending our service technicians out into the field to do what needs to be done – where our safety protocol permits. But we are also taking advantage of the opportunities presented by the crisis and pushing ahead with digitalization within the company: home offices are now a normal part of our everyday working lives, yet we are still globally active and there for our customers. Engine acceptance tests are now carried out via video conference and online training – even on the engine – has long been part of everyday life. We provide information about new solutions and products in webinars instead of at trade fairs, and the MTU Report will also appear in digital form next year.

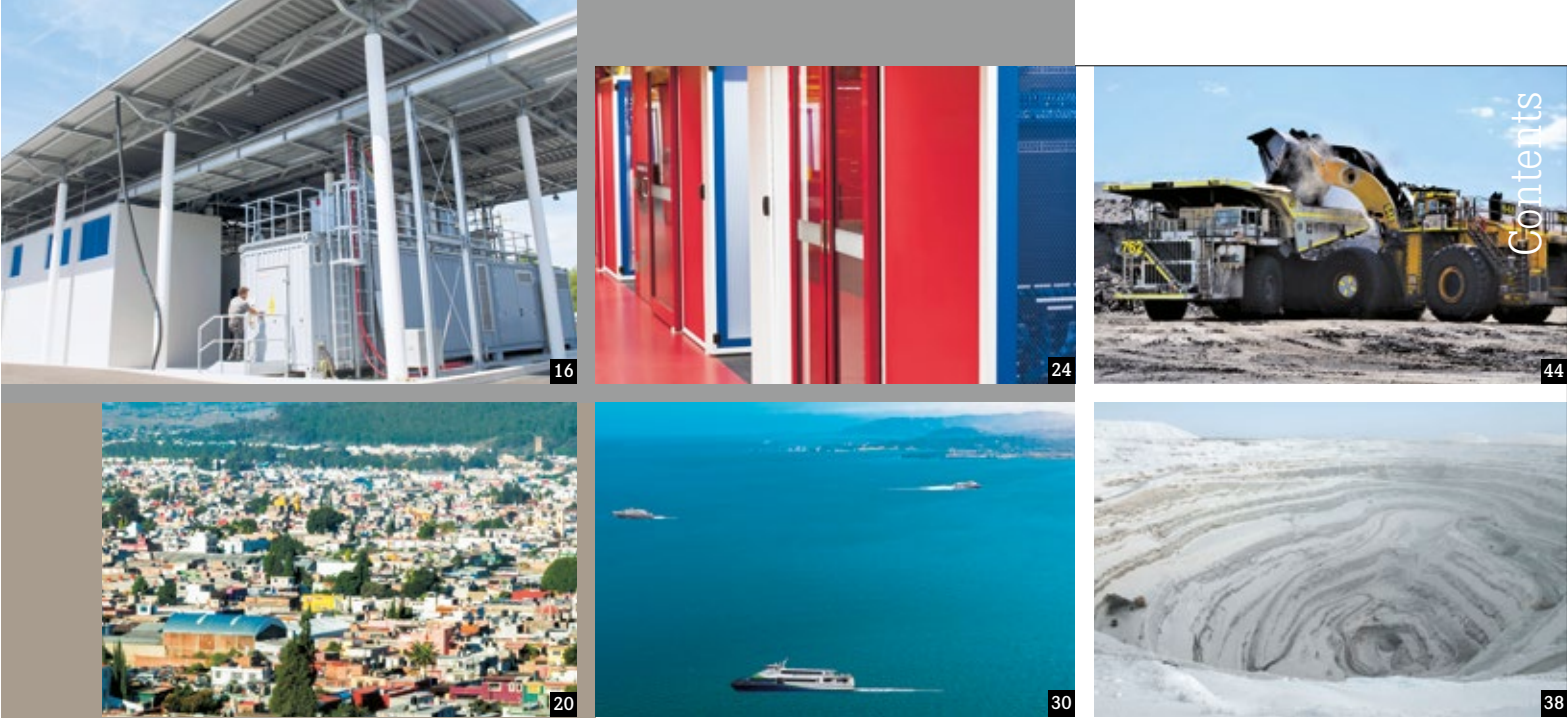
Indeed, we try to help wherever we can: some of our people, for example, have used a 3D printer to make brackets for protective visors and hospital equipment stands. We have donated these, plus 5,000 FFP2 protective masks to the local hospital and outpatient care services. Along with a Chinese partner, Rolls-Royce Power Systems donated an electrical generator set to the Red Cross Society to be installed in a hospital near the city of Wuhan.

At the same time as all these actions, we are also pressing ahead with transforming the company into a provider of sustainable solutions for energy management, propulsion and drive power. This issue highlights the different aspects of networking: in a data center and a self-sufficient power station, and of course featuring our microgrid. By highlighting several projects we illustrate how the solutions we offer – for example, the microgrid – can provide your operations with a stable and reliable, yet still highly flexible supply of power. Learn about how our emergency gensets are protecting Australia's data traffic – a vitally important job in the times we're living in. And why off-grid solutions are becoming ever more attractive: in Mexico, for example, we've engineered a stand-alone power plant for a meat-processing facility. The technologies we're working on to protect the environment and slow down global warming are numerous. Read about how we combine these technologies within our integrated solutions to produce driving power and energy in a way that is climate-neutral and ecologically sound.

The exceptional times we are currently experiencing have shown us once again that our systems and the job they perform in data centers, hospitals, trains and public sector vessels, are systemically crucial. That spurs us on in our mission – to keep developing the technology that the future needs.

Stay healthy!

Yours,  
Andreas Schell



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**Title image: The MTU Microgrid**  
With new products like the battery container and control system developed in-house, Rolls-Royce is coming up with new solutions for a more climate-friendly future. Pictured: the MTU battery container and Micro-grid Validation Center on the Friedrichshafen site.



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## Pretty in Pink

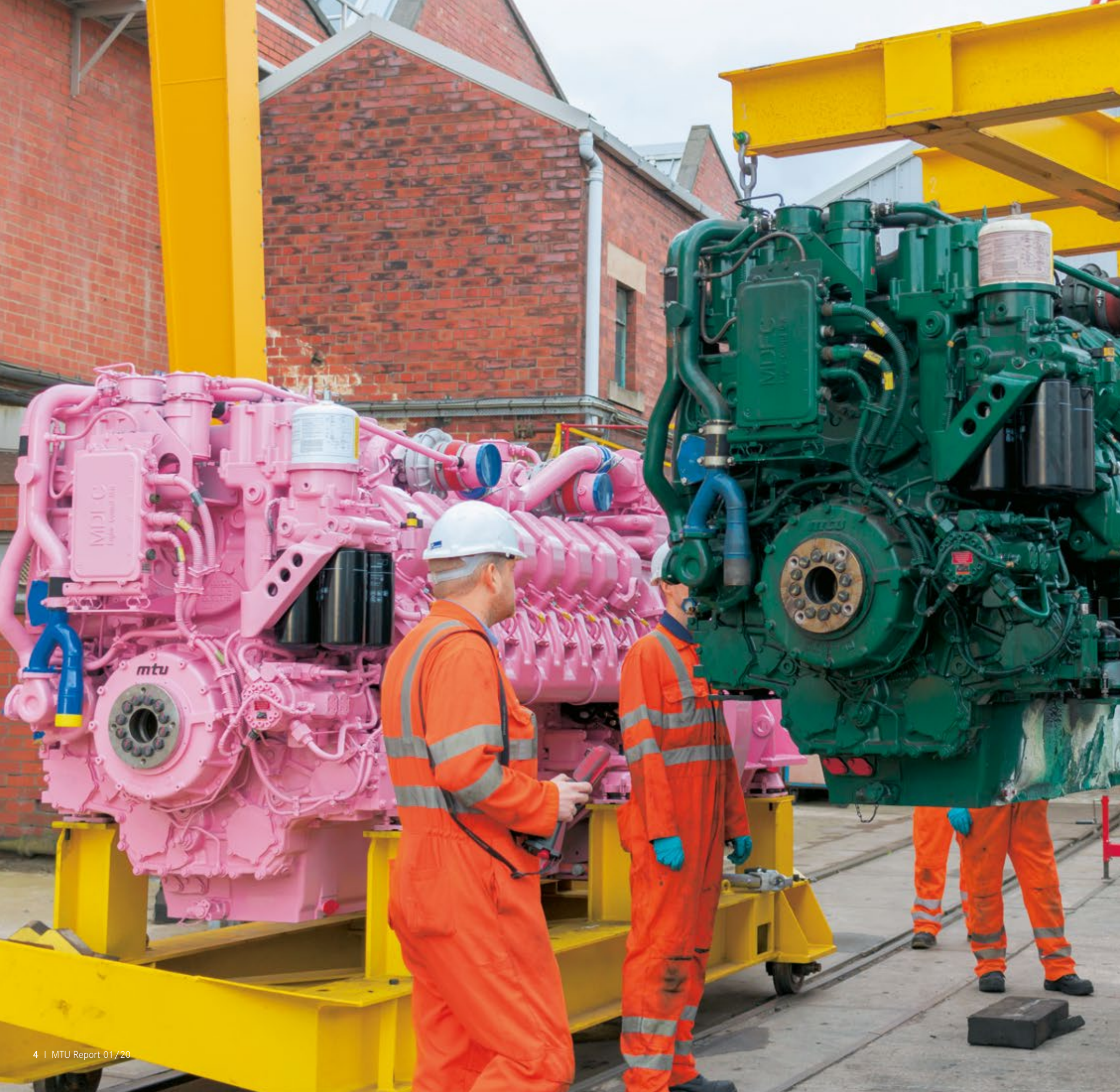
MTU rail engines are usually spray-painted blue or red. Since summer 2019, ScotRail has been able to boast a pink-finished MTU 16V 4000 unit in its InterCity 43127 locomotive. The Scottish train operator decided to hold a vote among Twitter followers on the color of the engine, giving them a choice of yellow, turquoise, or pink. Over 2,000 took part, with the color pink carrying the day.

The engine had been sent to MTU UK in East Grinstead for QL3 maintenance, which takes place halfway through the service life (TBO). A face-lift in the form of a new spray of paint is part of the service package, and ScotRail decided on a new pink look for one of its rail engines, which are usually grey. "It was Alan Stewart, ScotRail's service delivery manager for HSTs, who phoned to tell us about the campaign," grinned Rod Riley, Service Manager at Rolls-Royce. "Maybe we will suddenly find a big demand for pink engines," added sales colleague David Eaton.

ScotRail is introducing 26 fully upgraded InterCity high-speed trains for its services between Scotland's seven cities. Each train has two locomotives, each powered by a 16V 4000 unit. From now on, that means a fleet of 53 grey engines, with one painted pink. The trains are in service in Scotland, connecting the cities of Aberdeen, Dundee, Edinburgh, Glasgow, Inverness, Perth, and Stirling. ■

Quick change: the green engine of the ScotRail locomotive was removed and sent to East Grinstead for QL3 maintenance. The InterCity locomotive 43127 goes back into service with the unique pink engine.

Read the full story at  
<https://bit.ly/2X5slZk>





## Lifesaver in the flesh

Two MTU-powered Search and Rescue cruisers (SARs) belonging to the German Maritime Search and Rescue Service (DGzRS) will be going into service in 2020. The state-of-the-art special purpose vessels, one named *Hamburg* with internal designation SK 40, and its as yet unnamed twin, the SK 41, are each equipped with two 16-cylinder Series 2000 M72 engines. MTU developed the engines especially for coping with the extreme conditions at sea that challenge the rescuers in the course of their missions, which number over 2,000 per year. The DGzRS rescue team comprises 180 full-time staff and 800 qualified volunteers, and is poised for action around the clock, whatever the weather. Hence their service motto: "We head out to sea when others seek safe haven."

After its naming ceremony, the *Hamburg* is stationed in Borkum. Its predecessor, the *Alfried Krupp* is being decommissioned after 32 years in service. The second vessel under construction, the SK 41, will be christened in the new year and stationed in Grömitz. Its name is not to be revealed until the ceremony. This vessel is replacing the *Hans Hackmack*, which in the future will be used to substitute rescue cruisers which are not in service – for example when they are undergoing a general overhaul.

The SK 40 and 41 are the fourth and fifth special vessels in the new 28-m SAR cruiser class operated by the DGzRS, and have 4,000 hp for reaching speeds up to 24 knots. For the rescue teams and crew, going out on a mission also demands other exceptional skills. It is important that the SARs operated by the DGzRS remain maneuverable, no matter how rough the conditions at sea. This is where the MTU engines come in which have to keep on running, even in the event of heavy listing (tilting) or a complete capsize, when the vessel completes a 360° turn around its own axis. The engines are equipped with a special 'rough kit', which includes an extra-deep oil pan with special purpose bulkheads, a modified crankcase breather system and specially adapted engine control. ■

PHOTO: DGzRS

Read the full story at  
<https://bit.ly/2WIB5FT>



The *Hamburg* before the launch: The hull is completely welded. For further work, the *Hamburg* is moving to Berne-Motzen another part of Fassmer shipyard. This was the first time that the already buoyant hull came into contact with water.



# Being put to the test by Covid-19

The Covid-19 pandemic has significantly changed everyday life and work at Rolls-Royce.

**Covid-19 has turned the world upside down. Business trips have become the absolute exception, while working from home and holding digital meetings are suddenly the rule. At Rolls-Royce too, a lot is being done differently with the help of great creative input, digital tools, and, of course, dedicated teams. Staff are supporting commissioning work remotely, are facilitating engine classifications digitally, and have even persuaded sub-suppliers to run extra shifts.**

Today, production is underway in all Rolls-Royce Power Systems factories – albeit at reduced capacity due to the downward curve in orders. While Germany and the US managed to continue their operations, China had a three-week delay, resuming activities in mid-February. Now the new normal is social distancing and the wearing of protective masks. Even in this situation, however, on-time delivery of their MTU systems remains crucial for many customers. Emergency generator sets, for example, are indispensable

in vital facilities such as hospitals, while airports and data centers depend on them too. Moreover, China is starting to scale up its industrial activity again, which has brought a further challenge to our logistics team. Negotiating on a case-by-case basis, they have managed to persuade suppliers and freight forwarders to carry on shipping worldwide and have also obtained special confirmations for systemically relevant equipment to ensure that the necessary factories and border points stay open.

## Engine acceptances attended remotely

In these times of travel restrictions and stay-at-home orders, many customers are using the possibilities of Skype or Webex to attend the acceptance of their engines remotely and watch how the final test run goes off at the stand. Furthermore, staff at Rolls-Royce have been working with classification societies to enable engine classifications to take place in a similar way: At the Friedrichshafen site, mobile and stationary cameras have been installed at the test stand to enable the classification societies to monitor events at any time they wish. On the screens arranged at the test stand, the appraisers check the MTU engine data and

certify compliance with the given emissions stage at long distance. Increasingly, service and assembly technicians are giving instructions per video or on the telephone whenever it is not possible for them to go out into the field. On top of that, maintenance schedules are being modified to fit in with the new safety protocols and operational procedures.

## Commitment of staff and company

The sudden changeover to remote working was a tough call for the IT division at Rolls-Royce Power Systems. But it took a small team just a few days to increase the capacity of the digital infrastructure, stabilize the system and carry out a full-scale upgrade of the entire remote network.

Recipients of numerous donations made by the company around the world have also expressed their gratitude. Both Power Systems staff and the company have donated protective gear, FFP2 face masks and hospital equipment frames, while 3-D printers have been used to make face visors and brackets. In cooperation with a Chinese partner, a generator set was donated to the Yichang Red Cross Society and installed in a hospital on the outskirts of Wuhan.

# Flywheels for MTU emergency power



Kinolt's technology is based on a combination of kinetic flywheel energy storage with diesel engines and a generator that can also be used as an electric motor.

## Uninterruptible power supply systems in the power range from 200 to 3,200 kVA now complement Rolls-Royce's MTU portfolio.

To this end, Rolls-Royce has signed a purchase agreement for the Belgian company Kinolt, formerly known as Eurodiesel. Uninterruptible power supply systems are used whenever it is essential to have a power supply with high voltage and frequency stability, or where a power outage would have severe consequences. Examples include data centres, hospitals, airports and some manufacturing enterprises. Petar Pelemis, Vice President Corporate Strategy & Product Management, explains: "With Kinolt's expertise, we are the only manufacturer able to supply our customers with all components and thus a complete system for uninterrupted power generation."

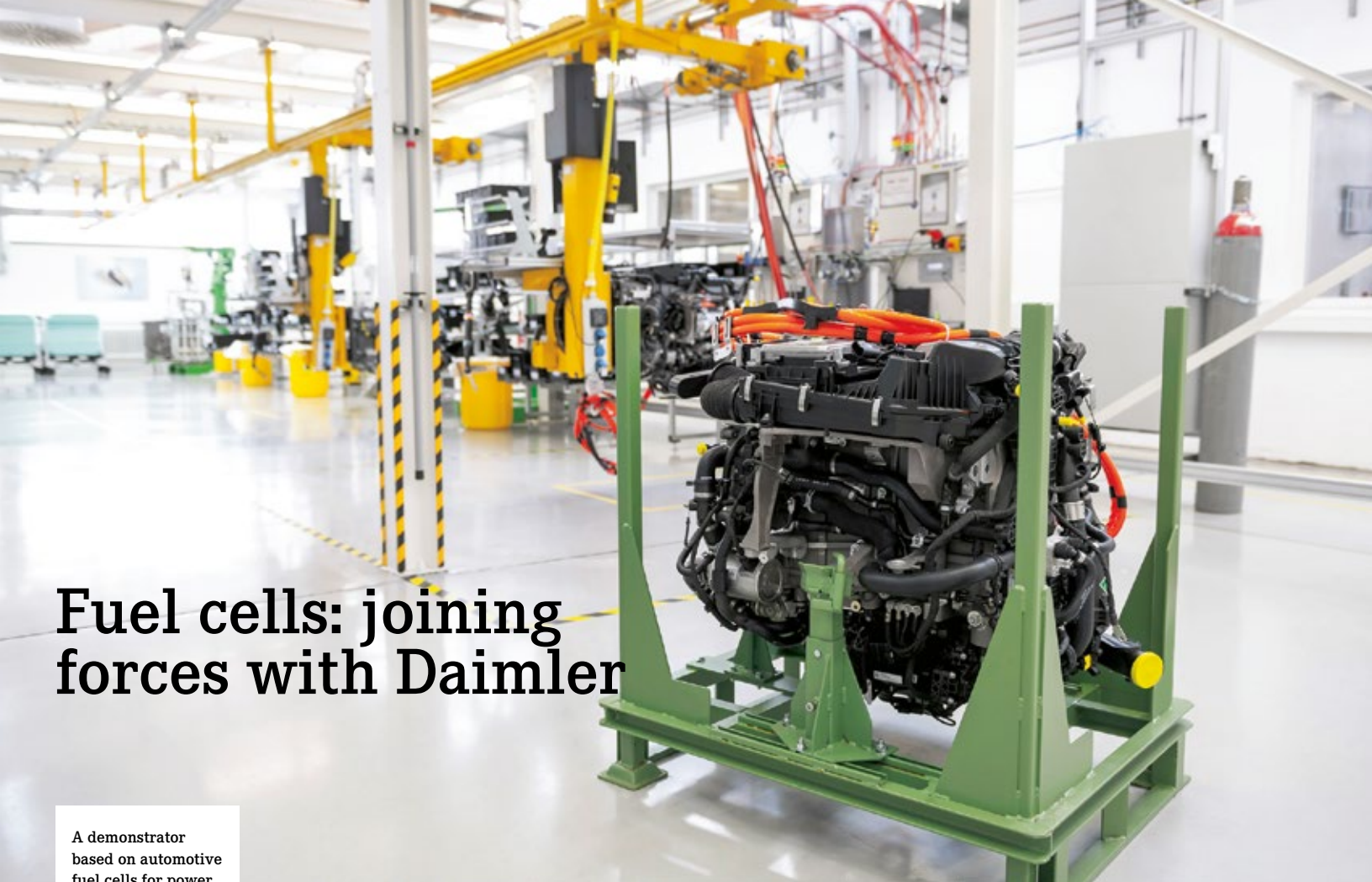
## Technology with momentum

Kinolt's technology is based on a combination of kinetic flywheel energy storage with diesel engines and a generator that can also be used as an electric motor. The system is installed

between the main power grid and safety-critical loads and delivers the required electrical power. It usually provides more stable network frequency and voltage than national power providers, which is important for applications such as data servers and computer-controlled plants which are vulnerable to failure even with comparatively slight power grid fluctuations. In the event of a power outage, the flywheel mass accumulator bridges the first few seconds before the diesel engine can take up the load in order to supply power without interruption.

"Power generation for safety-critical environments is an economically growing sector. With this deal, Rolls-Royce Power Systems will take its transformation as a provider of complete solutions one step further by moving into the realm of power transmission security, with Kinolt's core product and technology filling the gap between the engine and generator," says CEO Andreas Schell.





# Fuel cells: joining forces with Daimler

A demonstrator based on automotive fuel cells for power generation is to go into operation in Friedrichshafen at the end of the year.

Rolls-Royce plc and Daimler Truck AG plan to cooperate on stationary fuel-cell generators as CO2-neutral emergency power generators for safety-critical facilities such as data centers. They are to offer emission-free alternatives to diesel engines, which are currently used as emergency power generators or to cover peak loads. Both companies have signed an agreement to this effect. A comprehensive cooperation agreement is to be prepared and signed by the end of the year.

Daimler and Rolls-Royce are linked not only by longstanding cooperation on conventional drive systems for other applications. At the end of last year, Rolls-Royce Power Systems and Lab1886, Daimler’s innovation unit for new business models, had already agreed on a pilot project to develop a demonstrator for the use of this technology for stationary power supply on the basis of fuel-cell modules from

the automotive sector. It will go into operation in Friedrichshafen by the end of this year.

“Through the cooperation with Daimler Trucks, we will gain access to fuel-cell systems that meet our demanding requirements and will thus further strengthen our outstanding position in this growth market. As a supplier of integrated solutions, decarbonization of our drive, propulsion and power generation systems is a key strategic aim. In pursuing it, we're open to all technologies. Hence, fuel cells are set to become a key technology for us,” said Andreas Schell, CEO of Rolls-Royce Power Systems. “The idea behind the fuel cell is as ingenious as it is simple, but implementing it in practice can still be a challenge. It's now ready to go into production, and ready for the commercial marketplace,” explained Dr. Martin Teigeler, head of R&D at Rolls-Royce Power Systems.



# Center of Excellence for microgrids and batteries

In January 2020 Rolls-Royce acquired a majority stake in the Berlin-based electricity storage specialist Qinous. The former start-up, which now operates under the name Rolls-Royce Solutions Berlin, develops and sells battery storage systems and associated control systems and is active worldwide. The new Rolls-Royce competence centre for microgrid solutions is currently being built at the Berlin location of the new subsidiary. The modular component system of the coordinated Qinous and MTU product range will in the future allow the configuration of solutions from 30 kW/30kWh to several MW/ MWh. The range of services and capacities covers the needs of commercial enterprises, municipal utilities, energy suppliers and even larger industrial plants. "On our way to becoming a provider of integrated solutions for our customers, we have taken a big step forward with the majority acquisition of Qinous. In future, we will be able to offer not only the technical solution and service, but even the financing," says Andreas Schell, CEO of Rolls-Royce Power Systems.

Battery storage systems from 30 kW/30kWh to several MW/MWh complement the MTU portfolio.

# 500+ engines heading to China

In Shanghai, Rolls-Royce's Power Systems division has signed a total of five agreements with partners Cooltech, EPG, SUMEC Machinery & Electric Co Ltd, Tellhow, and AFAI Southern Shipyard. These cover over 500 MTU Series 4000 engines and systems for power generation, and Series 2000 hardware for marine applications. Initial deliveries of MTU Series 2000 engines were made to AFAI Southern Shipyards at the end of 2019 for installation in new ferries. The frame agreement with Shanghai Cooltech Power Co Ltd, a leading Chinese manufacturer of power generation systems, covers the supply of approximately 150 MTU Series 4000 engines and diesel systems. EPG Machinery & Electricity Co Ltd, a leading Chinese data center systems integrator, also signed an agreement for the supply of approximately 200 MTU diesel systems. SUMEC Machinery & Electric Co Ltd agreed to take delivery of a total of 70 separate MTU Series 4000 engines for power generation applications. A memorandum of understanding for the supply of 70 Series 4000 engines was signed by Tellhow, a Chinese manufacturer of power generation equipment.



Partnership agreement for mutual supply of natural gas generator sets (l to r): Rolls-Royce's Michael Wagner, head of Business Development for Distributed Energy Systems, and Andreas Görtz, Vice President, Power Generation, signed the contracts with CEO Christian Grotholt and Heiko Barth, head of Product Management, representing 2G Energy.

# Partnership with 2G Energy on natural gas gensets

Rolls-Royce is to procure from 2G gas-powered generator sets and combined heat and power modules in the 250 to 550 kW power range with and without heat recovery. After adding its own control units and other specific components, Roll-Royce will then market the systems under its MTU product and solution brand. In return, Rolls-Royce will supply 2G with MTU gas-powered generator sets based on Series 4000 engines delivering 776 to 2,535 kW. These will be used by 2G in its CHP modules for on-site generation of electrical power and heat. Now into their fourth generation, the Series 4000 engines boast excellent electrical and thermal efficiency, outstanding load switching capabilities, and a power density unrivaled on the market. The 2G products are to shortly replace CHP modules at the lower end of the power range that have hitherto been based on MTU Series 400 gas engines.



In brief:

**VPower group is new distributor**  
Rolls-Royce is moving forward with its growth strategy in China, despite the challenges posed by COVID-19. VPower Group, one of the world’s leading system integrators in the power generation sector, has become a new distributor for MTU products in China. The company has been integrating MTU engines and systems for more than 10 years into its customer solutions. The new distribution agreement covers the sales and maintenance of MTU engines and gensets for commercial marine vessels and gas-fuelled power generation.

**Fully independent grid**  
Another self-sufficient power grid featuring MTU natural gas gensets has gone into operation in Santa Cruz, Bolivia. In stand-alone operation, three MTU 16V4000L32 gas gensets will be installed, each generating 1.5 MWe of electricity for Empacar's industrial operations. The gensets and control system were supplied and installed by MTU distributor SvF Bolivia for what is the first autonomous power grid operated by an industrial company in Bolivia.



PICTURE: BABCOCK INTERNATIONAL GROUP

**Royal Navy opts for MTU**  
Rolls-Royce is to supply complete MTU propulsion systems for five new Type 31 general-purpose frigates for the Royal Navy. In total, the order comprises 40 engines and generator sets to be used for main propulsion and on-board power generation, the MTU Callosum propulsion control and monitoring system, and Integrated Logistics Support (ILS). Each new frigate will be powered by four MTU 20V 8000 M71 engines, each delivering over 8,000 kW. On-board power will be provided on each vessel by four MTU generator sets based on 16V 2000 M41 B

**Rolls-Royce is to supply complete MTU propulsion systems for five new Type 31 general-purpose frigates for the Royal Navy.**  
units, each delivering in excess of 900 kW. In September 2021, Rolls-Royce will deliver the first shipset comprising four main propulsion engines and four generator sets to prime contractor Babcock International Group.  
The Royal Navy relies on Rolls-Royce propulsion solutions across its surface and submarine fleets. MTU Series 2000, 4000 and 8000 units will feature in future in most Royal Navy warships – in destroyers (Type 45), all frigate classes (Type 23, 26, 31) and submarines (Astute class).

**New website: [www.mtu-solutions.com](http://www.mtu-solutions.com)**

Customers can now find all Rolls-Royce's MTU products and solutions and further information in one place, at [www.mtu-solutions.com](http://www.mtu-solutions.com). The new Internet presence has been designed strictly from a customer perspective and pulls together

content relating to the MTU and former MTU Onsite Energy brands on a single website.  
The new website includes details of all product and service offerings as well as application stories published in MTU Report. With content tailored to specific interests and subject areas, the customer can now follow the entire life cycle of a product – such as a marine engine – from point of purchase to in-life servicing, and also experience real-life customer examples in video and written formats, all under one heading. The new website forms part of the brand strategy, which is to underline that the Power Systems business unit with its MTU brand is a member of British technology group Rolls-Royce.  
Hence MTU Solutions is the search term to use to look for MTU products and solutions on the Instagram, Twitter, LinkedIn, YouTube and Flickr social media platforms.

**As well as carrying up-to-the-minute, multi-language content, the new website is also very user-friendly and compatible with various types of mobile device.**



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**The networkers**

Reliable and stable power supply – our customers depend on it. What exactly this power supply system looks like is something every customer can solve individually according to their needs: with a MTU solution from Rolls-Royce. NEXTDC, Australia's largest data center operator, relies on MTU emergency power gensets, which are activated whenever the public grid fails. Our Microgrid Validation Center makes it possible to demonstrate how customers can reliably and stably generate electricity by combining various energy sources e.g. renewables with existing generator sets and electricity storage systems. In Mexico, where a stable power supply can be a challenge in itself, our customer Granjas Carroll relies on a self-sufficient power plant with MTU gas engines.

Which technologies will play a role in generating electricity in the future? The answer is open, but our experts are analyzing, discussing and working on various scenarios to find one or more solutions for our portfolio. One prerequisite must be met: a secure and stable power supply.



# Technology troika to save our climate

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According to the estimate of the International Energy Agency (IEA), global CO<sub>2</sub> emissions in 2020 will drop by 8%, or almost 2.6 gigatons, to the level of about 10 years ago. This is because the coronavirus crisis has directly impacted energy consumption and led to lower emissions. However, as previous crises have shown, when emissions start to rise again, the increase could exceed the decrease, unless the investments being made to revitalize the economy are geared towards making our energy infrastructures friendlier to the environment.

So how can we generate electrical power in the future in a way that is reliable and ecologically sound? And what must our drive and propulsion systems run on if they are to deliver power with climate-neutral results? And how can we achieve all of these things with maximum cost-efficiency? There is no single and absolute answer to these questions. What is certain, however, is that a variety of solutions are needed to produce a cumulative effect. Among the most promising are high-capacity batteries, synthetic fuels and the fuel cell.

## The moment has come for batteries and fuel cells

Between January and March 2020, more than half of the electrical power generated in Germany came, for the first time, from renewable energies. But electricity generated from wind and solar is naturally dependent on the weather. Achieving a constant and reliable power supply from renewable sources is therefore possible only if they are combined with reliable modules that come onstream immediately whenever they are needed – e.g. when the wind is still, or when it is raining, or if renewable energy cannot be harnessed for a different reason.

That is why the hour might now have come for widespread use of batteries and fuel cells as the key to making our energy future clean and secure. “These technologies have long featured on our development road map,” explained Dr Peter Riegger, head of the Rolls-Royce Power Lab, the new division in which all the threads of the company's technological development run together. “We're testing a wide variety of scenarios and application fields,” he said. Batteries and fuel cells present such interesting possibilities because they are capable of interlinking the electrical power, heat and mobility sectors more strongly. Together, these sectors account for almost half of climate-damaging emissions. This 'sector coupling', as it is known in the trade, is a very important aspect of decarbonization.

## Wide-ranging portfolio for energy storage

On the Power Systems technology road map, the greatest headway has been made in the field of battery containers. Following the company's acquisition of a majority stake in the start-up enterprise Qinous, several batteries were added to the MTU product portfolio. The company's proprietary microgrid on site in Friedrichshafen, for example, has a battery container with the capacity to store 1 MWh of surplus energy. That provides the flexibility needed to use the different energy sources that the microgrid integrates. The batteries also facilitate a reduction in the amount of time the plant is powered using fossil fuels. Battery technology offers yet another advantage in that it supports frequency and voltage regulation in the power grid.

## Demand for flexible technologies

The more renewable energy sources are used however, the more important it is to have flexibility. Besides flexible power systems, load management, network expansion and energy storage, flexible sector coupling with Power-to-X technologies is another major building block. Power-to-X refers to the transformation of surplus electrical power into a different energy carrier. The manufacture of synthetic fuels is a particularly important aspect of sector coupling. “Synthetic fuels from Power-to-X processes offer a climate-neutral alternative to fossil fuels. They have the same calorific value, are simple to store and transport, and make it possible to use existing infrastructures based on diesel engines with climate-neutral results,” explained Dr Daniel Chatterjee, head of the Green and High-Tech program at Rolls-Royce Power Systems.

Rolls-Royce, in cooperation with policymakers, researchers and industry, is supporting research into green fuels in a variety of projects. One such joint enterprise is the settingup of a Power-to-X Center of Excellence in Lusatia in cooperation with the Federal State of Brandenburg, the Brandenburg University of Technology Cottbus-Senftenberg and other companies. Furthermore, Rolls-Royce is currently playing a leading role in the MethQuest project which is being subsidized by the German Federal Ministry for Economic Affairs and Energy (BMWi). The aim is to research into and develop technologies that allow methane to be produced as cost-efficiently as possible using electricity generated with renewable energy. 'Green' methane produced in this way could then be used to fuel power generation systems as well as trains and ships, thereby achieving climate neutrality.

## Fuel cells and the future

In cooperation, amongst others with Daimler, the PowerLab is currently examining the potential of the fuel cell as a climate-neutral source of driving power and energy. Fuel cells could initially be used as a source of energy for data centers, but also as a reliable component in microgrids. A fuel cell prototype is to be integrated into the MTU site in Friedrichshafen in 2020.

Implemented in isolation, none of the technologies outlined above will be able to satisfy the world's energy and mobility demands or slow down global warming. The real answer lies in integrated solutions that deploy different technologies in changing combinations. “We're taking an undogmatic approach to addressing the challenges of the energy turnaround and climate change, and that means we're open to all technologies,” said Andreas Schell, CEO of Rolls-Royce Power Systems. “And because we're highly committed, we've considerably revved up our activities.”

**WORDS: KATRIN AUERNHAMMER; PICTURES: ROLLS-ROYCE**

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# Cleverly connected

**Rising energy demands, decaying infrastructures, and a shift in public attitudes in favor of more sustainability are transforming the energy market and injecting pace into the energy turnaround. Accompanying the rise of regenerative energy sources is the growing trend towards microgrids, which integrate low-cost, ecological renewables with stable forms of power generation such as diesel- and gas-powered generator sets.**

Microgrids are small power grids that combine electricity from decentralized energy generation sources such as combined heat and power plants, diesel- and gas-powered generators, and renewable energies with batteries. A microgrid control system coordinates the energy sources in order to provide the energy required for industry, residential buildings or commerce accordingly.

It's a small, unremarkable construction recently put up by Rolls-Royce on MTU Plant 1 – with solar panels on the roof, air gratings for windows, and alongside it a grey 40-foot container. But it houses something very special – the company's brand new microgrid Validation Center with proprietary microgrid.

Inside are special transformers, inverters and switchgear that simulate the function of energy sources such as wind and hydropower that a microgrid can also integrate. The heart of the system is the 40-ft MTU battery container standing outside that provides the flexibility needed to use the different energy sources. In the Friedrichshafen setup, these are photovoltaic collectors on the roof of the Validation Center and a factory building delivering a total of 500 kW peak power, a combined heat and power module

Electricity from photovoltaic or wind power is integrated into the microgrid and is directly consumed or stored.

based on MTU gas engines, and an MTU diesel generator set. A smart controller developed in-house ensures optimal energy deployment by determining when it is most economical to use which energy source for feeding to consumers or charging the battery. The consumers in this case are the factories and an office building. “Our top priority is always to ensure the stability of the power supply so that there are no interruptions to our production operations,” explained Armin Fürderer, who, along with a team of colleagues, was responsible for the conceptual design and construction of the new energy system. Another objective is to provide electrical power that is as green, clean and cheap as possible, enabling for example, several hundred tons of CO<sub>2</sub> emissions to be cut each year. In addition, the combined heat and power module delivers heat which can either be used directly on site or as district heating for local homes. Overall, 4.8 MW of electrical power and 1.5 MW of thermal output are available for the company's on-site operations.

## Islanded or grid-connected

As the potential for using renewable energies grows, so does the challenge of storing the surplus energy produced by photovoltaic cells and wind turbines to be used as and when required. Another challenge is compensating the weather-induced fluctuations that the use of renewables inevitably involves. Microgrids meet both those challenges by connecting the sources of electrical power to batteries and a control system and integrating all elements by means of smart energy management that determines which type of energy can be optimally harnessed and when. This makes for a stable source of power that allows operators to loosen their dependency on the public grid or become fully autonomous. “This is a very interesting proposition for operators from all branches of industry, because they can either improve the capacity factor of

It's a small, unremarkable construction recently put up by Rolls-Royce on MTU Plant 1 – with solar panels on the roof, air gratings for windows, and alongside it a grey 40-foot container. But it houses something very special – the company's brand new microgrid Validation Center with proprietary microgrid.





their existing power installation or use the microgrid as a stable or autonomous source of power,” explained Fürderer. Such operators can be public utility companies already running CHP modules and photovoltaic installations, large-scale farms with biogas plants that likewise use solar and wind power, or businesses that want to free themselves from the public grid.

#### Individual microgrid simulations at the MTU Validation Center

Irrespective of whether the customer wishes to improve capacity utilization of their existing installations or integrate them better, or is looking for a brand-new microgrid suited to their local conditions, the Validation Center is at their service: “In our Validation Center, we can configure microgrids of various sizes, capacities and layouts and demonstrate to the customer how they will function – also taking into account the wind and sun conditions that prevail at the customer’s location,” said Fürderer. What takes place is not a computer simulation, but a realistic replication of an individually configured microgrid using high-tech components.

The Validation Center capabilities reflect the comprehensiveness of the MTU microgrid portfolio, which covers battery capacities from 50 kWh, enough for around 50 washing machine cycles, to 2 MWh, equivalent to the yearly power requirement of a single-person household. “Microgrids are almost freely scalable, and you can increase their capacity by using, for example, several battery containers, a bigger photovoltaic installation, or by adding on wind turbines and larger or extra generator sets,” added Fürderer.

#### New products to facilitate a single-source solution

Since microgrid solutions comprise not only traditional MTU products such as diesel- and gas-powered generator sets, but also batteries and controllers, Rolls-Royce Power Systems decided to broaden its portfolio, and duly launched its new MTU EnergyPack on the market in January 2019. Electrical power generated from the various sources is stored in the 40-ft battery container and can be made available at the push of a button. The battery container was developed in-house at Rolls-Royce Power Systems and comprises 154 modules with 3,388 lithium-ion cells. These can store just under 1,000 kWh of electrical power – 14 times as much as a Tesla Model X.

In cooperation with the start-up Qinous, in which Rolls-Royce Power Systems has acquired a majority stake and renamed Rolls-Royce

Solutions Berlin, the existing product portfolio is being harmonised and further developed. Qinous has already gained experience on more than 30 projects worldwide in the integration of battery storage and energy systems into microgrids and has also integrated MTU systems from Rolls-Royce.

#### US installs own solution

Rolls-Royce is currently setting up another proprietary microgrid at its MTU facility in Aiken, South Carolina (USA). In the short term, this microgrid will demonstrate “islanding” operation by powering a section of the facility using renewable energy sources, completely independent of the public grid. In the long term, it will demonstrate the peak-shaving concept by reducing the plant’s electrical peak power demand from the utility and help reduce its dependency on public grid. The site will take advantage of South Carolina’s abundant sunshine with 1 MW capacity of solar panels, many of them installed atop covered employee car parking. The solar array will be synchronized with a 1MWh MTU EnergyPack battery system and a microgrid controller. Additionally, a 1.9 MW diesel generator set will serve as a backup to the whole microgrid system. The microgrid will provide easy access to customers onsite who are interested in a demonstration. The US microgrid is expected to be fully up and running by fall-2020.

**WORDS: SILKE ROCKENSTEIN, WOLFGANG BOLLER, KATRIN AUERNHAMMER, BRYAN MANGUM**

**PICTURES: ROBERT HACK**

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**Individually scalable: no matter which power generators are in the microgrid, all elements are linked together in an intelligent energy management system that optimizes energy use.**

The self-developed 40-foot battery container stores electricity from any source and makes it available at the touch of a button. It consists of 154 modules and 3,388 lithium-ion cells.



The existing combined heat and power unit and the MTU diesel genset (right in the picture) were integrated into the microgrid.





Surrounded by the mountains of the Trans-Mexican Volcanic Belt, agriculture and industry are the prime movers in Puebla state, where tradition often converges with innovation. Industries here struggle to cope with the uncertainties of the power infrastructure.

# Reliable off-grid power supply

Sitting 8,000 feet (2,400 m) above sea level, the quaint town of Oriental in rural Puebla state, Mexico is surrounded by untamed mountain wilderness, scenic farming valleys, and charming Mexican villas. It is also the location of a Granjas Carroll pork processing plant that is a state-of-the-art powerhouse of production.

As part of one of the country’s largest pork producers, the Granjas Carroll facility has the capability to process 1.5 million hogs per year. With such a heavy

rotation of output, having reliable, consistent energy with no fluctuation in voltage or frequency is critical. But when the plant was first being built, having reliable power – or any power at all – was an uncertainty. Under the initial plans, the new facility was to receive service from the local

electricity company. As the project got underway, word suddenly came that the local provider would not be able to provide power after all.

This left the project managers in a scramble to construct a completely independent power plant, one that could operate off the grid in full island mode and produce enough electricity reliably enough to handle all the plant’s refrigeration and auxiliary needs. That’s when the Granjas Carroll team reached out to local distributed energy systems expert Electríz, S.A. de C.V. to assist them in designing a solution and to lead the engineering, procurement and construction

of the power plant project. Based on the specific needs of the plant and its 24/7 energy requirements, the experts at Electríz decided to suggest four MTU Series 4000 gas generator sets and one MTU Series 4000 diesel generator set, all operated under one overall control system to power the plant.

This resulted in the first off-grid solution of its kind in the Americas for Rolls-Royce Power Systems, manufacturer of the MTU products. Constructed in just a few short months, the facility went online in late 2018 and has enjoyed continuous, uninterrupted power ever since.







The residents of Oriental farm the fertile valleys at some 8,000 feet above sea level.

« This plant has to rely 100 percent on its own grid, so the challenge was to deliver a complete solution that would ensure grid stability at a high level. »

Alfredo Carrasco, Latin American Senior Sales Manager for gas systems at Rolls-Royce

“There were multiple factors beyond reliability that needed to be considered when deciding on power solutions for this facility,” said Daniel Salazar, President, Electriza. “Cost-effective efficiency at that altitude, while also taking environmental factors into consideration, is difficult. However we knew that by working with Rolls-Royce, we could get it done.”

“We have a vision at our company to be the most recognized and most preferred pork company in Mexico,” said Rafael Patino, Director of Environment & Energy, Granjas Carroll. “That is a big challenge and sustainability is one of our pillars of production, so our project came with very demanding specifications.”

The four gas units used at the facility are 20-cylinder Series 4000 natural gas systems delivering altogether 7.7 MW of electrical power, capable of handling the pork processing facility’s altitude demands with the lowest derating, ensuring maximum power availability at the site. In a second phase, it is planned to use the heat out of the exhaust gas, the oil cooler and the mixture cooler to efficiently produce steam and hot water, which can then be used in the production processes.

A single 16-cylinder Series 4000 diesel generator system with an electrical output of 2 MW is tasked with absorbing greater load blocks than the natural gas units, offering long-term stability to the plant. The diesel unit will run continuously with loads as low as 10 percent to minimize

fuel consumption, allowing the natural gas units to produce more energy. An MTU MCS master control panel integrates plant control and remote operation, and all systems run in isolation from the power grid, providing reliable, stable and efficient electrical power to the entire facility.

“This plant has to rely 100 percent on its own grid, so the challenge was to deliver a complete solution that would ensure grid stability at a high level,” said Alfredo Carrasco, Latin American Senior Sales Manager, MTU Onsite Gas Systems. “The reliability and efficiency of our systems, along with the ability of our team to meet the stringent requirements of gas, diesel and an integrated control system from a single supplier were major factors in us supporting this project.”

With the help of the flexible MTU systems, the plant will have the ability to double its capacity in the future – even connecting the power plant into the grid to provide additional power to the surrounding community. “With the success of this project, we now have the goal to eventually operate our power plant on the grid,” said Manuel Rodriguez, Energy Specialist, Granjas Carroll Mexico. “MTU’s technology is a key factor in us achieving this, and it will allow us to increase our power generation and provide sustainable and clean energy to our neighbors.”

At a later stage there are also plans to use biogas from livestock waste as another source of fuel to operate the plant. “There are a lot of good companies out there, but when you have a problem and a company proves that it is

dependable, quick and thorough in responding, you don’t want to do business with anyone else,” said Salazar.

“The name of the game in the power generation business is both efficiency and availability, and MTU’s solutions offer both.”

**WORDS: BRYAN MANGUM**  
**PICTURES: MATT HIEBER PRODUCTIONS**

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1 Lone island: Granjas Carroll has set up a state-of-the-art production plant with its own power supply.  
2 Straightforward genset monitoring: The plant and remote control systems are integrated in an MTU-MCS main control panel.



3 Granjas Carroll processes a good 1.5 million hogs per year in Oriental alone.  
4 Four 20-cylinder MTU Series 4000 natural gas systems deliver 7.7 MW of electrical power in total to cover basic requirements. A 16-cylinder series 4000 peak-shaving diesel genset ensures long-term stability.





The colour scheme at NEXTDC's B2 facility is unique but simple: Blue is the cold air side of the data hall, red is where the hot air goes.

Exceptional second generation data centre

# The heart of data

There's a building that lies in the heart of Brisbane, Australia. When you see it from the outside, it stands out amongst the usual grey and brown high rise buildings that lie close to the city centre. But it's not until you step inside that you truly understand how bright, and how important, this building is. In fact, this building is quite literally the backbone behind many local, national and global businesses. Welcome to NEXTDC, Australia's most proficient data centre operator.

Energy  
#connected

The data centre market in Australia is booming and is now one of the four major sub-markets for data centres in the Asia-Pacific region, along with Singapore, Hong Kong and Japan. Data centres are becoming larger and more efficient, and cloud providers are key players in the market, requiring space locally to assist with their own data centre operations internationally. The growth in the Australian market is expected to continue over the next five years.

NEXTDC's B2 facility is the second NEXTDC data centre to be built in Brisbane, the most modern in the city; and, let's be honest; it stands out from the crowd. It's also a bit like Fort Knox. Security cameras are on every corner, you must be identified by Security prior to entering the front door, and once you arrive at reception, they take your ID and replace it with a Visitor's Pass. There's even a bullet resistant chamber that takes you from the waiting area into the data hall itself, where you are weighed and filmed. It might seem crazy at first sight, but there's no doubt all of this security is essential. For a number of major corporations, NEXTDC is their lifeline, and the engineering and design behind B2 can mean the difference between their IT platform's success and failure. Chief Operating Officer Simon Cooper explains the "behind the scenes" of this incredible data centre – the first of its' kind in Australia. And why it's so important.





Special level of commitment: While NEXTDC's COO Simon Cooper (left) was invited to MTU Headquarters in Friedrichshafen, Germany to appreciate quality and standards of Rolls-Royce products, Andreas Goertz, Head of Power Generation Business at Rolls-Royce (right) was invited to Brisbane, to see the revolutionary Datacentre.



There is only a part of the building covered in red, still NEXTDC is outstanding amongst the usual grey and brown high rise buildings.

Security is essential: For a number of major corporations, NEXTDC is their lifeline, and the engineering and design behind B2 can mean the difference between their IT platform's success and failure.

« As the sites get larger and the numbers get bigger, we have to be very focused on delivering quality. By working with companies like Penske and Rolls-Royce, we can do that. »

Simon Cooper, COO NEXTDC



“A data centre is where your critical company IT infrastructure, and more importantly, your company data is hosted. This can be anything from your email to finance systems to your web presence. 15 to 20 years ago that was all on some hardware that you bought yourself and stored in a cupboard in your office building. But those cupboards weren't designed for security, the heat, or the power, and the hardware would expand, get out of control and become highly susceptible to breaches,” he says.

“The need for somewhere companies can store their data securely is growing exponentially, particularly with the rapid adoption of clouds. Large scale companies, like Amazon Web Services and Microsoft, build infrastructure for you and you just rent it from them, rather than buying and operating your own IT. But the hardware that is in the cloud still needs to physically live somewhere. And that's what a data centre does.” While some large-scale companies, such as banks, still build their own data centres, a large number of organisations use a third-party data centre that specialises in delivering unparalleled levels of reliability and security – NEXTDC.

NEXTDC has two buildings in Brisbane, as well as others in Sydney, Melbourne, Canberra and Perth. And while some of the other data centres are much larger than B2 (B2 has a 6MW capacity, whereas their second site in Melbourne has 40MW), there are a few things that set B2 aside as revolutionary, which simply enhances the importance of this colourful building.

The most noticeable aspect of B2 is the colour scheme - bright red, yellow, blue and orange; unique to this centre. According to Simon, the reasoning behind it is actually very simple. “Everything has a purpose. Blue is the cold air side of the data hall, red is where the hot air goes. The Yellow tray is for fibre, the blue and orange ducts carry diverse power supplies from elsewhere in the building. “It was important to design the building so that it operates independently in case of instances of power issues in the neighbourhood, for example, but you also design the buildings to flush out the inevitable human errors – and colour coding helps to achieve that,” he says.

#### What sets NEXTDC B2 Brisbane aside from any others?

“B2 was the first of our second generation data centres,” he says. “So that means we use technology that is completely up-to-date. As our engineering team progresses, our design makes it more efficient and more reliable.” And as a result of this cutting-edge technology, B2 became Australia's first data centre to achieve Tier IV certification for design and for constructed facility, from the Uptime Institute, as well as Gold Operational Sustainability. The building has 100% uptime, and can withstand failures of all kinds to maintain IT operations without fault. If a particular section of the building is

on fire or a cooling system leaks, the rest of the centre will keep working as though nothing has happened. And clients will never know the difference. NEXTDC is so important to their customers, they can't afford to let the power slide – even for a few seconds. If the NEXTDC power system shuts down, so does the flow of data for prominent businesses. Any downtime would be an impact that businesses can't afford.

This is where Penske and the Rolls-Royce brand MTU comes in, by providing diesel generators that assist in that process of 100% uptime. Around five years ago, Penske purchased the exclusive distribution agreement for MTU products and solutions for the Australian market and NEXTDC is the company's largest client to date. Steve Turton, Business Manager – Energy Solutions at Penske, said he'd been in talks with NEXTDC for some time before they came to market with a framework agreement for vendors to supply emergency gensets to the company's facilities across Australia. Today, Penske

“It was important to design the building so that it operates independently in case of instances of power issues in the neighbourhood, for example, but you also design the buildings to flush out the inevitable human errors – and colour coding helps to achieve that,” says COO Simon Cooper.



has provided a total of 40 units to NEXTDC sites across Australia, with another nine expected in 2020. “Penske were already active in the Data Centre market, but this contract was the long-term framework contract we'd been awarded,” Steve says. The two companies worked closely together to ensure a product was established that would fit NEXTDC's requirements. “The Penske team had been engaging NEXTDC's engineers for the years leading





A level of commitment no one else seemed to offer: NEXTDC chose Penske and Rolls-Royce because they understand the business model, and they're willing to work with NEXTDC today, and in future. From left to right: Hamish Christie-Johnston, Managing Director Off Highway at Penske, Jeff Van Zetten Chief of Engineering and Design at NEXTDC, Andreas Goertz and Simon Cooper.

« We also took NEXTDC's engineers to Rolls-Royce's MTU factory in Friedrichshafen, Germany, to give them an appreciation of the quality and standards that are applied to the build of the product. »

Steve Turton, Business Manager- Energy Solutions at Penske

The MTU gensets meet NEXTDC's stringent and specific requirements: to be synchronized and take full load in under 12 seconds contractually. The MTU gensets achieved that in eight seconds.



up to the framework agreement, providing technical commentary. We also took NEXTDC's engineers to Rolls-Royce's MTU factory in Friedrichshafen, Germany, to give them an appreciation of the quality and standards that are applied to the build of the product. Once we covered off the technical discussion we set to work around meeting the customer's commercial expectations."

The biggest challenges were NEXTDC's stringent and specific technical requirements. At NEXTDC, the switch room is where the power and generators connects to the building. In here is a Rotary Uninterruptible Power Supply (UPS), which provides a 15 second ride-through for the generators to start up, synchronise and take full load, should the power supply to the building be compromised. "We needed to be synchronized and take full load in under 12 seconds contractually. We actually achieved eight seconds on the test bed in the UPS manufacturer's facility in Germany," he explains.

B2 currently has three MTU gensets on site, with the space for seven – allowing the expansion of power as the data centre grows. Each generator at B2 can support 1.637MW, which is generally enough to support the centre as it stands, and having three on board means there is always a back-up. Simon says this is imperative to successful operations. "We work on the premise that one of them will fail from a reliability perspective," he says. "Having three on-site always ensures we have enough power ready to go. And as the customers fill the racks, and draw the power they need, we'll deploy more as we need them."

So why did NEXTDC choose to work with Penske? "The Penske team was super reactive to all of our requirements; figuring out how to minimise noise, minimise pollution, different modes we could use. They understood, commercially and project-wise, how we need to behave and they offered us a level of commitment that no one else seemed to offer.

"We wanted to be able to access generators whenever we need them, and we wanted someone who is committed to data centres. By using a big manufacturer like Rolls-Royce with its' MTU products, we knew we were getting a level of serious commitment. They understood our business model, and they're willing to work with us today, and in future." Penske and Rolls-Royce have already been announced as preferred supplier to NEXTDC for their Generation 3 sites. Talking about the future, what does the future hold for data centres? Steve says times are changing and Penske and Rolls-Royce must change with them.

"We are seeing disruption in all industries. There is certainly a drive towards cleaner, greener energy solutions, and I think we will see alternative fuel sources

become more prevalent in the coming years. The Penske organisation will need to adapt to the changing market to stay at the top of the pack in Australia, we're very much aware of this and are keeping our finger on the pulse, providing our customers with innovative solutions in all industries we operate in."

« There is certainly a drive towards cleaner, greener energy solutions, and I think we will see alternative fuel sources become more prevalent in the coming years. »

Simon Cooper, COO NEXTDC

The biggest challenges for NEXTDC are keeping up to date with the growth, both of the business and their customers, and the energy market. "As the sites get larger and the numbers get bigger, we have to be very focused on delivering quality. By working with companies like Penske and MTU, we can do that. And with the energy markets changing all the time, we're really excited about what the future holds," Simon says.

In 2012, NEXTDC put 400KW of solar on top of the Melbourne data centre, working out how to integrate it to make sure it was safe to use. "We focus on energy efficiency in our centres by minimising the power used in all aspects of the engineering and IT. De-carbonising the power we use is extremely important and we're working out different ways to buy power. These are really important things to us." And where does Simon see NEXTDC and Penske's relationship heading?

"When it comes to the gensets, I don't see a supply chain that can bring me bottled power on an emergency basis, other than diesel, at the moment. But that will change in future. And by working with a company as experienced as Penske, I'm confident we can work through any transition together."

WORDS: TARA TYRELL  
PICTURES: TARA TYRELL, PENSKE

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New developments in combination with an SCR system make engines more environmentally friendly

# Pure propulsion

*Pyxis*, a catamaran from WETA Ferries, was awarded 'Ship of the Year 2020' for its environmentally friendly propulsion system.

Eco-friendly marine propulsion is playing an increasingly important role, especially in protected sea areas and for reasons of social responsibility.

Free local transport in Luxembourg, VAT reductions, one-euro day tickets in Germany and possible speed limits – no government, state agency, or business can afford any longer to ignore the fact that mobility needs reorganizing to reduce pollutant emissions and prevent urban traffic from causing total collapse. In land transport, the highest potential for reducing emissions and reconfiguring traffic lies with e-mobility. On the water, e-mobility has yet to play a significant role. All the same, today's ferry and tugboat operators and yacht owners are increasingly at pains to make their chosen vessels as eco-friendly as possible. Although gas engines and hybrid propulsion can enhance the sustainability of a marine vessel, these technologies are still at a very early stage. For a new oceangoing vessel just entering service, diesel engine propulsion combined with Selective Catalytic Reduction (SCR) to significantly reduce nitrogen oxides still offers a clean alternative.

## Cleaner propulsion in San Francisco Bay

In the Bay of San Francisco, scrupulous care is taken with pollutant emissions, since the coastal region is under special protection and counts as California's most important ecosystem. Daily shuttle services are provided by WETA Ferries using 15 passenger ferries that transport over 3 million commuters and tourists per year. Now WETA has added three new catamarans to its fleet – and in doing so is stepping into the role of trailblazer, since these are the first vessels in the US to meet the new EPA Tier 4 emissions standard. *Pyxis*, the first, has even been awarded the 'Ship of the Year' accolade by American Ship Review magazine. One reason is its ferry propulsion system, which is equipped with twin 16-cylinder Series 4000 MTU units and an MTU SCR system developed by Rolls-Royce to ensure that the strict emissions regulations are complied with.

Current emissions requirements are challenging naval architects, shipyards, vessel operators and engine manufacturers alike. This is due to the add-on SCR systems that the engines require, and for which space must be found in the narrow engine rooms of the vessels. "It's not only the SCR system that needs accommodating. Customers have to find space for cables and reducing agent tanks, and you also need to make room for service work to be carried out," explained Andreas Peters, MTU Applications Engineer at Rolls-Royce.

In the case of WETA's three new vessels, the shipyard Dakota Creek Industries, the design team at AMD Ferries and MTU engine experts from Rolls-Royce worked together very closely from scratch to find the solution that everyone could live with. "Not taking up any more space than absolutely necessary while still meeting all the criteria governing add-on modules and ease of maintenance was initially a headache. But we were a closely knit



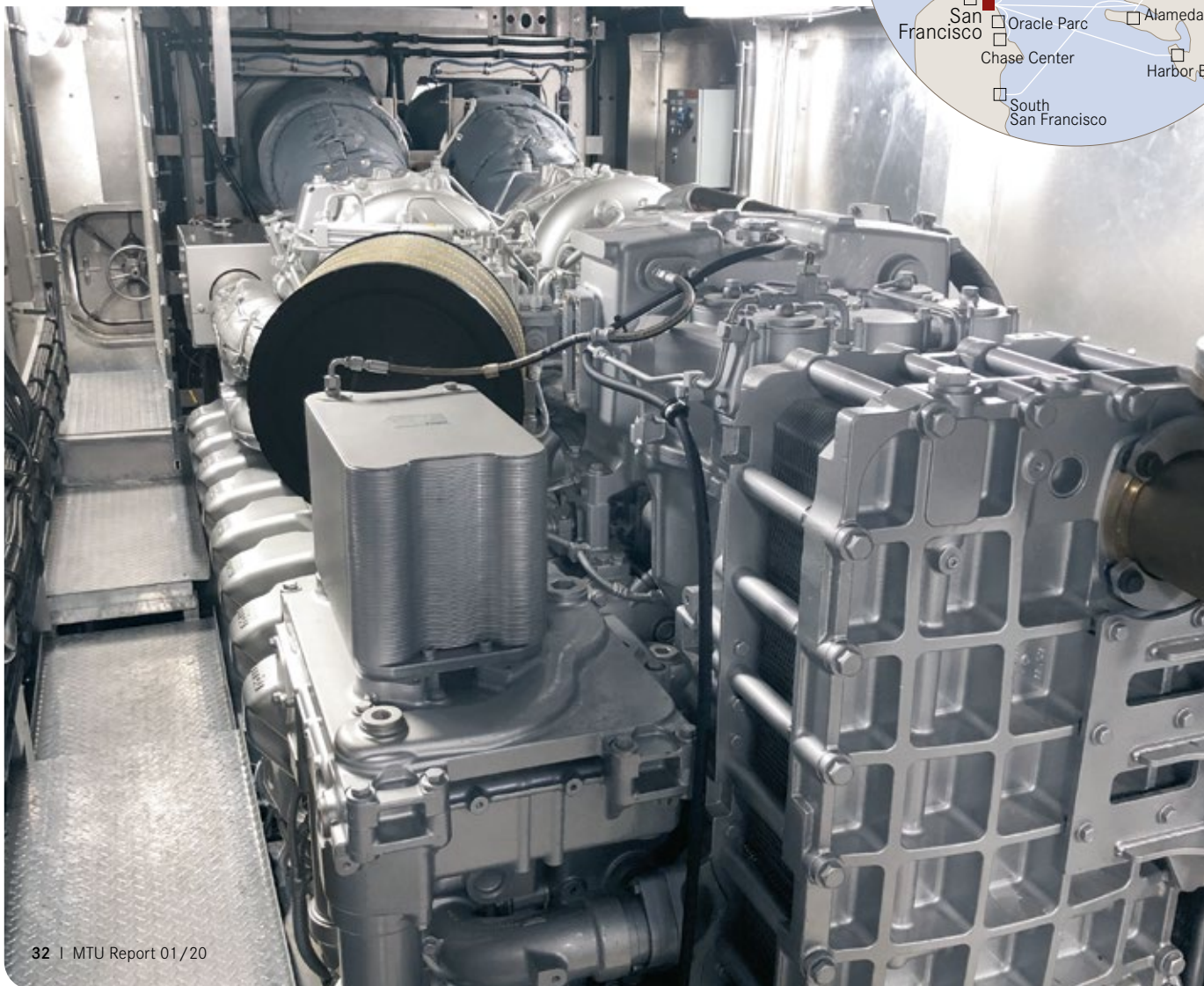


The Bilgin 263 is not only the largest yacht built in Turkey, it is also the first to comply with the IMO-3 exhaust emissions standard.

San Francisco Bay is a protected ecosystem. WETA Ferries will soon have 17 ferries in operation there for shuttle services, the latest of which comply with EPA Tier 4.



In the foreground, a further developed 16V 4000 MTU engine from *Pyxis*, connected to the SCR system at the back on the picture.



team and very focused from the start and made fast progress on planning and construction,” explained Jeff Sherman, from MTU marine engine sales at Rolls-Royce in the US.

The *Pyxis* plies the waters between Vallejo and San Francisco four times a day, carrying each way as many as 445 passengers who prefer to take a ferry rather than contend with traffic jams and overcrowded public transport. The crossing takes about an hour. The ferry's propulsion system comprises twin Series 4000 MTU engines, each with 2,560 kW power output, which can accelerate the vessel to 34 knots while still meeting environmental requirements. That is owing to advances in turbocharging, combustion and fuel injection, which, combined with the new SCR system, facilitate a 75% reduction in NOx emissions compared to IMO II, and a 65% reduction in particulates compared to EPA Tier 3.

#### Two solutions for yachts

No conditions are more cramped than in the engine room of a high-speed yacht, which can make a ferry or a tugboat seem roomy by comparison. Yet here as well, there are regulations to be followed, and Rolls-Royce has devised different ways of

combining the MTU engine and SCR system. The SCR comes in two different designs: either cube-shaped or in the form of a flat box, which yacht customers usually find more attractive. Both designs are manufactured by Rolls-Royce at its MTU facility in Ruhstorf. The SCR systems are especially adapted to suit the MTU engines, allowing the customer to benefit from the reliability of a package solution.

Three 80-m yachts compliant with the IMO III directive are currently being built at Turkish shipyard Bilgin. They are powered by MTU Series 4000 M03 engines of the previous generation linked up to suitably adapted SCR systems. To achieve that, slight adjustments were made to the 16-cylinder engines in the form of modified turbochargers and new-generation engine controllers as well as optimized coordination. The MTU SCR system enables comprehensive control with nitrogen oxide measurements in real time upstream and downstream of the SCR box to ensure that the reactive substance is precisely dosed.

“In the yacht segment especially, ever stricter demands are being placed on the propulsion system. Customers want their engines to be powerful, but also as clean as possible so that they can sail around sensitive marine areas. That's why it's immensely important for us to have green credentials,” said Denise Kurtulus, head of yacht and commercial marine sales at Rolls-Royce. Many customers choose to install an additional diesel particulate filter, even though it is not actually stipulated in the standard.

The Bilgin yacht propulsion solution has already received IMO III certification, making these yachts the cleanest in their class. For the *Pyxis* catamaran and its sister vessels, certification is still outstanding and is expected to take place in end-2020. “We're very confident about receiving approval. The engines installed in the *Pyxis* have run reliably over more than 2,800 hours of service and we're monitoring them very closely,” said Michael Drews, head of Series 4000 with exhaust aftertreatment for marine applications.

The energy turnaround in the maritime sector is just starting to take off. Rolls-Royce is examining various solutions – all the way from mobile gas engines and hybrid drives through to engines running on methane-based fuels from renewable sources, and fuel cells. “We've made it our mission to de-carbonize the marine propulsion,” summed up Daniel Chatterjee, head of the Green & Hightech program at Rolls-Royce Power Systems.

**WORDS: KATRIN AUERNHAMMER; PICTURES: WETA, BILGIN**

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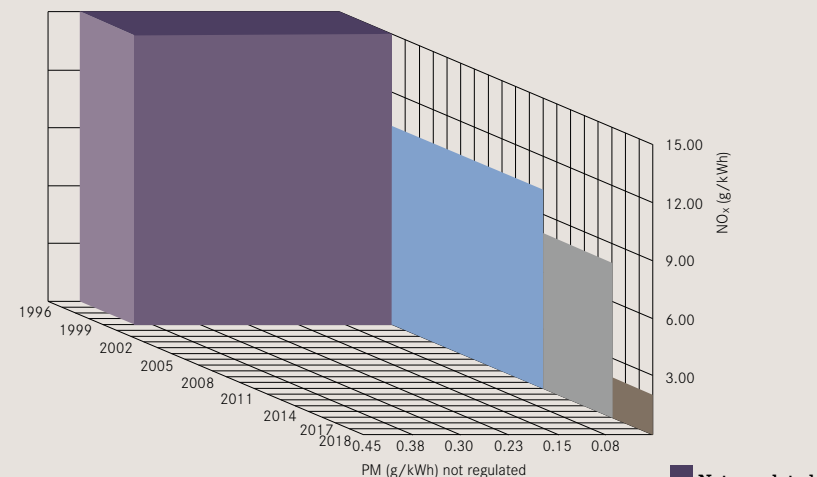


**More on that...**  
**A Video about WETA ferries in San Francisco Bay.**  
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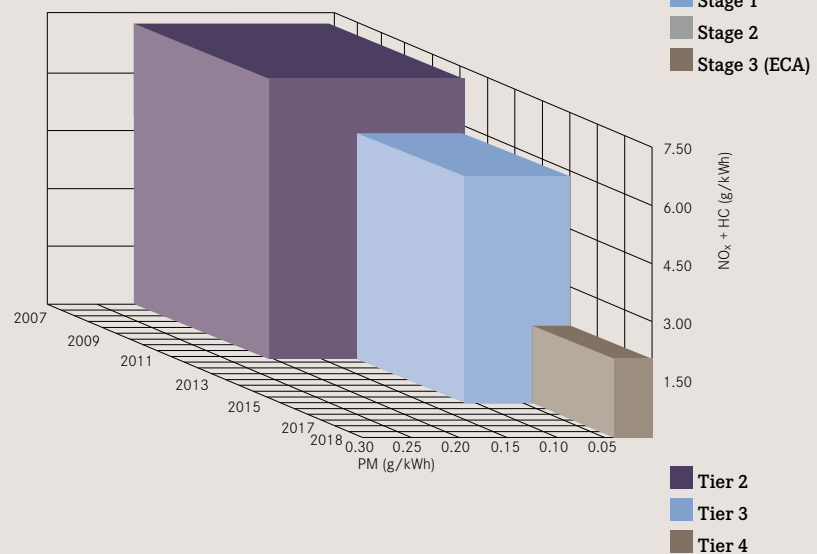
ONLINE

#### Emission stages in marine industry

##### IMO



##### EPA





# A New Yorker in Alaska

Trading skyscrapers for towering glaciers, *Bravest* has completed her first season of service for Phillips Cruises and Tours in Whittier, Alaska. For decades, the 127-foot high-speed catamaran provided commuter ferry service in New York Harbor. The vessel played a role during the 9/11 terrorist attacks, part of a makeshift fleet of boats that came together to carry 500,000 survivors off Manhattan Island - the largest sea evacuation in history.

Past breathtaking glaciers and untouched nature: as more and more tourists showed interest, Phillips Cruises and Tours expanded its fleet.



## «THE NEW ENGINES ARE QUIET AND SMOOTH. THEY'RE ALSO TIER 3-CERTIFIED.»

Gary Sommerfeld, Captain and Marine Operations Manager, Phillips Cruises and Tours.

As the *Bravest* traverses the pristine passages and fjords, passengers discover seabird species, bald eagles, black bears, killer whales, humpback whales, sea lions, seals and sea otters.



The *Bravest* was converted for use as a lookout ship and remotorized. Instead of commuting between skyscrapers, she now travels between glaciers.

Today, *Bravest* explores the glacier-filled fjords of Alaska's Prince William Sound. Phillips Cruises and Tours' signature tour, the 26 Glacier Cruise, follows a route that features views of 26 named glaciers and many others, and its popularity continues to grow every year. To meet the demand, the tour operator needed a vessel with the perfect combination of speed and capacity to handle the heavy workload of daily five-hour excursions. *Bravest* fit the bill. Phillips Cruises and Tours worked with Yank Marine in Tuckahoe, New Jersey to transform the commuter ferry to a sightseeing excursion vessel, a process that took more than two years.

### A change of scenery

*Bravest* underwent significant structural changes to improve the customer experience. Removing bulkheads and moving stairways that impeded sightlines made wildlife and glacier viewing easier for passengers. A galley was added for meal service, along with a new HVAC system, high-back seating and new electronics in the wheelhouse. Spaciously outfitted, *Bravest* provides 286 guests with seating on two levels.

Among Alaskan mariners, Phillips Cruises and Tours is well known for its fleet of smooth-cruising fast catamarans, all powered by MTU engines. The fleet operates seasonally, from May through early October. In order to endure long hours of daily operation with minimal downtime, *Bravest* needed to be repowered with powerful engines that were up to the tour operator's high standards for performance and speed.

"We cover 140 miles every day on our 26 Glacier Cruise, and we do it in five hours with lots of stops. We need 32-34 knots of cruising speed. Power is definitely necessary for our business plan," says Gary Sommerfeld, Captain and Marine Operations Manager, Phillips Cruises and Tours.

### Repowering reaps rewards

MTU distributor Pacific Power Group helped replace *Bravest's* aging twin MTU 16-cylinder 396 engines with twin MTU 16-cylinder 4000 M64 engines delivering 2,680 hp. The team has been a longtime partner with Phillips to keep its catamarans running at peak performance. "We've been working with MTU and Pacific Power Group for quite a few years. It made sense to stick with them," says Sommerfeld. "The new engines are quiet and smooth. They're also Tier 3-certified, so they're very clean burning. It's rare you see any kind of smoke out of them, even with cold starts."

With a cruising speed of 32 knots, guests are able to see the glaciers and abundant wildlife of Prince William Sound very efficiently. As *Bravest* weaves through the pristine passageways and fjords, passengers may spot a variety of seabirds, bald eagles, black bears, orca whales, humpback whales, sea lions, harbor seals and sea otters. The reliability of the MTU engines provides guests with more time to experience the amazing scenery and less time on the dock.

### A force of nature

From a business perspective, Phillips Cruises and Tours appreciates the uninterrupted service as well. In its inaugural season in Alaska, *Bravest* never missed a trip. The addition of *Bravest* has helped the company to nearly double capacity on its popular 26 Glacier Cruise route. On the calm waters of Prince William Sound, far away from the concrete canyons of New York City, *Bravest* has found new life, giving more people the opportunity to enjoy Alaska's natural beauty.

**WORDS: CHUCK MAHNKEN**

**PICTURES: WILLIAM ROME, PHILLIPS CRUISES AND TOURS**

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Between May and October the *Bravest* is five hours a day on the water and covers 225 kilometres. For the tourists' pleasure the ferry stops again and again. The many starts and stops are one reason why the operator relies on reliable MTU engines.



MTU powers haul trucks carrying diamond-containing rocks

# Diamonds in the ice

The Jubilejny open-cast mine has got to be one of the loneliest places on earth. It may be fairly close to the Siberian town of Aichal with its 13,000 inhabitants, but beyond that it's a long way to anywhere. The next town is 500 km distant, and you're just 60 km from the Arctic Circle. Over 10 million carats of diamonds are mined in Jubilejny each year with the help of MTU-powered haul trucks. The climate is extremely harsh – for man and machine alike.

**The mining town  
of Aichal**

Aichal is a small town with 13,000 inhabitants. It grew up in the sixties around the place where geologists discovered kimberlite – a type of rock that sometimes contains diamonds. The inhabitants of Aichal either work in the town's three diamond mines and related transport and processing operations, or they provide services in the town itself. Retired or former mining employees usually move away. Even today, the settlement has neither road nor railway links.

A place of extremes: Diamonds – weighing over ten million carats in total each year – are mined in the Jubilejny open-pit mine. Located in remotest Siberia, near to the Arctic circle, it's a place where permafrost challenges both man and machine. So far, the miners have succeeded in plumbing depths of 440 m in blasting operations. The aim is 720 m.





Chief Engineer Andrej Kajukow decided to set up a laboratory on location for carrying out spectral analysis of oil. Having the laboratory enables Alrosa to better maintain the MTU engines, thereby increasing their service life.

Belaz haul trucks with payloads of 136 metric tons rumble their way towards the open-cast mine. The Aichal Diamond Combine, owned by Alrosa, has 55 such dump trucks, of which 45 are equipped with 12-cylinder MTU Series 4000 engines. Michail and Yefgeni, two drivers taking a break from their difficult jobs, say their experience of the engine is very positive. They reckon it runs more quietly and with less vibration than other models, whilst being economical and not susceptible to breakdowns.

The sun shines in a cloudless sky. The hilly landscape has a covering of snow. Quarry stone has been scattered on the snow-covered gravel road to prevent the six-meter-high dump trucks from slipping. The thermometer is showing minus 21 degrees Celsius at the end of February, in fact temperatures here can drop as far as minus 46 degrees during December. The MTU engines are specially prepared for the chilly conditions in Siberia. Because the polar diesel used in this area has a kerosene content of 60 percent, making it much thinner than normal winter diesel, MTU has designed the injectors to be able to cope with the thinner fuel. Louvers in front of the radiator prevent the engine from cooling down. These are always closed when idling during really cold spells. The engine control unit automatically adjusts fuel quantity and injection timing in line with the air temperature. In addition, depending on ambient temperature, pre-injection is used alongside main injection during start-up.

**Visit to the control center**

In a windowed container right on the edge of the open-cast mine, two experienced workers keep in touch via radio, and online, with the haul truck drivers and the men in the shovel excavators. Blasting is carried out on Thursdays and Fridays, when the pit is closed. Excavators push the scree together for transportation. Huge shovel excavators, 19 meters high and weighing 600 metric tons, whose buckets can swallow up to 15 cubic meters, load it onto haul trucks in just a few minutes.

You cannot tell by looking at the rocky cargo just what value lurks within. The dump trucks take the rubble to the treatment plant, where it is dumped into shafts, producing levels of noise nothing short of deafening. The debris is then crushed in huge, rotating drums, and washed in basins. Separation systems detect the diamonds with the aid of X-rays and shoot them out of the rock with compressed air. The final stage has workers picking the diamonds out of the fine rubble by hand.

One metric ton of scree can be expected to yield 0.9 carats of diamonds – 0.18 grams. In 2017, diamonds weighing 10.16 million carats were mined here. The view across the open-cast pit is breathtaking. The mine is 2,5 kilometers wide. Blasting and drilling have driven a cone into the earth's crust that is already 440 meters deep and is planned to go to a depth of

720 meters. At the edge of the open-cast mine, a road spirals down into the depths, taking the mighty, six-meter-high haul trucks down to collect their loads of rubble. Viewed from the control center, they look like children's toys. Everything in the mine is running smoothly. There are no traffic jams. The men in the control center follow the haul trucks' progress on their screens running an online mining program. Everything simply has to work smoothly. If drilling or blasting is to be conducted somewhere, routes have to be changed in good time. In summer, water is used to bind the dust to the roads to prevent the engines' air filters from clogging.

**Good kindergarten and wide range of leisure activities**

The men in the control center are in a good mood. They say they've been living in Aichal for 30 years. The nicest, most relaxing hobby is to go hunting in the taiga woodlands. And their wives? They like the cross-country skiing, they say, and collecting berries and mushrooms is also popular. In the taiga, however, you have to protect yourself against the swarms of mosquitoes. The company, Alrosa, does a lot to enrich the lives of Aichal's 13,000 residents. There is a very well equipped kindergarten, an ice rink, a swimming pool, a sports hall and a newly built cultural center where choirs and dance groups rehearse.

**Retirement at 50**

The workers in the vehicle control center say they are both already pensioners, but still have to work because the pension is just 330 euros. In Russia, men retired at age 60 until 2018. There is a pension bonus for Russians living in the far north. An additional bonus is given to people working below 150 meters in open-cast pits. For mechanics in the Alrosa workshops, this means that they used to be able to retire at the age of 55. The two workers in the control center retired at 45 and 50 respectively because they worked in open-cast mining.

The biggest compensation for living in a wasteland is a good wage. The two tipper drivers Michail and Yefgeni earn 1,800 euros a month. They say they go on holiday once a year to China, Thailand or Montenegro. Many also have apartments in warmer parts of Russia – 'on the mainland' as they say in Aichal with more than a hint of irony. As soon as they retire, and their financial situation permits, most people want to leave Aichal. But there will always be a flow of new, young workers, fleet manager Lapygin assured us: “Good pay attracts people.” Today, 13,000 people live in Aichal. Four thousand of them work in the diamond combine, 1,000 of those in the transport sector alone. The brightly painted prefab buildings in Aichal were not built until the 1980s. Before that, there were only timber houses. And before that, the geologists and construction workers who laid out the town and the open-cast mine lived in tents. Until the 1980s, there were no elaborate medical facilities for childbirths, etc.



Rock and rubble: The Belaz dump truck has a payload capacity of 136 tons. But the precious stones only become visible during processing.

Alrosa operates 55 dump trucks. Forty-five are powered by an MTU Series 4000 unit. This engine is built to withstand the Siberian cold and can cope with temperatures as low as -46°C.

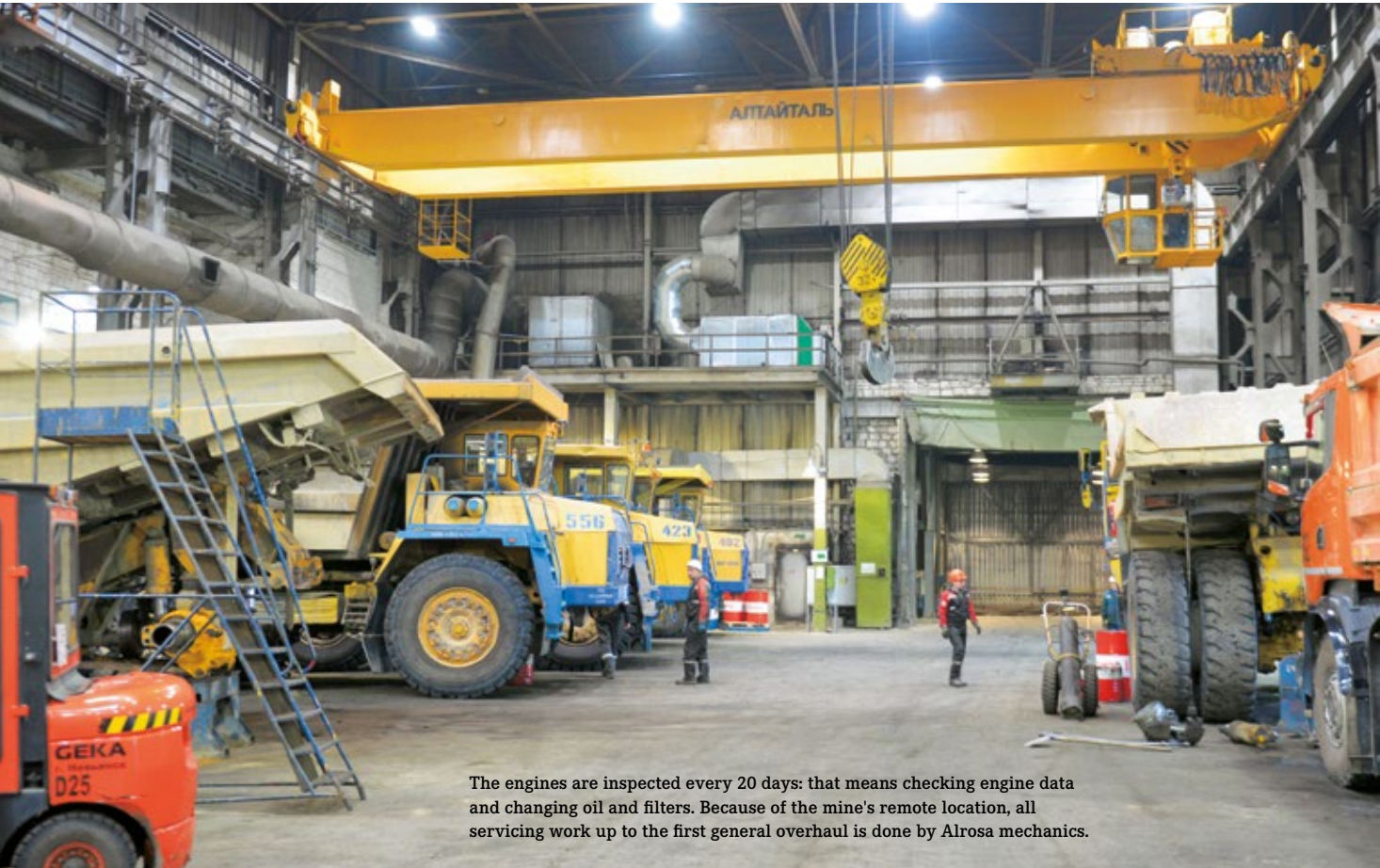






Mining

Ton after ton of rocks arrive at the processing plant, where they are crushed and washed in gigantic rotating drums.



The engines are inspected every 20 days: that means checking engine data and changing oil and filters. Because of the mine's remote location, all servicing work up to the first general overhaul is done by Alrosa mechanics.

Only highly experienced mechanics are allowed to perform service work on the MTU engines. Spectrometric analysis is dealt with by engineers. Due to the eight-hour time difference between Aichal and Friedrichshafen, service personnel in Friedrichshafen is only called upon in absolute emergencies.



### Mosquitoes, mud and permafrost

Weather conditions in and around the Arctic Circle are extreme. The ground is frozen for seven months of the year. In summer, the ground thaws up to half a meter deep. Aichal is even more remote in summer than in winter because, traveling by car, you can only get to the airport in Polyarny and to the city of Mirny, 500 kilometers away, where Alrosa's headquarters are located. People cannot go any further because in summer the roads are muddy, and Aichal is not connected to the Russian highway network. It is therefore anything but easy to ensure supplies for the town with its three diamond mines and two diamond processing plants.

### Spectrometric analysis of engine oil for improved maintenance

The first four 136-ton haul trucks with MTU engines were delivered to Aichal in 2005. “At the time, we sent five people to a coal mine in South Yakutia for training, where MTU engines were in use,” reported chief engineer Andrey Kayukov. At 38, he is one of the younger members of the workforce. The acquisition of an expensive spectrometric oil analysis laboratory was a major step forward in engine maintenance, he says. Spectrometric analysis of engine oil is now used to detect metallic particles caused by engine wear. This allows conclusions to be drawn about specific damage to the engine. The chief engineer reports that spectrometric analysis has postponed the general overhaul of the engines by a considerable length of time. A general overhaul is recommended after 25,000 operating hours. But Alrosa now has one MTU engine with 40,000 engine hours, and eleven MTU engines with 33,000 to 38,000 engine hours, which have had only minor repairs, but no general overhaul. Two of the MTU engines obtained in 2005 are still in use. “As soon as we find any metal particles in the engine oil, we have an indication of where the fault could be,” said Kayukov.

In order not to leave engine evaluation to the mechanics alone, a video endoscope is also used: “In a 12-cylinder engine, we could see metal abrasion in one cylinder”, says Kayukov. "We have decided to install two new cylinder sleeves. Without diagnostics, we would have replaced the entire engine.” “If we run out of ideas, we send the engine inspection files to Friedrichshafen,” he continues. “However, that doesn't happen more than once a year.” He says it is 'not very convenient' to contact MTU because of the eight-hour time difference between Friedrichshafen and Aichal.

### In service 24/7

The haul trucks are in operation 24 hours a day, seven days a week. The haul truck drivers work 12-hour days, after which they have two days off. The haul trucks only stand still when their drivers are taking a break. In winter, the engines are not switched off during breaks because it is difficult to restart them in the cold. If they do get turned off, an electrically operated heat source is placed near the engine. “Electricity is cheaper here than diesel,” explains the chief engineer. They order spare parts every three months from MTU's spare parts warehouse in Chimki near Moscow, according to Sergei Lapygin, head of the vehicle fleet. The spare parts are then flown from Moscow to Polyarny, a town one and a half hours north of Aichal, by the company's own Alrosa airline. That said, cargo planes from Moscow only take off if they are carrying aggregate loads of at least five tons.

### Diesel transported over long distances

The settlement is still not connected to the Russian road or rail networks. It came into being only because geologists found kimberlite rock here in



Engine mechanic Wenjamin Metelski has been servicing MTU engines since 2005. He's proud to report that the MTU engine behind him has clocked well over 60,000 operating hours.

December 1959 – cooled lava in which diamonds can also be found. It is unclear what will happen when the diamonds run out.

Transporting diesel fuel, new haul trucks and engines to Aichal is even more complex than transporting spare parts. Diesel is purchased from large refineries in central Russia and shipped 700 kilometers north up the Lena River to the city of Lensk. From there, it is brought to Aichal by road tanker. New haul trucks come to Aichal by the same route. Because of their size, they are dismantled for transportation. The fleet manager points to the welding seams under the payload area of a haul truck. “The vehicles are welded together here.”

### Engines checked every 20 days

How are the engines repaired? Chief engineer Kajukov explains: “Every 20 days we conduct a technical inspection. The engine data is checked, and the oil and filters changed.”

Mechanic Wenjamin Metelski is working in one of the repair workshops. Together with a colleague, he is currently overhauling an MTU engine. The 52-year-old Metelski proudly explains that he has been doing this job since 2005, when the first haul trucks with MTU engines came to Aichal. “In 2008, for the first overhaul, experts came from Germany and showed us slides to demonstrate how repairs are done.”

The engine the two workers are currently overhauling has run well over 60,000 hours, he tells us. Alrosa mechanics have installed a new diesel pump, a new turbo compressor and new high-pressure lines. There are only experienced mechanics working in the repair shop. Sometimes they are assisted by the haul truck drivers. The workshop looks very neat and tidy. Safety regulations are very strict. A cable or tool carelessly left behind can have disastrous consequences, given the size of the components the men have to deal with. Helmets are mandatory, and of course alcohol is prohibited in the workplace. At least it's nice and warm in the workshop. When you leave the bay, there's a cold wind and crunching snow – and the MTU-powered Belaz trucks are constantly going up and down with their valuable rocky cargo.

**WORDS: ULRICH HEYDEN; PICTURES: ULRICH HEYDEN**

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# Another 10,000 hours



Surrounded by a picturesque backdrop of mountain ranges and eucalyptus forests, the fertile soil of Australia's Hunter Valley region produces some of the world's best wines. It's also an abundant source of coal, a vital part of the region's economy for nearly two centuries. While tourists enjoy the nearby wineries and golf courses, miners and machines at Mount Thorley Warkworth (MTW) are hard at work, producing 12 million metric tons of coal annually.

The Komatsu 830E haul truck transports 220 tons of coal per journey. The big challenge for the fully loaded haul trucks is the 10% incline to be negotiated on the road passing through the mine. For the engines, that incline means that they spend about a third of their service life running at maximum rpm.



« Engine service life is over 10,000 hours longer than we were expecting. »

Shane Saunders, Senior Engineer at Yancoal Australia.

Mining company MTW produces a million tons of coal per month. That makes it very dependent on reliable machinery since even the slightest lapse reduces productivity and in turn sales revenues.



Australia's Hunter Valley is renowned worldwide for its wine country. Other key industries are coal-mining and power generation.

Going to great lengths

Compared to other mine sites with rich, deep coal seams, the ore at MTW takes more time to mine. Large volumes of waste rock must be blasted and removed in order to reach and extract the coal. “There’s a lot of hard work to get to the coal,” says Shane Saunders, Senior Engineer, Yancoal Australia. “For every eight tons of dirt, there’s one ton of coal. In addition, the site’s steep 10% grades put a heavy toll on the engines. The trucks run at full rpm about a third of the time they are in the field.”

It’s critically important that MTW’s fleet of haul trucks are fully equipped to handle the worksite’s challenges. The mine produces one million metric tonnes of coal every month. With any amount of downtime, the operation slows down and revenue is lost. To get the job done, MTW has a fleet of Komatsu 830E mine haul trucks at their command, each capable of hauling 220 metric tons per load.

Putting new engines to the test

In 2009, MTW’s first Komatsu 830E trucks were put to work. By the end of 2010, the fleet grew to 35 trucks. Due to the desire to extend engine life and reduce costs, MTW chose a different engine manufacturer to repower - MTU. Working in partnership with MTU distributor Penske Power Systems, the team repowered several Komatsu trucks with 16-cylinder MTU Series 4000 engines.

MTW’s team of engineers conducted a study and were pleased with the results. Over an 11-month period, the average engine downtime per unit was cut in half with the MTU-powered trucks. In addition, an independent fuel study was conducted. Under controlled conditions, the study revealed that average fuel consumption was lowered with the MTU Series 4000 engine. The MTW team was impressed with the uptime and fuel efficiency improvements. Over many hours of operation, the MTU-powered haul trucks generated considerable life cycle cost savings

Just like the trucks at MTW, the partnership continued going strong. “Penske has delivered MTU engines for the repower of haul trucks at MTW for several years. Over this time, we have developed a very strong working relationship with the customer,” said Jim Livermore, Business Manager, Mining, Penske Power Systems. “We have a great understanding of the customer’s requirements and of the conditions in which mining trucks operate, and thus how the MTU engines need to perform.”



### A life beyond expectations

The partnership has paid off in more ways than one. Over the years, MTW also has closely monitored another major factor in operating costs—engine life. The target engine life for the Series 4000 engine was 25,000 hours when first fitted. The team followed a strict preventive maintenance program every 500 hours. When it was time for an overhaul, the reports indicated there was plenty of life left in the MTU engine.

In 2013, engine life targets were extended to 28,000 hours and service intervals moved to 750 hours. Saunders says, “The Series 4000 C01 is a well-designed engine, specifically made for large earth-moving vehicles. Every time we looked at our reports, we found that the engine was ready for more. So we kept on extending our targets to see how far we could go. It was a good way for us to cut costs—especially at times when fuel prices rose and coal prices dropped.”

MTW and Penske Power Systems conducted more inspections of the disassembled engines. A few engines were left in the trucks to run. These engines were closely monitored through oil analysis to find their true life span. After they had run 40,000 hours, they were removed for inspection. Analysis showed this was very close to their limits. To be safe, the target life for all of the MTU-powered Komatsu 830E trucks was set to 36,000 hours. The life extension has eliminated one engine change from the life cycle, significantly changing the cost profile of the MTU fitted assets.

All the extra engine longevity across MTW’s fleet of Komatsu trucks has done wonders in protecting their bottom line. “The engine life is more than 10,000 hours beyond our expectations,” says Saunders. “Our trucks operate 6,000 hours a year. When you consider total time between overhaul, these engines are out in the field nearly two more years than we expected. Between engine life, reliability and fuel efficiency, they’re making our operations more competitive. The coal at our site is not easy to get, so we need every little margin that makes us more profitable.”

The Mount Thorley Warkworth mine has been in operation since 1981. Owned by Yancoal Australia Ltd., the country’s largest pure-coal producer, MTW is an open-cut mine that uses a dragline truck and shovel method to extract coal. A fleet of more than 100 trucks, loaders and dozers are in constant motion, along with more than 1,200 employees working in shifts to keep the mine operational 24 hours a day, seven days a week. The only days off are Christmas and Boxing Day.

After being washed and prepared for sale, the coal is loaded onto trains for transportation to Newcastle, the world’s largest coal export port. While some coal is used in Australia, most of MTW’s reserves are shipped to international customers for steel production and electricity generation.

**WORDS: CHUCK MAHNKEN**

**PICTURES: YANCOAL AUSTRALIA LTD.**

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« The combination of engine longevity, reliability and low fuel consumption has helped to make our operation much more competitive. »

Shane Saunders, Senior Engineer at Yancoal Australia.



MTU had originally recommended 25,000 hours of service for the engines powering the haul trucks. Close scrutiny showed however, that they reached the end of their service life after 40,000 hours. To be on the safe side, Penske and MTW were able to fix the service life at 36,000 hours - a whole 11,000 hours more than originally expected.



Complex component with high requirements

# →How do we make... ...conrods?

At first glance, conrods look simple enough. But in fact, these core components are more complex than almost any other part of the engine. Providing the crucial link between pistons and crankshaft means that these elements must function with perfect precision whilst also withstanding extreme mechanical stress. These are huge challenges.

Between eight and 20 conrods in each engine translate the linear, reciprocating movement of the pistons into rotational motion at the crankshaft. The moving connection at each end is seated in bearings and each conrod is subject to tension and pressure as well as torsional and bending stresses. "If the quality is right, the very special design of a conrod gives it enormous stability that enables it to withstand these extreme external forces," explained Frank Schneider who heads conrod production at the Rolls-Royce MTU facility. "However, if a conrod breaks, the result can be total engine failure. A broken conrod can literally blow out the entire contents of the crankcase." To make sure that does not happen, production of these components demands the very highest levels of precision. "The conrods for our Series 4000

engines are produced to a tolerance of 10µ," said Schneider. The Greek symbol 'µ' (pronounced 'myu') indicates a unit of length equal to 0.001 millimeters. For comparison, a human hair is roughly 50µ thick. In terms of conrod production, missing precision specifications by a hairsbreadth is therefore way off target.

## From raw blank to high-precision MTU conrod

The blanks are produced at a forge in line with Rolls-Royce's specifications and are then machined to their final form at the MTU facility. And the process produces a whole lot of machining chips. For example, the original blank for a Series 4000 conrod starts out at almost 15 kilos. After preliminary machining, that drops to a mere 9.75 kilos. Absolute 'µ-precision' is then

confirmed at the second station in the process where an unusual device is used to determine the mass of the conrod in motion. Because the conrod performs a rotating movement at one end and a reciprocating movement at the other, perfect balance during motion is vital. At this stage, the conrod also has to pass a hardness and distortion test. The component then comes under fire in the shot-peening unit where it is blasted with a stream of 1mm-diameter balls to compact the surface and enhance residual compressive stress.

## Products with memory and identity

Next, every conrod gets its very own individual identity in the form of a serial number and a code that are engraved twice on each rod. This is essential because the next step involves cutting

the component in two so that it can be secured on the crankshaft. Duplicating the engraved ID-signatures avoids the danger of mixing up the halves by mistake. The code contains information identifying the forge, batch, day and time – in short, the product memory. After a co-worker has cut the conrod and ground the razor-sharp serrated mating faces, both parts are assembled in accordance with strictly specified and standardized procedures. Then, before the two parts of the conrod are securely bolted together, two scanners check the ID-codes to ensure that they are a matching pair. If they do not fit perfectly, the screwing device shuts down automatically.

## Complex but strong: the bearing

A conrod has an 'eye' at each end (generally

Conrods are inspected for the tiniest hairline cracks in a darkroom using UV-light. The conrod is first immersed in a fluid containing magnetic particles. Any crack in the conrod would attract these particles and the accumulation of particles would be visible under UV-light.

called the big end and the small end). The small-end bearing is permanently joined with the conrod. The two-part, big end is bolted on a rod journal (crankpin) on the crankshaft. The bearings have a vital function. An exact combination of mobility and stability is essential and the more precise this is, the more engine power the conrod can cope with. With this in mind, eight years ago, funds were invested in a technology designed to substantially enhance this characteristic: ultrasonic shot-peening. Frank Schneider explained: "Ultrasonic is used to propel tiny balls around for six minutes. As they fly around, they impact the inside face of the conrod eye and create a surface structure that gives the bearing shell exceptional grip and enables it to withstand extreme stress." This means engine power can be increased with no loss of engine durability.



1



2

1 The smallest conrod is just 28 cm long and weighs in at 3 kilos. The biggest conrod is 110 cm long, weighs 103 kilos and is used in MTU Series 8000 marine engines.

2 Rolls-Royce produces 40 different MTU conrod models and their variants. With an annual production of 60,000 to 70,000 units, the most common is the medium-size conrod used in Series 4000 engines.



3

3 Machine-based checks and visual inspections by co-workers go hand in hand.

Not a single conrod leaves the plant without undergoing final visual inspections, hardness checks and crack tests. Only after every test has been passed is a conrod deemed fit for service in an MTU engine.

**WORDS: JULIA RIEß**

**PICTURES: ROBERT HACK**

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Things our editors have been impressed by

# Afterthoughts



Julia Rieß learned more about conrod production in the Assembly Plant 1 in Friedrichshafen.

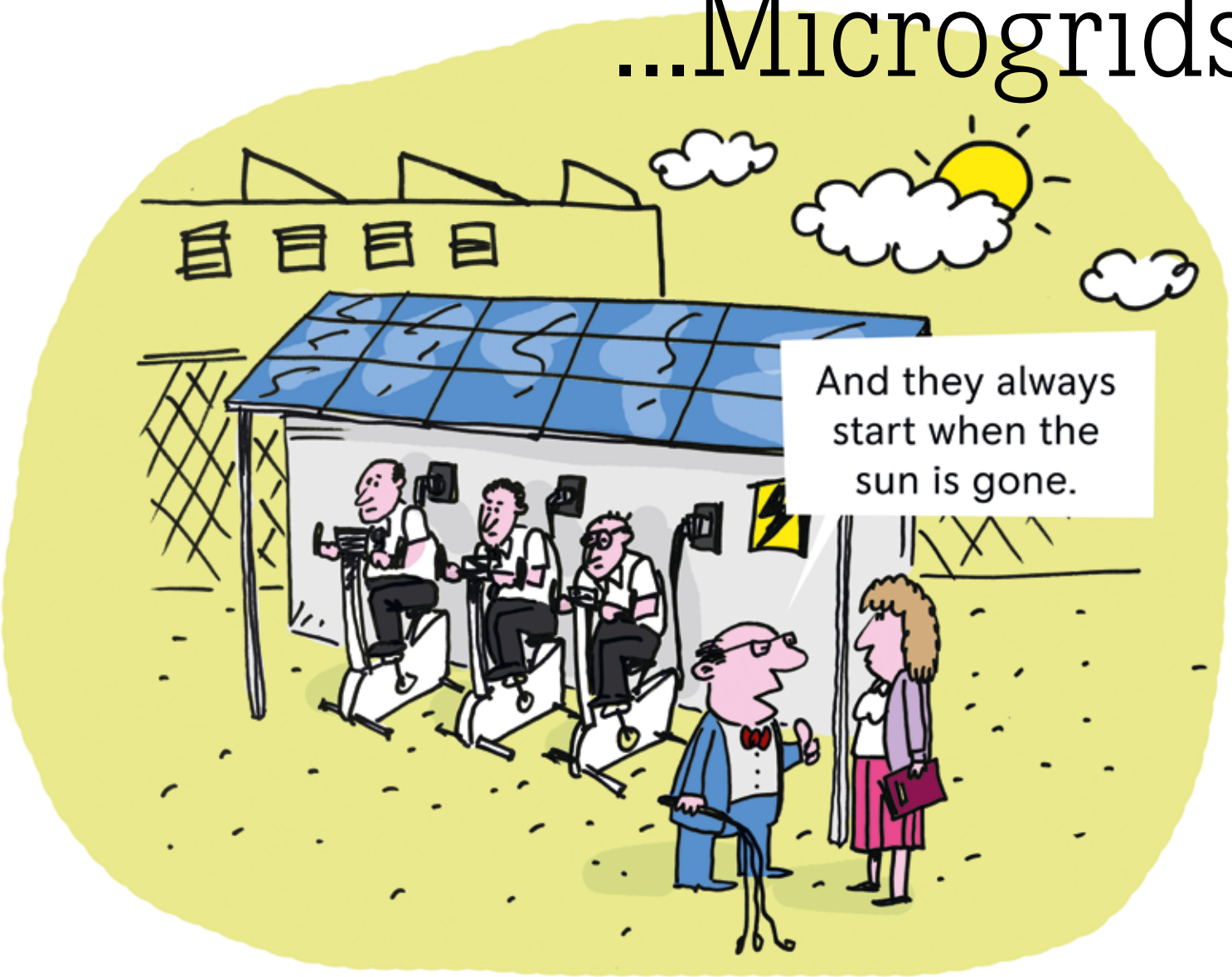
**The connecting rod in the bird skull**  
When researching for an article, it is of course best to look at the whole thing on the spot to understand the object of the report. However, desk research is always part of the process, and sometimes – especially on the Internet – you may come across interesting connections that you won't find in a production hall. During my research on the subject of “connecting rods” I lost myself in bird science literature for a short time. Too fascinating was the hint that there is a model in nature for this engine component, too. As a reminder, the connecting rod converts the linear motion of the power or working piston into the circular motion of the crankshaft – or vice versa, a circular motion into a linear motion. Well, such a kind of connecting rod can also be found – under the name Quadratojugal – in a bird's skull. This rod-shaped bone forms a bone bridge. It is connected to the movable quadratum on one side. When the bird lowers its lower beak, the quadratum swings forward like a pendulum. This circular movement transmits the quadratojugal like a connecting rod to the rear lower edge of the upper beak, which opens up. Thanks to this “ornithological connecting rod”, the bird is one of the few living creatures that can actively lift the upper jaw. Whether in the parrot skull or in the MTU engine: the connecting rod principle is simply ingenious.



Ulrich Heyden set off for Aichal in Russia, a place just outside the Arctic Circle to learn more about diamond mining.

**Cut off in the Russian North**  
One of the diamond mine employees drove me the 90 km from Polyarny airport to Aichal. The road was as straight as a die, and took us through snow-covered countryside. Only once did I see a person at the side of the road. To the right and to the left, there were only small pines that were frozen in snow and ice, and looked like they didn't want to grow any further. Here – in the far north of Russia, not far from the Arctic Circle – there is a total absence of tall trees. I had secretly been hoping for a dense, high, green forest... In the mining town of Aichal, the contrasts could hardly be greater. Workshops, prefabricated buildings and clouds of snow whirling up around the cars. The drivers of the haul trucks, which take rubble from the diamond mine to the processing factory, drive vehicles reminiscent of steel elephants. You can feel that there is an iron discipline around the mine. There is no other way for work to be done in this lonely part of the world. But there is a lot of normality as well. A white dog jumps happily across the street, followed by two men. Laughing children emerge from a school. On the outskirts of the village you have a wonderful view over a wooded valley, an icy lake and a ski slope with a lift. Every evening choirs and dance groups rehearse unusual choreographies in a cultural center. The people here are delighted to see any visitor who comes along. The curator of the local history museum proudly tells of the courageous geologists who, in 1959, went through the wilderness with backpacks to find the diamond mine.

# Talking of... ...Microgrids



Read more about Microgrids on pages 16 to 18.

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