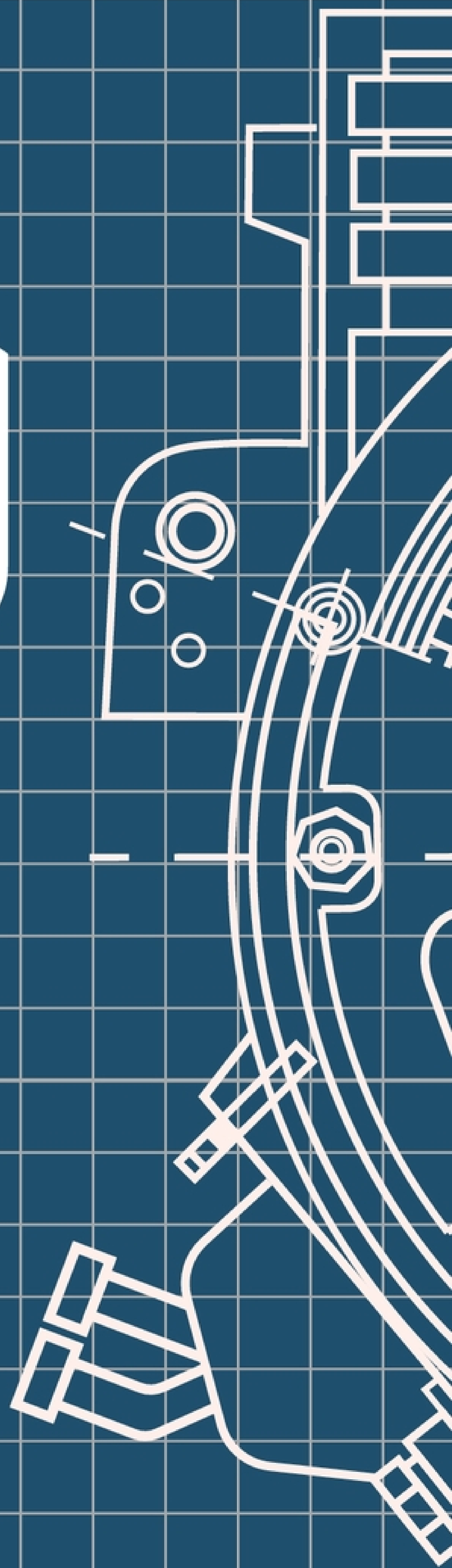
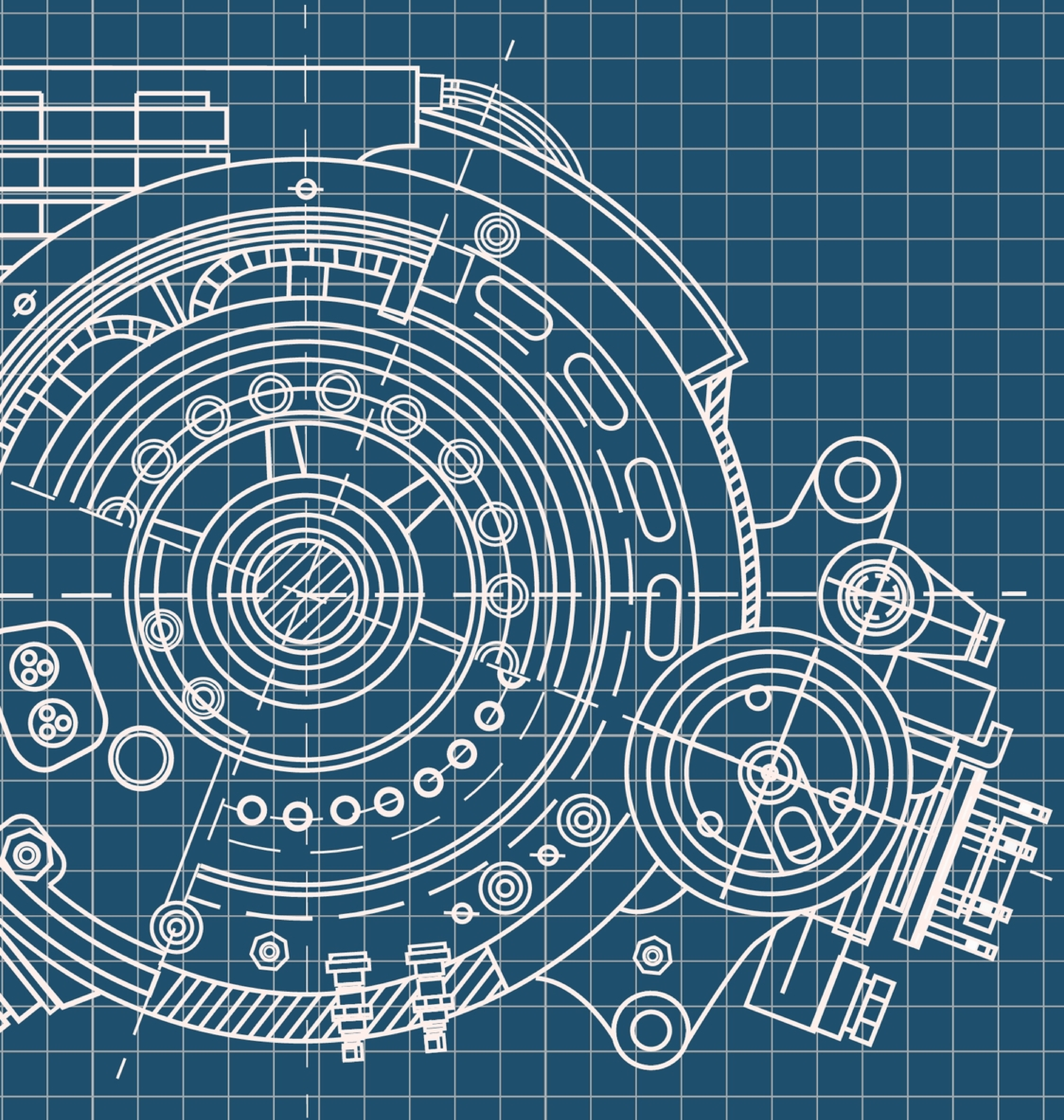
Testing times

As electrification continues to grow in prominence for OEMs, third-party testing specialists are adapting their offering to cope with increased demand

WORDS BY **LEM BINGLEY**





The electric vehicle movement appeared to get a shot in the arm last year. Rapidly improving technology plus a backdrop of tightening emissions legislation have pushed plug-in, hybrid and pure EV cars from the sidelines into the spotlight at many OEMs.

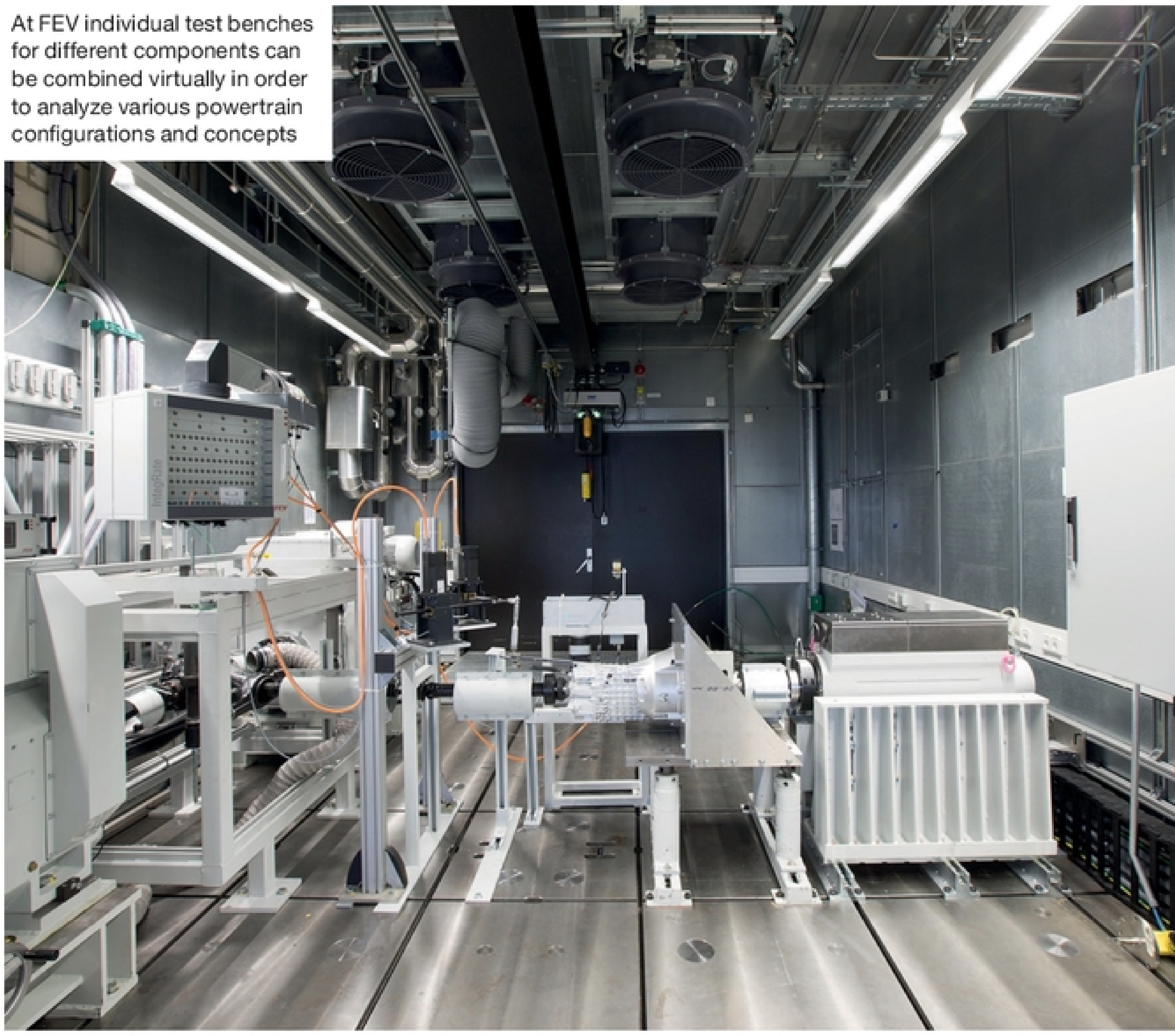
VW Group, for example, has announced plans to launch more than 30 new battery-powered cars by 2025, at least 10 of which are due to arrive before 2019. Fellow German OEM Daimler hatched EQ as an electric sub-brand in September and says it expects 15-25% of its Mercedes portfolio to be electric by 2025. Many other car makers have similarly ambitious plans.

MEETING DEMAND

The majority of these upcoming products are still to be developed, of course, but independent testing providers are already seeing a rapid rise in demand for hybrid and EV powertrain work.

"Our road map foresees much more testing in this area – much more dedicated to testing e-mobility," says Dr Stefan Trampert, group VP of business unit operations at FEV in Aachen, Germany. "Most OEMs have identified the components of an electric drive as a core competency. This means that they intend to develop their own technology and know-how."

David Meek, chief engineer at Intertek's powertrain testing laboratory in Milton Keynes, UK, paints a similar picture. "The industry is moving very fast toward electrification, driven by customer demand, legislation, public relations, cities setting up their own rules – there are many things pushing and pulling the industry toward electrification."



At FEV individual test benches for different components can be combined virtually in order to analyze various powertrain configurations and concepts

"Most OEMs have identified the components of an electric drive as a core competency. This means they intend to develop their own know-how"

Dr Stefan Trampert, group vice president of business unit operations, FEV

Complex assessments

The demands of electric powertrain testing can be very different to ICE work, says Intertek's David Meek, not least because the cars can connect to the mains electric grid. "For example, testing AC chargers, you have to simulate a Chinese brownout, which means the voltage and frequency both drop down and you have to check at what point the system shuts down," he explains. "Then as things come back up, does it restart automatically – otherwise you're left with a car that's not charged the next morning."

Similarly, Stefan Trampert says FEV is helping its customers test the complex software that decides how best to spend the mains charge of a plug-in hybrid. Satnav data and knowledge of the route's terrain can be used to optimize electric range. "If you'd like to test this on a bench, then full simulation becomes a very important topic," he notes.

Trampert says FEV can provide a test bench that accurately simulates real-world driving. "The test bench operator can see the road on screen, including altitude, cornering and traffic situations. As the vehicle is running virtually on screen, the powertrain on the bench is making gear changes, speeding up, slowing down, coasting down, braking, stopping. All the things it would do along with the real-time simulation."

Meek adds that he was hired three years ago to build up Intertek's electric testing expertise. "We had a plan to gradually introduce more electric work, but things have moved on much faster than we expected. Every time we deploy new facilities they're booked immediately. We can't build them quickly enough."

While the volume of work is increasing, demands are also becoming more elevated in engineering terms. "The kinds of speeds that drive motors run at is far in excess of anything the industry is used to," Meek explains. A faster running motor can deliver a given power with lower torque, which requires fewer ampere-turns, meaning less current and less copper in its coils. The result is a smaller, lighter, more efficient electric machine. "The industry is moving faster and faster and we have to keep up," he adds.

Intertek's Milton Keynes lab currently has the capability to test at up to 18,000rpm. "Customers are

ABOVE: Intertek's Milton Keynes lab, which was opened in 2016, houses state-of-the-art high-capacity battery simulators and the latest exhaust emissions measurement systems, designed to support the industry's push toward driveline electrification

BELOW: FEV adopts more of a multistage approach to battery testing, which can be adapted to the piece of equipment and evolve alongside future development methodologies

pushing it to 15,000rpm today and are asking for 20,000rpm in two to three years' time," Meek says. "We're in the process of specifying a rig that will support testing at speeds far higher than 20,000rpm."

The same performance requirements are also pushing EVs toward higher nominal voltages, which means test cells have to go higher still to assess over-voltage conditions. "Today the industry is at 500-600V, mainly limited by the inverter switching technology, but that is changing very rapidly as well. We set out 1,000V supplies to ensure we're future-proofed, but the future is moving very fast."

FEV's Trampert predicts that production voltages must settle down soon. "The issue is people handling high voltages when it comes to servicing in vehicle dealerships," he observes. "Beyond 1,000V, you need a very skilled and very specific education, so that's sort of a natural limit."

COMPONENT CHALLENGES

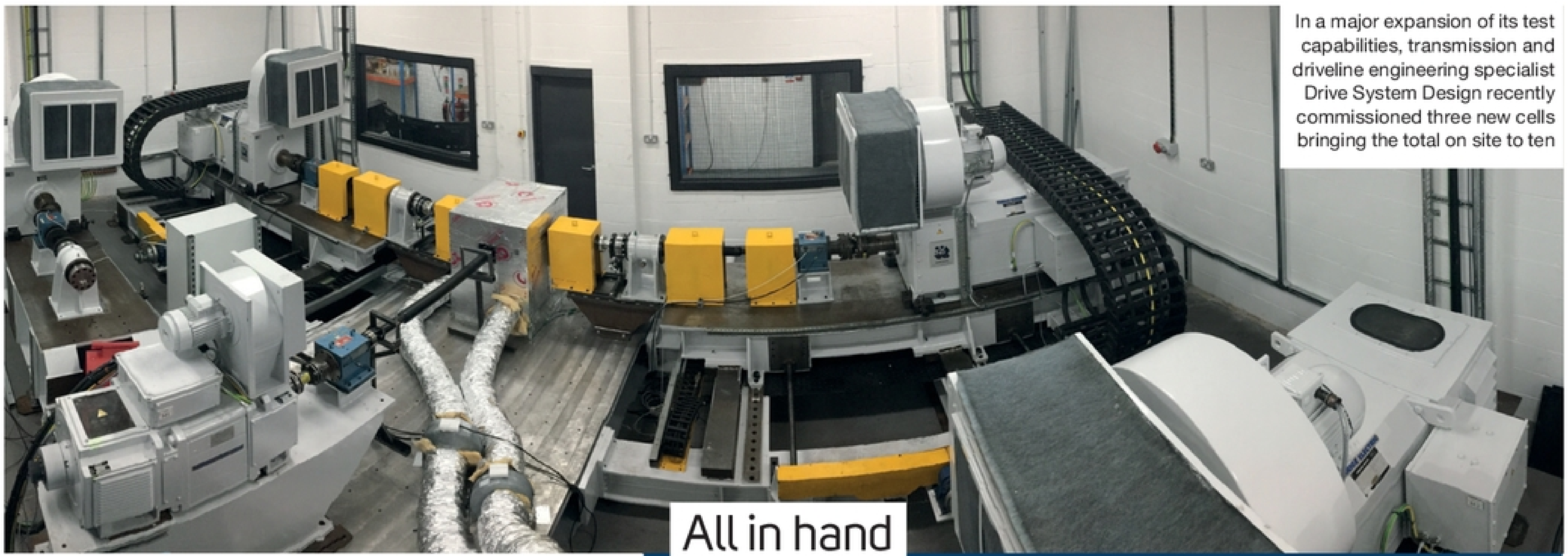
Trampert adds that a significant trend in ICE testing over the past decade has been a move away from component-level testing and toward evaluation of more complete assemblies – a situation enabled by the increasing sophistication of computer-aided engineering (CAE). With electric propulsion still at a raw level of maturity, it means a return to more fragmented, component-level testing. "I'm sure that this will change in the future when there is more possibility for virtual development of these types of components," he explains.

The number of different topologies seen among plug-in vehicles is also a challenge. Vehicle layouts vary tremendously, with some designs simply integrating the electric motor into the transmission, while others employ an ICE to propel one axle and a motor to drive the other, for example. EVs are also being designed with single-, twin-, triple- and quad-motor layouts.

"Everyone – not just us – is currently doing a lot of benchmarking and studies to cope with these requirements," says Trampert. "The big question is how to keep investment within reasonable limits – not to explode the investment – and the conclusion is that we need very flexible testing facilities."

"It's like the wild west at the moment," Meek says. "There are many technologies pulling in different directions – like a century ago when there were different spark plug concepts and carburetor designs. It took until the 1930s to settle down and we're in a similar situation now with motors and inverters, and batteries are just going crazy. I think there are many years of innovation and consolidation to run yet."

One of the techniques that FEV has developed to cope with today's diversity is the 'virtual shaft',



In a major expansion of its test capabilities, transmission and driveline engineering specialist Drive System Design recently commissioned three new cells bringing the total on site to ten

a digital network that can string different test cells together to create a closed-loop system, enabling separate components to be evaluated simultaneously as if they were physically bolted together.

"For example, we have a dedicated test bench for the battery, another for the e-motor, and another for the transmission or ICE testing," Trampert explains. "You can combine those test cells temporarily so they are running together." This approach allows OEMs to assess potential mix-and-match powertrains without the need for physical adaptation work.

EXTERNAL EXPERTISE

Of course, as more OEMs treat electric powertrain development as a core competency, there is a risk they will bring testing in-house. External specialists could be wrong-footed, investing in capacity today that won't be required over the long term.

Meek thinks this outcome is unlikely, however. "Our biggest customers obviously do have their own facilities – they just never have enough," he observes, adding that OEMs tend to be reluctant to tie up capital in facilities to meet their own peaks in demand. They also expect specialists to be nimble and responsive. "We can deliver new facilities quicker than they can in-house. We have much less downtime and we can fix things or change things more quickly," he says. "Because it's our lifeblood."

Similarly, specialists are also likely to devote more effort to future-proofing. "So far, we've been good at that – it's helped us to offer things that the customers didn't know they would need," Meek says.

Trampert argues that OEMs will have no option but to continue calling in outside expertise, noting that they won't be able to scale back development of ICEs for many years, for fear of losing market share. "They must keep alive their ICE development and they have, in parallel, the whole e-mobility development," he says. Only when ICEs begin to slide out of the mainstream will the development and testing requirement begin to ease, he predicts: "Maybe by 2040, in my estimation, we will eventually see a drop in development effort, because EV is a much simpler powertrain than ICE." ❮

All in hand

In a major expansion, UK-based transmission and driveline engineering expert DSD has commissioned three new test cells for hybrid and EV technology development. The facilities housed within the company's existing 1,500m² test base in Leamington Spa, took just six months to design and develop.

DSD chief engineer, Rob Oliver, says, "In recent years the majority of our work has focused on hybrid and EVs, and particularly in the last year there's been a step-change in the requirements of these vehicles."

Oliver, who notes that EV driveline configurations and architecture are still in the early stages of being defined, believes there will always be a need for facilities such as DSD: "Ultimately, in a few years when the OEMs do bring those capabilities in-house, then the outsourcing needs will reduce, but at the moment there's so much demand that outsourcing is the most sensible option."

The company has invested in equipment to test the electrical machine, the transmission and the electric powertrain as a whole unit. A complete range of transmissions, drivelines and vehicles with higher power outputs can now be tested. "We can allow for variations in track width by adjusting propshaft length, and e-machines are able to slide on their beds to accept wheelbase differences," reports Oliver.

The largest of the three cells (above) – the 5E rig – has five electrical machines, the four output motors each capable of 7,000Nm and 700kW, and can handle 4WD HEV transmissions and drivelines ranging in size from passenger cars to trucks and off-highway vehicles. It is equipped with an in-house-developed gear shift robot.

"We can run dynamic load cycles and road simulation cycles, or we can run simple block cycles. We have also invested in a new low-inertia, permanent magnet transient input machine, which enables us to mimic engine firing characteristics without the need for a physical engine," explains Oliver.

It is also more cost-effective as, rather than burning fuel, electrical power is recirculated from the output machines back to the input machine.

Three additional cells each equipped with three e-machines are used for testing transmissions and axles, and complement existing facilities that are in heavy demand.

The cells are outfitted with NI PXI control hardware, with the software designed in-house, and high-tech camera systems, which enable unmanned testing 24 hours a day. "We built our own control system because this gives us more flexibility to adapt the parameters according to the needs and integrate with other vehicle systems, such as FlexRay."

Test parameters are automatically adjusted, and if required, engineers can remotely log into the secure test network from any location.

Furthermore, the new facilities have NI LabView and VeriStand data acquisition and control systems. In the 5E cell, approximately 150 channels of data can be recorded at up to 20kHz.

Considerable investments in site infrastructure were required, including a dedicated 2,000kVA power supply. "Installation of the 5E cell went remarkably smoothly; however, implementing the electrical power supply, which involved digging up roads and putting a large transformer in, was a lot of work that was out of our control, so that was a bit of a challenge," comments Oliver.