

Cayenne testing under extreme conditions – real and virtual

16/09/2025 In the development of the Cayenne Electric, Porsche is relying more than ever on digital testing. But the human factor is still indispensable: during final test drives, engineers push the SUV to its limits – in the freezing cold and scorching heat.

Developed virtually, proven in real life: Porsche is showing how digital transformation and engineering expertise work together with the new Cayenne Electric. The new all-electric SUV is set to be unveiled towards the end of the year and will then be offered alongside the current combustion-engined and hybrid models. "This project was the first in which we moved directly from digital whole-vehicle testing to pre-series production," explains Dr. Michael Steiner, Deputy Chairman and Member of the Executive Board Research and Development. The 'construction' stage of testing, which uses individually built prototypes, was no longer necessary as about 120 test vehicles, which are time consuming to build, were largely replaced by digital equivalents. Engineers sent virtual prototypes on digital test drives as early as the design phase.

Initial component tests carried out virtually

Simulation and artificial intelligence have radically changed – and shortened – vehicle testing. This is based on three pillars: precisely digitised routes ranging from the Nürburgring to everyday traffic; the Weissach engineers' decades of experience from field testing; and the significantly increased computing power of modern systems for real-time simulations. This enabled the engineers not only to visualise the Cayenne virtually, but also to test it directly a virtual environment. In a development phase in which components are initially available in digital form and can therefore be easily modified, the experts used virtual reality (VR) to perform initial tests of the future SUV generation. The results of the digital tests were later verified with test bench tests of real, physical components.

State-of-the-art composite test bench simulates real-world loads

A completely new composite test bench was developed for this purpose. It allows the drive, battery, energy management and charging systems to be tested together under realistic conditions. The test bench's four powerful synchronous motors can be programmed in such a way that they precisely simulate different road conditions, acceleration resistance and forces experienced during recuperation and braking. "The machines are so sophisticated that we can even display different asphalt surfaces or tyre slip," says engineer Marcus Junige. Environmental conditions can also be fully simulated.

Permanent comparison with the digital twin

"Our test programmes are unique in terms of their requirements," says Junige. A spectacular example is a lap of the Nürburgring-Nordschleife – at the limit. The input for this is provided by the virtual prototype. All simulated impulses are fed into the composite test bench in real time. "Under all conditions, the vehicle must always deliver full power as soon as the driver demands it," says Junige. This maximum power release is particularly stressful for the thermal management of the high-performance vehicle: in order to condition the battery optimally under all conditions, the heating and cooling systems are more powerful than in any previous electric Porsche. At every point during the Nürburgring lap, the values measured on the composite test bench are compared with what was previously calculated for the digital twin. This confirmed that the simulation is now so accurate that there are hardly any deviations that need be corrected after acquiring the physical test results.

Testing at the limit and in all situations

As precise as the simulation is, the final tuning is still done by humans. "In reality, only humans can perform the finishing touches," says Sascha Niesen, Team Leader Overall Vehicle Testing at the Porsche Development Centre in Weissach. The importance of test drivers' experience in perfectly balancing driving dynamics and control strategies is particularly evident on racetracks. Whether in the city, on the

highway or off-road, the Cayenne Electric is tested in all realistic usage scenarios. A particular focus is on the management of charging. "No matter how the Cayenne is driven before stopping, it must always be conditioned for fast charging," explains Junige. Even traffic jams are taken into account by the vehicle in order to make optimum use of energy.

Tests under extreme climatic conditions pose a particular challenge. In hot regions such as the Gulf States or Death Valley in the US, the climate control and the thermal management of the battery and drive system, among other things, had to undergo demanding functional tests at temperatures of up to 50 degrees Celsius. In Scandinavia, where temperatures reach minus 35 degrees Celsius, cold starts, climate control, traction, handling and braking behaviour, and performance of the control systems relating to driving dynamics were all on the test programme for the pre-production vehicles. And in both climatic extremes, the Cayenne Electric had to be able to charge quickly without any problems – hardly any other manufacturer demands more from its vehicles than Porsche.

Greater precision, fewer resources, more efficient development

Endurance testing simulates a vehicle's life under conditions so harsh that customers would only experience them in extreme situations. Under everyday conditions, the vehicles cover more than 150,000 kilometres in shifts within a few months – in city traffic, on country roads and on highways.

From crash laboratories and endurance runs to testing under extreme conditions – the combination of digital preparation and real-world testing is proving its worth in all areas. It makes the development process more precise and efficient. Compared to a conventional development strategy, the timescale for developing the Cayenne Electric was reduced by 20 per cent. At the same time, state-of-the-art virtual testing is more resource-efficient too, thanks to reduced material consumption.

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