

Audi battery testing center in Gaimersheim: Where range and fast charging come together

- **Why Audi designs and develops battery cells on its own**
- **The technical objective is ideally balancing energy density and charging capacity**
- **Reliable results through testing and checks long before production begins**

Gaimersheim, June 8, 2022 – Electric models must be suitable for everyday use. Purchasing decisions are significantly affected above all by range, but also by the charging performance of the built-in high-voltage batteries. For this reason, Audi designs, develops, and checks battery cells and battery components on its own at its battery testing center in Gaimersheim.

Black, red, gold – these colors indicate the charging status of a battery cell. During charging, lithium ions are deposited in the graphite anode, and the graphite changes its color according to the charging status. When discharged, graphite looks black; charged halfway, it turns red; and when fully charged, graphite appears golden. “This lets us see and assess the charging status,” explains Dr. Bernhard Rieger, cell expert at the Audi battery testing center in Gaimersheim. When electrodes are charged, they don’t do so evenly. An electrode will charge the most quickly where the highest number of lithium ions are present. This results in a charging status gradient. Ideally, everything would be the same color. But that would require an extremely thin electrode that would in turn have a neglectable capacity. “When it comes to fast charging lithium ion cells, the art lies in precise current control to prevent overcharging the anode in the golden areas. That would result in premature aging,” says Rieger. “This means our task lies in ensuring the ideal operation of lithium-ion cells to achieve the best possible range and charging performance.” For Audi customers, this guarantees a battery electric vehicle with both excellent range and charging performance. “Once the basic need for range has been met, charging capacity becomes more relevant,” adds Rieger.

Balance between high energy density and fast charging times

The Gaimersheim cell technicians thus face conflicting goals. “We have a limited package available to us, into which we have to pack as much energy as possible,” comments Rieger. “But we also want to be able to recharge it as fast as possible.”

The equipment, data and prices specified in this document refer to the model range offered in Germany. Subject to change without notice; errors and omissions excepted.

**The collective fuel/electric power consumption and emissions values of all models named and available on the German market can be found in the list provided at the end of this text.*

The conflict lies in the fact that the greater the energy density, the longer it takes to charge the cell. This means the cell technicians are facing a balancing act that requires them to at least keep charging times at a constant while increasing energy density. In order to charge a lot of energy quickly, charging capacity is an early point on the agenda for project development. In this area, no less than two Audi models are setting standards today: The cells in the 93 kWh high-voltage battery used in the Audi e-tron GT quattro* can charge from 5 to 80 percent with up to 270 kW of power in only 22.5 minutes in ideal conditions. The Audi e-tron*, which first hit the market in 2019, is still considered the benchmark today with its unique plateau-like charging curve, where the charging power of up to 150 kW is available for a large part of the charging process.

“We invest a great deal of time in developing ideally controlled cells and current control to achieve as fast a charging time as possible coupled with high efficiency and a long service life,” explains Rieger. So in Gaimersheim, the focus is not limited to battery cells alone: The entire battery system with its electronics, thermal management system, and high-voltage periphery are equally relevant for the Audi fast charging concept. “Our systems are designed from day one with fast charging in mind because it is very difficult to increase charging capacity later on. Only a perfectly balanced total package where every detail counts from the earliest phase will reach the desired charging properties.”

From test stands to pre-series production – everything under one roof

In addition to the criteria of energy density and charging capacity, the battery cells also meet the highest service life and safety standards. To this end, the individual cells and the battery system as a whole have to pass numerous tests at the approximately 4,400-square-meter center in Gaimersheim. Each vehicle project entails a variety of service life and fast charging tests on several hundred cells. The cells have to run through different charging and load profiles that the Gaimersheim technicians perform in climatic chambers at temperatures between -30 and +60 °C. “Our tests and checks begin at an early sample phase about four years before the start of production to allow us time to make readjustments where necessary”, explains cell expert Rieger. In order to assess the cells’ aging phenomena, they are also exposed to high temperatures for the space of about a year. This allows Audi to simulate an in-car service life of up to 15 years. Service life test stands in Gaimersheim also allow the technicians to speed up reconstructed mileage scenarios of about 300,000 kilometers. Other tests include crash and overcharge testing as well as various safety tests. Diverse driving scenarios can be simulated in order to optimize the high-volt components’ operating strategy or thermal management. “This application allows us to perform the best possible fine-tuning on our batteries,” says Rieger. “New findings from cell measurements are rerouted right back to the virtual battery models so we can observe the effects on the vehicle.” Gaimersheim is also home to a construction facility for prototype batteries; here, employees build the high-voltage batteries from the ground up all the way to pre-series production.

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“At Gaimersheim, we have the competency to fine-tune our cells’ design and operational strategy to achieve properties that are perfect for Audi,” sums up Rieger. “How can I operate and build a battery to get the most use out of it? That’s a question we answer every day at the Gaimersheim battery testing center.”

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In 2021, the Audi Group delivered around 1.681 million cars from the Audi brand, 8,405 sports cars from the Lamborghini brand and 59,447 motorcycles from the Ducati brand to customers. In the 2021 fiscal year, AUDI AG achieved a total revenue of €53.1 billion and an operating profit before special items of €5.5 billion. More than 89,000 people all over the world work for the Audi Group, around 58,000 of them in Germany. With its attractive brands, new models, innovative mobility offerings and groundbreaking services, the group is systematically pursuing its path toward becoming a provider of sustainable, individual, premium mobility.

Fuel/electric power consumption and emissions values of the models named above:****Audi e-tron GT quattro**

Combined electric power consumption in kWh/100 km (62.1 mi): 21.8–19.9 (WLTP);
19.6–18.8 (NEDC); combined CO₂ emissions in g/km (g/mi): 0 (0)

Audi e-tron

Combined electric power consumption in kWh/100 km (62.1 mi): 26.1–21.0 (WLTP);
24.3–20.9 (NEDC); combined CO₂ emissions in g/km (g/mi): 0 (0)

***The indicated consumption and emissions values were determined according to the legally specified measuring methods. Since September 1, 2017, type approval for certain new vehicles has been performed in accordance with the Worldwide Harmonized Light Vehicles Test Procedure (WLTP), a more realistic test procedure for measuring fuel consumption and CO₂ emissions. Since September 1, 2018, the WLTP has gradually replaced the New European Driving Cycle (NEDC). Due to the more realistic test conditions, the consumption and CO₂ emission values measured are in many cases higher than the values measured according to the NEDC. Additional information about the differences between WLTP and NEDC is available at www.audi.de/wltp.*

At the moment, it is still mandatory to communicate the NEDC values. In the case of new vehicles for which type approval was performed using WLTP, the NEDC values are derived from the WLTP values. WLTP values can be provided voluntarily until their use becomes mandatory. If NEDC values are indicated as a range, they do not refer to one, specific vehicle and are not an integral element of the offer. They are provided only for the purpose of comparison between the various vehicle types. Additional equipment and accessories (attachment parts, tire size, etc.) can change relevant vehicle parameters, such as weight, rolling resistance and aerodynamics and, like weather and traffic conditions as well as individual driving style, influence a vehicle's electric power consumption, CO₂ emissions and performance figures.

Further information on official fuel consumption figures and the official specific CO₂ emissions of new passenger cars can be found in the "Guide on the fuel economy, CO₂ emissions and power consumption of all new passenger car models," which is available free of charge at all sales dealerships and from DAT Deutsche Automobil Treuhand GmbH, Hellmuth-Hirth-Str. 1, 73760 Ostfildern-Scharnhausen, Germany (www.dat.de).