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Audi e-tron – Charging and thermal management

### **Intelligent solutions for home and on the move: the charging concepts**

The large high-voltage battery in the Audi e-tron can store up to 95 kWh of energy and is thus the foundation for the long range. There is generally no need to stop at charging stations during everyday driving. On long trips, such as when going on vacation, customers can use fast charging stations to charge with direct current (DC) at up to 150 kW – a first for series-production automobiles. This means that the Audi e-tron is all set for the next long-distance stretch of a journey in approximately half an hour. The electric SUV can also be recharged with alternating current (AC) at up to 11 kW; recharging with 22 kW is available as an option. Proprietary Audi charging service provides e-tron customers with easy access to roughly 80 percent of the public charging stations in Europe. Whether AC or DC, 11 kW or 150 kW – a single card is all customers need to start the process. The procedure will become even more convenient with the function Plug & Charge, which will follow in 2019: The car self-authorizes at the charging station and activates it.

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### **Standard with 11 kW, optionally with 22 kW: charging at home**

The Audi e-tron will typically be recharged most often at home. And each charging cycle costs the owner just a few seconds of time, i.e. the time required to connect and disconnect the charging cable. In most cases, the electric SUV is charged overnight and then sets off the next morning with a fully charged battery and a range of more than 400 kilometers (248.5 mi) according to the WLTP test cycle.

Audi offers various solutions for charging at home. If desired, an electrician referred by the local Audi dealer will check the power supply in the garage and install the suitable technology. The standard compact mobile charging system can be used in two ways – with a charging power of up to 2.3 kW when connected to a 230 volt household outlet, and with up to 11 kW when connected to a 400 volt three-phase outlet. In the latter case, the battery can be fully recharged in roughly eight and a half hours. The optional connect charging system doubles the charging power to as much as 22 kW. This requires a second charger on board the Audi e-tron, which will be available from 2019. The connect system comprises a control unit with a 5-inch touch display and a wall mount. It enables customers to view their individual charging statistics and charging progress in the myAudi portal and the myAudi app.

Together with a home energy management system, the connect charging system offers intelligent functions. In this case, the Audi e-tron can be charged with the maximum power available with consideration of other consumers in the household to avoid overloading the



electrical system. Customers can also define their own personal priorities, such as charging when electricity is less expensive. If the home is equipped with a photovoltaic system, the car can be charged preferentially using the electricity generated by the system, and charging even considers forecast phases of sunshine.

### **At up to 150 kW: charging on the move**

Thanks to the long range of more than 400 kilometers (248.5 mi), there generally is no need to stop at a charging station during everyday driving. This is not the case for longer trips, however, such as when going on vacation. In these situations, the Audi e-tron can recharge with up to 150 kW DC at fast charging stations meeting the European Combined Charging System (CCS) standard – a first for a series-production automobile. This means that the electric SUV is all set for the next long-distance stretch of a journey in approximately half an hour. It is all made possible by the sophisticated thermal management of the lithium-ion battery, which allows charging at up to 150 kW. Plans call for the Ionity network to include 400 such high-power charging (HPC) stations installed at 120-kilometer (74.6 mi) intervals along European highways and main transportation corridors by 2020. The Volkswagen Group including Audi and Porsche, the BMW Group, Daimler AG and the Ford Motor Company are jointly promoting the expansion of the HPC network. Additional compatible HPC charging points are also being installed in Europe outside of this joint venture.

In addition to direct current, the electric SUV can also be charged on the move with alternating current at AC chargers, with up to 11 kW as standard and at 22 kW with the optional second on-board charger. The car is connected to the charging station using the standard mode 3 charging cable. Roughly 95 percent of all existing charging points in Europe currently conform to this standard.

### **Important performance factor: thermal management**

The effective thermal management system in the Audi e-tron guarantees fast DC charging with up to 150 kW, long battery life and reproducible road performance even under heavy load. For the customer, this means high performance at all times. The thermal management system of the Audi e-tron comprises four circuits that can be connected in various ways as required. It cools the electric motors including their rotors, the power electronics and the charger. It also cools and warms both the interior and the high-voltage battery. The rotors, which reach up to 13,300 revolutions per minute during real vehicle operation, consist of magnetically conductive electrical sheets and lightweight, high-purity aluminum. Coolant flows through the inside of the shafts to ensure that the temperature does not exceed 180 degrees Celsius. The stators and end shields of the electric motors are also water-cooled. The gearboxes mounted on the end shields benefit indirectly from this solution. Effective cooling posed new challenges for the developers, particularly with



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the coaxially arranged electric motor at the rear axle. The solution is to supply the coolant via a double-wall pipe and its ceramic seal on the electric motor rotor.

22 liters (5.8 US gal) of coolant circulate around the 40 meters (131.2 ft) of cooling pipes in the Audi e-tron. Being the hottest components in the powertrain, the electric motors provide the thermal management system with a large quantity of heat. The standard heat pump uses their waste heat - up to 3 kW of actual power losses are efficiently used for heating and air conditioning the interior. Depending on the outside temperature, that can boost the Audi e-tron's range by up to ten percent in customer operation.

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