

AUDI AG
Product Communications
85045 Ingolstadt
Germany
Tel: 49 (841) 89-32100
Fax: 49 (841) 89-32817

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Detroit showcar Audi e-tron

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The Detroit showcar Audi e-tron shows another variant of an electric vehicle developed by Audi

Detroit – Audi is showing an uncompromising purist compact sports car with all-electric drive at the first major auto show of 2010. The Detroit showcar Audi e-tron is the name of this 3.93 meter (154.72 in) long and 1.78 meter (70.08 in) wide but just 1.22 meter (48.03 in) tall two-seater; just a few months after the debut of the Audi e-tron at the 2009 Frankfurt Motor Show, this is now the second electric concept vehicle from the brand with the four rings.

Coupled with the Detroit showcar Audi e-tron's low gross weight of around only 1,350 kilograms (2976.24 lb), high-torque power units driving the rear wheels guarantee commensurate road performance. Two electric motors with a combined output of 150 kW (204 hp) and 2,650 Nm (1954.54 lb-ft) accelerate the coupe with ASF-design aluminum body from 0 to 100 km/h (62.14 mph) in just 5.9 seconds. The Audi e-tron accomplishes the sprint from 60 to 120 km/h (37.28 - 74.56 mph) in a mere 5.1 seconds.

The Detroit showcar Audi e-tron is able to distribute its electric motors' high torque between the wheels entirely as required. Its "torque vectoring" is the key to a thrilling level of active precision and excellent traction. Thanks also to its low weight, short wheelbase and perfect weight distribution for dynamic handling, the Audi e-tron has all the drivability of a go-kart – agile, good on bends and neutral right up to the very high handling limit.

Lithium-ion batteries, located for an optimal center of gravity behind the passenger compartment and ahead of the rear axle, make an effective energy content of 45 kilowatt-hours available. This makes an operating range of up to 250 kilometers (155.34 miles) realistically possible.

As previously with the first e-tron concept car shown in Frankfurt, Audi again bases all components in this electric vehicle on an integral concept with many revolutionary details: a heat pump as an efficient means of heating up and maintaining the interior temperature. The drive system, power electronics and battery have innovative thermal management – crucial for maintaining a high operating range coupled with outstanding interior comfort.

Design and package

Audi is presenting a further variant of an electric vehicle in the form of the Detroit showcar Audi e-tron. The vehicle body has a powerful, wide and muscular stance on the road, and looks extremely compact and puristic not least thanks to the typically short sports car wheelbase of just 2.43 meters (*95.67 in*) – a whole 22 centimeters (*8.66 in*) shorter than the R8.

The sweeping line of the front end and the flat curved roof immediately identify the two-seater as an Audi. The sides reveal familiar contours: The way the dynamic line is tailored above the sill and the prominent wheel arches, as is typical for an Audi R, combine the front, side and rear into a monolithic entity and strongly emphasize the typical Audi feature of round wheel arches enclosing the large 19-inch wheels. The highly tapered front end gives the Detroit showcar Audi e-tron distinctly wedge-shaped basic proportions.

1.78 meters (*70.08 in*) wide, just 3.93 meters (*154.72 in*) long and 1.22 meters (*48.03 in*) tall – those are the classic proportions of a sports car. That leaves space ahead of the rear wheels for the 399 kilogram (*879.64 lb*) battery unit, with converter and power electronics.

The two electric motors, which have their own cooling system, are mounted on the rear axle. This special package, featuring a 40:60 weight distribution, ensures perfect balance, which contributes to the driving dynamics of the Audi e-tron.

The trapeze of the single-frame grille dominates the distinctly wedge-shaped front end and is flanked by two large air intakes. The top of the grille merges into the flat strips of the adaptive matrix beam headlight modules with their clear glass covers. All light units use ultra-efficient LED technology.

The headlights are the core of a fully automatic light assistance system that reacts flexibly to any situation. The new technology recognizes weather conditions and adapts the illumination to rain or fog. The technology at the heart of the light assistance system is a camera that works together with a fast computer to detect oncoming traffic, recognize lanes and measure visibilities, such as in the event of fog.

If there is oncoming traffic, the high beams are turned off in the corresponding section of the illumination field. The cornering light system analyzes data from the navigation system and illuminates corners before the driver steers into them. The Detroit showcar Audi e-tron does not have conventional fog lamps that consume additional power. It intelligently varies the low beams instead; in fog, for example, it produces a wider, more horizontal illumination field, thus significantly reducing the glare from the car's own lights.

The variability of the headlights is also reflected in their design. The LED elements change appearance and thus the character of the front end of the vehicle depending on the speed driven and the ambient conditions. The innovative lighting technology now offers the Audi designers almost as much design freedom as the shape of the body does.

One design element that is specific to electric vehicles developed by Audi – such as the Audi e-tron – are the air intakes in the single-frame grille and behind the side windows on the C-post. They are closed flush under normal circumstances and opened by retracting slats when additional cooling air is required. The slats above the drive unit then also open to provide a better through-flow of air. These measures, too, maximize efficiency – the concept car is outstanding for an already low drag coefficient that is further improved when the flaps are closed.

The ASF body

Systematic lightweight construction is an even more important prerequisite for efficiency and range with electric vehicles than for conventionally powered automobiles. Lightweight construction is moreover the key to thrilling handling characteristics. Audi developers focused on a core competence of the company when creating the Detroit showcar Audi e-tron: The body structure is based on Audi Space Frame technology (ASF), with a hybrid design approach adopted. All add-on parts – doors, lids, sidewalls and roof – are made of a fiber-reinforced plastic.

The combination of aluminum and carbon fiber-reinforced composite material guarantees supreme rigidity coupled with low weight. Audi will soon use this technology in a similar form for future production vehicles. Despite the complex drive system layout with two electric motors and a high-capacity battery system, the total weight of the Audi e-tron showcar on display in Detroit is only around 1,350 kilograms (*2,976.24 lb*).

Interior and operating concept

Visual and functional references to the new drive concept characterize the purist interior design. They establish a connection between proven Audi genes and new formal hallmarks. Typical for the Audi design idiom is the reduction of the architecture, controls and information output to the essentials in favor of visible lightweight construction and a tidy overall impression.

The slim dash has a curve that extends laterally into the door panels. With no need to allow for a transmission, shifter and cardan tunnel, the designers took advantage of the opportunity to create a particularly slim and lightweight center tunnel and convex, arching center console. The flush gear selector, with which the driver chooses between the modes forward, reverse and neutral, emerges from the tunnel when the vehicle is started.

The Audi e-tron's cockpit, which represents a further development in an electric vehicle, is also oriented toward the driver – a further characteristic Audi trait. Instead of the classic instrument cluster, the concept car is the first Audi to be equipped with a large built-in central display with integrated MMI functions. It is flanked by two round dials.

The MMI is controlled via a scroll pad with a touch-sensitive surface on the steering wheel (“MMI touch”) – an element inspired by modern smartphones. The steering wheel itself is clearly flattened off at both the top and bottom, in a clear reference to motor sport.

A smartphone that can be integrated into the front section of the center console interfaces between the vehicle, the driver and external information sources. The driver can use a suitably equipped conventional smartphone as a car phone, address database, navigation system and video player. At the same time they can also use it as an operating unit for many specific on-board systems in the Audi e-tron. Many phones that are suitable for these functions are already available from various manufacturers.

The driver can then enter their route plan or adjust the sound system to their individual preferences, all from the comfort of their own home, for example. The Smartphone and vehicle communicate via the mobile communications network, even over considerable distances.

The system also provides a security function for the owner; within the range of the WLAN it can constantly monitor the current status of the vehicle, for instance whether all windows and doors are closed. If the Audi e-tron showcar on display in Detroit is parked at a charging station, for example, it also sends details of the current charge status to the driver's smartphone.

While an analog speedometer on the driver's right provides speed information, the instrument dial on their left tells them how much power is being drawn. The central display shows the range in the status bar and presents all key information from the infotainment and navigation systems. It also provides the driver with relevant data from the vehicle's communication with its surroundings. The instruments combine the analog and the digital worlds into a single unit.

Characteristic for the concept of the Audi e-tron – and therefore also characteristic for a further development in an electric vehicle – is the near total elimination of switches and small components such as the ignition. The climate control unit is located to the right above the steering wheel. The display provides temperature and ventilation information. Again drawing inspiration from a smartphone, the system is controlled by means of a touch-sensitive sliding control.

The equally racing-inspired lightweight bucket seats combine excellent lateral support with comfort. Two contrasting colors delineate the various zones of the interior. The colors and the high-quality materials combine elegance and sportiness.

Drive system and energy supply

Two asynchronous electric motors with a total output of 150 kilowatts (204 hp) give the Detroit showcar Audi e-tron the performance of a genuine sports car. The concept car can accelerate from 0 to 100 km/h (*0 – 62.14 mph*) in 5.9 seconds if necessary, and goes from 60 to 120 km/h (*37.28 – 74.56 mph*) in 5.1 seconds. The torque is distributed selectively to the wheels based on the driving situation and the condition of the road surface, resulting in outstanding traction and handling.

The top speed is limited to 200 km/h (*124.27 mph*), as the amount of energy required by the electric motors increases disproportionately to speed. The range in the NECD combined cycle is approximately 250 kilometers (*155.34 miles*).

The energy storage unit is charged with household current (230 volts, 16 amperes) via a cable and a plug. The socket is behind a cover at the back of the car. The charging time when the battery is empty is around 11 hours, but heavy current (400 volts, 32 amperes) cuts this to around just two hours.

The battery is charged not only when the car is stationary, but also when it is in motion. The keyword here is recuperation. This form of energy recovery and recharging of the battery is already available on many Audi production models. During braking, the alternator converts the kinetic energy into electrical energy, which it then feeds into the on-board electrical system.

The Detroit showcar Audi e-tron in its further developed version goes one decisive step further into the future; an electro-mechanical brake system means the potential of electric motors for energy recovery can now be exploited. A hydraulic fixed-caliper brake is mounted on the front axle, with two novel, electrically actuated floating-caliper brakes mounted on the rear axle. These floating calipers are actuated not by any mechanical or hydraulic transfer elements, but rather by wire (“brake by wire”). In addition, this eliminates frictional losses due to residual slip when the brakes are not being applied.

By virtue of being isolated from the brake pedal, the Audi e-tron’s electric motors can convert the entire deceleration energy into electric current and recover it. The electromechanical brake system is only activated if greater deceleration is required. These control actions are unnoticeable to the driver, who feels only a predictable and constant pedal feel as with a hydraulic brake system.

An automotive first: the heat pump

The heat pump, too – which made its first appearance in an automobile on the Audi e-tron concept car shown in Frankfurt – helps to boost efficiency and range. Unlike a combustion engine, the electric drive system generally does not produce enough waste heat to effectively heat the interior. Other electric vehicles are equipped with electric supplemental heaters, which consume a relatively large amount of energy. The heat pump used by Audi – and commonly used in buildings – is a highly efficient machine that uses mechanical work to provide heat with a minimum input of energy.

A high-efficiency climate control system is used to cool the interior. It works together with the thermal management system to also control the temperature of the high-voltage battery. This is because the battery, power electronics and electric motors must be kept at their respective ideal operating temperatures to achieve optimal performance and range.

As soon as the vehicle is connected to a charging station the vehicle is preconditioned as appropriate by the thermal management and other associated systems. In cold conditions the drive system is preheated, and in hot conditions it is cooled. This preconditioning can also be extended to the interior, if necessary, so that the passengers can step into a cabin that has been heated or cooled as appropriate for their comfort.

Driving dynamics

The drive system's power is transferred to the road by the rear wheels, reflecting the Audi e-tron's weight distribution of 40:60.

Both the individual motors, which are installed behind the wheels close to the vehicle's center line as wheel drives, also enable the Detroit showcar Audi e-tron's lateral dynamics to be intelligently controlled. This also boosts traction. Similar to what the sport differential does in conventional Audi vehicles, torque vectoring – the targeted acceleration of individual wheels – makes the newly developed electric drive of the Detroit showcar Audi e-tron even more dynamic while simultaneously enhancing driving safety.

Understeer and oversteer can be corrected by not only targeted activation of the brakes, but also by precise increases in power lasting just a few milliseconds. The concept car remains extremely neutral even under great lateral acceleration and hustles through corners as if on the proverbial rails.

The chassis has triangular double wishbones made of forged aluminum components at the front and rear axles – a geometry that has proven in motor sports to be the optimal prerequisite for high agility, uncompromising precision and precisely defined self-steering behavior. A taut setup was chosen for the springs and shock absorbers, but it is still very comfortable.

The direct rack-and-pinion steering gives finely differentiated feedback. Its electromechanical steering boost varies with speed, so that the Detroit showcar Audi e-tron only has to provide energy while steering, but not while driving straight ahead.

As befits its status, the Audi concept car rolls on 19-inch wheels of 35-spoke design. 235/35 tires up front and 255/35 tires at the rear provide excellent grip. Another special feature of the tires: Audi designers created the profile specifically for the Detroit showcar Audi e-tron.