PRESS INFORMATION

Audi.Vorsprung.

Premium future: the Audi route to the Vorsprung of tomorrow

Digital, sustainable and urban: the customer is center stage

The rise of the Premium Digital Car Company

1. Virtual shopping experience: Audi VR experience and Customer Private Lounge
   1.1 The Audi VR experience
   1.2 Audi Customer Private Lounge

2. Metal 3D printing: from toolmaking to the lunar mission

3. Modular assembly: no assembly line – just dancing racks
   3.1 Paint shop of the future
   3.2 Driverless transport systems
   3.3 Dancing racks
   3.4 Sitting pretty – without a seat

4. Smart logistics: Wearables and virtual reality training
   4.1 Wearable scanner
   4.2 Virtual reality training
   4.3 Autonomous forklift trucks at the Logistics Center
   4.4 Ray the parking robot

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. Fuel consumption and emission figures are indicated from page 3 on.
Company-wide sustainability

1. High tech in the service of efficiency
   1.1 Versatile: mild-hybrid technology
   1.2 Permanently available: quattro with ultra technology
   1.3 Lightweight construction: a supporting pillar at Audi

2. Audi g-tron models with Audi e-gas: the energy revolution in the tank
3. Environmentally friendly, sporty, practical – electric mobility at Audi
4. CO₂-neutral plant in Brussels: clean cars from a clean factory
5. Key technology for the future: the fuel cell
6. CO₂ capturing: clear air bubbling with added value

7. Audi Environmental Foundation: pushing the boundaries with greenovations
   7.1 Smart HOBOS – the high-tech beehive
   7.2 The megacities experiment

New premium mobility for urban reality

1. myAudi app: Vorsprung durch smartphone at the market launch of the A8
2. Audi on demand – premium mobility service in 15 markets by 2020
3. Audi Innovation Research: the vision from Beijing and San Francisco
Premium future: the Audi route to the *Vorsprung* of tomorrow

Premium means more. And it’s this “more” that the Audi Summit in Barcelona is showcasing. Audi is presenting every aspect of its new brand promise, from the car itself through to the company and its social engagement. The change brought about by digitally networked technology is fundamentally transforming competition in the motor industry. And with it comes a huge opportunity for the brand with the four rings to inspire people with *Vorsprung* (advancement) and the best technologies.

Marking a milestone on the road to becoming a sustainable premium digital car company is the launch of Audi’s new flagship. The Audi A8 pushes the benchmarks for design, sportiness, comfort and operation further on towards a premium future.

With its intelligent systems and technologies, Audi AI is paving the way towards fully automated driving and is evolving into an empathetic personal companion in the context of mobility. Tomorrow’s premium car will think with us, make our lives easier and save us time.

Customers, employees and society as a whole will get greater added value, whether that be during the initial customer contact, when working in the Smart Factory or living in the urban environment. With the digital revolution comes a changed set of values. Audi is seamlessly integrating its customers’ modern lifestyle, creating them a personal space in a sustainable world.
Audi. Vorsprung. 2025.
Digital, sustainable and urban: the customer is center stage

On the way to becoming the premium digital car company, Audi has launched the biggest transformation in its corporate history. The brand is becoming digital throughout and sustainably economical in order to redefine urban mobility.

The Fourth Industrial Revolution is disruptive. Every market player is duty bound to invent something completely new from the ground up. Otherwise, there’s a risk of being left behind by the competition; not least by those who have only recently emerged onto the mobility market with new approaches, services and ideas.

Just how inspired Audi is by this challenge can be seen in Barcelona. It reflects the very essence of the company and its employees. Vorsprung is in Audi’s DNA – it describes the approach that the company has always taken when driving forward its activities. An approach that Audi will also continue to pursue in the future, ensuring customers are offered solutions that create Vorsprung for them too.

quattro, lightweight construction, TFSI... all provide classic proof of this almost proverbial Vorsprung durch Technik (Advancement through Technology). And setting benchmarks again in this regard is the new Audi A8, whose launch will be the keynote event in Barcelona. The fact that Vorsprung means much more than just technology is proven by the innovations on show in the A8.

Like a start-up company, Audi is moving quickly and unconventionally into new business areas, introducing new methods of production and changing mobility in the urban landscape. As a pledge, Vorsprung is always associated with the desire to never be content with the status quo, but instead to question it in order to find better solutions. Because for Audi, Vorsprung means much more than being a pioneer – Vorsprung embodies the aspiration to give customers of the brand more freedom.

With this strategy in mind, three clear focal points are being presented in Barcelona. Audi. Vorsprung. 2025. – always digital, sustainable and urban.
Digital
The new digital era is here. The Internet of Things gives us immediate access to billions of items of data. Intelligent algorithms, self-learning machines and artificial intelligence are themselves able to evaluate Big Data, thus opening up a new dimension in added value for the customer.

Virtual reality tools will enable customers to configure their dream car interactively. Under the motto “an Audi when I want and where I want”, Audi plans to enhance the concept of individual mobility with premium on-demand solutions, to be rolled out in 15 markets by 2020. A new digital platform will provide Audi drivers and passengers with information, entertainment and added value.

The production facilities of tomorrow will also be networked. The Smart Factory synchronizes all manufacturing steps digitally. Modular production processes, artificial intelligence and human-robot cooperation make automotive construction more flexible and easier on resources.

Sustainable
The trendsetting postmodern and upper liberal milieus aspire to a sustainable lifestyle. They are Audi’s core target group. Other social milieus will follow their lead over the next few years. Audi acknowledges the responsibilities it has in a society where sustainability is a key element.

Greenovations, technological achievements which can be deployed to protect the environment and the climate, are emerging in ever greater numbers along the entire value chain. The Audi Environmental Foundation seeks out these greenovations and is active in seeing them implemented.

In the race for the future, electromobility is the driving force of Audi: by 2020 there will be three high-performance electric models with striking designs. Under the slogan “Clean cars from clean factories”, Audi is currently implementing measures to make Audi e-tron electric car production in Brussels CO₂-neutral. In the world of the combustion engine, too, Audi is resolutely focusing on CO₂-neutral mobility. Synthetic fuels, plug-in and mild hybrids, aerodynamics, and lightweight construction increase the efficiency of the core model series.

Urban
Vorsprung needs vision. Which is why Audi is also shaping the day after tomorrow. Trend scouts and designers from Audi Innovation Research are exploring future scenarios in megacities around the world, and are already deriving the next generations of products and services based on their findings. Mobility services such as Audi on Demand are evidence of the brand’s particular aspiration to premium mobility.
Vorsprung in the urban context is about having an understanding of the logic and life-world of cities and working with them to develop smart solutions. With technologies such as piloted driving and piloted parking, or networked urban infrastructure, Audi is playing an active role in the continuing evolution of urban mobility. For people on the move, new smartphone applications such as the myAudi app provide wide-ranging, personally tailored assistance for their day-to-day lives.

Audi. Vorsprung. In its ambition, this strategy extends far beyond 2025 and raises the entire company and its activities to a new level. Investment in any one of the three areas of strategic focus will inevitably have a positive impact on the other two. And in this respect, it is digitalization which often provides the key to greater sustainability and better urban solutions.

One example illustrates this point. Today, 40 percent of the urban traffic volume is made up of vehicles searching for a parking space. Audi is linking traffic flow information with the sensor data that can be obtained in anonymous form from other vehicles via the HERE digital map provider. As a result, it will very soon be possible to guide drivers with pin-point accuracy to vacant parking spaces. Driving around in search of a space will become a thing of the past, congestion will be reduced. AUDI AG has been a partner in HERE since 2016. Investment in a real-time reality index of the world is set to provide added value to everyone in the town or city, for example by helping to reduce unnecessary traffic. This will contribute massively to sustainability.

Digital, sustainable, urban. A three-point strategy with one result: Audi. Vorsprung.
The rise of the Premium Digital Car Company

Digitalization is more than just a technology for \textit{Vorsprung} in the car itself. It is fundamentally changing all business processes. To this end, the biggest transformation in the company’s history is in full swing. Digitally networked technology is enhancing the quality of cooperation throughout all areas at Audi. The brand exhibition in Barcelona will showcase this in the form of numerous examples.

1. Virtual shopping experience: Audi VR experience and Customer Private Lounge

The automotive world is changing fast – and with it, the needs and expectations that people bring with them when looking to purchase a premium car. Today, nine out of ten customers looking for a new car first do some fact-finding online. Many wish to research the important details themselves. To do so, they use the manufacturers’ websites, forums and social media, thus benefiting from swarm intelligence.

Today, this in-depth initial fact-finding mission usually precedes a visit to the dealer. As a result, by the time customers consult with the experts at the dealership, their expectations are higher when it comes to making comparisons, weighing up pros and cons and configuring vehicles to individual requirements. At the Summit, Audi is showcasing two solutions that will help to address these higher expectations: the Customer Private Lounge and a VR application.

1.1 The Audi VR experience

The latest generation of virtual reality allows customers to configure every Audi model to their own specific requirements. Wearing the VR headset, they will see their dream car appear directly in front of them, as if it were actually standing there. Thanks to stereoscopic 3D rendering and complex data models, the effect is very realistic, right down to the smallest of details.

The Audi VR experience also opens up further fascinating possibilities. Customers can experience their vehicles in a variety of different environments, take a virtual dive into specific parts of the vehicle to explore their technical design or witness special moments of the Audi brand in VR.

Audi has focused a great deal of its development efforts on performance and graphics quality which is based on game engine technology. Created in conjunction with British specialist Zerolight, it is specifically optimized for virtual reality. It combines consistently superior visual quality with very fluid image depiction. The game engine fluidly outputs the complex car data models stereoscopically in the VR headset at 90 frames per second and has a fast response time of less than 20 milliseconds.
Audi is the first vehicle brand to introduce a sophisticated VR system into its sales operations and in so doing is offering customers considerable added value as they make their purchasing decisions. It is fully integrated into Audi’s IT systems and the online presence is always kept up-to-date with the latest data from the product portfolio. In order to use it in a dealership, Audi has opted for VR glasses from long-term project partner Oculus. The headset will allow customers to experience their future Audi in virtual reality from the comfort of their seat.

Audi has also developed an expanded version for special formats such as brand events or trade fairs. With this version, the visitor, wearing a VR headset from HTC, remains standing and can move freely around a five meter (16.4 ft) square surface to explore the virtual car. Alternatively, he or she can sit in the virtual driver’s or front-passenger seat and take in all the visual details of the interior. This latest version of the system allows users to experience the virtual car in a very natural way.

1.2 Audi Customer Private Lounge

Audi customers are trendsetters in the digital world and have high expectations on the brand’s presence. Especially when they want to experience their new Audi to the full with all their senses. Enter the concept of the “Audi Customer Private Lounge”, which the premium brand developed initially for its Audi City sales concept and its future retail operations. In a separate, fully digitalized suite, visitors are able to configure their dream car, view it in almost life-like detail as a virtual model and adapt it to their requirements. This concept unites digital innovation with the expertise and personal attention typically offered by stationary trading methods.

AUDI AG has developed the concept together with international IT partners. For the first time, the dealer is able to present the diversity of the Audi portfolio, with all its technologies and equipment options, and to explain every detail clearly. The Lounge is equipped with a number of specially developed digital features. The high-tech system is controlled using a tablet. This means the salesperson can remain at the customer’s side while he or she configures their dream car.

With the tap of a fingertip, the individual Audi model can be transferred to the Audi VR experience, ready to be explored down to the last detail, be it the stitching on the leather seats or the various Audi lighting technologies.

The Customer Private Lounge provides a space for an in-depth and exclusive brand experience and a quiet environment for personal consultations.
2. Metal 3D printing: from toolmaking to the lunar mission

One excellent example of the Vorsprung that defines the Audi brand is additive manufacturing. In its most challenging form, this manufacturing approach is not just about the technology. It’s also about securing tomorrow’s Vorsprung today. Gathering experiences. Demonstrating expertise. Breaking new ground. At the Audi Summit, the topic of metal 3D printing will be used to demonstrate this aspect of Vorsprung.

3D printers that create objects out of powdered plastic are already firmly established. The next stage in their evolutionary process is the metal 3D printer. Audi is developing this expertise in the newly founded Metal 3D Printing Center at Audi’s production facilities. Here, Audi’s toolmaking and technological development experts manufacture steel and aluminum parts from metal powder using the laser melting process. This process is already being used in series production tools. Individual components for limited production vehicles could, perspectively, also be produced using this method in the years ahead.

In principle, all metals that can be welded are suitable for 3D printing; tool steel as well as aluminum or titanium. The process starts with metal powder with a grain size of 15 to 60 thousandths of a millimeter – as fine as a human hair. The printer deposits the powder in thin layers and the laser then melts it in accordance with the CAD data, to create the contours of the part. By means of metal 3D printing, objects can be produced with freeform highly complex geometries that would be very difficult or impossible to manufacture with other production methods. With the help of 3D printing, you can literally drill around corners.

Typical examples of such applications are steel parts with integral cooling channels or cooling grids of the type used in casting tools. Analyses and tests show that printed parts exhibit the same material properties as conventionally manufactured components. As a result of the complex geometries used, it’s even possible to achieve much greater component rigidity despite the lower weight.

Full steam ahead to the moon

Audi is aiming high with this new technology. As far as the moon, in fact! That’s where they will be taking the self-driving reconnaissance vehicle, the Audi lunar quattro. More than 85 percent of the vehicle is made from printed aluminum.
As part of the “Mission to the Moon”, a team of Berlin-based engineers by the name of the “Part-Time Scientists” aims to explore the moon around a landing site of one of NASA’s Apollo moon missions for the first time in more than 45 years. And Audi is supporting their efforts. A group of 16 Audi experts has been assisting the Part-Time Scientists with expertise in a number of technical fields, including optimizing the rover for the lunar mission.

In order to boost stability and increase the contact surface, the engineers and designers enlarged the rover and its wheels by more than ten centimeters (3.9 in). At the same time, they reduced its weight from more than 38 kilograms (83.8 lb) to under 30 (66.1 lb) by optimizing the material mix and with the aid of aluminum-based 3D printing.

The wheels of the Audi lunar quattro, for example, have a wall thickness of just one millimeter (0.04 in), but thanks to a sophisticated design are guaranteed to have the requisite strength. As a result of the huge weight savings achieved on the wheels as well as elsewhere, the researchers are now able to load the rover with more scientific equipment to the value of 1.8 million euros. The savings will also allow the mission to carry more fuel.

Development engineers were also able to run sophisticated tests, for instance in the Audi sun simulation chamber, to simulate the extreme conditions on the moon and examine the suitability of the rover’s components. An example of prototype development in the form of an original wheel variant of the lunar vehicle is on show at the Audi Summit.

3. Modular assembly:
   no assembly line, just dancing racks

The production of premium-class cars is becoming increasingly complex. This is because new market requirements, customer expectations and legislative frameworks increasingly call for innovative technologies and different vehicle variants. For more than a century, the fixed-interval assembly line was unbeatably efficient. But now, it’s losing this Vorsprung and the linear, fixed working procedure is, in some cases, even becoming part of the problem.

Because customers want differentiation, their cars are becoming more and more individual. As a result, the number of derivatives and variants grows and grows. And as it does so, it becomes more difficult to manage the high levels of complexity and integrate additional workflows into a rigid sequential process. A particularly well-equipped Audi S3 (combined fuel consumption in l/100 km: 7.1 – 6.4* (33.1 – 36.8 US mpg); combined CO₂ emissions in g/km: 163 – 146* (262.3 – 235.0 g/mi)), for example, requires numerous work steps to be carried out in a specific work cycle. While a less complexly equipped model also passes through the work cycle in question but with less added value This takes up space, time and money.

Audi is meeting this challenge and, in Barcelona, is demonstrating a revolutionary solution: modular assembly. Small, separate workstations support highly flexible workflows, both in terms of time and space. Driverless transport systems (DTS) transport the bodies and the required parts between these workstations.
A central computer controls the DTS with pinpoint accuracy; it identifies what each station needs, thereby ensuring a smooth workflow. And there’s one more significant effect: the person no longer has to keep pace with the cycle, as has been the case for a hundred years. The modular production method allows the individual needs of the employees at the various stations to be taken into account. One Vorsprung that will benefit all employees immediately.

For a few months now, “arculus”, a startup company established by an Audi employee, has been developing and testing the key principles of this new production system, working alongside the logistics division. Audi will be assembling electric motors using a modular assembly concept at its plant in Győr, Hungary. Series production is scheduled to start in 2018. There are also plans to implement parts of the modular assembly concept in a pre-assembly area at the Brussels plant.

Audi anticipates that modular production will increase productivity by at least 20 percent compared with today’s production line system.

### 3.1 The paint shop of the future

The present-day paint shop in essence still follows the same logic as assembly line production. The painting process involves the vehicle bodies passing through a fixed production chain structure where the different coats of paint are applied in a highly automated process. In between the individual process steps, the painted bodies also pass through a standardized dryer. In subsequent steps, corrosion protection and body sealing measures are applied. Everything takes place in a closely interlinked production chain. A long, linear route that’s highly efficient and thus as sustainable as it can possibly be. Here too, Audi has already taken major steps forward.

However, in the Smart Factory, the modular assembly process of the future is not about taking steps, but leaps. And this goes for the paint shop too. An animation of the paint shop of the future – demonstrating how the individual Audi will get its color in a highly efficient process – is being shown at the Audi Summit.

To this end, the manufacturer breaks with the chain concept, replacing it with a modular process, including in the various subareas of the painting process. Audi expects these structural changes to increase efficiency in application technology. In addition, special paint processes can be cost-effectively and sustainably integrated, thereby ensuring that the ever-increasing customer demands can also be met in this important area of individualization.
The paint shop of the future is based around a central store of vehicle bodies, alternative dryer concepts and module systems in selected sub-areas. Here too, therefore, every vehicle body can be optimally integrated into the production process according to its individual workload and content; only visiting those stations where work is actually required. Other bodies can skip such stages or move on to other steps.

By implementing a modular structure as part of the Smart Factory, the Audi paint shop of the future, will, among other things, ensure that individual processes – so important for constructing a car in accordance with the customer’s personal preferences – can be optimized to make it both highly efficient and sustainable. The result guarantees not only the highest possible flexibility, but also maximum customer focus. One Vorsprung that will be visible to every customer.

### 3.2 Driverless transport systems

Driverless Transport Systems (DTS) are a core technology of the Smart Factory. This Vorsprung is being demonstrated live at the Audi Summit by means of the Automated Guided Vehicle (AGV). This system is helping to revolutionize conventional production processes. Greater production flexibility also means greater opportunity for developing even more individualization options for the customer.

The AGV from Audi uses an intelligent system for navigation which was designed by the company on the basis of software which was specifically developed for this purpose within the automobile sector. As a result, they are able to bring goods from the store to the assembly line entirely freely and autonomously. They are able to detect complicated traffic situations and respond flexibly. The navigation system allows the AGV to move autonomously on a defined route which has been devised and simulated on the computer beforehand; alternatively, the AGV can learn and store a route during a manually guided run. Based on this map, it then moves freely within its radius. As it does so, it applies the principle of machine learning and constantly seeks the best path.

The Audi AGV – known in-house as “Paula” – has three on-board laser scanners, two at the front and one at the rear. These allow “Paula” to orientate herself and prevent her from colliding with people. The human has priority at all times. One of the front scanners is angled upwards so that it is even able to identify objects suspended from the ceiling.

The sensors are also used to record measurement data. The computer of the AGV then compares this data with the stored map data. At the same time, the navigation software compares the data measurements from the laser scanner with the wheel rotations. This enables even more precise localization.
Speed is limited to 4.2 kilometers per hour (2.6 mph). All braking is anticipatory, gentle and consequently energy efficient; when calculating the braking, the development engineers used similar algorithms to those which Audi used for controlling Adaptive Cruise Control (ACC) in their cars.

With its laser scanners, the AGV recognizes the workpiece trailer from its contours. The AGV drives up to it with millimeter accuracy, even if it is not standing exactly in its predefined position. The same precision is applied when parking over the charging plate. A touch display at the front, an extensive visual signal concept and voice output allow communication and interaction with the surroundings.

At Audi’s Technical Center for Production Assistance Systems, the AGV’s navigation system has now reached the third prototype stage and is close to series production. Like its predecessors, all aspects of “Paula” have been developed entirely in-house by Audi. Even the software is an in-house development. Since March of this year, the AGV is used in series production of the Audi A3/Q2 at the Ingolstadt plant.

DTS technology has huge potential: by networking the navigation data of several individual vehicles with an overarching fleet manager, it is possible to create an intelligent overall system. This will exponentiate the efficiency benefits.

### 3.3 Dancing racks

There is never just one way of achieving tomorrow’s Vorsprung. Once the goal is defined, implementing various working solutions to achieve it is precisely the mark of an innovative company. Proof of this Vorsprung is on show in the grounds of the Barcelona exhibition center where Audi is demonstrating another innovation in the field of Driverless Transport Systems (DTS), namely the so-called “dancing racks”.

The goal is very similar: the Smart Factory aims to increase efficiency and flexibility whilst at the same time allowing the person to set the pace. When it comes to the “dancing racks”, however, how that goal is achieved is very different. That’s because these vehicles have neither sophisticated computer control nor highly sensitive sensors.

This Driverless Transport System is controlled by the “Audi Laser Tracking System” via external sensors. Furthermore, this is the first and only system in which several vehicles positioned one behind the other can be recognized and controlled by one single laser scanner. This is a revolutionary approach. And Audi has already filed a patent application for it.

The invention is ideal for ensuring that parts show up at the right place at the right time. Logistics experts refer to this proficiency as the goods-to-person principle. The parts come to the employee whenever he or she requires them.
In addition, the employee no longer has to gather together the parts required in the “supermarket” and take them to the line workstation. And in any case, there won’t be an assembly line as part of the modular assembly system of the networked Audi Smart Factory, as it will have been dispensed with in line with the final development phase. Just like an A la carte restaurant, every car entering the assembly station puts together its own parts menu. The “dancing racks” then serve this up.

Bundled technology makes it all possible. The laser scanner recognizes each driverless transport vehicle (DTV) using the four 10-centimeter (3.9 in) tall aluminum reflector bars located at each corner. Apart from the bars, nothing else lies in this plane, so the laser beams are able to detect any DTVs located in a row one behind the other. The entire recognition and control process can be done from outside via the laser scanner and a PC. The vehicles receive the corresponding control commands via Wi-Fi.

And because the expensive, complex and heavy technology is not contained in the DTV itself, but solely in the command center, a very compact and energy-saving design can be achieved. However, the system doesn’t make any compromises when it comes to accuracy: the laser scanner ensures that the DTV can be positioned very accurately, to within less than a centimeter (0.4 in) of its target, in fact. Right where the human picker is waiting for his or her part. The “Dancing Rack” can also speak. Via the integral voice output system, it can notify its human partner of its current status – for example that it is approaching its target.

The dancing analogy is not a far-fetched one either: the rack can move in all directions – diagonally, to the left and right, forwards and backwards. It can even turn on the spot. All while interacting with other DTVs in the assembly area. Synchronous control works particularly well with this system as the sensor data is processed centrally.

And because the reflector-covered aluminum bars sometimes get hidden whilst the system is on the move, the recognition algorithm is robust enough to manage even if up to two bars on each vehicle cannot be scanned. The DTV will still find its target.

The system is still undergoing a trial phase. It can already master an operating radius of 18 meters (59.1 ft) with ease. It might even be possible, therefore, for one single scanner to cover a 30-meter-wide (98.4 ft) hall. To increase the range, several scanners can be combined into a sensor network. A later development stage could even see the scanner moving with the racks. This will open up new areas for this technology as no costly installation is required.
3.4 Sitting pretty – without a seat

Vorsprung can also be achieved sitting down: in the German automobile industry, when it comes to ergonomics, Audi is a truly innovative leader. That’s because good ergonomics in the manufacturing environment reduces physical strain, increases the efficiency of the production processes and ensures consistently high product quality. Visitors to the Audi Summit are able to see these benefits in action in the form of the “chairless chair”.

The “chairless chair” is a so-called passive exoskeleton. While working, employees wear it like a second pair of legs which always provide support whenever it’s needed. It is affixed to the back of the legs and, like a chair, improves a person’s posture while carrying out their work. Two seat surfaces support the buttocks and thighs, and the two struts in carbon-fiber-reinforced polymer (CFRP) transfer part of the body weight to the ground. The struts are jointed behind the knee and can be hydraulically adjusted to the person’s body size and the desired seating position.

Thanks to its lightweight construction, the “chairless chair” weighs just 2.4 kilograms (5.3 lb) and thus doesn’t constitute additional strain for the wearer. For many assembly operations, it allows employees to sit in an ergonomically beneficial position instead of standing – even with short working intervals. At the same time, this high-tech supporting structure improves posture and reduces strain on the legs.

The exoskeleton has already been successfully tested by Audi at a number of workstations. Based on the results from the pilot test phase, Audi, together with manufacturer noonee – a Swiss startup – has developed the “chairless chair” further in order to bring it to series production maturity for subsequent widespread introduction as an ergonomic aid. The goal is to improve the ergonomic working conditions of employees, to prevent excessive strain, to avoid illness-related downtime and, in particular, to ensure that older employees or those with a physical disability can be given a valued position in the production process.
4. Smart logistics: wearables and virtual reality training

Whoever is faster achieves *Vorsprung*. Quick action and reaction times should be beneficial to quality and customer-friendliness. In Barcelona, this is demonstrated in the form of four examples from the logistics division.

4.1 Wearable scanner

An innovative scanner glove has replaced conventional barcode scanners at selected workstations in the CKD (Completely Knocked Down) packing area of the international logistics facility in Ingolstadt. The scanner is already integrated into the “ProGlove” as it is called. The employee starts the scanning function simply by pressing their index finger against their thumb. The device in the glove does not need to be focused on the barcode. The scanning function is integrated in the natural hand movement. Optical (LED light), acoustic (buzzer) and tactile (vibration) signals tell the order picker that the item has been scanned.

The scanner communicates wirelessly with the receiver unit. This access point is connected via USB or a conventional serial connection and installation of additional software is not required. The battery charge is designed to last the period of one shift and can be fully recharged within two hours. By having the scanner integrated into the glove, the employee has both hands free to do his or her job. The number of hand movements required is also reduced – employees no longer have to pick up and put down the scanner for instance. It also minimizes walking. The work routine is more ergonomic as a result.

The *Vorsprung* achieved with this ergonomically optimized technology is already being piloted in a number of different areas within the Ingolstadt plant. Meanwhile, in Neckarsulm, the ProGlove is undergoing extensive testing. And Audi employees in Belgium, Hungary and Mexico are also already scanning with just the flick of the hand. Widespread introduction is in sight.

4.2 Virtual reality training

*Vorsprung* doesn’t always have to be a leap. Often, it’s also simply important to make the latest technology available to all employees concerned. And whoever manages to do so to the fullest extent, both practically and quickly, will reap substantial benefits in the global competitive environment. Even in the field of employee training, digital technologies make noteworthy efficiency gains possible.

An excellent example of this can be seen at the Audi Summit: virtual reality training for logistics. Until now, Audi’s logistics employees around the world used to undergo training with real components and containers, which meant these had to be available at the training centers. And that takes up both space and time.
Moreover, there is no training center for CKD Logistics (Completely Knocked Down) in Ingolstadt that can train employees in systems engineering, software and the use thereof. The perfect opportunity, then, for a new approach, a new type of training.

An innovative training concept based on the use of virtual reality headsets which provide all the materials necessary for logistics training in this area. Using the VR headset, the logistics specialists are able to see a previously programmed depiction of their logistics workstation from any location. Virtual images of all the necessary containers and parts are right there in front of them. They are even able to grasp their work tools and move them around. To do so, they operate two controllers by hand; these serve as their hands in the virtual world and they are able to see and move them.

The new technology not only saves time, space and money. It also overcomes distances and language barriers. Because in the future, employees from Logistics will also have the opportunity to train on other facilities worldwide at the same time and with other employees. An employee in the Logistics division in Ingolstadt, for example, will be able to operate virtually at the Mexico plant, and vice versa.

The pilot phase at the training center in Ingolstadt has impressed employees. As a result of this positive feedback, the new technology will now be used for other areas of the company and in plants around the world. Nothing gets in the way of the rapid spread of Vorsprung. The technical equipment required for this can fit into a single suitcase.

4.3 Autonomous forklift trucks at the Logistics Center

Autonomous forklift trucks are also about to go into routine use. At present, container transport at the Logistics Center at Audi in Ingolstadt is carried out with conventional forklift trucks driven by trained employees. Everything is controlled from the driver’s seat – from approaching the high-rack storage to picking up and putting down of transport containers. Autonomously guided forklift trucks will soon be taking over these tasks within the packing operation for the delivery of small parts. These trucks require less space, perform transport tasks more efficiently and reduce the risk of accidents at work. These benefits have been achieved thanks to the interaction between innovative technologies such as a 3D laser scanner for navigation and a number of safety sensors. Scanner and sensors together create a 360-degree safety radius around the forklift truck.

The trial run at Audi consists of several tasks: the autonomous forklift truck has to independently place large-load carriers into a high rack and take them out again. The second part of the test is autonomous delivery of the containers to where they are needed and bringing back surplus content. The large variety of containers presents a huge challenge. The forklift truck detects obstacles on its route with ease and waits until the way is clear before continuing with its transport task. If the autonomous forklift truck detects a problem in its routine, it independently warns the workstations concerned about the type of problem and initiates remedial actions.
4.4 Ray the parking robot

Systematically networked technology, combined with autonomous systems, allow significant efficiency gains to be achieved in the field of transport logistics too. In Ingolstadt, Audi has automated vehicle transportation by rail to a large extent. To this end, “Ray” the electrically powered parking robot sorts up to 2,000 cars per day for loading onto railway wagons.

Ten parking robots currently autonomously transport the new cars from the production facility to the railway loading point. To do this, each of the roughly six meters long by three meters wide (19.7 ft x 9.8 ft) robots, has a system of laser sensors. This measures the position, length and width of a car and adjusts the lifting systems accordingly. The central control system assigns a space to each robot where it can park the pre-sorted vehicle via the shortest route.

Once a sufficient number of cars have been accumulated for the same transport destination, the robots prepare the cars for loading onto the railway wagons. The driverless transport systems complete up to 8,000 movements per day and cover about 500 kilometers (310.7 miles). Ray even keeps an eye on its own charge status: if its batteries are running low, the robot docks itself in a changing station in good time. There, a fully automated battery change station swaps the entire battery unit for another one in the space of just a few minutes.

Ray is an example of Vorsprung from digitally networked technology that works. Outstandingly so, in fact: this driverless transport system has won Audi the 2017 VDA Logistics Award.
Company-wide sustainability

Sustainability is one of the cornerstones of the Audi Strategy 2025. It is becoming an increasingly important issue for the customer and is a political imperative. One element of the corporate philosophy is to minimize environmental pollution and conserve natural resources. At the same time, Audi ensures that materials are processed carefully whilst also maintaining high quality standards. At the Audi Summit, the brand is demonstrating just how attractive the concept of sustainability can be – both in terms of production activities and the products themselves.

1. High tech in the service of efficiency

Drop by drop, gram by gram: Audi has been using high-tech solutions to reduce the fuel consumption of its vehicles for years. The latest innovation is the mild-hybrid technology with which Audi is driving the electrification of its drive systems. In addition, numerous models benefit from quattro with ultra technology and lightweight construction using Audi Space Frame (ASF) technology.

1.1 Versatile: mild-hybrid technology

Audi is pressing ahead with the electrification of its drive systems across a broad front. In mid-2017, the new mild-hybrid drive vehicles (MHEVs) will start joining the product line. The next generation of luxury sedans, the Audi A8, will have them on board – in the 48-volt version – regardless of engine type.

The new technology is suitable for the interplay with either diesel or gasoline engines and can reduce consumption of a V6 gasoline engine by up to 0.7 liters per 100 kilometers (0.2 US gal per 62.1 mi) in real-world driving, for example. Unlike other efficiency technologies within the engine, the MHEV drive systems increase ride comfort, since they allow silent coasting within larger speed ranges of up to 160 km/h (99.4 mph).

Audi offers the MHEV drives in two variants. For the four-cylinder engines, they are based on the familiar 12-volt electrical system. The six-cylinder and eight-cylinder engines, as well as the W12 cylinder units, will receive a new 48-volt system generally serving as the main vehicle electric system. In particular, this technology offers many ways for making driving more efficient, sportier and more comfortable in the future.

At the 2017 Geneva Motor Show the brand presented the potential of its new technologies in the form of the Audi Q8 sport concept show car. Its 48-volt electrical system integrates a further developed MHEV system as well as an electric-powered compressor (EPC).
Together the two components provide a new level of dynamics. The efficiency is also significantly increasing – at low speeds as in parking, the show car can even be driven electrically.

**MHEV: the operating principle**
The mild-hybrid drive from Audi in the new A8 comprises two central components. One is a water-cooled belt alternator starter (BAS) on the front side of the engine. A heavy-duty V-ribbed belt connects it to the crankshaft. The BAS yields a recuperation level up to 12 kW and 60 Nm (44.3 lb-ft) of torque.

The second component is a lithium-ion battery with 10 Ah charge capacity and a constant voltage of 48 volts. In the new large sedan, the newly developed 48-volt power system serves as the main vehicle electrical system. The 12-volt system is connected to the main electrical system via a DC/DC converter. Located in the luggage compartment, the lithium-ion rechargeable battery is about the size of a large lead battery. Controlled air cooling provides the thermal management.

The 48-volt-based MHEV technology is particularly more comfortable and efficient. If the driver takes his/her foot off the accelerator at a speed between 55 and 160 km/h (34.2 to 99.4 mph), the car can coast for up to 40 seconds with the engine off completely. During slow coasting, the start-stop phase already begins at 22 km/h (13.7 mph).

Once the driver accelerates again – whether from a stop or while driving – the vehicle restarts quickly and very comfortably: the BAS revs up the internal combustion engine to the target speed, then injection occurs again and, in the case of a gasoline engine, ignition. While the conventional pinion starter remains on board, it essentially is used only for initial starting, when the engine oil is still cold and viscous.

In many situations, recuperation – recovery of energy during deceleration – is more efficient than coasting. To make this decision, the drive management system in the new Audi A8 uses the front camera and, optionally, data from the predictive efficiency assistant, the route data stored in the navigation system and other data supplied by the highly networked sensor set. The bottom line is that the mild-hybrid drive achieves fuel savings of up to 0.7 liters per 100 kilometers (0.2 US gal per 62.1 mi) in real-world driving (with the V6 TFSI).

Audi also offers the new MHEV technology with the conventional 12-volt electrical system. In this configuration, it interacts with the 2.0 TFSI engine. The functional principle is the same as with 48 volts, although the coasting phases, recuperation output and the CO₂ savings are somewhat smaller.
**Broad base: 48-volt on-board electrical system**

In a different layout – without MHEV functionality – the 48-volt system already entered volume production in 2016 in the Audi SQ7 TDI (combined fuel consumption in l/100 km: 7.6 – 7.2 (30.9 – 32.7 US mpg); combined CO₂ emissions in g/km: 199 – 189* (320.3 – 304.2 g/mi)). In this vehicle, the alternator still operates on a 12-volt basis, and a DC converter couples the 48-volt electrical subsystem. It in turn supplies the electric-powered compressor (EPC) for the V8 diesel as well as the electromechanical active roll stabilization (eARS).

The EPC supports the two turbochargers of the 4.0 TDI engine with up to 7 kW of power whenever they cannot draw enough energy from the exhaust stream. The power is immediately available when the driver accelerates – the experience is particularly impressive when starting off. The eARS is another innovation from Audi. Its centerpiece is an electric motor that uncouples the two halves of the stabilizer when driving straight ahead. The result is excellent ride comfort. During sporty driving along bends, the electric motor turns the stabilizer tubes towards one another, for greater tautness in handling.

Audi is now taking great strides in introducing the 48-volt and MHEV technologies into volume production. In a few years, other Audi model series will also be receiving the new mild hybridization scope. The new architectures allow the realization of even greater power and torque, and innovative features will enable greater fuel savings.

In the medium term, the brand plans to convert ancillary units like pumps and compressors to 48 volts; they will then be able to be more precisely controlled according to requirements, as well as them having a lighter and more compact construction. The same applies to large static convenience consumers such as window heating or sound systems. Small consumers such as control units or lights will remain in the 12-volt system well into the future, however.

**Electrical coasting, powerful boosting: Audi Q8 sport concept**

The brand has demonstrated the great potential of MHEV systems with its Audi Q8 sport concept car, which made its debut at the 2017 Geneva Motor Show. Located between the crankshaft and transmission, the starter alternator outputs 20 kW and 170 Nm (125.4 lb-ft). During deceleration, the powerful MHEV system can recover a high measure of energy and feed it back into the lithium-ion battery. At low speeds, it can drive the sports SUV by itself. Boosting by the internal combustion engine, a 3.0 TFSI, affords a total of up to 700 Nm (516.3 lb-ft).

The 48-volt system of the Audi Q8 sport concept features an electric-powered compressor (EPC) in addition to the integrated starter alternator. It closes the turbo lag and allows for a large and powerful mono twin scroll turbo. With a system output of 350 kW (476 hp), the show car accelerates from zero to 100 km/h (62.1 mph) in 4.7 seconds, and presses ahead to a top speed of 275 km/h (170.9 mph). The MHEV system lowers fuel consumption of the concept car by approximately one liter per 100 kilometers (0.3 US gal per 62.1 mi).

* Figures depend on the tire/wheel sets used and the number of seats
1.2 Permanently available: quattro with ultra technology

quattro drive revolutionized Audi and continues to characterize the brand with the four rings. It was born in the winter of 1976/77 during test drives in the deep snows of Sweden. Audi engineers developed the quattro system as all-wheel drive for sporty cars. The original quattro, the first Audi production model with quattro drive, debuted in 1980. Audi has continuously refined the technology over the decades – from a manually locking center differential to various types of self-locking center differentials. The developers are constantly optimizing these systems for dynamics and traction.

In 2016, the brand brought a trendsetting innovation to its production vehicles: quattro with ultra technology. This optimized all-wheel drive system is particularly efficient because it engages only when required. Despite this, the drive system exhibits no perceptible differences from permanent systems in terms of traction and driving dynamics.

The ultra technology reduces fuel consumption significantly. During test drives in normal traffic, the developers achieved average fuel savings of 0.3 liters per 100 kilometers (0.1 US gal per 62.1 mi) compared with a conventional all-wheel drive system. The conventional system, in turn, consumes roughly 0.5 liters (0.1 US gal) more than a front-wheel drive vehicle. This means that quattro with ultra technology reduces the added consumption associated with all-wheel drive by around 60 percent.

During moderate driving, quattro with ultra technology enjoys all the advantages of front-wheel drive. All-wheel drive remains permanently available however, and is there immediately when needed. The control system for the quattro powertrain is comprehensively networked. It acquires and evaluates data – in ten millisecond cycles – such as the steering angle, transverse and longitudinal acceleration and engine torque.

All-wheel drive is generally activated predictively, i.e. in anticipation of the need for it. For example, the control unit computes the point when the inside front tire will reach the limit of grip during fast cornering. The calculation is made roughly half a second in advance. Shortly before the wheel reaches the calculated traction limit, the all-wheel drive is activated. With reactive activation – which rarely occurs in practice – the system reacts to sudden changes in the coefficient of friction. These changes might occur, for example, when the wheels go from dry asphalt to a sheet of ice. Thanks to the very short switching times, full quattro performance is ensured even in these extreme situations.
The concept with two clutches in the powertrain gives quattro with ultra technology a key efficiency advantage over the competition. When the system changes to front-wheel drive, the front clutch – a multi-plate clutch at the transmission output – disconnects the propshaft. A decoupling clutch also opens in the rear differential. It shuts down the rotating components that cause the most drag losses here, such as the large crown wheel running in the oil bath. Despite the additional components, the quattro with ultra technology is nearly four kilograms (8.8 lb) lighter than the previous system.

The efficiency-optimized all-wheel drive system is currently available for many engine variants of the Audi A4, A5 and Q5. Other models will soon follow. The system can be used in combination with the manual transmission and the S tronic dual-clutch transmission on models with torque values of up to 500 Newton meters (368.8 lb-ft).

In 2016, 44 percent of all customers worldwide chose a quattro drive. It is most popular in the USA, Canada, Russia and the markets in the Middle East. In January 2017, the eight millionth Audi with quattro drive drove off the assembly line – a Q5.

The classic quattro technology is available in all model series, but there are conceptual differences between them. For example, the quattro drive used in the S1 (combined fuel consumption in l/100 km: 7.2 – 7.0* (32.7 – 33.6 US mpg); CO₂ emissions in g/km: 168 – 162* (270.4 – 260.7 g/mi)), Q2, A3, Q3 and TT features a hydraulically actuated, electronically controlled plate clutch on the rear axle. In the Audi R8, the multi-plate clutch is installed on the front axle.

Depending on the engine/transmission variant, models based on the modular longitudinal platform – the Audi A4, A5, Q5, A6, A7, Q7 and A8 – have either quattro drive with a self-locking center differential or quattro with ultra technology. The Audi Q7, A4 allroad quattro and A6 allroad quattro as well as the Audi A8 and R8 (combined fuel consumption in l/100 km: 12.3 – 11.4* (19.1 – 20.6 US mpg); combined CO₂ emissions in g/km: 287 – 272* (461.9 – 437.7 g/mi)), not mention all S and RS models are equipped as standard with the quattro drive system.

* Figures depend on the tire/wheel sets used and/or the transmission/drive variant
1.3 Lightweight construction: a driving force for Audi

The best material in the best place. This is one way of achieving a sustainable advantage that will also benefit the customer. Less weight and greater rigidity improve safety, the efficiency of the car and its sporty performance.

Audi is both a pioneer and a driver of innovation in the field of lightweight construction. The brand with the four rings acquired this worldwide reputation with the first generation of the A8. Vorsprung that has won many enthusiastic followers. The self-supporting aluminum body based on the Audi Space Frame (ASF) has shown off its advantages in truly sustainable fashion. Since 1994 Audi has built and sold more than one million production cars in ASF design. And now this successful technology is about to take a decisive step forward.

The material mix in the new Audi A8

The next generation of the A8 is yet again delivering Vorsprung to its owners thanks to an intelligent mix of four materials: aluminum, steel, magnesium and carbon-fiber-reinforced polymer (CFRP) are taking multi-material construction in the Audi Space Frame to a new level for the next generation of the A8. It’s not just the weight that is optimized by this mix. The torsional rigidity of the A8 surpasses that of its predecessor by up to 24 percent. A key parameter for precise handling and acoustic comfort.

A high-strength combination of CFRP and hot-formed steel components make up the occupant cell. Some of these sheet metal blanks are manufactured in varying thicknesses, while others also undergo partial heat treatment. That reduces weight and increases the strength, especially in areas of the vehicle that are particularly critical for safety.

Aluminum components in the form of cast nodes, extruded profiles and sheets – elements characteristic of the ASF design – make up the biggest share of the new Audi A8 body, at 58 percent. New heat-treated cast alloys attain a tensile strength of over 230 MPa (megapascals) – a much higher figure than previously achieved. Rounding out the intelligent mix of materials is the magnesium strut brace. A comparison with the predecessor model shows that it contributes a 28-percent weight saving.
The carbon rear panel in the new Audi A8
In terms of its overall dimensions, an ultra-high-strength, torsionally rigid rear panel made of CFRP is the largest component in the occupant cell of the new Audi A8, and it contributes 33 percent to the torsional rigidity of the total vehicle. To optimally absorb longitudinal and transverse loads as well as shearing forces, between 6 and 19 fiber layers are placed one on top of another, ensuring a load-optimized layout. These individual fiber layers consist of tapes 50 millimeters (0.2 in) wide and can be placed individually in a finished layered panel, with any desired fiber angle and minimal trimming of the fibers. The innovative direct fiber layering process specially developed for this purpose makes it possible to entirely dispense with the normally required intermediary step of manufacturing entire sheets of carbon fiber. Using another newly developed process, the layered panel is wetted with epoxy resin and cured within minutes.

Laser remote welding of aluminum
High precision work naturally demands new production processes to be adopted. With remote laser welding of aluminum, Audi has developed a new approach and in so doing has gained Vorsprung over other premium automakers. Exact positioning of the laser beam in relation to the welding edge considerably reduces the risk of hot cracking because the heat input can be precisely controlled. The size of the gap between parts being joined can immediately be determined and effectively filled in by means of process control strategies. The laser beam’s high feed rate and low energy use reduce CO₂ emissions by about one quarter. This new process also results in a 95-percent saving on recurring costs in series production because it eliminates the need for the costly process controls required with conventional laser welding.

Ultra lightweight construction in the R8 Spyder
Also seeking to use the best material in the best place is the new R8 Spyder (combined fuel consumption in l/100 km: 12.5 – 11.7* (18.8 – 20.1 US mpg); combined CO₂ emissions in g/km: 292 – 277* (469.9 – 445.8 g/mi). Here, the benefits are threefold: the sports car is lighter, stiffer and faster than its predecessor. Contributing significantly to this is the intelligent mix of materials, which has, of course, been precisely tailored to the peak performance levels of a driving machine which aspires to be an elite athlete.

To this end, the Audi Space Frame has a new multi-material structure with structurally integrated carbon. The entire ASF consequently weighs just 208 kilograms (458.6 lb), with the vehicle as a whole coming in 15 percent lighter than previously (a reduction of around 25 kg (55.1 lb)). Despite this, the engineers have succeeded in increasing the rigidity of the frame by 50 percent. A class-beating achievement. And it shouldn’t be forgotten that this consistent lightweight construction has once more improved driving performance. An output of 540 hp delivers a top speed of 318 km/h (197.6 mph), whilst the 0 to 100 km/h (0 to 62.1 mph) sprint takes just 3.6 seconds. Or put another way: Vorsprung durch lightweight construction.

* Figures depend the transmission/drive variant
2. Audi g-tron models with Audi e-gas:
the energy revolution in the tank

In addition to TFSI and TDI engines, Audi is increasingly banking on alternative drive systems. One focal point here is the g-tron models. They operate on compressed natural gas (CNG) and enable virtually CO2-neutral mobility thanks to the synthesized Audi e-gas.

Sporty, efficient and highly cost-effective: the Audi g-tron models

Audi launched its first natural gas-powered model in 2014 – the A3 Sportback g-tron (CNG consumption in kg/100 km: 3.6 – 3.3*; combined fuel consumption in l/100 km: 5.5 – 5.1* (42.8 – 46.1 US mpg); combined CO2 emissions in g/km (CNG): 98 – 89* (157.7 – 143.2 g/mi); combined CO2 emissions in g/km (gasoline): 128 – 117* (206.0 – 188.3 g/mi)). The compact five-door model features a 1.4 TFSI with an output of 81 kW (110 hp) and 200 Nm (147.5 lb-ft) of torque between 1,500 and 3,500 rpm. The compact engine sets standards with respect to efficiency and fuel economy. When equipped with the optional S tronic, the bivalent A3 Sportback boasts NEDC (New European Driving Cycle) fuel economy of just 3.3 kilograms CNG per 100 km (5.1 liters (1.3 US gal) gasoline), corresponding to emissions of 89 grams CO2 per kilometer (143.2 g/mi) and 117 grams CO2 (188.3 g/mi) in gasoline mode. Fuel costs for CNG are less than four euros per 100 kilometers (as of: May 2017).

The two tanks in the A3 Sportback g-tron (CNG consumption in kg/100 km: 3.6 – 3.3*; combined fuel consumption in l/100 km: 5.5 – 5.1* (42.8 – 46.1 US mpg); combined CO2 emissions in g/km (CNG): 98 – 89* (157.7 – 143.2 g/mi); combined CO2 emissions in g/km (gasoline): 128 – 117* (206.0 – 188.3 g/mi)) are located under the luggage compartment floor and each store around 7 kilograms (15.4 lb) of gas at a maximum pressure of 200 bar. They reduce luggage space only marginally and are constructed from a composite material, making them very lightweight.

Range with gas in the NEDC is more than 400 kilometers (248.5 mi). The 50-liter (13.2 US gal) fuel tank adds an additional 900 kilometers (559.2 mi). The car switches from one operating mode to the other automatically without the driver having to intervene. The instrument cluster separately displays the residual ranges in both modes.

In late summer 2017, the A4 Avant g-tron (CNG consumption in kg/100 km: 4.4 – 3.8*; combined fuel consumption in l/100 km: 6.5 – 5.5* (36.2 – 42.8 US mpg); combined CO2 emissions in g/km (CNG): 117 – 102* (188.3 – 164.2 g/mi); combined CO2 emissions in g/km (gasoline): 147 – 126* (236.6 – 202.8 g/mi)) and the A5 Sportback g-tron (CNG consumption in kg/100 km: 4.3 – 3.8*; combined fuel consumption in l/100 km: 6.4 – 5.6* (36.8 – 42.0 US mpg); combined CO2 emissions in g/km (CNG): 115 – 102* (185.1 – 164.2 g/mi); combined CO2 emissions in g/km (gasoline): 144 – 126* (231.7 – 202.8 g/mi)) will extend the natural gas lineup. Both models are driven by a 2.0 TFSI engine with the highly efficient “B cycle” combustion process developed by Audi.

* Figures depend on the tires/wheel sets used
The pistons and valves have been specially modified for gas operation and allow for an optimal compression ratio. The turbo engine adapted for CNG operation produces 125 kW (170 hp). Its maximum torque of 270 Newton meters (199.1 lb-ft) is available at 1,650 rpm. An electronic controller reduces the high pressure of the gas flowing from the tank from as much as 200 bar to a working pressure of 5 to 10 bar in the engine. This operation is performed dynamically and precisely in response to the power requested by the driver. The correct pressure is always present in the gas line and at the injector valves – low pressure for efficient driving in the lower speed range, and higher pressure for more power and torque.

Altogether, Audi engineers have achieved unparalleled efficiency in CNG engines through these measures. In the NEDC, the Audi A4 Avant g-tron with optional S tronic consumes just 3.8 kilograms CNG per 100 kilometers, corresponding to CO₂ emissions of 102 grams per kilometer (164.2 g/mi). In gasoline mode, these figures are 5.5 liters per 100 kilometers (42.8 US mpg) and 126 grams of CO₂ per kilometer (202.8 g/mi). The figures for the A5 Sportback g-tron with S tronic are identical in CNG mode. In gasoline mode, it consumes 5.6 liters per 100 kilometers (42.0 US mpg) and emits 126 grams of CO₂ per kilometer (202.8 g/mi). Both models accelerate from 0 to 100 km/h (62.1 mph) in 8.4 seconds. The A4 Avant g-tron reaches a top speed of 221 km/h (137.3 mph), the A5 Sportback g-tron 224 km/h (139.2 mph).

With a tank capacity (at 15 degrees Celsius) of 19 kilograms, both g-tron models have a range of up to 500 kilometers (310.7 mi). When the pressure in the tank falls to less than 10 bar with about 0.6 kilograms remaining, the engine management automatically switches to gasoline operation. The two mid-size models can cover an additional 450 kilometers (279.6 mi) in this mode. The filler necks for gas and gasoline are located together under the tank flap.

Two indicators inform the driver about the fill levels of the tanks. The driver information system shows the fuel consumption in the active operating mode. After refueling, the engine is first started with gasoline in order to analyze the gas quality. The same is true in extremely cold conditions. It then changes as quickly as possible to gas mode. Switching takes only a few tenths of a second and is virtually imperceptible.

The four cylindrical CNG tanks are mounted as a compact module in the rear of the car. They are optimized for the available space, and each is specifically sized. Sheet steel shells with tensioning straps hold the cylinders and protect them against damage, such as curbs. The complete CNG tank module, which also includes the 25 liter (6.6 US gal) gasoline tank, is installed during production of the g-tron models. The spare wheel well has been eliminated. The battery has also moved from the luggage compartment to the engine compartment. The loading floor is level with the loading lip, thus offering a full-fledged luggage compartment.
The CNG tanks follow the Audi lightweight construction philosophy. Thanks to their innovative layout, they weigh 56 percent less than comparable steel cylinders. Their inner layer is a gas-tight matrix of polyamide. The second layer, a composite winding of carbon-fiber-reinforced polymer (CFRP) and glass-fiber-reinforced polymer (GFRP), provides maximum strength. The third layer is pure GFRP and serves primarily as a visual inspection aid, turning milky white where damaged. Audi experts test each tank at 300 bar during production before it is installed in a car. The actual bursting pressure is much higher still and far exceeds the legal requirements.

**Virtually carbon-neutral driving: Audi e-gas**

Compared with gasoline, combustion of natural gas emits 25 percent less CO₂ due to the lowest carbon content of all hydrocarbons. In addition, particulate emissions remain very low. For an even better energy balance, Audi produces sustainable Audi e-gas, which is virtually identical chemically to high-quality natural gas. When operating with this synthetic gas, the g-tron-fleet is virtually carbon-neutral according to the well-to-wheel analysis (from fuel source to the wheel). The CO₂ balance sheet is lower by 80 percent relative to a comparable gasoline model**.

The fuel is produced from water and carbon dioxide with green electricity or from recyclable materials, such as straw and green waste. Production is petroleum-independent and does not compete with food production. With Audi e-gas, a g-tron model emits only as much CO₂ from its exhaust pipes as was bound during production of the fuel.

Audi offers this fuel for three years as a standard feature to customers ordering a g-tron model by May 31, 2018. Customers can fill up their g-tron model at any CNG filling station and pay the regular price. By feeding the volume of Audi e-gas consumed according to the NEDC into the European natural gas grid, Audi ensures the green benefits of the program, including the corresponding reduction in CO₂ emissions. This occurs automatically on the basis of surveys and service data from the cars. TÜV Süd, a German testing and certification authority, monitors and certifies the process. Audi g-tron customers receive a document that confirms their car will be supplied with Audi e-gas and informs them about the certification.

Audi obtains the e-gas from its own power-to-gas facility in Werlte in Lower Saxony (Emsland), among other places. In operation since 2013, the plant produces up to 1,000 tons of e-gas per year. Absorbing up to 2,800 tons of CO₂ in the process. This quantity enables around 1,500 Audi g-tron models to drive 15,000 kilometers (9,320.6 mi) each year virtually CO₂-neutrally.

**In pure gas mode (CNG) with a well-to-wheel analysis (a life cycle assessment that includes fuel production and normal driving of the automobile), in comparison with an equivalent model in the same performance class with a conventional gasoline engine**
The Audi e-gas plant produces the renewable fuel in two steps – electrolysis and methanation. In the first step, the plant uses renewably generated electricity to split water into oxygen and hydrogen. In the medium term, the latter can also serve as a fuel for fuel cell cars. The absence of any universal hydrogen infrastructure at present means that the focus today lies on the second process step: the hydrogen reacts with CO2 from the exhaust stream of an adjacent waste-fed biogas plant. The result is synthetic methane – Audi e-gas.

**Potential: expansion of the CNG grid and new production methods**

The Audi e-gas plant in Werlte demonstrates just how well the power-to-gas concept – the conversion of electricity into fuel – works. Power-to-gas plants allow storage of surplus renewable energy, thereby making a valuable contribution to the energy transition. At the same time, the Audi e-gas plant helps stabilize the power grid at high feed-in rates of renewable energy. This makes Audi technology both a part and a driver of the energy revolution.

In view of the growing g-tron fleet, Audi is expanding its e-gas capacities through new cooperative arrangements. Our partners are the Thüga Group and Viessmann GmbH. The latter is working on a biological rather than chemical methanation process. Audi also obtains methane from certified residual material biogas plants that meet strict sustainability criteria.

In early 2017, the Volkswagen Group, filling station operators and gas networks committed to expanding CNG mobility in a joint memorandum of understanding. The goal is, together with other automakers, to expand the CNG fleet in Germany tenfold to one million units by 2025. At the same time, the filling station network in the Germany is to be expanded from currently 900 to 2,000 locations by 2025. In other European countries, too, the consortium intends to press ahead with the expansion in compliance with the requirements of EU Directive 2014/94 (deployment of alternative fuels infrastructure).

Besides the e-gas project, Audi is conducting research on other sustainable fuels: the Audi e-fuels. Audi e-diesel, Audi “e-benzin” (e-gasoline) and Audi e-ethanol are also synthetic fuels of the latest generation. In the case of all these fuels, their production absorbs the quantity of CO₂ emitted by the car during operation – the carbon dioxide is recycled. The driving force in the production of e-fuels is renewable energy.
3. Environmentally friendly, sporty, practical – electric mobility at Audi

The car of the future is emission-free and does not burn fossil fuels. It is sporty, efficient and suitable for everyday use. Audi has taken an important step toward purely electric mobility with its plug-in hybrids. The Audi A3 Sportback e-tron (combined fuel consumption in l/100 km: 1.8 – 1.6* (130.7 – 147.0 US mpg); combined energy consumption in kWh/100 km: 12.0 – 11.4*; combined CO₂ emissions in g/km: 40 – 36* g/km (64.4 – 57.9 g/mi)) and the Audi Q7 e-tron 3.0 TDI quattro (combined fuel consumption in l/100 km: 1.9 – 1.8* (123.8 – 130.7 US mpg); combined energy consumption in kWh/100 km: 19.0 – 18.1*; combined CO₂ emissions in g/km: 50 – 48* g/km (80.5 – 77.2 g/mi)) combine the electric drive with efficient combustion engines. Thanks to the development of battery cells with a higher energy density and thus greater range, Audi will achieve the next milestone in 2018: all-electric driving in volume production models.

The sporty Audi e-tron SUV (This vehicle is not yet available on the market. It does not yet have type approval and is therefore not subject to Directive 1999/94/EC.) will kick things off. It offers the space and comfort of a typical Audi full-size vehicle and a range of over 500 kilometers (310.7 mi). This will be followed in 2019 by a four-door Gran Turismo – the production version of the Audi e-tron Sportback concept, which the premium manufacturer presented at Auto Shanghai 2017. Audi will expand its electric range to include a compact model one year after that. In 2020, customers will therefore be able to choose from three all-electric vehicles from the brand with the four rings. From 2021, all core model series are to be electrified, including mild-hybrid technology. Taking planned volume growth into consideration, one-third of all Audi models will drive exclusively on electricity in 2025. Two-thirds will be partly electrified combustion engine vehicles.

From combustion engine to electric drive: plug-in hybrid as bridge technology

Audi has been developing models with all-electric or hybrid drive since the late 1980s. The first production offering of a car combining a combustion engine with an electric motor was the Audi duo from 1997, which occupied the body of an Audi A4 Avant. A landmark technological development for electric cars was the Audi R8 e-tron, which was unveiled at the 2009 Frankfurt Motor Show and in 2012 set a record lap time for an electric car on the Nordschleife of the Nürburgring.

* Figures depend on the tires/wheel sets used
Since 2014 Audi has offered the 150 kW (204 hp) A3 Sportback e-tron (combined fuel consumption in l/100 km: 1.8 – 1.6* (130.7 – 147.0 US mpg); combined energy consumption in kWh/100 km: 12.0 – 11.4*; combined CO₂ emissions in g/km: 40 – 36* (64.4 – 57.9 g/mi)), which is both the first Audi plug-in hybrid as well as the first PHEV (plug-in electric vehicle) in the premium compact segment. A 1.4 TFSI is paired with a powerful electric motor for a system output of 150 kW (204 hp). A separating clutch controls the interplay between engine, motor and six-speed S tronic. The lithium-ion battery can be recharged via recuperation and using a cable. It provides 8.8 kWh of energy, enough for an all-electric range of up to 50 kilometers (31.1 mi).

2016 saw the debut of the Audi Q7 e-tron (combined fuel consumption in l/100 km: 1.9 – 1.8* (123.8 – 130.7 US mpg); combined energy consumption in kWh/100 km: 19.0 – 18.1*; combined CO₂ emissions in g/km: 50 – 48* (80.5 – 77.2 g/mi)). Powered by the combination of a 3.0 TDI engine and an electric motor, system output is 275 kW (373 hp) and 700 Nm (516.3 lb-ft) of torque. It accelerates from a standing start to 100 km/h (62.1 mph) in 6.2 seconds and is particularly efficient. Its battery has a capacity of 17.3 kWh. The Q7 e-tron thus has an all-electric range of up to 56 kilometers (34.8 mi) while producing zero local emissions. It is the world’s first plug-in hybrid with a V6 diesel engine and quattro drive. Like the A3 Sportback e-tron, the luxury SUV consumes on average less than two liters of fuel per 100 kilometers (117.6 US mpg). It uses a highly efficient heat pump for the thermal management of the drive and the interior.

The Audi A8 L e-tron quattro (This vehicle is not yet available on the market. It does not yet have type approval and is therefore not subject to Directive 1999/94/EC.) sees a plug-in hybrid model joining the new A8 model series line-up next year. Its 3.0 TFSI and the electric motor, which is integrated into the eight-speed tiptronic together with the separating clutch, generates 330 kW (449 hp) of system power and 700 Nm (516.3 lb-ft) of system torque. The lithium-ion battery stores 14.1 kWh of energy. The big sedan can cover roughly 50 kilometers (31.1 mi) solely on electric power.

From 2018: all-electric driving in volume models

Audi is launching its first all-electric production model next year. The brand presented its precursor, the Audi e-tron quattro concept, at the IAA 2015. As an SUV with a completely new design, the new Audi e-tron (This vehicle is not yet available on the market. It does not yet have type approval and is therefore not subject to Directive 1999/94/EC.) delivers a range of more than 500 kilometers (310.7 mi) despite offering the space and comfort levels of a typical full-size Audi model. This gives customers the freedom to continue driving in the future without having to change their habits.

* Figures depend on the tires/wheel sets used
The concept car is equipped with three electric motors producing a peak output of 370 kW and more than 800 Nm (590.0 lb-ft) of torque. The flexible management system enables electric quattro drive and electric torque distribution for high dynamics and stability. The large lithium-ion battery stores 95 kWh of energy and is mounted at the ideal center of gravity below the occupant cell. The Audi e-tron quattro concept sprints from 0 to 100 km/h (62.1 mph) in just 4.6 seconds. This is on the level of a high-performance sports car.

The production model of the electric-powered SUV will be produced at the Brussels site, where Audi is also building its own battery production facility. The Audi e-tron marks the dawn of a new era for the manufacturer. In 2020 the manufacturer will have three all-electric vehicles in its range, with a four-door Gran Turismo – the production version of the Audi e-tron Sportback concept – and a model in the compact segment joining the sporty SUV.

**Convenient charging solutions: for home and on the move**

Convenient and rapid charging is essential for the success of electric mobility. In 2018, Audi will already be equipping the A8 L e-tron quattro and the Audi e-tron (Both vehicles are not yet available on the market. They do not yet have type approval and are therefore not subject to Directive 1999/94/EC.) with a new technology as standard: Audi Wireless Charging (AWC) which enables inductive charging using alternating current. An inductive charging station with integral coil is placed on the floor where the car is to be parked, and connected to the power supply. Once the driver positions his/her e-tron model over the plate with the help of the MMI display, charging with roughly 3.6 kW begins automatically.

The alternating magnetic field induces an alternating voltage in the secondary coil fitted in the floor of the car, across the air gap. The integrated electronics convert the alternating current to direct current and feed it into the high-voltage electrical system. AWC technology is ideal for the garage or office parking lot. It is also suitable for outdoor use and can be bolted into the ground to prevent theft.

Alternatively, customers can charge their car’s battery at home via cable, for which Audi offers a convenient wall-mounted holder. A 7.2 kW industrial outlet can fully charge the A8 L e-tron quattro in roughly two hours. The all-electric Audi e-tron, whose charging cable supports a power of 11 kW, can be fully charged overnight. Total range on a fully charged battery is more than 500 kilometers (310.7 mi). The driver starts the charging process conveniently from the MMI system. Charging can also be started remotely using the driver’s smartphone and the my Audi Remote app, which also allows the programming of charging timers.
Whilst on the move, the drivers of all-electric cars can charge their vehicles using direct current – the higher the power, the faster the charging. Together with the BMW Group, Daimler AG and the Ford Motor Company, the Volkswagen Group with Audi and Porsche wants to establish the highest-performance charging network in Europe. Plans call for 400 stations with multiple chargers to be in installed along highways and freeways by 2020. Each charger will deliver up to 350 kW of power to provide true suitability for long-distance mobility.

**Racing as a development lab: Audi in the Formula E**

Racing is the toughest development lab and test bed for series production, and electricity is powering Audi’s race for the future through the company’s involvement in Formula E. In the current season, the motorsports division assists the ABT Schaeffler Audi Sport team. Audi is planning to enter a full factory team for the 2017/2018 season in order to gather additional experience with batteries, electric motors and power electronics under extreme conditions.

**4. CO₂-neutral plant in Brussels: clean cars from a clean factory**

More and more people are making their consumer choices based on sustainability. Audi has taken this core strategic concept of the premium brand one critical step further: the company takes a holistic approach to its product range. Anyone wishing to achieve genuine Vorsprung where sustainability is concerned needs to consider not just the product itself and its environmental footprint, but must instead start much earlier in the process. The Brussels plant is playing a pioneering role in this regard.

The Brussels plant is where the first electric car of the Audi brand is being manufactured. A car such as this calls for sustainable value creation. Audi therefore plans to make the energy supply for the Audi e-tron plant CO₂-neutral in the coming years. As at all other plants, a task such as this starts with a stock-taking exercise. Audi knows its own CO₂ footprint very precisely and has it certified independently. It is anticipated that the Brussels plant, for example, will emit around 30,000 tonnes of CO₂ in 2018. 97 percent of those emissions will originate from burning natural gas for heating, while the rest will come from the fuel consumption of company vehicles, heating oil and the burning of solvents.

Compared with its industry peers, Brussels is already an exceptionally green site. Audi gets all its electricity for the plant from renewable sources. There is also an on-going program of new energy management measures. These include, for example, a heat pump in the paint pre-treatment area, a cogeneration system for electricity and energy-saving LED lighting in all production halls. The next stage is the procurement of green gas in order to reduce emissions. As a result, the site will be CO₂-neutral from January 2018; this applies to both Scope 1 and Scope 2 emissions, as defined in the official Greenhouse Gas Protocol.
Any remaining emissions will be balanced out by compensation projects at other locations. The CO2 footprint of the Brussels plant will therefore be practically invisible, and this, of course, has been confirmed by independent certifying bodies. Or to put it simply: clean cars from a clean factory. That’s Vorsprung.

5. Key technology for the future: the fuel cell

Hydrogen as an energy source is the next big step on Audi’s electrification roadmap. With weight advantages and attractive system costs, the fuel cell is an alternative to high-voltage batteries, particularly for larger electric vehicles. Models with this technology have a long range and can be refueled in just a few minutes. Customers therefore don’t have to make any adjustments when switching from a combustion engine to a fuel cell.

Audi has the leading role at the Volkswagen Group for the development of this technology. The Neckarsulm site is the competence center for hydrogen and fuel cell research, one of the key technologies in the development of future drive systems. The brand with the four rings is currently expanding the site to include production and pre-production development.

The course has also been set with respect to infrastructure: filling station operators, vehicle manufacturers and the public sector have joined forces to establish a broad network of national and international funding programs to ensure the efficient use of resources. According to this group, the infrastructure required for large-scale series production in international markets will also be in place in 2025. Plans call for roughly 1,000 hydrogen filling stations in Germany by 2030 – enough for sufficient country-wide coverage.

Trendsetting: concept cars and technology demonstrators

Audi has been working on fuel cell concepts for more than ten years now. The first test vehicle, the compact A2H₂, was produced in 2004. It had a 110 kW electric motor, and a nickel-metal hydride battery served as a buffer. The Audi Q5 HFC (Hybrid Fuel Cell) followed in 2009. Its fuel cell had an output of 90 kW and was supported by a compact lithium-ion battery. Later Audi models with fuel cell technology bear the moniker “h-tron,” with the “h” standing for the element hydrogen. The company is using these vehicles to demonstrate its mastery of fuel cell technology – precisely as one would expect from the brand: sporty, emotional, efficient and clean.

A7 Sportback h-tron quattro

Audi presented the A7 Sportback h-tron quattro at the 2014 Los Angeles Auto Show. International automotive journalists were able to experience the technology demonstrator for themselves on public roads.
It uses a powerful, sporty electric drive system with a fuel cell as the energy source combined with a hybrid battery and an additional electric motor at the rear of the car. Its drive configuration makes the emission-free Audi A7 Sportback h-tron quattro a quattro through and through, with 170 kilowatts of power at its disposal. There is no mechanical connection between the front and rear axles. As an e-quattro, the big coupe features fully electronic management of torque distribution. With 540 Nm (398.3 lb-ft) of torque, it sprints from 0 to 100 km/h (62.1 mph) in 7.9 seconds on its way to top speed 180 km/h (111.8 mph). In fuel cell mode, the A7 Sportback h-tron quattro needs only about one kilogram (2.2 lb) of hydrogen to cover 100 kilometers (62.1 mi) – an amount containing as much energy as 3.7 liters (1.0 US gal) of gasoline.

The four hydrogen tanks of the A7 Sportback h-tron quattro are located beneath the floor of the trunk, in front of the rear axle and in the center tunnel. An outer skin made from carbon-fiber-reinforced polymer (CFRP) encases the inner aluminum shell. The tanks can store around five kilograms (11.0 lb) of hydrogen at a pressure of 700 bar – sufficient for a range of over 500 kilometers (310.7 mi).

Like a car with combustion engine, refueling takes no more than around three minutes. The range is boosted by up to 50 kilometers (31.1 mi) by a battery with a capacity of 8.8 kilowatt-hours, which is recharged by recuperation or alternatively from a power socket. As a plug-in hybrid, the A7 Sportback h-tron quattro thus has crucial extra range in reserve.

**Audi h-tron quattro concept**

The basic concept of the A7 Sportback h-tron quattro is similar to that of the Audi h-tron quattro concept. Audi presented this model at the 2016 North American International Auto Show in Detroit. Its fuel cell, or stack, is located in the front of the car. Comprising 330 individual cells, it has a peak output of 110 kW. With an efficiency rating in excess of 60 percent, it easily surpasses any combustion engine. At a pressure of 700 bar, the three tanks store enough hydrogen for a range of up to 600 kilometers (372.8 mi). It takes only around four minutes to completely refuel.

Mounted under the vehicle floor is a compact lithium-ion battery weighing less than 60 kilograms (132.3 lb). It provides as much as 100 kW of additional power when accelerating and stores energy when braking. With 550 Nm (405.7 lb-ft) of system torque, the Audi h-tron quattro concept sprints from zero to 100 km/h (62.1 mph) in less than seven seconds. Top speed is governed at 200 km/h (124.3 mph).

The power from the fuel cell and the high-voltage battery drives two electric motors – the first is located on the front axle and delivers an output of 90 kW, while the other is positioned at the rear axle and supplies 140 kW. This concept makes the technology study an electrified quattro. An intelligent management system controls the interplay between them as appropriate for the situation, placing maximum emphasis on efficiency. A heat pump for the interior air conditioning and a large solar roof that generates up to 320 watts, equivalent to adding up to 1,000 kilometers (621.4 mi) to the range annually, also boost efficiency.
In the NEDC, the concept car uses around one kilogram of hydrogen per 100 kilometers (2.2 lb per 62.1 mi), corresponding to the energy contained in 3.7 liters (1.0 US gal) of gasoline.

Hydrogen from Audi: global emission-free driving

The two h-tron technology demonstrators from Audi can drive emission-free not just locally, but also globally. This pre-supposes that the hydrogen in the tanks is produced using green, i.e. renewably generated electricity, such as is the case at the Audi e-gas plant in Emsland. The world’s first industrial power-to-gas plant in Werlte, Lower Saxony, began operation in 2013. It uses electricity generated with wind power to produce hydrogen via electrolysis. This process breaks down water into oxygen and hydrogen. The hydrogen is currently used in a second process step to produce Audi e-gas, a synthetic methane for the Audi g-tron models. In the future, however, the hydrogen can be used directly as fuel for fuel cell vehicles. Audi will launch the first production h-tron in the first half of the next decade.

6. CO₂ capturing: clear air bubbling with added value

Sustainability is only a token gesture if it’s not thought through to the end. Vorsprung means looking at the entire chain “from well to wheel”. Audi sets the benchmark in this regard. And at the Barcelona Summit, visitors can even taste the results. A new technology captures CO₂ from the air. The carbon dioxide collected in this way can be used to turn fresh water into sparkling water. A closed-cycle process that benefits the environment.

Audi has developed the technology together with Swiss start-up company Climeworks. Using a new type of filter material, the climate-harming gas can be chemically bound to the filter’s surface. Once the filter is sufficiently saturated, the CO₂ is released back out of the filter by heating it to 90 degrees C. The CO₂ can then be re-used to benefit the environment. Under Audi’s mentoring, a cooperative venture has been set-up between Climeworks and a partner of the beverage industry to add CO₂ captured directly on site to the drinks manufacturer’s bottles. As a result, the CO₂ no longer has to be delivered in cylinders, thereby cutting the number of transport movements considerably. A double bonus for the environment.

For Audi, CO₂ capturing has even greater long-term prospects: CO₂ and water, combined with renewable energy, can be used to manufacture synthetic fuels such as gasoline and diesel. This process can also be used to convert renewable energies into liquid fuels and store them. Together with partners sunfire and Climeworks, the brand with the four rings is already operating a pilot plant near Dresden which is manufacturing synthetic diesel from carbon dioxide, water and renewable electricity. At an efficiency of between 65 and 70 percent, around 160 liters (42.3 US gal) of Blue Crude can be manufactured per day. Nearly 80 percent of that can be converted into synthetic diesel. Audi e-diesel is free of sulfur and aromatics. It also has a high cetane number, which means that it ignites very easily.
7. Audi Environmental Foundation: pushing the boundaries with greenovations

More. This small word is often used to define what Vorsprung is all about. It means delivering more than what the customer, employee, society or the environment expects. An example of this is the not-for-profit Audi Environmental Foundation. AUDI AG founded it in order to commit itself on a voluntary basis to more than just the legally stipulated regulations, and to look at combining environment and technology with one another. In Barcelona, the Foundation will be showing its origins and its aims. It also benefits from the unique innovative potential of the premium brand. Engineering concepts have evolved into genuine greenovations which are helping us to comprehend and protect the very basis of our existence.

7.1 Smart HOBOS – the high-tech beehive
The Smart HOBOS high-tech beehive at Audi’s production site in Münchsmünster is a research station run jointly with the University of Würzburg. Cutting-edge technologies provide novel insights into the honey bee superorganism to anyone anywhere in the world, 24 hours a day.

Enthusiasts and scientists can observe the 20,000 honey bees in the hive via live stream at www.hobos.de (HOneyBee Online Studies). A 360-degree pivoting robot arm has also been installed inside the hive. This is fitted with an infrared and thermal imaging camera and a 3D sensor to record activities in and around the hive 24 hours a day. Thermographic images provide new perspectives of individual bees and the whole colony without disturbing the insects. The latest technology is also being used to document the effects of external factors such as air humidity, temperature and light incidence, providing a valuable insight into bee behavior.

7.2 The megacities experiment
The Audi Environmental Foundation has already planted more than 100,000 trees. There’s a scientific background to this green initiative which is enormously important, both for the environment and society, particularly in the light of increasing urbanization. An international research project is studying the plantations to examine the interaction between stocking density on the one hand and CO₂ absorption potential and biological diversity on the other. The objective is to establish how best to plant trees in order to achieve the greatest possible absorption of carbon and the best conditions for wide-ranging biodiversity. The oak is among the most suitable tree species because, as mature trees, they store a large quantity of carbon and also provide good conditions for biodiversity. Oaks are also especially robust when it comes to the changing demands of the future climate.
To this end, in megacities in different climate regions around the world, trees along measuring routes extending from the city center to the outskirts are being analyzed for their growth. Megacities were chosen because it is here where the urban climate effect is most obvious, and differences between the heavily built-up city center and the less densely developed peripheries are most pronounced. It also makes it possible to compare tree growth at test sites with different climates. The relationship between environmental conditions and tree growth will help to reveal how tree growth is likely to respond to climate change. Growth ring analyses, structural analyses, state-of-the-art scanning techniques and isotope analyses are used in the investigation.

The results of the project will be hugely relevant for both science and future practice. They will contribute significantly to research into climate change and forest growth and will help to develop suitable adaptation strategies for forests in the changing climatic conditions. *Vorsprung* for the environment, so to speak.

The project is unique in terms of the trees being investigated and variety of project sites. As the sites are spread throughout the world, it has been possible not only to discover more about tree growth in urban areas in different climate zones but also to analyze different growth conditions and factors influencing tree growth.

The project is being run by the Institute for Forest Growth Research at the Technical University of Munich.
New premium mobility for urban reality

Today, more than 75 percent of Germans live in towns. The worldwide trend is similar. Many regions of the world are seeing the emergence of more and more megacities with populations of more than ten million. In the long term, individual mobility will only be a viable prospect by working together with the cities and as part of an urban eco-system.

For some time now, Audi has been researching and developing concepts for comprehensive mobility in the networked Smart City. As part of the Audi Urban Future Award, the company has already tested such concepts in various megacities around the world. Thus when it comes to integrating individual premium mobility into an urban landscape, Audi is able to find the ideal solution which offers residents a better quality of life.

The Audi Summit is showcasing intelligent concepts and technologies that, in tomorrow’s Smart Cities, will help to make better use of scarce resources such as time, space and air. In so doing, life in the city will be sustainably improved.

1 myAudi app: Vorsprung durch smartphone at the market launch of the A8

The modern automobile has long since been regarded as the “Ultimate Mobile Device”. Just as the smartphone took the original concept of wireless telephony to a revolutionary new level, digital networking with the environment is opening up a new world of services for the customer in the high-performance “auto-mobile” computer. And these services have long since extended far beyond operation of the vehicle itself.

With myAudi, Audi is working on a new digital eco-system for its customers. In future, this will enable the customer to use an intuitive interface to book, manage and use all of the digital services offered by Audi. At the Audi Summit, the company is showcasing its new myAudi app which will enable customers to seamlessly integrate their world into tomorrow’s mobility. It saves the premium segment customer time, time that they can then spend on living life to the full.

The new myAudi app will debut with the launch of the new Audi A8. An update for other users of the previous Audi apps “MMI connect” and “myAudi mobile assistant” will be available from Google Playstore and iTunes. As a result, all users throughout the world are upgraded to the same technical level and are able to get all the appropriate services on their smartphone, depending on the vehicle model.
Existing users of the previous apps do not need to re-register with myAudi. New customers register and, from their smartphone, are then able to manage the individual connect services of their choice, as well as book service appointments and get information about their car. This requires that the relevant vehicle identification number be stored in the system. In future, the content will also be available on PCs via a web interface and will be optimized so that the customer is able to use the different functionalities wherever it is easiest and most sensible to use them – functions directly relating to the vehicle, for example, will be predominantly used via the smartphone.

Remote functions include, for example, piloted parking, locking and unlocking of the car, checking where the car is parked and calling up the vehicle status. The status report includes information that the customer can have displayed via smartphone about the opened/closed state of windows and unlocked/locked state of doors, remaining range, fuel level and oil level. The app can also be used to conveniently program the optional auxiliary heating function.

In e-tron models, the current charge level and remaining electric driving range can be called up using the app. The driver can activate the charging process and climate control remotely – including at specific times with user-configurable timers. Information on recent journeys and average electrical energy consumption, for instance, is still available to the driver at all times.

Where navigation is concerned, the myAudi app offers a very wide range of possible uses and, with the new myAudi navigation function, caters for all the user’s navigation needs. Firstly, all the user’s vehicles that have been added are displayed on a map. After the user selects a vehicle, the First Mile Navigation function guides him or her to where their Audi is located. At that point, the active route guidance function of the myAudi app is transferred to the vehicle, from where it can seamlessly continue doing its job. At the end of the journey, when the user leaves the vehicle, the Last Mile Navigation function of the myAudi app takes over to guide the user along the rest of the route to their final destination. The customer can also run a dealer search on the app to find their Audi Partner of choice.

The myAudi app is now even better able to assist with demystifying and simplifying the complex world of urban mobility and saving the customer time. Over the coming years, many more new related services will be added which will also integrate the world outside the car into the technical infrastructure of the Audi.

These new services will also be available for existing customers as updates or in-app purchases. By the middle of the coming decade, such services on the myAudi digital platform, together with the envisaged gain in efficiency, will make a substantial contribution to the company’s earnings. Vorsprung that creates the means to offer even more premium services in the mobile world.
2 Audi on demand – premium mobility service in 15 markets by 2020

The fascination with individual mobility is unwavering. Then as now, the car remains a symbol of this freedom of movement. For many people, however, this no longer necessarily means having to own your own car. In fast growing cities in particular, more and more people are using the available public transport system alongside conventional taxis services such as Uber and car sharing. The digital revolution is making this happen, helping to make a wide range of cars more readily available. And that simply by tapping on your smartphone.

Such services are already widespread in cities. The fast availability and high level of flexibility for which these services are noted have given rise to an exciting business segment that is driven by innovation. Coupled with the trend towards the sharing economy, new models of access to vehicles and associated new business models and potential for future growth are being developed. Audi is playing an increasing role here with innovative premium mobility offers. At the Audi Summit, the company is demonstrating solutions for those who wish to use the latest Audi models in a flexible way – when and wherever they want.

Audi aims to appeal to both private and business customers: with Audi select, which allows the customer to choose between up to the three different models in a year for an all-inclusive rate; with Audi at home, a mobility solution for upscale living in megacities; with Audi shared fleet, an intelligent company car management system; and with Audi on demand, a premium mobility service with billing by the hour and guaranteed rental of a specific model.

In future, all these services will be bundled together and offered under the Audi on demand product brand. The customer and his or her wish for flexibility and to make “more of their time”, combined with the promise of a premium driving experience, are at the heart of each one. The brand with the four rings is showcasing the new brand identity of Audi on demand at the Audi Summit and giving the first insights into the market launch strategy. Audi is aiming to have its range of mobility services present in 15 markets around the world by 2020. Audi on demand is about to be launched in China. By strengthening its partnership with Silvercar, a strong player on the American market, Audi is also pushing forward the expansion of these services there too. Additional locations and markets will likewise be added in Europe by 2018.

In 2013, as part of its mobility strategy, AUDI AG founded Audi Business Innovation GmbH, a wholly-owned subsidiary. The company complements the brand’s core business with Audi on demand and, amongst other things, provides a central booking platform as well as in-car technology for the service. Audi Business Innovation GmbH is also the interface for various forms of cooperation with external partners in the mobility sector.
3 Audi Innovation Research: the vision from Beijing and San Francisco

The future starts in the mind: with visions, wishes, desires. And is followed up with decisions and investments. Anyone seeking to keep track of future desires and values has the opportunity to invest in Vorsprung today. AIR, Audi Innovation Research, is an example of this.

Audi is inquisitive. The company is forever seeking solutions that move people. It does this throughout the world, where the future is being shaped and lived. At Audi, the AIR team of trend and innovation researchers in Ingolstadt, Beijing and San Francisco investigates the drivers of social change and inquire about the implications for the Audi brand. The three teams are part of a worldwide innovation network at AUDI AG. Their mission: the Next Big Thing.

The findings from AIR’s work fuel the high-performance work of the brand with the four rings: they provide stimulus for brand strategy and answer research questions from various technical departments – the core topic here being digitalization from the customer viewpoint. The findings allow insights into key strategic markets and give indications of undiscovered business potential. At the same time, they pass on open questions or customers’ wishes to the headquarters.

This knowledge exchange is enriching – especially as a live experience. The AIR teams “share” their latest results at SHAIRE, an event for Audi employees. This is a perfect meeting place for discussions and at the same time provides an insight into the lifestyle that is moving people in cities in key overseas markets.

An open attitude, regular exchanges of opinions and experience, and teamwork are the basic principles of AIR’s work. Meanwhile, a global network of creative people has been established which, together with AIR, is working on visionary concepts, testing prototypes or simply sounding out new ideas. As trend receivers, they inspire the work of AIR and launch innovations.

In this process, each office has its own role. In Beijing, the focus is on the customer’s living environment. Audi has been at that location for more than 25 years. During this time, the country has changed enormously – as have the customers’ needs. Today, China is a trendsetter and sets the pace in many areas. In China, there is tremendous will to exploit its huge potential for innovation. The tremendous openness of the Chinese people also means that new ideas, technology and trends are accepted extremely quickly and spread like wildfire. In future, it’s likely that many trends will emerge first in China and will be subsequently adopted by the Western world. And those who are familiar with these trends will be one step ahead – Vorsprung.
The main focus in the USA is on innovation scouting and partnering. Silicon Valley is a powerhouse of new ideas and a magnet for visionary startup founders. The power of digitalization has unleashed a new era from here. With its breathtaking pace of innovation, it is questioning classic business models and turning whole sectors on their head: it is re-inventing branches of industry and challenging longstanding concepts. It has already created a huge stir in the media, retail and services sector. Now, digitalization has reached the automobile industry and is challenging the sector’s major players. The battle cry “Go big or go home” applies to every innovation that wants to flourish here as the business model.

AIR’s heart beats in Ingolstadt. In addition to its own user research, the office there coordinates AIR’s activities. Proximity to the headquarters ensures fast communication and rapid decision making. Inquiries can be answered quickly and results can be distributed rapidly. This occurs in both directions. That’s because AIR doesn’t just keep its finger on the pulse of global trendsetters. It synchronizes that pulse with the wealth of innovative ideas that are being fed back from the Audi digital car company itself.

In so doing, it ensures that Audi’s urban mobility products and services are already being tuned to tomorrow’s trends. By 2020, for example, three pilot projects involving piloted driving and parking, traffic light systems, tailor-made mobility concepts and integrated traffic management will be underway around the world. Crucially, these projects are based on the findings of Audi Innovation Research. The trend is your friend.

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).