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Pure power – the Audi diesel engines

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The data and the performance and fuel consumption figures stated here refer to the model range offered for sale in Germany. Subject to amendment; errors and omissions excepted.

Short version

The Audi diesel engines Pure power

An output of 368 kW/500 bhp and 1,000 Nm of torque – Audi is unveiling an engine which sets new standards in the diesel sector. The majestic V12 TDI power unit with its capacity of six litres endows the high-performance Audi Q7 SUV with sports car credentials. It is the harbinger of a wide-scale model initiative, as Audi seeks to make major inroads into the US market with its diesel models – courtesy of a new emission control technology which cuts emissions drastically.

The Audi Q7 V12 TDI raises the bar in the burgeoning sports utility vehicle segment. A time of just 5.5 seconds for the dash from zero to 100 km/h and an electronically governed top speed of 250 km/h give the high-performance SUV sports car calibre. Its six-litre twelve-cylinder diesel unit demonstrates the tremendous technological expertise at Audi's fingertips. 18 years after the Ingolstadt brand invented the modern-day TDI engine, it is presenting it in an all-new high-tech, range-topping guise.

Audi makes the vital breakthroughs

All of the diesel engines from Audi deserve the tag of 'sporty' on account of their impressive performance – the six and eight-cylinder 2.7 TDI, 3.0 TDI and 4.2 TDI units serve to underline this. The pioneering role that Audi assumes in the field of diesel technology stems from the peerless expertise it has amassed over recent decades. Audi engineers have been responsible for one vital breakthrough after another – the most important of these was the world's first ever TDI engine to be fitted in a passenger car, which Audi introduced in 1989.

Last year, Audi demonstrated the dynamic potential of diesel power in most memorable fashion on race tracks around the world. The V12 TDI in the R10 sports prototype unleashed in excess of 650 bhp and left its petrol-engined competitors in its wake in each of the eight races it competed in. Highlights of this winning streak included its triumph at the gruelling Le Mans 24 Hours as well as its victories in the LMP1 category of the American Le Mans Series.

The trend towards diesel engines is gathering strength all the time in the United States too. Audi is firmly convinced that the TDI engine represents the powerful and economical alternative for the future of motoring, and is therefore preparing a model drive to bolster this trend. The Q7 3.0 TDI is expected to hit showrooms in the USA in late 2008. Thanks to the exceptionally low emissions resulting from its cutting-edge Bluetec technology, this engine even complies with the US Tier II Bin 5 standard which places extremely tough demands on nitrogen oxide and particulate emissions.

SCR catalytic converter for reducing nitrogen oxide levels

At the core of the Bluetec technology is a catalytic converter known by the abbreviation of SCR (Selective Catalytic Reduction). The second system component takes the form of an auxiliary tank which contains a carbonyl diamide solution. The solution is injected in small doses into the exhaust system where it decomposes into ammonia, which then breaks down the nitrogen oxides into nitrogen and water. The arrival of the ultra-clean Bluetec diesel engines will see Audi hold true to its tradition of always being at the very forefront of diesel technology.

Long version

The Audi Q7 V12 TDI Majestic power

Audi is advancing to the cutting edge of diesel technology development. The Ingolstadt brand already has a host of landmark achievements to its credit – and the list is about to be extended with the advent of the first ever V12 TDI passenger car engine. The six-litre unit under the bonnet of the Audi Q7 V12 TDI study delivers a majestic 368 kW/500 bhp and a formidable 1,000 Nm of torque. This injects the high-performance SUV with the dynamism of a powerful sports car.

The colossal power of the Audi Q7 V12 TDI takes it into a whole new dimension. A time of 5.5 seconds for the sprint from a standstill to 100 km/h and an electronically governed top speed of 250 km/h put the performance SUV from Audi on a par with high-calibre sports cars. The engine limits its consumption to an average of just 11.9 litres/100 km.

The new V12 TDI is the crowning glory of an engine line-up brimming with dynamic performance – each and every one of the diesel engines from Audi generates a high output and tremendous pulling power for a sporty drive. This character has emerged over and over again in the brand's models, not least in the form of the six- and eight-cylinder 2.7 TDI, 3.0 TDI and 4.2 TDI models.

The pioneering role that Audi assumes in the field of diesel technology stems from the peerless expertise it has amassed over a period of decades. Since the 1970s, the Audi engineers have been responsible for one vital breakthrough after another, the most important being the world's first ever TDI engine to be fitted in a passenger car which made its debut in 1989. And in 2008, Audi intends to start making inroads into the US diesel market with Bluetec technology: thanks to Bluetec, TDI models bearing the four-ring emblem are not just sporty and economical, they can also run so cleanly that they comply with the emissions legislation in all 50 US states.

A year ago, Audi added yet another new chapter to the ongoing diesel success story on race tracks around the world. Developing over 650 bhp, the V12 TDI fitted in the R10 TDI sports prototype left its petrol-powered rivals trailing in all of the races it participated in, including the most challenging of them all, the classic Le Mans 24 Hours. The R10 TDI also triumphed in the LMP1 category of the American Le Mans Series with an impressive string of victories.

The V12 TDI – the new flagship V engine

When working on the road-going version of the V12 TDI, which will be built in its Győr plant in Hungary, Audi drew on all of the know-how that underpins the racing engine. The range-topping diesel is the new flagship model in the Audi range of V engines, spanning petrol and diesel units with 6, 8 and 10 cylinders.

The V12 TDI's cylinders actually sweep a greater volume than the racing engine, which has a capacity of 5.5 litres. Its 5,934 cc are produced by a bore of 83.0 millimetres and a stroke of 91.4 mm, the same dimensions as the six-cylinder 3.0 TDI. The two banks of cylinders are positioned opposite one another with an offset of 17 millimetres. Measuring just 684 mm long, the V12 diesel has an extremely compact design. Indeed, its compact size was one of the key prerequisites for integrating the V12 into the Audi Q7.

The V12 TDI features the same 90 mm spacing between cylinders as the other models in the V engine series. However, the cylinder banks are placed at an angle of 60 degrees to one another instead of the customary 90 degrees. This particular V12 configuration suppresses all of the inertial forces and mass moments which would otherwise cause vibrations. Consequently, the engine's smoothness is flawless in every regard.

Lightweight construction: crankcase made from vermicular graphite

The V12 TDI's crankcase is made from a mixture of cast iron and vermicular graphite – Audi already uses this high-tech material, known as GJV-450, in the manufacture of the V6 TDI and V8 TDI. GJV-450, which is produced using a patented casting method, is around 40 percent more rigid than cast iron and twice as resistant to fatigue.

This enabled the development team to make the walls thinner, paving the way for a potential weight-saving of around 15 percent compared to conventional cast iron.

The crankshaft is forged from chrome-molybdenum alloy steel and is mounted with the aid of an extremely rigid main bearing bridge made from nodular cast iron. The forged connecting rods are cracked, and the pistons are made from aluminium.

The two cylinder heads each comprise three main elements. The bottom section, incorporating the intake and exhaust ports and through which the coolant flows, is made from a low-pressure die-cast aluminium alloy that has a high-strength, lightweight construction. The top section, which conducts the oil, is pressure-cast. The cylinder head is crowned by a reinforcing ladder-type frame which holds the two camshafts.

Perfect air ducting: flaps in the intake ducts

The valves are actuated by four camshafts acting via low-friction roller-type cam followers, the compression ratio is 16.0:1. The map-controlled swirl variation of the combustion air deployed in the V6 and V8 TDI models has been retained. With this system, one of the intake ports for each cylinder is either opened or closed by means of an electrically operated flap, depending on the engine's operating point. Intermediate flap positions are also possible. This allows the swirl to be adjusted for optimum exhaust emissions combined with high power delivery.

As is customary on V engines from Audi, the maintenance-free chain drive is fitted in a space-saving location on the rear face of the engine. The developers devised a new layout for the V12 TDI, however. The crankshaft's sprocket wheel meshes with an intermediate gear which in turn drives the camshafts by means of two simplex chains. Two additional chains drive the oil pump as well as both high-pressure pumps for the common-rail injection system.

2,000 bars of pressure: ground-breaking common-rail technology

The injection technology featured in the V12 TDI is every bit as revolutionary. The high-pressure pumps both form part of the common-rail system supplied by system specialist Bosch. The twin plunger pumps are capable of building up pressures as high as 2,000 bar in the rails, considerably more than the previous usual maximum of, at most, 1,600 bar.

The piezoelectric injectors with their eight-hole nozzles have also undergone a thorough reworking. The tiniest quantities of diesel fuel are injected into the combustion chambers through their eight-hole nozzles, whose diameter has now been reduced to a mere 0.12 millimetres. The high pressure produces an optimum spray pattern inside the combustion chamber, which makes for a faster, more homogeneous and, as a result, more acoustically refined ignition process. What's more, the improved combustion efficiency increases power output whilst reducing both fuel consumption and pollutant emissions.

Ultra-fast and ultra-precise: the piezoelectric injectors

The latest generation of inline injectors employs the piezo effect: piezo crystals expand slightly when an electrical voltage is applied to them. Over 300 piezo discs are packed into each of the V12 TDI injectors, which transmit the minimal expansion to the valve needle directly (inline) without the need for any form of transmission mechanism between the two. Each actuation takes just a few milliseconds – by comparison, a wink of the eye lasts 100 ms.

The fuel pressure and quantity can be adjusted according to requirements; the number of injection phases per power stroke can be varied up to a maximum of five with the piezoelectric technology in the V12 TDI. Main injection can be accompanied by both pilot and post-injection phases. Pilot injection lessens the harshness of the combustion sound, which is particularly noticeable at low engine loads. The delayed post-injection of fuel serves to increase the temperature of the exhaust gas – this allows any particulate residue to be burned off in order to regenerate the two particulate filters which are included as standard.

Supercharging: a turbocharger for each bank of cylinders

Attached to the outside of the engine's V are the two turbochargers which each supply compressed air to one bank of cylinders. Their variable vane geometry ensures that the full exhaust flow is directed through the turbine at all times – the turbochargers offer fast response even at low rev speeds and attain a high degree of efficiency.

Both turbochargers generate up to 2.6 bar of absolute boost pressure and therefore have a vital role to play in achieving the formidable peak torque of 1,000 Nm which the new V12 TDI constantly has on tap between 1,750 rpm and 3,000 rpm. The diesel's 368 kW/500 bhp equates to a specific output of 62.0 kW/84.3 bhp per litre.

Cooling effect: two intercoolers to reduce the temperature of the air

The temperature of the compressed air is reduced by two large intercoolers. The V12 comes with a double-flow exhaust system featuring two particulate filters. The intake system is similarly structured – for each bank of cylinders there is an air cleaner followed immediately by a hot-film air mass meter. Two control units operating based on the master-slave principle orchestrate proceedings inside the engine.

The Audi Q7 V12 TDI already complies with the Euro 5 emissions standard, which is due to come into force in mid-2010 and will make especially tough demands in terms of reducing nitrogen oxides. It was with this in mind that the Audi engineers devoted particular attention not only to the new common-rail system and its high-precision fuel metering, but also to the exhaust gas recirculation system.

At partial throttle, up to 50 percent of the exhaust gases are fed back into the intake air in order to reduce NOx emissions. The extensive recirculation system incorporates a water cooler which reduces the temperature of the exhaust gases sharply.

The awesome V12 TDI directs its power as standard to a fast-action, smooth-shifting new six-speed tiptronic transmission. From here, the forces flow to a quattro driveline, which splits the drive power 40:60 between the front and rear wheels under normal driving conditions. This results in slightly tail-heavy, sporty handling characteristics, exceptional agility and exemplary steering precision.

To ensure that its phenomenal performance can be safely harnessed, the Audi Q7 V12 TDI is equipped with powerful, ventilated disc brakes. The ESP dynamic handling control system features a hill descent assist as well as a special off-road mode. The safety specification is rounded off by the pairs of front, side and head airbags in the interior.

An elaborate double-wishbone independent suspension has been used for each of the four wheels, while the majority of the axle components are made from aluminium. The adaptive air suspension, incorporating an electronically controlled damper system, comes as standard, creating a perfect synthesis of sporty handling on the one hand and silky ride comfort on the other. The body's ride height can be adjusted from its starting position of 180 mm above the ground up to the lift mode offering a whole 240 mm of ground clearance. The Audi Q7 V12 TDI study rides on 20-inch cast aluminium wheels.

Design: the best of both worlds

The Audi Q7 V12 TDI is just as fascinating to look at as it is to drive. The principal feature which distinguishes it from its lesser-powered siblings is the contrasting paintwork of the underfloor panels at the front and rear. The striking, almost vertical single-frame radiator grille has a chromed finish and echoes the dynamic Audi S6 and Audi S8 models, which both head their respective ranges powered by V10 FSI engines. Flanking the grille are wide headlight units with visible light tubes.

The Audi Q7 styling has a thrilling air of elegance blended with dynamism, and displays both tremendous sportiness and the robustness of an accomplished off-road vehicle. The Audi Q7 cuts a powerful, elongated figure, boasting the sportiest proportions in its segment, with a length of 5,086 millimetres, a width of 1,983 mm and a height of 1,737 mm.

The high side panelling gives the vehicle's body a muscular feel, particularly in the way it contrasts with the flat, sporty styling of the window area. The dynamic line above the wheel arches, the powerfully contoured shoulder section and the flowing roof line combine with the standard-fit roof rails to emphasise the car's athletic looks. The distinctive tapering at the front end and the tail with its steeply angled D-pillars form the end markers of a distinctly coupé-like silhouette.

The Audi Q7 offers outstanding levels of spaciousness courtesy of a wheelbase measuring 3,002 mm. The three rows of seating accommodate up to seven people. The seats in the second row can be specified with fore-and-aft adjustment as an option and offer occupants a class-beating footwell length. Both of the rear rows of seats can be folded down flat, increasing load capacity to a maximum of 2,035 litres. The 5-seater version of the Audi Q7 offers 775 litres of load space in its luggage compartment, while the 6-seater version features individual second-row seats. The tailgate of the Audi Q7 V12 TDI opens and closes electrically at the push of a button.

Amplly sized interior plus innovative operating concept

The interior and cockpit area of the Audi Q7 create the impression of a light and airy expanse, flawless ergonomics and top quality. The standard-specification deluxe automatic air conditioning regulates heating and ventilation separately for the driver's and passenger's side, taking sunlight levels into account in the process. The Audi Q7 also comes equipped as standard with the MMI operating system which has already earned high praise in the A8 and A6 and can be expanded to include numerous additional functions.

A number of state-of-the-art driver assistance systems may be specified as an option. These include the radar-assisted "Audi side assist" for lane-changing manoeuvres, the "Audi parking system advanced" featuring both visual and acoustic guidance as well as a rearview camera, plus the latest-generation automatic proximity control system, Audi cruise control with braking guard, which is capable of braking the vehicle to a standstill if required.

The seats are upholstered in leather, and the front seats are heated. Carbon panels give added emphasis to the interior's sporting flair. And to ensure that drivers can enjoy supreme operating convenience there is a cruise control system, a driver information system and a multifunction steering wheel.

Audi already offers the Q7 with a choice of three engines: the 3.6 FSI has an output of 206 kW/280 bhp, the 4.2 FSI generates 257 kW/350 bhp and the 3.0 TDI delivers 171 kW/233 bhp. The eight-cylinder 4.2 TDI is due to be added to the model line-up in mid-2007.

Low-emission TDI engines for the USA Green power

The trend towards diesel engines is becoming ever more pronounced in the United States too. Audi, the inventor of the modern-day TDI, is going on the offensive in an effort to bolster this tendency. 2008 will see the arrival of the Q7 3.0 TDI in US showrooms. Thanks to the exceptionally low emissions resulting from its cutting-edge Bluetec technology, this engine is able to meet even the most stringent emissions limits.

In Europe, diesel-engined cars have been enjoying an inexorable rise in popularity for years now – in Germany, for instance, they accounted for over 45 percent of new car registrations in October 2006. Today's diesel engines are powerful, fast, efficient, smooth and dependable – virtues which Audi, in its capacity as a pioneer of diesel technology since 1989, has been instrumental in achieving.

The diesel market is also beginning to take off in the USA. In 2006, diesel-powered passenger cars and light trucks secured a market share of around 3.5 percent, and this figure is widely predicted to keep on rising. Firmly convinced that the TDI engine represents the powerful and economical alternative for the future of motoring, Audi is seeking to reinforce this trend: the Ingolstadt brand is embarking on its US diesel initiative.

Strict LEVII standard in California

The stringent legislation governing emissions represents a key criterion for all passenger car engines in the USA. The emission standard entitled US Tier II Bin 8, which is in force in 45 of the 50 US states, limits emissions of nitrogen oxides (NOx) to 0.20 grams per mile and particulate emissions to 0.02 g/mile. The LEVII standard, which is enforced in California and a number of states in the north-east, goes much further again, restricting emissions of nitrogen oxides to 0.07 g/mile and particulates to 0.01 g/mile.

The LEVII limits are simply beyond the capabilities of the emission control technologies required to meet the current Euro 4 standard in Europe.

This is why Audi has teamed up with Volkswagen and DaimlerChrysler to develop a revolutionary new technology – it is called Bluetec and denotes exceptionally clean-running diesel engines.

The Bluetec technology is built around a dedicated catalytic converter which goes under the abbreviation of SCR (Selective Catalytic Reduction) and is positioned downstream from the oxidation catalytic converter and the particulate filter. The second system component is an auxiliary tank containing an aqueous carbonyl diamide solution. The solution, which has been labelled "AdBlue", is injected into the exhaust system in small doses. Once in the hot flow of exhaust gases, it decomposes into ammonia which in turn breaks down the nitrogen oxides into nitrogen and water.

The "AdBlue" reducing agent is routinely topped up at the workshop each time the vehicle is serviced, without the customer having to lift a finger. Audi ensures that there is sufficient "AdBlue" to safely cover the distances between services. Additional benefits include the fact that "AdBlue" is biodegradable and the system's guaranteed effectiveness for the duration of the vehicle's service life.

Audi is a driving force behind the advancement of diesel engines

The ultra-clean Bluetec diesel engines see Audi hold true to its tradition of always being at the cutting edge of diesel technology development. The Ingolstadt brand developed direct injection technology back in 1989 – since then, the fuel efficiency of diesel engines has been improved by around 30 percent on average. Compared to 1989 levels, the European emission standard Euro 4 heralds a 93 percent reduction in passenger car particulate emissions; long before the standard came into effect, Audi had already brought out models onto the market which complied with the stipulated limits, even without a particulate filter.

The Audi philosophy has always been to offer customers the best possible solution. And as the only good emissions are those which are not created in the first place, Audi engineers gave top priority to implementing internal engine measures that would further refine the combustion process.

The common-rail technology in the new Audi Q7 V12 TDI with an injection pressure that has now reached the 2,000 bar mark is, for the moment at least, the last link in a long chain of diesel developments.

Others include the four-valve-per-cylinder technology and the accompanying swirl and inlet ports for controlling the airflows, as well as the controlled and cooled system of exhaust gas recirculation; the latter of these innovations is of great importance for the future of diesel engines at Audi.

Higher fuel prices, improved diesel infrastructure

The growing trend towards diesel power which is emerging in the US has been prompted by a number of developments. The sharp increase in energy prices has raised public awareness of the importance of making economical use of resources.

The infrastructure of filling stations stocking diesel fuel for passenger cars is growing, at the same time increasing availability of the low-sulphur diesel fuel (containing less than 50 ppm sulphur) that is one of the fundamental requirements for using Bluetec technology and particulate filters. Irrespective of this, Audi is promoting the development of sophisticated synthetic fuels derived from biomass or natural gas, which by their nature contain considerably fewer pollutants.

The Q7 3.0 TDI will be the first model from Audi to showcase the all-new, ultra-clean Bluetec technology when it is launched in the US in late 2008. Further models are set to follow. And other countries apart from the United States have voiced an interest in the new, extra-green diesel engines, including Japan, China and, not least, the Europeans.

High-tech diesel engines from Audi Technical superiority

The new V12 TDI with its supreme performance is a trademark Audi engine. Ever since it first invented the TDI engine 18 years ago, the brand has played a pivotal role in advancing technology in this field. Diesel engines from Audi are powerful, efficient and smooth, and they have demonstrated their superiority both on the road and the racetrack.

368 kW/500 bhp – the new V12 TDI engine in the Audi Q7 is a veritable pageant of technology and represents the new pinnacle of passenger car diesel development. The twelve-cylinder power unit provides unquestionable proof of the pre-eminent technological expertise at Audi. 18 years after the Ingolstadt brand invented the modern-day TDI engine, it is presenting it in an all-new high-tech, range-topping guise.

The wide-ranging pool of know-how at Audi is also plainly in evidence in the brand's other large diesel engines which likewise succeed in fusing sheer power with excellent efficiency. The two V6 TDI units summon 132 kW/180 bhp and 171 kW/233 bhp respectively from their capacities of 2.7 and 3.0 litres, with the V8 TDI drawing 240 kW/326 bhp from its 4.2 litres. The TDI engines from Audi are full of power and torque, yet they are also efficient and economical, as well as being quiet and smooth.

TDI engines are full of power

The three-litre TDI unit propels a variety of Audi models, ranging from the mid-size A4 up to the Audi Q7 high-performance SUV. Its 171 kW/233 bhp equates to an output of 57.6 kW/77.9 bhp per litre – a figure which up until just a few years ago was unprecedented outside of the sports car faction. In all of the models it is fitted in, the 3.0 TDI drives all four wheels via the quattro permanent four-wheel drive system, yet another Audi technology whose tremendous potential for motoring pleasure and driving safety underscores the brand's sporty essence.

The three-litre diesel engine ensures dynamic performance. It powers the Audi A8 luxury saloon, for example, to a majestic top speed of 243 km/h and from nought to 100 km/h in just 7.8 seconds. Yet more evidence of the Audi brand's exclusive expertise can be found in the A8 3.0 TDI quattro: its body tips the scales at a mere 222 kilograms thanks to its state-of-the-art Audi Space Frame (ASF). ASF reverses the weight spiral. Recently, Audi received the European Body Car Award for the TT body with its hybrid construction that makes intelligent use of aluminium combined with steel.

TDI engines are full of torque

The great strength of all diesel engines from Audi is their immense torque. The pulling power of diesel engines clearly surpasses that of comparable petrol units. What's more, their power is on tap at very low revs, just above idling speed in fact – meaning that the driver merely has to coax the accelerator pedal for a smooth yet persistent build-up of thrust. Consequently, the pulling power is there whenever it is needed, making for a composed and relaxed driving style.

Built in the vein of a classic American small block, the three-litre V6 transmits as much as 500 Nm of torque to the crankshaft at engine speeds as low down as 1,400 - 1,500 rpm. The diesel powerplant generates an exceptional 168.5 Nm for each litre of capacity.

TDI engines are efficient and economical

Diesel engines make more efficient use of the energy contained in the fuel they run on than petrol engines do. Audi has played a decisive role in the development of the many different solutions that have been devised to capitalise on this fundamental principle of physics – four-valve-per-cylinder technology for an optimum cylinder charge in any operating situation is just one example, as is the principle of variable turbine geometry used in turbochargers.

The A8 is a saloon of stately proportions, measuring 5.06 metres in length, but even in such a large car the 3.0 TDI demonstrates astounding restraint in terms of fuel consumption. On the EU driving cycle, it limits itself to an average of 8.5 litres per 100 km, while the 2.7 TDI in the Audi A4 is even more frugal, burning just 6.7 l/100 km.

Such high efficiency heralds more than just financial benefits for drivers, especially on long journeys: thanks to the 90-litre tank capacity, motorists adopting a relaxed driving style can cover far in excess of 1,000 km between refuelling stops – not only does this cut costs, it saves time and nerves too.

TDI engines are quiet and smooth

The sound from Audi's latest direct-injection diesel units is barely perceptible to passengers' ears, as they run every bit as quietly as their petrol counterparts. This is partly down to the extensive development work carried out by the acoustic engineers at Audi. Carefully positioned finning on the cylinder blocks nips vibrations in the bud, while all of the potential paths via which vibrations could be transmitted into the interior have been eliminated from the engine mountings and bodyshell.

One of the key advances can be attributed to the common-rail technology, as it virtually gives the control unit free rein over the injection of fuel, which can take place up to five times during each power stroke. The pilot injection phases take place well in advance of the main injection to produce a more gradual pressure build-up for smoother combustion. The innovative piezoelectric injectors used by Audi in its large diesel engines heighten this effect with their extremely fast, high-precision actuation, finally putting an end to the harsh knocking and metallic rattling sounds normally heard at partial throttle.

Audi – drawing on a wealth of TDI expertise

The engine unveiled by Audi at the Frankfurt Motor Show in the late summer of 1989 was nothing less than an absolute sensation: exhibited in the Audi 100, the five-cylinder turbodiesel mustered 88 kW/120 bhp and 265 Nm of torque from its capacity of 2.5 litres. It was the first ever passenger car diesel engine to feature direct injection and fully electronic management – in short, the world's first TDI.

The beefy power of the five-cylinder drive unit redefined standards in the diesel segment when it went into series production in 1990. And Audi has been consolidating its head start ever since with one new development after another.

1991 marked the debut of a four-cylinder TDI model which extracted 66 kW (90 bhp) and 182 Nm from its capacity of 1.9 litres. Four years later its output was upped to 81 kW/110 bhp, thanks partly to the inclusion of a brand new turbocharger with turbine vanes that could be adjusted flexibly to match current requirements. The advertising slogan "Where's the tank?" made the TDI's proverbial economy and its tremendous operating range famous in Germany – the 66 kW/90 bhp variant of the 1.9 TDI made do with a mere 5.1 l/100 km in the Audi A4.

The five-cylinder engine's output was updated to 103 kW/140 bhp in 1994; coupled to a six-speed gearshift and optional four-wheel drive, it advanced to the status of the first TDI quattro. With vital statistics reading 290 Nm of torque at 1,900 rpm, a top speed of 208 km/h, 9.9 seconds for the 0-100 km/h dash and a Euromix fuel consumption of 6.0 l/100 km, it set a new benchmark for sporty touring saloons to measure themselves by.

The world's first V6 TDI passenger car engine followed in 1997. Fitted with a four-valve cylinder head – yet another major innovation on the TDI front – it had an output of 110 kW/150 bhp. Audi premiered its first diesel engine with the pioneering common-rail injection system in 1999 when it unveiled the 165 kW/225 bhp V8 TDI. The very same technology is employed by the current family of V diesel engines, ranging from the 2.7 V6 TDI and the 3.0 V6 TDI to the 4.2 V8 TDI and finally the new six-litre V12 TDI.

For 18 years now, Audi has been harnessing all of the innovative flair it has amassed in this field to constantly push back the limits of what is possible. The TDI engines have been pivotal in the Audi brand's rise to the rank of sporty premium manufacturer; today, every second Audi that is sold worldwide has a diesel engine under the bonnet. The TDI engines have enjoyed an unparalleled triumph – and the success story is set to continue apace.

TDI on the racetrack: a quiet, efficient, dominating force

Initially, even the drivers could not believe their ears – seasoned professionals of the likes of Tom Kristensen and Frank Biela suddenly had to change their habits. Previously, they had used the engine noise emanating from their open sports cars as an important yardstick – and now the engine noise faded out altogether above a certain speed, so quiet was the V12 TDI in the new R10.

The V12 diesel race car from Audi has taken motorsport into a whole new era. Designed in accordance with the regulations that govern the Le Mans 24 Hours, the 5.5-litre TDI racing engine is a cut above the rest. With its prodigious torque of over 1,100 Nm, it comfortably outperforms any petrol model. At its rated engine speed, over 478 kW/650 bhp is on tap – translating into a top speed in the region of 330 km/h.

A further forte of the V12 TDI is its low fuel consumption. Measured against its already extremely efficient predecessor, the R8 with petrol direct injection, the R10 TDI burned considerably less fuel at Le Mans. This was despite the fact that the diesel was unable to make the very most of its strengths on the Sarthe circuit with its long straights and a full throttle ratio approaching the 75 percent mark.

The high range was crucial to victory

The high range and the resulting reduction in the number of refuelling stops proved to be a crucial factor in the victory at the classic 24 Hours. Frank Biela (Germany), Emanuele Pirro (Italy) and Marco Werner (Germany) only had to call in at the pits 27 times in their car with start number 8.

They completed 380 laps – 5,187 km – at an average speed of 215.409 km/h.

Spurred on by its triumph at Le Mans, Audi went on to achieve something that no other manufacturer had before it – the R10 TDI won all eight of the races it competed in over the course of the 2006 season. The sequence of victories spanned the breadth of the United States, starting in March at the 12 Hours of Sebring in Florida and culminating at Laguna Seca in California in October.

In the American Le Mans Series, Scotsman Allan McNish together with Dindo Capello from Italy emerged as the overall champions of the large LMP1 category long before the season had drawn to a close. With a total of 23 wins under his belt, Capello is the most successful ALMS driver of all time. Audi also took the constructors title in the large LMP1 category by a substantial margin after racking up 215 points ahead of Lola in second on 160 points.

A panel of judges from the British magazine "Race Engine Technology" voted the V12 TDI in the Audi R10 TDI "Race Engine of the Year 2006" and "Alternative Race Engine of the Year". The engine's design engineer Ulrich Baretzky, Head of Engine Technology at Audi Sport, and the Head of Audi Motorsport Dr. Wolfgang Ullrich perceive the V12 TDI as a perfect illustration of motorsport and series production cooperating closely with one another.

Transfer between motorsport and series production

"We can avail ourselves of the expertise and test facilities of our colleagues in series development," remarks Dr. Ullrich. The know-how flows both ways though, with technological highlights from the racetrack often injecting vital new stimulus into series development.

Audi performed a similar technology transfer back in the late 1980s. At that time, the touring cars from Ingolstadt were dominating the TransAm and IMSA races thanks to their quattro drive and turbocharged petrol engines that generated in excess of 700 bhp in some cases. 20 years on, large-scale series development is once again reaping the benefits of motorsport technology.