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## Rightsizing

Audi is driving forward progress in its gasoline engines. The term Rightsizing incorporates a host of innovative technologies. The key is to design engines with the optimum combination of displacement, power and torque delivery, fuel consumption and operating characteristics. Cylinder deactivation in the 4.0 TFSI is one example.

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Audi has been a pioneer of progress in spark-ignition engines for many years. At the end of the 1970s, it launched its first turbocharged gasoline engine, a sporty five-cylinder. The next milestone followed in 1995 with the 1.8-liter four-cylinder turbo and, in 2004, the brand placed itself at the very forefront of the competitive field with TFSI technology, the combination of forced induction and gasoline direct injection.

The strategy of downsizing – the replacement of displacement with forced induction – delivered substantial increases in torque. It enabled the development engineers to “downspeed” i.e. to use gearboxes with long ratios for improved fuel consumption. Audi continues to pursue this successful approach, with key competitors just beginning to follow suit.

The EA 888 four-cylinder engine family that made its debut in 2006 marks a further advancement in TFSI technology. Now in its third iteration, the 1.8 and 2.0-liter units are packed with hi-tech solutions. Among them are the Audi valvelift system (AVS), the exhaust manifold integrated into the cylinder head, the turbocharger with an electric wastegate actuator, the innovative thermal management with electric coolant control and the combination of direct injection with inlet manifold injection.

Overall, these solutions deliver impressive results. In the A4 with manual transmission, the 1.8 TFSI with 125 kW (170 hp) consumes an average of just 5.7 liters of fuel per 100 km – equating to CO<sub>2</sub> emissions of 134 grams per kilometer.\*\* The A4 from 2000 with the 1.8 T and an output of 110 kW (150 hp) emitted 197 grams of CO<sub>2</sub> per km.\*\* Improvements across many areas contribute to this progress. However, the most significant come from the engine.

The latest Audi innovation also has a noticeable impact on efficiency – the cylinder-on-demand (COD) system. In the new 4.0 TFSI and 1.4 TFSI engines, it shuts off four and two cylinders respectively when operating under partial load. This solution is a variant of the new rightsizing strategy, aimed at create the right balance between displacement and forced induction.

A central focus in rightsizing is the ongoing development of forced induction. Audi

engineers want to further optimize torque and its dynamic build up, especially in the lower rev range. Some highly promising starts have already been made here, with two-stage forced induction concepts delivering considerable increases in performance. The materials used in the turbochargers include extremely heat-resistant steel alloys and turbines made from titanium aluminide.

In the further development of forced induction technology, especially when it comes to increased charge pressure, there is also an opportunity to apply new combustion processes. Of particular interest here are low-pressure exhaust gas recirculation (LP EGR) and the so-called Miller and Atkinson cycles, which enable an extended expansion phase. Both technologies increase efficiency significantly under medium and high load. At the other end of the spectrum, under partial load, homogenous charge compression ignition (HCCI), lean combustion and variable valve control offer new opportunities to raise efficiency even further.

In the development of spark-ignition engines, a major role is also played by fuels of the future, such as Audi e-gas or Audi e-ethanol. The classic fields of internal friction, engine materials and thermal management complete the range of tasks being worked on by engineers. The extensive application of new technologies will deliver a further significant reduction in the consumption of TFSI engines – in the range of around 15 percent by 2020. The brand aims to offer a mid-size sedan with a TFSI engine that has CO<sub>2</sub> emissions of less than 100 grams per kilometer by the end of the decade.\*\*

\*\*Figures depend on the tires/wheels used.

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