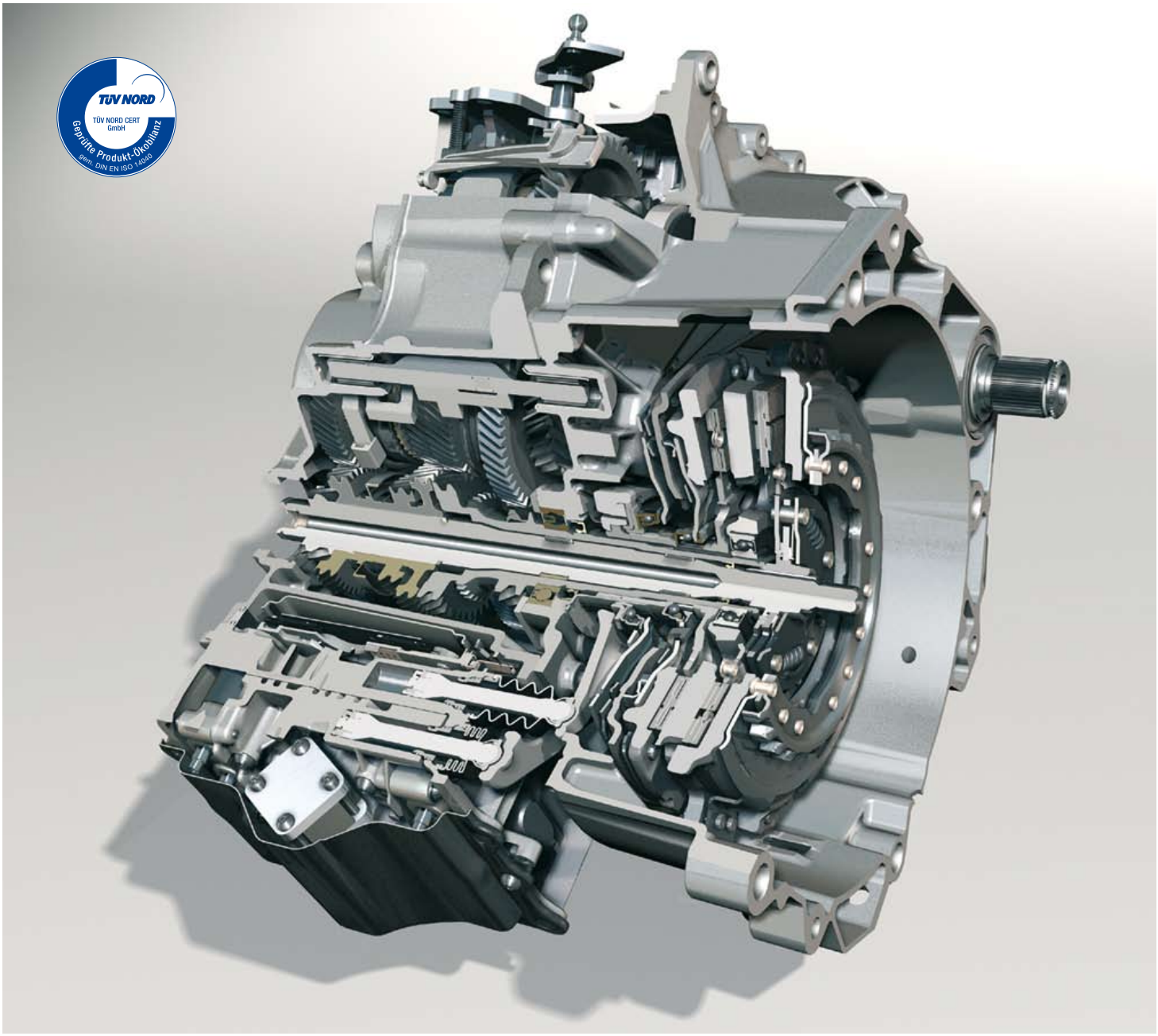
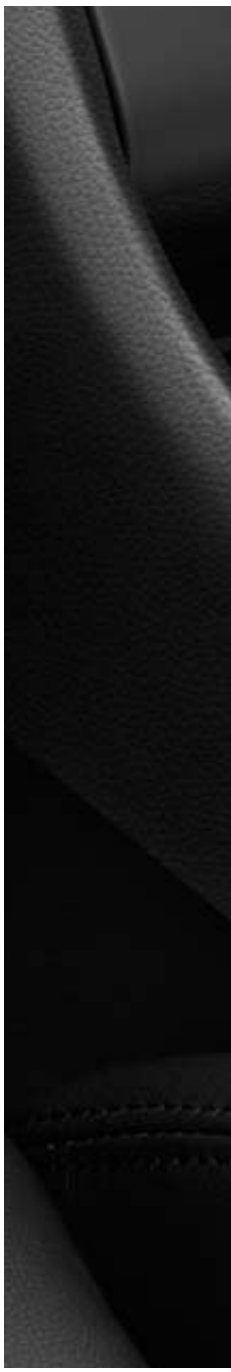
The DSG Dual-Clutch Gearbox
Environmental Commendation





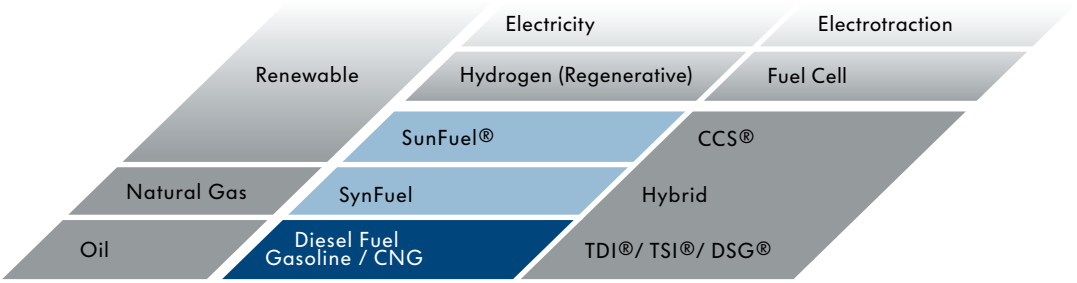
Shift Up to Environmental Protection

Volkswagen develops environmentally friendly technologies that help reduce CO_2 emissions. Our TDI and TSI engines, millions of which have been produced, are examples of environmentally compatible innovation. However, the fuel consumption and CO_2 emissions of a vehicle are not only determined by its engine. Volkswagen is committed to tapping all the opportunities for reducing fuel consumption and making technologies even more climate-compatible in the future. Our especially frugal BlueMotion models already meet these targets today. Our Powertrain and Fuel Strategy describes the technologies being pursued by Volkswagen with a view to implementing a long-term changeover to sustainable fuels and powertrains. Biofuels are just as much a part of this strategy as the fuel cell or electric propulsion systems.

The DSG intelligent automatic transmission developed by Volkswagen is also an integral part of this strategy for the future. In 2002, Volkswagen presented the first dual-clutch gearbox intended for series production, the 6-speed DSG. The dual-clutch principle ensures higher efficiency and lower fuel consumption than a conventional automatic transmission. In addition, it also makes for greater comfort and driving pleasure. In the meantime, Volkswagen has introduced a second dual-clutch gearbox, the 7-speed DSG, which is even more economical and will be used in the future on high-volume models with power outputs up to 125 kW and torque values up to 250 Nm.

Since the DSG dual-clutch gearbox was first launched, more than a million units have been sold, resulting in a new boom in automatic transmissions at Volkswagen. The proportion of new vehicles equipped with automatic transmissions has risen dramatically, from 5 to 10 percent with conventional transmissions to as much as 30 percent with the DSG. With the new 7-speed DSG, even more customers will automatically shift up to environmental protection.

Powertrain and Fuel Strategy of the Volkswagen Group



The Environmental Commendation

Our environmental commendations for new vehicle models and technologies highlight ecological progress compared with predecessor models and the technologies previously used. We use environmental commendations to inform our customers, our shareholders and other stakeholders how we are making our products and production processes more environmentally compatible and what we have achieved in this respect. As innovations such as the DSG dual-clutch gearbox are used across our model range, these technologies make a substantial contribution to improving the environmental compatibility and carbon dioxide emissions of the entire vehicle fleet.

The Volkswagen DSG dual-clutch gearbox is the first Volkswagen technology to receive an environmental commendation. Following the ADAC award „Gelber Engel 2008“ in the „Innovation and Environment“ category for the 7-speed DSG gearbox[1], the certificate issued by the technical inspection organisation TÜV NORD confirms the environmental progress achieved. The Life Cycle Assessment drawn up for the environmental commendation indicates that the DSG dual-clutch gearbox results in a significantly reduced environmental impact compared with a conventional automatic transmission. We can therefore say with a clear conscience that the innovative DSG automatic transmission from Volkswagen represents a significant step towards fuel-efficient, dynamic and comfortable driving.

[1] www.adac.de

Wet or Dry

The DSG dual-clutch gearbox developed by Volkswagen combines the comfort and convenience of an automatic transmission with the efficiency and performance of a manual gearbox. Two clutches ensure that shifts take place in next to no time. When a shift is imminent, one clutch disengages while the other is engaging, both in a few hundredths of a second. This is possible because the transmission always preselects the next gear to be used.

Rapid, precise shifting is the key advantage of the DSG over conventional automatic transmissions. With a DSG gearbox, there is no perceptible interruption in tractive force and therefore no jolting during gearshifts. And the dual-clutch gearbox also boasts much higher efficiency, saving fuel and cutting carbon dioxide emissions. And for those who still want to change gears manually, the Tiptronic shift function makes this possible too.

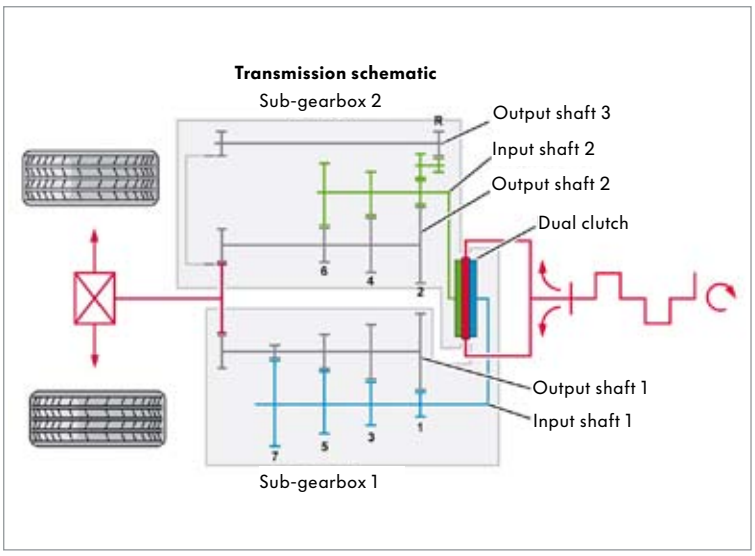
The DSG® in the Golf 1.4 TSI

Even before the 7-speed DSG was introduced, the ADAC awarded its 2008 „Gelber Engel“ in the „Innovation and Environment“ category to the Golf 1.4 TSI (90 kW)[2]. The fuel consumption figures for the Golf underscore the benefits of the DSG gearbox. With the economical manual six-speed gearbox, the Golf 1.4 TSI (90 kW) uses 6.2 litres of fuel per 100 kilometres (NEDC). With a 7-speed DSG, the average fuel consumption of the same Golf model is reduced by 0.3 litres to just 5.9 litres/100 km and CO_2 emissions are cut from 144 g/km to 139 g/km.

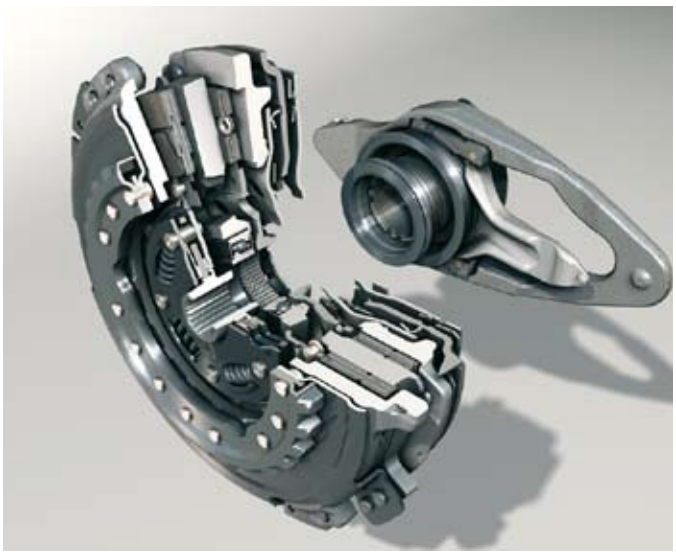
Volkswagen offers the 6- and 7-speed DSG gearboxes for models with various different engines. While the 6-speed DSG, introduced in 2002, is used for high-torque engines up to 350 Nm, the 7-speed DSG is available for engines with torque figures up to 250 Nm. The key innovation on the 7-speed unit is its „dry“ dual clutch. In contrast to the six-speed DSG, the new transmission does not have a „wet“ clutch with oil cooling. This change results in a whole raft of benefits, all leading to a further improvement in efficiency.

With the dual clutch, the efficiency of the DSG gearbox is significantly higher than that of conventional automatic transmissions fitted with hydraulic torque converters. Thanks to the DSG‘s intelligent transmission control system, its outstanding efficiency and its lower weight, vehicles equipped with the 7-speed dual-clutch gearbox may even present lower fuel consumption than comparable manual vehicles, depending on the individual style of driving.

[2] www.adac.de



7-speed DSG gearshift pattern



The dual clutch

Dual Benefits in Life Cycle Assessment

At Volkswagen, improving the environmental properties of a vehicle over its entire life cycle forms an integral part of the product development process. At this early stage, consumption and emission reduction targets are based on the environmental objectives of the Technical Development department. A Life Cycle Assessment investigates and precisely assesses the environmental impact of a product over its entire life cycle from production via service life to disposal. This also applies to individual vehicle technologies.

A Life Cycle Assessment in accordance with ISO 14040 of the type used for the environmental commendation for the DSG gearbox, consists of three phases. The first phase in a Life Cycle Assessment is to draw up a Life Cycle Inventory in which all relevant types and quantities of material as well as types and amounts of energy that go into the production, use and recycling of the vehicle are documented and quantified. Then an evaluation of potential environmental impacts is performed, regarding, for example, the greenhouse effect, summer smog and acidification or eutrophication of water and soil. Finally, the results are evaluated.

The Life Cycle Assessment drawn up by Volkswagen for the Golf shows a pattern typical of the automobile life cycle. During the vehicle's service life, environmental impacts are in many respects higher than in the production and disposal phases. For example, production and recycling only account for about 17 percent of the greenhouse effect caused by the vehicle, while the entire service life of the vehicle accounts for about 82 percent[3].

For the Life Cycle Assessment of the dual-clutch gearbox at hand, we compared both the 6-speed DSG and the 7-speed DSG with a conventional automatic transmission with torque converter. The main difference between the 6- and 7-speed DSG gearboxes are the dry clutch and the lighter weight of the 7-speed DSG. As cooling is not needed for the clutch of the 7-speed DSG, no oil cooler is required. This has enabled the volume of transmission oil to be reduced by 4.8 litres.

For all the transmissions investigated, consumption was determined on the basis of model calculations for a Golf 1.4 TSI (90 kW)[4]. The Life Cycle Assessment of the DSG gearboxes therefore only reflects their consumption benefits compared with automatic transmissions with torque converters (see table).

[3] For more information please see the Environmental Commendation of the Golf at **www.environmental-commendation.com**
[4] 5,9 l/100km, 139 g CO_2/km

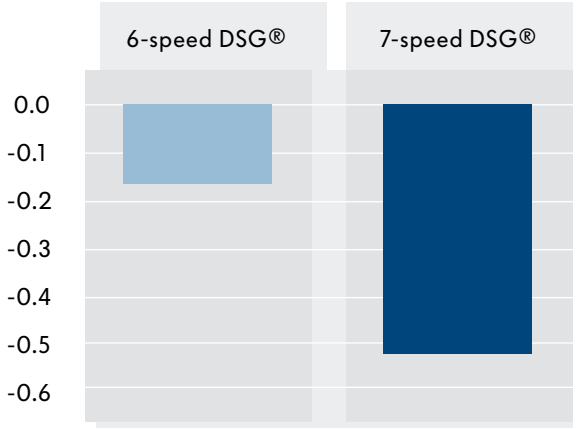
Transmissions investigated

	Torque converter transmission	6-speed DSG®	7-speed DSG®
Number of gears	6	6	7
Max. torque	320 Nm	350 Nm	250 Nm
Clutch	-	Wet	Dry
Transmission oil volume	5.8 l	6.5 l	1.7 l
Weight [a]	85 kg	93 kg	77 kg
Consumption advantage [b]	Reference	-0.3 l/100 km	-0.8 l/100 km
Efficiency [c]	83%	85%	91%

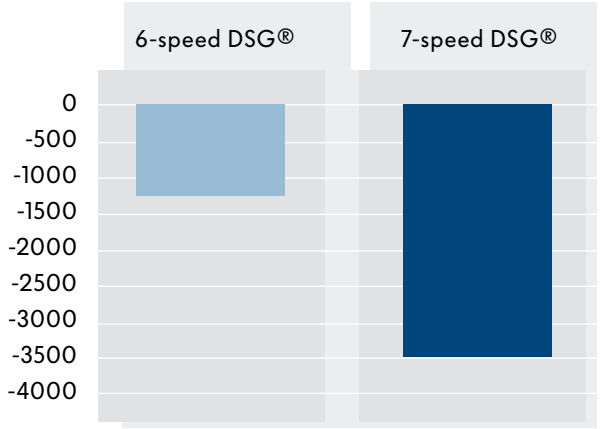
[a] including double-mass flywheel and oil
[b] compared with a Golf 1.4 TSI 90 kW with torque converter transmission (model calculation)
[c] average efficiency in 5th gear

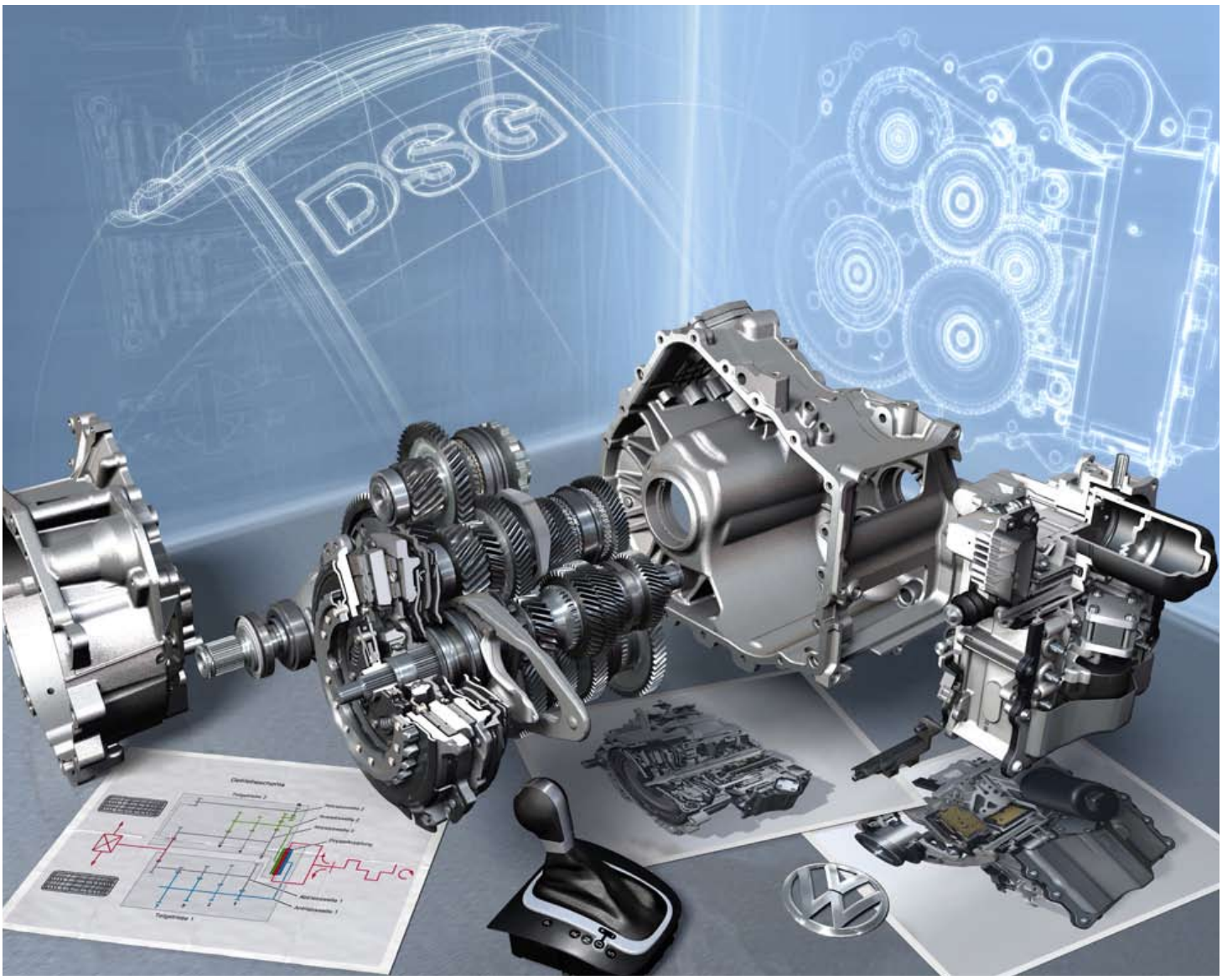
The results of the Life Cycle Assessment of the DSG dual-clutch gearbox indicate considerable improvements over the entire life cycle compared with a torque converter transmission. These improvements largely relate to the service life phase. Both in terms of greenhouse effect and as regards summer smog, the 6- and 7-speed DSG gearboxes present considerably better values than a conventional automatic transmission. Over the calculated service life of 150,000 kilometres, the 6-speed DSG results in a reduction of 1.2 metric tons of carbon dioxides emissions and the 7-speed DSG in a reduction of 3.5 metric tons. Clear improvements are also evident as regards summer smog. You will find a more detailed analysis of all the environmental impacts investigated in the background report to the environmental commendation at **www.environmental-commendation.com**.

Reduction in summer smog over the life cycle
(ethene equivalents in kg)



Reduction in greenhouse effect over the life cycle
(CO_2 equivalents in kg)





Environmental Description DSG® Gearboxes

The environmental profile of DSG gearboxes over the entire life cycle is generally improved, compared with torque converter transmissions[5] as a result of higher efficiency, lower consumption and reduced emissions.

Factors in reduced fuel consumption:
– use of dual clutch
– intelligent transmission control
– high efficiency

Significantly reduced fuel consumption:
– 0.3 l/100 km less with 6-speed DSG
– 0.8 l/100 km less with 7-speed DSG

Lower greenhouse effect over the entire life cycle:
– reduction of 1.2 metric tons in carbon dioxide emissions with 6-speed DSG
– reduction of 3.5 metric tons in carbon dioxide emissions with 7-speed DSG

Enhanced environmental protection and resource conservation:
– 71 percent less oil required (7-speed DSG)
– lower contributions to summer smog and acidification

[5] All values are based on a Golf 1.4 TSI with 90 kW (model calculation)

The Environmental Commendation

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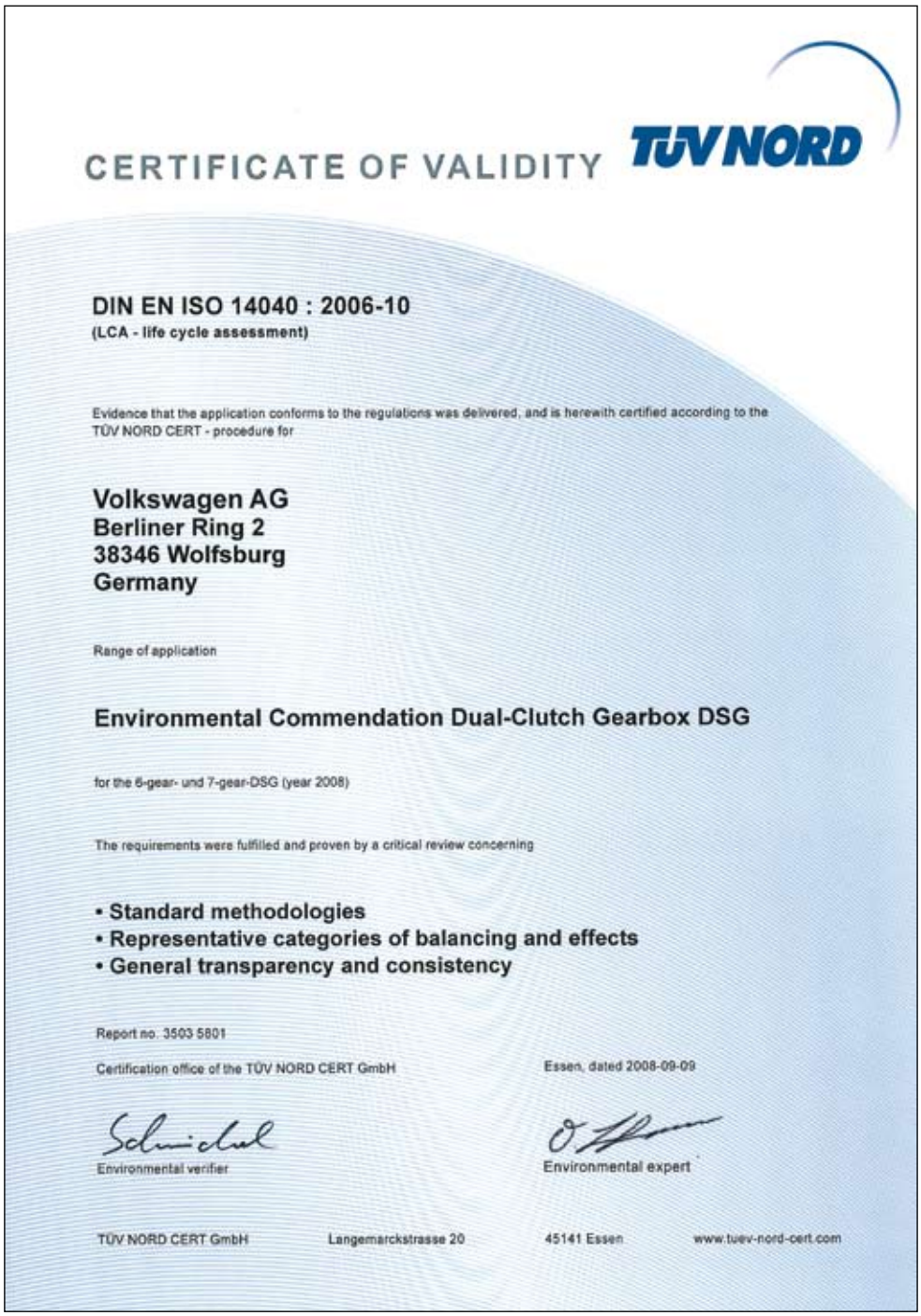
The information in this environmental commendation is based on the Life Cycle Assessment of the DSG dual-clutch gearbox, which has been reviewed and certified by the technical inspection organisation TÜV NORD. The certificate confirms that the Life Cycle Assessment is based on reliable data and that the methods used to compile it comply with the requirements of ISO standards 14040 and 14044.



CERTIFICATE OF VALIDITY

TÜV NORD

DIN EN ISO 14040 : 2006-10
(LCA - life cycle assessment)

Evidence that the application conforms to the regulations was delivered, and is herewith certified according to the TÜV NORD CERT - procedure for

Volkswagen AG
Berliner Ring 2
38346 Wolfsburg
Germany

Range of application

Environmental Commendation Dual-Clutch Gearbox DSG

for the 6-gear- und 7-gear-DSG (year 2008)

The requirements were fulfilled and proven by a critical review concerning

- **Standard methodologies**
- **Representative categories of balancing and effects**
- **General transparency and consistency**

Report no. 3503 5801

Certification office of the TÜV NORD CERT GmbH

Essen, dated 2008-09-09

Environmental verifier

Environmental expert

TÜV NORD CERT GmbH Langemarckstrasse 20 45141 Essen www.tuev-nord-cert.com

Technologies for the Future

The Volkswagen Powertrain and Fuel Strategy covers the entire range of present and future drive systems from current petrol and diesel engines via hybrid drives and engines with the Combined Combustion System (CCS) to electric vehicles with batteries or hydrogen technology. In developing our technologies, we are committed to reducing current emission levels and to ensuring zero-emission driving to the greatest extent possible in the future.

As regards fuels, Volkswagen is engaged in a number of projects with partners to produce fuels from various different raw materials. For Volkswagen, the main emphasis is on second-generation biofuels which can be produced from various types of biomass; during combustion, these fuels only release into the atmosphere the same volume of carbon dioxide as was absorbed by the plants as they grew. One example is SunFuel, a registered trademark of Volkswagen. SunFuel can be produced from forest or industrial wood residues, animal waste or straw and therefore does not compete with food production. SunFuel is already being produced in the world‘s first production plant at Freiberg in Germany. In technical terms, both petrol and diesel could already be replaced by SunFuel.

The benefits of hybrid drive are particularly evident in urban driving in large cities or conurbations. Of the various prototypes already presented, the Golf “TwinDrive” is especially promising. The special feature of the TwinDrive is that the internal combustion engine provides assistance for the electric motor, and not vice versa. This means that the vehicle can be driven considerable distances without producing any direct emissions. In electric propulsion mode, the range of the TwinDrive is about 50 kilometres. From 2010, up to 20 vehicles will be involved in an electric mobility fleet test to test electric propulsion in everyday use

The fuel cell is another technology that demonstrates the innovative capabilities of Volkswagen. The research and development team at Volkswagen has developed a unique type of high-temperature fuel cell that eliminates many of the problems associated with previous low-temperature systems. The high-temperature fuel cell will make the entire drive system installed in a vehicle lighter, smaller, more durable and less expensive – and these are the key factors as fuel cells are developed to readiness for industrial scale production. Volkswagen is expecting to test the first prototypes with high-temperature fuel cells in 2010. Current forecasts predict that the first production vehicles will not be launched before 2020.

In the long term, Volkswagen regards the electric motor as the drive system of the future. A key element in the growing trend towards electrification will be the use of energy from renewable sources such as wind or solar energy or hydropower. Ideally, an electric vehicle should be able to „fill up“ directly with electricity. The „tank“ or energy storage device is a rechargeable battery. This drive configuration has the benefit of high overall efficiency as the electric power is used directly for propulsion. In contrast to internal combustion engines, drive systems of this type generate no local emissions. In a zero-emission study of the space up! blue, Volkswagen has already demonstrated an electric motor drawing its power from a lithium ion battery system. Powered solely by batteries, the space up! blue can already cover the average daily distances driven in today‘s urban traffic.

Further Information

– The Golf – Environmental Commendation
– The Passat – Environmental Commendation
– Moving ahead. Thinking. Acting. Responsibility and Efficiency in the Vehicle Life Cycle
– Evolution not Revolution – The Volkswagen Fuel and Powertrain Strategy
– Making Zero Emissions Possible – Volkswagen Fuel Cells and Electric Drives
– Taking Responsibility – Volkswagen and CO_2
– The Volkswagen AG Sustainability Report 2007/2008

You will find all these publications on the Internet at **www.mobility-and-sustainability.com**.
Further information on the Environmental Commendation is available at **www.environmental-commendation.com**.

The DSG Dual-Clutch Gearbox
Environmental Commendation

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Art. no.: 815.1245.12.18
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