Environmental Report 2005

Interim Review

Acting with responsibility at Audi
# Contents

1 Editorial 3
2 The Audi Group 4
3 Environmental policy and organisation 12
4 Sustainable mobility 34
5 Production and sites 76
6 Service and sales 106
7 Occupational health and safety 116
8 Commitment and communication 120
Index 130
Ladies and Gentlemen,

Anyone who plans to sell cars successfully tomorrow needs to focus on the technology of the future today. This is a rich tradition at Audi. The company’s many technical innovations have frequently set new benchmarks and trends: the improvement made to the efficiency of diesel and petrol engines through direct injection, the perfecting of lightweight designs with aluminium bodies and the selection of environmentally-friendly materials have all led to clear advantages in eco-efficiency for the Audi models. The success of our brand is also based on the fact that intelligent technology can resolve the apparent contradiction between consumption and performance. The latest step on this path has been the modern TFSI engines, which we are currently using in the A3, A4 and A6 model series.

“Sportiness, emotional design, quality and environmental awareness are not irreconcilable goals at Audi.” We do not see any contradiction between driving pleasure and sustainable mobility. We are developing alternative engine concepts that will thrill our customers in ten or twenty years’ time. But we also want to offer products in the immediate future that make driving a pleasure for our customers while at the same time enhancing the emission behaviour of our engines even further. There is no single answer to this, so we are pursuing a variety of different technical concepts ranging from synthetic fuels to hybrid drive and even fuel cells.

At Audi, environmental protection covers the whole life cycle of the vehicle. The recipe for success is called the Integrated Product Policy: from the procurement and processing of raw materials to production, transport, marketing and consumption and even to waste disposal, all phases of the product’s service life are considered as an integral whole. Environmental management at Audi is based on the complex interaction between the ecological, economic and social effects of our vehicles. This foresighted management tool enables us to satisfy the staffing, technical and administrative prerequisites for complying with all environmental laws and achieving the high environmental goals we have set ourselves.

Closed water and waste cycles, the use of water-soluble paint and the recovery of heat energy have all helped to considerably reduce the environmental impact at all of our sites. Strict ecological standards are in force at all of our plants. Moreover, Audi is also committed to social responsibility at its sites.

Our major goal of “sustainable mobility” requires not only comprehensive environmental management, but also reliable political conditions. If we start developing a new model today, that vehicle will still be on the roads in over 20 years time, so we need reliable planning and we are strongly in favour of harmonised environmental standards—ideally, for the entire EU.

In this Environmental Report, Audi presents an interim review of its activities on the path towards a sustainable, automobile future. We wish you pleasant reading!

Prof. Dr. rer. nat. Martin Winterkorn
Chairman of the Board of Management, Technical Development
Audi is one of the world’s leading premium brands for high-quality and technically advanced cars that are among the most desirable on the international market. Our success is based on a progressive and innovative style of corporate management and development. We focus on the wishes of our customers in our continuous search for better solutions. This philosophy is reflected in our brand claim: “Vorsprung durch Technik”.

The Audi Group
Success has four rings
Audi owes its name to a pupil of Latin. When the founder of the Audi Group, August Horch, was searching for a name for his new car production plant in 1909, the son of the Chief Executive of the subsequent Audi Automobilwerke GmbH, Franz Fikentscher, came up with the perfect idea: Audi—derived from the Latin verb “audire”—which translates into German as “Horch!” (English: “Hark!” or “Listen!”).

Since then, the name Audi has become famous all over the world and is now one of the leading automotive brands. The small firm Audi Automobilwerke GmbH, founded in Zwickau, Germany in 1909, has grown into a multinational corporation with annual sales of EUR 24.5 billion (2004).

The four rings in the logo symbolise the merger of the four founding companies Audi, DKW, Horch and Wanderer. They merged in Chemnitz, Germany, in 1932 to form AUTO UNION AG. DKW developed motorcycles and compact cars and laid the technical foundation for the triumphant success of the modern front-wheel drive. Wanderer, Audi and Horch covered the exclusive segments from the upper midsize class up to the luxury class. The group was joined in 1969 by Neckarsulm-based NSU Motorenwerke, which was merged with Auto Union to form Audi NSU Auto Union AG. Since 1985, the company has operated under the name AUDI AG and covers the entire segment of sporty premium vehicles from the Audi A3 to the Audi A8.

Audi regards the present Environmental Report as an interim review because environmental protection at an innovative brand manufacturer has to adapt constantly to new challenges and technologies. Besides this report, the updated environmental declarations of the individual Audi Group sites also provide in-depth information about our progress with goals and measures relating to environmental protection.

Audi is moving towards a concept of sustainability reporting, so this Environmental Report also contains information on social issues such as occupational health and safety management and economic aspects such as the marketability of alternative engines. We regard environmental and sustainability reporting as a continuous, open process, which should be enhanced constantly and which will help to define the strategic orientation of the company in future. We therefore nurture critical dialogue with our stakeholders and encourage suggestions about the guidelines and standards needed for effective sustainability reporting, as recommended, for instance, by the Global Reporting Initiative (GRI). We have therefore been closely following the discussions about the specific amendments to the GRI Guidelines for the automotive industry. Unfortunately, the relevant pilot version of the GRI had not been completed at the time of printing of this report.

The publisher of this Environmental Report is AUDI AG. The reporting period extends from the start of 2000 until the end of 2004. The environmental data and measures described in the report refer as a rule to the European production sites for the Audi brand in Győr, Hungary and in Ingolstadt and Neckarsulm, Germany. Due to the ongoing consolidation process, the section Occupational health and safety features measures and data from the two German sites at Ingolstadt and Neckarsulm only.
2.1 The Audi brand

Milestones in automotive production
Audi continuously strives to build forward-looking cars. Our models—from the Audi A3 to the Audi A8 and from the Audi allroad quattro to the Audi TT—boast extremely strong driving dynamics, superlative finishing and outstanding design—a persuasive combination. Almost every Audi model has made history: for instance, in 1980, the Audi quattro was the first mass-produced passenger car with permanent all-wheel drive and became the driving force behind a development that has led almost all car manufacturers to provide an all-wheel version of their vehicles. The lightweight body of the Audi A8 revolutionised the automotive industry. With its direct-injection TDI engine, launched in 1989, Audi ultimately achieved not only better driving performance, but also much lower fuel consumption, which triggered a diesel boom that is still very much in evidence today.

These developments show how high driving pleasure and economical fuel consumption, technology and environmental protection can all be unified under the roof of an innovative brand like Audi.

Steady rises in turnover, production and unit sales have been clear indicators of the success of the Audi brand for the last ten years. For instance, turnover climbed by 4.2% in 2004 to the record value of EUR 17.9 billion, and at the same time Audi sold 779,441 vehicles—more than ever before in a single year.

<table>
<thead>
<tr>
<th>An overview of the production figures</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingolstadt</td>
<td>476,964</td>
<td>480,015</td>
</tr>
<tr>
<td>Neckarsulm</td>
<td>220,023</td>
<td>239,950</td>
</tr>
<tr>
<td>Győr</td>
<td>33,953</td>
<td>23,605</td>
</tr>
<tr>
<td>Commissioned by AUDI AG</td>
<td>29,285</td>
<td>39,724</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>760,225</td>
<td>783,294</td>
</tr>
</tbody>
</table>
International presence

Audi is a multinational corporation based in Germany. In 2004, a total of approx. 53,000 people were employed at the various sites all over the world. As well as its sites in Ingolstadt and Neckarsulm, the Audi Group is also represented in Hungary, Italy, Brazil, Australia, Japan and China. The central site for engine production is Győr in Hungary. This plant also produces the Audi TT.

The headquarters of the Audi Group, where more than half of all Audi employees work, is located in Ingolstadt, Germany. Around 2,000 cars are produced here every day—in particular, the Audi A3, the Audi A4 and—in co-operation with Győr—the Audi TT body. Roughly another 1,000 vehicles roll off the assembly line at the second German site in Neckarsulm, the home of the Audi A2*, A6, A8 and the Audi allroad quattro. The Neckarsulm site also includes the Audi Aluminium and Lightweight Design Centre, a technological competence centre that plays a crucial role in the development of the cars of the future.

* Up to mid-2005

Sales revenue of the Group

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue (in millions of euro)</td>
<td>19,952</td>
<td>22,032</td>
<td>22,603</td>
<td>23,406</td>
<td>24,506</td>
</tr>
</tbody>
</table>

Figures for 2001 provided in accordance with the International Accounting Standard (IAS) for the first time; for the purposes of comparison, values from the 2000 financial year have been transferred to IAS.

Staff development in the Group

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees (average)</td>
<td>49,396</td>
<td>51,141</td>
<td>51,198</td>
<td>52,689</td>
<td>53,144</td>
</tr>
</tbody>
</table>
International market share expanded
With 235,092 vehicles sold in 2004 and a market share of 7.2%, Germany remains the most important sales market for Audi. As the increase in the export rate to around 70% clearly proves, Audi was able to improve its position abroad even further during this reporting period. In Western Europe alone, 3.8% of all new registrations were Audi models, which enjoy notable popularity in Great Britain and Italy. The company is well positioned in Japan and the future market of China, where the demand for Audi models—especially those in the luxury class—remains high. For instance, by the end of 2004, over 300,000 cars with the four rings had already been assembled in the Far East.

The great model offensive
Since 2002, Audi has time and again caused sensations with its innovative models: the second generation of the Audi A8 sparked huge interest even before its market launch in 2002, and was then voted the best eight-cylinder luxury saloon by the readers of the specialist magazine “Auto Zeitung”. The Audi A4 Cabriolet was also unveiled in 2002 and surpassed all expectations for the new model within just a year. In 2003, the agile appearance of the second-generation Audi A3 thrilled the public, while another highlight of the model offensive was the new Audi A6 in 2004, which proved to be even sportier and more dynamic than its predecessor. The five-door Audi A3 Sportback followed in September 2004 in response to customer wishes for more elegance and leisure style in the compact class. In November 2004, the completely revised A4 model series was launched on the market.

With its future models, Audi intends to develop its position as a progressive premium brand, and will continue to focus on environmental issues. The new Audi A8 3.0 TDI quattro* is available with a maintenance-free diesel particulate filter and, even without this filter, complies with the EU IV emission standard. 20 Audi models with diesel engines complied with this standard—which will become binding in 2006—back in late 2003. No other car manufacturer was able to offer such a wide range of diesel vehicles that satisfy the EU IV emission standard as early as Audi.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
2.2 The Audi brand group

A team with three clear strengths
The Audi brand group consists of the brands Audi, Lamborghini and SEAT and provides a wide range of innovative products from the compact class to the luxury saloon and even super sports cars, which complement each other perfectly with their brand values of sport, design and technology.

The Italian subsidiary Lamborghini celebrated its fortieth anniversary in 2003 with a new production and sales record. The super sports car producer with the bull emblem has much to be proud of, including the successful market launch of its new model, the “Murciélago Roadster”.

The SEAT “Altea” prototype was unveiled at the International Motor Show (IAA) in Frankfurt in autumn 2003 as the first joint product of the Audi brand group, and launched on the market a few months later. The new SEAT “Toledo” was also unveiled in 2004.
The Audi A3 and Audi A3 Sportback – the compact challenge

With around 1.2 million units sold (as of January 2005), the forward-looking Audi A3 is now one of the best-known models in the compact class. But it is more than just that: the Audi A3 was the first car to make the compact class attractive for discerning customers. It offers the same quality of materials and finish to which the consumers are accustomed from the big Audi models. As a result, the A3 combines the prestige of an exclusive saloon with the economic and environmental efficiency of a smaller vehicle.

The second generation of the Audi A3, launched in 2003, increased the lead over the competition even further. In this three-door hatchback—so smooth that it seems to have been poured from a single mould—the developers focused even more closely than with its predecessor on an extremely dynamic character: outstanding driving performance, smooth cornering and a decidedly sporty power transmission all contribute to the driving experience. Efficient fuel consumption and numerous safety features are aimed at the responsible buyer. Environmentally-friendly production processes, such as the use of water-soluble paints, also speak in favour of the Audi A3.

The A3 product line was extended into a new segment in the summer of 2004 with the introduction of the Audi A3 Sportback, which combines the sporty elegance of a coupé with the versatility of a five-door hatchback. In this way, Audi is emphasising its long-term commitment to the compact class and is proving at the same time that excellent value and sporty elegance need not necessarily be equated with large dimensions.

All the Audi A3 models, including the diesel variants, comply with the EU IV emission standard. The advanced transmission technology offers possibilities for every style of driving and provides remarkable levels of efficiency even in the high-performance range.
Direct injectors with outstanding energy efficiency
Top marks on the path towards perfect efficiency are awarded to both the 110 kW (150 bhp) 2.0 FSI* with 7.2 litres per 100 km and the 103 kW (140 bhp) 2.0 TDI* with 5.5 litres with Euromix. Both engines satisfy the highest driver demands. The 1.6 FSI* with 6.6 litres and the 1.9 TDI* with just 4.9 litres in normal consumption boast even lower values—and are the absolute leaders in the general competition. It is clear that all the Audi A3 models can be driven extremely economically, but that, if necessary, they can also provide outstanding driving performance that has made the Audi A3 the sportiest car in the compact class.

Efficiency in the high-performance range
This is particularly clear in the latest engine variant: the Audi A3 Sportback 2.0 TFSI* accelerates with 147 kW (200 bhp) from 0 to 100 km/h in 7.0 seconds and yet only consumes 7.7 litres with Euromix. The maximum torque of 280 Nm is available from 1,800 right up to 5,000 rpm and so permits a relaxed, controlled driving style.

The new engine is the first series engine in the world to combine FSI direct injection with a turbocharger. This technology—also used in the Le Mans-winning Audi R8—allows a unique synthesis of top performance, excellent engine power in every speed range and exemplary economy. It represents perfectly the engine philosophy at Audi: the customer can drive with real passion—if he wants to. But he can also use the outstanding efficiency of his Audi to keep his fuel consumption low. And that, too, is a taste of freedom.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
Cars and their production should place as light a burden on the environment as possible—this is the core of the AUDI AG environmental policy. The company has developed an environmental strategy that is already ensuring uniform standards at all the sites. The focus is on the Integrated Product Policy: environmental protection must be taken into account at an early stage in the development of a product.
3.1 Environmental policy

Avoiding environmental impact by looking ahead

The production of vehicles inevitably burdens the environment, because every business needs energy and water and produces waste water, noise and emissions.

Audi has set itself a goal: to continuously minimise these burdens and produce environmentally-friendly cars. The reduction of energy and water consumption, cutting noise pollution and emissions and avoiding waste and pollutants are the main action fields of the Audi environmental policy.

The AUDI AG environmental policy

A harmonised environmental policy is in force at all sites. This policy defines the joint, Group-wide environmental standards, supplemented by specific environmental-protection criteria that regulate the implementation on a local level. The environmental policy commits AUDI AG to supplying cars that are comfortable, economical, safe and as friendly to the environment as possible. The golden rule for all activities is to avoid any impact on the environment by looking ahead. The planning and development departments play a key role in the implementation of this principle. Their task is to develop ecologically efficient processes and concepts for the Audi models. To achieve this, Audi defines targets and measures. These affect employees, but also suppliers, service providers and trade partners, who are regarded as a permanent component of a Group-wide environmental partnership. The Member of the Board in charge of the Production division is responsible for compliance with the environmental policy.

Although compliance with environmental legislation is regarded as second nature at all the Audi sites, the company is not satisfied with this. Both in terms of corporate and site-specific environmental protection, Audi goes beyond the statutory requirements, e.g. with its early fulfilment of the EU IV emission standard, which becomes valid in 2006, in the majority of the Audi models and with its numerous employee training courses on the topic of environmental protection.

Principles

1. AUDI AG supplies high-quality cars that satisfy its customers’ requirements in terms of environmental friendliness, economy, safety, quality and comfort in equal measures.

2. Research and development are crucial elements in Audi’s environmental policy. AUDI AG develops ecologically efficient processes and concepts for its products and so increases its own international competitiveness.

3. It is the declared aim of AUDI AG to avoid detrimental influences on the environment in all its activities by looking ahead. Compliance with all environmental regulations is taken as a matter of course.

4. Environmental management at AUDI AG—together with supplier companies, service providers, trade partners and recycling companies—ensures that the environmental friendliness of the cars and the production sites are continuously being improved.

5. The Board of AUDI AG is responsible for compliance with the environmental policy and the functioning of the environmental management system. The environmental policy is reviewed regularly to ensure that it is suitable and functional; if necessary, it is updated.

6. Open and clear communication with customers, dealers and the public is taken as a matter of course by AUDI AG. Co-operation with the government and authorities is based on trust. It includes emergency precautions and maintenance at the individual production sites.

7. All employees at AUDI AG are informed, qualified and motivated on the subject of environmental protection in accordance with their individual function, so that their sense of responsibility for the environment is encouraged. They are obliged to follow these principles.

8. This environmental policy is binding for all sites within AUDI AG and is supplemented and/or made more specific by site-related main action fields.
In terms of environmental protection, the focus of national, regional and European attention has shifted in recent years more and more towards the search for solutions to global environmental problems such as climate protection and preservation of resources. Nowadays, environmental protection is increasingly discussed under the heading “sustainability” rather than “ecology”. This reflects the point that all our business actions, with due consideration of economic and
social aspects, must be adapted in line with the fact that the bearing capacity of the natural balance is limited. For businesses like Audi, sustainability means that not only economic success but also ecological and social awareness is indispensable.

In the development of our products and the definition of procedures and processes in production, an integral approach is absolutely crucial. In the context of our Integrated Product Policy, the effects of our products on mankind and the environment are considered throughout the entire product service life. Our aim—in the context of the environmental management system at Audi—is to apply an integral philosophy that is oriented towards sustainable development to every pending decision.

The customer also plays a decisive role in the Integrated Product Policy. By deciding to buy an Audi vehicle, customers play a role in ensuring that products are developed and manufactured that place a lighter burden on the environment both in their use and in their production.

"sibility is crucial"
3.2 Environmental organisation

Decentralised environmental protection
Committees have been set up on two levels at Audi to co-ordinate environmental protection at the company. On the one hand, the Environmental Protection Co-ordination Committee is responsible for the Group-wide steering of environmental protection activities within the Audi brand group, while at AUDI AG—and similarly at each of the other brands—an Ecology Steering Committee acts as a central committee for the cross-site and cross-divisional implementation of environmental activities.

Under the leadership of the Member of the Board for Production, the Environmental Protection Co-ordination Committee consists of the respective Environmental Management Commissioners from AUDI AG, AUDI HUNGARIA MOTOR Kft., Automobili Lamborghini Holding S.p.A. and SEAT S.A. It is concerned with strategic environmental protection issues and commissions the environmental committees at the brand group to develop relevant proposals. The Plant Manager at the Ingolstadt site acts as the General Manager, and in this function represents the interests of the Co-ordination Committee in the Group Environmental Steering Committee of the VW Group.

Ecology Steering Committee co-ordinates environmental protection at AUDI AG
The Ecology Steering Committee plays a central role on the level of AUDI AG by implementing the tasks commissioned by the super-ordinated Environmental Protection Co-ordination Committee and also developing suitable environmental
protection strategies. It has the task of raising employee awareness of ecological issues and of setting up cross-divisional and cross-site working groups for developing and implementing topics relating to environmental protection. The Plant Manager at the Ingolstadt site and the Environmental Protection Manager invite the members of the Steering Committee, which consists of representatives of the various divisions at Ingolstadt and Neckarsulm, to joint meetings several times a year.

At the Ingolstadt and Neckarsulm sites, several thematic working groups on topics such as end-of-life vehicle recycling, sustainability, environmental report, environmental management and IPP report to the Ecology Steering Committee. They develop programmes of environmental protection measures, produce a communication concept, make suggestions for strategic environmental protection issues and present them to the Ecology Steering Committee. The Environmental Protection Manager at Ingolstadt is the chairman of the Ecology Steering Committee.

Environmental protection is a job for the bosses
The overall responsibility for environmental protection lies with the Managing Board, which has entrusted the Member responsible for the Production division with the performance of environmental protection tasks. The Member of the Board for Production is therefore responsible for compliance with the environmental policy. According to § 52a of the German Federal Immission Control Act (BImSchG), his duties include monitoring compliance with the legal environmental stipulations for systems requiring permits. However, as he is entitled to delegate these tasks, the Member of the Board for Production passes these responsibilities on to the operators of any environment-related systems.

The Operational Environmental Protection departments are responsible for corporate and site-related environmental protection, while the Environment and Transport department is responsible for product-related environmental protection. The Environmental Protection Manager in Ingolstadt also manages the cross-site co-ordination of issues relating to operational environmental protection at AUDI AG.
At each site, the Board of Management appointed the Environmental Protection Manager as the Operational Commissioner for Environmental Protection and has given him the task of ensuring that each plant fulfills the statutory requirements. Each site also has its own Environmental Management Commissioner, who is responsible for the successful implementation of the environmental management system. In Ingolstadt, this task is assumed by the Plant Manager; in Győr, it is carried out by the Managing Director for Production and in Neckarsulm the Environmental Protection Manager performs both the function of the Environmental Management and Environmental Protection Commissioner.

Involvement in the Group Environmental Steering Committee at VW
At VW Group level, Audi plays a crucial role in the development of the environmental protection strategy through the Group Environmental Steering Committee and the Group Environment Conference. In this function, Audi hosted the 2nd Environment Conference of the VW Group in May 2002 in Ingolstadt, in which 130 environmental experts from Audi, SEAT, Lamborghini, VW, Škoda and Bentley took part. In future, the focus will be on driving forward environmental protection at suppliers, the CO2 strategy, a sustainability concept and the harmonisation of the environmental protection standards within the Group.
3.3 Environmental management

**EMAS II and DIN EN ISO 14001 as indicators**

The DIN EN ISO 14001 standard requires environmental management systems to implement a system audit and then provides confirmation—in the form of a certificate—of the environmental performance of the company. Validation in accordance with EU Regulation 761/2001 (EMAS II) includes the requirements of DIN EN ISO 14001 and also stipulates continuous improvements and the creation of a standardised environmental declaration. Audi fulfills this reporting obligation at site level.

**Environmental management systems at the sites**

The sites Ingolstadt, Neckarsulm and Györ each possess their own environmental management systems in accordance with EMAS II and DIN EN ISO 14001. Other sites in the Audi brand group, including SEAT in Spain, also implement an environmental management system. In its environmental declarations, the company reports about continuous improvements in the context of its EMAS II environmental management system.

The Ingolstadt site has expanded its environmental management system during this reporting period and has introduced a system for assessing environmental performance that is derived from the Swiss SAEFL procedure (Swiss Agency for the Environment, Forests and Landscape – BUWAL). Using a points system, environmental effects can be determined statistically and then weighted according to the set priorities. This procedure allows an optimised assessment of direct and indirect environmental aspects and has been applied in Ingolstadt and Neckarsulm since 1999.

**Environmental management systems at the individual sites**

<table>
<thead>
<tr>
<th>Site</th>
<th>DIN EN ISO 14001</th>
<th>EMAS and/or EMAS II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingolstadt</td>
<td>Since 2000</td>
<td>Since 1997</td>
</tr>
<tr>
<td>Neckarsulm</td>
<td>Since 1995</td>
<td>Since 1999</td>
</tr>
<tr>
<td>Györ</td>
<td>Since 2002</td>
<td>Since 1999</td>
</tr>
</tbody>
</table>
Ildiko Beres, Environmental Protection, Győr

"With our commitment to environmental pioneering role in the Hungarian econo
Even though Hungary has only belonged to the European Union since May 1st 2004, we are already very familiar with the European environmental legislation. We have participated in the EU eco-audit system since 1999, and we also have our site certified every year according to the international environmental standard ISO 14001. The active design of an environmental management system is a major challenge, so we are particularly proud that we successfully completed the reaccreditation according to EMAS II in 2002. In spite of these good results, we will definitely be taking more steps to improve our environmental performance. At present, we are focusing particularly on training our employees. In this way, we hope to raise awareness and the presence of the environmental management system in our operations even more. Our environmental manual and the environmental information that our colleagues can access at any time on the Intranet have been a great help in this. We present the results of our commitment to the environment every year in our environmental declaration.
Responsibility for environmental protection in operations

In terms of environmental management, Audi has chosen a special path. Employees qualified specifically in operational environmental protection communicate to other Audi employees the environmental knowledge they need for their field. To this end, the company has appointed Operational Managers for Environmental Protection (BVfUs), whose task is to support the Environmental Commissioner and their superiors in their environmental protection responsibilities. Each of these BVfUs should carry out regular inspections and generally keep their eyes open around the plant, and also support the system operator with his operational duties.

Regular training events are held for the BVfUs to help them in their task of promoting environmental protection in the long term in their field of responsibility, encouraging and instructing the employees to maintain environmental awareness in their behaviour and informing them about the latest developments. The events teach them to act as interfaces, conveying the specialist knowledge they have gained to their colleagues and acting as contact partners for them and for the environmental protection department. To fulfil their documentation duties, the BVfUs also produce regular quarterly reports and forward these to the relevant people including the Environmental Protection Commissioner.

There are a total of around 90 BVfUs at Audi, who promote the implementation of the environmental management systems as environmental interfaces: around 50 are in Ingolstadt, 20 in Neckarsulm and 20 in Győr.

The environmental protection department in Ingolstadt supports the training courses for the Production Group Leaders (FGLs), in which the top operational management level is trained in the focal points of operational environmental protection at AUDI AG. The technical departments are also regularly informed about and trained in the latest environment-related legislation.

Environmental manual sets out the framework

The environmental management system at Audi works according to the classic pyramid principle: the super-ordinated, environmental action principles of AUDI AG are at the top, which lead to a framework concept and several guidelines and are ultimately implemented on a broad basis by the employees. The Group’s environmental manual firstly specifies the procedures and responsibilities for environmental protection at Audi and thereby forms the starting point for the
environmental protection guidelines decided on by Audi. In addition, there are also internal, cross-
divisional procedural instructions on environmen-
tal protection that are binding for all employees.
Details stipulate the special working procedures
which are also binding. Finally, every employee at
Audi must comply with the environmental
guidelines and make a contribution at his or her
own workstation towards implementing the Audi
environmental policy in practical terms every day.

**Harmonised environmental standards**
Other standards and regulations above and
beyond the environmental management system at
Audi guarantee harmonised international
environmental standards within the Audi Group.
The environmental standard for vehicles, the
“Board Directive 081 Environmental Protection
Guidelines” and the Environmental and Human
Compatibility Specifications apply to all the Audi
sites all over the world. The product and quality
assurance department, Quality Readiness, whose
experts carry out local audits everywhere—
including at the suppliers—monitor worldwide
compliance with these standards.

The plants that Audi runs jointly with partners in
Brazil and China are just as stringent in terms of
operational environmental protection as the
European sites, because the investments there are
in line with the state of the art, which already fully
incorporates the latest environmental protection
technologies.

Interest in an environmentally-friendly
production style is particularly strong in China, so
employees from the East regularly come to
Ingolstadt to find out about the latest trends in
operational environmental protection. In this way,
Audi transfers its expertise in the field of
environmental protection.

---

**Documentation of the environmental management system**

**Principles**
The environmental policy at AUDI AG sets out the
environment-related action principles of AUDI AG.

**Framework concept**
The environmental manual describes procedures and
responsibilities for operational environmental protection.

**Guidelines**
Internal procedural instructions are binding for all
employees. They control the cross-divisional work contents.

**Regulations for individual cases**
The internal working instructions are binding specifications,
which are designed to regulate specific details.

**Implementation**
Within the context of his/her own activities, every employee
is also responsible for environmental protection
and the implementation of the Audi environmental policy.
Annual audit of the management systems
Every year, external assessors audit the environmental management system at the sites. The environmental declarations produced during these audits document the achieved progress.

The audit is carried out in two separate steps. Firstly, the management system as a whole is inspected, as the Environmental Management Commissioner explains the status of the environmental target agreements and documents the result in the management review. Selected areas are then audited and the submitted data are validated in the context of the environmental declaration.

Environmental protection excursions for trainees
Even the trainees have environmental protection on their timetable, which covers topics such as heat recovery, water purification, waste prevention and separation and noise control. A wide selection of training materials on the subject of environmental protection is also available to support the trainers.

A training day on environmental protection topics is organised once a year for every occupational group. Additionally, internal and external environmental protection excursions are organised; and anyone who requires more information can consult the special section on environmental protection and disposal of resources on the training web. The trainees have
learned their lesson and are actively contributing to environmental protection. For instance, a team is currently attempting to improve the waste-disposal concept for plastics in the training department. The trainees also provided the stimulus for improving heat insulation during the renovation of the training hall in Ingolstadt by applying heat-insulating plaster and replacing the old wired-glass windows with polycarbonate windows.

3.4 Tools for environmental protection

**Integrated Product Policy takes environmental protection into account from the outset**

Previously, environmental protection was often only applied at the end of the production process in the form of end-of-pipe solutions. However, nowadays it is no longer adequate to fit filters to chimneys, set up treatment plants for industrial waste water or destroy waste in incineration plants. Efficient environmental protection must be applied to the entire life cycle of a product, because the use of raw materials, energy consumption and emissions all depend on how a product is developed, produced, used and disposed of. Audi therefore follows an Integrated Product Policy (IPP) to reduce the impact on the environment even further.

With the IPP, it is considered right from the development phase of a product which effects it may have at a later stage, i.e. in all the phases of its life cycle, from material procurement to waste disposal. Audi has been using this Integrated Product Policy, which integrates all aspects of environmental protection from the very beginning, for many years and has considerably lessened the Group’s environmental impact as a result.

For instance, in 2001, the Ingolstäd site became actively involved in various pilot projects related to the Integrated Product Policy within the context of the Environmental Pact of Bavaria II. The aims of these projects included the investigation of tools designed to reduce the environmental effects of cars, which are effective in all stages of a car’s service life.
An example for the further development of the Integrated Product Policy is the E2Pro project, which is dedicated to the development of comprehensive databases. With the help of these databases, Audi engineers will be able in future to integrate ecological aspects such as the improvement of energy efficiency and recycling capacity into the development process. The project is promoted by the German Federal Ministry of Economics and Labour (BMWA) and is supervised by the project organiser, the Forschungsinstitut Jülich. It is intended to support the federal government’s efforts to reduce CO₂ emissions and to create an Internet platform which communicates information about innovative, climate-friendly materials and technologies.

Simultaneous Engineering creates synergies

Audi employs the Simultaneous Engineering tool right from the first phase of product development and in the planning of the production process. Simultaneous Engineering at Audi refers to the open, selective co-operation of all parties involved, including the suppliers. The aim is to integrate environmental aspects into all processes through intensive communication and co-ordination and to raise awareness of environmental issues among the developers. For instance, valuable cost, material and even environmental protection synergies can be created by taking the later recycling or the ease of repair into account in the selection of materials. This also allows problems that do not arise until the production process to be detected and solved at an early stage.
Co-operation with the suppliers via the IMDS

Co-operation with the suppliers is another important component of the environmental protection strategy at AUDI AG. The co-operation ensures that the necessary environmental protection specifications are observed along the entire supplier chain.

The Group purchasing section has developed an Electronic Supplier Link with an online database, which must be used by the suppliers. This provides them with a detailed list of the guidelines and standards that Audi prescribes in its Environmental and Human Compatibility Specifications and the “Environmental standards for vehicles”.

As a cross-industry solution, an Internet-based database for material descriptions has been produced by Audi together with other car manufacturers and the support of the German Association of the Automotive Industry (VDAI). The partners in the supplier chain use this International Material Data System (IMDS) to communicate the material contents of their products to their respective customers and ultimately to the car manufacturers. On this basis, Audi checks the conformity of the material contents with the statutory requirements and its own criteria.
The involvement of its employees plays a crucial role at Audi. The company has created its own organisational concept, the Audi Production System (APS), which creates order with a methodical, structural framework and so provides greater clarity and networking, especially in production. The APS plans “cascade” training courses, which will ensure the fulfilment of the Audi standards in all divisions of the company. In recent years, environmental protection has also been integrated into the APS.

### Environmental Policy and Organisation

- **3 Environmental policy and organisation**
  - **3.1 Environmental policy**
  - **3.2 Environmental organisation**
  - **3.3 Environmental management**
  - **3.4 Tools for environmental protection**
  - **3.5 Environmental programme**

### APS Integrates Environmental Protection

The involvement of its employees plays a crucial role at Audi. The company has created its own organisational concept, the Audi Production System (APS), which creates order with a methodical, structural framework and so provides greater clarity and networking, especially in production. The APS plans “cascade” training courses, which will ensure the fulfilment of the Audi standards in all divisions of the company. In recent years, environmental protection has also been integrated into the APS.

The “environmental protection” element of the Audi Production System promotes active environmental protection by sensitising the employees to the issues that they can influence themselves in their workplace. For instance, employees are motivated to use water sparingly or are instructed in how to reduce energy consumption—either by minimising compressed-air leaks, optimising the operation of systems or simply by switching off unnecessary sources of light. With the help of the APS, the employees are instructed to comply with internal environmental protection specifications and to fulfil the statutory requirements whenever systems or processes are changed. Audits are carried out regularly to inspect the APS elements.
Ecological and energy assessments for concept comparisons

Audi evaluates innovative vehicle concepts, assemblies and production processes using comparative ecological and energy assessments, including material flows, energy consumption and emissions. In this way, for instance, the innovative aluminium body of the Audi A8 was evaluated in comparison to conventional concepts.

For valve hoods, the most favourable energy variant was determined from options such as sheet steel, sheet aluminium, cast aluminium, cast magnesium and plastic injection moulding. Other investigations have been and are still being carried out on matters such as the use of renewable raw materials, painting processes and transport protection.
AUDI AG environmental investments

The tables of the operational and investment costs show to what extent Audi has invested directly in environmental protection. Operational environmental costs refer to the expenses for the operation of systems or measures that support environmental protection, e.g. waste disposal costs, ground maintenance at the operational premises and the redevelopment of abandoned contaminated areas. On the other hand, environmental investments cover the acquisition of tangible assets that primarily protect against detrimental influences on the environment arising from the activities at the site. Another part of environmental investment falls under the general investments of the Group: these are primarily funds for the construction of tangible assets in which specific environmental protection measures cannot be easily recorded separately from the other processes and the construction measures.

While operational costs have recently remained relatively constant, investment costs have varied. These increased considerably in Ingolstadt and Neckarsulm during 2002. In Ingolstadt alone, investments doubled to EUR 33.5 million due to extensive renovation of the pre-treatment plants for the painting process and the related systems for water treatment.

### AUDI AG environmental investments

<table>
<thead>
<tr>
<th>AUDI AG in EUR (millions)</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental investments</td>
<td>20.1</td>
<td>16.0</td>
<td>36.3</td>
<td>22.2</td>
<td>27.7</td>
</tr>
</tbody>
</table>

Ingolstadt and Neckarsulm sites

### AUDI AG operational environmental costs

<table>
<thead>
<tr>
<th>AUDI AG in EUR (millions)</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational environmental costs</td>
<td>14.7</td>
<td>15.9</td>
<td>18.6</td>
<td>16.9</td>
<td>17.1</td>
</tr>
</tbody>
</table>

Ingolstadt and Neckarsulm sites
### 3.5 Environmental programme

#### Objectives and status of environmental protection at AUDI AG

<table>
<thead>
<tr>
<th>Environmental objective</th>
<th>Individual measure</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribute to the fulfilment of the agreement made by the European Automobile Manufacturers Association ACEA to reduce CO₂ emissions of new cars to an average of 140g/km by 2008.</td>
<td>Continued development of materials to promote progress in lightweight construction.</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>FSI engines to be offered in all model series from 2006</td>
<td>2006</td>
</tr>
<tr>
<td>Equip Audi diesel vehicles with a particulate filter.</td>
<td>Logically-implemented, standard fitting of a particulate filter in any diesel vehicle that does not conform to the limits of the Euro IV standard through internal engine measures by model year 2006</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Optional diesel particulate filter for vehicles that fulfil the Euro IV exhaust standard even without a filter.</td>
<td>2006</td>
</tr>
<tr>
<td>Optimise vehicles in terms of dismantling and recycling; optimise disposal at the end of the vehicle life with regard to ecological and economic issues.</td>
<td>Implementation and development of lifecycle analyses for all relevant materials, procedures and technologies</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Intensive development of materials with the aim of making them easier to recycle.</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Expansion of the contract dismantling network for recycling of end-of-life vehicles in Germany to at least 80 companies.</td>
<td>2005</td>
</tr>
<tr>
<td>Co-operate with other European car manufacturers in the standardisation of vehicle-vehicle communications in order to improve traffic flow and increase safety on the roads.</td>
<td>Evaluation of investigations from the current research project C2C on data transfer between individual vehicles.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Promotion of a decision on pan-European, cross-manufacturer frequency bands for vehicle-vehicle communication.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Development and use of Audi vehicles for experimental fleets in Europe and the USA.</td>
<td>2006</td>
</tr>
</tbody>
</table>
### Aims and status of environmental protection at AUDI AG

<table>
<thead>
<tr>
<th>Environmental objective</th>
<th>Individual measure</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue the strategy aimed at early compliance with the most stringent emission standards</td>
<td>Compliance with the Euro IV standard, which will be binding from 2006, for all Audi vehicles produced for European markets.</td>
<td>2005</td>
</tr>
<tr>
<td>Optimise water protection</td>
<td>Reduction of the nickel content of waste water by 90 percent before it is fed into the internal neutralisation system at the Ingolstadt site by using a partial-flow treatment system for waste water containing nickel in the North paintshop.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Reduction of the nickel content of waste water by 35 percent before it is fed into the public sewage plant at the Neckarsulm site by extending the existing waste water treatment plant.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Establishment of a central wash station with a suitable waste water treatment plant at the Neckarsulm site, so that even external companies can clean oily parts in an environmentally-friendly way.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Avoidance of carry-over of drawing oils through the use of dry-film lubricants for all materials to be processed in the pressing plant at the Neckarsulm site.</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>Reduction of waste water from the cataphoretic dip primer (KTL) by 50 percent at the Ingolstadt site by using more effective rinse zones and increasing the ultra-filtration performance in the KTL.</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Reduction of cooling lubricant carry-over, subsequent metering, waste disposal and transportation by using a press for aluminium filings in the production of drag bearings at the Ingolstadt site.</td>
<td>2005</td>
</tr>
</tbody>
</table>
### Aims and status of environmental protection at AUDI AG

<table>
<thead>
<tr>
<th>Environmental objective</th>
<th>Individual measure</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce energy consumption</td>
<td>Appointment of further energy teams/energy commissioners at the Ingolstadt site.</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Optimisation of the running times and air volumes in the ventilation systems at the Neckarsulm site.</td>
<td>2005</td>
</tr>
<tr>
<td>Optimise waste management</td>
<td>Reduction of the phosphate sludge to be disposed of as special waste at the Neckarsulm site using extraction procedures and chemical recycling resulting from technical experiments at the Clausthal-Zellerfeld Technical University.</td>
<td>2005</td>
</tr>
<tr>
<td>Increase employee involvement in environmental protection</td>
<td>Expansion of the environmental protection element of the APS into the non-production areas.</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>
In order to meet the increasing need for mobility in business and society efficiently but with minimum impact on resources, Audi has adopted a pioneering role for the future, and is never afraid to explore unconventional routes. The company has made its cars more efficient through numerous technical innovations such as its TDI and FSI engines and lightweight design technology. Fuel consumption and emissions have both been significantly reduced. At the forefront of these future-orientated concepts is the use of alternative fuels and drive systems. One of Audi’s most exciting visions for the future is the fuel cell car, which is driven by renewably generated hydrogen. And in the more immediate future, diesel and petrol engines could be efficiently powered by biomass fuels. Of course, the push towards sustainable mobility can only work as an integral venture, so it is also necessary to develop communication and safety systems that will allow the intelligent co-existence of road users, prevent congestion and make travelling by car safer than ever before.
Combining reduced fuel consumption with greater mobility

Mobility is one of man’s most fundamental needs, as acknowledged by French philosopher Blaise Pascal over 300 years ago. Without mobility, our economic and social structures would grind to a halt. In today’s society that is characterised by individual needs, the car plays a key role.

Over the past few decades, there has been an increase in the number of cars registrations and the mileage covered by road users, and yet the quantities of pollutants emitted by traffic, such as carbon monoxide, hydrocarbons, nitrogen oxides and particulates, have decreased considerably. Progress has also been made with regard to emissions of carbon dioxide (CO$_2$), which has been cited as one of the greenhouse gases responsible for accelerating global warming. This tide has now turned: the rise in carbon dioxide emissions from cars has been halted in Germany and the trend reversed. According to report no. 8/03 by the DIW (German Institute for Economic Research), the 1.5 percent decrease in total CO$_2$ emissions produced by road traffic in 2002 compared to 1999 was almost exclusively attributable to cars.

This confirms the success of a strategy orientated towards long-term plans for binding, pan-European regulations regarding the reduction of fuel consumption and exhaust emissions. Based on this strategy, Audi engineers have developed particularly environmentally friendly models—cars that use only 3 litres of fuel per 100 km, vehicles with hybrid drive or even diesel engines that come within sight of the desired closed CO$_2$ cycle by running on extracted or synthetic vegetable oil or biomass fuels.

Target: 25 percent reduction in CO$_2$ emissions by 2008

The European automotive industry aims to reduce the average CO$_2$ emissions per vehicle to 140 grams per kilometre by 2008, which would correspond to an overall 25 percent reduction in emissions compared to the base year, 1995. Audi has been working to reduce its vehicles’ carbon dioxide emissions for some time now. Every Audi model series includes versions offering lower consumption than the competition (see diagrams on pages 38/39). This means that, simply by choosing an Audi, customers can contribute to a reduction of greenhouse gas emissions. Audi is also ahead of the field as regards the reduction of pollutant emissions and implementation of the long-term Euro IV European emission standard, which is set to become binding in January 2006: over 95 percent of Audi vehicles sold in the EU already complied with this standard by the end of 2004.
“Environmental protection is an intrinsic part of the product creation process”
A car is one of the most exciting products to work on. Manufacturing a car involves all kinds of innovative materials, along with the latest technologies and processes. The car is also more than just a means of transport; it is also an indicator of social and emotional values.

When developing a car, there are a lot of very different requirements to take into account: in the early stages, we have to anticipate the political and social requirements. During the development process, as the project becomes increasingly tangible, we have to consider legal regulations, customer requests, safety requirements, comfort and fittings, and much more—including environmental impact, of course.

Our job includes outlining the environmental attributes right from the start at a design meeting for everyone involved, setting specifications and working to them during the development process. The job can be demanding at times, but it’s always exciting, worthwhile, fulfilling, varied—in a word, it’s fun!
Audi on the right road

Audi’s advanced technology has enabled it to overcome the age-old contradiction between fuel consumption and performance. With the objective of continuously reducing fuel consumption and emissions whilst making driving more enjoyable, the Audi engineers have created innovations for all vehicle components with an astounding eye for detail—from the engine and gearbox to the vehicle’s weight and aerodynamics.

Audi’s advances in the field of engine technology were partly due to the introduction of direct injection. The TDI and FSI engines have considerably increased the efficiency of diesel and petrol engines and reduced fuel consumption.

Improvements have also been made to the interplay between the gears and the engine. The innovative generation of multitronic stepless transmissions and the sporty DSG direct shift gearbox with twin-clutch transmission allow Audi vehicles to run even more efficiently and economically.

Audi has reached another ecological milestone with its Audi Space Frame aluminium body (ASF). The decreased vehicle weight drastically reduces fuel consumption, and so plays a significant role in reducing consumption of resources and environmental impact over the whole life cycle of the vehicle, from production to recycling. The clearest example of the numerous measures taken to reduce fuel consumption is the Audi A2 1.2 TDI three-litre car*. Many of the technologies used for this model will also be applied to future Audi products.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
A vision of the car of the future

Audi has no intention of stopping at the successes it has achieved so far. The engineers are working flat out to design the “car of the future”, and will continue to come up with unexpected solutions. These plans may extend over decades: an innovative and extraordinarily agile fuel cell vehicle is currently being put through its paces on the Technical Development section’s test tracks at Audi’s Neckarsulm site. As part of its sustainable fuel strategy, Audi is also testing environmentally-friendly fuels such as SynFuel and SunFuel. But sustainable mobility is not restricted to vehicles; it also affects the entire road transport system. Audi is involved in several projects designed to prevent congestion and improve safety on the roads.

However, market conditions dictate that the concept of sustainable mobility can only work if the customer’s needs are taken into consideration. Audi is therefore constantly searching for the perfect compromise between optimum environmental features and the embodiment of the Audi brand: sportiness, performance and quality.

And, as specified in its Technical Development team’s list of objectives, Audi is determined that, wherever possible, each model series should include versions that surpass their competitors from an ecological point of view. This means that customers will always be able to opt for the environment by choosing an Audi.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
4.1 Engine technology

“Vorsprung durch Technik”—TDI and FSI

The principle of improving performance whilst reducing fuel consumption is one that Audi has successfully applied to its engine technology. The pioneering TDI and FSI engines extract more performance from every litre of petrol and are therefore less damaging to the atmosphere.

The company was one of the first car manufacturers to introduce direct injection for diesel cars, bringing the Audi 100 TDI on to the market as early as 1989. The TDI engine’s groundbreaking emission levels, smoothness and performance—a combination once thought impossible—together with its remarkable fuel efficiency, helped the direct injection diesel engine to achieve a breakthrough in the field of car development. It had previously been used almost exclusively for commercial vehicles. These days, more than half the new Audis registered in the EU are fitted with a TDI engine.

The TDI technology has enabled Audi to pull ahead of its competitors in terms of environmental and climate protection. The TDI models developed by Audi emit between 20 and 25 percent less CO₂ than conventional petrol cars with manifold injection. Audi played a decisive role in diesel cars’ move towards social acceptability. In 1990, only 15 percent of new cars registered in Europe were diesels; this has now increased to well over 40 percent.

Audi is still one step ahead today: as the first manufacturer of engines featuring piezoelectric injectors and the third-generation common rail system, Audi and its 3.0 TDI and 2.7 TDI engines are setting new standards for emissions, smoothness and performance. These engines also contain a modern diesel particulate filter system that is designed to last for the vehicle’s entire lifespan and does not require any additives.
FSI saves petrol
Direct injection has brought diesel cars into the limelight and could achieve a similar level of success for petrol cars. Audi intends the "Vor sprung durch Technik" that the diesel engine has enjoyed to be extended to the petrol engine. One thing is clear: the abbreviation FSI, used for Audi’s petrol direct injection systems, is already well established in petrol engine terminology.

FSI engines are more efficient, have higher torque and use a lot less fuel, particularly when a vehicle is driven in an environmentally considerate way. Fuel consumption can be reduced by 5 to 10 percent. For example, the 85 kW (115 bhp) Audi A3 1.6 FSI* boasts a Euromix fuel consumption of just 6.6 litres per 100 kilometres.

Audi considerably extended its range of FSI engines in 2004, when it began series production of its 2.0 TFSI and 3.2 FSI six-cylinder engines. The main objective of these two new developments was to combine a significant improvement in the engines’ performance and sporty nature with low fuel consumption. Both engines were therefore designed as direct injectors with a homogeneous fuel mixture (“Lambda 1” throughout the combustion chamber).

Combination of direct injection and turbocharging
The 2.0 TFSI engine is one of the first ever direct injection turbo petrol engines, and falls well below the strict emission limits set by the EU IV (Europe) and ULEV2 (USA) standards, even with a high mileage. Its compression ratio of 10.5:1 is above average for a turbo engine and, combined with the benefits of direct injection, this allows a considerably higher level of thermodynamic efficiency than traditional manifold injection engines.

The 2.0 TFSI* in the Audi A3 Sportback and Audi A4 outperforms other engines in its performance category with an output of 147 kW (200 bhp) at an average consumption of 7.7 litres.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
A baptism of fire in Le Mans

The FSI engine was well and truly put to the test on the motor racing circuit. It was used for the first time in 2001 in the form of a V8 biturbo engine during the world’s toughest endurance race, the Le Mans 24 Hours. The team in the Audi R8 romped home in first place, starting a run of victories that is still continuing today. The FSI engines succeeded in reducing the racing cars’ fuel consumption by 8 percent. This meant an extra lap per tankful of petrol and, consequently, fewer pit stops.

Thanks to TDI and FSI, the Audi models have won numerous prizes over the past few years. In 2002, the well-known Wuppertal-based Öko-Trend environmental institute named the Audi A2 1.2 TDI* the “most environment-friendly compact car”. The ADAC (German Automobile Club) placed the Audi A2 1.6 FSI* second in its 2003 Eco Test, which evaluated 33 compact and lower-midsize vehicles according to their pollutant and CO₂ emissions.

4.2 Transmission technology

Perfect partners: the synergy between transmission and drive technology

Just like a team of individuals, a car needs the right level of interplay, especially between the engine and the gears. Audi is not only a pioneer where engines are concerned: it also leads the way with regard to transmission technology, efficiency and overall quality—for vehicles with both manual and automatic transmission.

Audi has developed manual gearboxes that offer dynamic acceleration, ease of use, a high level of fuel efficiency and enhanced driving enjoyment in equal measure. The car manufacturer is a trendsetter in this field. Let us take six-gear transmission as an example: in 1991, the Audi 100 2.5 TDI was the first ever diesel car to be fitted with a six-gear system. The extra sixth gear provides a wider range of transmissions, enabling lower revs. This means that the car uses less fuel, produces fewer emissions and is much quieter. Since then, numerous other vehicle manufacturers have followed Audi’s example and have brought out some of their diesel models—and an increasing number of petrol models too—with six-gear

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
The power of two
When the Audi TT 3.2 quattro* was launched on the market in early 2003, the Audi engineers introduced an innovative new transmission for the sportier models, inspired by motor-racing technology: the direct shift gearbox (DSG) with twin-clutch transmission. This combines the advantages of manual and automatic gearboxes. At the heart of the gearbox are two electro-hydraulically operated wet multi-disc clutches that guarantee a high level of efficiency. The gear change takes place with no loss of traction, ensuring a completely smooth ride, which increases acceleration and makes driving more enjoyable. The fact that it is also environmentally friendly is not just an incidental side effect. The Audi TT 3.2 quattro* with DSG uses roughly 8 percent less petrol than the same model fitted with manual transmission. The DSG direct shift gearbox is now available for a range of different

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
Neither the Coupe nor the Roadster version of the Audi TT lacks the temperament that discriminating customers expect from a sports car. What is more, the TT also minimises environmental impact: some of its inner cladding is made from renewable resources, thereby improving the Audi TT’s ecological balance. The main feature that stands out is its exceptionally low fuel consumption for a sports car—even in the more powerful models.
The two versions of the Audi TT 1.8 Turbo* with front-wheel drive and engine outputs of 110 and 132 kW (150 and 180 bhp respectively) fared extremely well in an international brand comparison, as they combine a Euromix fuel consumption of just 8.1 litres per 100 kilometres with a remarkable eagerness to perform. The two supercharged five-valve engines can accelerate from 0 to 100 km/h in just 8.9 and 7.8 seconds respectively. Even more impressive and more relevant to drivers, however, is the two turbo engines’ celebrated flexibility: the maximum torque is available at less than 2,000 rpm and the low revs allow a confident and fuel-efficient style of driving.

The comparisons speak for themselves
The 3.2 quattro*, with its high cubic capacity six-cylinder engine, lapped up even more praise in the comparison charts than the TT turbocharged versions: where else would you find an output of 184 kW (250 bhp) and acceleration from 0 to 100 km/h in 6.4 seconds with a standard consumption of 9.8 litres? To increase efficiency, the engineers developed a continuously adjustable intake/exhaust camshaft. This also has a favourable effect on exhaust emissions, which are well within the limits specified in the Euro IV standard. The Audi TT’s direct shift gearbox (DSG), taken from the world of motor racing, combines the qualities of a six-gear manual transmission with those of a modern automatic. Its key feature is an innovative twin clutch, which engages the next gear even before it is selected. The gear change takes place under load, without any interruption to the power flow. This enables the Audi TT with DSG to achieve better performance and a fuel consumption that is 8 percent more economical than the version with a traditional six-gear manual transmission, which was itself designed for optimum efficiency. As a result, the DSG plays a significant role in the Audi TT’s outstanding efficiency and dynamic performance. It also provides yet another example of the way energy-efficiency innovations often demonstrate their potential in the top high-performance versions, with a view to achieving wider distribution in models with higher unit sales at a later date.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.
Smooth gear-changing with multitronic

Audi has introduced a new generation of stepless gearboxes for longitudinal engines onto the market: multitronic transmission. Unlike the previous stepless CVT gearboxes (continuously variable transmission), which maintained a specific engine speed during acceleration, giving the impression that they lacked power, the multitronic system leaves the driver in no doubt that the increasing engine speed is linked to the acceleration process.

The multitronic has no mechanically defined gear steps, but instead uses steplessly variable transmission ratios. The transmission automatically looks for the speed range in which the engine operates at optimum efficiency. The electronics use the position of the accelerator pedal and other parameters to analyse the driving situation and driver input within milliseconds, and adjust the transmission ratios to the driving conditions. Instead of a heavy hydraulic torque converter that sends fuel consumption through the roof, the multitronic only requires a compact, electronically operated multi-disc clutch. In the Audi A6 2.5 TDI, for example, the multitronic reduced fuel consumption by 14 percent compared to the earlier torque converter with tiptronic transmission, whilst noticeably improving performance and enabling easier gear-changing. The multitronic was first used in the Audi A6 2.8 in 1999, and is currently available in a wide range of engine variants in the Audi A4, A6 and A8 model series.
Automatic appetite suppressant for the Audi A2 1.2 TDI

Audi has developed a gearbox that is resolutely determined to keep fuel consumption low: the Automatically Controlled Manual Transmission (ASG) used in the Audi A2 1.2 TDI, which allows both tiptronic manual gear selection and fully automatic operation.

The automatic’s already fuel-efficient gear system is complemented by a special “Eco” mode that can be selected at the flick of a switch. This helps to reduce additional fuel consumption caused by frequent stopping at traffic lights or in traffic jams and is therefore more environmentally friendly. Up to 20 percent of petrol can be saved by turning off the engine in city traffic. When the vehicle stands still for longer than four seconds, the engine automatically switches itself off. When the brake pedal is released, the system starts the engine up again. This process may take a while to get used to, but there is no doubt that drivers will soon recognise its high level of fuel efficiency.

For thrifty drivers, the ASG Eco mode offers an additional function: if the driver releases the accelerator while driving, the clutch is automatically disengaged, and the vehicle coasts along in neutral. The next time the driver presses the accelerator pedal or brake, the clutch is re-engaged automatically. An anticipatory style of driving therefore allows other noticeable savings to be made.

The findings gained from practical experience of this consumption-orientated style of transmission will prove a valuable basis for engine development at Audi, even after the end of A2 production.
4.3 Intelligent lightweight design

Top priority: weight reduction

Besides its innovations in engine and transmission technology, Audi has set new standards with its consistent lightweight design techniques, whilst making a significant contribution to environmental protection. The judicious use of renewable resources and recyclable vehicle parts is set to extend Audi’s ecological lead even further.

The lighter a vehicle is, the less energy it needs for its drive system. Even a weight reduction of 100 kilograms decreases fuel consumption by around 0.4 l/100 km, depending on the model and vehicle category. Every litre of petrol saved reduces CO₂ emissions by approximately 24 grams per kilometre.

By habitually using aluminium, Audi considerably reduces the weight of its vehicles. This material allows the construction of much lighter designs than steel does. Aluminium provides a car with a better energy and environmental record than steel throughout the vehicle’s life.

After just a short time on the road, the extra energy required for manufacturing primary aluminium is made up for by the reduced fuel consumption. In fact, it will pay for itself several times during a vehicle’s life cycle (see diagram on p. 51). As the aluminium is also sent for recycling after use and replaces primary aluminium, this useful material certainly has a lot going for it from a sustainability point of view.
The second-generation ASF is born
Audi’s 100% aluminium body first went into series production for the Audi A8 and enjoyed its world premiere at the 1994 Geneva Motor Show. The experience gained from the Audi A8 enabled further enhancements to the Audi Space Frame. In 1999, the aluminium-bodied Audi A2 was introduced at the IAA motor show in Frankfurt. This marked the birth of the second generation of ASF technology. At 156 kilograms, the Audi A2’s aluminium body weighs 43 percent less than comparable vehicle bodies made of steel. By using an increasing number of multifunctional large cast parts, the Audi engineers managed to reduce the number of components from 334 in the Audi A8 to 238 in the Audi A2. Cold joining techniques used for the Audi A2, such as the punch riveting process, enabled a further reduction in heat distortion to the body. Furthermore, during production of the Audi A2, Audi achieved an extraordinarily high level of automation at 85 percent. Only 25 percent of the manufacture process was automated when the first Audi A8 was produced.

The Audi Space Frame revolution
Lightweight design is more than just changing materials. By the mid-1980s, the Audi engineers had already developed their own basic design for the aluminium body: the Audi Space Frame, or ASF for short. This consists of an extremely solid framework made of aluminium extrusions and multifunctional die-cast components into which large load-bearing aluminium panels are inserted.

The ASF technology reduces the body weight of the Audi models it is used in by about 43 percent compared to conventional steel bodies. This also opens up potential for reducing the weight of other components, e.g. the chassis and surrounding area, and all in all means reduced petrol consumption and fewer emissions. This is combined with the remarkable rigidity of the ASF, which envelops passengers like a protective shell, to provide best-in-class safety with a lower weight.
The Audi A8 sets new lightweight design standards

In the second-generation Audi A8, premiered at the 2002 Paris Motor Show, even more improvements have been made to the Audi Space Frame technology. The ratio between the body’s stability and weight is now even better. The use of fewer large, geometrically precise and highly rigid cast parts reduced the number of components, while the body’s static torsional rigidity was 61 percent higher than in the previous model. The Audi A8’s aluminium body therefore provides not only improved safety and lower fuel consumption, but also greater driving enjoyment: the new Audi A8 is characterised by its outstanding driving dynamics, agile handling and confident, sporty cornering.

Audi is streets ahead of its international competitors in its use of light metal, and has already received around 40 awards for the designs of the Audi A2 and Audi A8 aluminium bodies. The company has been carrying out research into vehicle bodies made completely from aluminium as a lightweight construction material for about 20 years, and has set up a centre specifically for aluminium and lightweight design in Neckarsulm.
More than 100 employees at this site are working on the development of vehicles with an aluminium structure and other possible methods of intelligent lightweight construction. By the end of 2004, over 320,000 aluminium-bodied Audis had already rolled off the production line at the Neckarsulm plant.

**Composite construction proves its worth**
From an economic and technical point of view, however, it is not always advisable to use purely aluminium structures. The use of tailored blank sheets shows that steel also continues to play an important role in intelligent lightweight design. These allow tailor-made, economical material usage. The tailored blanks are extremely robust in areas subject to a lot of strain while in less hard-working areas, the panels are much thinner and lighter.

One model in which the composite construction method has been successfully implemented is the Audi A4. While the amount of steel used decreased by approximately 7.5 percent compared to the previous model, the proportions of the lightweight construction materials aluminium and magnesium as well as plastics increased. This resulted in a further considerable weight reduction.

**Weight loss programme for all vehicle parts**
In order to extend Audi’s lead over the competition in the field of lightweight design, the Audi researchers’ attention has now naturally turned towards other vehicle parts. For example, the bonnet and front wings on the Audi A6 and Audi A6 Avant are made of aluminium, and aluminium chassis are being used for the Audi A4, A6 and A8 series. Changes have been made to the engines too: Audi’s V8 petrol engines have been made of light metal since 1988, and since then, this construction method has been extended to the majority of V6 and four-cylinder engines. Aluminium has even been used for the cylinder head and crankcase in the Audi A2 1.2 TDI’s* small TDI engine.

---

**Time taken to counterbalance the increased energy required to manufacture an aluminium body in the operating phase (example used: Audi A8)**

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>Cumulative use of primary energy (GJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>200,000</td>
<td></td>
</tr>
<tr>
<td>300,000</td>
<td></td>
</tr>
</tbody>
</table>

- *A8’s ASF body: 273 kg
- *Steel body of a virtual A8: 478 kg

Data source:
IKP Stuttgart 10/1995; Eyerer, Schuckert, Saur, Gediga, Beddies

*Details about fuel consumption and CO₂ emissions can be found in the glossary
Dr. Carina Kögler of the Aluminium and Lightweight Design Centre in Neckarsulm

“Innovations in lightweight design benefiting the environment”
The Aluminium and Lightweight Design Centre is a technological highlight of AUDI AG. The material and joining processes and technologies developed here have enabled us to set the prerequisites for a considerable reduction in the weight of our vehicles. And this is achieved not just directly through lighter components, but also indirectly, because the engine, chassis, brakes etc. can be made smaller in lighter cars without adversely affecting the driving dynamics. The total weight reduction results in much lower fuel consumption. But the effects of these innovations extend even further: the new standards that Audi has set by using aluminium have given rise to a similar challenge for steel and other materials, which has led to lots of fantastic new ideas and will continue to do so. So if steel bodies are getting lighter these days too, that’s partly down to us and our innovative technologies.
Vehicle components made from renewable resources
Besides metals and plastics, the Audi suppliers also use materials for individual vehicle parts that are made from renewable resources in accordance with the environmental specifications, which reduces the need for fossil resources. For example, natural fibre-reinforced thermoplastics are used for cladding. There are all kinds of other potential applications for these fibre-reinforced plastics, from parcel shelves and sun visors to wheel arch cladding.

In the Audi TT, for instance, various parts of the boot liner are made from fibre-reinforced plastics. The rear wall cladding in the passenger compartment of the Audi TT Roadster is made partly from a flax/polypropylene composite.

The fibre-reinforced materials are better for the environment in two ways. Not only have they been obtained from renewable resources, but they are also lightweight construction materials. Of course, using renewable resources only makes sense if the materials are lighter than the conventional alternatives with similar properties. Especially with high-performance vehicles like those produced by Audi, the ecological benefit achieved by using renewable resources in the production process would soon be cancelled out by the increased fuel consumption throughout the vehicle’s life cycle due to the extra weight.
Natural tanning agents for treating leather
The leather used at Audi is treated with tanning agents of 10 to 15 percent vegetable origin. Tara tannin is more widely used for Audi’s leather components. This is obtained from the pods of the thorny Tara tree, which grows in the dry regions of South America, particularly Peru.

Tests on rhubarb leather
For the treated leather in the seats, headrests and centre armrests, Audi has been testing a natural tanning agent not commonly used in the automotive industry: rhubarb. Rhubarb’s roots yield a juice that can be used to tan and colour leather. This does not create any waste that could harm the environment. Because the rhubarb root extract imparts its own unique colour to the leather, however, it is currently only used on dark leather for customised special-purpose vehicles.

Only vehicle manufacturer to use quebracho
AUDI AG’s subsidiary, quattro GmbH, also uses quebracho, another tanning agent from South America. Quebracho is a tree with a twisted trunk that grows mainly in Argentina. The wood from this tree yields an extract containing 75 percent tannin. Audi is the only vehicle manufacturer in the world to offer products featuring leather almost exclusively tanned with quebracho (through quattro GmbH). The leather has a very pleasant fragrance and is extremely robust, so that even scratches are easily removed. So far, however, the quebracho tanning agent has only been used for dark colours on natural leather.

Possible uses for fibre-reinforced plastics

- Centre armrest bracket (NMT, natural fibre moulding material)
- Roof lining
- Seat upholstery
- Head rest upholstery
- Sun visor (fibre-reinforced PUR, rubberised hair)
- Parcel shelf
- Electronics cover (NMT, TPNF)
- Spare wheel cover (NMT, TPNF)
- Boot lining (natural fleece)
- Trim (natural fibre materials)
- Wheel arch cladding (TPNF, partly recycled material)
- Side cladding bracket
- Noise shield insulation (natural fleece, cotton fleece)
- Noise shield bracket (NMT, TPNF, partly recycled material)
- Door cladding bracket
- Head rest upholstery
Joining the recycling economy
Recyclable materials are becoming increasingly important for the composite construction method normally used for car production. Since 1988, in accordance with a decision by the board of directors, every new Audi model must be produced from materials confirmed as recyclable. Furthermore, AUDI AG had already devised its own recycling standards for vehicle parts, materials and lubricants by 1992; these have now been extensively adopted by other vehicle manufacturers. The reward for their research has been a number of awards for innovative recycling strategies and recycled products.

Because of legal regulations making it compulsory to take back end-of-life vehicles, it is in all automotive manufacturers’ interests to use materials that allow for easy and effective recycling. The German Directive on end-of-life vehicles specifies that, from 2015, at least 95 percent of a vehicle and 85 percent of the materials used (manufactured and raw materials) must be reusable. No more than 5 percent of the end-of-life vehicle’s weight may be dumped. The degree of recyclability specified in the design phase and the high-quality materials used mean that current Audi models offer the best credentials for economical recovery at the end of their life cycle.

Experts refer to this construction of a vehicle from a recycling point of view as the “design for recovery”. This does not only affect Audi’s internal processes. Audi’s simultaneous engineering process means that recycling strategies for specific modules and components are investigated alongside product development, in cooperation with system developers and suppliers. Internal checklists, specifications and standards, such as the binding VW 91102 environmental standard at Audi, offer guidance to everyone involved in environmentally friendly development.

The focal point of all these recycling efforts is to reuse materials, the primary objective being the substitution of new materials with secondary raw materials to help to conserve resources.
Separation process for shredder residue
If the recycling quota is to be met, shredded waste material will also have to be reused in future. With this in mind, Audi and Volkswagen AG’s associate companies commissioned the development of a separation process for shredder residue (VW SiCon process) in 2000. The products emerging at the end of this practical process are mainly raw materials tailored to market requirements.

For recycling to work in practice, recycled products need buyers. Audi considers itself duty-bound not only to put recyclable products on the market, but also to identify processes that lead to a large proportion of recycled materials being used in production. The binding specifications for suppliers therefore stipulate that, where components are equally suitable and comparably priced, items made from recycled material are preferable. This incentive has resulted in substantial development work to this effect. Several recycling processes have already been incorporated in series production: battery covers and spare wheel wells have been manufactured from recycled plastic since the 1990s. Audi’s collaboration with its suppliers has also resulted in the introduction of a recycling process for plastic composites.

Lightweight design more important than recycling quotas
Materials that are perfect for lightweight automotive construction tend not to be ideal for material recovery, but are more suitable for raw material or energy recovery. However, prioritising material recycling due to inflexible quota regulations would result in a conflict of objectives for the vehicle developers. Life cycle records make it clear that recycling at any price can actually be ecologically counterproductive. Excessive recycling regulations drastically restrict the selection of materials available to developers, especially where lightweight construction designs are concerned. Slightly reducing the weight of a car’s components nearly always has greater ecological benefits than improving their suitability for material recycling. Because the vehicle’s weight has a significant effect on fuel consumption throughout its entire period of use, a reduction in weight would as a rule still be advantageous even if it was due to a component unsuitable for material recovery. The potential environmental benefits to be obtained by reconditioning components to make secondary materials are actually relatively low when compared to the possible reductions in fuel consumption.

Audi’s rationale and experience have helped to ensure that current end-of-life legislation in the EU does not stand in the way of lightweight design.
4.4 Emission reduction

Going beyond the EU IV emission standard

Audi is focusing on all types of vehicle emission, and is using various technological measures in an attempt to reduce its vehicles’ exhaust and noise levels. Audi already leads the way in this area, as most new vehicles supplied by Audi in the EU complied with the EU IV emission standard by the end of 2003.

Thanks to the comprehensive groundwork undertaken by the thermodynamics experts and the meticulous work on engine and transmission development details, most of Audi’s models complied with the EU IV emission standard in good time: the standard will not become compulsory until 2006. Let us take the V6 TDI as an example: extensive modifications to the cylinder head, substantial fine-tuning of the mechanics and combustion process, and further improvements to the high-pressure fuel injection system resulted in the vehicle’s emissions falling below the strict limits. This meant that, by the end of 2003, approximately 20 Audi models with TDI engines stayed within the limits prescribed by the EU IV emission standard. For some time, therefore, the Audi plants were producing by far the widest selection of EU IV-certified diesel cars. These days, the range extends from the three-litre Audi A2 1.2 TDI* with an output of 45 kW (61 bhp) to Audi’s sporty, 171 kW luxury saloon with automatic transmission and permanent all-wheel drive, the A8 3.0 TDI quattro*.

In 2004, over 90 percent of Audi models with diesel engines were approved under the EU IV standard. The latest generation of long-life particulate filters has also been introduced as an optional extra. The first model to feature this was the Audi A8 3.0 TDI quattro* in autumn 2004, followed by other versions in the Audi A4 and Audi

*Details about fuel consumption and CO2 emissions can be found in the glossary.
Audi insists on the most cutting-edge filter technology for this: the catalysed soot filter (CSF), which does not require the use of any additives. On long journeys at constant speeds—on the motorway, for example—the soot deposits in the catalytic converter are slowly converted to CO₂ in an environmentally friendly manner. When the car is driven for any length of time at a low load, such as in city traffic, an increase in the exhaust emission temperature to approximately 690 degrees Celsius every 1,000 kilometres prompts an additional regeneration of the filter. As the filter does not use any additives, no cleaning or replacement costs arise.

Audi’s main focus is on universally reducing its vehicle emissions in such a way that damage to the environment by private transport is decreased most significantly in those areas where new vehicles currently account for a considerable proportion of the total environmental impact.

In this context, the relevant political functionaries are responsible for establishing and prioritising global and local environmental objectives. It is also necessary to identify the main origins of environmental problems and then, taking technical and economic constraints into account, to embrace binding long-term measures that all market operators can adapt to and depend upon.

Exhaust emission treatment with diesel particulate filter in the Audi A8 3.0 TDI quattro
Silence is power
Traffic noise is believed to be a source of stress, which can present serious health risks. Audi therefore aims to help improve the whole vehicle/tyre/road system. A similar objective enabled automotive manufacturers to bring about a drastic reduction in engine noise in the past.

Reduction of exterior vehicle noise
While drive system noise has been successfully decreased by many manufacturers, the reduction of other driving noise remains a complex issue. The experts in the Audi acoustics laboratory are therefore testing noise emissions on a approved mobile test track, using driving conditions that enable systematic evaluation of the noise emissions arising as a result of airflow, rolling tyres and the vehicle’s drive system. For this, they are using a four-wheel exterior noise test rig, a four-wheel component test rig and an acoustic engine test rig.

The new measuring process used for assessing the exterior noise on the test track, which Audi is actively helping to develop, allows adequate consideration of a vehicle’s contributory sound sources, according to the actual proportion of traffic noise that they represent. The measurements clearly indicated that the noise from the tyres and carriageway represents a significantly higher percentage of the overall noise emissions than previously thought.

Audi is therefore working hard to reduce its cars’ rolling noise. The Audi acoustics experts are investigating the acoustic properties of the types of tyre used, to enable them to fit Audi vehicles with low-noise tyres. They are also working in close co-operation with the tyre industry to develop tyres that are better adapted to the road surface and therefore make even less noise.
An integral strategy encompassing all components of a car’s mobility system is crucial for the effective reduction of traffic noise. One of Audi’s commitments is therefore to create a model for traffic noise as part of the EU ROTRANOMO (Road Traffic Noise Modelling) research project. The aims of this are to research the relevant influencing factors and to create a reliable basis for specifying binding limits. The standardisation of international legislation limiting exterior noise is also on Audi’s agenda.

Substantial progress has already been made, although the road surface itself now shows potential for even greater improvement. The authorities responsible for research into road construction therefore worked with tyre manufacturers and universities to develop alternative road surfaces, including one known as “whisper asphalt”. According to the ADAC, this could help to reduce noise levels by up to 40 percent. However, nation-wide implementation of this project is not likely to take place for a few years, due to the huge public investment required.
4.5 The world’s first five-door three-litre car

The fuel-efficient miracle

The Audi engineers have set new ecological standards with the Audi A2 1.2 TDI*: it is the world’s first five-door three-litre car.

The three-litre car has even met with approval from the international world of art. The New York Museum of Modern Art rated the Audi A2 as a “paragon of economic and ecological common sense with a uniquely hedonistic side”.

*Details about fuel consumption and CO₂ emissions can be found in the glossary.