Environment and Aviation

Facts, Measures, Perspectives
Foreword

Mobility has become a key factor in people's lives, both privately and professionally. Flying connects people and brings the world another bit closer together. At the same time, the air transport industry is of vital economic significance – as an employer, trading partner and driver of economic growth in the respective regions.

Alongside these social and economic achievements, for several years now the focus has increasingly been placed on a third component: our responsibility towards the natural world and the environment. The Austrian aviation industry is convinced that sustainable development of air traffic can only be built upon a combination of these three pillars.
In this brochure the companies of the Austrian air transport industry present the activities they are undertaking in the interests of the environment and climate protection, thus underlining the industry’s clear commitment to a sustainable development of air traffic. The brochure illustrates the companies’ activities in the environmentally relevant fields of aviation and outlines future developments.
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Glossary / Contacts / Links
What does sustainability mean to the Austrian aviation industry?
Equal focus is placed on environmental protection, social aspects and economic performance.

**Economic, Social, Environmental**

These three pillars form the basis for sustainable development of the European and Austrian aviation industries. Equal focus is placed on economic performance, social and societal aspects and environmental measures.
1 | Sustainable economic development

Creating jobs in the region, providing air ambulance services in the event of accidents and ensuring the environmental compatibility of flight operations are all examples of sustainability at work in the aviation industry. Today and in the years to come, sustainable development combining economic, social and environmental objectives is and will remain a key factor in our corporate success.

Austria by air

Vienna is a highly attractive travel destination – as a global capital of music and culture, as a seat of the UN and other international organisations, as a conference venue, and not least thanks to its high quality of life and environmental standards.

Or perhaps you prefer Salzburg? The Salzburg Festival and other highlights of the arts and cultural calendar draw 6.8 million visitors a year to the city of Mozart. Likewise, the magnificent mountain scenery surrounding Innsbruck is a big attraction for many guests. Every year, some two million tourists visit the Innsbruck region.

But no matter whether they’re visiting Vienna, Salzburg or Innsbruck, Linz, Klagenfurt or Graz – a large number of culture vultures, mountain fans, conference participants and businesspeople arrive in Austria at one of the country’s airports.

The Austrian air traffic system consists of the international hub of Vienna International Airport and the well-integrated regional airports in Salzburg, Graz, Innsbruck, Linz and Klagenfurt. Within this system, Austrian Airlines is Austria’s major carrier, providing the majority of the connections to the regional airports as well as direct flights to many destinations worldwide. Austro Control, as the Austrian air navigation service provider, ensures the safe, efficient management of air traffic at all the country’s airports and in Austrian airspace in general.

Sustainable and forward-looking

The Austrian aviation industry is taking measures to ensure that air travel to and from Austria remains a sustainable pleasure. This applies not only to the flights themselves, but likewise to the airports and their infrastructure, the economic sustainability of the airports and their regions as business locations and the satisfaction of both employees and customers alike.

“Sustainable development” means that today’s generation has to manage the available resources intelligently in order not to compromise the prospects and lifestyle of future generations. This requires balanced development based on three equal pillars: the economic, the social and the environmental. In order to achieve positive results in the long term all three have to be taken into account, the objective being to create the best possible basis for subsequent generations and their development. The principle of sustainability thus applies
to the economic activities of the Austrian aviation industry and the social environment of its employees, passengers and neighbouring communities, as well as to the companies’ environmental activities.

A strong network firmly anchored in the regions

The commercial airports in the Austrian regional capitals strengthen the network of flight connections. Especially for the local economies, it is important to have fast, direct connections to Europe’s major centres.

Linz Airport is an important partner for the industrial centres of Upper Austria, with direct scheduled services to eleven destinations. A wide range of charter flights complete the programme. Approx. 773,000 passengers were carried in 2007. Scheduled traffic and industrial cargo shipments (35,000 tonnes) have seen particularly strong growth in the past few years.

As the business and tourism gateway to the region of Salzburg and western Austria, Salzburg Airport has a special economic significance for local enterprises. And as the main artery for tourism and international business traffic the airport has become a vital factor, not only for the southern parts of the region, but increasingly also for the city of Salzburg, its immediate surroundings and neighbouring Bavaria, too. In 2007 Salzburg Airport handled 1.94 million passengers, with a moderate increase of 1.9% in the total number of scheduled and charter flight movements. Network traffic and scheduled services are the future foci of Salzburg Airport’s traffic management strategy.

Graz Airport strengthens the local economy in its catchment area. The years 2002 to 2007 saw constant growth, notably in the scheduled traffic and air cargo segments, to 948,140 passengers and 11,300 tonnes of cargo respectively. The airport is especially attractive for its easy accessibility and its excellent connections to the three hubs of Vienna, Frankfurt and Munich.

Innsbruck Airport has been posting constantly growing passenger figures for many years now. In 2007 a combined total of 859,832 charter and scheduled passengers were handled. The winter charter programme in particular, comprising 22 destinations, creates important impulses for tourism in the Tyrolean region.

An important partner for the enterprises on site, Klagenfurt Airport also assures convenient travel for the people of the region with its direct connections to the surrounding hub airports.

Vienna International Airport as a business location

Vienna International Airport is the hub of Austria’s air traffic system. With 18,000 employees, the airport itself and the companies on site are also the biggest employer in eastern Austria. Not to mention an additional 52,500 jobs and 6.3 billion euros in turnover that are
directly attributable to the airport. Studies show that one million additional passengers create 1,000 new jobs on site. Two per cent of Austria’s entire gross value added are generated by the companies located at the airport.

As a result of the enlargement of the European Union to incorporate Austria’s immediate neighbouring states, Vienna – and hence its airport – acquired an even more central position within Europe. This is evidenced by the emergence of a common economic space, the CENTROPE region. Vienna is the focal point of this common living and economic environment, which is coalescing into a strong, attractive region thanks to intensive cooperation.

The CENTROPE region is currently experiencing an economic upswing which is also greatly benefitting Vienna International Airport. By 2007 the annual passenger figures had risen to 18.8 million, transported on 254,870 flight movements. A third of these passengers use Vienna International Airport for transfer to a further destination, and this hub function is essentially important to the airport’s attractiveness. A total of 192 destinations are served by direct flights from Vienna.

In order to cope with this continuing growth, Vienna International Airport is making ongoing investments in expansion and improvement of its facilities. The growing volume of passenger traffic, assurance of the airport’s high quality standards and the official provisions for the separation of Schengen and non-Schengen operations have necessitated an expansion of the terminal areas. The Skylink terminal extension project is based on a concept designed to allow a flexible response to developments in traffic volume. The multifunctionality of the new terminal building and the short distances for passengers guarantee that the airport’s extremely competitive minimum connecting time of just 25 minutes, one of the fastest in Europe, will continue to be upheld in future.

The strongest airline at Vienna International Airport is Austrian Airlines. In 2007, 53 per cent of the passengers at Vienna International Airport used Austrian Airlines to reach their destination. The carrier has therefore been a significant factor in Vienna International Airport’s development into a central East-West hub. Austrian Airlines operates from Vienna to 48 destinations in Central and Eastern Europe (2008 figure) and is thus tapping the potential of major up-and-coming economic centres. The whole of Europe can be reached within three hours by air from Vienna. The Austrian Airlines Group as a whole transported just under eleven million passengers in 2007, and since 2002 the carrier’s passenger figures have increased by an average of five per cent annually.

In 2007, Austro Control recorded a total of 1.2 million flight movements in Austrian airspace.

### Air cargo

The volume of goods transported by air has increased dramatically in the past few years. Air cargo services are ever more frequently used, especially when time is a decisive factor,
and air cargo predominantly consists of highly valuable or highly perishable goods. A large number of cargo shipments are not transported on separate flights, but utilise the capacity available in the cargo holds of passenger aircraft. At Vienna International Airport, for instance, fewer than 2% of flight movements are pure cargo flights. This avoids the need for additional flights and the associated environmental impacts.

The social aspect – flying connects people

Be it a well-earned holiday, a weekend break in a major city, a new job in a foreign country or exploring foreign cultures – these are things that have very high priority on many people’s wish-lists. And nowadays, realising the dream requires a great deal less effort than it did just a few decades ago. The wide choice of flights and destinations available today is allowing increasing numbers of people to discover unknown parts of the world. Air travel creates swift connections between regions and continents, and shorter journeys bring far-flung places ever closer together. Flying allows people to bridge huge distances, cultivate friendships, maintain business contacts and reunite family members.

Airborne assistance

Air transport is often a decisive factor when urgent assistance is required. In the event of natural disasters, aircraft are the fastest way of getting relief teams and aid supplies to those affected. The swift dispatch of teams of rescue dogs to remote earthquake zones is of decisive importance in ensuring victims’ survival.

Another frequently overlooked example of how rapid air transport can help save lives on a daily basis is the transportation of transplant organs. With these transports every single minute is crucial, so a perfectly functioning air transport system is absolutely imperative. Innsbruck plays a pioneering role in this field: the surgical team at the city’s university hospital enjoys a worldwide reputation and Tyrol Air Ambulance was the world’s first scheduled air ambulance service. To date, the latter has transported a total of 24,500 victims of winter sports accidents back to their home countries on some 2,390 winter “plaster shuttle” flights.

The environmental impact – responsible aviation

The air transport industry strives to implement positive economic development strategies while simultaneously reducing the impact on the environment. Under the third pillar of sustainable development – environmental sustainability – the industry is therefore considering and delivering a wide range of measures to keep the negative impacts on the environment to a minimum.

>> In the following chapters of this brochure, the companies of the Austrian air transport industry explore the topic of the environment and climate protection and present their related objectives and measures.

>> Austria’s commercial airports are working continuously to improve their ecological footprint and implementing projects to optimise processes and minimise the impacts on the environment.

>> The ongoing technical development of the Austrian Airlines fleet is allowing an increasingly efficient flight performance and reducing the environmental impact per kilometre flown.

>> Through safe, efficient airspace management, the Austrian air navigation service provider Austro Control is making an important contribution by optimising flight movements to avoid unnecessary emissions.

>> The companies of the Austrian air transport industry are living up to their responsibility to minimise the impacts of aviation on people and the environment and deliver further improvements in the future.
How much does aviation actually contribute to the global CO₂ emission load?
In fact, only 2% of all man-made CO₂ that is released into the atmosphere is produced by air traffic.

(Man-made) CO₂ emissions

Contrary to widely held beliefs, aviation accounts for only 2 per cent of global man-made CO₂ emissions (IPCC 2006). Its contribution to the total level of greenhouse gas emissions – including non-CO₂ gases – is about 3.5 per cent. How much air traffic actually contributes to climate change is currently the subject of worldwide research.
Climate change is closely linked to the growing amounts of carbon dioxide and other climate-relevant gases released into the earth’s atmosphere. Emissions arise in all sectors of the economy, and just like industrial production, power generation, agriculture and road transport, aviation also contributes to the global rise in CO₂ levels and thus to climate change. It is therefore important to work on minimising CO₂ output.
According to analyses conducted by the International Air Transport Association (IATA), the rapid increase in air traffic volume by more than 200 per cent since 1990 has resulted in a CO₂ emissions growth rate of 3.4 per cent p.a. Of the total emissions volume, 80 per cent is attributable to passenger flights over distances longer than 1,500 km, for which no comparable alternative transport options exist.

The air transport industry is working to bring down emissions further despite the growing air traffic volume. In the context of these efforts, one important goal is to eliminate the connection between increases in air transport volume and rises in CO₂ emissions. Studies by several airlines have shown that by 2006, fuel consumption per passenger kilometre had already been brought down to 70% of the comparable 1990 level.

The future strategy for low-emission aviation

The operators in the air transport sector have agreed on international goals for the reduction of greenhouse gas emissions. Under the industry’s plans, a further 25 per cent reduction in fuel consumption per passenger kilometre will be achieved through new developments in aircraft technology and improved airspace management.

The future strategy for low-emission aviation is founded on four pillars. The first major pillar is modern aircraft and engine technology, the second is development of alternative fuels that will help minimise fuel consumption; thirdly, additional fuel reduction potentials can be realised through optimum loading and capacity utilisation; and the fourth important factor is airspace management, where major improvements – more efficient planning of flight paths, streamlined processes at airports – will

Air traffic volumes have grown rapidly in recent years, but operators have already managed to eliminate the connection between CO₂ output increases and traffic volumes – CO₂ emissions have risen at only half the rates of traffic volume growth. The aviation industry plans to continue on this course. Its international goal is to achieve CO₂-neutral growth, i.e. further increases in traffic volumes at constant CO₂ emissions levels.
result in reduced emissions. Economic instruments such as incentives, R&D efforts and eventually also compensatory measures will help accelerate these developments. For example, it is planned to include all airlines that operate flights into and/or out of the EU in the emissions trading system starting from 2012. However, the effectiveness of this measure is still subject to controversy.

Although aircraft and engine manufacturers are continuously working to develop currently available products further, there are limits to the environmentally effective improvements that can be achieved. It is believed that the next generation of aircraft will again have greatly improved characteristics as regards fuel efficiency and exhaust gas emissions. Achieving these improvements is not only an explicit goal on the part of manufacturers, there are also plans to ensure its realisation through the tightening of relevant international regulations. As new provisions enter into force, a new generation of engines will have to come into service, and new technologies – some of which are still at a basic stage of research – will have to be put in place in many areas.

Modern aircraft and technological progress

Over the last few years, Austrian Airlines has followed a consistent policy of replacing aircraft with high fuel consumption with more fuel-efficient models. One case in point is the sale of the MD 80 fleet in 2004 and 2005. This aircraft type not only needed more fuel, but also produced much greater NOX emissions and more noise than other comparable aircraft. Today, all engines in service in Austrian Airlines aircraft meet the standards of the international emissions certification of ICAO, Annex 16, Volume II.

Whether climate-relevant gases that are emitted at high altitudes have a greater impact on the environment than ground-level emissions of the same gases is a question still under debate in the research community. The current international standard for comparisons of different transport modes is therefore the amount of CO₂ released.

<table>
<thead>
<tr>
<th>Ratio of RTK to CO₂ emissions</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTK (revenue tonne kilometres)</td>
<td>2,374,229</td>
<td>2,563,184</td>
<td>2,715,039</td>
<td>2,306,193</td>
</tr>
<tr>
<td>CO₂ in tonnes</td>
<td>2,646,896</td>
<td>2,747,816</td>
<td>2,807,497</td>
<td>2,657,706</td>
</tr>
<tr>
<td>CO₂/RTK</td>
<td>1.12</td>
<td>1.07</td>
<td>1.03</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Source: Austrian Airlines

Through further development of its fleet, Austrian Airlines has succeeded in bringing growth rates for CO₂ emissions down to below the rate of increase in air transport volume, which is internationally measured in revenue tonne kilometres (RTK). As a result of restructuring of the route network (reduction in the number of long-haul flights), less CO₂ was emitted in absolute terms in 2007 than in the preceding years.
Through precisely planned loading, weight is distributed within the aircraft so as to optimise its aerodynamic position, resulting in reduced fuel consumption.
Climate-effective measures on the ground

When we think of greenhouse gases in an aviation context, we tend to focus mainly on the exhaust fumes from aircraft engines. However, ground traffic at airports, feeder services and cargo transport on the ground also contribute to emissions.

Processes can be streamlined not only in the air, but also on the ground to save time and fuel and minimise climate-relevant exhaust gas emissions. A collaborative decision-making approach that results in smooth interactions between airport management, airlines and airspace management contributes to time-optimised arrival and departure processes to keep pollutants and noise emissions to a minimum. “Sequencing” — i.e. optimised queuing of aircraft at the so-called holding point immediately before take-off — helps to minimise ground-level noise and exhaust fumes. This part of the take-off process is shortened through streamlined handling procedures, especially at peak times (for a more detailed discussion, see the chapters on flight operations and airspace management).

At any airport, there is a lot of motorised ground traffic: passenger cars, lorries, buses and special-purpose vehicles, e.g. for snow clearance and de-icing of aircraft, plus airport fire brigade vehicles all move around, powered by petrol or diesel engines or, in rare cases, by electric motors. Most airports and the Austrian Airlines Group, which has its own ground fleet at Vienna International Airport, increasingly rely on vehicles that run on natural gas or electric power. The Vienna Airport Group currently operates 37 natural gas-powered vehicles. Chapter 7 describes how the vehicles are used in airport operations.

Optimising operational measures

Working to keep aircraft fuel consumption as low as possible is one option in the struggle for minimum emission levels, but it is not enough. While fuel-efficient engines and lower aircraft weight reduce fuel needs, cargo management and how planes are loaded play an important role too.

The amount of goods transported by air has grown at a rapid pace in recent years. Air transport is used with increasing frequency, especially when time is an essential factor, and air cargo predominantly consists of either perishable or very valuable goods. One important aspect is the distribution of weight in the aircraft. Advanced computing is used to design the most favourable distribution pattern whereby the placement of cargo will optimise the aircraft’s aerodynamic position, resulting in a significant reduction in fuel consumption.

In many instances, goods are not transported on separate flights; instead, free capacities in the holds of passenger planes are used to carry cargo shipments. This practice eliminates the need for additional flights and the consequent environmental impacts.
Contrails and cirrus clouds

The contrails – short for condensation trails – that are sometimes visible behind flying aircraft consist of water vapour. At air temperatures above minus 40 degrees centigrade or low humidity, the water evaporates immediately, and there is just a short white flag trailing behind the plane. With high humidity and temperatures below minus 40 degrees, the white wisps do not dissolve right away, but take up more water vapour from the atmosphere, and given the right atmospheric conditions, cirrus clouds may form around the contrail. As these clouds reflect solar radiation, they may contribute to global warming, but they may also have a cooling effect. How aircraft contrails may affect global climate is still unclear, and researchers are using complex modelling techniques in attempts to answer this question. Recent studies have concluded that contrails – to the extent they can be distinguished from naturally occurring cirrus clouds – cover 0.5 per cent of the earth’s surface over Central Europe (annual mean value).

The CLIMATE AUSTRIA project

More and more passengers feel the need to compensate for the greenhouse gas emissions caused by their personal air travel. Responding to this need, airlines are increasingly offering offsetting programmes in which passengers can participate when buying tickets. Through the voluntary purchase of “carbon offsets”, passengers compensate for the emissions caused by their business or holiday flight.

In mid-2008, Kommunalkredit Public Consulting (KPC) launched an offsetting imitative focused on Austria. The “Climate Austria” initiative aims to raise funds for domestic climate protection projects with the help of private sponsors. The money is used to provide additional, non-government funding for highly innovative climate protection projects.

The Austrian Airlines Group has become the first partner of “Climate Austria” and offers its passengers participation in a voluntary carbon offset scheme. Passengers can make a contribution to compensate for their CO₂ emissions when booking tickets via the Austrian Airlines website, but also at so-called “Climate Corners” that have been established at Vienna International Airport and can be used by passengers of any airline. The funds thus raised are used to support ecological projects in Austria and international climate protection projects under the JI/CDM (Joint Implementation/Clean Development Mechanism) schemes. Passengers can buy carbon offsets for part or all of the CO₂ emissions caused by their flight, and can decide which specific projects they want to support.

>> As passengers often overlook carbon offset offers during the online ticket booking process, the “Climate Corner” in the departure area provides a second chance to purchase CO₂ compensation before boarding. The calculated CO₂ amounts are based on current operating data of the Austrian Airlines fleet, but passengers can also enter any flight route from tickets of other airlines to calculate the compensation sum. Vienna International Airport is the first airport worldwide offering this type of service in the interest of raising environmental awareness; there are plans to extend the service in the future, with “Climate Corners” at other Austrian airports, major conference centres and hotels.
How much noise does an aeroplane generate?
Modern aircraft emit less noise than their predecessors.

“Noise footprint” generated by a starting aircraft
Maximum noise level 65 dB

Rapid technological advances have resulted in a significant reduction in aircraft noise levels. The “noise footprint” is the characteristic noise contour of any given type of aircraft. It is calculated from the noise data of the aircraft to model current and projected noise effects and plan noise abatement measures. When taking off, a modern Airbus A319 aircraft only generates maximum noise levels of over 65 dB(A) in the immediate vicinity of the airport.
Noise is the one impact of air transport on man and the environment that is most frequently and most distinctly noticed. However, the level of typical aircraft noise is being reduced continuously as new aircraft types are developed. The enterprises and institutions involved in air transport – aircraft and engine manufacturers, airports, air traffic controllers and airlines – all do whatever they can to keep noise pollution as low as possible. In these efforts, at-source reduction of noise emissions takes priority. Additionally, passive noise mitigation measures are being taken to further reduce the impact of the remaining, unavoidable noise emissions.

As a result of technological advances in aircraft technology and optimisation of airport procedures, air transport-related noise pollution has decreased in recent years, despite the dynamic growth in the number of flight movements.
Why do we hear aircraft?

Aircraft noise arises mainly from moving engine components, from the fuel combustion process and from the effects of airflow along the body, wings and tail of the aircraft. Aerodynamic noise is caused by air turbulence that forms on the contact surfaces as air flows along the body and wings of the aircraft. In aircraft with older engine types, most noise is generated when the hot, high-speed exhaust jet collides with cold, much slower-moving ambient air. Another noise-generating factor are rotating components in the aircraft’s compressor and turbine. Modern power units with front-mounted fans are not only much less noisy, but also more fuel-efficient than older jet engines. The bigger the aircraft, the more important the aerodynamic noise component.

Aircraft noise is heard mainly at and around airports – the sound emitted by a jet at cruising altitude is hardly discernible from the ground. During take-off, when the engines are running at high power levels, the dominant noise component is engine noise. During approach and landing, aerodynamic noise is caused by the landing gear and the extended landing flaps. After touchdown, engine noise is temporarily increased by the reverse thrust used for braking.

Individual perception of aircraft sounds varies, and the subjective nuisance effect depends on what is seen and heard, but also on the observer’s expectations and emotions. Modern passenger aircraft compare surprisingly well with other everyday noise sources, as the graph on the right illustrates.

Sources of aircraft noise

The engines, landing gear and airflow along the body are the major sources of aircraft noise.

Noise emissions from different sources

<table>
<thead>
<tr>
<th>Source</th>
<th>db(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disco</td>
<td>105</td>
</tr>
<tr>
<td>Car horn</td>
<td>105</td>
</tr>
<tr>
<td>Long-distance train (160 km/h, 25m away)</td>
<td>97</td>
</tr>
<tr>
<td>Lawnmower (1m away)</td>
<td>90</td>
</tr>
<tr>
<td>Lorry (7.5m away)</td>
<td>85</td>
</tr>
<tr>
<td>Moped (7.5m away)</td>
<td>80</td>
</tr>
<tr>
<td>Passenger car (7.5m away)</td>
<td>75</td>
</tr>
<tr>
<td>Airbus 320 (5000m from end of runway)</td>
<td>70</td>
</tr>
<tr>
<td>Vacuum cleaner (1m away)</td>
<td>65</td>
</tr>
<tr>
<td>Normal conversation</td>
<td>60</td>
</tr>
<tr>
<td>Quiet residential area</td>
<td>50</td>
</tr>
</tbody>
</table>

*) max. sound level during take-off

Source: Vienna International Airport
A large number of mobile and stationary devices are used to capture noise data at the airports of Graz, Innsbruck, Klagenfurt, Linz, Salzburg and Vienna. Noise levels are recorded and the resulting data analysed in cooperation with the competent environmental authorities. Public access to the findings is ensured through regular publication in “Noise Reports” or via the Internet.

At Vienna International Airport, the noise generated by all starting and landing aircraft is measured by a system called FANOMOS (Flight Track and Noise Monitoring System) that consists of 14 stationary and four mobile recording stations and monitors all flight movements on the basis of flight information data provided by Austro Control.

The same system is used at Salzburg Airport, where six stationary recording stations and one mobile one are employed to capture aircraft noise data.

The recorded flight tracks are used to map actual noise zones which form the basis for evaluation. It is thus possible to pinpoint and analyse what is happening in the air and how specific noise situations arise. The system is also used to monitor compliance with the prescribed approach and departure paths.

In addition, the captured noise data are linked to the flight path records of the RAFIC (Radar and Flight Information Capture) system, and the combined information is used to optimise flight paths and identify unnecessary noise events and/or deviations from flight corridors and the aircraft responsible for them.
At-source noise prevention

Our top priority is to prevent noise from being generated in the first place. Where this is not technically feasible, other actions are taken to protect human health and the environment. In Vienna, a combination of night flight regulations, jointly defined approach and departure paths and technical noise mitigation measures is in place to provide a comprehensive noise protection package. Noise abatement in aviation relies mainly on technologically advanced aircraft that generate lower sound levels. Engine noise, for example, has been greatly reduced in comparison to the noise levels emitted by the first generation of jet engines. The noise levels of today’s turbofan engines are about 20–30 dB lower than those of the 1960s – which means that audible noise has been reduced to between one quarter and one eighth of the original levels!

Turbofan, or bypass, engines divide the air entering through the intake into two streams. The first stream enters the combustion chamber via a compressor; from the combustion chamber, the air moves onto the turbine. This stream serves mainly to produce the power that drives the fan. The second, much bigger stream is only accelerated by the movement of the fan, which acts like the airscrew of a propeller engine. As this second air stream “bypasses” the compressor, combustion chamber and turbine, it creates an envelope of air that impedes the outward propagation of sound waves. Additionally, the casing of the power unit is designed to significantly reduce engine noise propagation. Other advantages of this engine type are its much improved fuel efficiency and reduced pollutant emission rates (see also the chapter on flight operations).

How much noise an aircraft may generate is regulated in the Convention on International Civil Aviation, Annex 16, Volume I. Aircraft that meet the so-called “Chapter 2” limits have been banned from taking off and landing within the EU since April 1, 2002. In order to be allowed to land or take off at an Austrian airport, aircraft have to comply, at minimum, with the “Chapter 3” standards. 22 of Austrian Airlines’ fleet of 27 aircraft already meet the most recent “Chapter 4” standard of certification, which must be met by all aircraft that have been first registered since January 1, 2006.

Innsbruck Airport introduced noise-based landing fees in 2004 as a disincentive for noisy aircraft (such as the MD 80 group or YAK 42, for example). A similar system is currently being prepared for Vienna International Airport in a dialogue process with local community representatives.
Night flight regulations

Night flight regulations ensure quiet nights at Austrian airports from 11:30 pm at the latest until the morning hours. The only Austrian airport that is under obligation to operate around the clock is Vienna International Airport: here, the number of flight movements between 11:30 pm and 5:30 am is limited; at the other airports, the regulations only allow flights during this period in exceptional cases.

One of many points on which agreement was reached during the mediation process on the construction of the third runway at Vienna Airport (see the chapter on stakeholder dialogue) was the introduction of a limit on flight movements to prevent noise during the night hours. Under this agreement, the number of flight movements between 11:30 pm and 5:30 am is gradually being reduced, starting in 2007, until a maximum of 3,000 flight movements per year is reached when the third runway becomes operational. This corresponds to an average of four landings and four take-offs per night. By comparison, the average number of night-time flight movements between 11:30 pm and 5:30 am was 17 to 18 in the base year 2006. Additionally, the use of approach and departure paths is strictly regulated during the night hours. Between 9:00 pm and 7:00 am, only two defined flight paths are open for take-offs and landings, and wide segments over the built-up area of Vienna are out of bounds to air traffic.

Training flights by smaller aircraft and helicopters, as well as glider-towing, which together account for a significant share of flight movements at smaller airports, are also optimised for noise abatement. In Graz, a flight map for training rounds over the airport was prepared in consultation with residents of nearby communities and local authorities. The map defines vulnerable residential areas over which aircraft should not be flown. In Salzburg this has been standard practice for some years now, based on the publication of relevant information sheets for pilots.

Reduction of noise on the ground

Air traffic also generates noise on the ground. This so-called ground noise is a significant factor on the airport premises and in the surrounding area, particularly when certain wind directions prevail. A number of measures have been developed for parking and taxiing aircraft to minimise noise emissions from the apron. For example, one engine is turned off when aircraft are taxiing on the apron, as single-engine taxiing saves energy and reduces noise.

On the apron, aircraft are supplied with electricity from mobile ground power units, most of which run on diesel. At the gate itself, most airports can provide power lines for electricity supply into the interior of the aircraft. Additionally, many types of aircraft carry small auxiliary gas turbines to start up the engines and provide air to the air conditioning system until the engines start running. These auxiliary power units are typically located in the tail section of the aircraft and can also supply electricity in cases where no ground power unit is available.
Sequencing is a practice that helps optimise the queuing of aircraft at the holding point before take-off, reducing ground noise and pollutant emissions. Noise prevention also plays an important role in maintenance and testing. For example, silencers are used for engine testing of specific aircraft in front of the Austrian Airlines hangar at Vienna Airport.

At Innsbruck Airport, the engine test runs which are a mandatory part of aircraft maintenance procedures may only be conducted in an engine testing range which has been specifically designed for this purpose. Additionally, the airport management and the maintenance operators located at the airport have agreed that during the core night hours, engine test runs may only be performed if absolutely necessary. This agreement is an active noise reduction measure.

Noise protection programmes

To date, Salzburg Airport has invested over EUR 10m in noise protection measures that range from noise protection windows to the purchase of plots of land adjacent to the airport and construction of noise protection walls planted with greenery.

The Vienna Airport Noise Protection Programme was established as part of the 2005 Mediation Agreement. Its goals are to protect human health and improve the quality of life of people living close to the airport. As early as 1996, the Vienna Airport Group introduced a voluntary programme to co-finance the installation of noise protection windows in nearby homes. 1,600 households received financial support for new windows with better sound insulation until the programme expired in June 2006, when it was replaced by the Vienna Airport Noise Protection Programme.

The Vienna Airport Noise Protection Programme was originally devised to cover only the noise zones of the planned system of three runways, but was extended in response to the wishes of local citizens’ initiatives and communities. Now, the Programme beneficiaries also include those nearby residents who will in fact be exposed to less noise after the start-up of the three-runway system and will no longer live in one of the noise zones. Until the third runway becomes operational, the Vienna Airport Group will invest some EUR 35m in the Noise Protection Programme. The cost of the expansion of the Noise Protection Programme, which will be about EUR 5m, will be borne by a fund (“Umweltfonds”) financed by the Group.

The Vienna Airport Noise Protection Programme covers zones with a continuous noise level of more than 54 dB during the day and more than 45 dB during the night. Depending on the particularities of the home in question, the following investments are supported:

- installation of noise protection windows and/or noise protection doors
- renovation of walls and roofs
- installation of noise-protected ventilation systems
- under certain conditions, construction of conservatories.

Depending on the noise zone, 50% to 100% of the investment cost is covered by the Programme. In flight noise zone 4 (with continuous noise levels of over 65 dB during the day and over 57 dB during the night), property is purchased at market value upon request of the owner.
Are airports backing renewable energy?
Power for 84 households from a photovoltaic plant

Salzburg’s biggest photovoltaic plant has been installed on the roofs of the hangars and the cargo warehouse at Salzburg Airport. Nearly 3,000 sqm of photovoltaic cells produce sufficient electricity to cover the needs of some 84 households all year round.
Environmental management

Environmental management systems (EMSs) are used to systematically identify, document and monitor all operational activities and processes that have an impact on the environment. Environmental experts use this documentary basis to define key indicators and develop action programmes for the continuous improvement of organisations’ environmental performance. Additionally, implementation of an EMS also ensures regular internal and external communication – for example, in the shape of biennial environmental reports.

Certified EMSs are in place at several airports in Austria. Linz Airport holds certification in accordance with the international standard ISO 14001, Innsbruck Airport is certified under the European Eco-Audit Regulation EMAS, and Salzburg Airport even boasts both certifications.

In 2007, Innsbruck was the first Austrian airport to receive the EMAS Award for its efforts in environmental management and operational environmental protection policies.

Airports and airlines are working continually for more environmentally sound aviation. Measures for more environmentally compatible and sustainable development are not only taken in the air, but on the ground as well. The generation of waste is avoided wherever possible, and the wastes that do arise are collected and reused or recycled. Efficient and economical use of water, electricity and heat energy is another important operational environmental protection policy.

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<tr>
<th>ISO 14001</th>
<th>EMAS</th>
<th>ECO-Audit</th>
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<td>Austrian Airlines</td>
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<td>Austro Control</td>
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<td>Salzburg Airport</td>
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Prizes for environmental activities were also awarded to Graz Airport, Austrian Airlines and Austro Control, which were designated as “Ecoprofit operations” by the city administrations of Graz and Vienna.

Vienna International Airport took a deliberate decision against certification and opted instead for a grassroots dialogue process with local communities. Through a mediation process that was launched in 2000, followed by an environmental impact statement, all environmentally relevant data were collected and used for a forecast model.

Waste and recycling

The best way of dealing with waste is of course to avoid generating it in the first place. Waste prevention thus has priority, both on the ground and in the air. Less waste generated means less waste to separate and dispose of. Waste prevention begins with procurement. Some suppliers will take back packaging material and used goods, such as spent toner cartridges or ink ribbons. Preference is given to environmentally sound products that meet criteria such as ecologically sound manufacturing processes, no unnecessary packaging, durability, reparability and reusability. Efficient use of resources also helps to keep the waste stream small.

Waste separation is not an easy task at an airport with its many different waste materials. Waste streams originate from aircraft, from catering and from business operations located at the airport, and there are hazardous wastes that require different forms of special treatment. About two thirds of all hazardous wastes are waste oils and paint residues, some of which are recycled by specialised disposal companies. A consistent policy of separating waste streams into recycling material, hazardous wastes and non-recyclable wastes helps to keep the amount of residual waste that has to be landfilled as small as possible.

Passengers and airport visitors are also called upon to contribute to waste separation efforts. For this purpose, centralised collection and separation systems have been installed at all airports in Austria. Container banks with clearly marked containers help passengers to dispose of their rubbish correctly.

Waste separation policies do not end at take-off. On board aircraft, most waste material comes from catering and the papers

With a new waste management system, Austrian Airlines more than halved the amount of residual (mixed) waste between 2003 and 2006.
Electronic ticketing

Passengers who book online with Austrian Airlines are issued with electronic tickets only – this saves paper and printing material and the corresponding environmental impact. As of 1 June 2008, the International Air Transport Association changed to this paperless system for ticket sales worldwide.

Energy use

Airports need a lot of energy: for lighting of terminals, apron, taxiways, runways and other structures at night, heating/air conditioning of buildings and operation of ground equipment. In addition, aircraft operation on the ground also requires an external power supply.

Electrical power is used as efficiently as possible, and the power consumption of the airports is continually monitored and analysed. Substantial energy savings are realised on an ongoing basis through the use of state-of-the-art lighting technologies (runway edges, apron, offices and terminal halls). All new buildings are designed for optimised energy utilisation, and all Austrian airports buy their electricity from mixed sources with a high share of renewable resources, in particular hydropower. A staggered emergency power system ensures energy supply even in exceptional situations.

Vienna International Airport is supplied with heat via a 4,300m long remote heating pipeline from Schwechat oil refinery. The heat comes from a heat-power cogeneration plant, a particularly environmentally-friendly operation. Cooperation between the Austrian petroleum company OMV and the Vienna Airport Group has created a doubly positive environmental effect because the refinery can thus eliminate excess process heat instead of using additional energy for cooling, saving on fossil fuel consumption. The resulting CO₂ emissions levels are lower than if the refinery were to supply heating fuel directly to the airport. The airports at Graz and Linz also use remote heating systems, whereas Innsbruck has opted for natural gas.

An innovative and energy-saving method is used at Salzburg and Innsbruck to cool the...
airport buildings: groundwater is pumped up from wells and used for cooling; after running through the cooling cycle, the water – now only slightly warmer – is returned to the groundwater table.

The cooling plant at Vienna International Airport consists of three cooling centres located at different points. The excess heat from all air-conditioned structures is carried away via this cooling plant, which in turn is connected to a pipeline for air-conditioning water. The 15 cooling units of the plant are operated using environmentally benign refrigerants, such as R123, R34a and R717, reducing potential damage to the earth’s ozone layer by more than 98 per cent in comparison to older refrigerant types. Cooling units are switched on and off in response to rising and declining demand. One investment that has turned out to be especially profitable is the installation of heat feedback loops for further use of the thermal energy contained in exhaust air from the buildings.

Water consumption

Airports and airlines are committed to the preservation of natural bodies of water and water resources. The main focus is on the preservation of drinking water resources through economical consumption, increased use of rainwater and service water and reduction of the wastewater stream through environmentally compatible disposal practices. In this context, it is also very important to exercise great caution in the handling and use of substances that may constitute a hazard to water quality.

Airports are major consumers of water, with bars and restaurants, catering services and airlines being the main sources of demand. While most Austrian airports get their water supply from the local community networks, Vienna International Airport operates four own groundwater wells that supply all drinking water and service water.

Despite rapidly rising passenger figures, water use at Austrian airports has been declining continuously. From 1996 to 2007, the amount of water consumed at Vienna International Airport, for example, declined by 17 per cent, although the number of passengers increased by 93 per cent.

Wastewater is disposed of in separate systems at all airports, with communal wastewater streams (wastewater from sanitary facilities and the kitchens of bars, restaurants and
At Vienna International Airport, wastewater and surface runoff are collected and piped to the treatment plant in Schwechat. Waste-water that is contaminated with de-icing agents is put in interim storage and released gradually into the sewer system.
catering facilities) entering the local municipal sewer system.

At Vienna International Airport, a network of sewers carries away surface runoff from all sealed surfaces – apron, taxiways and runways – which together cover 2.4 million square metres. The water is piped to the wastewater treatment plant at Schwechat, where the municipal wastewater is also treated. In winter, some of the surface runoff is contaminated with de-icing agents, especially that from the aircraft de-icing points. This wastewater is kept in reservoirs for interim storage and gradually, over several months, added to the wastewater stream that is piped to the Schwechat treatment plant.

At the regional airports, the surface runoff from runways, aprons, parking spaces, roofs, car parks and roads is caught in sewers and subjected to several treatment stages (silt traps, screens, activated carbon filters and mineral oil filters) before it is allowed to trickle away into the ground.

For cleaning purposes, the airports use biodegradable products that do not constitute an environmental hazard.

Nature conservation

The large, contiguous green areas at airports are high-quality ecosystems. Especially close to major urban agglomerations, the open meadows provide valuable sanctuaries for endangered wildlife and plant species. A nature guide to Graz Airport illustrates that, in addition to a rich and varied grassland flora, rare insect species and many mammals, birds, reptiles and amphibians have found a home within the airport perimeter. A study conducted by ÖKO Team Graz at Salzburg Airport found a total of 54 bird species, including ten endangered species that have become extremely rare in Austria, such as the grey heron and the black kite. As a rule, the meadows are used by local farmers who cooperate closely with nature conservation experts in managing the land.

The open grass areas at Vienna International Airport constitute eastern Austria’s largest contiguous meadow landscape. With grass cut to different heights, a complete lack of artificial fertilizer and fencing all round, the area provides an attractive habitat for migratory and ground-breeding birds and for a small colony of rare ground squirrels (sousliks).

>> Removing ice and snow

During the winter, all exposed surfaces that are used by aircraft and other vehicles, as well as the aircraft themselves, must be kept free of snow and ice. If snow or ice is allowed to remain on an aircraft’s wings or tail, serious problems may occur during take-off. To prevent this from happening, aircraft are treated with a heated mixture of water and a de-icing agent immediately before take-off. The main ingredient of the de-icing agent is glycol, which also prevents new ice from being formed between the de-icing procedure and take-off (anti-icing). Once airborne, the aircraft is protected by on-board de-icing systems.

The glycol mixes used at Austrian airports are fully biodegradable. However, the mixture of water and de-icing agent carries a higher pollutant load than municipal wastewater. This is why there are special de-icing points – for example, at Vienna International Airport – where the wastewater from de-icing is caught and fed into the wastewater cycle in controlled batches.
How are airports linked to public transport?
The accessibility of airports by bus or rail is continuously being improved.

In Vienna, a constantly increasing number of passengers arrive by public transport.

More and more passengers use a bus or train for their journey to the airport. The integration of airports in landside public transport networks is growing in importance as airline passenger numbers continue to increase. Developments at Vienna International Airport are in line with the international trend in this respect.
Day by day, thousands of people come to the airport to go on a journey, meet someone from a flight or work on the premises. Just as many arrive daily on incoming flights and continue their journey from the airport. Goods are delivered, loaded and flown to their destinations.

Airports are intermodal transport hubs that must be easy to reach by reliable means of transport and within a calculable length of time – whether by road or by rail. The common objective of everyone involved is therefore to improve these incoming and outgoing flows of airline passengers, cargo and airport employees, integrating them in the traffic and transport systems of the adjoining cities and their wider environs.

International developments show that intelligent networking of different transport carriers is an efficient approach that produces satisfactory, demand-oriented solutions. In the past, efficient links to the major road network used to be the most important factor. But road capacity limits and the needs and concerns of the people affected by these traffic flows set a limit on this development.

“Seamless travel” – this catchword challenges all transport carriers to take joint action towards developing and implementing intelligent and efficient transport concepts. The objective is both integration in the railway network and efficient links to the road system. Good landside accessibility always enhances the attractiveness of an airport.

<table>
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<tr>
<th>Share of locally available rail or road transport services in the modal split (2007)</th>
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<tr>
<td>Vienna (CAT, S7, bus)</td>
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<tr>
<td>Graz (rail and bus)</td>
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<td>Salzburg (bus)</td>
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<td>Innsbruck (bus and shuttle services)</td>
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<td>Linz</td>
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<td>Klagenfurt</td>
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The table shows the share of passengers using public transport for their journey to the airport.

Source: airports
Large airports have therefore been focusing efforts on establishing links to high-capacity rail networks and promoting their integration into public transport services to the city centres. All measures taken in the field of improving transport links are subsumed in the concept of "seamless travel", i.e. reducing the number of necessary transfers between rail and air services to a minimum.

Internationally, the number of airports with direct links to rail services has tripled over the past 20 years. Direct links to high-capacity rail routes and the improvement of shuttle services to city centres has greatly enhanced the attractiveness of travelling by rail and by air.

Vienna International Airport established a seamless and attractive link to the city of Vienna with the CAT (City Airport Train) services that started operation in December 2003. Complementing the S7 local rapid rail services, CAT services run at intervals of 30 minutes from 5:30 a.m. to midnight. The environmentally friendly CAT connects the city and the airport in just 16 minutes transfer time, with no traffic jams en route.

The CAT’s Wien-Mitte city terminal is directly integrated into the Vienna U-Bahn metro system. Flight passengers may also check in at this terminal – a further step towards seamless travel. In 2008 the range of CAT services was expanded to include door-to-door services with CAT cabs. The CAT cabs, gas-powered city taxis, can be booked via the Internet to collect up to four people from their hotel, company or place of residence and bring them to the Wien-Mitte city terminal.

Future plans for the transport system of Austria’s eastern region include the establishment of a direct rail link to the high-capacity rail network at the new Vienna Central Station. These plans take up a trend adopted by airline hubs such as Frankfurt, which is to establish direct links between airports and long-distance rail routes. The completion of the long-distance railway station at Vienna International Airport is scheduled for 2010. The adaptation and redesign of the railway infrastructure at the airport opens up huge potential for upgrading the rail network towards the east, thus expanding the radius of seamless, environmentally friendly travel options far into the CENTROPE region.

Linz Airport is currently linked to Linz Central Station by an hourly shuttle bus service whose timetable is harmonised to coincide with that of international scheduled flights. A free pick-up service is also available from the nearby local railway station. An important construction decision has just been taken that will result in a further optimisation
of the modal split in the Linz area: in future, all four tracks of the Vienna-Linz-Wels-Salzburg high-capacity rail line will get a direct link to Linz Airport.

From Salzburg Airport, which is located only 4 km from the city centre, passengers can get into the city easily and quickly by public transport (trolleybus services). The nearby tourist regions of the provinces of Salzburg, Upper Austria, Styria and Tyrol as well as neighbouring Bavaria are optimally linked to the airport by a separate arterial road to the motorway.

Since 2003, Graz Airport has been directly accessible from the A2 motorway. Co-financed by the airport, this motorway link saves travellers a detour of nine kilometres and additionally enlarges the airport’s immediate catchment area. Graz Airport also boasts excellent bus and railway connections to the public transport system of the city of Graz. From Monday to Friday passengers have the option of taking one of 20 rapid rail or 21 bus services to and from the airport; weekend services are operated on a slightly reduced schedule. Along with other regional mobility providers, Graz Airport actively participates in the Graz Airport Transport Committee, a working group set up by the provincial government of Styria.

Innsbruck Airport is connected to the city centre by a city bus running at quarter-hourly intervals. This bus stops at all of the city’s major transport junctions, including the central railway station. Additionally, a number of bus and shuttle operators offer their services in close cooperation with tourism providers; these services transport guests directly to and from their accommodation, above all during the peak winter charter season.

Kärnten Airport in Carinthia is located directly on the A2 motorway and linked to the nearby southern rail route. A scheduled bus service to the city centre of Klagenfurt four kilometres away operates at half-hour intervals. Moreover, a wide variety of shuttle bus services transfer travellers from the airport directly to the different regions of Carinthia.
The Austrian airports are accessible by public transport. The CAT City Airport Train, for instance, carries passengers from Vienna city centre to the airport in just 16 minutes.
What is the future of the European airspace?
Reduction of control areas from currently 60 to less than 10 will enhance efficiency.

Optimised traffic flows and harmonised technology – these are the main objectives of the Single European Sky initiative launched by the European Commission. All to the benefit of the passengers, this initiative is aimed at further increasing the safety, punctuality and environmental compatibility of European air traffic, which is currently expanding at a rate of four per cent annually.
Air Traffic Management (ATM), though largely unperceived by the passengers, is probably the most important and critical component of every flight movement. Using radar control equipment, the air traffic controllers guide pilots and aircraft from one airport to the next – not an easy task considering that almost 4,000 aircraft frequent the Austrian airspace every day.

Austro Control is the Austrian air navigation service provider and as such responsible for the safe, efficient and environmentally compatible management of air traffic in the airspace above Austria and at all Austrian commercial airports. At the individual airports, ground controllers in the towers are responsible for controlling all ground movements of aircraft – on taxiways and runways, issuing take-off permissions and clearing aircraft for take-off or landing. Once in the air and away from the airport, the arrival and departure controllers take over, coordinating the climb and descent of aircraft and guiding pilots on their proper routes to their destination airports or, vice versa, from the airways to the airport’s instrument-based landing system. Once arrival or departure operations are concluded, the ACC (Area Control Centre) directs the aircraft to the destination airport along a network of airways. In the case of international flights the aircraft is passed on from ACC to ACC.

The routes of aircraft frequently intersect, both in the airport area and high up in the air. The tower controllers of Austro Control are responsible for ensuring safety and compliance with minimum separation requirements (distances between aircraft). The minimum separation required is five nautical miles (approx. 9 km) lateral and at least 1,000 feet (approx. 300 metres) vertical spacing at the same cruising altitude.

Better planning, less kerosene

Better navigation, improved communication and sophisticated IT systems create the basis for more effective flight management on a “gate-to-gate” basis. The objective is a continuous reduction of both on- and off-ground running periods of aircraft engines by optimising taxiing times and flight
routes. The more efficiently an aircraft can be directed through the flight process – from the moment the engines are started to their being turned off at the destination airport – the less kerosene the aircraft will consume and the less emissions will be produced. State-of-the-art aircraft design and improved flight routes offer potential to optimise kerosene consumption while permitting more environmentally compatible operations. The key challenge for air traffic management is to reconcile all these requirements with an increasing air traffic volume and to prevent unnecessary kerosene consumption.

Choosing the shortest route between two destinations is not always possible. Owing to restrictions in the airspace above individual states, aircraft are often compelled to fly zigzag routes. In Europe, for instance, the airspace resembles a “patchwork quilt”, subdivided into many smaller segments that are often controlled by different air traffic control systems. The development of a uniform European airspace will also entail significant improvements for the environment. More efficient and shorter flight routes and optimised flight profiles will help to reduce flight times and kerosene consumption substantially.

Innovative arrival and departure procedures also make an important contribution to reducing emissions. With the development of self-contained satellite navigation systems, the past few years have witnessed rapid developments in this respect. The operational principle of these systems is relatively simple: Virtual navigation points (waypoints) are set in the landscape. The aircraft follows these waypoints guided by its on-board flight management systems. This makes it possible to have the aircraft “glide” onto the runway from a predefined approach point with its engines idle and reduced pollutant emission and low noise. These innovative arrival and departure procedures are developed and approved by Austro Control. Austrian Airlines, for instance, already uses the so-called Continuous Descent Approach (CDA) with some of its aircraft, one of the most promising innovations in this area. The same technology also makes it possible to define take-off routes by setting exact waypoints that allow settlement areas to be circumnavigated to the extent possible.

Joint improvement of airport processes

Collaborative decision-making (CDM) is a joint initiative to ensure time-saving, trouble-free airport procedures. By means of perfect coordination between airports, air traffic controllers and airlines, the time efficiency of arrival and departure operations can be maximised through measures such as improving pre-departure sequences or optimising operational procedures to reduce the impact of bad weather. In Vienna a CDM project has been launched by Vienna International Airport, Austro Control and Austrian Airlines.
Using the Continuous Descent Approach the aircraft glides to the airport maintaining an optimum, constant angle during descent. The positive effects are less noise and reduced fuel consumption.

**Comparison of conventional and reduced-noise approach**

- **Conventional approach**
- **Reduced-noise approach**
- **Noise**

Source: Austro Control
Single European Sky – for a common European airspace

Single European Sky (SES) is a European Commission initiative that pursues an ambitious goal: the concept not only aims at enhancing the efficiency of traffic management in European aviation, but has also launched Europe’s largest climate protection project. The European airspace is currently subdivided into more than 60 air traffic control zones. This EU initiative now aims at reducing the number of these control zones to just a few Functional Airspace Blocks (FAB) exclusively defined by operational requirements. This should result in an optimised European route network. Planning activities have been taken up throughout Europe and first concrete plans for setting up a Scandinavian airspace block and a block encompassing France, Germany, Switzerland and the Benelux States (FAB Europe Central) have already been presented. Through Austro Control, Austria has been working on the implementation of a common airspace block for Central Europe. The Functional Airspace Block Central Europe (FAB CE) is to be established together with the Czech Republic, Slovakia, Hungary, Croatia, Slovenia and Bosnia-Herzegovina (for details see chart on page 43).

A study presented by the Eurocontrol Performance Review Commission (PRC) in December 2006 estimates the European cost saving potential of the SES project at two to three billion euros annually. Moreover, reducing detours and additional loops could result in about 300 million kilometres of savings in terms of distances flown.

The European Commission estimates that the implementation of the Single European Sky initiative will help to reduce carbon dioxide emissions by 7 to 12 per cent per flight, which corresponds to a reduction of 16 million tonnes annually.

Last, but not least, the implementation of the Single European Sky programme also hinges on technological developments. This perspective is dealt with by the SESAR (Single European Sky ATM Research) initiative, which, among other things, aims to reduce the environmental impacts of air traffic by ten per cent by 2020.

Hubs and spokes

The hub-and-spoke network concept is a system of connections arranged like a wheel, in which all long-distance traffic is bundled from hubs – such as Vienna, Munich and Zurich. It is not efficient to offer direct flights from all airports to all destinations. Instead, feeder flights bring passengers to the hubs, where they transfer to connecting flights to smaller regional airports (spokes). Arrival and departure schedules are perfectly harmonised in such a system, helping to minimise transfer times and considerably reducing overall travelling times for passengers.

The operationally determined minimum connecting times (MCT) vary considerably from airport to airport. While the time required averages 45 minutes in Frankfurt, passengers at Heathrow may have to spend more than an hour on the ground before taking off again, especially if they have to transfer to another terminal. At Vienna International Airport the minimum connecting time is 25 minutes on average.
What is one of the principal objectives in the development of new aircraft?
The focus is on minimising kerosene consumption. Substantial savings can be achieved in this area.

Kerosene consumption in the course of time

Modern commercial aircraft fly more than three times the distance with the same amount of kerosene as they did 40 years ago. Development progress in aircraft engine technology, aircraft construction and flight operations has helped to reduce specific kerosene consumption by 32 per cent over the past 15 years.
Technical progress in the aviation industry often goes hand in hand with environmental protection and environmental objectives. An important development objective is to minimise fuel consumption in the air as well as in take-off and landing operations and ground movements.

Since 1970 Austrian Airlines has reduced specific kerosene consumption by 70 per cent. In 2007 specific kerosene consumption was at 4.5 litres per 100 passenger kilometres.
Saving fuel to reduce emissions

The fuel consumption of aircraft is being continuously reduced – thanks to ongoing innovations in engine technology, aircraft fuselage and surface materials and in aerodynamics and electronics.

Lower fuel consumption results in lower carbon dioxide and non-carbon dioxide emissions from aircraft and thus reduces direct and indirect environmental impacts. The term non-carbon dioxide emissions is used as a collective term for the pollutants generated in kerosene combustion, the most important being nitrogen oxide (NOX), carbon monoxide (CO), unburned hydrocarbons (UHC), sulphur dioxide (SO₂) and carbon particulate matter.

In 2006 Austrian Airlines launched its Save Fuel Programme aimed at reducing fuel consumption in all areas of flight operations. In 2006 and 2007 this programme helped save some 3,800 tonnes of kerosene each year. Sub-projects of this programme, among others, include optimised loading of baggage and cargo to improve the aerodynamic properties of the aircraft in the air and optimised fuelling of the aircraft – exactly adjusted to the weight of the aircraft on departure. Modern airspace management additionally allows adjustment of the cruising altitude, the route and the cruising speed so as to optimise fuel consumption.

Better aerodynamics – lower fuel consumption

Although the aerodynamic design of modern aircraft has improved enormously in recent years, there is still a potential for further improvements aimed at reducing air drag. Winglets affixed to the tip of the foil are one of the technical innovations introduced by aircraft manufacturers. These angled extensions at the tip of each wing reduce air drag and hence kerosene consumption and pollutant emissions. Annual fuel savings per aircraft amount to as much as 600 tonnes of kerosene. By improving the airflow at the tip of the wing, the winglets also reduce noise emission during the aircraft’s landing approach.

Clean air

The objective is to keep the impacts of air traffic on the local air quality in the environs of the airports as low as possible. The main impacts on the air quality are observed in the landing and take-off zone (LTO zone). Vienna International Airport has been measuring the air quality in the immediate apron and runway area for more than 15 years. The results correspond to those observed on the outskirts of a large city, with low carbon monoxide, sulphur dioxide, dust, benzene and heavy metals immission plus moderate nitrogen oxide levels. Ozone

The highest fuel consumption and hence the largest saving potential is observed in the landing and take-off cycle.
52

levels in the airport area are comparable to those generally observed in the Vienna Basin. Hence there is no evidence of an additional impact of air traffic on the regional air quality in the Greater Vienna area.

Austrian Airlines aircraft of the types Airbus A319 and A320 and Boeing 737 are equipped with turbofan engines, which stand out for their very low nitrogen oxide (NO\textsubscript{X}) emission. Emissions such as carbon monoxide and hydrocarbons have been reduced by 50 to 90 per cent over the past 40 years (source: IATA, 2004). In terms of emissions the aircraft in the Austrian Airlines fleet all comply with the very stringent ICAO Annex 16 Standards. By modernising its fleet, the Austrian Airlines Group has attained an important goal: aircraft emissions no longer rise proportionately to flight performance (RTK – Revenue Tonne Kilometres, the key transportation performance indicator).

Environmentally compatible maintenance and cleaning

Aircraft engine servicing and maintenance operations are based on state-of-the-art trend monitoring, i.e. specified key engine data are continuously compared over time. These regular data records provide a database characterised by high data density. In this way, minor changes in terms of performance and fuel efficiency can be identified at a very early stage. Servicing intervals can thus be adapted with a view to minimising fuel consumption.

In its aircraft hangar Austrian Airlines uses a new system for cleaning aircraft engines that requires only a minimal amount of chemical cleaning agents. Dust and dirt accumulating primarily on the fans and compressors of the engines is removed at regular intervals using a powerful jet of water. Dust on fan and compressor blades increases fuel consumption by up to two per cent.

Fuel dumping – discharging kerosene

Fuel dumping from an aircraft in flight is a measure rarely taken, and only specific long-range aircraft types are fitted with the required technical equipment. It is performed in emergency situations if an aircraft is compelled to return to the airport shortly after take-off. These emergency situations are precisely defined and usually involve technical defects or medical emergencies.

The reason for dumping fuel in exceptional cases is that the maximum take-off weight (MTOW) of long-haul aircraft is higher than their maximum landing weight (MLW). However, most aircraft types are built to land with their take-off weight if required and have no fuel dump systems installed, like the Airbus A320 medium-range jets used by Austrian Airlines, for instance.

Aircraft are usually directed to unsettled areas for fuel dumping operations. In Austria there are no predefined kerosene dumping zones. During the dumping process the aircraft rises in a spiral several kilometres in diameter. As jettisoned kerosene vaporises rapidly and
immediately oxidises to water and carbon dioxide (especially at flying speeds of several 100km/h) it is rather unlikely that any liquid fuel ever reaches the ground.

In the period 2004 to 2007 Austrian Airlines was compelled to dump fuel only five times for technical reasons, and none of these instances occurred in the airspace above Austria.

Vienna: a dedicated pipeline for kerosene

Vienna International Airport is supplied with kerosene via a pipeline built in 1991. From four tanks with a total capacity of 30,000 cubic metres located on the OMV premises the kerosene is pumped to the fuel depot at the airport at a maximum rate of 180 cubic metres per hour. In 2007 the total supply volume ran to 774.1 million litres. The pipeline contributes to reducing heavy-duty traffic and safety risks on a heavily frequented section of the A4 motorway to Hungary. The fuel volume needed in 2007 would have required 25,803 tanker loads to be transported to Vienna International Airport.

The underground refuelling system in operation at Vienna International Airport also ensures groundwater protection. All aircraft refuelling is effected from a closed circular pipeline on the apron. The method in use in commercial aviation is pressure fuelling, as this system reduces fuel evaporation and consequently the evaporation of hydrocarbons to a minimum.

At the Austrian regional airports aircraft are refuelled by mobile refuelling vehicles. Rail-based supply options are being considered for the future.

Natural gas-powered vehicles at Vienna International Airport

Since 2008 Vienna International Airport has had 37 natural gas-powered vehicles in operation. These vehicles are mainly used in the apron area, where they serve as mobile offices for managing ground handling operations.

Using natural gas to fuel these vehicles reduces the engines’ specific carbon dioxide (CO₂), nitrogen oxide (NOₓ) and particulate emissions. A natural gas-fuelled VW Caddy generates 30 per cent less CO₂ emissions than a comparable petrol-driven vehicle, and the emissions of sulphur dioxide and carbon particulate matter typical of diesel engines are prevented altogether. Thanks to low fuel consumption the higher acquisition costs are amortised within a single year. The next step will be to replace the entire vehicle fleet in use for aircraft handling operations – 100 vehicles in total – with natural gas-powered VW Caddies.
How do airports communicate with their neighbours?
The focus of the Vienna International Airport Dialogue Forum is on reconciliation of interests.

Aiming at reconciliation of interests

Following the conclusion of the mediation process regarding the airport’s expansion plans, the Vienna Airport Dialogue Forum Association continues to foster the dialogue with the individual interest groups in the region. Key issues include ongoing airport operations, the airport’s expansion plans and the impacts on affected communities and residents.
Airlines, airports and air traffic controllers have been making an active effort to establish a constructive and critical dialogue with all interest groups. These include customers, employees and shareholders, suppliers and business partners, political and administrative authorities, scientific and educational institutions, citizens' initiatives as well as neighbours and communities. Along with open and transparent communication, the involvement of these stakeholders creates the basis for a sustainable business policy for Austrian aviation industry companies.

The group of people who are primarily affected by flight noise or aircraft pollutant emissions are the residents in the environs of an airport. For this reason, the Austrian airports have established contact points for anyone interested in or affected by airport operations. Every complaint is registered, forwarded, processed and answered, irrespective of how it was expressed and who filed it. The way in which noise is perceived differs from person to person. For airlines and airport operators, comprehensive measurements and the subjective perceptions of the people living in the environs of the airport constitute an important basis for a permanent learning process. Efforts are always aimed at keeping overall exposure as low as possible.

Information and cooperation

In line with the Mediation Agreement, Vienna International Airport, for instance, has established a German info hotline "Umwelt und Luftfahrt" (0810/22 33 40) dealing with environmental and aviation issues. The website www.vie-umwelt.at (in German) additionally offers a comprehensive information and communication platform on environmental issues. Besides general facts and figures on aviation and environmental protection, this page offers up-to-date information on flight movements on the individual runways, presents the results of stationary and mobile flight noise measurements and also includes a comprehensive service section with an environmental lexicon, publications and e-mail contact links. In 2007 a total of 44,563 visitors were registered on this website.

The feedback received via mail or info hotline is taken into account in the work of the Dialogue Forum.

Linz Airport also maintains a separate contact number (07221-600 1800) for lodging
complaints. Every complaint or suggestion is registered and submitted to the airport’s advisory board for environmental matters. In Linz the so-called URIS stakeholder feedback and information system, a platform for dialogue and exchange of information between eight communities adjoining the airport, the provincial government of Upper Austria, representatives of interest groups and Linz Airport was established back in 1999. This initiative aims at ensuring a sustainable development of the airport by involving all interest groups in its immediate vicinity and guaranteeing that their interests are accommodated to the largest possible extent.

At Graz Airport too, complaints and enquiries mostly come in by telephone and are answered by the airport operations manager on duty. Moreover, complaints, suggestions, etc. may also be posted in a box at the airport information point. Every non-anonymous complaint is processed and enquiries are evaluated annually. A round table on environmental matters made up of representatives of the provincial government, Austro Control, the municipalities, the locally represented aviation companies, the Feldkirchen Environmental Association, a local citizens’ initiative, and Graz Airport convenes at regular intervals to discuss and evaluate possible solutions to topical problems.

At Salzburg Airport a regular dialogue is maintained with the Salzburg Airport Local Residents’ Protection Association, the Rupertiwinkel Protection Association and political representatives. Interest groups and residents in the airport’s environs in Austria and nearby Germany are also invited to the meetings of the German-Austrian Flight Noise Commission, which meets once a year.
At Kärnten Airport complaints can be lodged with the Corporate Communications Department, where they are handled immediately.

With the objective of optimising communication with all parties involved and establishing an even more transparent and target-oriented communication process, Innsbruck Airport initiated a stakeholder analysis within the framework of the EMAS Process (see also the chapter on environmental protection in operations). The aim of this analysis is to identify all the individual interest groups with a view to defining and developing individual communication channels for the future.

Vienna Airport Dialogue Forum

The mediation process at Vienna International Airport and the Vienna Airport Dialogue Forum are internationally considered a best practice example of an open, fair and transparent citizen participation procedure. The Vienna Airport Dialogue Forum was established when the mediation process was concluded in June 2005. The Dialogue Forum, which is financed by Vienna International Airport, is a non-profit association that serves as an information and communication platform for continuing the dialogue initiated with the mediation process. Approximately two million people are given a voice in the forum through the representatives of the different interest groups.

The Dialogue Forum ensures compliance with the contracts concluded in the mediation process and deals with issues, questions and conflicts arising in the context of the development of air traffic and the extension of the airport. The Mediation Agreement among other things contains agreements regarding the location of a possible third runway, night flight restrictions, flight noise limits, an environmental fund and a noise protection programme. Municipalities and citizens’ initiatives in this way enforced numerous concrete and actionable regulations going far beyond the noise prevention measures prescribed by law. Furthermore, the Dialogue Forum conducts negotiations on all measures and ideas that may contribute to keeping the negative effects of air traffic as low as possible. The success of these measures is seen in the fact that flight noise exposure...
in the area of Greater Vienna could be kept more or less constant in the period 2000 to 2007 even though passenger figures surged 73 per cent in the same period.

In order to be able to evaluate whether the goals aspired to are actually attained, all flight operations at Vienna International Airport are closely monitored by an evaluation group set up within the Dialogue Forum. The annual evaluation reports are a key basis for further joint work on improvements.

Objectively measurable exposure and subjective perception of disturbance and nuisance are equally registered and given equal weight in the discussions of the Dialogue Forum. The results of the annual evaluation reports drawn up by the Dialogue Forum are thus based on the noise data established with the FANOMOS measuring system on the one hand, and on people’s subjective perceptions on the other. The latter depend on a number of different factors and may greatly deviate from objectively measurable noise exposure levels.

The primary goal of the Dialogue Forum is to improve the situation of the people most heavily affected by air traffic. A second objective is to keep the number of affected people as low as possible.

VISITAIR CENTER – how an airport works

In its VISITAIR Center the Vienna Airport Group offers visitors an opportunity to gain an insight into the airport and its operations. Residents from the surrounding area and other interested visitors (school children, pensioners, families, club groups, etc.) can learn more from a permanent exhibition, which along with facts and figures provides detailed descriptions of the airport and its operations. Displays illustrate how the individual processes and operations interlink and what happens from the arrival of the passengers to the take-off of the aircraft. Moreover, the exhibition takes up the issue of the airport as a neighbour, documents the history of Vienna International Airport and presents the airport’s plans for the future. For visitors seeking greater detail, there is a research station where they can read up on individual topics and call up publications.

The “Sound Station” explores the phenomenon of noise and offers technical background information. Audio clips invite visitors to listen to flight noise, traffic noise and ordinary daytime noise and a “sound check” provides an opportunity to experience the subjective nature of noise perception.

VISIT MANAGEMENT – backstage at an airline

Austrian Airlines has responded to the wish expressed by many passengers and visiting groups for guided tours and more information. Under the VISIT MANAGEMENT programme, the airline now offers a tour of its maintenance hangars, an introduction to passenger handling and a visit to the emergency training centre. Additionally, lectures for school classes, information material and special courses can be selected and booked via the German Internet portal www.austrian.com
What are the future objectives in air transport?
Research aims at making air transport cleaner, quieter, more affordable and safer.

Visionary goals for 2020

European nations, businesses and other organisations have joined forces in ACARE, the Advisory Council for Aeronautics Research in Europe, to formulate visionary goals for the year 2020. The focus is on optimising research efforts to make air transport cleaner, quieter and more affordable and raise the level of general and technical safety.
The Austrian aviation industry is engaged in national and international cooperation in innovative and scientific research projects. Many current international research and development projects have goals that will generate positive environmental effects.

ACARE

ACARE, the Advisory Council on Aeronautics Research in Europe, has prepared a Strategic Research Agenda (SRA) for the period up to 2020. In the SRA, the involved European states, aviation and other organisations have listed development goals for aircraft, airport technology and airspace management. The goals are ambitious, but the developments will be necessary for the air transport industry of the future. With respect to the environment, the major objectives are the reduction of noise emissions and of CO₂ emissions per passenger kilometre, the reduction of NOₓ emissions and the creation of a single European airspace management system.

In detail, the ACARE goals for 2020 are as follows:

- Reduction of perceived noise to half of the current average level
- Reduction of CO₂ emissions by 50% per passenger kilometre
- Reduction of NOₓ emissions by 80% per passenger kilometre
- Reduction of aircraft accident rate by a factor of 5
- Less than 5% of all flights to have delays in excess of 15 minutes
- Waiting times at the gate: less than 15 minutes for short-distance, less than 30 minutes for long-distance flights.

AERONET

AERONET is a network of all important players in European aviation that has been established to foster continued environmentally compatible development in aviation and promote the exchange of experiences and expertise. Potentials for the reduction of CO₂ and pollutant emissions are to be
realised through cooperation between atmospheric research and technological development. AERONET gives a voice to European aviation that will help position it better in international competition. Another item on the agenda of the network is the exchange of up-to-date expert knowledge with the European Union.

MOZAIC

The research project MOZAIC (Measurement of Ozone by Airbus in Service Aircraft) has been launched to investigate chemical reactions at cruising altitude. The goal is to achieve a thorough understanding of the processes that happen in the atmosphere and the impact of human activity on them. To this end, aircraft of the Airbus A340 type are fitted with sensitive measuring instruments that record a dense network of data; these data are used to investigate how ozone and water vapour react with each other at altitudes ranging from nine to twelve kilometres. Austrian Airlines participates in the project and has installed the required measuring instruments in one of its aircraft. The data collected up to 2007 are being used to make global climate models more precise.

PARTEMIS

PARTEMIS is a project for the investigation of aircraft emissions under normal operational conditions at airports. Readings are taken for carbon dioxide (CO₂), carbon monoxide (CO),
nitrogen oxides and other hydrocarbons during certain events, including taxiing on the ground. In the context of this project, data have been recorded at various airports, among them at Vienna International Airport in summer 2001.

PAZI
Soot and particles are the focus of the PAZI project (Particles from Aircraft Engines and Their Impact on Contrails, Cirrus Clouds and Climate). The project investigates the formation of soot and other particles in engines and how they affect the earth’s atmosphere. This research aims to answer the question whether the combination of particles from the engines of aircraft and their vapour trails change the cloud cover in a way that has an impact on the global climate.

NO-WASTE
Waste management on board: the cooperation project NO-WASTE, which has been planned with six project partners, investigates on-board separation of different waste types, the amount of waste generated in each waste group, and the associated work processes on board. The objective is to develop an improved waste trolley model that will contribute to easier waste separation, waste volume reduction and general weight reduction of aircraft.

Clean Sky JTI
Under the 7th EU R&D Framework Programme, development of an environmentally sound high-capacity aircraft will be supported by the “Clean Sky” Joint Technology Initiative with a prospective research volume of EUR 1.6bn. Eight major European aircraft manufacturers have joined this initiative. A research project has been launched under the heading “Radical reduction of the environmental impact of air transport” to reduce fuel consumption, further improve the sound emissions of low-noise aircraft and make aeroplane lifecycles more ecological and economical. A number of highly competitive Austrian companies will cooperate in “Clean Sky”, providing research expertise in the fields of composite fibre materials, aluminium alloys, environment-friendly production and surface finish technologies, electronics and power production.

SESAR
The Single European Sky Initiative has been launched to transform Europe’s various regional and national air traffic control organisations into a single air traffic control system to cope with future air traffic volumes. In the SESAR project, a group of agencies headed by Eurocontrol, the European air traffic control organisation, is working to devise a Master Plan for Air Traffic Management (ATM) which is to be implemented by 2020. A whole bundle of measures will be required, including establishment of high-performance telecommunications systems for data and voice communication and the development of mature automated systems for optimised approach and landing processes and for the active use of satellite
navigation in all flight stages. The budget for these plans is about EUR 1.8bn. Austria’s air traffic control agency, Austro Control, is a member of the Air Navigation Service Providers Group and participates in activities such as the evaluation of existing ATM systems and preparation of an ATM master plan for the consolidation and identification of technical requirements for the long-term implementation of ATM systems.

New fuels and engine technologies

The cost of fuel has become an essential factor in any air transport operation. Operators in the air transport industry also have to prepare themselves for a future in which jet fuel (kerosene), a petroleum distillate, will become scarce and expensive and fuel supply will be a central issue. The worldwide consumption of kerosene has quintupled since 1970 and is expected to rise still further. The fact that crude oil is becoming scarcer and costlier not only entails substantial risks, but also opens up new opportunities for alternative fuels that are not derived from petroleum. The International Air Transport Association (IATA) has included “Substitute jet fuels” on its agenda.

An aspect of overriding importance in the search for new fuels is flight safety. Moreover, the new substitutes must be available in sufficient quantity at acceptable cost, and they must meet numerous criteria to be fit for use in aircraft engines. Combustion performance, interaction with other materials, flowability at low temperatures and spray dispersion are some of these criteria.

Generally speaking, current aircraft technologies require fuels with high energy concentrations – a criterion more easily met by liquids than by gaseous alternatives.

Substitute fuel research in aviation in principle focuses on the same substances as similar research for road transport. The source may be natural gas which is processed to make a liquid fuel. As this so-called GTL (gas-to-liquid) fuel is based on a fossil energy source, it contributes to CO₂ emissions. When biomass is used as an alternative energy source, established and novel technologies are employed to produce a new, synthetic fuel type. The first commercial-scale pilot plants which use different processes to produce BTL (biomass-to-liquid) fuels are currently being tested.

Comparing a number of liquid and gaseous substitute fuels, a German study has concluded that BTL fuel is the best alternative. However, a lot of development and support is still needed before BTL fuel can be made broadly available. Points that have to be kept in mind are debates about securing the resource base, avoiding any competition with food production, and a favourable energy and CO₂ balance of the technologies used.

>> As a leading aviation supplier, FACC is working intensively on the development of new lightweight composite fibre materials and improvement of existing ones. Using advanced lightweight structural components, the company provides ecologically efficient solutions that reduce the weight, fuel consumption and lifecycle cost of aircraft, while raising their capacity, economic viability and environmental soundness. Many FACC innovations can be found in the new A380 and Boeing 787 aircraft types. As an aviation supplier of worldwide standing, FACC provides a broad range of top-quality products, from structural components and systems for aircraft fuselages and wings to engine components, engine casings and complete commercial aircraft interiors.
Glossary

ACG – Austro Control – Austria’s civilian air traffic control agency.

Anti-icing – Preventative measure used for a limited period to protect aircraft against the formation of frost, snow and ice.

Apron – The area of an airport between the terminal buildings and the runways, where aircraft are positioned for loading, unloading and refuelling. Prior to take-off, aircraft taxi to the holding point just before the runway.

CO₂ – Carbon dioxide is the substance most relevant to climate change as it accounts for the majority of greenhouse gas emissions currently being produced. The lion’s share of aircraft engine emissions also consist of carbon dioxide. It is produced from the burning of kerosene and makes a decisive contribution to the greenhouse effect due to its long lifespan.

Collaborative decision-making – Smooth interaction between airport management, airlines and airspace management contributes to time-optimised arrival and departure processes and thus keeps pollutants and noise emissions to a minimum.

Condensation trails – Consist of water vapour, which is produced when fuel is burnt. They can remain visible in the sky for a long time and contribute to the formation of cirrus clouds.

Continuous Descent Approach (CDA) – Virtual navigation points (waypoints) are set in the landscape and followed by the aircraft guided by its on-board flight management systems. This allows the aircraft to “glide” onto the runway from a predefined approach point with its engines idle, resulting in reduced pollutant emissions and lower noise.

Decibel dB(A) – Noise levels are measured in decibels. The decibel is the unit of measurement for the sound pressure on the ear drum. The weighted measurement dB(A) additionally takes into account the human ear’s sensitivity to different frequencies. An increase in the noise level by approx. 10 dB(A) represents a subjective doubling of loudness.

EMAS – The abbreviation for Eco-Management and Audit Scheme, also known as the European Eco-Audit or Eco-Audit. Developed by the European Union, EMAS is a system of environmental management and environmental audit measures for organisations seeking to improve their environmental performance.

Emission – The release or discharge of (usually) irritant or pollutant substances (gases, liquids or solids), noise, vibrations or radiation from an emission source into the environment.

EPNdB – Effective Perceived Noise in dB – This method of measuring aircraft noise takes account of the way sound is perceived by the human ear by incorporating the different frequencies and durations of aircraft noise patterns, including extreme frequencies.

Equivalent Continuous Noise Level (Leq) – A recognised index for assessment of noise exposure. It represents the combined sound energy from all noise events within a given time period and takes account of the maximum peak value of individual noise events, their duration, frequency and time of occurrence.

FAB CE – Functional Airspace Block Central Europe – Airspace block covering Central Europe including Austria; part of a unified European airspace under the Single European Sky initiative.

FANOMOS – Noise monitoring system in place at Vienna and Salzburg Airports. Recording stations (18 in Vienna, 6 in Salzburg) capture aircraft noise data and record flight tracks in the vicinity of the airports. These combined data allow the overall noise situation to be mapped, documented and evaluated.

Flight noise zone – A flight noise zone is an area that is exposed to a specified equivalent continuous noise level.

Fuel dumping – Discharging by an aircraft of the fuel volume exceeding its maximum landing weight prior to an unscheduled landing. It is only done in emergency situations and only by a few specific aircraft types.

Holding point – The position just before the runway where aircraft queue with their engines running before being cleared for take-off. The time spent at this point should be as short as possible.

IATA – International Air Transport Association – The organisation devoted to the safe, orderly and economic transportation of people and goods by air.

ICAO Annex – International Civil Aviation Organization – A special agency of the UN that is responsible, among other things, for the standardisation and safety of air transport. The annexes to the Convention on International Civil Aviation provide for a uniform international approach to different practical
aspects of aviation, thus enabling international flight operations without requiring special training of flight crew for each individual country and ensuring minimum service standards in global civil aviation.

IPCC – The Intergovernmental Panel on Climate Change was founded by UNEP and the World Meteorological Organisation (WMO) and is the leading research centre for climate change and its prevention.

Kerosene – Fuel used for jet (turbojet, bypass or turbopfan) and turboprop engines. Very similar to petroleum, it is a medium distillate obtained from fractional distillation of crude oil. There are international standards for kerosene fuel.

LTO – The so-called LTO (landing and takeoff) cycle was defined internationally for the measurement of aircraft engine emissions near ground level. It characterises the operational conditions of an aircraft engine within the environs of an airport and comprises the stages of approach, landing, taxiing, takeoff and climb up to an altitude of 3,000 feet (approx. 900 m). When approaching in accordance with the Instrument Flight Rules the aircraft descends below this altitude approx. 20 km prior to landing. Aircraft taking off leave the LTO zone after about 7 km. Due to the denser atmosphere and the ascent/descent of the aircraft, different consumption values apply at this stage than during overflight.

Modal split – The use of several different modes of transport for a single journey, e.g. for the journey from St. Pölten to London the combination of passenger train to Vienna, CAT to the airport and flight to London. From the airports’ point of view, the modal split refers to the percentage of passengers using the various different modes of transport for their journey to the airport.

\[ \text{NO}_x \] – Nitrogen oxides are produced during the combustion of fuels at particularly high temperatures such as those reached in aircraft engines. Nitrogen dioxide (\( \text{NO}_2 \)) affects the functioning of the lungs in humans, and nitrogen oxides are also responsible for acidification and over-fertilisation of the soil. Depending on altitude, nitrogen oxides change the ozone content of the atmosphere.

PKM – Passenger Kilometres – The actual number of passengers carried multiplied by the kilometres flown.

RAFIC – Radar and Flight Information Capture – This system links the airport radar data with the flight information and maps the results online. The RAFIC data are transferred to the central server for further processing and evaluation of the flight path records.

RTK – Revenue Tonne Kilometres – The cargo capacity in tonnes multiplied by the kilometres flown.

Seat Kilometres (SKM) – The number of seats available multiplied by the kilometres flown.

Sequencing – Prior to take-off, aircraft have to queue at the holding point. Sequencing is a method of shortening the time spent waiting with engines running.

Single-engine taxiing – In single-engine taxiing, one engine is turned off when aircraft are moving across the apron (from the runway to the gate position). It is thus a measure implemented to save kerosene and reduce noise.
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## Austria

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