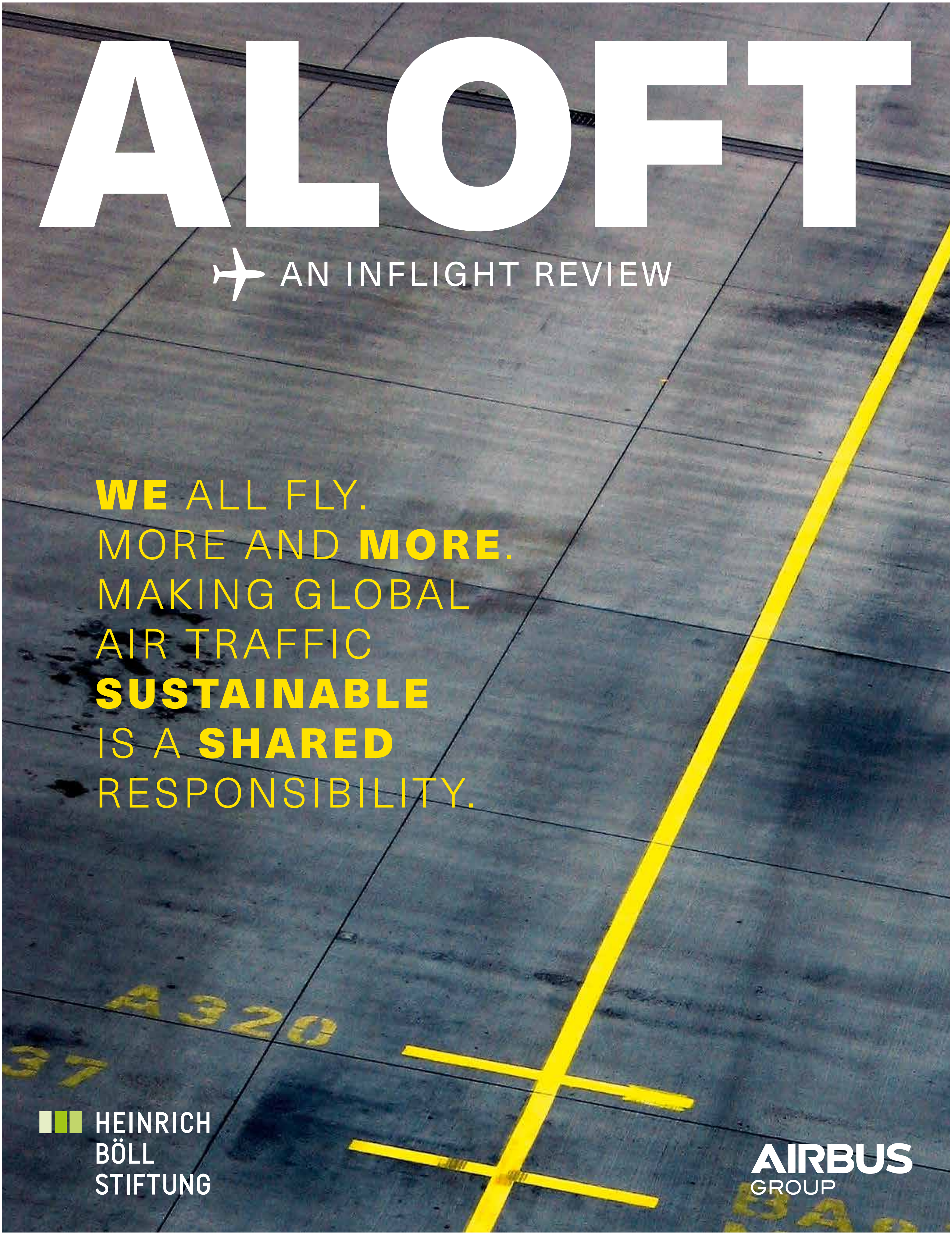
ALOFT

AN INFLIGHT REVIEW



WE ALL FLY.
MORE AND **MORE**.
MAKING GLOBAL
AIR TRAFFIC
SUSTAINABLE
IS A **SHARED**
RESPONSIBILITY.

HEINRICH BÖLL STIFTUNG

AIRBUS GROUP

IMPRINT

ALOFT AN INFLIGHT REVIEW is jointly published
by the Heinrich Böll Foundation and the Airbus Group

German edition: **OBEN** IHR FLUGBEGLEITER

Managing editor, author (unless otherwise specified): Dietmar Bartz
Art director: Ellen Stockmar

Atlas Manufaktur
52° 31' N, 13° 24' O

Translator: Maureen Polaszek
Proofreader: Maria Lanman

Editorial responsibility (V.i.S.d.P): Annette Maennel, Heinrich Böll Foundation
1st edition, May 2016

For further inquiries please contact:
Ute Brümmer, Heinrich Böll Foundation, Schumannstraße 8, 10117 Berlin, bruemmer@boell.de
Florian Keisinger, Airbus Group, Rahel-Hirsch-Straße 10, 10557 Berlin, florian.keisinger@airbus.com

Print: Druckerei Conrad GmbH, Berlin
climate neutrally printed on 100% recycled paper

ClimatePartner°
klimaneutral
Druck | ID: 11380-1605-1004

Order and download address:
Heinrich-Böll-Stiftung, Schumannstraße 8, 10117 Berlin, Germany,
www.boell.de/aloft

DEAR READERS!

Air traffic is a key component of our modern, globally connected world. This applies to both our professional and our private lives. Aviation has created a global network connecting people and goods. It is hard for anyone who wants to become familiar with the world and participate in global exchange to refrain from flying.

We currently record about 3.3 billion air trips per year. Within the next two decades, there are likely to be twice as many. Air traffic is growing rapidly, especially in Asia, the Middle East and in other emerging economies. Correspondingly, the number of passenger aircraft will increase, and, in the next twenty years, it is expected to double to around 37,500 jets.

Until recently, flying was limited to a small number of people, mainly in the western part of the world. This has changed dramatically in recent years. Cheaper ticket prices and the growth of a global middle class have led to a "democratization of flying." Air travel has become a part of modern mass culture.

Supporters of the Green Party travel by plane more frequently than others. This sheds light on the conflicts environmentally conscious people are confronted with when it comes to the subject of flying. Mobility represents a taste of freedom. The global interconnection of politics, economy, science and culture are increasing. At the same time, the environmental impact of flying can no longer be ignored.

This is particularly true with regard to climate change. Considerable efficiency gains in fuel consumption are outweighed by high growth rates in international air traffic. As a result, this leads to an increase in climate-relevant emissions. We need a turnaround for aviation to contribute to climate protection. Air traffic needs to become more environmentally friendly and more sustainable.

This applies to engine technology, the fuels used, the aircraft design and the materials utilized, as well as to air traffic management and airport operations. It will take a few more decades before the vision of carbon-neutral flying becomes a reality. But on the way there, we will have to succeed in considerably reducing carbon emissions in aviation.

With the introduction of new jets, such as the A350 or the A320neo, the eco-audit of modern aircraft fleets will be improved by about 20 per cent. Nevertheless, reducing kerosene consumption must and will have to continue in the future. This will be especially true when taxes are levied on future CO_2 emissions in global air traffic. The same applies to noise. Quieter aircraft are needed to achieve the optimal use of takeoff and landing times in densely populated areas.

At the same time, environmental issues are becoming increasingly important for public acceptance of air traffic. Despite all the improvements in noise and emission protection that have been made in recent years, a great deal must be done from a political and technical point of view.

An ongoing controversy is how to regulate the aviation industry and what constraints are effective. At best, they should take place at an international level, establish a uniform competitive framework and encourage technological innovations. The goal of an open dialogue between the Airbus Group and the Heinrich Böll Foundation in the past year was to explore the need for action with regard to attaining sustainable air traffic. In the course of the discussions, it became clear that, in spite of sometimes diverging views, there was a basic consensus on where the journey should go.

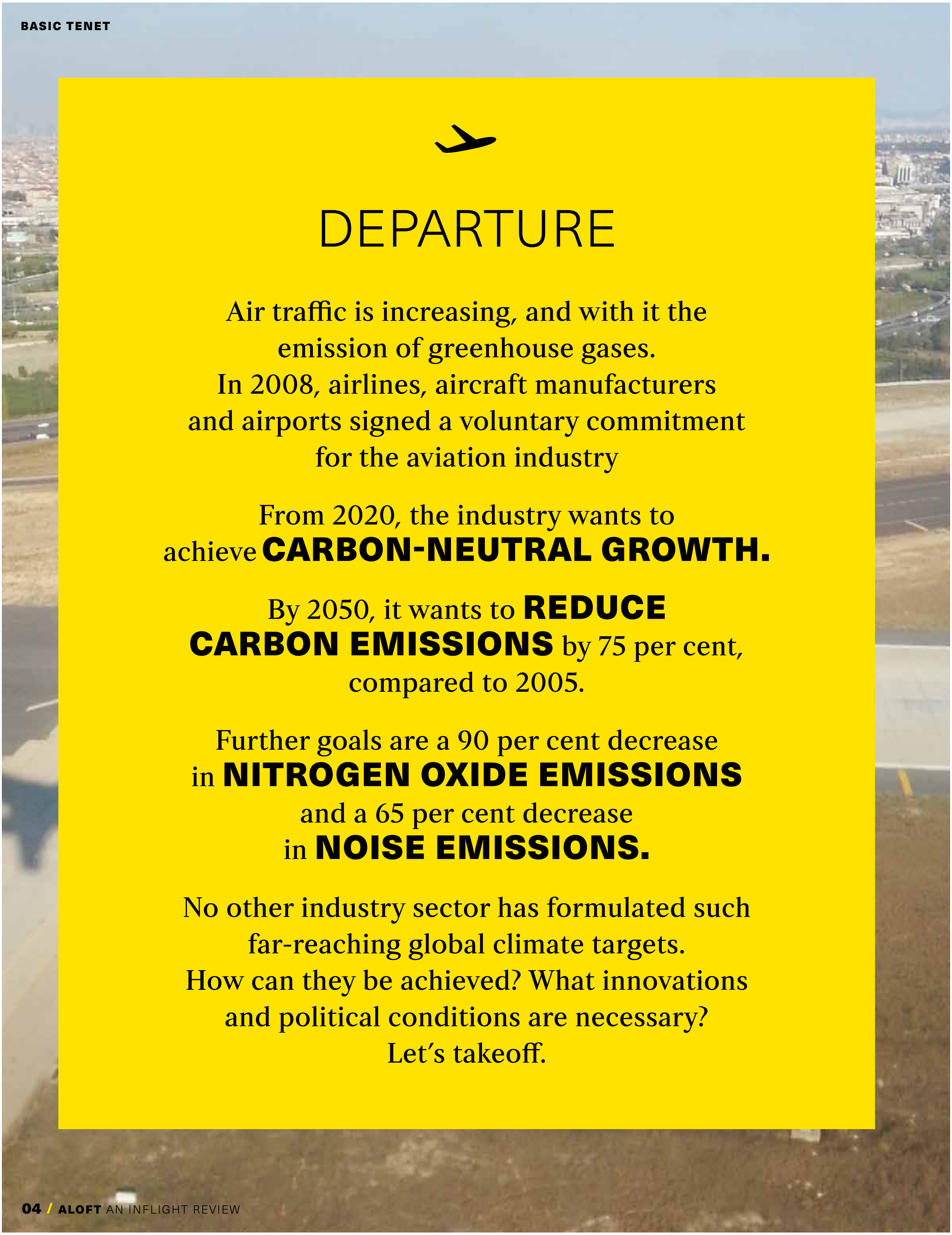
Economy and ecology are not necessarily at odds when it comes to the issue of sustainable aviation. On the contrary: ecological and economic reasoning are closely interwoven and mutually dependent. Despite the current moderate oil price, fuel is still the key cost factor in the aviation sector. Airbus will only survive in global competition when its aircraft can fly as efficiently as possible. In this respect a great deal has been done in recent years.

Nevertheless, even with common goals, there may be different views regarding the question of which road to take. This applies particularly to the design of the policy framework for air transport, taking economic efficiency and competitiveness of the industry into consideration. Accordingly, our series of open discussions also focused on this issue. The exchange between aviation industry experts, green climate politics and NGOs was definitely a worthwhile enterprise.

Although this publication does not provide final answers, it does provide important insights into the current state of technological developments and the political debate surrounding the sustainable future of flying, and it can serve as a basis for further dialogue in the coming years.

RALF FÜCKS
President
Heinrich Böll Foundation

TOM ENDERS
CEO
Airbus Group



DEPARTURE

Air traffic is increasing, and with it the emission of greenhouse gases. In 2008, airlines, aircraft manufacturers and airports signed a voluntary commitment for the aviation industry

From 2020, the industry wants to achieve **CARBON-NEUTRAL GROWTH.**

By 2050, it wants to **REDUCE CARBON EMISSIONS** by 75 per cent, compared to 2005.

Further goals are a 90 per cent decrease in **NITROGEN OXIDE EMISSIONS** and a 65 per cent decrease in **NOISE EMISSIONS.**

No other industry sector has formulated such far-reaching global climate targets. How can they be achieved? What innovations and political conditions are necessary? Let's takeoff.

ALOFT
AN INFLIGHT REVIEW

AIR TRAVEL VERSUS ...

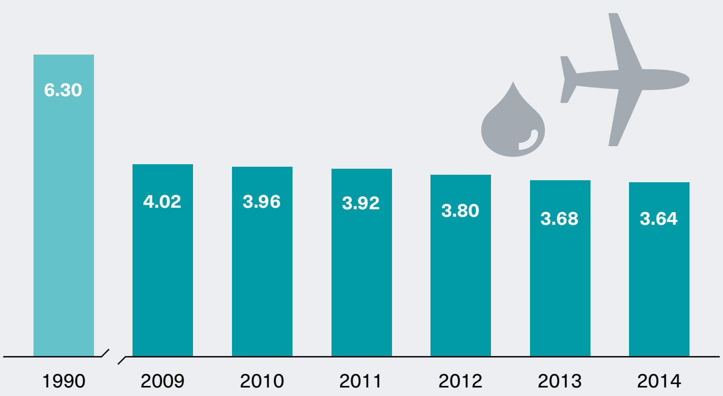
Experts in Germany and the EU are ascertaining the environmental ranking of different transport modes.

By train? By car? By bus? Or even by plane? The most environmentally friendly means of getting from A to B depends on several factors: how modern the means of transport are, how much time is available, the quality of the infrastructure and the location of points A and B. The number of voyagers also plays a role. The more people travelling together and the longer the journey, the better the ecological footprint per capita. However, the overall ecological burden continues to increase as a result of the rapid growth of global air traffic.

FUEL CONSUMPTION

Kerosene, litres per passenger and 100 km, German air fleet, annual average

BDL



The situation is paradoxical: the air traffic boom makes the individual journeys more environmentally friendly. Not only technical improvements, but better operational efficiency, as well as longer and more fuel-efficient flight distances, have resulted in the continuous decline of the German air fleet fuel consumption.

According to an "Energy Efficiency Report" published by the German Aviation Association (BDL) in 2015, the fuel consumption of the German air fleet was 6.3 litres per 100 passenger-kilometres in 1990. In 2014, the number sank to 3.6 litres (cf. bottom left chart). For short distances (up to 800 km), the fuel consumption ranges from 4.2 to 6.8 litres, on medium distances (800 to 3,000 km) from 2.6 to 4.2 litres and on long distances (over 3,000 km) from 2.9 to 3.5 litres. On average, charter flights consume less kerosene per person because they tend to be planned and booked long in advance and usually operate at a higher passenger load factor than scheduled flights.

Based on information provided by members of the BDL, the average value of 3.6 litres for Germany corresponds approximately to the 4.9 litres of petrol equivalent ascertained for 2014 by the "Tremod" (Transport Emission Control) computer model. Tremod is used by federal ministries, automobile manufacturers, the Deutsche Bahn railway company and the Federal Environmental Agency. At 6.1 litres, the fuel consumption for car passengers well exceeds that of air passengers, because the average car only carries 1.5 passengers, whereas 71 per cent of airplane seats are occupied.

The air transport figures for emissions of greenhouse gases show a different picture. If they are converted into carbon dioxide equiv-

ROAD, RAIL, AIR

Emissions in grams per passenger and kilometre, petrol equivalent per passenger and kilometre, 2014

UBA

		Motor car	Coach	Rail traffic, long-distance	Aircraft	Public bus	Rail traffic, short-distance	Rapid transit
Assumed passenger load		1.5 pers./motor car	60 %	50 %	71 %	21 %	28 %	19 %
Greenhouse gases[1]	g/pkm	142	32	41[2]	211[3]	76	67[2]	71
Carbon monoxide	g/pkm	0.66	0.05	0.03	0.15	0.07	0.05	0.04
Volatile hydrocarbons	g/pkm	0.14	0.02	0	0.04	0.03	0.01	0
Nitrogen oxides	g/pkm	0.31	0.21	0.06	0.55	0.41	0.21	0.07
Fine dust	g/pkm	0.005	0.004	0	0,005	0.003	0.002	0
Consumption of petrol equivalent	l/100 pkm	6.1	1.4	1.9	4.9	3.3	3.0	3.3

[1] CO_2, CH_4 and N_2O are given in CO_2 equivalents [2] Production of electricity for rail traffic in accordance with the overall electricity mix in Germany
[3] Taking all proven effects of air traffic that have an impact on the climate into account.

alents in order to make them comparable, an average of 21.1 kg are attributable to a person who flies 100 km. Those who travel by car, emit 14.2 kg; and coaches, with only 3.2 kg, are still ahead in this respect. Railway transport figures are worse, with 4.1 kg in long-distance transport and 6.7 kg in local public transport. In the transmission process from the power station to the train, operating power is lost, and the power stations themselves also emit large quantities of pollutants. With regard to many other emissions, however, rail traffic has better values than road and air traffic (cf. table above). Contrails and cirrus cloud formation at high altitudes as a result of air transport may have a significantly higher impact on the environment than presently assumed. However, so far no data is available.

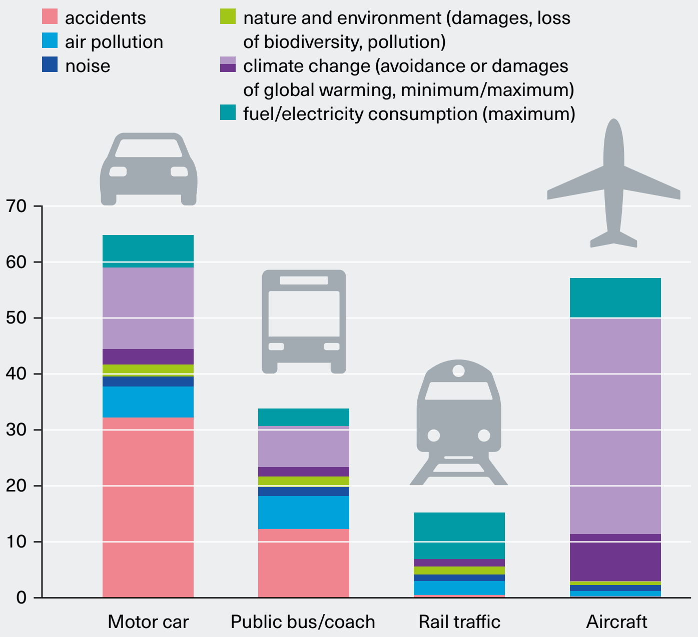
Since 1999, the EU has attempted to calculate the exact costs of transport – those that arise in society or nature and are not financed by traffic participants. These "externalised" costs ensue from congestion and accidents, air and noise pollution, soil and water pollution and from climate change and soil sealing. Calculations are made on what can be expressed in monetary terms, based on questions such as what it would cost to eliminate or avoid this damage? How strong is an economy burdened by inaction, illness and premature death, by crop failure and the reduction of biodiversity?

Calculations for 2014 were very accurate. EU experts estimated that the externalised costs of aircraft noise produced by a plane landing and starting in Luxembourg, amounted to 285 euros. In Warsaw it was only 27 euros. However, major uncertainties remain with regard to the impact climate change will have. Valid calculations regarding what proportion of flooding or storm damage can be attributed to global warming are hard to perform. In a comparison of transport modes compiled by the EU for 2008 (cf. chart below), these uncertainties are particularly pronounced in air traffic because it emits the most greenhouse gases. However, it is already possible to conclude that assuming maximum harmfulness of emissions, air and road traffic are approximately on a par when it comes to externalised costs.

HIDDEN COSTS

Euro per person and 1,000 kilometres in the EU, air traffic: inner-European flights, 2008

CE DELFT ET AL.



GOING **GREEN** AT **AIRBUS**

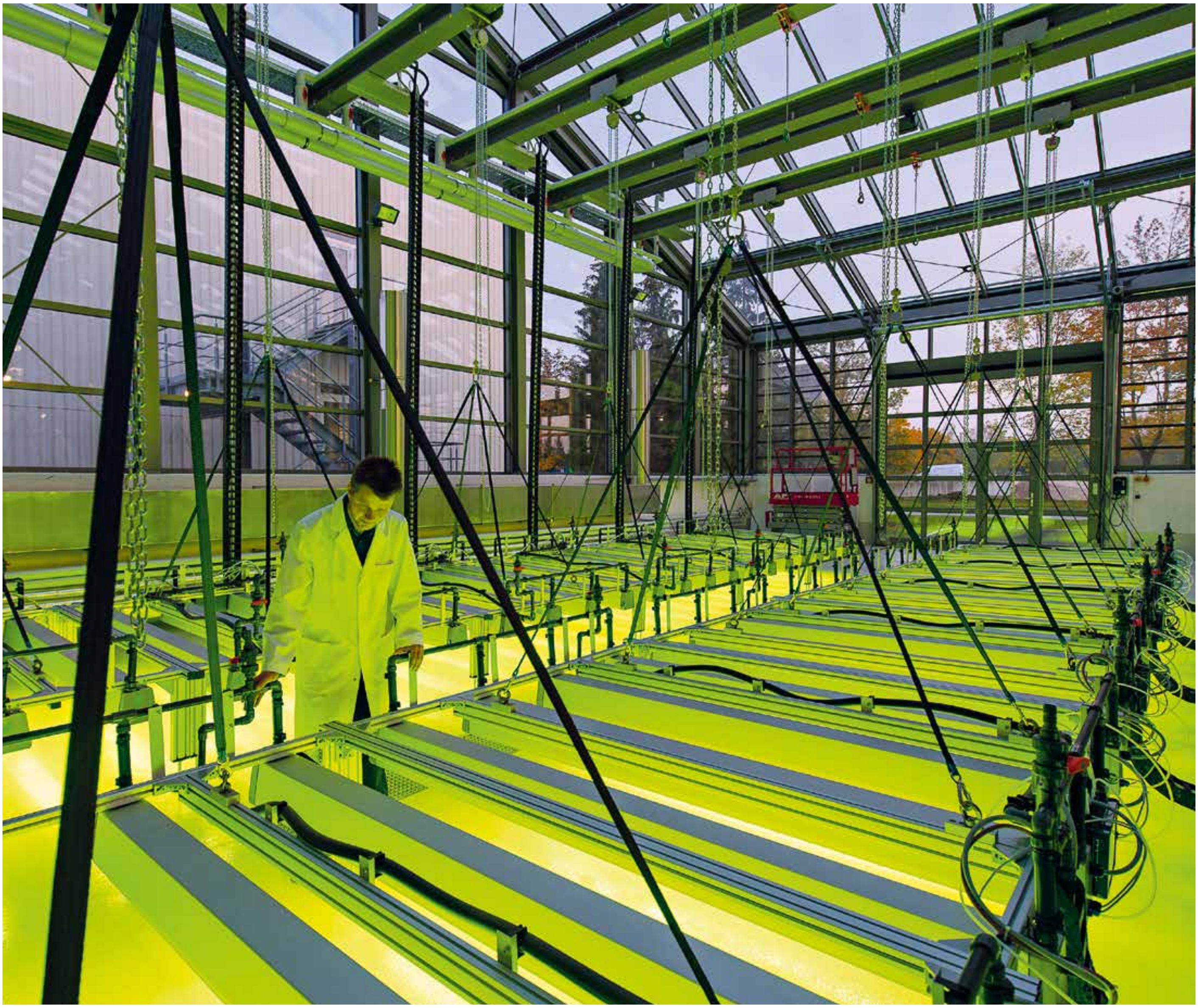
Sea algae that could replace kerosene in future are being farmed in the facilities of the new “Algentechnikum” algae pilot plant of the Technical University Munich on the Airbus premises

KEROSENE MADE FROM ALGAE OIL TO MAKE JET FUEL SUSTAINABLE

The idea: mix fossil fuel with ever increasing amounts of kerosene from renewable algae. This could significantly improve the carbon footprint of air traffic. Experts say that technological progress in turbine construction or in aerodynamics alone cannot sufficiently reduce the emissions per kilometre flown.

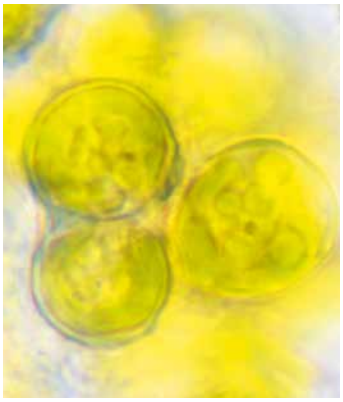
The problem: celebrated a decade ago as renewable resources and as a substitute for all kinds of fuel, oil from rapeseed and other crops is no longer acceptable from an ecological point of view. Huge monocultures have emerged all over the world, damaging biodiversity, destroying the naturally grown vegetation in developing countries, as well as competing with food production. “Fuel instead of food” is a highly undesirable development.

Algae researchers have resolved to change this situation. The experiments are still in their infancy, but Airbus is following this approach with great interest. Their participation in the



Algae need light to grow. A series of tests will determine the optimum hours of sunshine and the water temperatures required

Under the microscope: in search of a fast-growing super algae with thin membranes that can be easily squeezed out



The first test flight with a small aircraft using algae kerosene was carried out in 2010

research has resulted in the establishment of the "Algentechnikum" algae pilot plant, a worldwide unique laboratory located on the Bölkow Campus next to the Airbus premises in Munich-Ottobrunn, which organizationally belongs to the Technical University. The aim is to develop aviation kerosene on the basis of algae biomass.

It appears as though they have thought of everything. The target is a simple technology that can produce the largest possible quantities. The algae will be kept in open basins, will grow twelve times faster than land plants and have a an oil yield thirty times higher than rapeseed and similar plants.

Production will take place on fallow instead of agricultural land. To avoid a conflict over freshwater, they are using "saline algae", i.e., algae that live in salt water. This resource is available in unlimited quantities along the coasts. Algae farms are also conceivable in nitrogen-rich, over-fertilized waters, or in the vicinity of sewage plants or dairies. From a technical point of view, it is even imaginable to include growth-stimulating CO_2 from gas firing facilities or other industrial processes. The water-bound form of carbon dioxide remains available in salt water longer than in

/ THE INHABITANTS OF THE SALT WATER BASINS WILL GROW TWELVE TIMES FASTER THAT LAND PLANTS

fresh water, where it quickly outgases and stops feeding the algae. The claim is that sufficient space is available in southern Europe to cover 30 per cent of the total consumption of kerosene in Europe – 1.7 billion litres a year. The researchers have turned their attention to Greece and

Professor Thomas Brück at an open photo-bioreactor. The promising organisms are cultivated in these types of basins

Experiments to manufacture algae oil for aircraft fuel are not only being carried out in Munich. The Jülich Research Centre near Cologne has hung up tubes as photobioreactors for fresh water algae

In the "Algae Science Centre" in Jülich, algae and nutrient solution drip through sieve plates that are placed closely together. However, the production and maintenance of these plates is a very complex process

Dutch manufacturer Ingepro did trials with outdoor basins

Albania in particular. The parameters required are sunlight, temperature and humidity. The basins, open because of the need for sunlight, will be 100 hectares in size. Storm, dust and rain cannot do much harm when farming saltwater algae.

This process is regarded as being particularly robust, whereas farming algae in freshwater would constantly be threatened by such contamination. In addition, the content of the basins does not endanger the surrounding environment; even if living beings were introduced together with the salt water, they would not be able to survive.

The end product is a gooey mass with a water content of 60 per cent. The separation and processing of the oils is effected with chemicals, so-called "green solvents". Their job is to separate 92 per cent of the oils. The residual materials will be used to produce biogas, hydrogen and methane, which in turn can generate energy. Ideally, no residuals remain from the whole process.

There is no solid information available yet about the CO_2 and energy footprint. It is still unclear how much land is needed to produce a given amount of kerosene. The yield after all production steps could be set at 25 grams per square metre. In comparison: if biomass is converted into fuel, the yield is about 2.5 litres per square metre per year. However, an algae harvest cycle is much shorter than that of rapeseed or maize.

More research has to be done to determine which algae strains can achieve this goal. Biologists are aware of a total of 120,000 strains, 37 of which are on the shortlist. To study their growth in more detail, sunlight is simulated on the Bölkow Campus using LED lights. The algae can therefore behave as if they were growing in Hawaii or California. Combined with the current data of a geographic information system, real weather patterns can even be simulated. Under favourable conditions a commercial use could be viable in seven to ten years.

"ALMOST EVERYTHING IS NEW"

THOMAS BRÜCK, Professor of Industrial Catalysis at the Technical University of Munich, on progress in the algae pilot plant.

The "Algentechnikum" opened in October 2015. Have you found out anything yet?
Yes. We have discovered three new strains of algae. They grow better than what we have found in the literature. They have a very good fat content. It has already risen to 50 per cent in the laboratory, but we will increase it. We have tested some strains in our algae pilot plant. Up till now the highest yield reported in the literature was 40 grams per litre. We have already reached 60 grams.

Your facility has cost ten to eleven million euros. Is such a small amount adequate, given the significance of the problem that you are trying to solve?
Algae biotechnology is still in its infancy. When assessing whether the research is worthwhile in accordance with the so-called Technology Readiness Level, we have achieved four to five out of ten points. The economic feasibility and the question of whether we will be able to procure sufficient areas at a later date have not yet been taken into consideration. And we need time. However, Airbus has contributed four million euros and that is a lot.

Why do you need seven to ten years?
Almost every process step is new, not only the cultivation but also the separation and processing into fuel. The methods and the logistics must match the ongoing operations of a petroleum company. We are working here in a litre range, but our partner OMV is thinking in the dimension of millions of litres per day.

If one-third of the fuel demand in Europe is to be derived from algae, what size of area would be required?
If we want to cover the entire fuel requirement in the EU from algae, we need an area about the size of Portugal. One third is feasible. However, we are initially proceeding from the 5 per cent target that IATA, the association of airlines, is aiming at, i.e., 85 million litres per year.

That would be 50,000 square kilometers or five million hectares. Where are these areas supposed to be located?
We need long periods of bright and warm weather for the processes to run efficiently. Therefore, Portugal and Spain, Greece and Albania are conceivable. They have plenty of unused coastlines that would not be ecologically strained by large seawater basins. In North Africa it would include all the countries bordering on the Mediterranean.

THE GREENS FLY THE MOST

BUT WITH A GUILTY CONSCIENCE

Ironically, a German survey has revealed that Green Party voters travel more often by plane than others.

"I've flown in the last twelve months". This statement was confirmed by 32 per cent of SPD (Labour) supporters, 36 per cent of CDU/CSU (Conservatives) supporters and 42 per cent of Left voters. For the Greens, the response was 49 per cent.

"I've never flown in an airplane". Among those asked, 16 per cent of CDU/CSU voters, 13 per cent of SPD and 17 per cent of Left voters agreed with this statement. The share of Green supporters who have never flown at all is zero per cent.

"It's a good thing that many people can afford to fly today". This statement was only agreed with by 48 per cent of the Green voters, but by 69 to 77 per cent of the other parties.

There is a widespread consensus about the interpretation of these results. Those who are favourably disposed to the Greens are often well educated, earn higher than average salaries and travel frequently on business matters. In addition, they are curious about the world and enjoy long-distance travel. However, a strong minority feel that it would be better for people to refrain from flying as long as air travel damages the environment.

The representative survey of Forschungsgruppe Wahlen commissioned by the German Aviation Association (BDL) was published in autumn 2014.

TECHNOLOGY
OF THE FUTURE

In the coming decades, new aircraft engines and production methods could make flying more sustainable. "Hybrid flying" using electrical energy has already begun and 3D printing promises higher efficiency and a cleaner production process

It is less than a plan, but more than an idea. Engineers are envisaging how "hybrid flying" will propel a passenger aircraft in 2050. At takeoff and climb, the electricity from a gas turbine and from a battery will jointly power the turbine blades that provide the thrust. When cruising, the turbine alone secures the propulsion power, while simultaneously recharging the battery. In the first phase of descent, the turbine is turned off. The aircraft is now a glider and the power required for the onboard systems comes from the battery. During the second phase, the turbine blades are driven by the air stream and the electric motors turn into generators that again recharge the batteries. And finally for landing, the gas turbine is restarted and provides the thrust for the propulsion system at a low level, to assist the electrical landing process, if necessary.

This "hybrid flying" concept named E-Thrust, is part of a joint development by Airbus and Rolls-Royce. In collaboration with Cranfield University in the UK, the aircraft and the engine manufacturers have designed a completely new aircraft where the wings are set further back to the rear. The aircraft engine is integrated in the fuselage. Several electrically driven turbine blades, the fans, are on the wing roots. What is new is that turbines and fans are separated, enabling entirely new structures with optimization

The Airbus concept study “E-Thrust”: smaller engines for hybrid-driven aircraft enable better aerodynamics

of both elements, and subsequently lower fuel consumption.

The aerodynamic advantages are enormous compared to the turbines located under the wings that are currently used. The air flowing along the aircraft can be directed into the fans which benefits the thrust, instead of acting only as air resistance. If the peak power of an aircraft engine, which is presently only used at takeoff, is generated by both the gas turbine and batteries, the gas turbine can be significantly smaller than it is today. The aircraft will be quieter. In turn, less weight and less aerodynamic drag make it possible to reduce the size of the wings and tail unit, thus further reducing the weight and fuel consumption.

The list of reciprocal positive influences can be continued. However, the basic technologies that would enable this breakthrough are still lacking. This includes superconductivity that causes certain materials to lose their electrical resistance when they are cooled to temperatures well below minus 100 degrees Celsius. Motors and cables that transport the power of the turbines and batteries to the fans could be designed to be much lighter, smaller and more efficient. Cooling the components will then be the next challenge.

Moreover, what is commonly regarded as “better batteries” is still missing. This refers to a new generation of energy storage systems. Lithium-air batteries give rise to optimism since their energy density is more than twice as high as today’s storage systems. The aircraft and turbine manufacturers give their electrical engineering colleagues 25 years to develop the batteries to

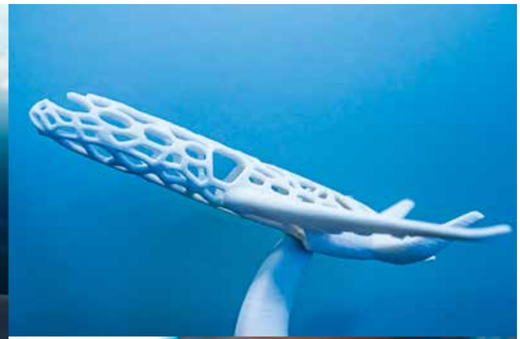
/ THE AIRCRAFT MANUFACTURERS GIVE ELECTRICAL ENGINEERS 25 YEARS TO DEVELOP NEW ENERGY STORAGE SYSTEMS

technical maturity. The amount of time the manufacturers will also need to adjust turbines, aircraft structure and aerodynamics.

The target year 2050 was not determined arbitrarily. The aviation industry has aligned its goals in environmental protection to this target, which they presented in 2011 to the European Commission in the report “Flightpath 2050 – Europe’s Vision for Aviation”. These objectives include a 75 per cent reduction of carbon emissions, a 90 per cent reduction of nitrogen oxides and a 65 per cent reduction of noise from aircraft. The basic parameters are similar to those announced by the aviation industry in its self-commitment in 2008.

A smaller aircraft, also based on a hybrid concept, is expected to be realised sooner than E-Thrust. By 2030, in less than 15 years, Airbus expects to have a regional traffic passenger jet for up to one hundred passengers ready for production.

There is still a long way to go. The machines could emerge from the small, all-electric training aircraft, which will be built in series under the name E-Fan 2.0 in the near future in southern France. It is to serve as a “proof of concept”, as a



In the E-Thrust study, the turbines and blades, the "fans", are separated. At takeoff electricity comes from a storage unit that is charged by the fans during descent (left). The 3D printout of an aircraft model and a component of today demonstrate that biomimetic structures allow for more stability with less material usage (both right)

flying testbed and, a factor of enormous importance in aviation, as a model for the certification of electrical aircraft concepts. The additional engine in the fuselage of the follow-up model, 4.0, will increase the range significantly. The hybrid engine could also come from Germany. In April 2016, Airbus and the Siemens technology group agreed to develop a series of prototypes for different engine systems by 2020. Siemens has already created an electric motor for aircraft. With no change in weight, its performance has been increased fivefold within a few years.

One of the concepts of 2020 might be of relevance to the jet of 2030. But Airbus and Siemens could also work on hybrid helicopters, unmanned aerial vehicles with electric and hybrid engine systems, as well as drones. The two companies have already pooled 200 employees for this project; the investment in the next five years is expected to exceed 100 million euros.

/ IDEAS FOR NEW AIRCRAFT ARE ANTICIPATING THE ENDEAVOURS OF THE COMPETITION IN THE NEXT DECADES

Climate protection is not the sole concern at the centre of all this research and development. It is also about technological leadership in the global aircraft market, as the EU openly stated in its Flightpath report. With its regional jet, Airbus would enter a market in which two companies from the American continent are striving to become the world's third largest aircraft manufacturer after Airbus and Boeing: Embraer from Brazil and Bombardier from Canada. Conversely, both are pushing heavily into the "higher" segment of short-haul aircraft that is dominated by Airbus and Boeing.

Yet another competitor has appeared on the scene – Comac from China, a state-owned enterprise founded in Shanghai in 2008. A twin-propeller regional jet, equipped with engines from General Electric, was delivered as early as 2015, and a Comac short-haul aircraft should be ready for serial production by the end of 2018. Moreover, Comac and Bombardier signed a long-term cooperation agreement in 2011 to develop alternatives to Airbus and Boeing. In this dynamic environment, a technological leader in hybrid flying with regional and short-haul jets could keep a number of competitors at bay.

The electrical engineers working on today's E-Fan two-seater are also focused on tomorrow's 100-seater and the prospective 300-seater aircraft. And the same applies to process engineers. Specialising in carbon fiber composites, they have done a good part of their homework, as more than 50 per cent of the A350 consists of stable and lightweight CFRP. The next step is just around the corner. The use of 3D printers has also gained ground in the aviation industry. Manufacturing moulds has been eliminated and there is less material loss because cutting, turning and drilling have become unnecessary.

The days in which the common layer printers with their command of simple geometries stood in factory workshops are gone. Today, laser printers can create complex structures, for example, overhanging shapes (cf. picture top).

Acceleration of the process has been enormous. What previously took 15 hours to layer-print, can now be accomplished in two to three hours.

But once the production extends beyond prototypes and individual pieces, the calculation begins. Even if the method is resource efficient, if it only constitutes a technological stand-alone solution, the investment costs will be too high and the printing will not be cheaper than the previous methods. In order to optimise the use of the printer, more and more segments of the production process have to be aligned to it. Mechanical engineering last experienced such a development in the 1980s, when Computer Integrated Manufacturing (CIM) led to the end-to-end interconnections of entire design and manufacturing workflows.

A change of strategy at Airbus is already on the agenda. Until now, prefabricated parts and components were bought from suppliers. But the Airbus plant in Varel, in northern Germany, has already started printing its own components. In future, up to ten per cent of the components and spare parts will be produced on site in the facilities. There are even dreams of complete aircraft coming out of the printer. Select the model, specify the number of seats, press the button, and the next morning the rough body of the Airbus rolls out of the printing hangar.

The first steps have already been taken. Airbus has printed the first mini airplane "Thor" in Hamburg. Only the two electric engines and the steering controls are classical fixtures. The unmanned aerial vehicle, with a length and wingspan of four metres, is already being tested. It was assembled from nearly 50 parts because the largest printer available could only print pieces

/ AFTER THE BREAKTHROUGH IN CARBON FIBRE COMPOSITES, 3D PRINTING IS NOW BECKONING

under 2.10 metres in length. The assembly took four to six weeks. But the industry is working on the development of more powerful systems. To enable the Airbus developers to become familiar with the technological possibilities, the group has bought a stake in the US car manufacturer, Local Motors, which is planning to print cars. Dozens of Airbus engineers are now being trained in 3D printing.

The "Thor" parts were melted from the powder of plastic polyamide. In the next two years they will be made from titanium, stainless steel and aluminum. In 2025, the first cargo plane could be printed. The rough body would still be assembled from individual parts, but maybe even that will change when the E-Thrust takes-off in 2050.

Peter Sander, Head of Emerging Technologies & Concepts at Airbus and his team have put the test aircraft "Thor" into the air. It is made up of approximately 50 printed components

THE **ANCESTORS** OF AIRBUS

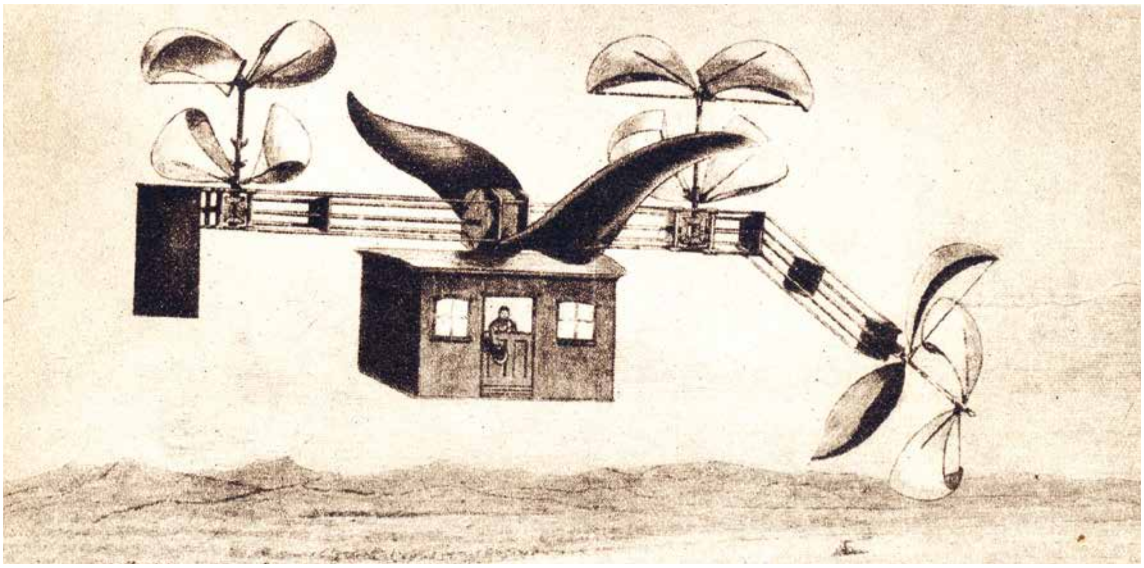
In the 15th century, Leonardo da Vinci had already depicted flying by means of rotary wings. With the term "helicopter" he invented the name of a whole class of aircraft. In the 19th century the aim of the designers was already apparent, the transportation of passengers in a sky omnibus.

Despite all the utopias, helicopters never developed into a quick and inexpensive means of mass transportation. But they are indispensable as working and rescue equipment, as well as for military purposes.

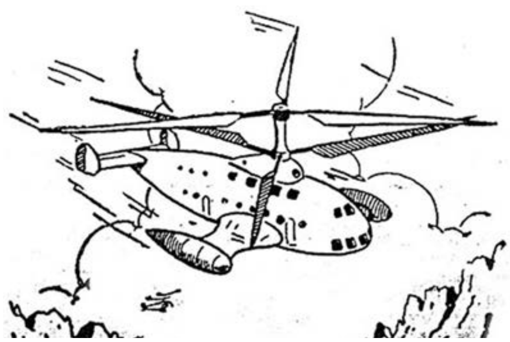
However, "Airbus" became the name of an airplane. Today it designates an aerospace group. The group's helicopters were eventually given the same name. Since 2015, the old and new models are labelled "Airbus Helicopters".

In 1923, the magazine Science and Invention put an aerodynamic shaped cabin helicopter on the title page, illustrating what a car was supposed to look like 50 years later, in 1973

A universal genius wanted to fly and drew a helicopter. Leonardo da Vinci sketched his rotary-winged aircraft between 1487–1490



An 1877 engraving from Frank Leslie's Illustrated Newspaper depicts a coach as a model for an air carrier. Powered by wings and sails, it would be welcomed today as a hybrid system



“Here Comes the Flying Bus” was in an advertisement for the US aluminum company Bohn in 1946. The graphic designer, Arthur C. Radebaugh, let his imagination run wild in a late Art Deco style

The Belgian comic book magazine Spirou was reissued in autumn 1944, immediately after Belgium's liberation from German occupation. Later that year, the illustrator Kulavik sketched an aircraft with a combination of rotary and rigid wings

Airbus helicopter of the future: The X6 is a concept study presented in 2015 for use at sea in the oil and gas industry

Compiled and annotated by Heinrich Dubel, Berlin. Blog: helikopterhysteriezwo.blogspot.com

THREE PANELS, FIFTY EXPERTS. THEIR TASK: HIGHLIGHTING OPTIONS TO DECARBONISE AIR TRAFFIC

The Heinrich Böll Foundation and the Airbus Group discussed the future of flying. In the end, the participants agreed on a catalogue of commonalities and differences

Using less kerosene results in reduced strain on the climate. The reduction of fuel costs and a decrease in the use of natural resources go hand in hand. If consumption per kilometre flown decreases more than air traffic increases, the industry is moving in an ecologically desirable direction. In this respect, there is a consensus between the aviation industry and its critics.

But how can flying become more sustainable? Ninety per cent of the funds for research and development at Airbus are aimed at more efficient and environmentally compatible flying. What else would be technically feasible beyond this? Where is some scope for manoeuvre in spite of competitive pressure? What role should politics play? These issues were addressed in three discussion panels organised by the Airbus Group and the Heinrich Böll Foundation. Experts from companies, associations, institutions and politics were also invited. The discussions were characterised by the search for common ground and for an understanding of the other side's point of view.

REGULATORY POLICY

The regulation of civil aviation is subject to an industry-specific dilemma. Aviation takes place

Guests and hosts included the following:
1 Matthias von Randow, General Manager, German Aviation Association (BDL)
2 Dieter Janecek, MP, Green Party
3 Katrin Göring-Eckardt, MP, Chairwoman of the Parliamentary Group, Green Party
4 Marwan Lahoud, Executive Vice President International, Strategy and Public Affairs, Airbus Group (front), Werner Reh, Friends of the Earth Germany (BUND)
5 Dirk Langolf, Fraunhofer Center MOEZ **6** Kerstin Andreae, MP, Green Party
7 Ivo Rzegotta, Head of Strategy Planning, BDL **8** Klaus-Peter Siegloch, President, BDL
9 Cem Özdemir, MP, Party Chairman, Green Party
10 Anton Hofreiter, MP, Chairman of the Parliamentary Group, Green Party

in an international market, but is controlled nationally, with the EU adding an intermediary level. National and EU-wide requirements to reduce carbon emissions should have a guiding effect and ensure that "domestic" airlines and airports adopt a leading role.

Simultaneously, in the EU, private airlines geared towards a member country, compete with many state-owned or semi-public airlines, whose corporate offices and hubs are located outside the regulatory area. For them, regulated Europe only constitutes a small part of their business area. Additional costs of imposed regulations can be easily redistributed. This does not apply to carriers who do most of their flights within the "expensive" EU. If asymmetric environmental regulations increase the price of certain carriers' airline tickets, cost-conscious passengers will use other airlines from outside the EU. With this in mind, regional regulations that promote environmentally-friendly aviation might actually result in a step backwards.

From the industry's perspective, national or EU intervention could lead to a disruption of the international "level playing field". So what needs to be done to promote domestic competitiveness and how can cost disadvantages be compensated? A solution from an environmental perspective would have the governments abstain from incorporating revenues from environmental requirements imposed on the airlines into their budgets, and "keep them in the aviation system" instead. Increases as well as decreases in costs can result in pressure for more innovation. For example, traditional thinking suggests nudging airlines into buying quieter aircraft by simply raising the landing fees for noisy aircraft. However, the incentive would be significantly stronger if the landing fees for quieter planes were reduced to the same extent.

About 40 per cent of the total cost of operation is allotted to kerosene. A reduction in fuel consumption is, therefore, undoubtedly the most powerful driver of innovation in this industry.

/ A REGULATION DILEMMA: FOREIGN POLLUTERS GET MORE CLIENTS WHEN EU RESTRICTIONS ARE IMPOSED

A second driver is government regulation with its technical and legal constraints. If the aircraft manufacturers are unable to sufficiently reduce emissions on their own, should the government then step in and close the innovation gap, e.g. with new provisions regarding biofuels?

There is also a conflict of objectives regarding airplanes. On the one hand, their operational life should be long; on the other hand, technological innovation should quickly take effect. Large passenger aircraft have a life cycle of approximately thirty years. Their long service life results in a

structural lag of obsolete and outdated aircraft in the global fleet mix. The effectiveness of replacing individual components with new components is limited. A major advance would be to redesign the entire aircraft. In order to significantly reduce emissions, a new airplane must be

/ AIRCRAFT SHOULD HAVE A LONG LIFE CYCLE. BUT THIS MIGHT PREVENT THE PURCHASE OF BETTER PLANES

purchased. The old plane is sold and continues to fly in regions where emissions are less of an issue. So could new technical standards shorten the service life and modernise air fleets worldwide? In the "flight discussions" no conclusive answer was given.

The demands on the infrastructure of air traffic and local economic requirements do not always coincide. In Germany, national interests such as retaining and supporting the hubs are not always compatible with the desire for direct international flights from smaller airports without the need to change planes in Frankfurt or Munich. Improvements in airport "connection quality" are needed. To reach airports in a more environmentally friendly manner, national transport concepts involving trains are required. Endeavours should also be made to replace short-haul flights. Ultimately, airports located within tighter and larger railway networks can expand their inclusion radius, easing access and thus generating more passengers.

"What do you expect from politics?" In the talks, green legislators asked what claims the airline industry puts on an aviation policy that recognises and supports the industry's contribution to climate protection. The sector is concerned that the development of air traffic could be curbed on a national or EU-wide level. Given the strong global growth of aviation, economies of scale would, however, after a short phase of stagnation lead to a rapid shrinkage of market shares. Air traffic would not decrease; passengers would fly with other airlines instead. Taking climate political perspectives into consideration, it must therefore be assumed that this, in turn, would benefit airlines and airports with lower environmental objectives.

CONTROLLING MEASURES

Aviation is a global business and requires global standards, including the reduction of greenhouse gases. But international aviation and shipping was excluded from the Kyoto Protocol adopted in 1997. The desired controlling instrument should, therefore, be a global market-based mechanism (GMBM). The UN aviation organization ICAO wants to introduce a global trading of certificates from 2020 onwards. Whether it will be effected via an actual reduction of emissions

or by compensation (“offsetting”), for example by offsetting funds for the protection of the rainforests, is to be determined in the course of 2016.

A general expectation voiced in the debate was that the ICAO will agree to adopt an offsetting model at the end of their negotiations, since for political reasons emissions trading can no longer be enforced on a global scale. Due to sheer volumes and areas required, offsetting and biofuel bring about daunting problems. The 30 per cent reduction via a global mechanism that people had hoped for, is not achievable by offsetting.

In order to directly intervene in the aviation market and to achieve environmental objectives at all or faster, some controlling tools were developed in Germany and in the EU. Their use is limited because they only apply to a group of providers and can distort competition. These isolated solutions included the incorporation of international aviation in the system of the EU Emissions Trading Scheme (ETS). This has led to conflicts and threats of boycott from the US and China. After the measures were removed for non-EU companies, the European airlines remained unilaterally burdened. For the Greens, however, the European ETS still remains an attractive means of decarbonising aviation.

A market-based mechanism is just one of four measures to reduce carbon emissions from aviation. In addition, the industry must focus on innovation resulting from new fuselages and cleaner engine technologies. The aim is to improve air traffic management by applying more efficient approach procedures and aircraft movements on the ground. Furthermore, alternative fuels are being developed. The industry urges policies that promote these four measures by supporting innovation as well as structural and regulatory measures, in order to maintain a competitive edge.

Another controlling tool is the national kerosene tax on commercial domestic flights. It has been legally possible to impose this tax since 2003, but it has rarely been used. Environmental organizations and railway companies demand that it is levied. A tax of this kind would increase the cost of jet fuel, which is already the largest expense factor for airlines. The control effect of such a tax is disputable.

/ MUTUAL REGRET: EMISSIONS TRADING FOR GLOBAL AIR TRAFFIC HARDLY STANDS A CHANCE

Introduced in 2011, the aviation tax in Germany has had little impact on the extent of air traffic. It remains debatable whether air traffic has migrated to neighbouring countries to a significant extent. In summary, a coordinated EU-wide strategy that ensures a “level playing field” for the respective member countries in all such measures is needed.

In Germany, passengers pay the full VAT rate of 19 per cent on tickets for domestic flights, as do passengers on long-distance rail traffic. A value added tax on tickets for international flights is only possible for the flight section over German territory. The legislator has refrained from implementing this in the Value Added Tax Act. The Greens are also not advocating extending this to international flights.

Regulatory instruments for airports include limited operating hours, as well as takeoff and

5

10

1 Alexis von Hoensbroech, Board Member Product and Sales, Lufthansa Cargo
2 Stefan Schulte, Chairman of the Executive Board, Fraport AG
3 Anja Hajduk, MP, Green Party **4** Winfried Hermann, Minister for Traffic and Infrastructure, Baden-Wuerttemberg
5 Philipp Lehmann, Airbus Group **6** Sabine Gores, Institute for Applied Ecology
7 Alexander Mahler, Deputy Managing Director, FÖS
8 Peter Gerber, Chairman of the Executive Board, Lufthansa Cargo
9 Thorsten Posselt, Institute Director, Fraunhofer MOEZ (front), Volker Thum, CEO, German Aerospace Industries Association (BDLI) **10** Matthias Duwe, Ecologic Institute, Berlin

landing fees, which are based on the respective noise levels. However, the economic pressure from such measures is not high enough to restructure an air fleet. Most German airports are in public ownership. Politicians are, therefore, obliged to further reduce the considerable

/ THE SPEED OF INNOVATION HAS TO INCREASE. OTHERWISE THE AVIATION INDUSTRY WILL NOT SUCCEED

emissions on the ground, as well as reduce noise pollution and make airports as a whole more resident friendly.

The Greens still adhere to a strict ban on night flights. Airports and airlines complain that this inhibits growth. Cargo flights in particular often move to airports in neighbouring countries. The operating times should not be further reduced and the current status should be legally anchored.

1 Stephan Kühn, MP, Green Party (front), Michael Kerkloh, CEO and President, Munich Airport
2 Tom Enders, CEO, Airbus Group
3 Alexander Reinhardt, Head of Airbus Group Public Affairs, Germany
4 Ralf Fücks, President, Heinrich Böll Foundation

INNOVATION POLICY

Technological innovations in propulsion systems and the materials used in aircraft construction have significantly improved the eco-efficiency of flying in recent years. They have also brought about economic benefits. New types of aircraft such as the A350, the A320neo or the A380 emit 25 to 40 per cent less CO_2 and NO_X than their predecessor models. However, the current speed of innovation is insufficient to reach the medium and long-term carbon reduction targets in air traffic, particularly in the face of the global growth dynamics of the sector. In order to achieve this, not only continuous (“incremental”) optimizations are required, but also “radical” innovations or leapfrogging in propulsion technology and with the fuels used.

From the industry’s perspective, the German aviation research program (LuFo), initiated by the Federal Government in 1995, has proven to be an important driver of innovation and a suitable tool for the German aviation industry. There is a need for discussion regarding more fundamental subsidization methods, e.g. within the framework of tax benefits for the costs of research and development. Another suggestion was to put more focus on aviation in the subsidization of electric mobility.

Should the government provide research subsidies if, as the Greens have also called for, new fuel and propulsion concepts, new materials and production methods are introduced faster than originally planned? Industry research alone will not be able to achieve leapfrogging to the extent it is needed; basic research is also required. Breakthroughs can be achieved more quickly if they are combined with new policy requirements. With regard to fuels, this would be the interconnection of mobility and energy transition. Power-to-liquid, obtained in wind farms could replace fossil fuels. With the emergence of photovoltaic technology, Germany proved how quickly the industry can react when a technology is ready for the market.

INTERNATIONAL TRANSPORT POLICY

Very little can currently be expected from the EU transport policy. The airspace over Europe consists of many zones under national civilian or military control. It ought to be unified to optimise airspace management. The initiative is called Single European Sky (SES). Specific objectives are to increase airspace capacity and safety while reducing the cost of air traffic management and environmental impact. Using an optimised process, up to 12 per cent of carbon emissions from European air traffic could be saved. But further progress is currently blocked because the EU lacks the willingness to reach an agreement. Opponents of reform fear that the EU Commission could intervene in sovereign tasks. They are also afraid that existing air navigation service providers (ANSPs) with their tens of thousands of air traffic controllers could be dissolved, and the use of airspace for military purposes could be restricted.

A global court of arbitration is necessary to consistently evaluate whether environmental regulations and other political steps lead to distortions in competition. The ICAO has market-relevant responsibilities but does not have established institutions to resolve conflicts. It should therefore be considered whether relevant international rules be established for aviation, along the lines of the WTO regime, or whether the WTO should be directly commissioned with this task.

"PRINCIPLE OF REAL COSTS"

In the discussion regarding a desirable configuration of transport from the perspective of climate policy, the concept of "real costs" shows how high secondary damages are for the environment. The aviation industry has increasingly supported this approach in recent years. But it points out that the real economic costs for all three industry segments (aircraft construction, airlines and airports) must be specified as well as the ecological costs. Direct and indirect subsidies contradict the idea of user financing and of a competitively neutral configuration of the international market.

CLIMATE POLICY OBJECTIVES

The European aerospace industry has set itself ambitious goals with the "Flightpath 2050" vision of the European Commission. The aim is to reach carbon-neutral growth from 2020 onwards. However, from a climate policy perspective it is not sufficient to keep carbon emissions from aviation at a constant level in subsequent decades. This sector also has to contribute to the decarbonization of industry and transport.

Over the past fifty years, the aviation industry has been able to reduce their relative (in relation to flight performance) CO_2 emissions by 70 per cent, their NO_X emissions by 90 per cent and noise emission by 75 per cent. This was mainly achieved because new technologies were introduced and operations were improved. The aim of the international aviation industry is to save fuel for the entire fleet to the order of 1.5 per cent per year until 2020. Thereafter, the net carbon emissions should be reduced by up to 75 per cent by the year 2050, compared to those recorded in 2005. Airbus products including the neo-versions of existing aircraft families (A320, A330; with neo standing for "new engine option") already provide an important contribution with savings of up to 20 per cent. Since the aircraft have a long life cycle, the next generation of aircraft will have to emit significantly less CO_2.

ICAO. The International Civil Aviation Organization (ICAO) is a specialised United Nations agency with 191 member states. Meetings are held every three years. The 2013 meeting decided to develop a system for reducing carbon emissions by their next meeting in 2016, which would achieve carbon-neutral growth from 2020 and, by 2050, a reduction of emissions by half the level recorded in 2010.

The meetings were characterised by debates about the measures taken by the EU. In accordance with a decision taken in 2007, the EU extended its emissions trading system in 2012 to intercontinental aviation. After considerable tension with India, Russia, the US and China, the European Commission suspended the scheme. The 39th ICAO assembly is scheduled for autumn 2016 at its headquarters in Montreal/Canada.

AVIATION CONCEPT. In Germany the so-called Posch Commission, an initiative of the German Aviation Association (BDL), met in 2013. The eleven members came from BDL, from the Federation of German Industries (BDI) as well as from the national government and federal states. Led by the previous Hessian transport minister, Dieter Posch, it developed a paper on "Requirements for an Aviation Concept for Germany." It dealt with competitiveness, climate protection/fuels, infrastructure, citizen participation, aircraft noise, innovation support, air traffic control and security issues. After the federal elections, the new coalition agreement of November 2013 scheduled the establishment of an aviation concept for this legislative period.

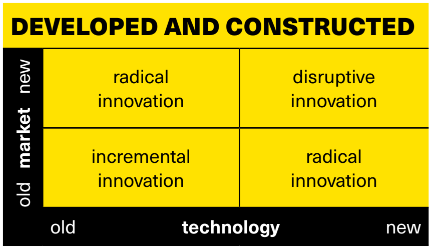
In 2014, the leading Federal Ministry of Transport and Digital Infrastructure (BMVI) staged three hearings for representatives of the federal states, national associations and organizations, and the respective federal ministries. A market and location analysis requested by the BDL and the Posch Commission was publicly tendered in spring 2015. The aim of this expert opinion is to describe the economic importance of German aviation. Based on this, the BMVI is developing the aviation concept of the Federal Government. It is to be released in late 2016.

In the middle of 2015, eight NGOs passed their own aviation concept. In anticipation of the aviation concept of the Federal Government it put forward a ten-point plan requesting a climate and environmentally acceptable restructuring of the sector.

BIT BY BIT

“Incremental” innovations continuously improve aircraft. The process is of strategic significance, but that alone is not enough

Classifying types of technical progress is a task of innovation research. The relationship of “market” and “technology” is depicted in a standard mo-del with two axes (see adjacent chart). In its four segments, three types of innovations are specified: “disruptive”, “radical” and “incremental”.



A standard model of innovation types: “incremental” innovation changes products and enterprises slowly, “radical” innovation in leaps and bounds. “Disruptive” innovations can destroy everything that has previously existed in the market

Disruptive innovations have the most far-reaching effects. They are caused by new technologies which simultaneously create a totally new market. Disruptive innovations affect an entire company and its whole production chain. They are rare. An example is the iPhone with its combination of display control, online access and external apps. Such mobile devices are increasingly replacing other products, from laptops to TV sets. They are revolutionising the information and communication market.

However, the label “disruptive” has become somewhat of a buzzword. There are few significant technical developments to which media have not assigned this label. In the aircraft industry these developments range from new engines to new materials, and even new construction methods. But experts are aware that, essentially, this kind of progress is “radical”.These innovations reshape their market but do not create a completely new one. Radical innovation leaps can lead to an abrupt loss in market share for competing products.

However, the search for less spectacular “incremental” innovations is part and parcel of everyday business in research and development departments of high-tech companies. These ongoing innovations are also referred to as the “continuous improvement process”, or kaizen. Companies who integrate more of these incremental changes into their products than their competitors will be rewarded with a gradual increase in market share. Unlike “radical” innovation, the economic risk associated with incremental improvement is manageable, because it builds on products that are already proven and does not require new and error-prone workflows. Risks may decrease further when innovations arise from modifications requested by the customer.

Airbus spends around three billion euros per year for research and development from their approximate sixty billion euros annual turnover. These funds cannot simply be labelled “incremental” or “radical”. Although there is always a “radical” background hum in Airbus research, demand for a new aircraft is currently not on the agenda. Would a new aircraft cost ten billion euros, or twice that amount? Instead, since 2010, Airbus has been working on a one to two-billion dollar overhaul of existing models. The focus is on more economical engines. The names of the respective aircraft bear the additional abbreviation “neo” for “new engine option”.

This modernization of entire aircraft series consists of incremental innovations and “neo” has been adopted as the official corporate strategy. Fuel savings of between 15 and 20 per cent can be achieved with the new models, when measured with the industry yardstick “litres per 100 kilometres and seat”. However, when comparing the planes, altered ranges and seating configurations must be taken into account. For example, the per-seat-consumption depends significantly on the size of the business class area with its increased space requirement.

The “neo” program currently includes two model lines. One is the A320 family, a group of short and medium-haul aircraft, which in addition to the basic model A320 also includes the shortened A319 and the extended A321. A 320neo completed its first commercial flight in January 2016 for Lufthansa from Frankfurt to Munich. The A321neo will follow in approximately two years; the prototype made its maiden flight in February 2016. The long-haul version LRneo is said to follow in 2018. The maiden flight of the A319neo is still pending.

The second model with “neo” lifting is the A330, a wide-bodied aircraft for medium and long-haul distances. The two versions with up to 406 or 440 seats are due for delivery at the end of 2017. The model policy is in itself innovative. Airbus has developed a transition model, an A330-300, its takeoff weight increased by eight tons for long-haul operation. However, this model consumes one to two per cent less kerosene, because several incremental innovations that improve aerodynamics have already been implanted. The engineers changed the fuselage tank between the wings, and the slats at the front

MEASURED AND COMPARED

WIKIPEDIA

previous model	year of first flight	seats	consumption*	"neo" model	seats	consumption*	routes**
A320	1987	150	2.61	A320neo	154	2.25	RS
A321-200	1996	180	2.50	A321neo	192	2.19	RS
–	–	–	–	A321LRneo	154	2.41	M
A330-200	1997	241–293	2.37–3.11	A330-800neo	n. s.	n. s.	ML
A330-300	1992	262	2.98	A330-900neo	310	2.42	ML

*1/100 km and seat. ** regional= (R), short-haul = (S), medium-range = (M), long-haul = (L). n. s. = not specified

Compared to their predecessors, the "neo" models have a lower fuelconsumption. Most of the models are still in development and the consumption data has only been estimated. But competition requires the communication of realistic figures

edge of the wings. In addition, the linings of the landing flap actuators were shortened to improve aerodynamics.

The Rolls-Royce Trent 700 engine offered for this model is a precursor to the Trent 7000, a new design, which will be used exclusively for the A330neo. According to the manufacturer, the engine alone will save ten per cent on fuel. The two future A330neo models will likewise have a wingspan that is enlarged by 3.7 metres, and improved aerodynamic features. Airbus announced that, ultimately, these measures would reduce fuel consumption by 14 per cent per seat compared to previous models.

The further development of the A330 illustrates the interconnection of control technology and consumption. A new electronic gust control uses automatic rudder throws to prevent a wing from overloading during turbulence. Airbus can, therefore, use a wing that was originally designed for a lighter aircraft without the increased weight and fuel consumption related to structural reinforcements.

The most visually striking innovation, however, goes across the whole model range. It is the so-called Airbus "sharklets", folded up wingtips. Their shape is reminiscent of shark fins, but functionally they are modelled on the wingtips of certain species of birds. The 2.4 metre high components reduce air resistance and fuel consumption, thus, lower emissions by about four per cent and also reduce noise. For the same purpose, Airbus has mounted disk-shaped "wingtip fences" on or under the wings. They do not alter the wingspan, and allow unrestricted rolling and parking at cramped airports.

Individual incremental innovations can therefore lead to significant carbon reductions, but this is still not enough. For example, the savings connected with reduced kerosene consumption lead to an increase in flights, the rebound effect. In addition, the long life cycle of an airplane limits possible reductions. An aircraft that flies for thirty years with 15 per cent less kerosene, only yields an average annual improvement of 0.5 per cent. With modernizations in the course of an aircraft's life cycle, the amount may increase to 1 or 1.5 per cent. But more will have to be done to achieve the self-determined objective of a reduction that significantly exceeds the annual growth in air traffic of 4.7 per cent over the next twenty years.

Aircraft and engine manufacturers are not alone responsible for achieving this reduction. Airlines, airports and policy makers must also play their part. But without radical innovations that enable the manufacturers to achieve their own goals and reduce emissions by 20, 30 or even 40 per cent, it will not work. There is a consensus on this in the industry.

ORDERED AND DELIVERED

WIKIPEDIA

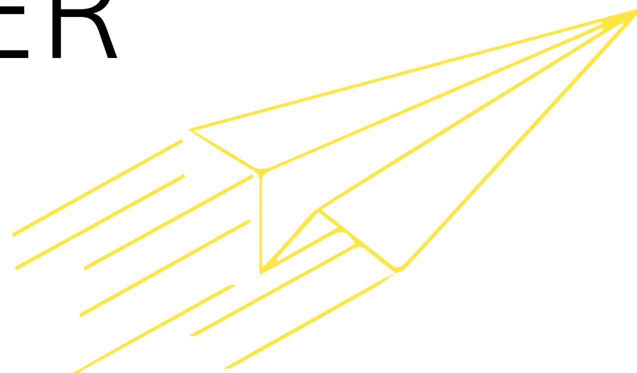
"neo" model	year of first flight	year of delivery	ordered/ delivered units	seats (max.)	flight range km	list price million dollars
A319neo	2016[e]	n. s.	50/0	160	7,800	98.5
A320neo	2014	2016	3,344/2	189	6,900	107.3
A321neo	2016	n. s.	1.114/0	240	6,760	125.7
A321LRneo	2018[e]	n. s.		206	7,400	n. s.
A330-800neo	2017[e]	2018[e]	10/0	406	13,900	252.3
A330-900neo	2016[e]	2017[e]	176/0	440	12,130	287.7

As of: 29 February 2016 [e]=expected. – n.s. = not specified

Economically the "neo" program is very successful. Hardly any aircraft have been delivered yet, but 5,000 planes have already been ordered

FASTER AND FASTER

Until now Silicon Valley has not been a major player in the process of redesigning civil aircraft. However, this is about to change



The remark refers to the new electric aircraft, E-Fan, a two-seater plane. "It was built under Silicon Valley conditions", an Airbus manager said proudly. In fact, a team of five to eighteen people completed the development of the aircraft in just 18 months, from the start of the project until its first flight in March 2014. Now a new factory has to be built in southern France and operate at full speed for a two-seater to go into production in 2017, and for a four-seater in 2019. Proof of compliance with "Silicon Valley conditions" is only given if Airbus achieves these deadlines.

What Silicon Valley stands for so far is the opposite of the procedures prevalent in the aircraft industry. In California's high-tech industry, ideas and innovations constantly emerge. A product cycle at Intel or AMD is measured in months, updates from Adobe or Cisco come every few weeks. However, at the Airbus and Boeing sites, aircraft take a decade to develop, followed by a life cycle of thirty years.

Here the hoodies; there the lab coats. This generalising juxtaposition, however, only touches the surface and is unfair. Airbus and Boeing are producing their own aircraft, whereas the workbench of the Valley, or at least part of it, is in China. But the Valley has direct inhouse communication paths and uncomplicated procedures, a lot of multi-millionaires under 40 and the hippest employers in the world. Aircraft companies, on the other hand, are regarded as vast hierarchical enterprises with a growing number of older engineers.

CULTURAL DIVIDE

In his book "From Counterculture to Cyber Culture", Stanford communication professor, Fred Turner, describes the roots of many high-tech start-ups in the hippie movement in California. Criticism of the conformity and rigidity of the technology existing at the time led not only to its rejection, but also to an attempt to appropriate the equipment, thereby "taking it away from the military and politics." This applied to computers in particular. The West Coast mixture of drop-outs and start-ups emerged in this spirit, characterised by a certain distance to the government and its organizations; a mind-set that was a matter of course for the nerds in Silicon Valley. Ironically, the first great boom in the area was triggered by orders from the Pentagon and NASA. During the Cold War and Vietnam, local defence companies, such as Lockheed Martin, and military research at Stanford University were the drivers of innovation.

Even Boeing, where military equipment accounts for more than 50 per cent of its turnover, fits into the picture. At Airbus military equipment amounts to 20 per cent; in addition the company was initiated by politicians. However, the Europeans remained widely unnoticed for a long time in the United States while the digital utopians kept their customary distance from Boeing. An investigation revealed that for years, there had been only minimal contact between the tens of thousands Boeing and Microsoft employees at Boeing headquarters in Seattle and neighbouring Redmond (not in Silicon Valley, but also on the West Coast), where the two blue chip companies had their corporate headquarters.

The tech blogger, Paul Gray, detected at least one synergy with the Valley. Boeing, he railed, had probably been inspired by the quasi pretentious first letter in the name of Apple's iPod to also give its new 7E7 aircraft a trendy vowel. But not for long: the machine was soon renamed 787.

UNTAPPED POTENTIAL

Corporations are accustomed to in-house development departments taking care of continuous "incremental" innovations. They require thinking ahead, but no fundamental rethinking. Leapfrogging or "radical" innovations that lead to entirely new products take a different approach. They are often triggered off by creative lateral thinkers, basic researchers and enthusiasts. Companies without direct access to them need to locate them.

The unconventional Valley did not show much interest in conventional aircraft manufacturers and their products. And vice versa. Yet the knowledge profile of the "computer geeks", as they were called by the uncomprehending, would have been well fitted to the leapfrogging innovations with which Airbus and Boeing have been taking sizeable market share away from each other for three decades. In fact there could have been more breakthroughs than the big four leaps that have fundamentally transformed the aircraft industry since Airbus and Boeing have been the main competitors.

LEAP 1: FLY-BY-WIRE

Fly-by-wire, the "wired" electronic flight control, is one such leap. Introduced with the Airbus A320 in 1987, this digital system replaced the traditional mechanical control. The starting point was an Airbus weakness: the multitude of locations at which the politicians in France, Germany, Spain and Britain had set up a partly state-owned aerospace group. Since then, fuselages, wings and cabins are transported crisscross through Europe, until the passenger aircraft is fully assembled. Boeing, however, manufactured its aircraft centrally near Seattle and could install the wire gearing for the controls throughout the aircraft without any problems.

The decentralization of Airbus required the assembly of prefabricated components with cable connectors and digital signal transmission. This enormous structural simplification, as a result of considerably reduced mechanical components, secured Airbus significant economic benefits. At Boeing, the concept met with resistance, because the control was no longer exerted by the physical sensation of the pilot, but rather by a joy stick and the programming of an on-board computer. In 1994, with the new 777, Boeing introduced a fly-by-wire control system, which, however, retained a strong similarity to the old system, as it largely simulated the familiar mechanics.

LEAP 2: COCKPIT COMMONALITY

A further "keep it simple" Airbus idea is now considered a radical innovation: installing as much identical equipment and instruments as possible in the cockpits of various models. This so-called commonality not only saves costs in production and maintenance, but also enables the pilots to fly various aircraft.

LEAP 3: COMPOSITES

With the use of composite materials, it was Boeing that achieved a technological lead. The new 787, delivered since 2011, consists of 50 per cent composite materials to reduce weight. Kerosene consumption decreased by 21 per cent compared to the previous model. Airbus followed suit. The A350, which went into service at end of 2014, consists of 53 per cent carbon fibre plastic mixtures. It consumes 6 per cent less fuel than the 787.

But Boeing could have been ahead of its competitors by a further 300 deliveries, if the 787 had not gone into service three years later than scheduled. For the first time Boeing had assigned larger parts of production to companies throughout the world, to benefit from global knowledge regarding the materials and components, which for some experts constituted the real innovation. But there were numerous delays in technical coordination and documentation, and the suppliers often had to wait for each other. The communication was too complex, a problem that could have been easily solved by the network experts of Silicon Valley.

LEAP 4: NEW ENGINES

Boeing and Airbus do not produce their engines themselves, but purchase them mostly from the major manufacturers, GE Aviation, Pratt & Whitney and Rolls-Royce, whose last innovation leap dates back to the 1960s and 1970s. This brought forth the high-bypass turbofan engine, which the three companies have since further developed. It has also given aircraft manufacturers the resources for their own innovation leap. They recently started offering the airlines, their customers, very distinctive combinations of aircraft and engine variants with either two or four power units. Boeing was quickly followed by Airbus. This time, however, in-house resources of the manufacturers were sufficient, not requiring the use of any Silicon Valley virtues.

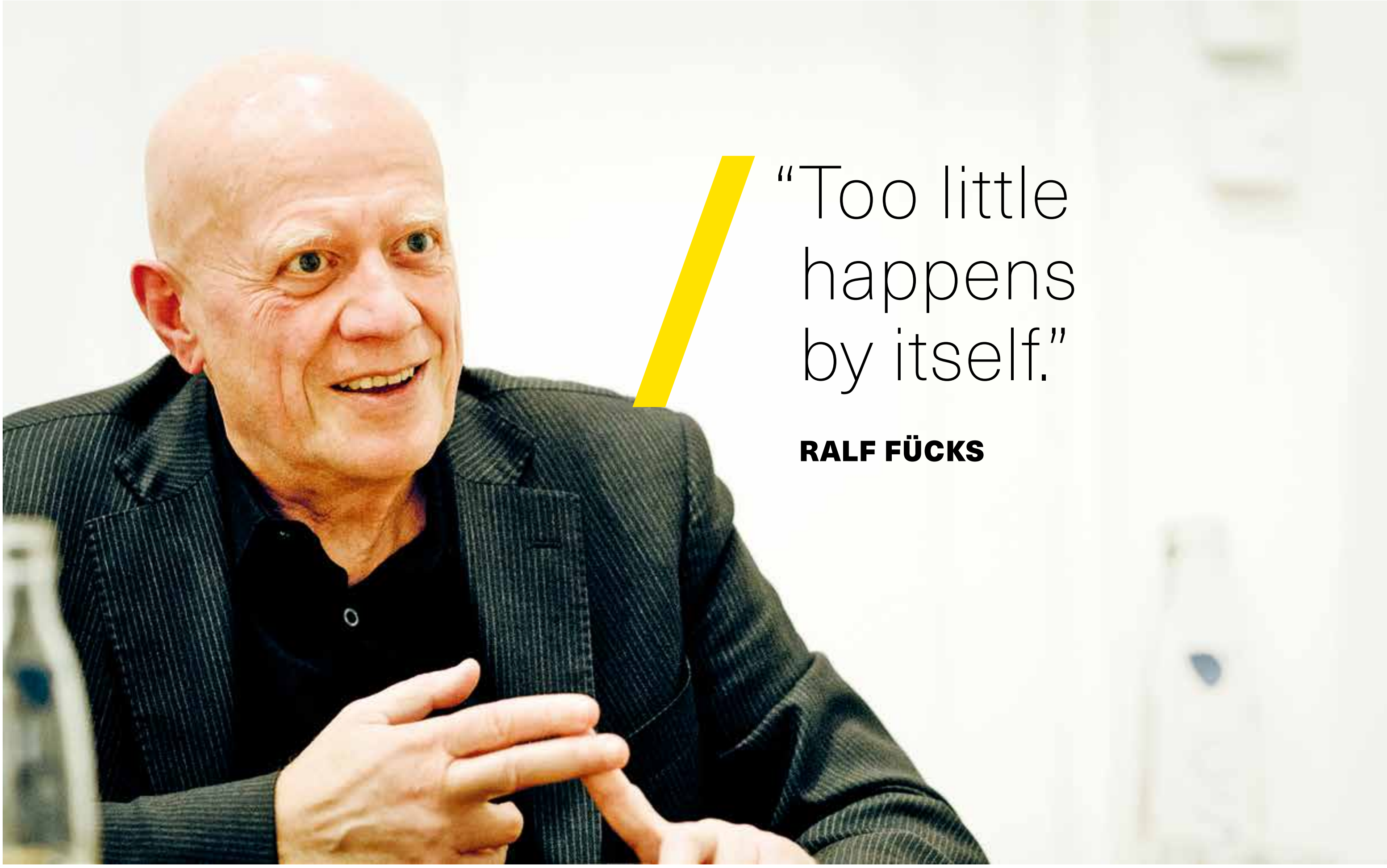
VIEW OF THE VALLEY

But in the end, innovations in the aircraft industry have a lot to do with Silicon Valley. Firstly, because Airbus and Boeing use their high-tech products in planes and in production processes. Secondly, because both companies maintain close contact with the Valley. At the beginning of 2016, Airbus put its own A^3 (read: A-cubed) innovation centre into operation in San Jose. Thirdly, whole new synergies between the hot Valley projects and the passenger aircraft industry are beckoning and not only in 3D printing. Anyone who now buys a Tesla, may one day be interested in boarding an electrically powered jet. Those who are not frightened of Google's self-driving cars or Amazon's cargo drones, will, most likely, at some point fly in an aircraft without a pilot.

The innovation process alone could also be radical. For instance, the Moffett Airfield operated by Google is located in the midst of tech companies. What would happen if Airbus put an aircraft there for the Valley engineers to tinker with, to dismantle, to try out? It would be like disclosing a software source code. This is how Android became the world's most successful operating system for mobile phones.

This presupposes the readiness to be surprised by the ideas of the developers, of young people without tunnel vision and without any respect for tradition. For a few weeks they could crawl through the machine and then disappear to experiment in their garages or in their companies with 500+ employees. But this would not call for the usual company internal suggestion system, and work would be performed under real Silicon Valley conditions. Anyone with a formidable idea would open up a start-up with Airbus as its first customer.

There are enough inverstors around. One of them might well be Airbus Group Ventures. The Airbus Group recently opened this investment fund with 150 million dollars at its disposal. Operations commenced in 2016 – and it is based in Menlo Park, in the heart of Silicon Valley.



“Too little happens by itself.”

RALF FÜCKS

HOMEWORK FOR POLITICS AND INDUSTRY

Interview: RALF FÜCKS is President of the Heinrich Böll Foundation. TOM ENDERS is the CEO of the Airbus Group.

Mr. Enders, Mr. Fücks, is the climate debate putting pressure on the aviation industry?

Ralf Fücks: Absolutely! An aircraft is the dirtiest means of transport.

That's a surprising statement, Mr Fücks! On Facebook people can follow you jetting around the world.

Fücks: I am subject to the same schizophrenia as a good number of the green electorate. We are aware of the harmful effects of flying but we do it anyway. Our Foundation has partners and projects all over the world. So I travel a lot. Everything today is global: politics and economy, science and culture – even love. This is why I want to make flying as en-

“Regulation produces no progress.”

TOM ENDERS

vironmentally friendly as possible and simultaneously reduce unnecessary flights.

What do you mean by that?

Fücks: I think it's decadent just to fly to London to go shopping. Most domestic air travel could be replaced with train journeys.

Tom Enders: There are studies that say: no one spends as much time in the air as the supporters of the Green Party. At the same time it is the Greens who want to prohibit everyone else from flying. Drink wine and preach water, that's your motto!

Fücks: Objection! We do not want to stop people from flying. I am not opting for sermons and prohibitions but for the ingenuity of science and industry.

Enders: Bill Gates once said that the airplane became the first World Wide Web, bringing people, languages, ideas, and values together. And that's more important than ever.

But flying is far more environmentally harmful than the Internet.

Enders: We have been eco-efficient even longer than the word has actually existed. Our customers, the airlines, have always been interested in economical aircraft for cost reasons and this also benefits the environment. Engines now consume 70 per cent less kerosene than forty years ago.

Fücks: Stop looking through rose-tinted glasses. Global air traffic grows by 5 per cent a year. You cannot save that amount of fuel with improved efficiency using conventional technology. Flying alone is responsible for 5 per cent of climate change.

Enders: Now hang on a minute here! If one considers the emission of carbon dioxide, it only amounts to 2 per cent.

Fücks: But you also have to include nitrogen oxides, soot particles and water vapour. They increase the carbon effect considerably.

Enders: The deforestation of the rainforests causes on average 25 per cent of climate change. If the Greens took care of the rainforests with the same intensity they devote to air traffic issues, it would make life a lot easier.

Fücks: But we do!

Enders: We are the only industry that has set itself tough climate targets. From 2020 onwards, we will have a carbon-neutral growth, in spite of a continual increase in air traffic. By 2050 we will have reduced the carbon emission by 75 per cent and that of nitrogen oxides by as much as 90 per cent. The noise of aircraft will then be reduced by 60 per cent. We are spending almost our entire research funds on eco-efficiency. So there is no reason to reproach me for not doing enough.

Fücks: But you will have to dramatically increase the speed of innovation. You will never succeed in reaching these targets with improvements to existing technologies. We need leapfrogging with regard to engines, fuels and materials. After all, the number of aircraft will have doubled worldwide by the mid-2030s. But there is a conflict of objectives: the industry shies away from moving to new technologies, because the companies first of all want to fully amortize their old investments.

You do not seem to be satisfied with Mr. Enders' answer, Mr. Fücks?

Fücks: No. The industry must be given binding climate targets and its privileges and subsidies must finally be eliminated.

Which ones?

Fücks: Until now the aircraft industry has been excluded from trading with carbon emission rights; kerosene is not taxed and VAT is not applicable for international flights. In total, these subsidies amount to ten billion euros, without having to provide any consideration for the environment. Mandatory regulations are desperately needed.

Enders: This argument is neither here nor there! Air traffic is the only mode of transport which is self-financing. In addition, a lot would be gained if politicians did their home-

work. European territorialism, for example in air traffic control, is responsible for many unnecessary tons of kerosene, because the aircraft have to make detours and fly in holding patterns.

Fücks: I still maintain that political regulation is inevitable. Too little happens by itself. Ambitious environmental requirements act as innovation drivers in the industry. They not only further ecological but also technological progress.

Interim result: Mr. Enders, you say: We are ecologically innovative for competitive reasons. Mr. Fücks, you insist on regulation.

Fücks: Yes I do. Whoever brings the first aircraft into the market that flies with a combination of an electric engine and algae fuel, will also be ahead in economic terms.

Enders: Objection! Regulation produces no progress. Boosts of innovation are not the result of regulation, otherwise the GDR would have been a high-tech state. And the fact is, we are working on electric aircraft, alternative engines, lighter materials and more in this vein.

Fücks: Volkswagen is an example of what happens when old technologies are not replaced.

Enders: All the money that the airlines pay for regulation cannot be invested in research or products for more eco-efficiency. I am not in principle against every regulation. But if they are put into effect, then please not unilaterally but on a global scale, because our industry is global.

Does the extremely low cost of kerosene make airlines sluggish?

Enders: No, because fuel can quickly become more expensive. Our customers know this; they always plan on a long-term basis. There are no cancellations. People prefer flying around the world in modern machines.

When will we be able to fly with a noiseless battery-powered Airbus from Frankfurt to New York?

Enders: We have a clear technological vision. In twenty years we want to fly an electric aircraft with around 90 to 100 seats, almost noiseless and emission-free. The future lies in such topics, although we have to admit that we still have a lot of work ahead.

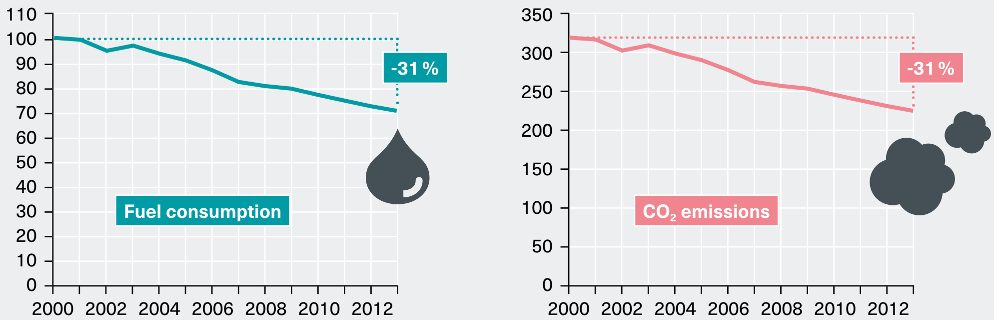
Interview by Ralph Bollmann and Rainer Hank. It was published in the Frankfurter Allgemeine Sonntagszeitung on November 22, 2015

MAJOR TRENDS

Economy and ecology, kerosene and carbon dioxide all determine the future of aviation. The air fleet is becoming more modern. But the market is booming where the environment is not the focal point

REDUCTION

Decline in fuel consumption and reduction of CO_2 emissions, kilogram per passenger and flight (average)



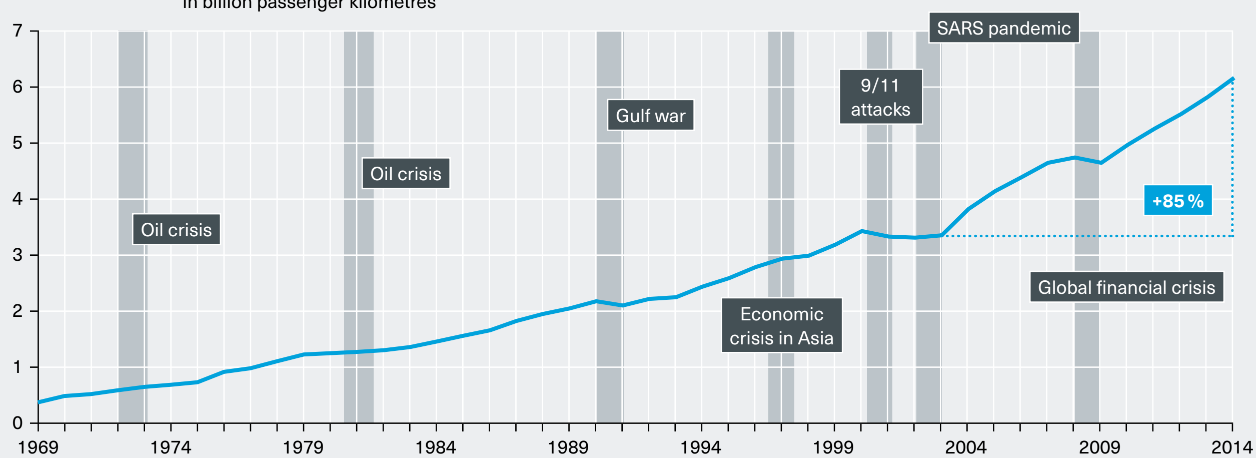
AIRBUS

Within the past twelve years, kerosene consumption and carbon emissions per flight have been reduced by almost a third. This is due to technical improvements as well as better load factor

Within the past twelve years air traffic has almost doubled. Crises have merely subdued the growth

GROWTH

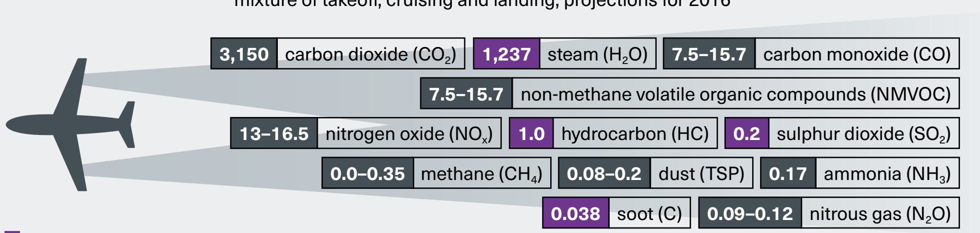
Increase in air traffic and effect of crises, in billion passenger kilometres



ICAO/AIRBUS

EMISSIONS

Release of substances from combustion, in grams per kilogram of kerosene, mixture of takeoff, cruising and landing, projections for 2016



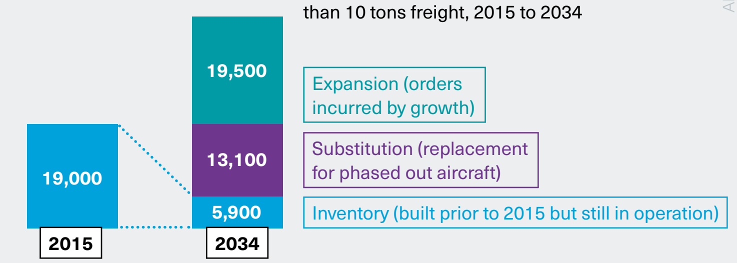
IFEU/UBA

■ These emissions can also cause contrails and cirrus clouds. They possibly have a similar effect on the climate as CO_2 emissions

The carbon dioxide from air traffic has an impact of two to three per cent on climate change. Taking all the pollutants into account the percentage exceeds five per cent

THE NEW FLEET

Orders for passenger aircraft with more than 100 seats and for cargo aircraft for more than 10 tons freight, 2015 to 2034



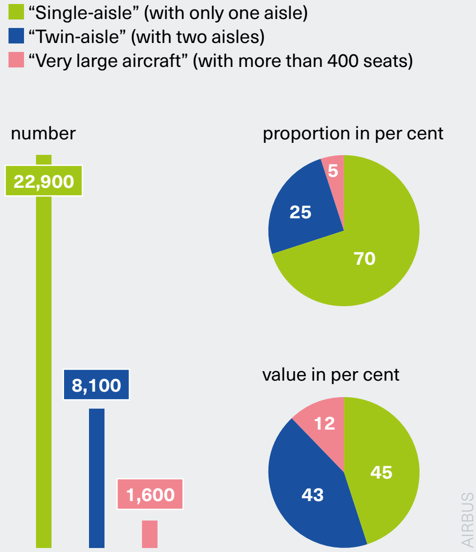
Airbus estimates that the global air fleet will grow by 32,600 large-sized civil aircraft by 2034. The new jets will have to be more fuel efficient, because they will stay on the market for decades

The bigger the aircraft, the more lucrative its production. But even in the coming two decades, it is the smaller aircraft that will generate high volume business

The trend line shows: within a period of 40 years, the kerosene consumption of newly developed models has sunk by 25 per cent. And another competitor is on the market

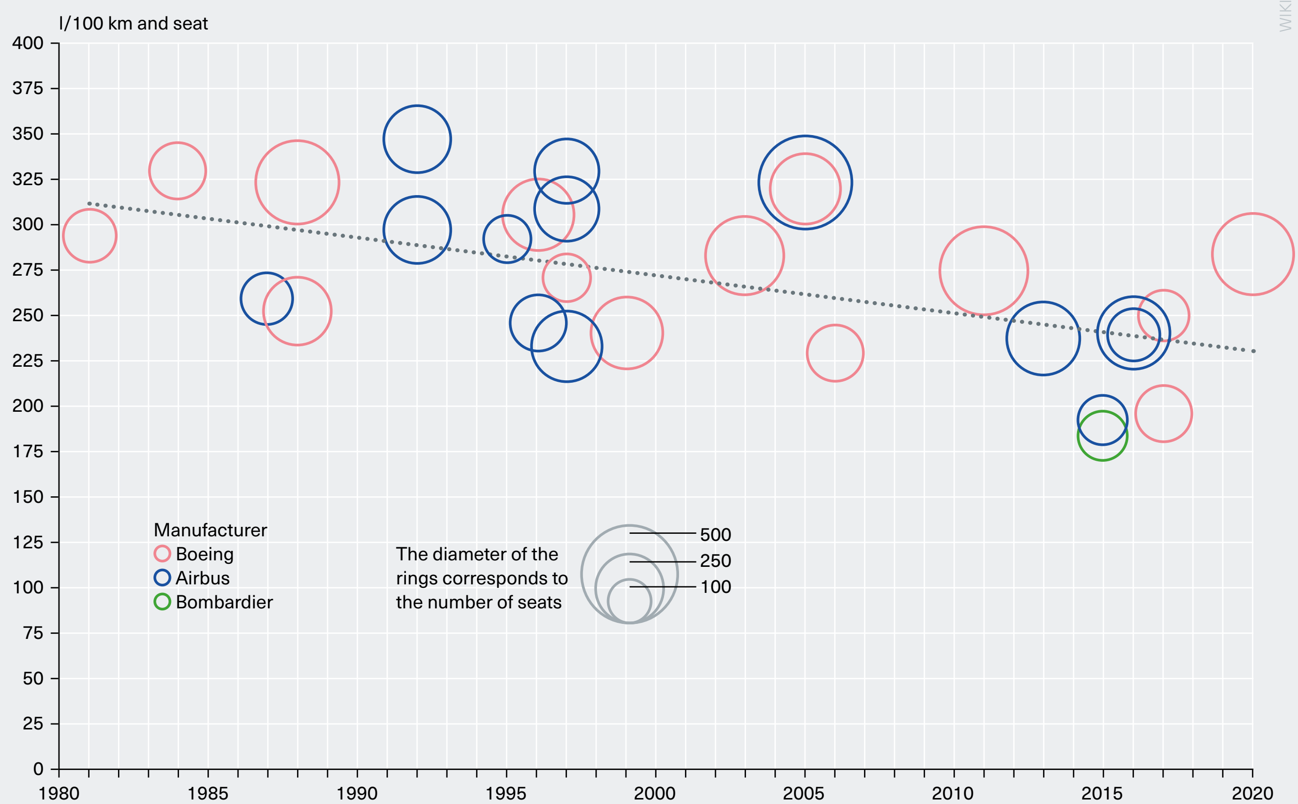
USEFUL 2ND AISLE

Deliveries of passenger aircraft with more than 100 seats and for cargo aircraft for more than 10 tons freight, 2015 to 2034, according to size, number and levels of turnover



DESCENT INTO THE FUTURE

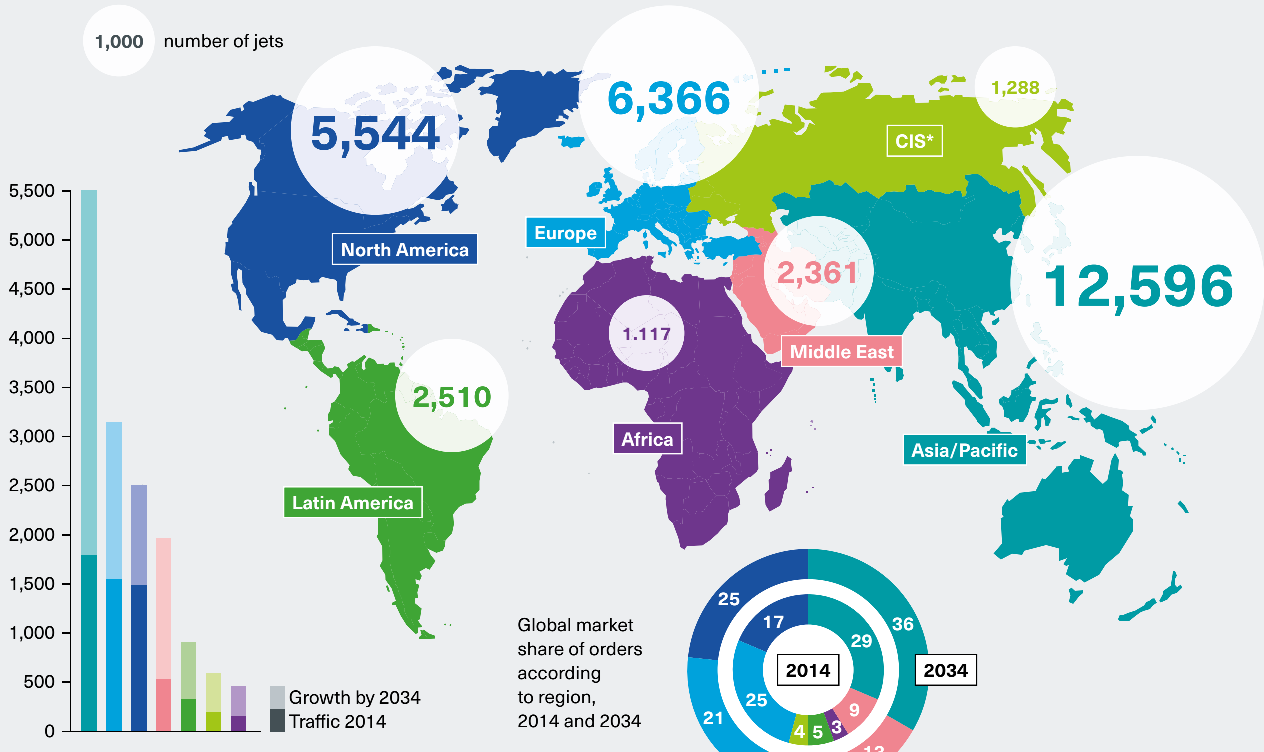
Fuel consumption of selected types of aircraft, in accordance with the year of their first flight or calculations; consumption, number of seats and manufacturer



THE BOOM REMAINS ASIAN

Ordered passenger aircraft according to the region of origin of the airline, 2014-2034, and transport capacity 2014/2034

AIRBUS



Air traffic in billion passenger kilometres, 2014 and 2034

*Commonwealth of Independent States

If the middle classes of China and India continue to expand, the global demand will increase. By 2034, approximately half of all the aircraft orders will be allotted to Asia/Pacific and the Middle East with the Gulf States

The era of sluggish state airlines is over. The fight for market shares is increasing

MORE COMPETITION

Airlines that offer flights from Frankfurt to Peking, as of April 2015

BDL

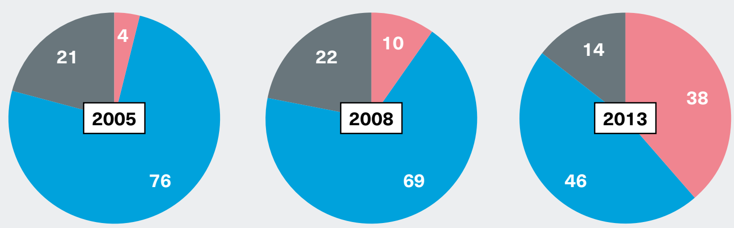
German
European
Third countries

LOST CLIENTS

Passengers in the traffic flow USA-India-USA, Shares among connecting regions in per cent, without direct flights

BDL

Europe
Middle East
other regions



Even if the routes are longer and the emissions are higher, the Gulf State airports attract flight traffic to and from destinations in Asia with their low kerosene and airport tax prices

NEGOTIATION MATTERS

The EU wanted to exert international pressure to speed up the reduction of carbon emissions in air traffic. However, it failed because its climate policy met with existing conflicts of interest

In air traffic to and from Europe, it is mainly the Europeans who put strain on the climate. They pay for this but the others don't

On 1 January 2012, the European Union expanded its emissions trading system (ETS) to air traffic. Its aim was to create price pressure to decarbonise this industrial sector, i.e., to significantly reduce its emission of climate-related pollutants. All airlines that take off or land in the EU, Norway, Iceland or Liechtenstein were supposed to report the carbon emissions of their flights in the course of the year.

Key elements of the concept were: the airlines are not responsible for 87 per cent of their respective amount, but have to bid for EU certificates for the remaining share. In 2012, the EU will reduce the issuance of these certificates by 3 per cent and from 2013 to 2020 by 5 per cent annually. This makes them increasingly expensive. The increase in cost is determined by the demand at the auctions and thus by the market. The simplest way to avoid these costs is to save kerosene. The EU calculated that in 2020, this could reduce carbon emissions by about 70 million tons.

The ETS was supposed to cover emissions on the entire route, including the country of origin and destination, as well as over the oceans. What followed was a global public outcry. Politicians abroad complained that the EU were imposing their own agenda on other states and even impeaching their sovereignty. Rather than participate, China, India and the US threatened retaliation, e.g. to deny overflight rights.

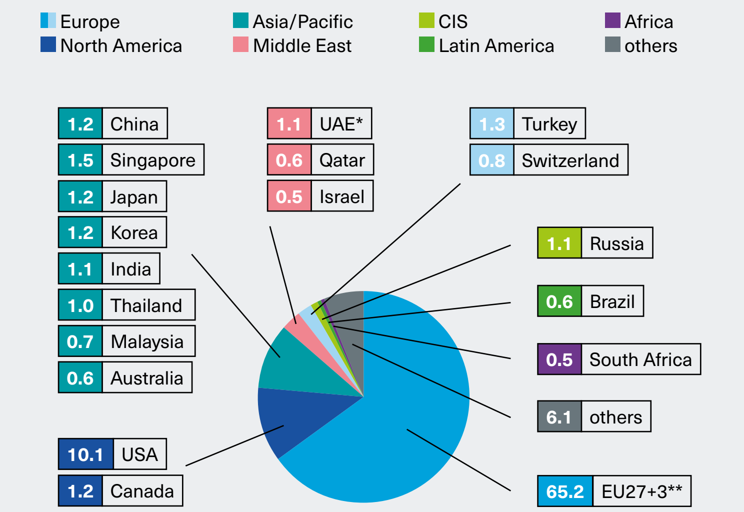
As a consequence, the EU initially suspended the introduction of the ETS for one year. They subsequently restricted the covered distances to EU territory, excluded all airlines from third countries and finally limited this regulation until 2016. Only airlines that are based in the EU are subject to the ETS and they are now complaining about the cost disadvantages compared to competing companies from third countries. Some EU airlines simply added the additional costs onto the ticket price. Flying therefore became slightly more expensive, but not cleaner.

At the same time, the pressure of finding a global solution to the problem increased. The Kyoto Protocol of 1997 instructed the UN aviation organization ICAO to develop a reduction model. In the same year, the ICAO proposed a voluntary efficiency improvement of only 2 per cent per year. Global models did not follow until 2012. These included emission trading, but also offsetting. By means of this "compensation", carbon emissions are compensated by funding carbon reductions elsewhere, such as forest conservation. However, the emissions themselves are not reduced.

The submission was too late for a decision at the ICAO Assembly in 2013. As the organization meets only every three years, it was resolved to decide on the new system at the meeting in autumn 2016. It has already been agreed that it should become effective in 2020.

DOMESTIC TWO-THIRDS MAJORITY

CO_2 emission in the area valid for the EU emissions trading scheme (ETS), according to the country in which the airlines have their head office, 2011, in per cent

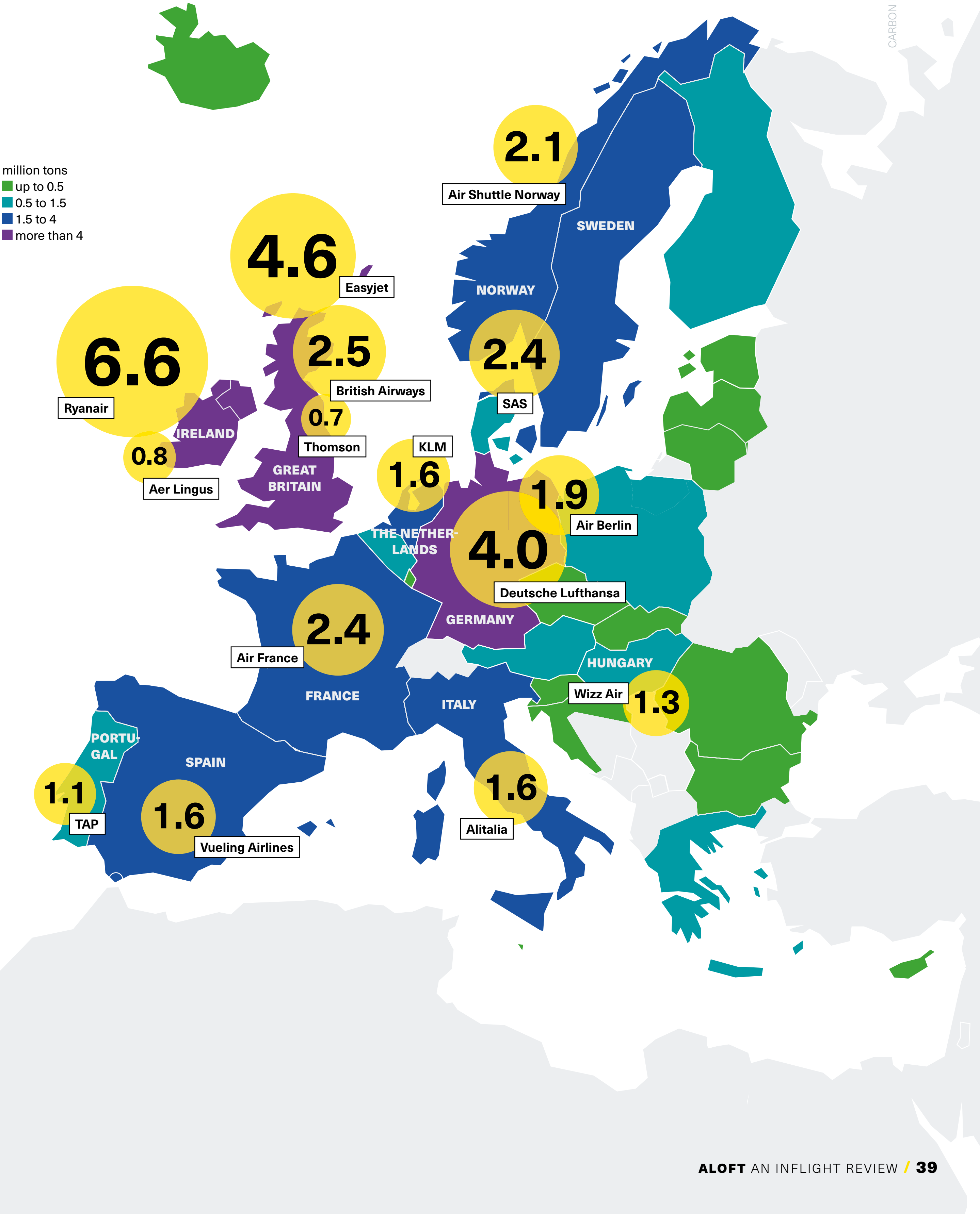


* United Arab Emirates ** With Norway, Iceland and Liechtenstein

STILL A LOT TO BE DONE

Confirmed emissions of 2014 of the aviation sector, according to the airline's country of origin, as well as the 15 airlines with the highest carbon emissions according to data of the EU-emissions trading scheme, in million tons CO_2

CARBON MARKET DATA



CELESTIAL DETOURS

The "Single European Sky" could replace the cumbersome and expensive European aviation traffic system that causes serious environmental harm. But a broad alliance opposes the uniform organization of airspace

During the 1990s and early 2000, delays in European airspace accumulated. They became a serious political and economic transport problem. As a result of inefficient organization of responsibilities, incompatible air traffic control technologies, as well as detours along state borders and restricted military zones, flying holding patterns became a part of everyday life. Eurocontrol, the professional organization responsible for harmonising the system, asserted itself in managing this muddle. At the same time, it was overstrained because its competencies were insufficient to carry out urgently needed changes.

The European Commission, therefore, developed a plan labelled "Single European Sky" (SES) for a unified European air control system. Sixty control centres divide the airspace into numerous fragments. Five major air traffic control organizations deal with 54 per cent of air traffic, the rest is divided among 32 small facilities. All 37 control centres together cost 8.6 billion euros annually. They have 57,000 employees of whom 17,000 are air traffic controllers, handling about 27,000 flights per day. In terms of figures, each flight requires about two-thirds of a traffic controller's working day.

The commission estimates that the price tag for the "non-existence" of the SES comes to four billion euros annually. The EU estimates that each flight is on average 49 kilometres longer than the shortest possible route. In 2006, an additional 4.7 million tons of carbon dioxide was emitted solely by detours in air transport, amounting to approximately 5 per cent of the total emissions. In 2010, EU Transport Commissioner Kallas stated that the sum of all unnecessary aviation emissions in Europe amounted to around sixteen million tons of carbon dioxide.

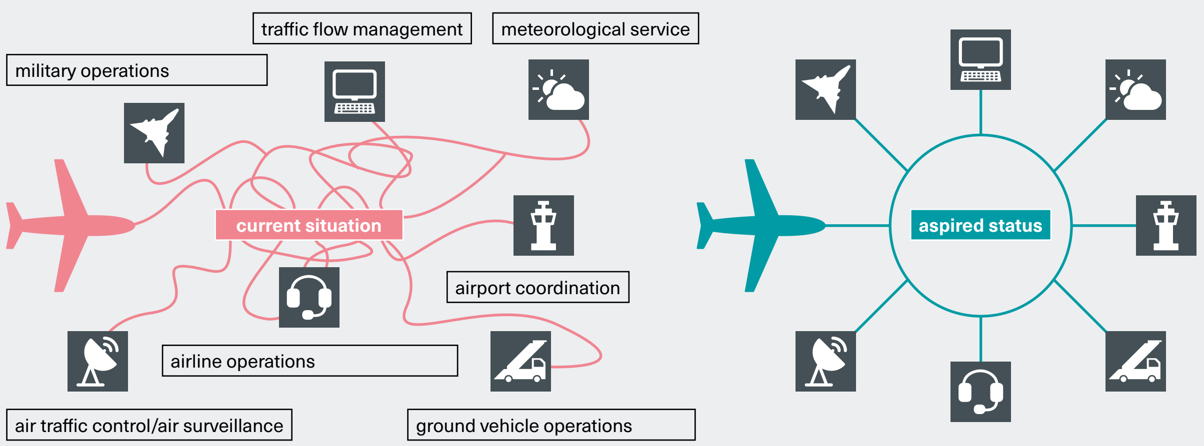
However, it is not just about the shortest distance between two locations, but also about op-

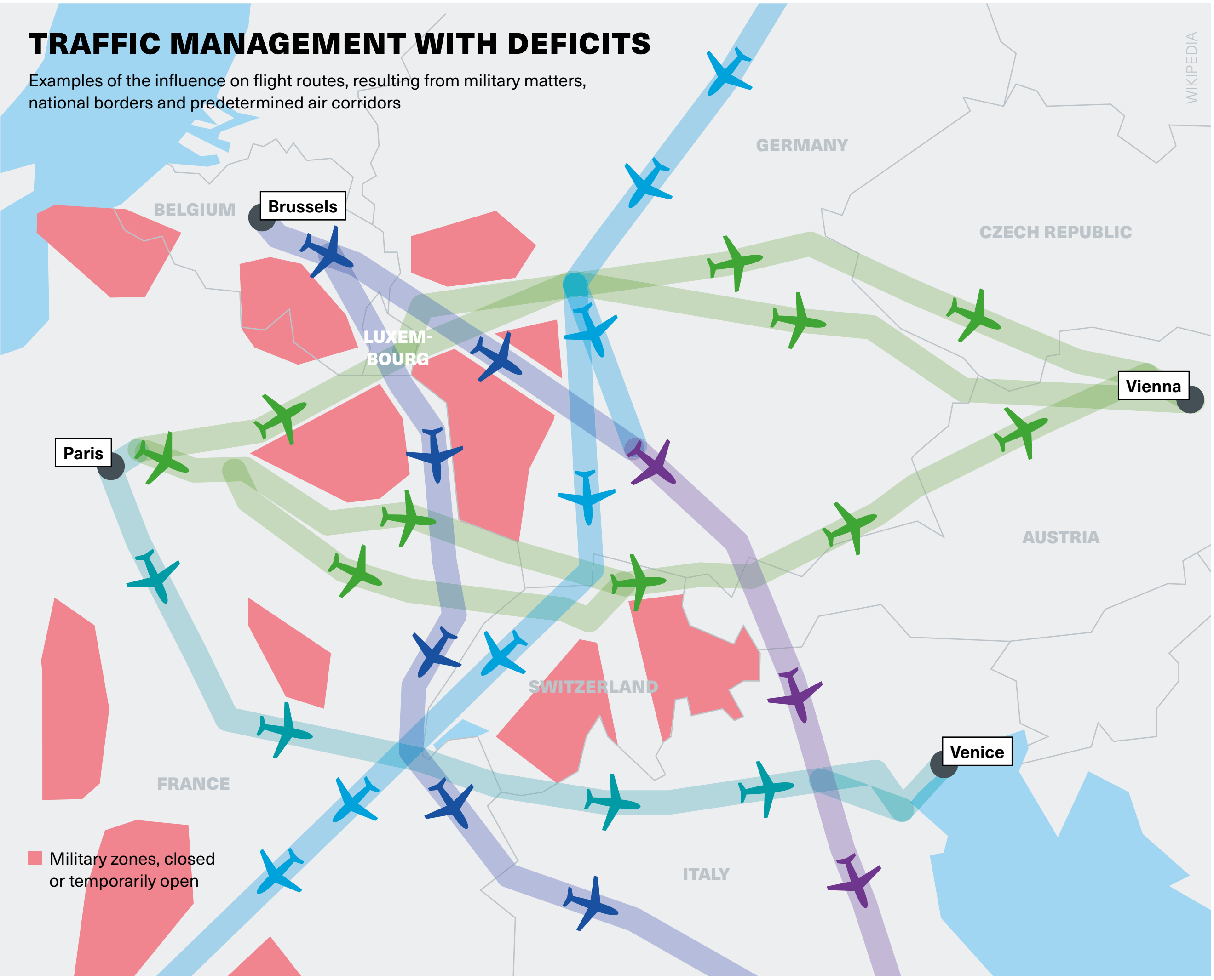
The EU program SWIM (System Wide Information Management) is to create a unified network structure for European airspace

MANY PLAYERS AND NOT ENOUGH ORGANIZATION

A schematic diagram of present and possible future information channels in air traffic management, according to EU plans

EUROCONTROL





timum courses of climb and descent, as well as altitudes. This can be quite different for individual aircraft due to technical, traffic or weather conditions. But the structures to communicate and control these data are missing. The cost of a Europe-wide unified system was estimated at twenty billion euros – a decade ago.

The EU wanted to reorganize the existing 37 zones into fewer "functional airspace blocks". The aim of these new blocks was to overlap national borders and simultaneously take military needs into account. But just as the first concept was completed in 2001 and the target date of 2020 was set for the SES, the problems began.

Self-interest on the part of the respective EU member states dominated the negotiations. A powerhouse in pursuit of pan-European interests was missing. Air traffic control organizations were opposed to restructuring, private competition and market-oriented fees. Unions and professional bodies fought back with strikes and protests against downsizing and additional working pressure. Besides, several states refused to permit the control of their military flights by civilian EU air traffic controllers.

To speed up the arduous process of reform, a EU program called "SES2+" came into force at the end of 2015. New institutions are supposed to increase the pressure, especially on member countries. Business representatives in the committees, however, criticise the Commission, because sustainability still takes a back seat to flight safety and economic efficiency. Airlines and manufacturers insist on meeting the climate policy goals, in order to move ahead with the SES and reduce costs. Carbon emissions as an industry argument for reforms, a situation made possible by the price pressure of global competition.

Civil aviation has to avoid military zones. Depending on whether a zone is currently open or closed, different flight corridors are assigned

CONCEPTS, PLANS, MATTERS OF OPINION

How sustainable could flying be? Where will the fuel of the future come from? What are the burdens the industry can or cannot absorb? In Germany, eight non-governmental organizations and the German Aviation Association argue over the upcoming Federal air traffic conception

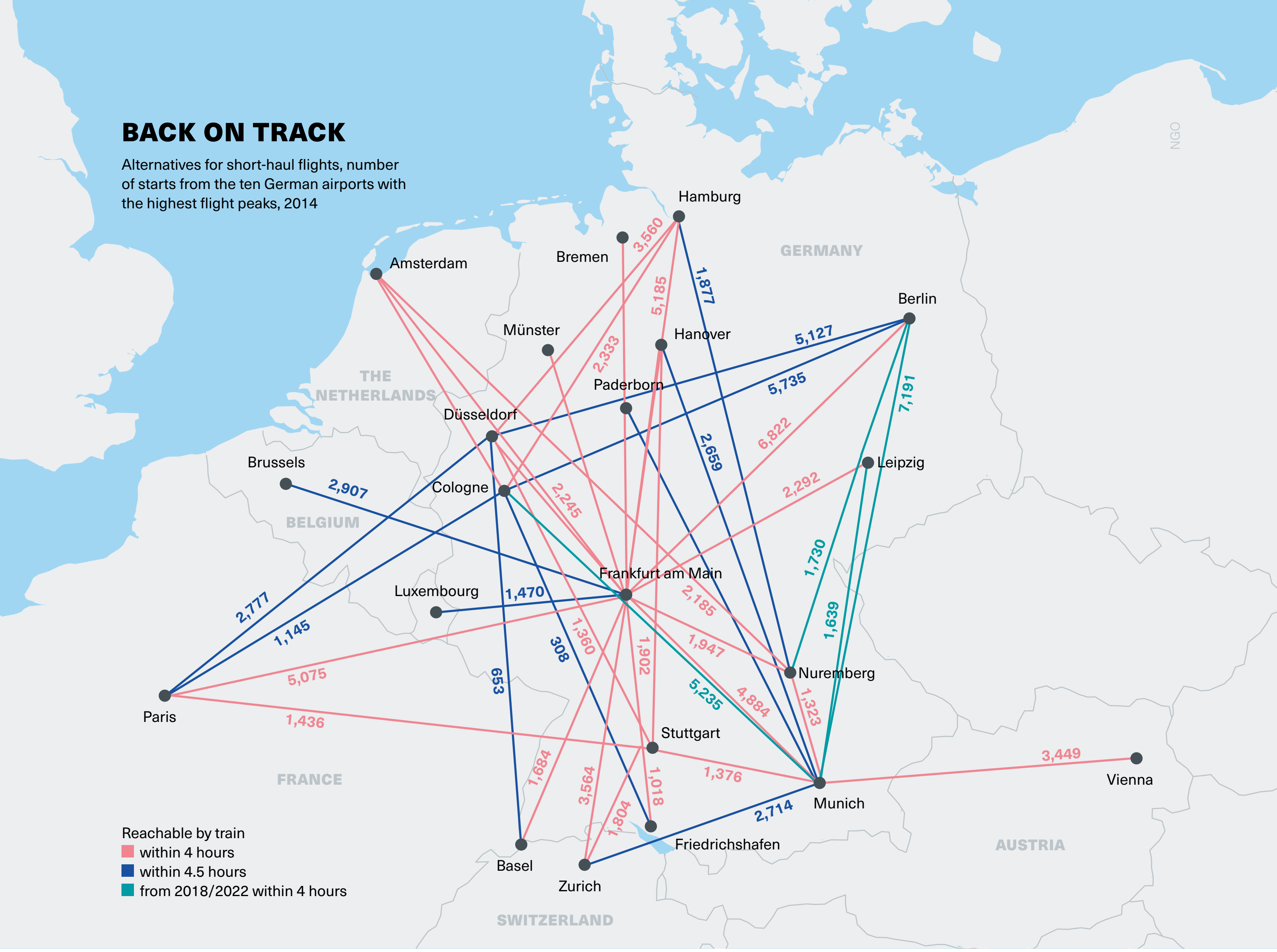
At the end of 2016, the Federal Government is expected to present its air traffic plan as agreed in the coalition contract, specifying how the sector should develop in the upcoming years, as well as in the long term. Economics, environment, technology and security are major issues. In anticipation, eight non-governmental organizations have published their own NGO aviation concept. They are demanding that air travel be considered in conjunction with all other transport systems, and embedded in a strategy of sustainable mobility. They fear that the responsible Federal Ministry of Transport and Digital Infrastructure might place too much focus on the growth of air traffic, thus, neglecting the sustainability targets that were self-defined by the Federal Government. If greenhouse gas emissions are to be reduced by 80 to 95 per cent by 2050 compared to 1990, the emissions of air traffic will also have to be drastically reduced.

> / THE CRITICS AND THE INDUSTRY AGREE THAT COST DUMPING IS ADVERSE. THE DISSENT IS IN THE DETAILS

In principal matters NGOs and the industry are in some cases not very far apart. The NGOs write: “It is a matter of priority to determine a policy for the internalization of external effects, against dumping, as well as for securing adequate wages and good working conditions. Without measures to ensure fair competition, a race to the bottom and a decline in prosperity are inevitable.” Negotiations between the states “can be used specifically for a policy against dumping”. With regard to regulatory measures, both sides are pulling in the same direction to achieve equal economic conditions for everyone, including the global financial burden of reducing carbon emissions.

Similar views also exist with regard to rail transport. Both NGOs and the industry are dissatisfied with the fact that rail and air transport have not yet sufficiently interlocked their services. Furthermore, both sides expect more effort on the part of the railway to replace domestic flights in Germany. Their shuttle function for major airports needs to be expanded. The NGOs even speak of an “Airrail Plus” system with shared tickets and convenient baggage logistics. The NGOs concede that German domestic air traffic has made progress. From 2004 to 2013, the number of passengers on domestic flights remained approximately the same, while fuel consumption per passenger kilometre sank by 20 per cent and the German economy grew by 13 per cent.

Ending the “airport sprawl” and subsidies for regional airports, as demanded by the NGOs, is, however, not an option for the German Aviation



Association (BDL). This association, founded in 2010, also represents smaller airlines and airports that continue to rely on domestic routes and that can be easily reached by car. There is an even stronger divergence of views when it comes to major political action against environmental strain.

The NGOs maintain that the concept of carbon-neutral growth, negotiated in the UN aviation organization ICAO, is unsuitable for limiting the temperature rise to two degrees. They stress that the particularly potent effects from emissions other than CO_2 are not taken into account, e.g. cirrus clouds. Biofuel is criticised by the NGOs for its lack of sustainability. They regard power-to-liquid, i.e., the production of synthetic liquid fuels from renewable electricity and a few raw materials, to be the only viable approach, even if the technology is still in the testing phase.

In order to accelerate the move away from conventional liquid fuels, the NGOs want to introduce a global climate levy on carbon equivalents. It would start in 2020 at ten US dollars per ton, and also extend to other emissions in 2025. To reduce harmful aircraft noise, appropriate concepts ought to be developed at all airports. These include better management of air operations and consequent noise regulations that ensure eight hours sleep. This worries the industry more than any other location-based requirement. At many airports, the "core night" currently only comprises the time from 11 pm or midnight until 5 am.

The NGOs support rather maximalist views. The EU emissions trading system for intercontinental flights should be reinstated, although it only affects European airlines. The aviation tax that brings in one billion euros tax revenue, but has very little controlling effect, is also regarded as contributing towards the reduction of high

Tens of thousands of feeder flights and city connections could be shifted from air to rail, if offers were attractive enough subsidies in the aviation sector. These subsidies consist of 7 billion euros from the non-taxation of kerosene and 3.5 billion euros from VAT exemption for international tickets. Regulatory policy supports both sides: the perks are indeed protectionist measures, but they simultaneously compensate for the competitive advantages held by airlines from third countries that fly with untaxed kerosene and no surcharge on the tickets.

BALANCING CARBON EMISSIONS AMONG INDUSTRIES? "OFFSETTING" IS DESIRED AND CONTESTED

Large differences exist in the evaluation of biokerosene. The NGOs reject the use of biomass. In their opinion it destroys biodiversity by establishing monocultures and by increasing the use of pesticides and fertilizers. "Indirect land use changes", as it is labelled in technical terms, are seldom recorded. They ensue when the cultivation of industrial plants pushes food cultivation on to unused, ecologically sensitive areas. We use the term "Fuel versus food" to describe the direct conflict that arises when food and fuel compete for the same land or the same water.

To counter the growing criticism waged against biofuel, industrial and scientific companies and organizations joined forces in 2011 in the »Aviation Initiative for Renewable Energy in Germany" (aireg). The current 29 members include many companies in the aerospace and chemical industries; the Airbus Group is also a participant. Aireg is striving for biofuels to account for ten per cent of the kerosene used for aircraft in Germany by the year 2025. The initiative acknowledges that the cultivation of biomass has problematic consequences, but does not regard the approach in itself as discredited.

Aireg relies on comprehensible production conditions in various regions of the world. Their aim is to introduce an ambitious certification to guarantee the natural and socially acceptable cultivation of crops for their use in Germany. The secured demand would stabilise the crop revenue and bring prosperity to the growing regions. According to "Friends of the Earth, Germany" (BUND), this is wishful thinking: "This is not about theoretical evaluation models, but rather about the implementation in practice." Aireg replies that such a defensive attitude currently "fails to take advantage of the developmental opportunities of bioenergy cultivation."

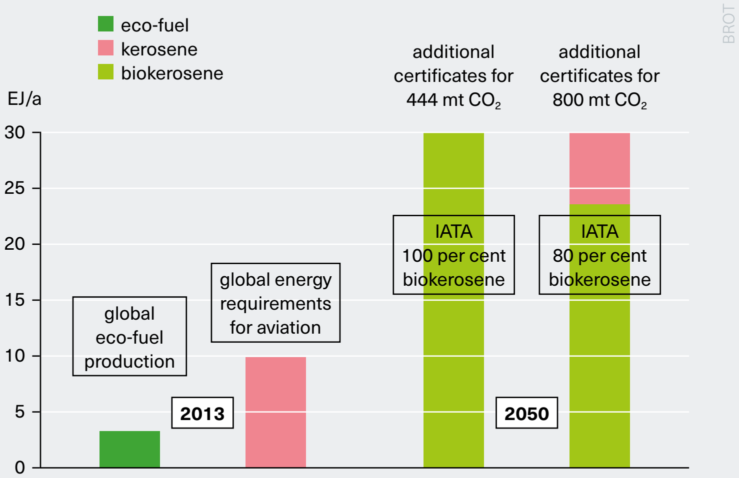
Offsetting, an idea that is being negotiated in the ICAO is also controversial. The concept allows the industry to compensate for their carbon emissions with a carbon reduction elsewhere in the world. Investments could include outdated coal power plants in India, guidance systems for bus services in the congested cities of Latin America or reforestation in northern China. However, the disadvantage of this method is the substitution: climate-effective projects that were already planned are now postponed until funding through carbon offsetting is available. In the worst case scenario, all the funds from offsetting go into projects that would otherwise have been paid for by public authorities or companies, reducing their efficiency to zero. The control of state or company investment plans can only prevent such a "refinancing" if it is blatantly obvious.

The NGOs are also opposed to shifting emissions to other sectors because each sector should bear its own responsibility for climate protection. The German Aviation Association (BDL) on the other hand maintains that open structures, as those in the EU Emissions Trading Scheme, are actually aimed at achieving savings in sectors where this is most efficiently possible. If the NGOs were to ask, "Should the industry be allowed to buy themselves out?" the BDL's answer would be, "The main thing is to reduce emissions".

Even if practically all global projections are disputed, the sheer dimensions show how strong the pressure for enlarging the farming areas for fuel plants is

BIOKEROSENE SUPPLY AND DEMAND

Global energy requirements in aviation 2013 and 2050, as well as eco-fuel production in 2013, in exajoules per year



IATA: International Air Transport Association, mt: million tons

AIRCRAFT NOISE **PROS** & **CONS**

Airports put a strain on people who live near them. However, the noise at takeoffs and landings has declined in recent years. Four questions addressed to MONA NEUBAUR, leader of the Green Party in North Rhine-Westphalia, an advocate of protection against aircraft noise and CHARLES CHAMPION, Executive Vice President Engineering at Airbus

Have we already exceeded the so-called "peak noise" related to aircraft noise pollution, at least in Europe?

Mona Neubaur: There are measurement results that indicate that peak noise has been reached or even exceeded in Europe. However, further development depends on many factors, such as the increase of air traffic and the kind of machines and engines that are used. Aircraft noise is and will remain an important issue for thousands of people living near airports, and thus also for us Greens.

Charles Champion: The perception in Europe is that aircraft noise is worse than rail or road, but in fact population noise exposure to High Speed Rail is far higher – by a factor of 4 – than from aviation in Europe. It is also worth noting that for aviation, although passenger-kilometres flown in Europe has even increased by 32 per cent from 2004 to 2015, the population exposed to noise has actually decreased.

What are the next important steps to further reduce aircraft noise?

The challenge the federal government faces is to provide a system of noise limits, from which active and passive noise protection measures can be developed for local residents. Residents must be able to get a good night's sleep, preferably between 10 p.m. and 6 a.m. In the interests of health and taking into consideration the economic interest in a functioning aviation sector, changes to the operating times or routes could be made.

We are committed to the European Union's "Flightpath 2050" technology targets including reduction of perceived noise by 65 per cent. Also. Airbus fully endorses the ICAO's "Balanced Approach" to address noise through reduction at the source, operational procedures, land-use planning, and operational restrictions. We are moving forward to improve aircraft operational capabilities and allow optimised departures and approaches such as "gliding approach", all contributing to reducing the noise.

Would less aircraft noise result in increased air traffic at the airports? Will we have a rebound or even backfire effect?

Even given a slight decline in noise readings, an airport still causes a major strain for thousands of affected residents. Therefore, we advocate effective noise protection measures. We assume that local residents would appreciate the better quality of life if noise levels declined and no rebound effect occurred.

No, because airport traffic is driven by many different factors. Aviation environmental performance can continue to improve with the various players – aircraft and engine manufacturers, airlines, air navigation service providers, government agencies, research centres, airports ... working together to develop and implement the best and most efficient solutions worldwide.

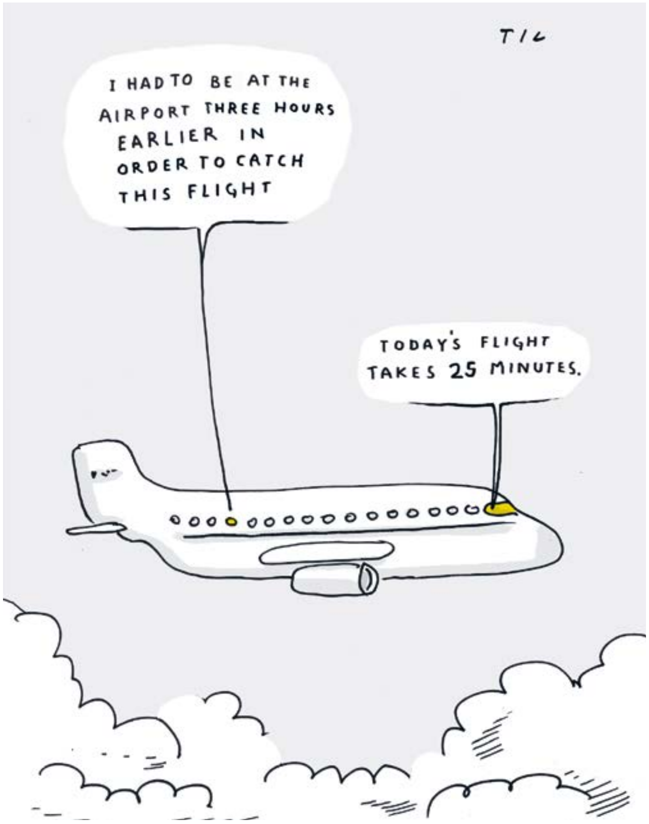
Could very quiet engines lead to a reduced ban on night flights? Could this be an economic incentive to speedily develop such engines?

Protecting the residents from noise, especially at night, is of crucial importance for us. The right to normal sleeping hours is not open to discussion. Any initiative that reduces noise is welcome and quiet engines reduce noise pollution even during the day.

Many environmental factors are being taken into account on top of safety, performance and industrial aspects. Regarding noise, Airbus remains fully engaged in the pursuit of breakthrough lower-noise technologies and operational capabilities such as those we achieved on A350 XWB, for which certified exterior noise levels are far below current regulation (-21 EPNdB – Effective Perceived Noise Decibel), below ICAO Chapter 4 requirements.

"HAVE A **PLEASANT FLIGHT**!"

Hamburg cartoonist, TIL METTE, on the shortcomings and absurdities of flying



Security check in a world without terrorism

With kind permission taken from Till Mette's book *Guten Fluch!*, Lappan Verlag Oldenburg, 2013, ISBN 978-3-8303-3327-2

HIGHFLYING AND NOSEDIVING

The history of the Greens and Airbus – a short journey through time

1966 The emergence of the hippie and the Civil Rights movements in the United States. All over the world, students protest against conservative governments.

1968 In France, civil unrest and mass strikes shatter society and government. One of the student leaders is French-German **Daniel Cohn-Bendit,** who would later become the leader of the French Green Party and win 16,3 per cent of votes in the 2009 European Parliament (EP) election. From 2002 to 2014, he was one of two leaders of the EP's Greens/EFA political group.

1976 Resistance forms against a new airport near **Nantes,** France. As part of the government in the 2000s, the French Greens oppose the project in Notre-Dame-des-Landes. After decades of protest, a regional consultative referendum is scheduled for 2016.

Late 70s, 80s In many European countries, ecological and green parties are founded and successfully start to contest seats in local, national and European **elections.**

per cent of all Members of the European Parliament (MEPs), and name of the political group

1.5 later Rainbow coalition members

1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982

Up to 1966 Against the dominance of the US aircraft companies Boeing, McDonnell Douglas and Lockheed, Western European politicians initiate the **Airbus project** for civil aircraft construction. A consortium is formed by public and private companies from France, Germany and Great Britain.

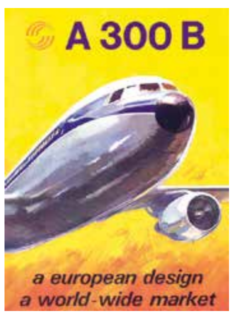
1967 The decision is made to construct the first model, later called **A300B.** In 1969 Great Britain leaves the consortium.

AIRBUS INDUSTRIE

The logo of the Airbus consortium in its first years.

1970 The German Airbus GmbH and Aérospatiale from France found Airbus Industrie, each holding 50 per cent. The conservative politician, **Franz Josef Strauß** becomes Chairman of the Supervisory Board and is an unerring supporter throughout all the crises.

1972/74 The first flight/first delivery of the **A300B.** By 1979 only 19 aircraft are sold and in 1976 alone 16 jets are stockpiled. The A300 is the first twin-engine aircraft with two aisles. For the first time the shorter A310 has a two-person cockpit.



1.6 billion dollars turnover, Airbus Industrie

1979 Great Britain rejoins the project. The shares are now: Aérospatiale and German Airbus holding 37.9 per cent each, British Aerospace 20 per cent, CASA (Spain, since 1971) 4.2 per cent. The announcement of the **A320** is a success. The demand for this model counteracts the market access crisis. Up to 90 per cent of development costs for new models are covered by the governments.

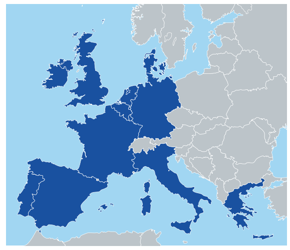
1984 At Frankfurt Airport, the much disputed **Runway West** goes into service. Today the airport continues to expand despite years of protest and unrest, as well as participation by the Greens in Hesse's state government.

1990s E.U. regional subsidies to extend aviation infrastructure begin to pour into the regions, triggering an airport **construction boom** mostly deprecated by environmentalist and green groups.

1988 For the first time, the climate impact of aviation emissions in higher altitude is adressed in a national parliament. Leading German politician **Petra Kelly** put the topic onto the agenda.

1990 German greens call for a **kerosene tax** of 5 DM (€ 2,50) per litre within the next decade. They strongly oppose the company mergers which lead to DASA, an Airbus Group predecessor.

1990–1992 The end of the cold war, the removal of intra-EU borders and the prospect of a single European currency change green politics from a eurocritical to **pro-European** alignment. Mobility becomes a key Green issue.



4.6 Rainbow coalition (1984)

5.8 Greens (1989)

4.1 Greens (1994)

Greens/EFA **7.7** (1999)

1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999

3.0 billion dollars turnover, Airbus Industrie (1984)

6.0 billion dollars turnover, Airbus Industrie (1990)

9.6 billion dollars turnover, Airbus Industrie (1995)

1991/92 Maiden flights of the long-haul jets, **A340 and A330**

1999 The foundation of **Airbus Military** for the production of tanks and transport aircraft. The division is dominated by tension regarding orders from the defense industry, as well as technical problems.

The 1980s: As previously experienced in the aerospace and defense industries of France and Britain, a wave of mergers and acquisitions also occurs in Germany. Daimler-Benz buys up the companies involved in German Airbus, often together with their defense divisions. In addition to Airbus, a new defense company emerges. Resistance to industrial policy, monopolies and subsidies remain unfruitful. In 1989 ministerial approval allows the merger of **Daimler-Benz and MBB.**

1995 The weak dollar increases the cost of Airbus aircraft. Orders are lost. The recovery program **Dolores** (Dollar Low Rescue) reduces the workforce and costs by 30 per cent. The pressure to reform the complex group structure grows.

1994 the **"Beluga"** – transporter commences operation between the Airbus sites.

AIRBUS

2006 The Labour government intends to build a third runway for London's **Heathrow Airport.** In 2010, the plan is rejected by the new Tory/LibDem government. Expansion plans are renewed in 2015 causing protests with strong green support.

2015 In Frankfurt, airport supervisory board member and green politician Frank Kaufmann welcomes the takeover of twelve **Greek airports** arguing that this would diminish domestic expansion pressure on Fraport.

2015 In **Lyon,** the European Green Party adopts a resolution about aviation. Main elements: Within the EU, environmentally harmful subsidies including the exemption from kerosene tax and Value Added Tax must be phased out. If the ICAO fails to agree on an effective global market mechanism, the EU Emission Trading System should be extended to cover all flights within, to and from Europe. The aim is the development of a mutual approach that will limit social dumping in EU aviation.

EUROPEANGREENPARTY

2016 In Austria, former green leader **Alexander Van der Bellen** becomes President-elect with 50,3 per cent of votes.

2011 In the state elections in Baden-Wuerttemberg, Germany, the Green Party obtains 24.2 per cent of votes. Within a coalition with the Social Democrats, Green politician **Winfried Hermann** becomes Minister of Transport and thus supervisor for the state's airports, notably Stuttgart. Hermann stays in office after the 2016 election with 30.3 per cent of votes for the Green Party.

The Greens | EFA
in the European Parliament

5.8 Greens/EFA (2004)

7.5 Greens/EFA (2009)

6.7 Greens/EFA (2014)

2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016

24.2 billion euros, EADS, 59 per cent of these at Airbus

30.1 billion euros turnover accrued at EADS

39.1 billion euros, EADS, 64 per cent of these at Airbus

49.1 billion euros turnover accrued at EADS

64.5 billion euros, Airbus Group, 71 per cent of these at Airbus

2000 The European Aeronautic Defense and Space Company is founded. **EADS** becomes the 80 per cent owner of Airbus SAS, the remaining 20 per cent being owned by British Aerospace Systems; 2006 BAe once more leaves the company.

2006 A380 in crisis: as a result of technical problems, there is a threat of more than a loss of 6 billion dollars in the following 4 years. The world's largest passenger jet is also confronted with turnover problems.

2015 The production in Mobile (Alabama, USA) begins.

2009 The factory in Tianjin (China) goes into operation.

2014 New name "Airbus Group" and new corporate governance

2016 Ownership: now 74 per cent of the shares are free float shares, a joint locking minority by France and Germany, each holding 10.9 per cent and Spain holding 4.1 per cent.

2007 The plan **"Power8"** is implemented and the workforce is reduced by 10,000 persons. In the Group, the Franco-German dual leadership is removed.

AIRBUS GROUP

2016 The first **A320neo** ("new engine option") is delivered. More than 3,300 aircraft are pre-ordered; together with the A319neo and A321neo this amounts to more than 4,500 pre-orders.

SOURCES

IMAGES, PICTURE CREDITS AND COPYRIGHTS **Cover:** mapi/photocase.de. **p. 4:** Dietmar Bartz. **p. 6:** krockenmitte/photocase.de. **pp. 8–10, 11 B:** Andreas Heddergott/TUM. **p. 11 RT/LT:** Airbus Group. **p. 12 T, C:** Forschungszentrum Jülich. **p. 12 B:** Wikimedia Commons/JanB46, Microalgenkwekerij te Heure bij Borculo.jpg, licence: CC-BY-SA 3.0. **pp. 14–15:** travnikovstudio/istockphoto.de. **pp. 16–18 TL, TRT:** Airbus Group. **p. 18 TRB:** Ansgar Pudenz, Deutscher Zukunftspreis. **p. 19:** Airbus. **pp. 20, 21 T, C:** archive. **p. 21 B:** Airbus Group. **pp. 22–26:** Stefan Röhl. **pp. 32–34:** Julia Zimmermann. **pp. 46–47:** Til Mette. **p. 48 LT:** Associated Press, **TC:** archive, **C:** Airbus, **B:** Wikimedia Commons/Robert Ward, Franz-Josef Strauß 1982.jpg, licence: CC0. **p. 49 T:** archive, **CL:** Archiv Grünes Gedächtnis, **B:** Airbus. **p. 50 T:** Richmond & Twickenham Green Party, **TR:** Tadej Zupančič/istockphoto.de, **B:** Airbus.

DATA AND INFOGRAPHICS **p. 6:** Bundesverband der Deutschen Luftverkehrswirtschaft (BDL), Energieeffizienzreport 2015, http://bit.ly/1r9AgUa. **p. 7 T:** Umweltbundesamt (UBA), Vergleich der Emissionen einzelner Verkehrsmittel im Personenverkehr – Bezugsjahr: 2014 (2016), http://bit.ly/1U1Xk1Z. **p. 7 B:** CE Delft et al., External Costs of Transport in Europe (2011), pp. 8–9, http://bit.ly/1NwY2hd. **p. 29 T:** Wikipedia, Fuel economy in aircraft, http://bit.ly/22HkzPe, **B:** Wikipedia, Airbus, http://bit.ly/1NifTgY. **p. 35 T:** Airbus, Flying on demand. Global Market Forecast 2014/2033, p. 35, http://bit.ly/23S9XiQ, **C:** Airbus, Flying by Numbers. Global Market Forecast 2015, presentation, slide 12, http://bit.ly/1wGpPUc, **B:** UBA, Überarbeitung des Emissionsinventars des Flugverkehrs (2010), p. 20, http://bit.ly/1qBfPP8. **p. 36 TL:** Airbus, Flying by Numbers. Global Market Forecast 2015, presentation, slide 25, http://bit.ly/1wGpPUc, **TR:** ibid., slide 4, http://bit.ly/1wGpPUc, **B:** Wikipedia, Fuel economy in aircraft, http://bit.ly/22HkzPe. **p. 37 T:** Airbus, Flying by Numbers. Global Market Forecast 2015, Booklet, p. 10, 34, http://bit.ly/1wGpPUc, **C:** BDL, 2015, unpublished data, **B:** BDL, Herausforderungen der deutschen Luftverkehrswirtschaft, 2015, slide 28, http://bit.ly/1SOXzva. **p. 38:** EU, Aviation and Emission Trading. ICAO Council Briefing, Sept. 29, 2011, slide 41, http://bit.ly/20PUWwp. **p. 39:** Carbon Market Data, GreenAir online, Apr. 17, 2015, http://bit.ly/1WAJ9Sp. **p. 40:** Eurocontrol, System Wide Information Management (SWIM), http://bit.ly/1ycWZdl. **p. 41:** Wikimedia, http://bit.ly/1VwK9Hw. **p. 43:** NGO-Luftverkehrskonzept. Schritte zu einem zukunftsfähigen und umweltverträglichen Luftverkehr in Deutschand (2015), p. 29, http://bit.ly/1N5kQcL. **p. 44:** Brot für die Welt: Grüner fliegen. Potenziale, Risiken und Perspektiven für Agrotreibstoffe im Flugverkehr. Aktuell 47, p. 4 (2014), http://bit.ly/1NwYNXq.

T top, **C** centre, **B** bottom, **R** right, **L** left

PUBLISHED BY
Heinrich-Böll-Stiftung, Schumannstraße 8, 10117 Berlin, Germany, www.boell.de
Airbus Group, Rahel-Hirsch-Straße 10, 10557 Berlin, Germany, www.airbusgroup.com