ZEROe, Airbus' Flying Wing
for 200 passengers

READY FOR SUSTAINABLE TAKE-OFF?

Flying is considered the most damaging form of mobility for the environment. Often criticised in the past for noise pollution, today the focus is primarily on CO_2 emissions. Developments for more sustainable flying were demonstrated at the AERO in Friedrichshafen, one of the leading international trade fairs for the aviation industry. Reason enough for forum to outline the state of affairs and prepare a special on the topic.

By Mathias Warlich

The topic of sustainability and decarbonisation in aviation is not new. As early as 2009, airlines, manufacturers, air traffic control and airports had adopted a climate protection strategy to increase fuel efficiency. In 2016, a globally valid CO_2 compensation system (CORSIA) was set up by the UN aviation organisation (ICAO), whereby air traffic should at least grow in a climate-neutral manner from 2020. In 2021 the goal was formulated to achieve "Net Zero" in 2050" for global air traffic. Apart from targets and regulations, there are, as in other industries, sustainability-motivated pioneers who are working with great commitment on viable innovative new aviation concepts. For the first time, AERO presented promising development directions for environmentally friendly flying on the Sustainable Aviation Trail.

Batteries and electric propulsion

They already exist – but so far only as 2-seaters and with flight times of less than an hour. If fuelled with regeneratively produced electricity, the flight is not only completely emission-free, but also significantly quieter. However, scaling up to use battery-powered electric engines in large commercial aircraft is not possible with current state of the art. The achievable flight times are too short and the necessary batteries too heavy. For certain applications, however, electric propulsion can already be used, for example, on short distances in the world's traffic-clogged major cities and in places that are difficult to access. In the case of small electric-powered aircraft and helicopters, there are various forms of vertical take-off, similar to drones. In technical jargon, they are called eVTOLs (electric Vertical Take-Off and Landing). From a sustainability point of view, eVTOLs have the advantage of not needing an extensive infrastructure on the ground for runways, roads and rails, bridges and tunnels. One of these projects, the start-up FlyNow Aviation from Salzburg, Austria, even emphasises the social aspect of the sustainability. CEO Jürgen Greil is convinced that the air taxi will become established if it serves the general public and not just business travellers and the wealthy: "The car did not become established because the perfect Mercedes was built, but because of Volkswagen's Beetle, which was affordable for everyone." Drones, after all, have already arrived in the mass market. Under the title "Drones in the Service of Society", AERO is dedicating a separate area to these flying machines in BOS use (Behörden und Organisationen mit Sicherheitsaufgaben, German for authorities and organisations with security tasks). This platform for exchange is of great importance for all stakeholders – especially for air traffic control and for the binding regulations of these new airborne traffic participants.

Efficiency improvements and fuel innovations

Improvements in efficient flying are achieved through weight reduction, new materials, better engines and aerodynamics. More direct flight routes, reducing holding patterns and the optimization of waiting times on the ground are to be taken in consideration.

Especially when it comes to fuel, there is still a lot of room for improvement. It is hard to believe that the transformation to unleaded fuel, implemented 40 years ago in cars, is only now taking place in aviation. And CO_2 is only part of the emission problems: nitrogen oxides, sulphur dioxide and water vapour in the contrails also have an extremely climate-damaging effect on the atmosphere. That is why there are new approaches for the production of sustainable aviation fuels (SAF), such as bio-kerosene, Power-to-Liquid (PtL) or Sun-to-Liquid (StL) fuels. A complicating factor in their development is that they have to meet high aviation safety standards with regard to freezing point, energy density and flash point. In addition, these fuel alternatives are far from being available in large quantities. Thus, all SAFs currently cover only 0.01 per cent of global jet fuel demand. The advantage: SAF can already be used in engines without any problems or blended in as drop-in fuel. The production of bio-kerosene from agricultural raw materials such as jatropha or other oleaginous plants is also not a major challenge, but must under no circumstances be in competition with food production. Therefore, the current focus is on the use of vegetable and industrial waste such as frying oils and fats, wood residues and sawdust or biomass with an appropriate energy content. The big disadvantage is the still significantly higher price. Lufthansa, for example, makes its passengers pay for the use of bio-kerosene as a compensation measure. Other waste can also be turned into fuel: through plastic pyrolysis, it is possible to turn non-pure plastic waste into fuel. This is neither "bio" nor CO_2 neutral, but at least the plastic waste would be eliminated.

A further approach is synthetic kerosene derived from air, waste CO_2 and electricity. Numerous researchers are working

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on this electricity-based Power-To-Liquid (PtL) technology. According to the operators, the world's first kerosene plant capable of producing the aircraft fuel synthetically on an industrial scale was already inaugurated last year in Emsland, Germany. The pilot plant produces kerosene synthetically from water and electricity supplied by wind turbines from the surrounding area. In addition, waste CO_2 from a food leftovers biogas plant and CO_2 from ambient air are used.

CO_2 plus H2O and energy = StL Gold rush fever guaranteed

In Spain, work is being done on a Sun-to-Liquid kerosene project in cooperation with Eidgenössische Technische Hochschule (ETH) Zurich. All that is needed is sunlight, water and carbon dioxide (CO_2). If the required CO_2 is extracted from the air beforehand, the pollutants produced later during combustion are compensated for. The fuel is thus climate-neutral. More than 160 mirrors in the plant focus the sunlight onto a reactor that reaches a temperature of 1500 degrees C. and produces a synthetic gas with the help of a catalyst. The company Synhelion, a spin-off of the ETH, plans to build the first plant for the industrial production of solar fuel in Jülich, Germany this year, which shall then be used in regular flight operations from 2023.

From 2026, at least 0.5 per cent of aviation fuel in Germany must consist of PtL kerosene. This corresponds to around 50,000 tonnes per year, thus far more than what the current plants can produce. In 2030, the blending quota will rise to two per cent. According to the German Federal Environment Ministry, this regulation creates a sales guarantee for new fuels and thus investment security for companies.

Taking off with hydrogen

Another option for truly CO_2-free flying is hydrogen. In 2020, Airbus presented 3 aircraft models that are to be ready for the market by 2035. Instead of jet fuel, hydrogen is burned in the turbines, releasing not CO_2 but only water vapour. Hydrogen in liquid form has the advantage of being lighter, but the disadvantage of being larger in volume than jet fuel, and it must be stored under pressure and at -253 °C. Special tanks are needed for this, which require completely new aircraft designs. This solution only makes sense if green hydrogen is used, but the present production capacities are still far too small. In addition, green hydrogen is very expensive because its production requires a lot of energy. The exact effects of water vapour in the atmosphere also need to be taken into account and studied in detail, as water vapour also contributes to the greenhouse effect.

Hydrogen is set – leaves the question whether burned in the turbine or in the fuel cell?

Instead of burning hydrogen in aircraft turbines, fuel cells can be used to convert it into electrical energy. The advantage of the fuel cell is its higher efficiency, the disadvantage is its weight. The HY4, a development of the manufacturer H2FLY in cooperation with the German Aerospace Centre and the University of Ulm, has already completed test flights with this technological approach. In partnership with DLR, German Aerospace Center, it is intended to scale the proven concept of the 4-seater aircraft to a regional aircraft for 40 passengers with a range of up to 2,000 km. Nevertheless, flying with hydrogen with large jets is a thing of the future as not only the aircraft but also the ground infrastructure have to be developed.

Conclusion: Despite inspiring concepts, the environmentally conscious passenger will have to live with "flight shame" for a long time and voluntarily compensate his flight for CO_2. With political pressure to make CO_2 compensation mandatory for all air travellers, the goal of climate-friendly flying would be achieved more quickly and passengers would become accustomed to airfares which include environmental costs. One thing is already clear: climate-neutral flying will become significantly more expensive – but flying without climate protection will cost us even more. Innovation and behavioural change are therefore more in demand than ever.

Note – Call for papers: You may submit your ideas, projects and products for the special "Sustainable Aviation" to the editorial team or realise a booklet in a coming magazine together with us. «

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