PARE Article

Protecting the Environment and the Energy Supply

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Prepared by

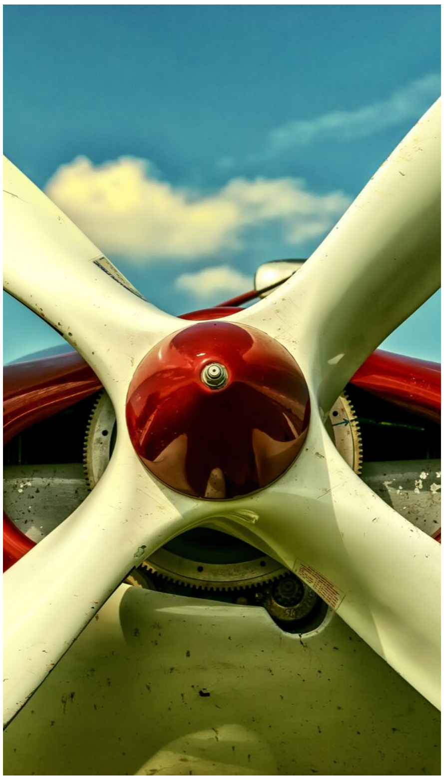
PARE

PERSPECTIVES FOR AERONAUTICAL RESEARCH IN EUROPE

02

Protecting the Environment and the Energy Supply

INTRODUCTION



In 2050, the effect of aviation on the atmosphere must be fully understood by the general public and must convince it that the aviation sector has made the utmost progress in mitigating environmental impacts and therefore air travel is environmentally sustainable. For this, a combination of measures, including technology development, operational procedures and market - based incentives should be taken into account to mitigate environmental impacts at a rate outweighing the effects of increasing traffic levels.

To ensure that this overall goal is met, ACARE established the specific Flightpath 2050 goals 9 to 13, concerning the reduction of noise and emissions, emissions – free taxying, recycling enabled by design, alternative fuels and atmospheric research, respectively. The 4th chapter of PARE's 1st yearly report, entitled "Protecting the Environment and the Energy Supply" addresses this set of 5 goals.

REDUCTIONS OF NOISE AND EMISSIONS

The growth of air transport at a rate of 3 to 7% per year leads to flights increased to the double by 2030, and triple by 2050. In order to avoid increased noise exposure near airports and emissions in cruise, the corresponding reductions must be made per flight. To be concrete, in 2050, technologies and procedures available must allow a 75% reduction in Carbon Dioxide (CO_2) emissions per passenger kilometre (km), a 90% reduction in Nitrogen Oxides (NO_x) emissions and a 65% reduction in the perceived noise of flying aircraft. These reductions are relative to the capabilities of typical new aircraft in 2000.

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KEY FINDINGS

- Overall noise reduction at airports requires consideration of two classes of noise sources: engine noise sources and aerodynamic noise sources. Noise is dominated by the engine at high thrust at take - off and by aerodynamics at approach with the engine at idle;
- The major contributor to the reduction of engine noise has been the increase in the by - pass ratio of turbofan engines, which also decreases fuel consumption, leading both to lower emissions and more favorable economics;
- The overall noise exposure of near airport residents can be reduced by land planning and by operational measures, such as noise abatement procedures (NAP), which can be broken down into three broad categories: noise abatement flight procedures, spatial management and ground management;
- Aviation emissions of CO2 and NOx are produced by aircraft, support vehicles and ground transportation dominantly. The emissions from these sources fall into two categories: emissions that cause deterioration in local air quality (LAQ) and emissions that cause climate change;
- In 2012, aviation represented 13% of all European Union (EU) transport CO2 emissions and 3% of the total EU CO2 emissions. European aviation specifically represented 22% of global aviation's CO2 emissions. Similarly, aviation now comprises 14% of all EU transport NOx emissions, and 7% of the total EU NOx emissions;
- As a result of technological improvements, the noise footprint (85 decibels dB (A) maximum sound pressure level contour) of new aircraft is at least 15% (up to 50%) smaller than that of the aircraft they replace. Further design improvements offer the potential to reduce perceived noise from aircraft by 65% by 2050;
- ACARE runs the research projects Aviation Noise Research Network and Coordination (X - Noise EV) and Forum on Aviation and Emissions (Forum AE), related to aviation noise research and emissions research, respectively.

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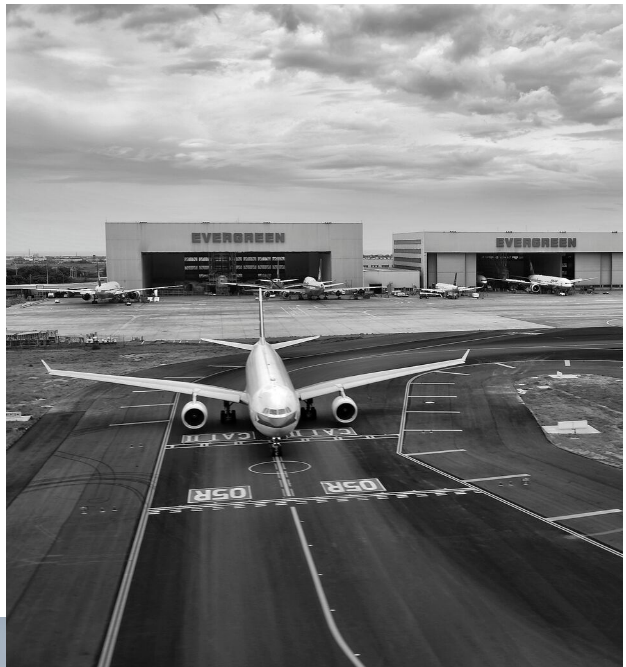
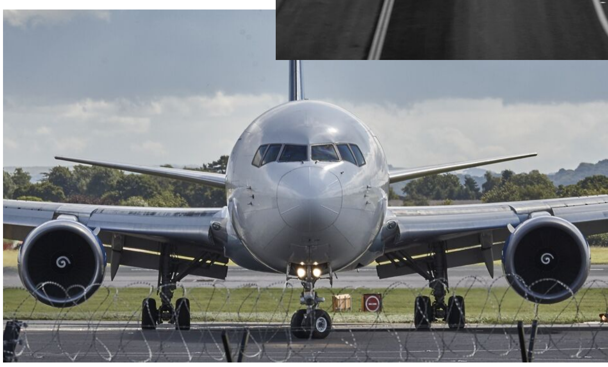
KEY ACTIONS

It is recommended that:
1. A broad research effort is supported to reduce aircraft noise at the source through operating procedures and taking into account psychoacoustic effects;
2. A modest effort is made towards a long-term definitive solution: aircraft inaudible outside airport boundaries and hydrogen propulsion that emits only water vapour, besides struggling with short-term solutions to an increasingly pressing noise problem;
3. A set of trade-offs is formulated between different types of emissions (CO2, NOx, particles and water vapor) in local airports and global cruise flights.

EMISSIONS - FREE TAXYING AT AIRPORTS

The taxying of aircraft on engine power and the use of auxiliary power units (APU) on the ground can be significant contributors to emissions at airports and also generate noise. By 2050, aircraft movements must be emissions – free when taxying, which can be achieved with electric towing vehicles and power supplies, especially batteries. Therefore, the feasibility and economic of emissions - free taxying critically depends on the available battery technology.





KEY FINDINGS

- The current preferred battery technologies for ground movements at the airport or on the airfield and in the aircraft itself are the lead – acid and the nickel – cadmium (Ni - Cd) batteries. However, since these batteries are technically exhausted, no significant improvement in terms of energy density, cycle life, calendar life, etc. is expected;
- There is a shift to lithium – ion (li - ion) technology in the aviation industry, being that li - ion chemistry offers a large variety of materials and cell architectures, which enables the possibility to design high - power as well as high - energy systems;
- In general, regarding li – ion batteries, an increase in the energy density, with state-of-the-art chemistry, could be mainly achieved by optimizing the form factor and the cell production process. Nevertheless, even if the current chemistry has proven itself, efforts are still to be made to increase the energy density as well as other key performance parameters to meet future requirements;
- There are several deficiencies of actual day li – ion batteries that, if remedied with suitable ease and cost parameters, would enable superior li – ion batteries that could open new applications and expand the market for present ones;
- Although electric towing and power supplies are feasible, the investment in vehicles and support infrastructure must be assessed as well as how costs are covered.

KEY ACTIONS

It is recommended that a methodology to comprehensively assess the implications of electric taxying and electrical energy supply is developed in terms of requirements, costs, land and environmental impact for a variety of airport configurations.

DESIGN AND MANUFACTURE BEARING IN MIND RECYCLING

Competition in the aircraft industry market and global warming has driven the industry to think along economic and environmental lines. For instance, in 2050, air vehicles must be designed and manufactured to be recyclable, preventing depletion of limited resources and making better and repeated use of materials already available. This goal has resulted in the emergence of a more electric aircraft (MEA) concept, providing the utilization of electric power for all non – propulsive systems.

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KEY FINDINGS

- Recycling of aircraft parts depends mostly on the materials used and also on the fabrication process. The choice of materials for an aircraft is subject to a considerable set of constraints related to performance, weight, availability, cost, ease of manufacture and maintenance, durability and resistance to hostile environments. Adding the recycling ability is an additional constraint which can bring benefits in several of other areas;
- Recent technological advances in the field of power electronics, fault-tolerant architecture, electro-hydrostatic actuators, flight control systems, high density electric motors, power generation and conversion systems have ushered the era of the MEA;
- A small size, high energy density (more than 100 watt-hour per kilogram (Wh/kg)) battery is the need of the aircraft industry as a 10 kg decrease in the weight of aircraft will result in the savings of 17,000 tons of fuel and 54,000 tons of carbon dioxide emission per year for all air traffic worldwide. The reduction in battery weight is also profitable in terms of cost;
- The life duration of an aircraft battery depends on various factors such as number of operating hours, ambient temperature, start frequency and on-board charge. It is therefore difficult to determine in advance how long the expected life of a battery will be in the real situation;
- Though most of the civil aircraft have used Ni - Cd batteries, the trend is shifting towards li - ion batteries with its tremendous opportunities to be employed in MEA. However, li - ion cells comprise a sensitive electrochemistry which needs a detailed knowledge of its characteristics to allow its benefits to be exploited fully while ensuring maximum safety;
- In general, the same processes used to recycle automotive batteries are used to recycle aircraft batteries. Examples of battery recycling plants operating in Europe are: Batrec in Switzerland, Umicore in Belgium, and SNAM and Recupyl in France.

KEY ACTIONS

It is recommended that a comprehensive assessment of materials used in aircraft production is made and that recyclable alternatives and related issues of availability, ease of use, certification, maintenance and cost are assessed.

SUSTAINABLE ALTERNATIVE FUELS SOURCES

Nowadays, there is a strong need to reduce the dependence on fossil fuels which affects all modes of transport. Even though aviation is not the largest user, it should try to improve its position and contribution to the whole by finding sustainable alternative less polluting fuels and possibly also safer handling with undiminished energy density per unit weight and volume.

European aviation specifically must guarantee that, in 2050, Europe is established as a centre of excellence for sustainable alternative fuels, including those for aviation, based on a strong European energy policy.

KEY FINDINGS

- The European Commission (EC), Airbus, and high-level representatives of the Aviation and Biofuel producer's industries launched in 2011 the European Advanced Biofuels Flightpath. This action is scheduled to achieve 2 million tons of sustainable biofuels used in the EU civil aviation sector by the year 2020;
- By now, several alternative biofuels are under scrutiny or are already approved: synthetic Fischer – Tropsch (FT); hydrogenated esters and fatty acids (HEFA); pyrolysis oils (HPO); and alcohol to jet (ATJ). Although there are already potential alternatives, it is not easy to match the energy density, usability and cost of kerosene/paraffin in large quantities;

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- The use of alternative biofuels has been explored by the Initiative Towards sustAinable Kerosene for Aviation (ITAKA) project. ACARE also runs the research project entitled Coordinating research and innovation of Jet and other sustainable aviation Fuel (Core – JetFuel);
- Although airlines have been willing to test new fuels, a coordinated effort must be done far upstream to: consider a variety of sources of fuel, that do not interfere with food production and whose environmental impact is neutral or positive (waste disposal); establish the technical feasibility to meet all applicable quality and safety standards and certification requirements; and assess the economic and environmental feasibility of large-scale sustained production, distribution and use.

KEY ACTIONS

It is recommended that a comparative study of potential alternative fuels, their availability in the required large quantities and the feasibility and cost of large - scale production, distribution and use is performed.

ATMOSPHERIC RESEARCH, WEATHER AND THE ENVIRONMENT

Aviation is one of the most climate/weather sensitive industries: it is affected by changes to visibility, storminess, temperature, icing events, etc. Therefore, one of the most important activities is to assess the atmosphere and the environment state in order to predict the future climate issues and develop mitigation strategies, which would help to reduce possible disturbances in the airspace and allow an increase in airports capacity. Taking this into account, in 2050, Europe should be at the forefront of atmospheric research and take the lead in the formulation of a prioritized environmental action plan and establishment of global environmental standards.

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KEY FINDINGS

- The monitoring of the atmosphere is performed by a vast array of earth and satellite sensors, plus specialized weather aircraft used to fly through tropical storms and collect in-situ (non-space) atmospheric data. It is possible to obtain much more comprehensive weather data both in time and locations aboard aircraft in regular flights;
- There are several methods to monitor the atmosphere, such as: routine ground – based measurements (made by ground – based sensors – land based and buoys); systematic aircraft measurements (made by aircraft and balloons); and satellite measurements (made by space – borne sensors);
- Changes to temperature, precipitation, and storm patterns are all expected in the near-term, certainly by 2030. The impacts of sea level rise are more gradual and not expected until later in the century. However, more frequent and intense storm surges will have an earlier impact on European aviation, reducing capacity and increasing delay;
- Currently, there are several European initiatives and projects that have as main objective monitoring the atmosphere through satellite and airborne instrumentation, which are:
  - Copernicus project, previously known as the Global Monitoring for Environment and Security (GMES);
  - Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) project;
  - Advanced Satellite Aviation Weather Products (ASAP) initiative;
  - European Organisation for the Exploitation of Meteorological Satellites (EUMESAT);
  - In – service Aircraft for a Global Observing System (IAGOS) project.

KEY ACTIONS

It is recommended that regular airliner flights are used to collect in-situ atmospheric data, which should further be processed to have near real - time knowledge of conditions along flight routes. This data could be supplemented by drones – unmanned aircraft systems (UAS) - specifically designed to fly in more remote regions of the atmosphere.

For more information about these topics, you can access the full chapter here.