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Balance Approach achievements to aircraft noise exposure management in airports

A new Strategic Research and Innovation Agenda for a European Partnership on Clean Aviation was proposed under the umbrella of European Green Deal (COM/2019/640). The task facing the aviation sector in this and the next decades is to develop and introduce safe, reliable, and affordable low- to zero-emission air transport for citizens and to concurrently ensure Europe's industrial leadership is maintained and strengthened throughout the transition to a climate-neutral Europe.

Main results from EU PARE project

Civil Aviation is at a crossroads as never since the Second World War or even over its entire century-old history due to the combination of three factors:

(a) the goal of green aviation requires new technologies (a life-cycle approach) as concerns propulsion (electric and hybrid thermoelectric) and new fuels (hydrogen or sustainable fuels) to replace internal combustion engines using fossil fuels;

(b) the wide range of options and the considerable resources needed to mature these new technologies are no longer available in the context of the COVID-19 pandemic, that leads to the most significant economic crisis on the aviation history, with high pressure on costs for new orders, and whose recovery is difficult to predict;

(c) the recent tragic events in Ukraine have civil as well as military consequences, not only direct restrictions on airline routes but also a domino effect on diplomatic, commercial and human relations worldwide.

The main purpose of the project PARE (Perspectives for Aerospace Research in Europe) was to consider progress up to 2050 in comparison with the ACARE (Advisory Council for Aeronautical Research in Europe) goals, and identify gaps and correcting measures. This 3-year Coordination and Support Action (CSA) started on October 1, 2017 and finished on December 30, 2020. Its conclusion was extended by 3 months (to December 31, 2020) in part motivated by making the preliminary assessments of the COVID-19 as the biggest crisis in the history of world civil aviation.

Towards 2050, the forecast growth in the aviation industry will drive the need to deliver revolutionary technology solutions at an increasing rate and secure the path to sustainable energy supplies that can displace today's fossil fuels to mitigate fully the potential impact on the atmosphere. The challenge with respect to the environment is to reduce continuously the environmental impact in the face of continuing expansion in demand for aviation. This expansion will also put pressure on existing energy supplies. Transforming from the current, entirely fossil-based kerosene fuel-powered system to such a future aviation system with multiple energy carriers and architectures constitutes a massive and systemic challenge. This new challenge is connected closely with: The "New Green Deal" objective of carbon-neutral aviation by 2050[1];

The "Fit for 55" objective of 55% reduction in CO_2 emissions by 2030[2];

The ACARE Goals in Flightpath 2050[3] and Fly the Green Deal 2030-50[4];

The PARE project objectives and recommendations [5];

The European Partnership for Clean Aviation (EPCA) initiative focuses on activities at TRL4 and beyond [6];

The importance of a complete Life Cycle Assessment (LCA) including design, testing, certification, production, operations, and maintenance as stated in the present call for proposals;

ICAO's long term aspirational goal for global aviation sector development;

Other variant of market-based measures realized by the approach of CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation). It is based on comparing the total CO_2 emissions for a year (from 2021 onwards) against a baseline level of CO_2 emissions, which is defined as the average of CO_2 emissions from international aviation covered by the CORSIA for the years 2019 and 2020 [7].

PARE project outcomes are fundamental for this challenge (Fig. 1):

- besides struggling with short term solutions to an increasingly pressing noise problem a modest effort should be made towards a long-term definitive solution: aircraft inaudible outside airport boundaries (perceived noise emission of flying aircraft is reduced by 65%);
- support a broad research effort to reduce aircraft noise at the source, through operating procedures and taking into account psychoacoustic effects (non-acoustic factors);
- make every effort to achieve long-term goals to reduce greenhouse gas emissions, namely: hydrogen-powered aircraft (75% reduction in CO_2 emissions per passenger-kilometre);
- collect a set of trade-offs between different types of emissions (CO_2, NO_x, particulate matter and water vapor) at local airports and on global cruise flights (90% reduction in NO_x emissions);
- perform 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;
- development of methodology towards stable identification of electricity, taxing and electrical supply.

Integration problems for air traffic transportation in following decades

New expansions of the global air traffic are the following (Fig. 2):

- Usual subsonic traffic (middle- & long-range, FF/SAF/LH2) – at airports;
- Supersonic traffic (BA + PAX) – at airports;
- EVTOLs (including UAS) – at airports and vertiports of the UAM;
- Urban Air Mobility - at vertiports of the urban environment.

NASA estimates that by the end of the decade there will be about 23,000 air taxis carrying about 740 million passengers worldwide. With UAM, we can reduce fossil fuel emissions and open doors to use airspace to provide emergency assistance to people in crisis. UAM was seen as a good option to reduce the impact on the local environment by reducing urban traffic congestion and improving local air quality, as long as it does not affect wildlife. This trend's two-way foray into the aviation sector:

- The community is getting closer to the airport (provider of air transport services) - the usual trend of creating better conditions for both people's lives and business;
- Air transport services (urban mobility) are getting closer to the community - a new trend in meeting the needs for comfortable and fast transportation.

Safety is their primary concern influencing people's willingness to use eVTOL aircraft in UAM. The second highest public perception factor is the type of noise generated by such vehicles, followed by the time of day and altitude at which eVTOLs are flown inside urban environment.

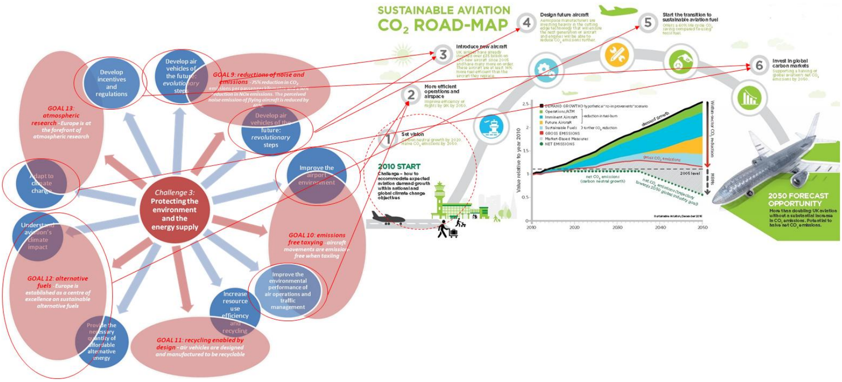

Fig. 1. The goals and action areas for *ACARE Challenge 3* in relation to fuel/energy consumption & GHG reduction along Sustainable Aviation Roadmap 2050

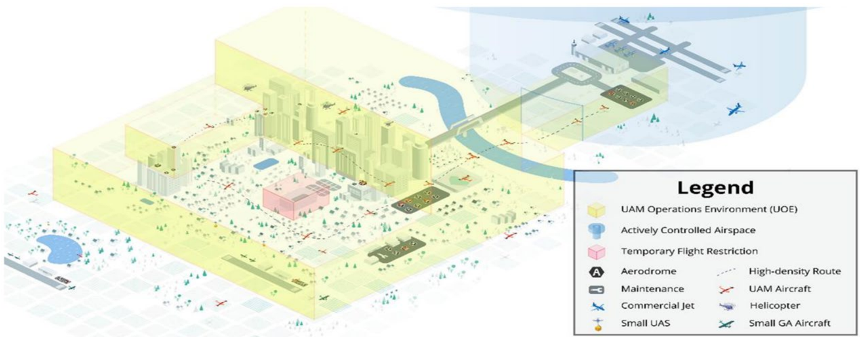

Fig. 2. The air traffic integration between usual air traffic system (airports and airlines) and the Urban Air Mobility

Aircraft Noise in Urban Environment

UAM aircraft are designed to produce noise levels that are acceptable to the communities in which they operate, at levels of only slightly above that of ambient urban noise. Aircraft noise is addressed primarily through advanced aircraft designs and the incorporation of noise-reduction technologies such as distributed electric propulsion and low-noise rotors. Community noise is measured/calculated and considered in the context of a fleet in addition to a single aircraft – similar with road traffic flow noise and not the separate flight events only. .

Spatial aircraft noise exposure assessment must consider numerous sound reflections from the surfaces with different impedance performances - the number of sound rays contributing to noise exposure at the point of noise control may be big. To consider the direct sound path only is not enough for noise exposure assessment. Principles of aircraft noise optimization (for minimum noise exposure at the point of noise control) with sound source flight trajectory inside the spatially urbanized environment are different from the optimization for noise exposure over the planar residential area located below the aircraft flight trajectory around the airports.

Results and conclusions

Aircraft noise exposure is accompanied by visual disturbance produced by flying vehicles - the new non-acoustical impact factor for air transportation, important itself, but evidently emphasizing the noise impact from air traffic in urban conditions.

A balanced approach for aircraft noise exposure management as it is developed for airports is evidently limited for Urban Air Mobility noise control – as for noise exposure so as for noise impact management. New ideas are necessary for managing the noise annoyance from UAM!

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