ACARE

Advisory Council for Aviation Research and Innovation in Europe

Time for change

The need to rethink Europe's FlightPath 2050

ZEROe: zero-emission concept aircraft

Content

Foreword

ACARE Chairman Jean-Brice Dumont

EVP Engineering, Airbus Commercial Aircraft

'The vital contribution of the European aviation industry to Europe's economic growth and cohesion is well recognized.

Today, the new threefold challenge for aviation is to survive the immediate COVID-19 crisis for airlines and the entire ecosystem, to lead a recovery plan for a more resilient sector, and to accelerate the engagement to secure a sustainable and competitive aviation future.

Europe has the ambition and the know-how to innovate and lead the way towards carbon neutral aviation. Significant research investments and a joint effort from the entire value chain - researchers, industry and public authorities - are required to develop the necessary technology breakthroughs. We must act together, now, to offer future generations the promise of freedom of exchange across continents in a total respect of our planet.'

High-flying aviation achievements

Europe's aviation sector has delivered substantial progress towards the objectives of Flightpath 2050 and realised significant physical/technical, economic, societal and environmental advances over the last 20 years. Changes have enabled impressive performance improvements in nearly all spheres of aircraft operation.

Numerous research and innovation efforts have contributed to the technical, technological and manufacturing, process and operations improvements below.

See examples of projects, grouped according to the Flightpath 2050 objectives, at the end of this document.

Read more about each project (link).

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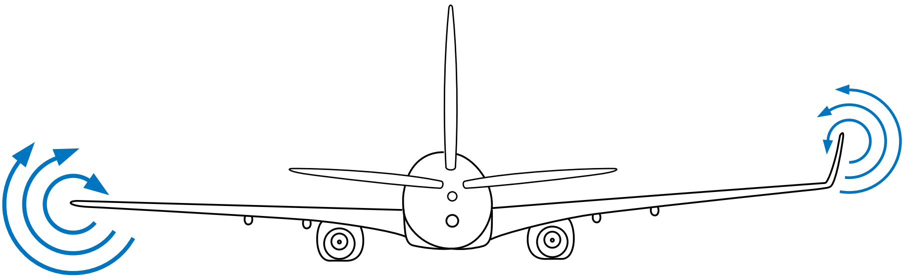
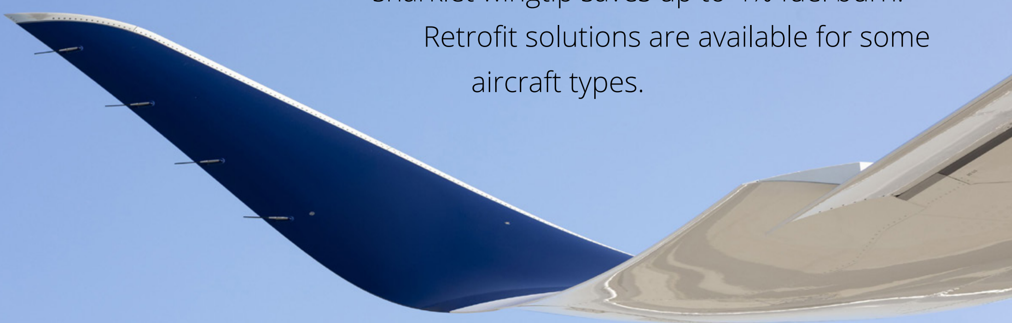
Wings and wingtips
- saving fuel, reducing noise

Wing design for large passenger aircraft such as the Airbus A380 and A350 has introduced new wing flexibilities and control behaviours for efficient flight. However, wingtips are the most visible advanced solution for all of the most efficient modern aircraft. All new aircraft designs entering the market in the last decades are equipped with large, graceful-looking, upturned wing extensions that save fuel by reducing drag. The winglets also contribute to reducing noise emissions by improving take-off performance.





Winglets typically reduce fuel burn and CO_2 emissions by up to 4-5 per cent. For example an A320neo sharklet wingtip saves up to 4% fuel burn. Retrofit solutions are available for some aircraft types.

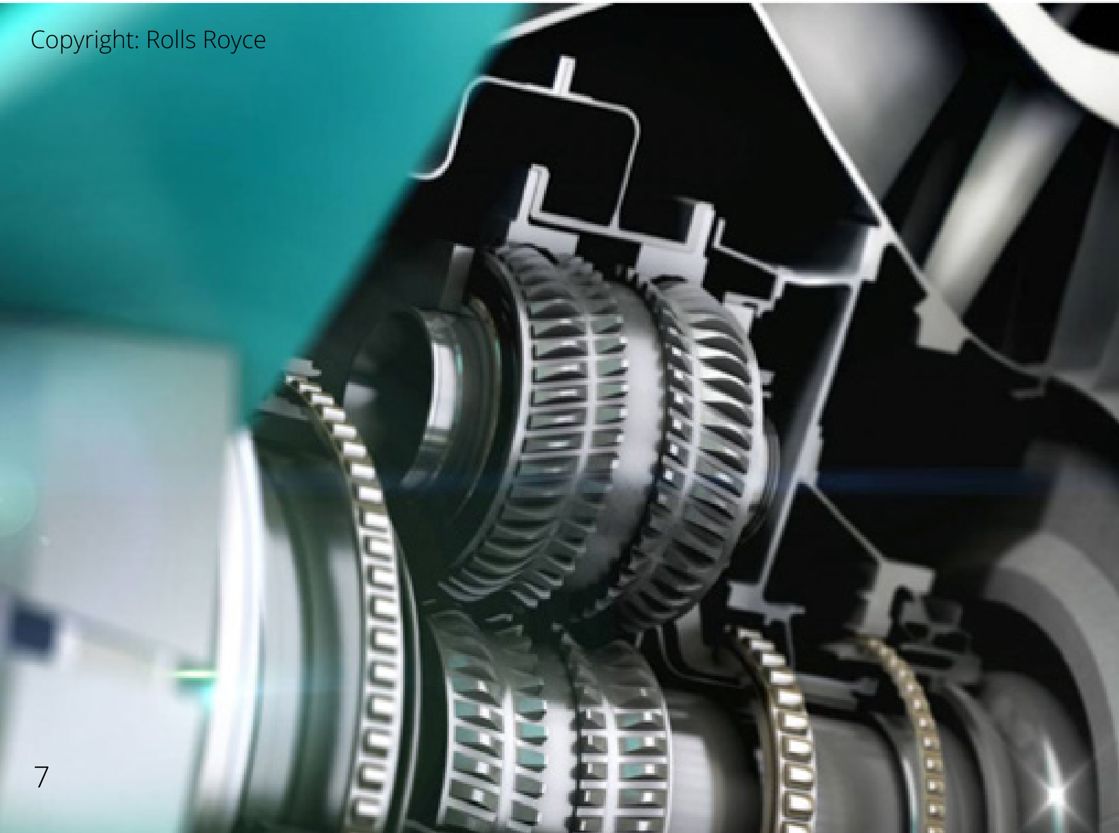
Efficient and quiet engines

Today's aircraft are powered or propelled by a new generation of engines with increased diameter and internal gearboxes that reduce fuel consumption and noise.

Advanced turbofan engines deliver up to 15% fuel reduction compared with the previous generation of engines. The increased diameter engines are cleaner, quieter and give better economical flight performance.

Geared turbofan engines allow the fan and turbine to rotate separately in their own optimum speed ranges. The fans are one of the main sources of noise for engines, so the larger fans with lower rotational speeds have reduced engine noise.

The European aviation industry has continued to implement innovative technologies to further reduce jetliner noise emissions and meet the goals of Europe's FlightPath 2050 guidelines – leading to a 65 per cent reduction in noise emissions by airborne aircraft relative to year 2000 levels. The most stringent requirements on aircraft noise are in the vicinity of airports.



Copyright: P. Masclet, Master films, Airbus

Individual aircraft have become less noisy due to technological improvements. For example, the A350 is quietest in its class with 40% noise footprint reduction versus previous generation aircraft.

The total noise energy in Europe follows flight counts closely – it was found to be 5% lower in 2017 than in 2005 indicating that noise technology has managed to compensate for the increase in average aircraft size. The average noise energy per flight indeed went down by 14% over this period thanks to a percentage of the latest aircraft types now entering the fleet and delivering reduced noise levels.

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Composite fuselage and tailplane - lighter, stronger, more durable

For more than 30 years, Europe's aviation industry has been at the forefront of materials science and pioneered the use of carbon fibre reinforced materials in commercial jetliners. With their winning combination of high strength, low weight and durability, it's easy to see why. Latest-generation aircraft extensively use carbon fibre reinforced materials that are lighter than aluminium, stronger than iron and more corrosion-resistant than both of them. The reduced weight and improved aerodynamic shapes contribute to lower fuel consumption.

The European aviation supply chain has also been updated so that now an aircraft can be provided with a full composite fuselage and tail. The composite airframe can be tougher, stronger and lighter while also requiring less maintenance in airline operation.

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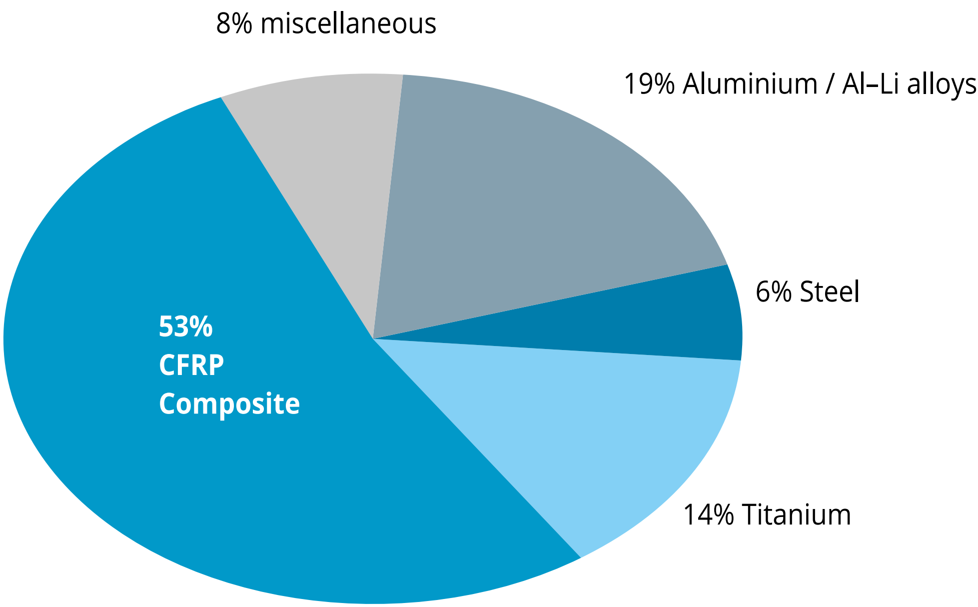
For example, over half (53%) of the A350 XWB's weight-efficient airframe is now made from innovative all-new carbon fibre reinforced plastic (CFRP). This combines with other advanced materials such as titanium and advanced aluminium alloys.

Percentage of composite in A350 XWB weight-efficient airframe



The wing of the A350 XWB is also composed of the lightweight carbon composites, including its upper and lower covers.
Measuring 32 metres long by six metres wide, these wings are amongst the largest single aviation parts made from carbon fibre and the next generation of aircraft will have far more 3D-printed parts, further reducing weight and costs.

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Increased passenger comfort

Cabins today offer passengers more comfortable and safer flying

The need to increase space and weight efficiency and to individualize passenger experience has defined new cabin requirements and led to today's flexible and optimised cabin which is hugely improved compared to thirty years ago.

An aircraft cabin in 2020

Copyright: Airbus

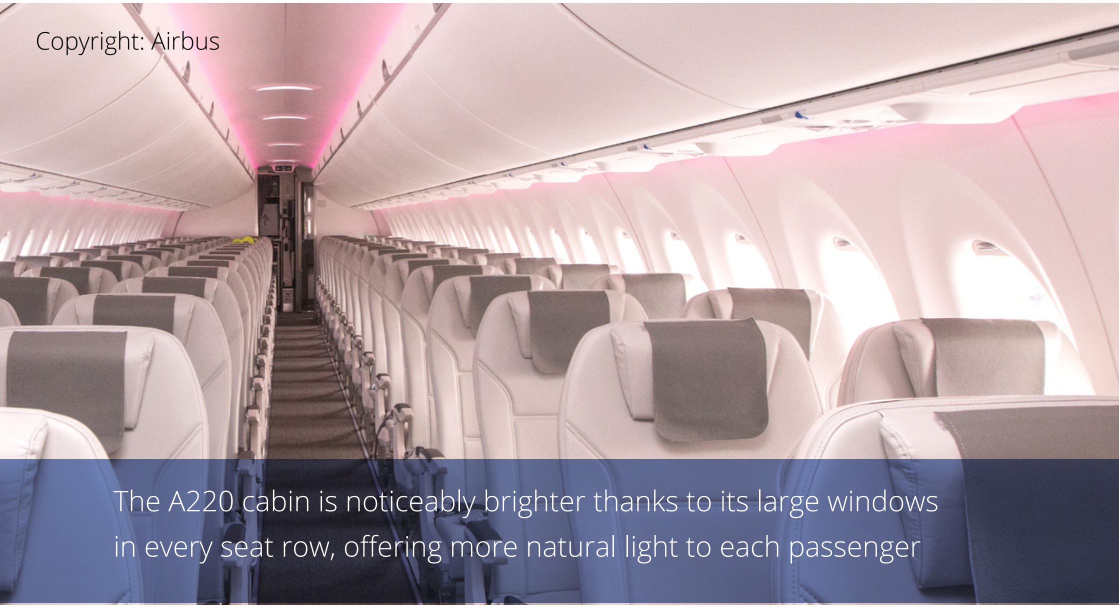
Individual lighting, ventilation and entertainment increase comfort. Novel cabins improve the protection of passengers in the event of accidents and safety risks are counteracted. Flexible cabins allow airlines to respond to regional, demographic or seasonally changing needs.

In the modern connected world, passengers and airlines also benefit from seamless access to high-speed broadband internet and mobile telephony just as they do at home. Passengers now enjoy the latest in-flight-entertainment with greater viewing comfort, thanks to larger high-definition screens and more content choices.

"Family concept" services enable multi-purpose use of seats booked by a family, with sitting and sleeping possible throughout the flight.

Aircraft cabins are equipped with state-of-the-art entertainment and broadband connectivity

Cabins have become cleaner, brighter and quieter, and are preparing for future cabin technologies such as the 'artificial cabin exterior view'.



The A220 cabin is noticeably brighter thanks to its large windows in every seat row, offering more natural light to each passenger

Creative designer's impression of the futuristic almost perfect 'artificial cabin exterior view'

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Laminar flow technology
- reducing emissions

The BLADE project – which stands for "Breakthrough Laminar Aircraft Demonstrator in Europe" – was tasked with assessing the feasibility of the technology for commercial aviation, to improve aviation's ecological footprint, with a 50% reduction of wing friction and up to five percent lower CO_2 emission.

The A340 Flight Lab demonstrator includes the most aerodynamic design, the most innovative industrial solutions and leading edge measurement technologies.

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Laminar flow technology can reduce energy consumption and emission of the next aircraft generations.

The EU Flight Lab 'BLADE' has been the most ambitious flying research demonstrator in a European framework so far, with 20 key partners and around 500 contributors from all over Europe, involving the whole eco-system from universities to research centres and the supply chain.

Due to its size and complexity, this project was only possible thanks to the European Research initiative Clean Sky!

Safety record

Aviation is the safest mode of all transport modes with great progress made in terms of safety in the past decades. Evidence indicates an ongoing decline in the number of major accidents despite a significant growth in the number of flights and passengers.

The commercial aviation industry has had a long and ongoing commitment to place safety at the heart of its mission, enabling this reduction of the accident rate. A significant part of this success is due to effective regulation, a strong safety culture, improvements in training and advances in aircraft systems technology.

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Sustainability - a life-cycle approach

Sustainability covers the concepts of ECO design and a circular economy. Emerging new technologies are regularly reviewed to see if their environmental impact can be reduced in terms of waste, energy or volatile organic compounds. Since 2007, it also covers the development of capabilities and processes for end-of-life aircraft dismantling and recycling of parts.

Perfect Flights is a high profile initiative including aircraft manufacturers, airlines, government agencies, air traffic management (ATM) organisations and engine manufacturers to determine the most eco-efficient air travel possible today. The world's first Perfect Flight in October 2011 (Airbus & Air France) achieved a 50% saving in CO_2 emissions compared to a regular flight. The first North American Perfect Flight in June 2012 (Airbus & Air Canada) resulted in a saving of over 40% in the flight's CO_2 emissions.

The Sustainable Aviation Engagement Programme is a framework for collaboration with airline customers to promote and seek opportunities regarding the environmental performance of Airbus products and services. It looks at how the environmental performance of latest-generation aircraft can be optimised to reduce fuel burn and noise. It takes the best practices from 'Perfect Flights', and includes the use of sustainable fuels, optimised ATM and ground operations.

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ATM Air Traffic Management - greater efficiency

The introduction of Free Route Airspace has saved more than 2.6 million tonnes of CO_2 since 2014 (approximately 0.5% of total aviation CO_2 emissions). [Ref European Aviation Environmental Report 2019].

The Single European Sky ATM Research Programme (SESAR) aims to modernise and harmonise Air Traffic Management systems according to innovative technological and operational solutions.

Technology upgrades are now being deployed to improve efficiency, reducing emissions and mitigating noise.

In addition, the Single European Sky (SES) Performance Scheme has defined indicators and targets (both local and at EU level) in the fields of environment, safety, efficiency and capacity. For example, the En Route Horizontal Flight Efficiency indicators monitor the success of ATM systems to reduce the percentage of additional distance flown compared to the great circle (shortest) distance. The reasons why the actual trajectory flown can vary from the unimpeded trajectory include adverse weather, avoidance of 'Danger Areas', need to maintain minimum separation, diversions due to lack of capacity, and avoidance of relatively high route charges.

Five factors of change

Five factors of change

New factors and forecasts are influencing the world and the aviation industry. It is time for the sector and policy makers to adapt their position and strategies.

1) Policy adaptation

Aviation prosperity depends upon a strong and stable policy environment. Recent changes oblige the aviation sector to adapt its policies:

Deregulation and protectionism

Stable policies towards deregulated markets and reduced state intervention have enabled global connectivity and allowed aviation and the economy to expand. However, an increasing tendency towards trade conflicts often linked to increased protectionism will severely limit both economic growth and aviation which serves this expanding global market. Strong policies are necessary to protect the expansion of global trade.

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Environmental policy: the European Green Deal towards climate neutrality

EU member states have adopted a new growth strategy for a sustainable, resource-efficient and competitive economy. The EU aims to impose a legal obligation to be climate neutral in 2050. New requirements and expectations require immediate long-term investments in radical technology solutions for future aviation.

Technical policy: Research & Innovation strategy / international cooperation towards non-EU countries

Building on designs using continuous incremental R&I strategies have been sufficient and could be developed within Europe. However, disruptive design for future aviation - such as Cyber Physics Systems (CPS), Sustainable Alternative Fuels (SAFs) and hydrogen - will require international alignment on policies, from strategy to fuel taxation. Academic qualifications and coordination of talent from all over the world also require policies.

2) Economic evolutions

Prior to the 2008-2009 economic crisis, international government policy drove deregulation of markets and reduced state intervention. The aviation sector enabled the growth of global mobility by increasing efficiencies across the sector. The cost of air travel has been markedly reduced, and there has been a significant increase in connectivity, driving global growth and job creation.

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Economic factors driving the aviation industry are:

Air Traffic volume and network pattern efficiency

Air traffic volume has more than doubled since 2000. Air travel has become more affordable driving global tourism and responding to increased demand from the growing middle classes in emerging markets. New network patterns are emerging with city-pairs creating new routes enabled by more efficient Air Traffic Management.

Optimised air vehicle technical and operational efficiency

The air transport industry has vastly improved air vehicle efficiency lowering costs per passenger kilometre through investment in new technologies, improved design and manufacturing. Achievements in new technology have contributed to lower operating costs and together with new concepts in operations have made flying more affordable, leading to exponentially expanding markets.

Industrial design & manufacturing efficiency

Design for Excellence methodologies have optimised aircraft designs and improved manufacturability and reliability. The rate and capacity of aircraft manufacture has increased making aviation more affordable and accessible to new markets.

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3) Technical advances

New and advanced technologies, engineering integration & digital transformations

Amongst other innovations, the use of stronger and lighter materials, more aerodynamic designs, more efficient power plants, and systems has led to numerous improvements in air vehicles.

Technological advances have included wingtips, composites, and laminar flow. Digitalisation has enabled design tools such as Computer Aided Design and aircraft systems such as fly-by-wire.

The aviation sector requires an updated forecast of fundamentally new technologies, integration methodologies and digitalisation enablers that will need to be applied in the next decades, so that all stakeholders can be coordinated, to best meet the FlightPath targets for 2050.

Numerous new aviation technologies

The aviation sector relies on a large number of fundamentally new technologies that need to be explored, matured and ultimately combined to bring solutions for the next 30 years.

These include:

- New fuel designs such as hybrid-electric, Sustainable Aviation Fuels and hydrogen.

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- New materials such as advanced composites and alloys, graphene, Additive Layer Manufacturing, and smart fabrics.
- New advanced aircraft designs such as the blended wing body aircraft concept, Boundary Layer Ingestion and Distributed propulsion systems.
- New air vehicle designs include drones, Urban Air Mobility (UAM) vehicles and regional hybrid-electric aircraft.
- Advanced Aircraft Engine designs.

New aviation engineering integration challenges

With the clean and efficient use of energy being a key factor in the coming years, new and disruptive technologies must impact on how the energy is stored on the aircraft, as well as on energy provision at airports, engine designs, and many other aspects including the aircraft environmental and thermal management.
For example heated air from the engines may no longer be available (for heating the aircraft), fuel mass may no longer be available as a heat sink (for cooling the aircraft), and hydrogen stored in liquid form requires management of very cold cryogenic temperatures.
All these aspects require the aircraft technical design to be completely reworked.

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Digital transformation

Digital transformation enablers are raising huge challenges such as how to digitalise the aviation sector's current processes, they also offer huge opportunities to harness technologies in a digital ecosystem that delivers better solutions, faster.

Some examples of digitalisation enablers:

- Cloud computing and data connectivity including big data, connectivity of data across analysis platforms, data lakes, and the Internet of Things (IoT).
- Artificial Intelligence and Machine Learning are exciting aspects of digitalisation that are especially good for very quick, early design studies to drive design decisions.

Example of forecasts for aviation digital transformations:

- Design & Certification: New design methodologies are tending towards Model Based Systems Engineering concepts. For certification, the trend is for more analysis and simulation, and reduced but smarter physical testing, and storage of the test results so that they can be used over many years.
- Air Traffic Management: The digital trend is towards efficient sharing of Air Traffic Controllers across multiple airports, also including optimised flight paths, atmospheric conditions, and mobility solutions door-to-door.

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- Aircraft maintenance: Usage monitoring data lakes from airlines coupled with 'digital twin' simulation models for each aircraft allow customised maintenance schedules for individual aircraft.
- Industrialisation & manufacturing: The Factory of the Future, based on Design for Manufacturability and increased commonalities between design and manufacturing departments enables optimal combinations of machines, robotics, tooling and supply chain management to achieve the highest production efficiencies.
- Safety and security: Safety digital transformations include passenger and baggage checking and dynamic re-routing in the event of volcanic ash. Digital transformation of security includes airspace (drones), airport perimeters, and cyber security.

4) Societal expectations

Changed public awareness and an enhanced political will has been manifested by the United Nations through the ratification of the COP21 and by the European Commission in adopting the European Strategy for Low-Emission and the Accelerating Clean Energy Innovation Communication as part of the Energy Union initiative. The aviation industry must move faster, in response to societal pressure, to reduce the environmental footprint of air transport.

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Environmental commitment / Green Deal objectives

Societal expectations on CO_2 mitigation have strongly increased, especially in the field of aviation. Aviation has been pinpointed as a potential major contributor to CO_2 emissions and global warming, although it is currently estimated that the aviation industry represents only approximately 2% of global human-induced CO_2 emissions.

The ratified Green Deal objectives demand that the European aviation sector achieves drastically reduced emissions by 2030 and climate neutral aviation by 2050. These targets include emissions, air quality and noise around airports, and ECO-design and end-of-life recycling.

This societal change demands disruptive technological solutions; conventional technologies are not enough. New energy sources need researching, integrating, and deploying as new generation aircraft types enter airline fleets.

Mobility

Societal mobility requires not only a new category of solutions (such as drones, Urban Air Mobility and regional hybrid-electric aircraft) but greater cooperation with other modes of transportation and other stakeholders. ACARE needs to reach out to external stakeholders (such as public transport, service providers and atmospheric observational networks) to ensure cooperation in delivering complete door-to-door mobility solutions.

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Aviation people

Future skill requirements need to be defined for the workforce, upgrading EU university courses and qualifications, and deploying up-skilling / re-skilling at a speed to match the industry's growth. This highlights recourse to international policies to engage the best global academic talents, and an acute short-term need to preserve skills through the COVID-19 crisis.

Safety and security

Technical safety levels in the aviation sector must be continuously increased in cooperation with the European Union Aviation Safety Agency (EASA) by fundamentally transforming present operations through innovation. The scope is wide and covers autonomous and piloted aircraft, as well as navigation and traffic management. New health safety measures must also be applied with the COVID-19 crisis. Security of facilities includes screening passengers and baggage, perimeter security and surveillance, access control, and cyber security.

5) COVID-19 impact

The COVID-19 pandemic is an exceptional crisis, with severe impacts on the aviation sector. World air traffic has dropped by 70% and is not expected to recover before 2023. The sector urgently needs a well supported plan on how best to survive this crisis.

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Particular attention should be paid to:

Policy

For a fast and efficient recovery, aviation, and the wider economy need efficient international cooperation and coordinated state intervention. There is no place here for national protectionism.

Economic

With airlines fighting for survival, it is difficult for them to invest in efficient new aircraft without dedicated stimulation, especially in the open and competitive European markets. Aviation will require the accelerated deployment of existing decarbonisation solutions and adequate investments in new technologies.

Airlines are in danger of bankruptcy and need a coordinated rescue plan to ensure survival of the sector until 2023 without long-term damage.

Highly skilled jobs across the sector must be protected and investment encouraged in airline deployment of existing decarbonisation solutions and across the whole sector.

Europe must maintain its world competitiveness, building on strengths and defending its leading position. The aviation business is crucial to the economic recovery of nations, facilitating European industrial growth even beyond its borders.

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Technical

Urgent solutions are required for COVID-19 passenger screening, review and upgrading of HEPA air conditioning filters, and aircraft disinfection between flights. Major efforts have been made to develop and implement safer air travel and to secure government endorsement to open country borders but also to reassure travellers.

Technical expertise and skilled engineering jobs are also at risk due to COVID-19 effects.

Societal

New safety measures must be communicated and implemented in airports, and jobs and skills must be preserved until a recovery is secured.

Time to rethink

Time to rethink

The political, economic, technical, societal and pandemic factors, compel Europe to revise the Flightpath 2050 vision covering a wider perimeter including research, innovation and deployment.

Policy

Recent changes require the aviation sector to adapt its policies. Considering political deregulation and protectionism, and the need for climate neutrality by 2050, Research and Innovation strategy needs to be aligned beyond EU countries.
A coherent approach and alignment between European aviation research policy and the regulatory framework is essential.
This predicates a more holistic approach to international cooperation beyond R&I, in line with partnerships and synergies proposed for the regulation establishing the Horizon Europe research framework.

Economic

The health of the world economy is reliant upon the aviation sector for providing affordable connectivity and mobility. Air travel has doubled in size over the last 20 years.

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The COVID-19 crisis has completely disrupted the economic business models of the airlines. Europe needs consistent economic impact analysis and dedicated advice on how its aviation can recover from this crisis, become more resilient, re-establish societal mobility and European cohesion and support the recovery of related sectors.

Technical

Although a technology leader in some areas, the aircraft industry is a technology follower in others. Recent digitalisation enablers such as cloud computing and artificial intelligence are challenging the industry to follow at a pace never seen before and to integrate industry newcomers.

The industry also needs to accelerate technology for Sustainable Aviation Fuels and new fuel/energy designs such as hydrogen. A fundamental change of aviation fuel requires a long term strategic preparation for infrastructures to be adapted, for example, to the transition to hydrogen. Airports as hydrogen hubs could become a key part of the route to hydrogen deployment for aviation.

The aviation sector requires an updated technology forecast, including fundamentally new technologies, integration methodologies and digitalisation enablers that will be required in the next decades. so that all stakeholders best meet the FlightPath targets for 2050.

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Societal

Society is expecting a greener environmental future sooner. This is driving the accelerated technical challenge for new energy sources. Increased societal mobility requires increased cooperation with external stakeholders, the need to protect and up-skill the aviation workforce requires urgent attention, and safety & security remains critical, especially due to new COVID-19 measures.

ACARE recommends fully revising the FlightPath 2050 vision in alignment with the Paris Agreement (2015) and the new European Green Deal (2019).

ACARE recommendation to revise FlightPath 2050

The European aviation sector is facing serious challenges. It is essential to have a comprehensive and highly efficient response across the whole value chain. Achieving the 2050 objectives requires consistent attention to the closely dependent investment chains of aviation stakeholders. Policy and regulation must stimulate the increased investment requirements of research and innovation stakeholders and enable operators to integrate high performance products into their operations.

A revised FlightPath 2050 needs to address the wider perimeter and advise on recovery, resilience, and sustainability to continue to support societal mobility and economic strength.

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ACARE stands ready to embrace the new challenge and to coordinate all stakeholders efficiently to provide sound analysis and advice to the European Commission.

Success stories

A selection of projects enabling technological advances in aviation. Read the stories (link)

Meeting societal & market needs

- DORA – Door-to-Door Information for Airports and Airlines
- PJ05 REMOTE TOWER - Remote Tower for Multiple Airports
- CORUS - Concept of Operation for EuRopean UTM Systems

Maintaining and extending industrial leadership

- NHYTE - New HYbrid ThErmoplastic Composite Aerostructures Manufactured by Out of Autoclave Continuous Automated Technologies
- Flight Test Bed #2 Project - In-flight demonstration in FTB#2 295 aircraft / ground test demonstrations in test benches/rigs

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- MULTIDRILL - Multi Material Drilling Conditions
- ReMAP – Real-time Condition-based Maintenance for Adaptive Aircraft Maintenance Planning
- TOICA – Thermal Overall Integrated Conception of Aircraft
- EWIRA - External Wing Integration for Regional Aircraft demonstrator

Protecting the environment and the energy supply

Gaseous emissions

- Geared Pusher Open Rotor (Clean Sky – Sustainable And Green Engines)
- Lean Burn Combustion Technology (Clean Sky – Sustainable And Green Engines)
- BLADE - Breakthrough Laminar Aircraft Demonstrator
- JETSCREEN - JET Fuel SCREENing and Optimisation
- ALTERNATE – Assessment on Alternative Aviation Fuels Development
- ENABLEH2 - ENABLing cryogEnic Hydrogen based CO_2 free air transport

Noise

- JERONIMO - Jet noise of high bypass ratio engine: installation, advanced modelling and mitigation
- AFLONEXT - Active Flow, Loads & Noise Control on Next Generation Wing ('2nd Generation Active Wing')

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- Research policy and atmospheric research
- REACT4C - Reducing Emissions from Aviation by Changing Trajectories for the benefit of Climate
- ATM4E - Air Traffic Management for environment

Recycling

- PAMELA - Process for Advanced Management of End of Life of Aircraft
- AiMeRe - Aircraft Metal Recycling
- RESET – Re-use of Thermoplastic Composite
- EFFICIENT – Environmentally Friendly FIre suppression for Cargo using Innovative greEN Technology

Emission-free taxiing

- ACHIEVE – Advanced mechatronics devices for a novel turboprop electric starter-generator and health monitoring system

Ensuring safety and security

Safety

- EUNADICS-AV - European Natural Airborne Disaster Information and Coordination System for Aviation
- VISION - Validation of Integrated Safety-enhanced Intelligent flight cONtrol
- SARAH - Increased Safety and robust certification for ditching of aircrafts and helicopters

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Security

- COPRA - Comprehensive European Approach To The Protection Of Civil Aviation
- SESAR WP16.06.02 - ATM Security Coordination and Support
- XP-DITE - Accelerated Checkpoint Design Integration Test and Evaluation
- GAMMA - Global ATM Security Management
- OPTICS2 - Observation Platform for Technological and Institutional Consolidation of Research in Safety & Security

Prioritising research, testing capabilities and education

- PERSEUS - Promoting Excellence & Recognition Seal of European Aerospace Universities
- RINGO - Research Infrastructures - Needs, Gaps and Overlaps

International cooperation

- ICARe - International Cooperation in Aviation Research