EASN european aerospace science network

WHITE BOOK ON AVIATION

2026-2029 AND BEYOND

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Preamble

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Executive Summary

The **EASN White Book on Aviation – 2026–2029 and beyond** presents a strategic academia vision for the future of European aviation research. Developed by the **European Aerospace Science Network (EASN)**, the White Book articulates **breakthrough scientific priorities, disruptive research directions, and long-term perspectives** that are essential to achieving a sustainable, competitive, climate-neutral, safe, and resilient aviation sector.

Building upon previous EASN White Book editions and continuous consultation within the EASN community, this document reflects the evolving technological, environmental, societal, and regulatory context in which European aviation must operate. It is positioned **upstream of implementation-oriented roadmaps**, such as Strategic Research and Innovation Agendas (SRIAs), and focuses on **low- to mid-Technology Readiness Level (TRL) research**, where the role of academia is critical.

STRATEGIC CONTEXT

European aviation faces a convergence of unprecedented challenges: to achieve the goal of deep decarbonisation, in line with the **European Green Deal, and, at the same time further enhance competitiveness and resilience**, to secure the present European global leadership in the sector and thus contribute to the prosperity of the European societies, including the contribution to a resilient and safer continent.

A sustainable and competitive aviation system is envisioned as a framework that simultaneously delivers climate neutrality, technological leadership, industrial resilience, and societal value. **From the EASN perspective, this requires a holistic sustainability framework that extends beyond the reduction of emissions and integrates performance, operational efficiency, environmental impact, economic viability, safety, certification readiness, dual-use implications, social responsibility, and geopolitical changes**. Achieving climate neutrality while simultaneously increasing competitiveness and resilience, to ensure global leadership in the sector, will require **systemic transformation**, encompassing the exploration and implementation of disruptive solutions, exploiting digitalisation and automation, novel propulsion and energy architectures, disruptive aircraft configurations, operations, and manufacturing processes, lifecycle management, and certification procedures.

EASN fully endorses the **impact-driven** orientation of European aviation research and sets as its priority to support universities in responding to their indispensable role in enabling this approach through the generation of knowledge, technological innovation, and highly skilled human capital. It is worth underlining that European aerospace engineering universities are increasingly contributing **not only to low-TRL exploratory research** supported by programmes such as Horizon Europe, but also to **higher-TRL technology development, integration, and validation** within initiatives such as the Clean Aviation and SESAR Joint Undertakings.

Through close collaboration with industry and European institutions, academia acts as a bridge between fundamental research and operational implementation, strengthening Europe's **technological sovereignty and resilience** while supporting the development of **dual-use capabilities** relevant to both civil aviation and defence. In this context, reinforcing structured cooperation between universities, industry — including SMEs and start-ups — and policy frameworks is essential to accelerate innovation uptake and maintain Europe's safety, resilience, and strategic competitiveness in aviation.

Yet, **insights gathered through EASN conferences**, newsletters, and policy dialogues over the past five years consistently underline that **incremental technological improvements are insufficient**. Therefore, the **interpretation of Impact** must go beyond the rapid integration and demonstration of existing technologies that support the sector's ecological sustainability and competitiveness. It must also **include low-TRL research aimed at exploring and maturing new technologies**. These technologies are **essential for achieving the stated high-level goals but are currently unavailable**. In this context, Europe must invest in foundational science, inter-disciplinary research, and disruptive concepts that can redefine aviation systems beyond current assumptions. It is worth noting that special attention must be paid to the needs of start-ups, as they have emerged to an essential stakeholders in Europe's economy of knowledge and innovation and represent strategic allies for academia, as well as to achieving full gender equality in the sector which will allow the exploitation of valuable underutilised human potential in Europe.

The White Book is part of EASN's role in representing academic research interests within *European aerospace policy and research frameworks* such as Horizon Europe. It complements other EASN activities like conferences, workshops, and stakeholder consultations.

To support a coherent and comprehensive vision of future aviation research, EASN has developed a structured **Research & Technology taxonomy** (Annex A.2) that captures the full thematic landscape of academic aerospace research in Europe. This taxonomy provides the underlying framework through which emerging challenges and technological directions are analysed and systematically connected to the **Priority Research Topics** presented in Chapter 3.

PRIORITY RESEARCH TOPICS

The White Book identifies **ten priority research topics** where academic research is essential for achieving high long-term impact. These topics collectively address aircraft, operations, manufacturing, and lifecycle aspects, and are deliberately framed to support **breakthrough innovation beyond current development cycles**.

CROSS-CUTTING ENABLERS

Across all topics, **five cross-cutting themes** are identified as decisive enablers: **Engineering for holistically sustainable aviation; Artificial intelligence and digital trust**; **Lifecycle thinking and circularity**; **Certification and regulation readiness** aligning research with future certification needs and supporting the evolution of regulatory frameworks; and **Skills and education**. Without coherent progress in these transversal areas, technological advances alone will hardly translate into deployable aviation solutions.

ALIGNMENT WITH EUROPEAN FRAMEWORKS

The White Book is aligned with **Horizon Europe**, the **European Green Deal**, the **Strategic Research Agendas of the Clean Aviation and SESAR Joint Undertakings**, and the **White Paper for European Defence – Readiness 2030**. It complements them by:

- feeding **post-2035 concepts** into long-term strategic thinking,
- supporting **high-risk, high-reward research** aligned with European policy goals,
- and providing a **scientific evidence base** for future regulatory and certification evolution.

STRATEGIC RECOMMENDATIONS

Based on the collective expertise of the EASN community, the White Book formulates the following strategic recommendations:

- Sustain strong investment in **upstream, low-TRL academic research** alongside demonstrator-driven programmes.
- Embed **sustainability-by-design and lifecycle assessment** as core research principles.
- Develop **trustworthy digital and AI methodologies** tailored to aviation's safety-critical nature.
- Anticipate certification challenges through **pre-normative research and validation frameworks**.
- Modernise aerospace education and training to reflect **interdisciplinary and digital skill needs**.
- Strengthen **structured dialogue** between academia, industry, regulators, and policy makers.
- Test skills, capabilities, and infrastructures.
- Support **critical innovation and skill development** towards a **safe and resilient** Europe through **dual-use technologies**.

CONCLUDING PERSPECTIVE

The EASN White Book positions the **European academic aerospace community** as a **strategic partner in shaping the future of aviation**. EASN articulates scientifically grounded priorities and long-term perspectives, to inform European research agendas, support evidence-based policy decisions, and contribute to a future aviation ecosystem that is **innovative, sustainable, safe, and globally competitive**.

KEY CHARACTERISTICS OF THE EASN WHITE BOOK ON AVIATION:

Scope: The White Book captures *upstream, high-impact research priorities* proposed by EASN members, National Contact Points, and the Board of Directors (BoD). It is designed to contribute on shaping future research agendas and provide academic input into both European and national research planning. It covers *breakthrough innovation and disruptive concepts* in the aviation sector and focuses on fundamental and forward-looking research topics rather than incremental developments.

Content: The document includes a compilation of *priority research topics* and *strategic recommendations* drawn from extensive consultations within the EASN community. The content aims to help structure Europe-wide academic research priorities on topics that could transform future aviation systems.

Status and Access: The White Book is *dynamic and continuously updated* with new input from the EASN membership. Access to the full document is available through the EASN portal. A periodic update of the White Book will take place and be agreed upon at the respective meetings during the EASN International Conferences.

1 Introduction

Ensuring that Europe retains global leadership in aviation while successfully transitioning towards an environmentally neutral society constitutes one of the most demanding strategic challenges of the coming decades for the European aviation ecosystem. Aviation is a cornerstone of European connectivity, industrial strength, and technological sovereignty, yet it operates under increasing pressure to drastically reduce its environmental footprint. Addressing this dual challenge requires a long-term vision that reconciles ambitious climate objectives with the need to preserve Europe's competitiveness in a rapidly evolving global aviation landscape.

In this context, future European aviation research must **simultaneously address and ensure synergies between three fundamental pillars shaping FP10 and contributing to the achievement of the following high-level objectives**:

1. **Environmental sustainability**, with a strong focus on emissions, climate impact, and resource efficiency;
2. **Global competitiveness**, encompassing technological leadership, industrial resilience, economic viability, social acceptance and prosperity; and
3. **Europe's strategic autonomy and security**, including the development of dual-use technologies and stronger synergies between civil aviation research and relevant European defence initiatives.

Achieving meaningful progress across all pillars demands a **holistic sustainability approach** for the aviation sector, **one that goes beyond current approaches aimed at technological improvements in the individual areas and instead adopts concepts that interlink environmental performance, system efficiency, industrial capability, regulatory readiness, and societal acceptance**. Such an approach is essential to balance the long-term interests of Europe's diverse aviation stakeholders and enable a coherent, durable transition of the sector.



1.1 The role of EASN

In the above context, the European Aerospace Science Network (EASN) plays a unique and strategic role within the European aviation research ecosystem. Being a pan-European association representing universities and academic laboratories active in aerospace sciences, EASN serves as a **collective voice of the academic community** in aviation and space research and expresses its views, visions, and suggestions.

EASN operates at the interface between **fundamental science and disruptive research on one hand and applied industrial research and its implementation on the other**. Its members span the full spectrum of aerospace disciplines, including aerodynamics, structures and materials, propulsion, flight mechanics, systems engineering, digital technologies, environmental sciences, and operations. This breadth enables EASN to address aviation challenges from a **system-level and interdisciplinary perspective**, complementing industry-led initiatives and policy-driven roadmaps.

Through conferences, workshops, position papers, and continuous interaction with European institutions, EASN contributes to shaping research priorities, fostering excellence in academic research, and supporting the renewal of Europe's scientific and engineering capacity in aviation. The White Book builds upon this role by providing a **structured, forward-looking synthesis of academic insight**, aimed at informing European strategic research and innovation agendas.



1.2 Objectives and scope of the White Book

The EASN Aviation White Book is conceived as a **strategic scientific reference document** that articulates key research priorities, breakthrough directions, and long-term perspectives for the future of aviation. Its primary purpose is to inform and support European research policy, funding frameworks, and strategic initiatives by conveying the **collective understanding and vision of the academic aerospace community**. In this context, **the White Book is a dynamic, living document, subject to updates reflecting emerging needs and disruptive new ideas**.

It is stated that in the current European and global context, universities play an increasingly active role in the aviation ecosystem by contributing to knowledge generation, technological innovation, and the development of highly skilled human capital. As aviation faces simultaneous pressures related to climate neutrality, technological competitiveness, strategic autonomy, and resilience, academic institutions provide the scientific foundations and multidisciplinary expertise required to address these challenges. Through their participation in European research frameworks and collaborative programmes with industry and public institutions, universities support the advancement of both low-TRL exploratory research and the maturation of emerging technologies, while also educating the next generation of engineers and researchers. This positions academia as a key enabler for sustaining Europe's technological leadership and ensuring the long-term resilience and competitiveness of the aviation sector.

The White Book does not aim to replicate existing technology roadmaps or Strategic Research and Innovation Agendas (SRIAs). Instead, it deliberately positions itself **upstream of implementation-driven programmes**, focusing on:

- Low- to mid-Technology Readiness Level (TRL) research;
- Disruptive and non-incremental concepts;
- Foundational scientific challenges and enabling methodologies;
- Long-term horizons extending beyond current development cycles; and
- Future skills and expertise needs

Its scope encompasses aircraft technologies, operational concepts, manufacturing and lifecycle aspects, digitalisation, sustainability, and regulatory considerations. By addressing both **technology-specific and cross-cutting themes**, the White Book seeks to highlight where academic research can most effectively contribute to Europe's ambition for a competitive, climate-neutral, safe, and resilient aviation sector.

In support of this objective, EASN has established a structured **Research & Technology taxonomy** that reflects the breadth and depth of academic aerospace research in Europe (see Annex A.2). The taxonomy serves as a conceptual foundation for analysing future aviation challenges and for ensuring completeness and consistency across research domains. The **Priority Research Topics** defined in Chapter 3 are derived from and mapped onto this taxonomy, translating detailed disciplinary knowledge into a set of strategic, system-level research priorities.

1.3 Methodology and Community-Driven Approach

The White Book is the outcome of a **structured, community-driven process** rooted in extensive consultation within the EASN network. It builds upon previous EASN knowledge and position documents, while integrating updated perspectives reflecting recent technological, environmental, and societal developments. The methodology follows three core principles and is designed to represent a **collective, evidence-based vision** of the EASN community, intended to stimulate dialogue, guide strategic decisions, and support the continuous advancement of European aviation research.

Inclusiveness and expertise	Priority Research Topics were identified based on broad consultation within the EASN community, ensuring representation across disciplines, institutions, and career stages. Topic Leaders were selected for their recognised expertise and scientific leadership, and contributions were solicited from a wide range of academic stakeholders.
Synthesis rather than compilation	Contributions were guided by a common template to ensure consistency and comparability. Emphasis was placed on synthesis, critical assessment of the state of the art, identification of gaps, and articulation of future research directions.
Strategic and policy relevance	All inputs were framed with explicit consideration of European research and innovation frameworks, regulatory environments, and long-term societal objectives. Editorial harmonisation from the Board of Directors (BoD) ensured coherence, clarity, and alignment with the overarching goals of the White Book.

2 Strategic Context for Future Aviation

The aviation sector faces an unprecedented convergence of **technological, environmental, societal, resilience-related, and regulatory challenges** that will define its evolution over the next decades. European aviation research must therefore operate within a context of **deep decarbonisation goals, digital transformation, operational complexity, dual-use goals and sustainability imperatives**.

The European policy framework, anchored by both sustainability and strategic autonomy, calls for a climate-neutral and resilient continent by 2050. Within this broader policy, aviation has been recognised as a sector requiring **industry-wide transformation** across aircraft design, manufacturing, maintenance and repair (MRO), propulsion systems, operations, materials, and systemic integration (e.g., contrails, lifecycle emissions, and digital security). EASN's strategic engagement with policy dialogues, as reflected through interviews and community responses, has consistently emphasised that reaching these policy targets requires **far-reaching scientific advances**.

EASN's newsletters and annual conferences over the past five years further demonstrate the increasing prominence of **sustainability and innovation** as core drivers of research discourse. Contributions from senior leaders of the Clean Aviation Joint Undertaking, SESAR Joint Undertaking, the European Commission, and CINEA at EASN events highlight a collective European recognition of the need to accelerate technological development, but also to **reconcile academic research trajectories with policy timelines and industrial deployment pathways**.

Academic contributions at EASN conferences and newsletters have placed a particular emphasis on the **role of upstream research**. EASN has publicly advocated for dedicated support for low-TRL, breakthrough research within European funding instruments, arguing that **without sufficient early-stage investment, the ecosystem risks shortfalls in long-term innovation capacity**. This position was articulated in a high-profile joint communication from the EASN Board and Stakeholders Advisory Board, warning about a decline in upstream aeronautics research funding and urging policy makers to ensure **balanced investment across TRL levels**.

Within this strategic context, the European aviation research agenda must increasingly recognise the **cross-cutting nature of aviation challenges**: Engineering for holistically sustainable aviation, Digitalisation (AI and digital trust), Lifecycle sustainability and circularity, Certification and regulatory readiness, and Skills and education. Emerging topics — such as digital twins for the full lifecycle, condition-based maintenance, and integration of alternative energy carriers — demand not only individual research advances, but **holistic frameworks** that bridge technological domains and align with European research structures.

3 Priority Research Topics

This chapter presents the Priority Research Topics identified by the EASN community as critical enablers for the long-term sustainability, competitiveness, resilience and strategic autonomy of European aviation. The topics are applicable to both low- and higher- TRL research and adopt a breakthrough-oriented perspective, addressing disruptive technologies, system-level integration challenges, and emerging regulatory and societal constraints. Together, they form a coherent research landscape bridging fundamental science, future aircraft and ATM concepts, and their pathway towards implementation.

The Priority Research Topics defined in this chapter are consistent with the established EASN taxonomy of Research & Technology Areas, ensuring comprehensive coverage of the Association's thematic landscape while maintaining a strategic, system-level perspective.



3.1 Efficient Propulsion and Sustainable Energy Solutions

KEYWORDS

SAF and SAF-enabled advanced propulsion concepts, Hybridisation, Hybrid-Electric solutions, Batteries, Liquid Natural Gas, Hydrogen.

SCOPE

The next decade is critical for aligning global aviation with net-zero carbon emission pathways and should focus on accelerating the development, validation, and deployment of disruptive propulsion technologies and sustainable energy solutions. The objective is to enable a 30% to 100% reduction in aircraft emissions across all segments of commercial aviation (especially regional, short-medium and long range) to best mitigate global warming from both CO2 and non-CO2 effects where applicable.

Current turbofan architectures are approaching their thermodynamic limits. Research must pivot toward radical propulsion configurations that maximise thermal and propulsive efficiency as well as sustainable energy solutions from low- or zero-carbon fuels or electricity:

- SAF-enabled advanced propulsion concepts: Open Rotor Architectures (Overcoming acoustic and integration barriers for unducted fans), Ultra-High Bypass Ratio Engines (Developing advanced gearboxes and lightweight composite fan blades), Small Core Engine Technology (Improving high-pressure compressor efficiency and high-temperature materials), Boundary Layer Ingestion (Integrating propulsion systems into airframes to reduce aerodynamic drag), etc.

Hybridisation bridges the gap between current drop-in fuels (SAF) and future hydrogen ecosystems, optimising energy use during high-demand flight phases.

- Hybrid-Electric architectures, including distributed electric propulsion, Megawatt-Scale Powertrains (Developing high-power-density electric motors and power electronics), High-Voltage Distribution (Mitigating partial discharge and corona effects at high altitudes), Energy Storage Systems (Advancing solid-state batteries with energy densities exceeding 500 Wh/kg), Dynamic Power Management (Creating intelligent control algorithms for real-time gas turbine and battery balancing).
- Fully electric,battery-based propulsion for smaller-scale aviation vehicles.

Hydrogen offers the highest energy density per unit mass, presenting a viable path for true zero-carbon regional and narrowbody flight, provided that the volumetric density challenge be resolved with Cryogenic Storage Systems (Designing ultra-lightweight, insulated liquid hydrogen (LH2) tanks). Propulsion solutions include:

- Hydrogen Fuel Cell Power Trains (Scaling megawatt-class fuel cells for primary propulsion, engineering advanced heat exchangers to manage extreme cooling requirements, system integration at aircraft level and optimisation of volume-to-weight ratio).
- Hydrogen Combustion (especially with Low NOx emissions) or dual-fuel combustion options.
- Other low-carbon fuel solutions such as LNG (Liquefied Natural Gas, i.e. primarily methane (CH4))

3.2

New generation of electrical actuators for high DoF systems enabling morphing of aerostructures and adaptive aerodynamics

KEYWORDS

New generation of electrical actuators, including polymers, Carbon-Nano-Tubes, piezoceramic actuators, hybridization of actuator properties, morphing, high DoF systems of electrical actuators, shape and vibrations optimization, AI-driven 4D printing with "time" as the fourth dimension.

SCOPE

ACARE's European Commission targets (DG MOVE/ DG RTD), Flightpath 2050 that include a- 80% reduction in CO2 emissions per passenger-kilometre to support the Air Transport Action Group target: "Carbon-neutral growth starting 2020 and 90% or practically zero CO2 emission reduction by 2050", as well as a 90% reduction in NOx emissions and noise emissions reduced by 65% require the development of advanced systems based on new generation of electrical actuators targeting aerodynamic performance increase in alignment withthe overall objectives of "More Electric Aircraft". This is a core topic that allows lightweight smart devices with very short time response to be embedded in lifting structures in order to apply optimal deformations and vibrations to strategic areas of the aircraft, thereby optimising the fluid-structure interaction system and improving aerodynamic performance.. In parallel, the development of efficient feedback controllers enabled by these devices is another key topic that permits a practically instantaneous application of optimal control commands to actuate the system of electrical actuators in response to external solicitations including realistic gust effects. The use of Artificial Intelligence for constructing through 4D printing new generation of electrical actuators with hybrid properties through the combination of polymers, nanomaterials such as Carbon-Nano-Tubes and piezoceramics, as well as for constructing advanced systems composed of high DoF miniaturised piezo-actuators/sensors embedded on aeronautical structures is also a key topic to achieve pollution reduction. Application of these new-generation systems able to autonomously change their shape or vibratory behaviour in response to environmental triggers on aircraft and UAV wings and nacelles to reduce drag and increase lift, as well as on compressor blades in new-generation of propulsive engines and helicopter rotors and fuselages are important research topics towards pollution reduction.

3.3 Disruptive Aircraft Configurations for Sustainable Long-Range Aviation

KEYWORDS

Concepts of operation, aircraft architecture, overall aircraft design, multidisciplinary approaches, sustainable design, certification, digital twin, digitalization, optimization, uncertainty, higher fidelity simulation tools, computing intensive approach, system modelling, life-cycle-oriented analysis, Machine Learning, Artificial Intelligence, iron bird, flying demonstrators, retrofitting, training in aircraft design.

SCOPE

The development of future transport aircraft designs is closely linked to the growing ability to evaluate new configurations quickly and more accurately, in order to achieve the best balance between performance, cost and safety. To achieve this, new systems and technologies must be taken into account as early as possible in the design process, with a balanced perspective on the fact that the future of commercial aircraft design will be shaped by a range of competing objectives, including environmental performance, economic competitiveness, industrial resilience, geopolitical constraints and technological sovereignty. Preliminary design is therefore evolving from a problem of performance optimisation into a strategic systems engineering challenge, with the following major challenges, expected to define the next generation of transport aircraft design:

- Decarbonisation of Aviation, with special emphasis on propulsion-related technologies: Sustainable Aviation Fuels (SAF), Hydrogen, Battery- and Hybrid-electric propulsion, Lean combustion technologies, reduction of non-CO_2 climate effects, such as contrail formation
- Early consideration of Certification challenges (CRL scale), integration of operability requirements at preliminary design stage, and early incorporation of life-cycle considerations (from manufacturing to recycling-disposal)
- More balanced comparison of non-conventional aircraft configurations, such as high-aspect-ratio wings, blended-wing-body, twin or lifting-fuselage configurations, more laminar aircraft, etc.
- Deeper analysis of new concepts of operation: urban/short/regional mobility, firefighting & emergency capability, dual use.
- Full leverage of emerging methodologies: scalable Multidisciplinary Design Optimisation (MDO) based on AI approaches and high-performance computing, along with refined multiphysics and coupled physics models, leading to designs under uncertainty control.
- Significant effort on physical demonstrations to validate advanced simulation methods, up to mid-and full-scale demonstrators.

3.4 Advanced Aircraft Structures, Multifunctional Materials and Manufacturing Technologies

KEYWORDS

Advanced materials, including thermosetting, thermoplastic, metallic, and ceramic composites, metallic materials, hybrid-, nano-, multifunctional-, self-healing-, disordered-, cellular, bio-materials, etc., advanced aircraft differential- integral-, and morphing structures, circularity, advanced manufacturing processes for composite, metallic, hybrid-, and ceramic materials, joining technologies, exploitation of digitalization, Machine Learning, and Artificial Intelligence, circularity, recycling.

SCOPE

Reducing structural weight is a straightforward means to reduce fuel consumption and the related emissions. The development of aircraft structures involving advanced circular, recyclable and sustainable aircraft structural solutions integrating advanced metallic materials, polymer-based composites, and hybrid materials, including bio-based, architected and multifunctional concepts such as self-healing, lightning strike protection and ice protection capabilities, is a mandatory enabler to meet the objective of environmental sustainability, without compromising competitiveness, resilience, and technological sovereignty.

In the above context, material selection and hybrid material combinations, structural adaptions linked to the implementation of alternative or hybrid propulsion systems, structural optimisation implementing eco-design, lifecycle-oriented and circular design approaches, design for holistic sustainability relying on the exploitation of AI, as well as certification challenges for next-generation aerostructures, including the exploitation of digitalization, represent emerging disruptive research topics of high priority.

In addition, the further development and optimization of advanced manufacturing technologies for metallic and polymer-based materials, such as additive manufacturing (metal, polymer-based, and functional), cold spray processes, out of autoclave and thermoforming processes, etc., as well as the further exploration and maturation of advanced joining technologies such as laser- and friction stir welding, adhesive bonding of similar and dissimilar materials, etc., are essential enablers for the development of disruptive aircraft structures, and need to be explored and matured.

Finally, the elaboration of scalable and sustainable production routes and the full exploitation of Digital Twins, Machine Learning, and Artificial Intelligence in material development and selection, design and optimization of aircraft structures, and development and optimization of aircraft structure manufacturing are demanding research topics of high priority.

3.5 Integrated Digital Aviation Operations for Climate Impact Reduction, Resilience and Crisis Management

KEYWORDS

Climate impact of aviation, trajectory-based operations, mission-based operations, ATM digitalisation, U-space, UTM, drones, crewed and uncrewed aviation, heterogeneous airspace users, advanced air mobility, vertiports, crisis management, emergency response, climate adaptation, operational resilience, environmental optimisation, non-CO_2 effects, sustainable aviation, Clean Aviation, SESAR, digital twins, artificial intelligence, trustworthy AI, human–automation teaming, interoperability, multi-sector collaboration.

SCOPE

Development of integrated digital aviation operations aimed at reducing the climate impact of aviation while strengthening the role of aviation as a key enabler for crisis management, emergency response and climate-adaptation services, including operations related to forest fires, flooding, severe weather, humanitarian assistance and other disruptive events. The topic includes the evolution and generalisation of trajectory-based operations as a backbone for future aviation operations, extending from conventional ATM and airline operations to U-space/UTM, drones, advanced air mobility and crisis-response missions. Research should address gate-to-gate, airspace-wide and network-wide optimisation of trajectories and missions, considering fuel burn, CO_2 and non-CO_2 climate effects, noise, local air quality, airspace capacity, predictability, resilience and equity among airspace users.

A central priority is the seamless coexistence of drones and other uncrewed systems with conventional crewed aviation, including scenarios with highly heterogeneous airspace users in terms of performance, equipage, autonomy, mission objectives, operational constraints and levels of human involvement. Research is needed on digital orchestration mechanisms capable of coordinating crewed and uncrewed aircraft, commercial aviation, general aviation, rotorcraft, emergency aircraft, advanced air mobility vehicles and drones in shared or adjacent airspace. These mechanisms should enable the aviation system to exploit the specific strengths of each type of aircraft and operation, ensuring safe, scalable and efficient integration for transport, surveillance, monitoring, emergency logistics, firefighting support, flood assessment, infrastructure inspection and disaster response.

The priority also includes the adaptation of ground infrastructure to new operational models, including vertiports, drone hubs and new forms of distributed aviation infrastructure, which will need to be safely accommodated within the wider ATM, UTM and airport ecosystem. Research should address their operational integration, data exchange requirements, energy and charging implications, surface and terminal-area interfaces, and their coordination with conventional airports and airspace management processes.



Research is needed on advanced decision-support systems, digital twins, simulation and validation platforms, data-driven and model-based optimisation, trustworthy artificial intelligence, human–automation teaming, cyber-resilience, degraded-mode operations and certification approaches for safety-critical digital systems. These developments should be supported by interoperable data architectures, common operational scenarios, standardised interfaces and robust governance mechanisms for data sharing across aviation and non-aviation stakeholders.

This research priority should promote stronger alignment between SESAR, Clean Aviation and related European aviation R&I programmes, ensuring that advances in aircraft technologies, propulsion, energy systems, environmental performance and operational digitalisation are developed coherently and validated through integrated air–ground and network-level concepts. The topic should also foster collaboration with other sectors, including ICT, artificial intelligence, climate science, emergency management, meteorology, Earth observation, telecommunications and emerging computational technologies such as quantum computing. Addressing these challenges requires a multidisciplinary and cross-sector research approach, combining aviation engineering, operations research, digital technologies, environmental science, safety assessment, human factors and policy. The expected outcome is a more sustainable, resilient and service-oriented European aviation system, capable of reducing its own climate footprint while contributing actively to the management of climate-related crises and other major societal disruptions.

3.6 Digital Aviation, AI-Aided Engineering, and Data-Driven Certification

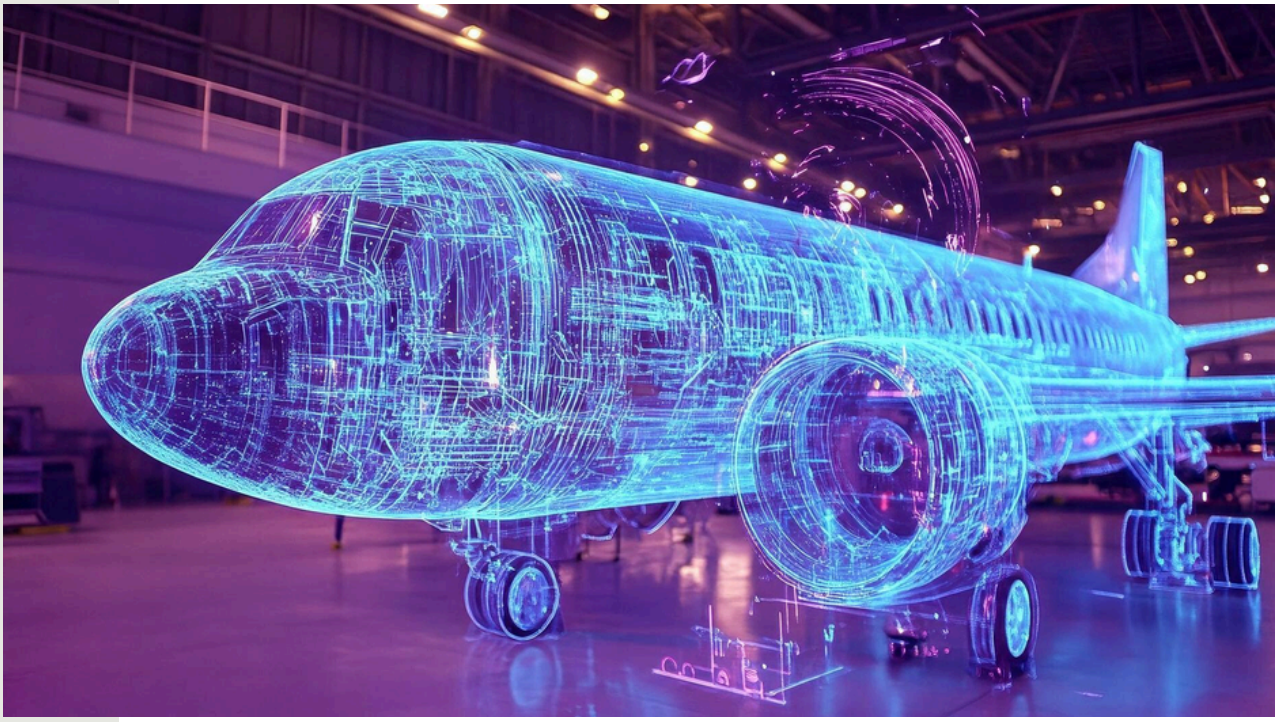
KEYWORDS

Digital and connected aircraft design, Certification by analysis and simulation, Safety assurance for AI-enabled systems and solutions, Digital twin and continuity, Machine learning, AI-assisted engineering, AI trustworthiness, Human-AI collaboration, Maintenance of the future, Predictive and prescriptive maintenance, Cybersecurity by design, AI-ethics by design, AI-augmented human factors, Agentic AI.

SCOPE

Digital transformation is a strategic enabler for the aviation sector, with applications spanning its entire value chain – R&I, product design, manufacturing, certification and airworthiness, maintenance, operations, and recycling. While industry has already deployed solutions leveraging advancements in AI and Machine Learning, recent breakthroughs in these fields unlock a major leap forward for the sector by enabling the design of digital-native products and systems, ensuring digital continuity across the product lifecycle, and transforming engineering and certification methods and processes. The topic includes:

- Design of next-generation digital-native and connected aircraft/systems, with extended connectivity to their environments to decrease emissions and improve flight safety and performance, enhanced data for certification and maintenance, AI-enabled cockpits and systems, and integration with digital twins.
- AI-aided design and engineering leveraging Agentic AI and human-AI collaboration, with digital twins including high-fidelity models to support design, modification, certification, continuing airworthiness, maintenance, and support.



- Data-driven certification with advancement in certification by simulation/analysis and by design, digitalization of certification processes, AI agents to support compliance demonstration, and data- and AI-driven safety monitoring.
- Digital MRO and fleet support leveraging extended connectivity to digital twins with data availability and processing, asset optimization, AI-based cobots, prescriptive maintenance, advanced inspection and anomaly-detection techniques that support certification of disruptive aircraft architectures

To unlock this transformation, challenges must be addressed. These include safety assurance for AI-enabled products and systems, as well as the certification of AI agents and AI-aided engineering practices. AI and machine learning algorithms must be demonstrated to be verifiable, reproducible, and trustworthy, in the highly safety critical field that is aviation. Cybersecurity by design and the resilience of digital infrastructures are needed. As humans remain the ultimate decision-makers supported by digital assistance (e.g. engineers, certification engineers, and pilots), "AI-augmented" human factors must be considered as a new risk area, alongside ethical AI.

3.7 Holistic Sustainability-by-Design Frameworks

KEYWORDS

Holistic Sustainability, Lifecycle thinking, Lifecycle assessment, Sustainability metrics, Multi-criteria decision-making (MCDM), Design optimisation, Circular economy, AI-driven design, Social impact, Safe-and-Sustainable-by-Design (SSbD).

SCOPE

Future aviation systems require a transition from traditional performance-oriented design approaches towards holistic Sustainability-by-Design frameworks, aligned with the principles of the Safe-and-Sustainable-by-Design (SSbD) framework, where environmental, economic, technological, circularity, safety, and social aspects are considered simultaneously from the earliest conceptual and preliminary design phases. Research should focus on developing integrated methodologies that quantify sustainability through comprehensive metrics, incorporating lifecycle environmental impacts, cost, technical performance, resource efficiency, material circularity, end-of-life strategies, safety considerations, and social impacts related to workforce, accessibility, and societal acceptance.

Such frameworks should enable multi-objective optimisation and decision-making under complex trade-offs, supporting the identification of solutions that balance sustainability, safety, performance, manufacturability, economic viability, and societal needs. The integration of lifecycle assessment (LCA), lifecycle cost analysis (LCC), circular economy principles, social impact assessment, risk assessment methodologies, and multi-criteria decision-making (MCDM) approaches will be essential to guide responsible design choices across aircraft architectures, materials selection, manufacturing processes, and operational strategies.

Artificial intelligence (AI), machine learning, digital twins, and advanced optimisation techniques should be leveraged to accelerate sustainable design exploration, enable data-driven decision support, and predict the environmental, economic, technical, safety, and social performance of future aviation technologies. These approaches will support the development of next-generation aviation systems that are not only efficient and competitive but also safe, sustainable, circular, and socially acceptable, considering the complete lifecycle of aviation products and technologies.

3.8 Structural Integrity, SHM/NDT, Reliability, and Secure Connected MRO

KEYWORDS

Structural Health Monitoring (SHM), Advanced Non-Destructive Testing (NDT), Predictive Maintenance and Digital Twins, Smart Aviation Maintenance Systems.

SCOPE

Future research should advance the structural integrity, reliability, and maintainability of current and next-generation aircraft through the development and deployment of advanced Structural Health Monitoring (SHM), Non-Destructive Testing (NDT), and intelligent maintenance solutions. Research should address SHM maturity and deployment barriers, advance NDT technologies (including bond inspection, computed tomography (CT), laser-based methods, acoustic emission, and multimodal sensing) and improve data-driven reliability analysis, prognostics, and predictive maintenance. Research should also promote secure IoT-based SHM, maintenance digitalisation, and fleet-scale digital twin integration to enable connected and intelligent aviation maintenance systems. Future work should further improve the monitoring of corrosion, moisture-related degradation, and icing, including advanced icing detection and prevention technologies, while accelerating the deployment of autonomous and robotic inspection systems. In addition, research should support the inspection, qualification, and certification of composite and additive-manufactured structures, together with the development of harmonised certification and standardisation frameworks for next-generation SHM, NDT, and maintenance technologies.

3.9

CO_2 emissions, Non-CO_2 Effects, Environmental Resilience, and Community Impact

KEYWORDS

CO_2 emissions, Non-CO_2 climate effects, Contrails, NOx emissions, Water vapour, Aerosols, Air quality, Atmospheric hazards, Environmental resilience.

SCOPE

Reducing CO_2 emissions remains the cornerstone of aviation decarbonisation and the primary objective for achieving climate neutrality. Future research should accelerate the development and deployment of technologies and operational solutions that deliver substantial lifecycle CO_2 reductions, including highly efficient aircraft configurations, advanced lightweight structures and materials, next-generation propulsion systems, sustainable aviation fuels (SAFs), hydrogen-powered and electric aircraft, hybrid-electric propulsion, improved aircraft operations, air traffic management optimisation, and digital technologies enabling fuel-efficient operations. Research should also improve the robustness and harmonisation of methodologies for measuring, monitoring, verifying, and assessing lifecycle CO_2 emissions across the entire aviation value chain, supporting science-based policy and investment decisions.

While reducing CO_2 emissions remains the primary objective of aviation decarbonisation, non-CO_2 effects are increasingly recognised as a major contributor to aviation's overall climate impact. Future research should improve the understanding, prediction, assessment, and mitigation of non-CO_2 effects, including persistent contrails and contrail cirrus, NOx emissions, water vapour, soot particles, and aerosols, together with their interactions with atmospheric chemistry and cloud formation. This includes the development of climate-aware flight planning and operational strategies, advanced propulsion technologies, cleaner combustion concepts, and sustainable aviation fuels that reduce non-CO_2 impacts.

Environmental resilience should also be strengthened by improving aircraft and operational robustness against atmospheric hazards, including severe weather, turbulence, icing, volcanic ash, wildfire smoke, and extreme temperatures. Furthermore, reducing local air quality impacts around airports and adopting integrated assessment methodologies that consider both CO_2 and non-CO_2 effects will be essential to support environmentally sustainable and socially acceptable aviation growth.

3.10 Aircraft noise and Aeroacoustics

KEYWORDS

Aircraft noise, Aeroacoustics, Community noise, Low-noise aircraft, CFD/CAA, Multiphysics modelling, Digital twins, Simulation-based certification, Hybrid electric and hydrogen propulsion, Distributed propulsion, Noise mitigation.

CONTEXT

Although significant progress has been achieved over recent decades through advances in propulsion, aerodynamics and operational procedures, emerging and future aviation concepts may introduce fundamentally new noise-generation mechanisms and environmental challenges.

The introduction of emerging and disruptive aircraft configurations and propulsion technologies, including hybrid-electric and hydrogen-powered aircraft, distributed electric propulsion, open rotors, ultra-high bypass ratio engines, blended-wing-body concepts, and Urban and Advanced Air Mobility (UAM and AAM) services in populated areas, offers opportunities for improving efficiency and reducing emissions. Yet, they also create complex acoustic challenges due to new, or poorly understood interactions between new propulsion systems, airframe devices, structures and operational environments. Meanwhile, environmental impacts require aviation noise to be addressed beyond aircraft certification metrics alone. Future research must consider not only noise generation at the aircraft level, but also community exposure, human perception and societal impact.

To maintain industrial leadership in aviation, Europe needs to establish a new generation of scientific and technological capabilities that enable aircraft to be designed, certified and operated with noise performance considered as a fundamental sustainability objective, together with economic viability.

SCOPE

Along with experimental research and methods, future research should establish predictive, physics-based and computationally efficient methodologies capable of supporting the design of low-noise aircraft. This requires moving beyond conventional component-based noise assessment towards integrated, multidisciplinary, coupled, and noise-aware aircraft design approaches.

Priority should be given to the development of advanced multi-physics modelling frameworks combining high-fidelity Computational Fluid Dynamics (CFD), Computational Aeroacoustics (CAA), turbulence-resolving simulations, structural dynamics, propulsion modelling, aero-structure-thermoacoustic coupling and reduced-order approaches. Particular attention is required for fundamental understanding and prediction of complex noise-generation and control mechanisms, including turbulent flow-acoustic interactions, propulsion-airframe integration effects, installation noise, flow-structure-acoustic coupling and novel propulsion architectures.

Digitalisation provides a significant opportunity for Europe to achieve leadership in next-generation noise technologies, where we have already established world-leading modelling and simulation platforms. Research should address digital twins, physics-informed artificial intelligence, uncertainty quantification, real-time prediction and validated simulation frameworks enabling future simulation-based certification. Such capabilities will support rapid multidisciplinary design optimisation and continuous noise management for aircraft operation.

Moreover, aviation noise research must pay increasing attention to the human health and environmental impacts. Advanced methodologies linking acoustic prediction with atmospheric propagation, airport operations, psychoacoustic perception, health impacts and community response are required to develop meaningful noise assessment approaches beyond traditional sound-level indicators.

Priority for low-TRL research topics in future European calls include:

- Fundamental acoustic mechanisms associated with emerging and disruptive aircraft configurations and propulsion systems, including hydrogen, hybrid-electric and distributed propulsion, etc.
- Multi-scale and high-fidelity CFD-CAA methods integrating turbulence, propulsion, thermodynamics, structures and acoustic radiation.
- Physics-informed techniques, reduced-order modelling and uncertainty-aware prediction methods for efficient aeroacoustic analysis and low-noise aircraft design across subsonic to supersonic transport.
- Active and adaptive noise mitigation technologies, including flow control, smart structures and innovative aircraft integration concepts.
- Digital twins and real-time noise monitoring and optimisation for future aircraft and mobility systems.
- Integrated modelling of aircraft-airport-atmospheric interactions, accounting for atmospheric turbulence, meteorological variability, terrain and urban environments.
- Human-centred community noise assessment incorporating psycho-acoustics, environmental exposure, and societal acceptance.
- Verification, validation and uncertainty quantification methodologies supporting simulation-based noise certification.

4 Cross-Cutting Themes

Beyond specific technologies or system architectures, the future of aviation will be decisively shaped by a set of **cross-cutting themes that permeate all research domains, Technology Readiness Levels (TRLs), and stakeholder communities**. These themes influence how aviation systems are conceived, designed, validated, certified, operated, and sustained over their full lifecycle.

The EASN community identifies five such transversal dimensions as critical enablers and risk factors for future European aviation:

1. Shift from engineering for environmentally neutral aviation to engineering for holistically sustainable aviation;
2. Artificial Intelligence and digital trust;
3. Lifecycle thinking and circularity;
4. Certification and regulatory readiness, and
5. Skills and education needs.

Addressing these themes coherently is essential to ensure that technological progress translates into safe, sustainable, certifiable, and socially accepted aviation systems.



4.1 Shift from engineering for environmentally neutral aviation to engineering for holistically sustainable aviation

Environmental neutrality remains a fundamental objective of aviation research, particularly through reductions in CO_2 and non-CO_2 climate effects, noise, and local environmental impacts. It is, however, a necessary rather than sufficient condition for sustainable aviation. Future aircraft and air-transport solutions must also satisfy requirements for safety, technical performance, affordability, industrial scalability, resilience, strategic autonomy, and societal acceptance. Holistic sustainability should therefore be treated as a system-level engineering property, preventing improvements in one dimension from creating unacceptable penalties in another.

Research should focus on Sustainability-by-Design methods that translate these dimensions into explicit requirements, constraints, and decision criteria from the earliest design stages. Multi-objective optimisation, multi-criteria decision analysis, uncertainty and sensitivity analysis, and transparent stakeholder needs are required to expose trade-offs, avoid burden shifting, and compare technologies across plausible operational and market scenarios. The objective is not to identify a universally optimal solution, but to generate traceable evidence for robust technology and configuration choices while preserving non-negotiable safety and performance thresholds.



4.2 Artificial Intelligence and Digital Trust

Artificial Intelligence (AI) and data-driven methods are rapidly transforming all domains of aviation research and engineering, from conceptual design and optimisation to manufacturing, operations, and maintenance. Machine learning, physics-informed AI, surrogate modelling, digital twins, and autonomous decision-support systems offer unprecedented opportunities for performance gains and lifecycle efficiency.

However, the large-scale deployment of AI in aviation critically depends on the establishment of **digital trust**. This includes confidence in the correctness, robustness, transparency, and traceability of AI-enabled systems. Unlike conventional physics-based tools, many AI approaches rely on data-driven inference, introducing challenges related to explainability, uncertainty quantification, bias, and domain validity. From an academic perspective, key research challenges include:

- Development of **trustworthy AI frameworks** that integrate physical laws, uncertainty modelling, and data-driven learning.
- Methods for **verification, validation, and robustness assessment** of AI-based tools.
- **Transparent and explainable AI** approaches suitable for safety-critical applications.
- **Secure data governance** across the aviation lifecycle.

The EASN community emphasises that **digital trust must be addressed by design**, not as an afterthought, and that academic research plays a central role in creating the theoretical and methodological foundations needed for industrial adoption and regulatory acceptance.



4.3 Lifecycle Thinking and Circularity

Future aviation systems must be designed, assessed, and optimised through a full lifecycle perspective, covering raw material extraction, manufacturing, operation, maintenance, and end-of-life management. Lifecycle thinking is therefore a core paradigm for future aviation sustainability, moving beyond component-level efficiency towards system-wide optimisation.

Within this framework, circularity becomes a key design driver, aiming to maximise value retention of materials and structures through reuse, repair, remanufacturing, and recycling. This requires a shift towards “design for circularity”, where disassembly, material recovery, and lifetime extension are already embedded at the conceptual design stage.

Key research directions include:

- Lifecycle-driven design methodologies integrating circularity from early development stages.
- Quantification and tracking of material flows, reuse potential, and end-of-life pathways.
- Design strategies for disassembly, repairability, and structural reuse.
- Assessment of lifecycle impacts considering multiple scenarios and uncertainties.

Lifecycle thinking and circularity must be supported by advanced modelling, digital tools, and optimisation frameworks, including digital twins, to enable robust decision-making across the full aviation value chain, as advocated by the EASN White Book through a **sustainability-by-design** approach where lifecycle and circularity considerations guide design decisions from the outset.



4.4 Certification and Regulation Readiness

Certification and regulation represent a **critical path** for the deployment of novel aviation technologies. Many emerging concepts, such as AI-enabled systems, hydrogen propulsion, additive manufacturing, multifunctional materials, and SHM-driven maintenance, challenge existing certification procedures.

Ensuring certification readiness requires that research activities anticipate regulatory needs and constraints, rather than treating them as downstream barriers. This does not imply limiting innovation, but rather **co-developing technologies and certification-relevant evidence**. Priority research needs include:

- New validation and verification methodologies for non-deterministic and data-driven systems.
- Digital evidence frameworks supporting certification through modelling and simulation.
- Qualification approaches for novel materials and manufacturing processes.
- Certification concepts for condition-based and predictive maintenance enabled by SHM.

Academic research is uniquely positioned to explore **pre-normative methodologies**, support regulators such as EASA with scientific evidence, and reduce long-term certification risks for industry.



4.5 Skills and Education Needs

The transformation of aviation systems places unprecedented demands on the **skills and competencies** of engineers, researchers, and decision-makers. Future aerospace professionals must operate at the intersection of classical disciplines and emerging digital, environmental, and systems-oriented domains. Key challenges include:

- Integration of AI, data science, and digital engineering into aerospace education.
- Strengthening systems thinking and interdisciplinary problem-solving capabilities.
- Education in sustainability, lifecycle assessment, and circular design principles.
- Global concept architecture in more complex and integrated concepts, design methodologies exploiting full digital potential in Systems Engineering & MBSE.
- Awareness of certification, safety, and regulatory constraints from early career stages.

The EASN community highlights the need for a **foundationally robust and, at the same time adaptive aerospace engineering education, implementing forward-looking education models**, including modular curricula, industry–academia collaboration, and lifelong learning frameworks. Ensuring Europe's long-term leadership in aviation requires **sustained investment in human capital** alongside technological development.



CONCLUDING REMARKS

The cross-cutting themes presented in this chapter underpin all priority research topics identified in the EASN Aviation White Book. Artificial intelligence without digital trust, sustainability without lifecycle integration, innovation without certification readiness, and technology without skilled people will fail to deliver the desired transformation of aviation.

Addressing these themes in a **coherent and integrated manner** is therefore essential to ensure that future European aviation systems are not only technologically advanced, but also safe, sustainable, certifiable, and societally accepted.



The EASN Aviation White Book is conceived as a **strategic scientific interface** between the European aerospace academic community and the evolving European research, innovation, and regulatory ecosystem. Rather than duplicating existing roadmaps or Strategic Research and Innovation Agendas (SRIAs), the White Book aims to **inform, challenge, and complement** them by articulating upstream scientific priorities, disruptive concepts, and long-term perspectives for aviation beyond incremental development cycles.

Through this explicit alignment, EASN's White Book positions itself as a **strategic reference document** that connects academic excellence with European research programmes, partnerships, and policy objectives. Its value lies not in prescribing solutions, but in **shaping the scientific foundations** upon which future European aviation strategies can confidently be built.

The European aviation research and innovation ecosystem is structured around several complementary instruments, each serving a distinct role. Horizon Europe provides the overarching Research and Innovation Framework Programme of the European Union. Within this framework, dedicated partnerships and joint undertakings, such as the Clean Aviation Joint Undertaking and the SESAR Joint Undertaking, support targeted research, technology maturation, integration, and demonstration activities in specific domains. In parallel, advisory bodies such as ACARE provide long-term strategic guidance, helping to align policy, research priorities, industrial needs, and societal expectations.

In this context, this section provides reference links to key European frameworks and strategic documents relevant to the White Book priority themes.

Horizon Europe Framework

- Clean Aviation Joint Undertaking (CAJU) - Strategic Research and Innovation Agenda (SRIA)
- SESAR Joint Undertaking - Research and innovation digest 2025
- European Defence Fund (EDF)
- European Defence Agency (EDA) - The 2023 EU Capability Development Priorities

ACARE – Advisory Council for Aviation Research and Innovation in Europe

- Strategic Research and Innovation Agenda – 2017 update

European Green Deal

- Fly the Green Deal - Europe's vision for sustainable aviation

European Union Aviation Safety Agency (EASA)

- EASA Artificial Intelligence Concept Paper - Proposed Issue 3

Conclusions and Strategic Recommendations

Based on the preceding analysis and the EASN community's collective outputs from newsletters, conferences, position dialogues, and expert interviews, the following **strategic conclusions and recommendations** are proposed for guiding future European aviation research:

Prioritise upstream, disruptive research alongside technology demonstration. 1

European research programmes should ensure that *disruptive, low-TRL research*, incubated within academia and collaborative networks, receives sustained funding and integration pathways into industrialisation frameworks. This is critical to avoid an innovation bottleneck at later TRLs.

Embed sustainability and lifecycle thinking from conceptual design onward. 2

Research must move beyond component efficiency to *lifecycle and systems-level sustainability* metrics. Sustainability should be a design criterion, not a post-hoc evaluation, integrating environmental, economic, and societal dimensions.

Promote digital trust as an enabler of innovation adoption. 3

AI and other advanced digital methods offer transformational potential but require a robust foundation of **trustworthiness, explainability, and validation** to be effectively adopted within safety-critical aviation domains.

Align research agendas with regulatory foresight. 4

Certification and regulatory frameworks need to evolve in step with technological innovation. Research should proactively address certification readiness, developing data-driven evidence and validation methodologies that regulators can reference.

Foster interdisciplinary skills and education. 5

To support the transformation of aviation systems, European academic programmes must adapt curricula and training models, emphasising *systems thinking, digital competencies, sustainability literacy, and regulatory understanding*.

Strengthen stakeholder integration across initiatives. 6

EASN participates in ACARE with the aim of contributing, through the academic perspective, to the shaping of both the short- and long-term research strategy of the aviation sector, as well as to the ongoing discussions on FP10 in general and the Clean Aviation Moonshot in particular, building on its successful past contributions to programmes such as CAJU and SESAR JU. Furthermore, EASN considers close collaboration with the relevant industry and research associations, namely EREA, EUROMART and, ASD, to be of critical importance and the continuous strengthening of these partnerships remains a core strategic objective.

Sustain Europe's global competitiveness through knowledge leadership. 7

European aviation research must not only respond to internal policy drivers but also anticipate global technological shifts. Maintaining leadership in foundational sciences, through collaborations and open knowledge exchange (e.g., special journal issues, open proceedings from EASN conferences), will be essential.

In summary, the strategic direction for European aviation research must be rooted in **deep scientific research, integration across disciplinary and policy boundaries, and sustained investment in people and methods**. By adopting the recommendations outlined above, the EASN community and its partners can contribute decisively to a future aviation ecosystem that is **sustainable, resilient, innovative, and globally competitive**.

Annex A1. Acronyms

AAM	Advanced Air Mobility
AI	Artificial Intelligence
ASD	AeroSpace and Defence Industries Association of Europe
ATM	Air Traffic Management
BoD	Board of Directors
CAA	Computational Aeroacoustics
CAJU	Clean Aviation Joint Undertaking
CFD	Computational Fluid Dynamics
CINEA	European Climate, Infrastructure and Environment Executive Agency
CO_2	Carbon Dioxide
CRL	Certification Readiness Level
CT	Computed Tomography
DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
DoF	Degrees of Freedom
EASA	European Union Aviation Safety Agency
EASN	European Aerospace Science Network
EDA	European Defence Agency
EDF	European Defence Fund
EREA	Association of European Research Establishments in Aeronautics
EU	European Union
EUROMART	European Cooperative Measures for Aeronautical Research and Technology
FP10	Framework Programme 10 for Research and Innovation
ICT	Information and Communication Technology
IoT	Internet of Things
JU	Joint Undertaking
LCA	Life Cycle Assessment
LCC	Life Cycle Cost Analysis
LH_2	Liquid Hydrogen
LNG	Liquefied Natural Gas
MBSE	Model-Based Systems Engineering
MCDM	Multi-Criteria Decision-Making
MDO	Multidisciplinary Design Optimisation
MRO	Maintenance, Repair and Overhaul
NDI	Non-Destructive Inspection
NDT	Non-Destructive Testing
NO_x	Nitrogen Oxides
R&I	Research and Innovation
R&T	Research and Technology
SAF	Sustainable Aviation Fuel
SESAR	Single European Sky Air Traffic Management Research
SHM	Structural Health Monitoring
SME	Small and Medium-Sized Enterprise
SRIA	Strategic Research and Innovation Agenda
SSbD	Safe-and-Sustainable-by-Design
TRL	Technology Readiness Level
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UTM	Unmanned Aircraft System Traffic Management

Purpose of the EASN Taxonomy

The European Aerospace Science Network (EASN) maintains a structured Research & Technology (R&T) Taxonomy to organise, classify, and communicate the full spectrum of academic research activities covered by its member institutions. This taxonomy provides a common reference framework for research coordination, conference structuring, expert mapping, and strategic documents such as the present White Book. The Priority Research Topics presented in Chapter 3 are strategic, system-level syntheses that build upon this taxonomy, ensuring full thematic coverage while maintaining a forward-looking and policy-relevant perspective.

EASN Research & Technology Areas

Materials and Structures

Aerostructures: Materials & Structures

- Materials & Processes
- Advanced Characterisation
- Design and Modelling
- Smart by Design
- Smart Materials
- Hybrid Materials
- Nano-enabled Composites
- Material Testing
- Structural Analysis
- Smart Structures
- Aeroelasticity
- Structural Behaviour

Aerostructures Manufacturing

Manufacturing Technologies

- Additive Manufacturing
- Out-of-Autoclave Composite Manufacturing
- Advanced Joining and Bonding
- Digital Manufacturing
- Automation and Robotics
- Industry 4.0 → Industry 5.0 Paradigms
- Quality Assurance and Process Control

Flight Physics

Aerodynamics and Aeroelasticity

- Turbulence and Transition
- Laminar Flow Technologies
- High-Speed and Compressible Aerodynamics
- Gust Loads and Atmospheric Effects
- Aeroelasticity
- Noise and Aeroacoustics

Energy Storage

Hydrogen in Aviation

- Cryogenic Storage
- Fuel Cells
- Thermal Management
- Safety and Certification

Fuels and Energy Storage

- Batteries
- Alternative Fuels
- Hybrid Energy Systems
- Energy System Integration

Propulsion

Advanced Propulsion Systems

- Hydrogen Combustion
- Hybrid-Electric Propulsion
- Distributed Propulsion
- Ultra-High Bypass Engines
- Alternative Fuels
- Propulsion Thermal Management

Aircraft Design

Design and Optimisation

- Multidisciplinary Design Optimisation (MDO)
- Conceptual and Preliminary Design

Innovative Concepts and Scenarios

- Novel Aircraft Configurations
- Integrated Aircraft–Propulsion Concepts

Small Air Transport Technologies

- Regional and Short-Range Aircraft
- Emerging Mobility Concepts

Unmanned Aerial Systems

UAS Technologies

- Autonomous Flight
- Sense-and-Avoid Systems
- Swarm Operations
- Certification and Airspace Integration
- UAS-Specific Propulsion

Aircraft Systems & Human Factors

Systems and Integration

- Avionics
- Flight Control Systems
- Human–Machine Interaction
- Automation and Autonomy
- System Safety
- Cybersecurity

Aircraft Operations

Air Traffic Management and Airports

- 4D Trajectory Management
- U-space / UTM Integration
- Airport Digitalisation
- Operational Safety
- Capacity and Network Resilience

Maintenance, Repair and Overhaul (MRO)

- Structural Health Monitoring (SHM)
- Non-Destructive Testing / Inspection (NDT / NDI)
- Digital Twins for Maintenance
- Predictive and Condition-Based Maintenance
- Smart Repair and Remanufacturing

Space Technologies

Space Systems and Applications

- Space Structures and Materials
- Space Manufacturing Processes
- Space Propulsion
- Space Power Systems
- Robotics and Autonomous Systems
- On-Orbit Operations and Servicing
- Satellites and Payload Technologies

Sustainability in Aerospace

Lifecycle and Circularity

- Life Cycle Assessment (LCA)
- Circular Design
- Recycling Technologies
- End-of-Life Strategies

Green Technologies

- Sustainable Materials
- Environmentally Friendly Manufacturing
- Environmental Impact Mitigation

Regulations and Policies

Safety and Certification

- Aviation Safety
- Certification of Novel Technologies
- Standards and Compliance

Policy and Governance

- European Aviation and Space Policy
- Research Coordination and Support Actions
- International Cooperation

Relationship to the White Book Priority Topics

The EASN Research & Technology Taxonomy represents the foundational thematic landscape of the Association. The Priority Research Topics defined in this White Book aggregate and integrate multiple branches of the taxonomy, reflecting system-level challenges, cross-disciplinary interactions, and long-term strategic objectives for European aviation. This approach ensures both thematic completeness and strategic clarity, allowing the White Book to serve as an effective interface between academic research, European research programmes, and policy development.

EASN european aerospace science network

easn.net

/easn-association



An open association networking academia in aviation and space research