EASN Position paper on “Clean Aviation Moonshot for the Disruptive Transformation of the Sector”

European aviation faces a convergence of unprecedented challenges: achieving deep decarbonisation in line with the European Green Deal, while simultaneously enhancing sustainability and competitiveness, securing Europe’s global leadership in the sector, and contributing to the prosperity of European societies. At the same time, it must reinforce European technological and industrial sovereignty in an increasingly competitive and geopolitically complex world.

A sustainable, competitive, and sovereign 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 Clean Aviation Moonshot, that will provide the holistic sustainability framework needed that extends beyond reduction of emissions and integrates performance, operational efficiency, environmental impact, economic viability, safety, certification readiness, dual use implications and social responsibility.** Achieving climate neutrality by increasing at the same time competitiveness, to ensure the global leadership in the sector, will require **systemic transformation**, encompassing the exploration and implementation of disruptive solutions exploiting digitalization and automation, novel propulsion and energy architectures, disruptive aircraft configurations, operations, and manufacturing processes, lifecycle management, and certification paradigms. Said mandatory systemic transformation cannot be achieved without the development of next-generation flying demonstrators that showcase the full integration of breakthrough technologies, concepts, and systems, at reduced development and demonstration times and at affordable cost. These demonstrators should go beyond incremental efficiency gains. Instead, they should prove, through realistic and representative mission profiles, that an aircraft can be designed and operated by simultaneously addressing environmental impact, economic viability, operational performance, circularity, and societal acceptance. The moonshot should emphasize the orchestration of multiple innovations into a coherent and operationally viable platform.

EASN fully endorses the **impact-driven** orientation of European aviation research, recognizing that universities play a pivotal role in enabling this approach through the generation of knowledge, technological innovation, and highly skilled human capital. European engineering universities contribute not only to low-TRL exploratory research supported by programmes such as Horizon Europe, but increasingly to **higher-TRL technology development** and validation within initiatives such as the Clean Aviation Joint Undertaking and SESAR. 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, and policy frameworks is essential to accelerate innovation uptake and maintain Europe's safety, sovereignty, 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 include, in addition to the quick integration and demonstration of existing technologies facilitating to achieve the ultimate goals of ecological sustainability, competitiveness, and autonomy of the sector, also low TRL research, exploring and maturing technologies which are mandatory for achieving mentioned high-level goals, but are currently simply missing.** In this context, Europe must invest in foundational science, interdisciplinary research, and disruptive concepts that can redefine aviation systems beyond current assumptions. At the same time, a unified and coherent European funding and research framework is required to align priorities, reduce fragmentation, and ensure continuity across the full innovation cycle, from early-stage research to large-scale demonstration and deployment. It is worth noticing that special attention must be paid to the needs of start-ups, as they have emerged to an essential stakeholder in Europe's economy of knowledge and innovation and are representing strategic allies for academia, as well as to achieving full gender equality in the sector which will allow the exploitation of valuable untaped human potential in Europe.

Academia is prepared to contribute to the systemic transformation as a trusted developer of knowledgeable and skilled people – ultimately what makes the difference in practice. Their neutral and evidence-based perspective allows them to contribute meaningfully to public consultations, certification frameworks, and the development of new standards. This independent expertise bridges the gap between industrial innovation and societal expectations, helping to align safety, sustainability, sovereignty, and competitiveness objectives. In parallel, universities continue to inspire and engage the next generation of students and professionals, ensuring the long-term vitality of Europe's aerospace research community. Universities do not simply complement industry; they enable it by providing the people, knowledge, infrastructure, and credibility upon which innovation depends.

To effectively deliver on the proposed Clean Aviation Moonshot and ensure that both disruptive innovation and rapid deployment are achieved, future research project structures should be organized into three complementary layers aligned with technology readiness levels and expected impact. **Long-term impact c**ollaborative research projects should focus on disruptive exploration and maturation up to TRL 4, coordinated by universities, research and technology organizations (RTOs), and SMEs. **Medium-term impact** collaborative research projects should target system-level integration and demonstration from TRL 4 to TRL 6, with coordination shared between universities, RTOs, SMEs, and industry. Finally,

short-term impact deployment projects should address the transition from TRL 6 to TRL 8, led by industry and SMEs, with the objective of facilitating market uptake. Ensuring the effectiveness of this structure requires sufficient overall funding, with an equal allocation of resources between early-stage exploration and maturation of disruptive technologies and downstream demonstration and deployment activities, so that breakthrough innovations can both emerge and reach the market. Such allocation is essential, as recent European research frameworks, including Horizon 2020 and Horizon Europe, have placed increasing emphasis on higher-TRL activities, creating a risk of underinvestment in disruptive, low-TRL research. Addressing this imbalance is critical to avoid erosion of the knowledge base and to ensure a continuous pipeline of breakthrough innovations for the aviation sector.

To support a coherent and comprehensive vision of future aviation research, EASN proposes an underlying framework of Priority Research Topics through which emerging challenges and technological directions are analysed and systematically connected. The Priority Research Topics identified by the EASN community span a strategic research spectrum needed for the future of European aviation. They include Net-Zero Propulsion and Energy Architectures, Ultra-Efficient Aerodynamics and Flow Control, Disruptive Aircraft Configurations for Sustainable Long-Range Aviation, Digitalization of Critical Aviation Operations: ATM/UTM Evolution and Airport Digitalisation, Digital Twins, AI-Enabled Engineering, and Data-Driven Certification, Holistic Sustainability-by-Design Frameworks, Advanced Structures and Multifunctional Materials, Next-Generation Manufacturing and Joining for Scalable, Sustainable Aerostructures, Structural Integrity, SHM/NDT, Reliability, and Secure Connected MRO, and Non-CO_2 Effects, Environmental Resilience, and Community Impact. Finally, three **cross-cutting themes** are identified as decisive enablers, **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, **skills and education**. Without coherent progress in these transversal areas, technological advances alone will not translate into deployable aviation solutions.

Current global geopolitical challenges, rising uncertainty, and growing threats to Europe's prosperity, sovereignty, and political autonomy require bold and strategic action to secure its economic, technological, sustainable, and competitive autonomy, while strengthening Europe's position as a global leader in innovation and breakthrough technologies.