Strategic Cooperation Plan on Net-Zero Aviation between Portugal and the Clean Aviation JU

- in the scope of the Memorandum of Cooperation signed on 18/03/2025 by Portugal and the Clean Aviation Joint Undertaking

1. Context

The Clean Aviation Joint Undertaking (CAJU) is the European Union's (EU) leading research and innovation programme for transforming aviation towards a sustainable and climate-neutral future, in line with the European Green Deal. It is a European public-private partnership between the European Commission through Horizon Europe (HE) (2021-2027), the EU research and innovation programme, and the European aeronautics industry. It has a budget of €4.1 billion divided into €1.7 billion in EU funding and €2.4 billion in private funding. CAJU objectives are pivotal to the European Green Deal and for the climate objectives set by the EU at international level. Clean Aviation's disruptive technologies will help reduce the greenhouse gas (GHG) emission footprint of Short-Medium Range (SMR) and Regional (REG) aircraft by no less than 30% compared to 2020 state-of-the-art aircraft. The technological and industrial readiness of the Clean Aviation technologies will support the entry into service of new product by 2035, with the aim of replacing 75 % of the global civil aviation fleet by 2050. Clean Aviation programme (2022-2031) builds on the knowledge and expertise of the Clean Sky programmes (2008-2024). For the next R&I framework programme, Horizon Europe (2028-2034), and in alignment with the European Competitiveness Fund, the EU suggests clean aviation as one of the moonshot projects to position Europe as a global leader in strategic fields.

On March 18, 2025, Portugal and CAJU signed an Memorandum of Cooperation (MoC) with the main aim to align national and European priorities and explore the R&I opportunities at EU level. This was an important added value towards the Portuguese engagement in the sustainable aviation sector at EU level. Portugal hosts leading industrial and academic actors in aeronautics and, with this MoC, aims to invest in strengthening and growth the Portuguese hub for research and innovation in clean technologies and the design, development, and production of next-generation green aircraft. With its ambitious 2022–2027 Operational Programme, Portugal also aims to contribute to the European vision of making the Union a pioneer in zero-emission air transport by 2050. This is well reflected in the Portuguese Smart Specialization Strategy (RIS), where aeronautics is identified as a strategic area for regional development, with objectives/priorities that are well aligned to the CAJU objectives. The RIS builds on research and innovation as key elements to succeed in the decarbonisation, reindustrialisation and reskilling of the aviation sector at regional level.

2. Main challenges

Achieving climate neutrality in air transport is a medium to long term ambition. To meet this challenge, it is essential to bring together the best expertise and resources from beyond the typical aviation ecosystem and include world-class research and innovation from other strategic sectors, such as Energy related with hydrogen, batteries and digital technologies. Yet, achieving a climate-neutral aviation system is well beyond the private sector's ability and capacity to invest on its own, as current estimates of the aviation sector suggest that at least €12 bn in research and innovation would be needed over the timeframe of HE. No single country in Europe has the financial, technological and industrial capacity to fully support the required transition.

Addressing this investment and coordination gap requires joint and aligned efforts. These efforts should be made at European Union, Member State and Regional level by coordinating shared roadmaps and managing synergies, pooling funding and financing sources from regional, national authorities and the European Union's Multiannual Financial Framework.[1]

3. Purpose and scope

The purpose of the Strategic Cooperation Plan on Net-Zero Aviation between Portugal and the Clean Aviation Joint Undertaking is to outline the strategic areas of cooperation between Portugal and the CAJU in the implementation of the jointly signed MoC in order to address the **investment needs and coordination technological gap,** by establishing and maximising synergies between Portugal, its regions, and the European Union, on Net-Zero Aviation. This document presents the high-level/strategic objective of the cooperation, areas of technical collaboration and the expected impacts, as well as funding opportunities launched by both parties.

4. High level objectives

The objective of this cooperation is to accelerate the demonstration of low-emission aircraft technologies and concepts, so that these innovations can be integrated in existing, under development and new aircraft from 2035 and beyond, in the pursuit of the Union's vision of Net-Zero Aviation. Specific areas of cooperation under this MoC should be followed by the Portuguese Civil Aviation Authority (ANAC) at national level to contribute to a swift certification process with European Union Aviation Safety Agency (EASA) when required (e.g. virtual certification).

5. Areas of cooperation

The CAJU's *Strategic Research and Innovation Agenda* (SRIA) sets out the path towards achieving the overall Clean Aviation vision, in terms of timeframe and scale of impact, focusing on three *thrusts:*

i) hybrid-electric regional aircraft,
ii) ultra-efficient small/medium range (SMR) aircraft
iii) hydrogen-powered aircraft.

Focus is placed on the regional and SMR segments targeting increased efficiency in commercial aviation by no less than 30% for SMR aircraft and for the regional range aircraft, as these segments account for more than 50% of global aviation GHG emissions. The first phase (2022-2026) of the Clean Aviation programme focuses on the development of concepts, technologies and architecture options. The second phase (2026-2030) will address the integration and demonstration of these technologies along clearly identified aircraft concepts having 30% GHG emissions reduction compared to 2020 state-of-the-art and with a targeted Entry in Service in 2035. The second phase ambition is detailed in the SRIA revision published in September 2024[2].

The Smart Specialization Strategy of Portugal has a strong focus on aeronautic R&I on low-emission technologies for general and commercial aviation, including regional and safety management system (SMS) segments. Several thematic areas are addressed, including ultra-efficient powertrain systems with zero/very low emissions, advanced materials, smart mobility and manufacturing, and security. In addition, the RIS3 of Portugal builds on other strategic policy priorities that are expected to play a key role in supporting the transformation of aviation towards a sustainable and climate-neutral future. In particular, the green and digital transitions where Portugal

[1] COMMISSION NOTICE Synergies between Horizon Europe and ERDF programmes https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022XC1104(02)&from=EN

[2] https://clean-aviation.eu/sites/default/files/2024-09/2024-Clean-Aviation-SRIA.pdf

plans to invest, for example, on fuel cells, hydrogen production and storage, biofuels, green airports, eco-friendly materials, recyclable materials, additive manufacturing, industrial process automation and digitalization, digital twin and digital technologies.

In line with the high-level common objective, Portugal and the CAJU will pursue **joint and aligned cooperation and synergies** in R&I on the following technical areas.

5.1. Technological Areas

i. **Intersecting synergies**, i.e. areas of intervention by both parties:

- Hybrid-electric regional aircraft with 30% increased efficiency compared to 2020 state-of-the-art aircraft available for order/delivery, namely:
  - Aircraft architecture;
  - Airframe systems;
  - Light weight airframe structures (e.g., wing, fuselage, empennage);
  - Thermal management;
  - Electrical distribution;
  - Energy generation and management;
  - Batteries for aviation application;
  - Fuels cells for aviation application;
  - Multi-MW hybrid-electric propulsion system based on fuel cells and/or battery, including system integration, sub-systems, modules and components;
  - Ground and flight demonstration and testing;
  - Novel terminal flight procedures simulation and certification, based on potentially new flight envelopes generated by Hybrid aircraft;
  - Aircraft cabin interiors – lighter and eco-efficient materials and subsystems.
- Ultra-efficient SMR aircraft with 30% increased efficiency compared to 2020 state-of-the-art aircraft available for order/delivery, namely:
  - Aircraft architecture;
  - Airframe structures;
  - Light weight airframe systems (e.g. wing, fuselage, empennage);
  - Industrial process automation and digitalization. Energy efficiency and resource optimisation manufacturing processes technologies;
  - Ultra-efficient propulsion system able to use 100% sustainable aviation fuels (SAF) or hydrogen (H2) as fuel, including system integration, sub-systems, modules and components;
  - Ground and flight demonstration and testing;
  - Aircraft cabin interiors – lighter and eco-efficient materials and subsystems.
- Hydrogen-based technologies enabling the development of regional/SMR hydrogen-powered aircraft:
  - Technology and demonstrators for multi-MW H2-fuel cell propulsion and aviation systems;
  - Propulsion system based on H2 burn gas turbines, including system integration, sub-systems, modules and components (with ultra-low NOx hydrogen combustion);
  - Liquid and cryo-compressed H2 storage and distribution onboard and on ground;
  - On-board H2 refuelling system (with venting);
  - Digitalization and integration of control and monitoring systems & data-driven predictive and adaptive systems to minimize defects and downtime,
  - Ground and flight demonstration and testing.

- Transversal areas:
  - Novel certification methods (virtual certification) and means of compliance, including simulation systems;
  - Integration of digital twins and design/in-service simulations to develop initial aircraft maintenance programs as well as maximize predictive and on-condition maintenance;
  - New sustainable, lightweight and high-strength materials and manufacturing processes;
  - Advanced materials (e.g. coating) and additive manufacturing considering circular economy;
  - Digital technologies for simulation in design and production, integration, modelling and digital twin;
  - Artificial intelligence for simulation and design including generative approaches. Digitalisation in the field of manufacturing, maintenance and certification (e.g. modelling and virtual certification, quality 4.0, Instance-level Traceability, and digital thread/AI in quality management);
  - Flight trajectories optimization and eco-flight assistance, including integration with operators, air navigation service providers and Network Managers;
  - Life-cycle assessment considering circular economy;
  - Noise mitigation technologies compatible with existing and foreseen evolutions of the European noise regulatory framework in the Union's framework (2035);
  - Advanced automation of complex manufacturing processes and Industry 6.0;
  - Sustainable industrialization (e.g. including sustainable materials and processes, reduced/renewable energy use in aeronautical manufacturing but also interdisciplinary topics on social impact of advanced manufacturing and work-force needs, training and context, etc.);
  - Advanced Digital based Dynamic scheduling and resource allocation in production or Maintenance, Repair, and Overhaul (MRO) units, reducing downtime and optimizing workforces;
  - Airport infrastructure definition, including energy generation from sustainable sources, energy storage and energy supply chain, compatibility with legacy systems and safety procedures.

The RIS3 of Portugal also focus on low-emission technologies. R&I on these technologies demonstrating "scale-up" opportunities onto regional and SMR segments could also be an area of cooperation.

ii. **Complementary synergies**, i.e., areas to be explored by Portugal (as such areas are not covered in the CAJU SRIA) and that go beyond research and innovation:

- infrastructure at airport:
  - ground-based refuelling (including protocols) and supply systems for liquid/gaseous H2 for regional/SMR aircraft;
  - large liquid H2 storage;
  - infrastructure for charging batteries ;
- Development, production, storage and use of green hydrogen and SAF in Portugal;
- Advanced Air Mobility concepts (next-generation UAS platforms);
- Development of novel interior systems and materials for legacy and advanced air mobility in the context of Net-Zero Aviation;
- Testing and Maintenance.

6. Expected impacts

The cooperation between Portugal and the CAJU is expected to maximize impact on the following areas:

- Increased number of demonstrated low-emissions aircraft technologies and concepts with EIS by 2035.
- Increased number of spill-over effects including new stakeholders, competences, and capabilities (including newcomers from other sectors to the field of aeronautics, in particular SMEs, start-ups and/or knowledge research centres that can bring disruptive innovation) from the outset of CAJU and Portuguese funded projects contributing to the high-level common objective, as stated in section 4.
- Increased exposure of legal entities (such as research institutes, SMEs and public administration) based in Portugal to the CAJU opportunities and increased engagement of these entities to the Clean Aviation objectives and EU Green Deal objectives.[3]
- Increased exposure of legal entities (such as research institutes, SMEs and public administration) based in Portugal to the R&I in aviation at European level and leading players worldwide, including CAJU Members and beneficiaries.
- Developed capabilities required for the future supply chain of the next generation of aircraft, and growth and increased competitiveness of the legal entities based in Portugal.
- Enhanced positioning Portugal as a high-level expertise industrial Hub for OEMs and TIERs actors to invest and implement their production and Excellence Centres.
- Increased number of jobs, skills and competences in Portugal relevant to support transition towards climate neutral aviation by 2050.

7. Funding and timeline

As mentioned in section 1, CAJU is jointly funded by the European Union (€1.7 billion) and private members (€2.4 billion), bringing the total budget to €4.1 billion for the period 2021-2027 (end of funding in 2031). Funding is assigned to applicants according to the HE regulation through open and competitive calls for proposals. Since the programme started, CAJU has launched three calls and funded 31 European projects. Further calls for proposals will be launched during the programme. In phase 1 of the Clean Aviation Programme (2022-2026), the focus is placed on developing and down-selecting technologies with highest potential to reach TRL 6 by 2030. In phase 2 (2026-2031), the focus is placed on ensuring further maturation and demonstration of the selected technologies up to TRL 6, including aspects related to industrialisation to maximise potential entry into service around 2035.

Portugal will mobilise 15 million euros **from ERDF for the period 2025-2026 and will explore additional funding from other programmes** (e.g. national funds) for innovation projects in sectors that RIS considers to be priority systems, such as aerospace, mobility, advanced manufacturing, and green technologies. During the 2021–27 period, Portugal will also be able to allocate additional funding to support the aviation sector from programmes.

As a first action of this plan, Portugal, through the National Innovation Agency (ANI), has planned:

- call for proposals "SIID – I&D Empresarial – Operações em Copromoção ou Individuais – Parcerias Internacionais (Canadá)" supported by **€ 9 million euros** for Research and Development (R&D) operations, carried out individually or in co-promotion, aligned with the priority areas of the Research and Innovation Strategy for Smart Specialisation, which aim to promote strategic partnerships in the Space, Aeronautics, and Defence sectors between Portugal and Canada launched in 2024.
- call for proposals supported by € **6 million euros**, under the thematic scope of the current roadmap, by the 2nd semester of 2025.

[3] Through the financial tool "Contract Innovation", the Piemonte Region supports companies that need to carry out feasibility studies in order to assess the viability of a project before applying to CAJU's Calls for proposals

8. References

- Council Regulation establishing the CAJU, (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf.
- CAJU Strategic Research and Innovation Agenda (2024) https://clean-aviation.eu/sites/default/files/2024-09/2024-Clean-Aviation-SRIA.pdf
- COMMISSION NOTICE Synergies between Horizon Europe and ERDF programmes https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022XC1104(02)&from=EN

9. Glossary

CAJU : Clean Aviation Joint Undertaking
EIS : Entry-In-Service
EU : European Union
HE: Horizon Europe
RIS3: Research & Inovation Smart Specialization Strategy
SMEs : Small Medium Enterprises
SMR : Short-Medium Range
SRIA : Strategic Research and Innovation Agenda