Institute for Sustainable Aviation: Three Years of Interdisciplinary Research and Training Excellence

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Located in Toulouse, at the heart of the European aeronautics metropolis, the Institute for Sustainable Aviation (ISA) is a large academic consortium dedicated to advancing research and training for sustainable air transport. Bringing together leading institutions of the University of Toulouse, such as ISAE-SUPAERO, ENAC, and the Toulouse School of Economics (TSE), ISA fosters interdisciplinary collaboration at the intersection of engineering, economics, and environmental sciences. Over the past three years, ISA[1] has been driving forward key initiatives that contribute to shaping the future of air transport. This article highlights some of the most impactful research projects, partnerships with stakeholders, and training programs, demonstrating its commitment to preparing the next generation of experts in sustainable aviation.

Pioneering Research for a Greener Aviation Future

AeroMAPS: A Comprehensive Decision-Support Platform

The AeroMAPS (Aviation Environmental Roadmap for Multidisciplinary Assessment of Prospective Scenarios) framework has been developed as an open-source tool designed to model and evaluate decarbonization pathways for air transport. This platform integrates models of air traffic evolution, fleet renewal strategies, alternative fuels, and environmental impact assessments to provide a holistic view of aviation sustainability. Its growing scope and transparency have brought it much legitimacy and interest from Airbus, EUROCONTROL, and a growing user community.

More than just a modelling tool, AeroMAPS serves as a collaborative platform enabling researchers, policymakers, and industry stakeholders to explore future scenarios. By simulating various technological, economic, and regulatory measures, it helps anticipate challenges and optimize strategies for reducing aviation's environmental footprint. Its accessibility through a web application[2] positions it as an ideal resource for young researchers seeking to engage with real-world sustainability challenges in aviation.

PhD Research: Transforming Fleet Assignment for Decarbonization

Research led by Paco Viry focuses on advancing global fleet assignment models to better capture the dynamics of aircraft allocation on different routes. Traditional fleet

1 www.isa-toulouse.com
2 https://aeromaps.isae-supaero.fr/

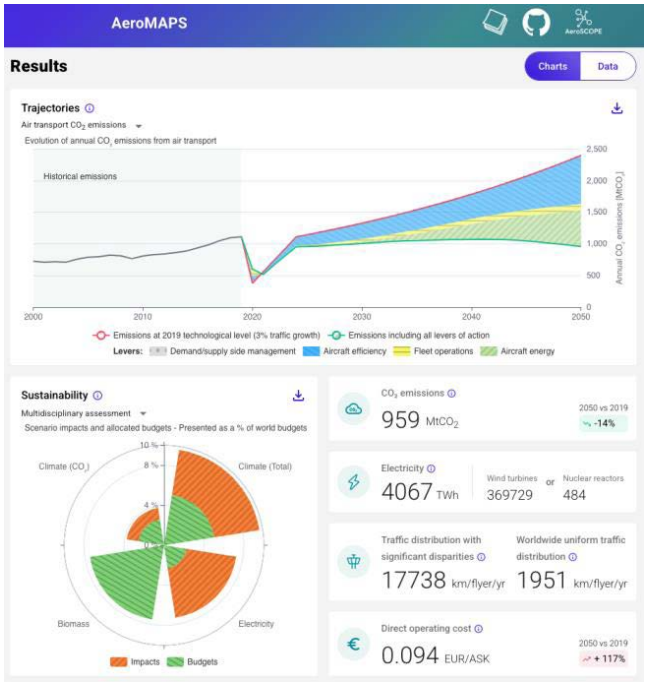

FIGURE 1: Overview of the AeroMAPS modelling tool.

segmentation approaches rely on static classifications of aircraft by size and range, which fail to account for evolving aircraft capabilities and market changes.

By employing an adapted weighted multinomial logit model, this research introduces a more flexible, data-driven approach to fleet renewal planning. The model incorporates route-specific characteristics, fuel efficiency trends, and competition dynamics, allowing for a more precise estimation of how new aircraft types—such as hydrogen-powered or hybrid-electric planes—will integrate into airline operations. This work lays the foundation for more accurate projections of fleet evolution and its impact on aviation decarbonization strategies.

PhD Research: The Economic Viability of Low-Carbon Fuels

Research conducted by Antoine Salgas explores the economic implications of integrating low-carbon fuels into future aviation scenarios. Using the Climate and Aviation - Sustainable Trajectories (CAST) simulation framework, this study links fuel production costs to industry-wide sustainability strategies. Access the PhD report here[3].

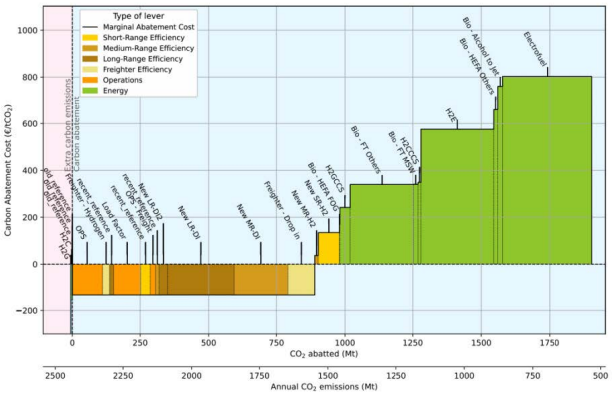

FIGURE 2: Example of carbon abatement cost assessed with the Climate and Aviation - Sustainable Trajectories (CAST) simulation framework.

Findings indicate that while sustainable aviation fuels (SAF) and hydrogen will play a critical role in reducing emissions, their adoption comes with significant financial challenges. By analysing various cost scenarios, including the impact of carbon pricing and policy incentives, this research supports decision-making processes aimed at designing pathways that balance environmental goals with economic feasibility. Such insights are essential for shaping investment decisions in aviation's transition to a low-carbon future.

PhD Research: Welfare Effects of Decarbonizing Aviation through market-based policies

Mudit Dhakar's research, conducted at the Toulouse School of Economics (TSE), investigates the welfare effects of market-based policies aimed at reducing aviation emissions. The study focuses on the impact of taxation mechanisms such as fuel taxes, carbon pricing, and airport charges on air traffic demand, airline strategies, and consumer welfare.

By employing a two-sided market model, the research assesses the trade-offs between environmental gains and economic costs, providing insights into how taxation policies can be optimized to achieve decarbonization goals with minimal adverse effects on passengers and industry stakeholders. This work is instrumental in guiding policymakers toward effective and balanced aviation decarbonization strategies.

3 https://depozit.isae.fr/theses/2025/2025_Salgas_Antoine.pdf

Innovating Education for Future Leaders in Sustainable Aviation

The TransitionS Program: A New Educational Paradigm

To equip future professionals with the knowledge and skills required for sustainable aviation, ISAE-SUPAERO and ENAC have jointly developed the TransitionS program, a groundbreaking interdisciplinary training initiative. This program redefines aviation education by integrating online learning, engineering expertise, and socio-economic perspectives.

TransitionS offers a diverse range of courses tailored to different audiences:

- **MOOCs (Massive Open Online Courses)**: Short, accessible courses (57 hours) designed for the general public, launching in 2025.
- **Certification Programs**: More in-depth modules (30-60 hours) aimed at undergraduate students and industry professionals, available from 2025.
- **Online Master's Degree**: A comprehensive 500-hour program focusing on sustainable aviation strategies, set to launch in 2026.

Beyond conventional aeronautical engineering training, TransitionS emphasizes systemic thinking. Participants explore the economic models of aviation (functional and circular economies), evolving travel behaviours, and the environmental impacts of aviation (climate, biodiversity, andresource use). The curriculum is designed to develop three core competencies:

1. **Environmental impact assessment** of aviation-related products and services.
2. **Designing sustainable solutions**, including new aircraft concepts, alternative fuels, and regulatory strategies.
3. **Implementing transformation strategies** in aviation organizations, ensuring a practical, real-world approach to sustainability challenges.

By leveraging online education, the TransitionS program breaks the barriers of traditional classroom learning, making high-quality, interdisciplinary training accessible to a global audience. This initiative demonstrates a commitment to engaging bright minds worldwide in the quest for sustainable aviation.

Collaborating with Industry for a Sustainable Future

Partnership with Airbus: Advancing Environmental Impact Assessment

Collaboration with Airbus focuses on refining methodologies for assessing the environmental impact of air transport. This partnership aims to develop comprehensive Life Cycle Assessment (LCA) tools that account for both CO_2 and non-CO_2 climate effects, as well as the broader environmental consequences of aircraft operations.

Through the integration of improved climate models into AeroMAPS, this initiative bridges the gap between theoretical impact assessments and practical industry applications. Work includes refining NO_x emissions impact models, updating aviation life-cycle inventories, and developing open-source climate assessment tools. Additionally, a complementary research project examines the influence of climate risks on passenger demand. This initiative explores how financial and environmental uncertainties shape travel behaviours, providing Airbus with insights into future market trends and sustainable business strategies. These efforts contribute to Airbus' long-term strategy for reducing the environmental footprint of air transport and tailoring AeroMAPS to become Airbus' reference scenario platform.

Collaboration with Thales: Tackling Air Traffic Inefficiencies

In partnership with Thales, research is being conducted to address inefficiencies in air traffic management (ATM) to improve operational sustainability. By analysing real-world flight data and simulating optimized air traffic scenarios, researchers are developing new methodologies to measure and mitigate inefficiencies in the ATM system.

The project employs a dual approach: a data-driven analysis of past flight trajectories to quantify operational inefficiencies, and a simulation-based method to model and optimize air traffic flows under various constraints.

This work is crucial in identifying and reducing excess fuel burn, unnecessary delays, and operational bottlenecks, all of which contribute to aviation's carbon footprint.

Through this partnership, these findings are being implemented into real-world scenarios within the AeroMAPS platform, demonstrating tangible pathways for increasing the efficiency of global air traffic operations.

Looking Ahead: The Next Chapter in Sustainable Aviation

As a leading academic consortium, ISA will continue to expand its research and education efforts. New projects are on the horizon, focusing on hydrogen-powered aviation, air-rail multimodality, and enhanced regulatory frameworks. By fostering collaboration between researchers, industry leaders, and policymakers, ISA aims to accelerate the aviation sector's transition to a more sustainable future.