Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #
Preferred Topics: SUSTAV / CLINAV
Corresponding author: WEINOLD Michael
e-mail of corresponding author: michael.weinold@psi.ch
Type: Oral
Status of corresponding author: Student
For student corresponding author: student member of one of the following:
SVFW (Schweizerische Vereinigung für Flugwissenschaften)

Title

Aircraft Fuel Efficiency Improvements: The Pathway to Evidence-Based Forecasts

Authors

Michael WEINOLD[1], Philipp ROHRER[2], Russell McKENNA[3,4]*

** Corresponding author*
[1] Paul Scherrer Institute, Group for Technology Assessment, Villigen, Switzerland, michael.weinold@psi.ch
[2] ETH Zurich, Department of Mechanical Engineering, Zurich, Switzerland, rohrerph@ethz.ch
[3] ETH Zurich, Department of Mechanical Engineering, Zurich, Switzerland, rmckenna@ethz.ch
[4] Paul Scherrer Institute, Laboratory for Energy Analysis, Villigen, Switzerland

Abstract

Air transport today constitutes around 2% of global carbon emissions [1]. Industry and policy makers have agreed to work towards *"net-zero air transport by 2050"* [2]. High levels of efficiency improvements have already been achieved in air transport, for instance modern passenger aircraft presently burn 95% less fuel per passenger kilometer than the first jet aircraft of the 1950s [3]. Hence the required efficiency improvements will necessitate novel aircraft designs and the large-scale production of synthetic fuels.

However, the underlying drivers of this improvement are still poorly understood. This is because overall efficiency is an aggregate metric, which is affected by aircraft weight, engine efficiency, drag, seat load factor, routing, operational procedures, etc. Some of these are limited by physics, others by economic considerations. While data is readily available for overall efficiency, the disaggregation into sub-efficiencies, such as the thermodynamic efficiency of the engines, requires advanced statistical methods. This means that past and future efficiency improvements are often discussed only superficially in scientific literature and government reports, for instance *"Future efficiency improvements are expected to continue at a much lower rate."* [4]. This presents a vital gap in our understanding of technological innovation in aviation. It is thereby difficult to make evidence-based policy recommendations about further research to accelerate innovation in sustainable aviation.

Our contribution will provide the most up-to-date rendering of data on historical aircraft fuel efficiency improvements from the first jet aircraft of the 1950s to today in the context of a larger ensemble of propulsion technologies. It will provide first insights into the underlying drivers of this improvements and contextualize the respective contributions of future improvements by providing physical and economic limits. This will provide a foundation for high-level discussions about the future of sustainable aviation and any related policy measures.

References

[1] Prussi, Matteo, et al. "CORSIA: The first internationally adopted approach to calculate life-cycle GHG emissions for aviation fuels." Renewable and Sustainable Energy Reviews 150 (2021): 111398.
[2] "Waypoint 2050," ATAG, Geneva, Switzerland, Tech. Rep., Sep. 2021. [Online].
Available: https://aviationbenefits.org/environmental-efficiency/climate-action/waypoint-2050/.
[3] D. Lee, D. Fahey, A. Skowron, et al., "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018," en, Atmospheric Environment, vol. 244, p. 117 834, Jan. 2021, ISSN: 13522310. DOI: 10.1016/j.atmosenv.2020.117834.
[4] S. Nick and P. Thalmann, "Towards True Climate Neutrality for Global Aviation: A Negative Emissions Fund for Airlines," en, Journal of Risk and Financial Management, vol. 15, no. 11, p. 505, Nov. 2022, ISSN: 1911-8074. DOI: 10.3390/jrfm15110505.