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Title

Consideration of Technology Scalability in the Design of Electric Propulsion System Architectures

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Abstract

This work presents an investigation of electric propulsion system architectures for different aircraft categories with the focus on identification of scaling opportunities for the underlying technologies across different aircraft categories. The aviation community has committed to a net-emission free operation of commercial aircraft until 2050 [1], which requires radical technology advancements on overall aircraft and subsystem level. Both electric and hybrid electric propulsion represent promising concepts to achieve net-zero emission [2]. While traditional combustion engines only leave small room for further improvement, electric propulsion systems open a new design space with various possibilities for propulsion layout and subsystem architectures. Previous research shows that there is no "one-fits-all" optimal propulsion system layout for the different aircraft sizes [2, 3]. This has led to multiple solutions being developed in parallel in which the focus is set on a single specific aircraft class or application, resulting a lack of scalability for the technologies used.
Instead of optimizing a system architecture for each aircraft category and specific use case, this work, which is part of the European project SIENA [4], takes a novel approach focused on the aspect of scalability in the design process answering the question whether a less optimal systems architecture for a certain application enables commonality and reusability of the underlying technologies over a wider range of applications. Building on the experience from small aircraft categories, where electric propulsion is already feasible today, towards larger aircraft categories can reduce the time for entry into service significantly. In this context, so-called switching points are identified, i.e., "seams" in the design space of aircraft categories and system architectures where optimal technology options change. Based on a pre-selection of candidate system architectures, this work presents a vehicle-level evaluation of these architectures for five aircraft categories ranging from nine-seat general aviation aircraft up to large, long-range commercial transport aircraft. In this regard, the main key performance indicators for the evaluation on vehicle level are the takeoff gross weight and the payload-range energy efficiency which is the inverse of the energy required to fulfill the aircraft's transportation task on a given flight mission.

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References

[1] E. van der Sman, B. Peerlings, J. Kos, R. Lieshou, T. Boonekamp, Destination 2050: A Route to Net Zero European Aviation, NLR-CR-2020-510, Amsterdam, 2021
[2] National Academies of Sciences, Engineering, and Medicine, Commercial Aircraft Propulsion and Energy Systems Research: Reducing Global Carbon Emissions, Washington, DC, 2016
[3] R.H. Jansen, C. Bowman, A. Jankovsky, A. Dyson, J.L. Felder, Overview of NASA Electrified Aircraft Propulsion (EAP) Research for Large Subsonic Transports, 53rd AIAA/SAE/ASEE Joint Propulsion Conference, Atlanta, GA, 2017
[4] B. Aigner, A. Garcia Garriga, G. Sirtori, C. Riboldi, L. Trainelli, C. Mariani, M. Mancini, Overview and preliminary results of the Scalability Investigation of hybrid Electric concepts for Next-generation Aircraft (SIENA) project, EASN Conference, Barcelona, Spain, 2022