TECHNOLOGY SELECTION FOR HOLISTIC ANALYSIS OF ELECTRIC COMMUTER AIRCRAFT

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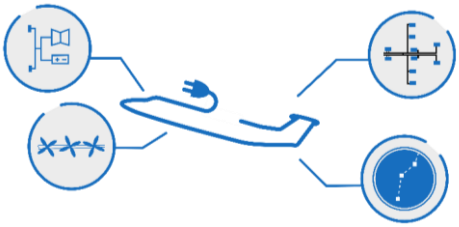
Abstract

The electrification of powertrains opens up the possibility of an improved environmental impact compared to conventional aircraft engine by using alternative energy sources, such as batteries or hydrogen. Since the mere change of a conventional propulsion to a (partially) electric powertrain leads to non-optimal and unrealistic heavy designs, suitable electric propulsion architectures in combination with upcoming technologies have to be identified[1]. These technologies, which are enabled by the electric powertrain, can provide better aircraft performance through synergy effects with different forms of aero-propulsive integration, electrified aircraft systems, and operating strategies. The results will serve as a starting point for the detailed analysis of the selected technologies to enable a holistic evaluation of electric flight in the LuFo-project GNOSIS in terms of emissions, costs and safety aspects.

Based on the conventionally powered Beechcraft 1900D, the CO_2 and NO_X emissions, cost, and noise trends of the different technology options were estimated on aircraft level through literature review and simplified methods and compared to the conventional aircraft. An initial preliminary design space exploration determined different hybridization architecture and -ratios (piston/gas turbine + generator, battery) within the CS-23 guidelines and considered changes in wing mass, specific battery energy and propulsive efficiency. Afterwards, incompatible technology combinations were excluded to form technology packages for the time horizons 2025 and 2050. Finally, the technology packages were ranked using the TOPSIS (Technique for order preference by similarity to ideal solution) methodology[2].

The technology ranking and the preliminary design space exploration yielded a partial turbo-electric powertrain for the 2025 timeframe. The conventional gas turbine is either located at the tail (wake ingestion) or at the wing powering additional electric driven propellers at the wing leading edge. For 2050, a serial hybrid powertrain, which combines a gas turbine or a fuel cell with a battery, turned out to be most promising. At this timeframe, thrust is generated electrically by fuselage propulsion and distributed propellers at the wing.

An investigation of the regulatory aspects of the CS-23 and CS-25 concluded the technology selection and revealed that the integration of the internal combustion engine at the tail in 2025 is associated with different certification aspects and significant integration challenges.



[1] Moore, M. D., and Fredericks, B., “Misconceptions of Electric Propulsion Aircraft and their Emergent Aviation Markets”, 52nd Aerospace Sciences Meeting, American Institute of Aeronautics and Astronautics, National Harbor, Maryland, 2014. doi:10.2514/6.2014-0535

[2] Hwang, C.-L., Yoon, K., „Multiple Attribute Decision Making: Methods and Applications: A State-of-The-Art Survey”, Springer-Verlag, Berlin, 1981. ISBN 978-3-642-48318-9