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Title

Feasibility studies for a medium size regional aircraft with battery powered propulsion system

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Abstract

With increasing awareness for global warming and research efforts in all industries to reduce climate impact, electrification of transport is an omnipresent topic. In aviation, electrically powered aircraft are often proposed as part of the solution. The electric powertrain components generally have much higher efficiencies for converting energy into thrust than combustion engines and would allow additional integration benefits, such as distributed propulsion or boundary layer ingestion, to further improve energy efficiency of aircraft. Preventing the wide introduction of electrically powered aircraft in all aircraft classes is energy storage. The gravimetric energy density of batteries is magnitudes lower than for fossil fuels, limiting range and aircraft size where battery electric propulsion is feasible [1].
But battery technology is improving and interest in aircraft electrification is increasing, the first battery powered small general aviation airplanes are commercially available and aircraft of the commuter class are being developed (Pipistrel Velis Electro, Eviation Alice).
In this paper a preliminary sizing of a battery powered regional aircraft based on an ATR 42-500 is presented. The focus is on the powertrain sizing, utilizing analytical and empirical models for electric motors, inverters, batteries and thermal management systems combined to a powertrain, while the aircraft design or outer mold line is only scaled. The sizing is based on a time-step simulation of a full aircraft mission, from take-off over climb and cruise to descent, including reserves. The methodology has already been used in [2] for different propulsion architectures.
To validate the sizing procedure and baseline aircraft data, a conventionally powered aircraft is sized to the ATR 42-500 requirements and compared to the original data. Thereafter, a fully electric version of the baseline aircraft is sized, utilizing state of the art technology. Preliminary results indicate that mission requirements will have to be relaxed to enable a fully electric design. As comparison of different propulsion architectures is only fair if the operating strategy is optimized for the corresponding powertrain [3], parameters like climb rate, altitude and speeds over the mission will be optimized for the new aircraft.
In a final study, aircraft for future technology levels, improving weight and efficiency of the electric powertrain components, and different mission profiles will be sized and analyzed to assess the impact of especially battery technology on the weight and efficiency and therefore feasibility of medium size regional aircraft.

References

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