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Title

High-level Sizing Method for Hybrid Electric Distributed Propulsion Aircraft

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Abstract

New concepts of aircrafts associated with new energy carriers question the sizing processes of such aircrafts. The assessment of some sizing parameters, especially masses, is usually based on historical data and laws [1]. The validity of these data and laws is questionable for new aircraft concepts. This work takes place in the research and development team at Avions Mauboussin, a French light aircraft manufacturer. The research work aims at developing a new sizing method for hybrid electric distributed propulsion aircraft.

The case study is based on a hybrid electric distributed propulsion aircraft. Different propulsion systems are studied under the influence of several parameters. The sizing of these systems depends on the management of energy throughout the mission profile [2] and the management of power for some flight phases. The following powertrains are studied: serial hybrid, parallel hybrid and serial hydrogen fuel cell hybrid.

The high-level aircraft sizing constraints require to work with a broad design space [3]. Inputs, parameters and outputs of the developed methodology follow rules. On the one hand, inputs and parameters are managed by the aircraft manufacturer. On the other hand, outputs are provided to part manufacturers. The wing profile is an example of such an input/parameter rule: it can be assessed by an aircraft manufacturer through wind tunnel testing.

The method follows model-based design concept. Therefore, models representing flight mechanics, aircraft aerodynamics or even electric motors standardized behaviours are implemented in a global model which allows a first design definition. Some limits are imposed by the model assumptions. The aircraft is modelled as a tube-and-wing configuration with rectangular wings. The distributed propulsion is positioned upstream from the wing leading-edge. The outputs of this methodology belong to two categories. Some outputs, such as hybridization rates, are used by the aircraft manufacturer to better understand the propulsion system and its energy sizing. The other outputs, such as thrust coefficient, power coefficient, advance ratio, speed-voltage ratio, etc., are then used by part manufacturers.

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