



DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

# Performance assessment of part-electric General Aviation aircraft

Task definition of *Diplomarbeit* at HAW Hamburg

## Background

The power of an internal combustion (IC) engine, being approximately proportional to the mass flow of air into the engine, reduces with an increase in altitude as the air density drops. At an altitude of 8000ft (2440m), which is typical for a long distance cruise of a light aircraft, the power output is reduced by approximately 21% (the air density is about 0.79 of that at sea level). The power output of an electric motor is independent from this density change, so that a hybrid engine, consisting of an internal combustion engine and an electric motor, would suffer a smaller reduction in power output. Currently this power loss is prevented by engine mounted turbo- or superchargers. Solar cells, attached to the aircraft's upper surfaces, are a possibility to partly recharge the energy storage during flight..

## Objective

The objective is to assess if a hybrid engine, is, or under what circumstances could be, a competitive alternative to the currently used IC aero-engines. The investigation shall consider aspects of technical feasibility, operating costs, and environmental pollution. Furthermore, it is required that the investigation considers a practical and useful design, rather than an experimental, technology demonstrator. Task breakdown:

- The candidate shall perform a literature review of (1) existing applications of hybrid and electric propulsion systems in General Aviation (GA) aircraft, (2) automotive hybrid engines, and (3) electric motors, energy storage devices and solar cells.
- The candidate shall select an aerodynamically efficient GA aircraft (or number of aircraft) as a reference aircraft and shall determine its primary aerodynamic and performance characteristics (e.g. drag polar, propeller efficiencies, power, range, climb performance and endurance).
- The candidate shall complete a short concept design study, which will replace the existing IC engine with a hypothetical hybrid engine. Considering a reference mission, the required fuel volume and battery capacity will be determined. The primary output of the study will be the change in aircraft weight.

- The candidate shall investigate the maturity of the technologies used (e.g. the battery weight and storage capacity, fuel cost, electric motor power to weight ratio, solar panel efficiency) and explore the future viability of the concept.

The results have to be documented in a report. The report has to be written in a form up to internationally excepted scientific standards. The application of the German DIN standards is one excepted method to achieve the required scientific format.



The thesis is prepared at the University of Limerick, Department of Mechanical & Aeronautical Engineering. Supervisor is Dr. Trevor Young.