

Fuel cell system design and optimization: The *airfox* tool

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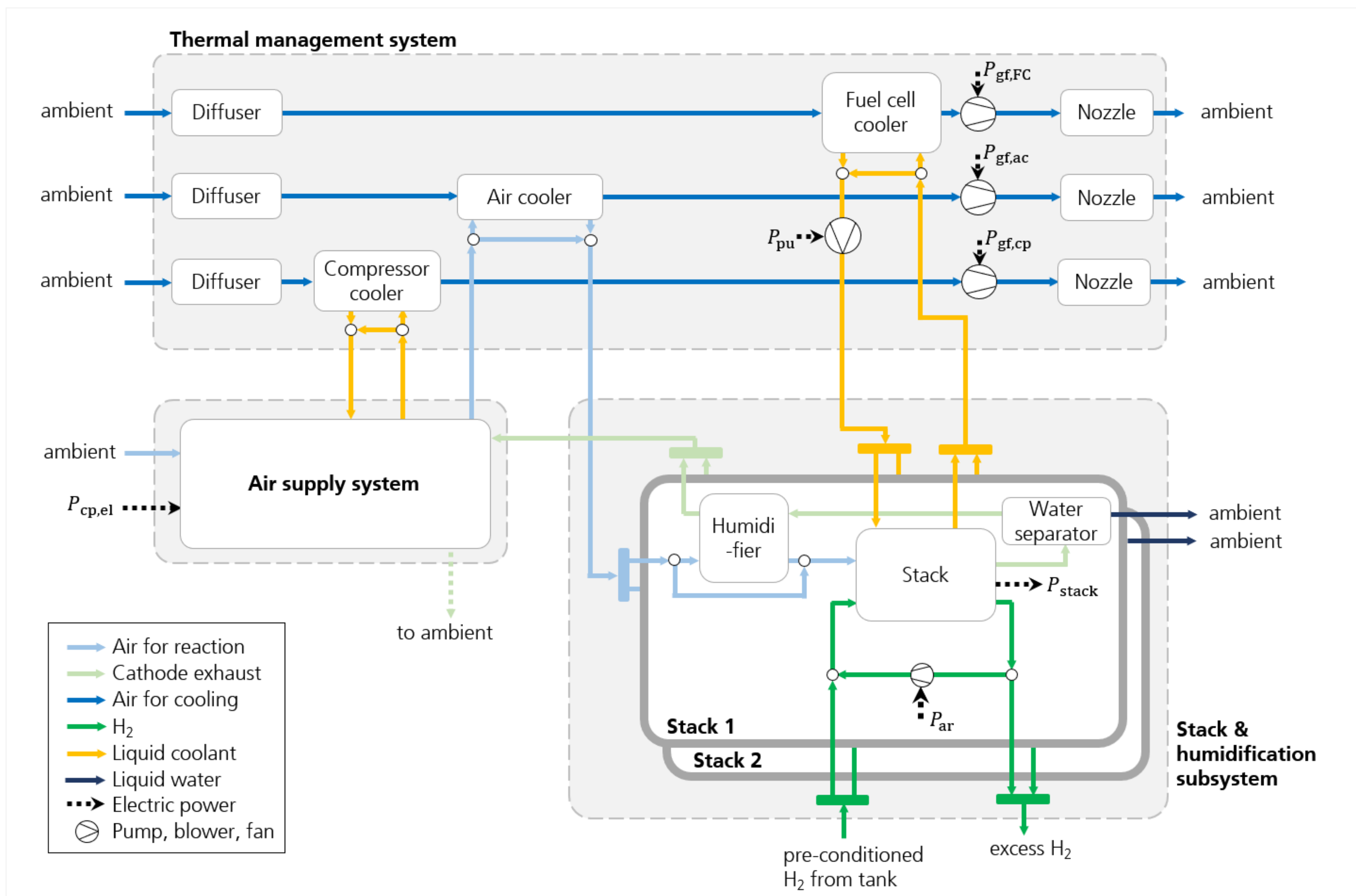


Fig. 3: Layout of one of the fuel cell systems in the MHEP short-range aircraft [1]

Fuel cells in the EXACT project

In EXACT, fuel cells are investigated as an auxiliary power source for the Mild-Hybrid-Electric-Propulsion (MHEP) architectures for short-range aircraft (see Fig. 1).

Fuel cells are a promising technology for the auxiliary power supply in aircraft with hydrogen combustion because of their unique efficiency characteristics:

- Because fuel cells are not limited by the theoretical Carnot cycle efficiency, they can achieve higher efficiencies than gas turbine engines.
- The efficiency of fuel cells increases for partial load operation, whereas the efficiency of gas turbines decreases at partial loads.

A challenge for fuel cell systems is their specific power (0.5 to 0.75 kW/kg), which is much lower than that of modern gas turbine engines. This challenge is addressed in EXACT, where we aim to improve the specific power of fuel cell systems for aviation with innovative air supply system topologies and an optimized fuel cell system design.

The *airfox* tool

The analysis of various fuel cell system configurations is conducted with DLR's *airfox* tool. The tool has been developed by DLR's Institute of Engineering Thermodynamics (TT).

The tool is successfully used for DLR-internal projects, third-party funded projects and industry research.

The tool predicts the efficiency, mass, volume and drag of fuel cell systems in various power classes, ranging from 100 kW up to 1.5 MW. Exemplary results are shown in Fig. 2. The tool currently focusses on LT-PEM fuel cells, because this type achieves a superior specific power and lifetime compared to other fuel cell types.

The system layout of a LT-PEM fuel cell system and its thermal management system are depicted in Fig. 3. The tool simulates the interaction of the stacks and auxiliary components with validated models for the fuel cell stack, humidifier, air supply system and thermal management system.

Learn more about our work on fuel cell systems in our latest publication:



[1] <https://doi.org/10.1016/j.enconman.2024.118338>

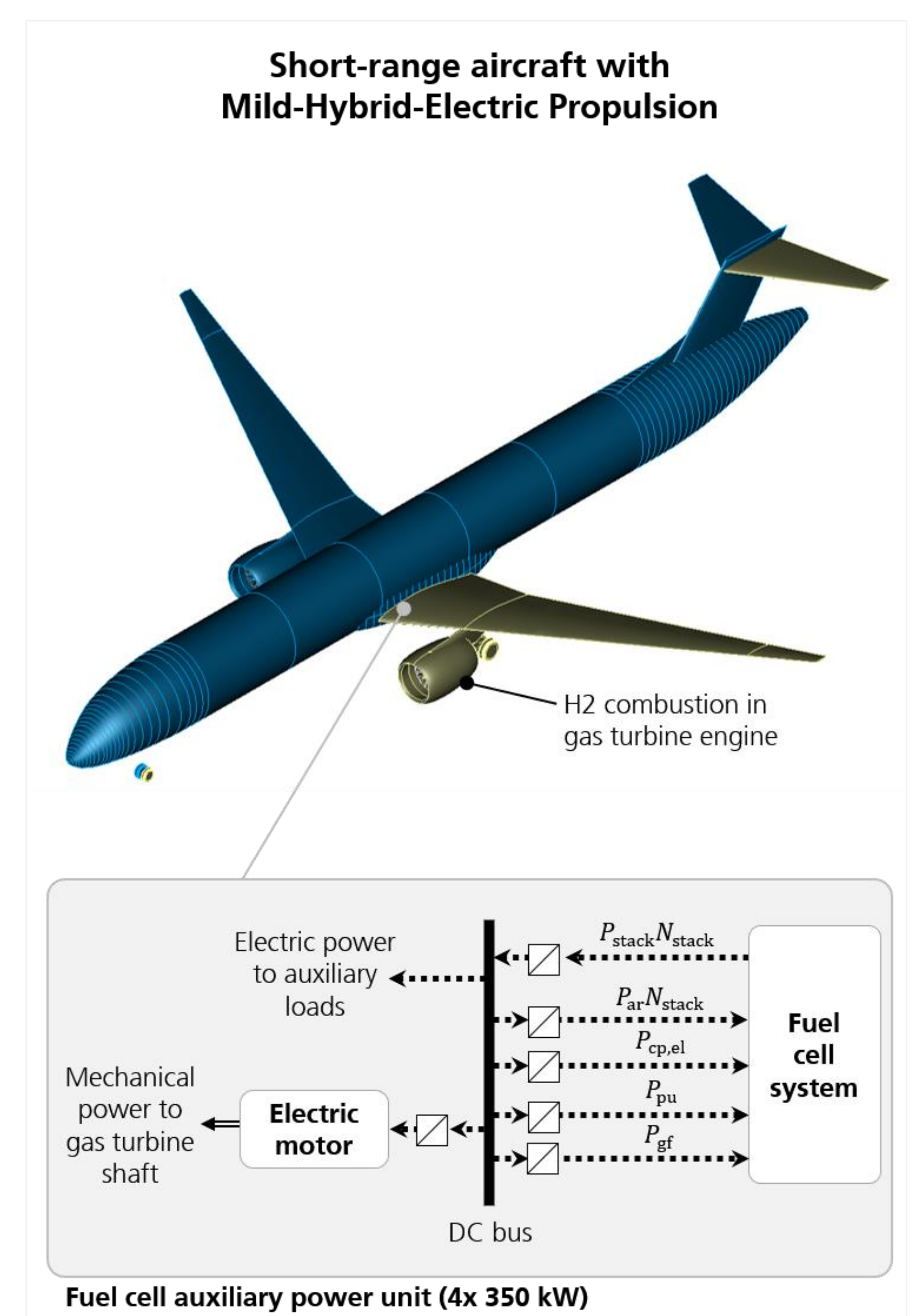


Fig. 1: Fuel cell system interfaces in the MHEP short-range aircraft

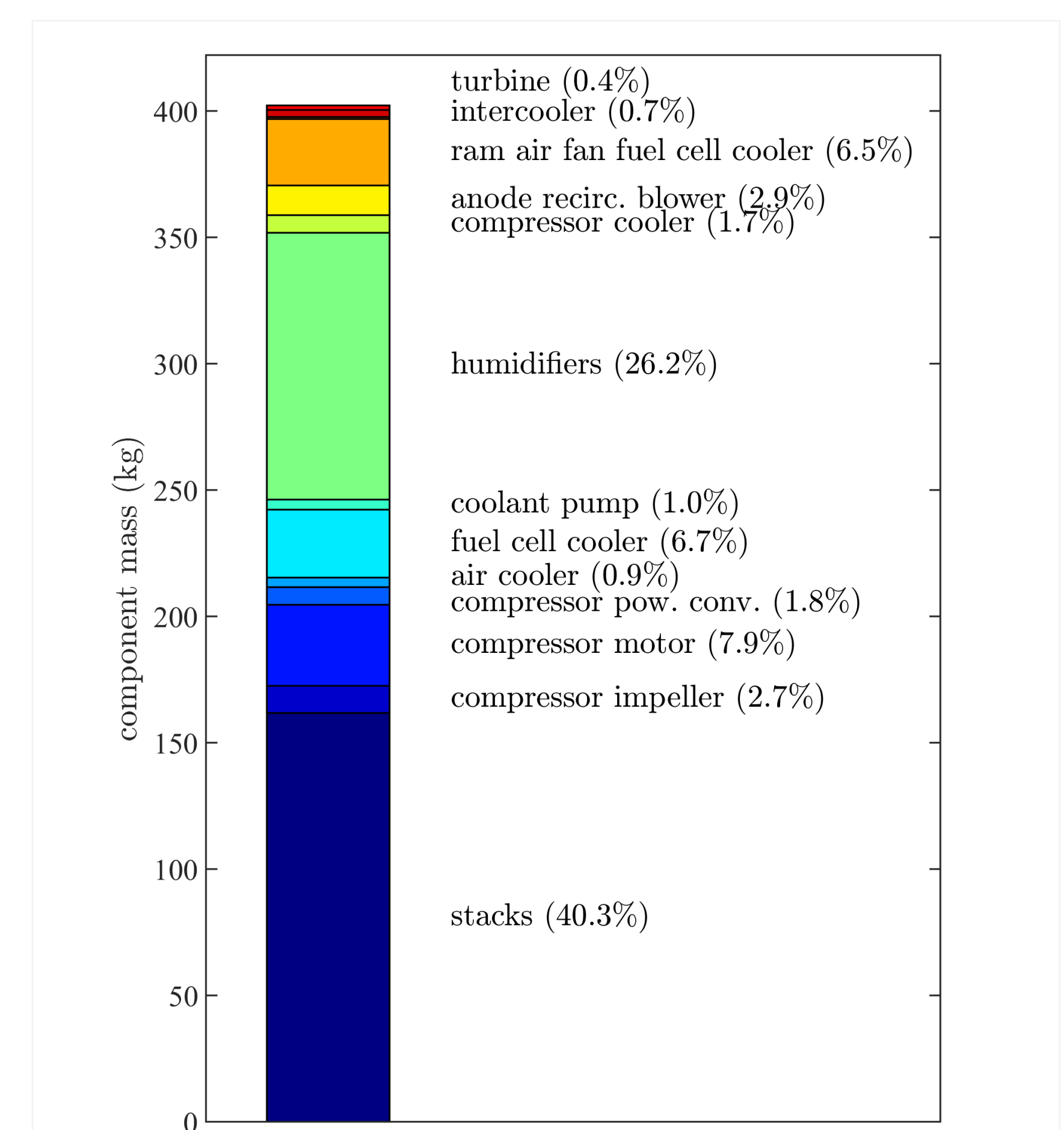


Fig. 2: Predicted mass of components in a 350 kW fuel cell system, with technology assumptions for 2040

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