FlyECO

FUTURE ENABLING TECHNOLOGIES FOR HYDROGEN-POWERED ELECTRIFIED AERO ENGINE FOR CLEAN AVIATION

Project Coordination: Dr. Stefanie de Graaf, DLR Institute of Electrified Aero Engines

Outcomes

- Increase of overall propulsion system efficiency by use of hybridisation strategies
- Deliver advanced simulation tools, validation methodologies and controls approaches
- Eliminate aviation CO_2 emissions as well as reduce NO_x emissions

Hybridisation Strategies

Mechanical Integration

Using the electrical energy produced by the solid oxide fuel cell (SOFC) to contribute to the total IPPS power leads to

» reduction of power demand for the gas turbine (GT)

» improved block fuel efficiency

Thermodynamic Integration

Injection of all output products from SOFC into GT combustor leads to

» increase of enthalpy and reduction of NO_x emissions

» elimination of additional compressor to feed the SOFC

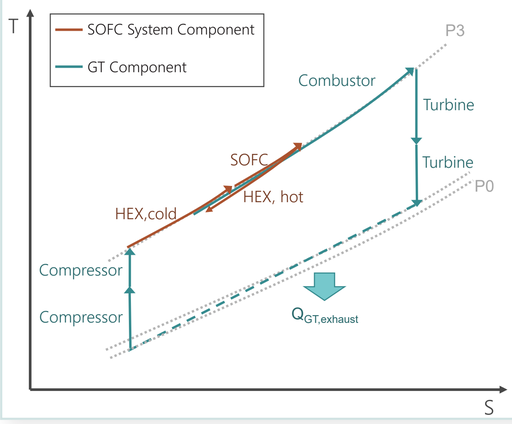
» improved block fuel efficiency

Methodology and Preliminary Results

Development of a 1D **SOFC performance model** along the gas channel, based on a validated 0D model

Thermodynamic **GT modelling for performance analysis** of take-off and cruise conditions, performed in *Turbomatch* - a software from Cranfield University

Ideal T-S Diagram



Requirements Analysis of the Integrated Power and Propulsion System (IPPS) and detailed design of Balance of plant components enable the GT and SOFC components to work together respecting their operating ranges during the whole mission

IPPS Parametric Design Analysis considering SOFC operating limits for temperature and pressure as well as ist mass flow requirements for bleed air from gas turbine for an electrical degree of hybridisation between 10% and 50%

Preliminary Functional Analysis to define primary functions

Preliminary Organic Analysis to identify the physical system components

Results

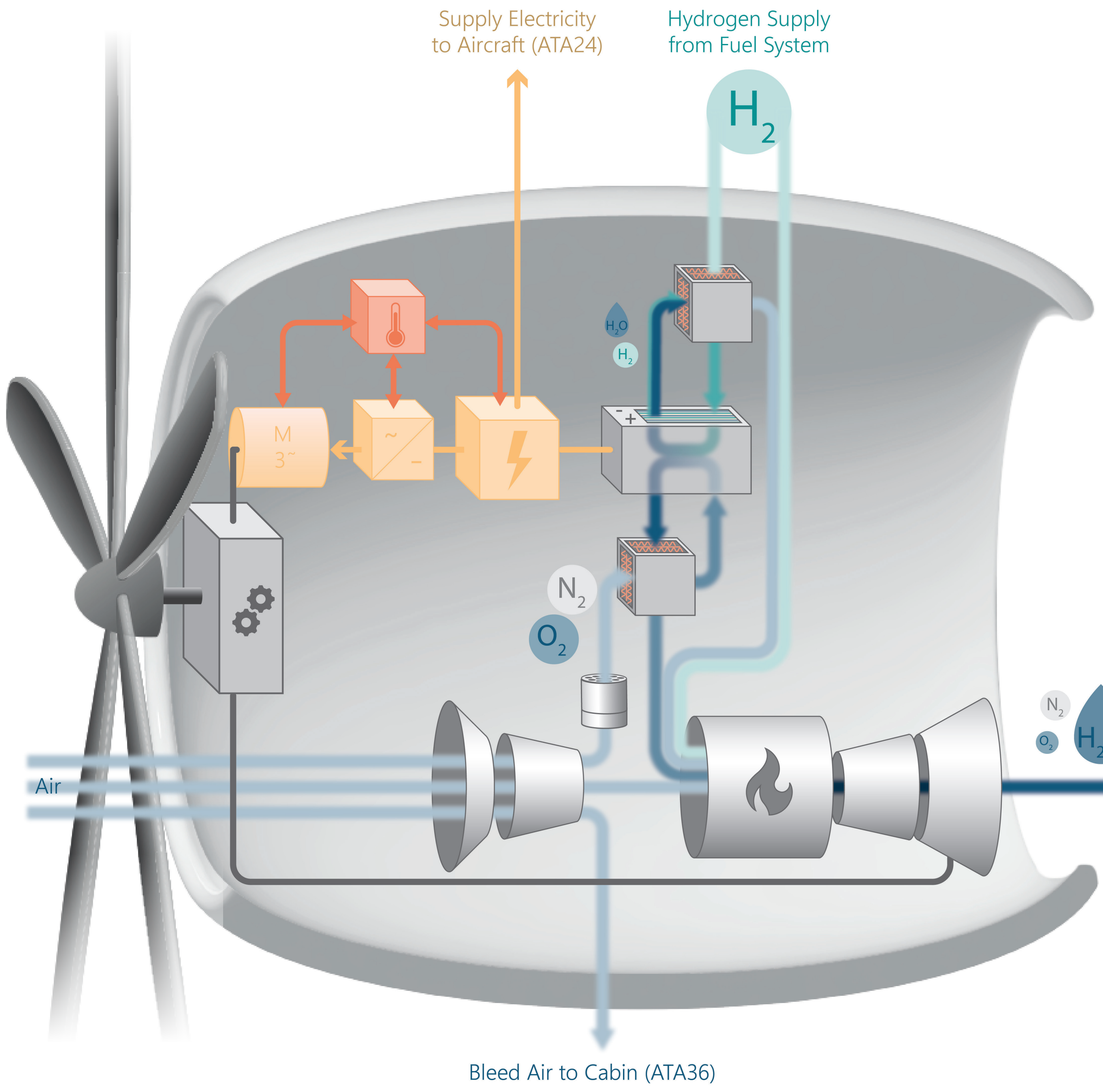
- temperature difference between compressor exit and SOFC inlet requires integration of heater or heat exchangers
- air utilization of SOFC must be controlled to ensure operation within temperature limits
- bleed air utilization decreases thermal efficiency of GT, which is compensated by hot gas recuperation and steam ingestion

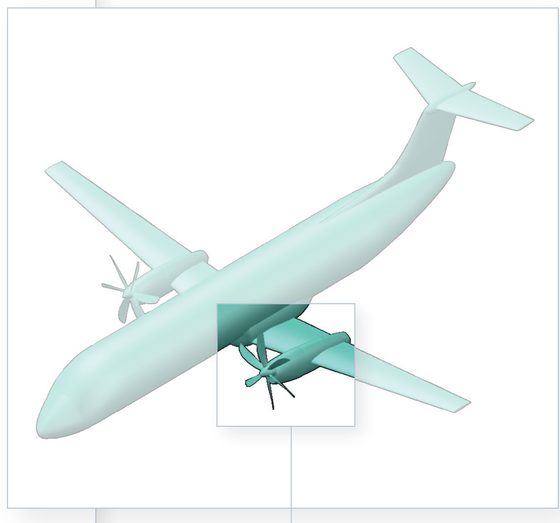
Initial Functional IPPS Architecture considering potential synergies and suitable interfaces have been defined

Next Steps

- Development of mechanical IPPS architecture and key component technologies
- Preliminary system safety assessment
- Demonstration of IPPS power and energy management via testing
- Development of local and global control strategies and models for optimized energy efficiency

Integrated Power and Propulsion System





Note: Components are not displayed to scale in this schematic. Architecture is subject to change with the evolution of the project.

Flows and Streams

- Hydrogen
- Air / Exhaust Gas
- Electricity
- Cooling Fluid
- Mechanical Energy

System Components

- Motor
- Inverter
- Power Management and Distribution System
- Thermal Management System for Electrical Components
- Heat Exchanger
- Solid Oxide Fuel Cell
- Filter
- Compressor
- Combustion Chamber
- Turbine
- Gear Box

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