Case Study

Fuel Cells for Hydrogen-Electric Flight

How EH Energy became the fuel cell stack development partner to a leading commercial aircraft manufacturer



Overview

When one of the world's leading commercial aircraft manufacturers set out to prove hydrogen fuel cell propulsion for its next generation of zero-emission aircraft, it needed a fuel cell stack partner who could benchmark cutting-edge materials, build hardware with no commercial precedent and design a fuel cell stack at a power density the market has never delivered. It turned to EH Energy - now engaged across three parallel technical workstreams within the program.

CLIENT SNAPSHOT	
Client	A leading global commercial aircraft manufacturer
Sector	Hydrogen-electric commercial aviation
Engagement	Fuel cell stack benchmarking, development and design
EH Energy Scope	Concept design, detailed design, manufacturing and testing - short-stack and full-size hardware
Status	Active engagement

The Client

EH Energy's client is a leading global commercial aircraft manufacturer pursuing hydrogen fuel cell propulsion as a central pillar of its zero-emission aviation roadmap. Its fuel cell program is developing hydrogen stacks capable of meeting the power density, lifetime and certification demands of commercial aircraft, across both low-temperature PEM (LT-PEM) and high-temperature PEM (HT-PEM) technology tracks. Under the terms of the relationship the client's identity and technical requirements are confidential; this case study describes EH Energy's contribution without disclosing them.

The Challenge

Fuel cell stacks for commercial aviation are among the most demanding hardware in the hydrogen industry. The program called for performance and reliability that no off-the-shelf fuel cell technology delivers:

Power density beyond the state of the art.

Aircraft propulsion demands far more power from far less weight and volume than any conventional fuel cell stack can provide, at aviation-grade durability.

Technology with no commercial precedent.

Air-cooled HT-PEM stacks operating well above conventional PEM temperatures do not exist as commercial products - they must be designed and built from the ground up.

Full-mission characterization.

Performance has to be understood at every phase of flight - idle, takeoff, climb, cruise and descent - a duty cycle fundamentally different from stationary or marine use cases.

Aerospace qualification.

Stacks must withstand the aerospace vibration environment, cold-start conditions and operation without external humidification.

Aerospace timelines.

The program moves in tight windows, demanding engineering agility and manufacturing readiness to turn design into hardware fast.

The Engagement

EH Energy was engaged across three parallel workstreams, each drawing on a different dimension of its fuel cell expertise - from independent characterization, through novel high-temperature hardware, to next-generation stack design for propulsion.

Workstream 1
Independent stack benchmarking

EH Energy assembled and tested short stacks using catalyst-coated membranes (CCMs) supplied by the client, mapping stack performance across the full flight mission profile - from idle through cruise to takeoff. The campaign delivered polarization curves, electrochemical impedance spectroscopy (EIS) characterization, a detailed sensitivity analysis of operating parameters and a final benchmarking report - all inside a tightly fixed engagement window. The work gave the client independent, mission-resolved data on how the candidate materials perform under real aviation conditions.

Workstream 2
Air-cooled HT-PEM stack development

EH Energy is developing air-cooled high-temperature PEM (HT-PEM) stacks - a configuration with little commercial precedent - building on its own cell microstructure and integrating membrane materials supplied by the client. The work follows a structured proof-of-concept: single-cell design and CFD-driven optimization, then short-stack and full-size (large) stack build and testing, with post-test analysis feeding each design iteration. Being trusted to integrate the client's non-commercial materials reflects a level of technical confidence extended to very few partners.

Workstream 3
Next-generation stack design

Building on the benchmarking and HT-PEM work, EH Energy and the client are in advanced discussions on a broader, multi-year collaboration to develop a next-generation, high-power-density stack for commercial aircraft propulsion - spanning concept design, detailed design, manufacturing and testing across both short-stack and full-size hardware. The aim is a single-stack architecture that combines the power, weight and volume performance aviation requires with the durability and cold-start capability of a certifiable aircraft system.

Why EH Energy?

Selection across multiple workstreams - including benchmarking, novel hardware and clean-sheet stack design - reflects a demanding evaluation of fuel cell capability. Several factors set EH Energy apart:

Class-leading power density.

A patented flat-plate PEM cell microstructure enables the industry's highest power density in a single-stack architecture - the core requirement for flight.

Trusted with non-commercial materials.

The client supplied EH Energy with proprietary membrane materials not available on the open market, integrated into EH Energy's own stacks.

Dual-platform expertise.

Parallel LT-PEM and HT-PEM development lets a single partner deliver two complementary stack technologies, reducing interface complexity for the client's team.

Aviation mission profiling.

A test methodology built around the full aviation duty cycle provides the mission-resolved data needed for aircraft-level system sizing and certification.

Rapid prototyping.

A proprietary, highly automated stack-assembly process supports fast hardware iteration on aerospace timelines.

Certified, scalable manufacturing.

ISO 9001:2015 certified operations and a proprietary automated production process - designed to scale toward gigawatt-level output - support the path from prototype to series supply.

Partner with EH Energy

EH Energy works with aerospace integrators, OEMs and certification authorities to bring hydrogen fuel cell propulsion into flight. If you are developing a hydrogen aircraft program and need a proven fuel cell technology partner, we welcome the conversation.

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