



THERMAL MANAGEMENT EXPO 2024 - © BEYOND AERO  
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**Dr. Flavio Accorinti**

Lead Thermal and Environmental  
Systems Engineer

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## Flavio Accorinti

Lead Thermal & Environmental Systems Engineer

Flavio Accorinti, Ph.D., is an engineer specialized in thermal, fluid, and energy sciences. He earned his Ph.D. from ISAE-ENSMA (Ecole Nationale Supérieure de Mécanique et d'Aérotechnique), focusing on the thermal management of power electronics for hybrid aircraft within the CleanSky2 project: HASTECS. Flavio served as a research engineer at the Pprime Institute, contributing to the design and development of an aerothermal test bench. He assumed the role of R&D coordinator at Calyos S.A., in the development of capillary pumping technologies for aeronautical applications. As Lead Thermal Management Engineer, Flavio drives the development of thermal management systems for hydrogen-powered aircraft in Beyond Aero.

TEAM



Thermal Management System

# Hydrogen-Electric Aircraft: Thermal Management Solutions



# Aviation will be electric

Unlocking full potential with hydrogen

VISION ●





Tackling the Most pressured industry

# Business Aviation Most Emissive per Usage

2t of CO<sub>2</sub>/h

10 times more polluting per passenger  
than commercial

23,000

Jets to electrify, 40% might fly with SAF,  
we can expect 60% to be replaced by  
hydrogen-electric aircraft

PROBLEM •





We are making possible, certifiable and profitable, the first

# Electric Business Aircraft Designed for Hydrogen Propulsion

ONE ●

Building Electric business aircraft

# 6 passengers on 1500 km

## Base specs

Range	800 NM
Max speed	310 KTAS
Max power generated	1.4 MW
Emissions	0.0 CO <sub>2</sub> eq IN FLIGHT
Passengers	6-8 PAX
MTOW	8.6 t

ONE







5 to 6 years for a conventional aircraft

## CS23 Certification



.01

### Air Intake System

Compromise For  
Cooling Need & Drag

.02

### Thin Wing

No Fuel In The Wing  
Close To A Glider  
Wing

.03

### Fly-By-Wire Avionic

Certification 2 Pilots First  
Later 1 Pilot

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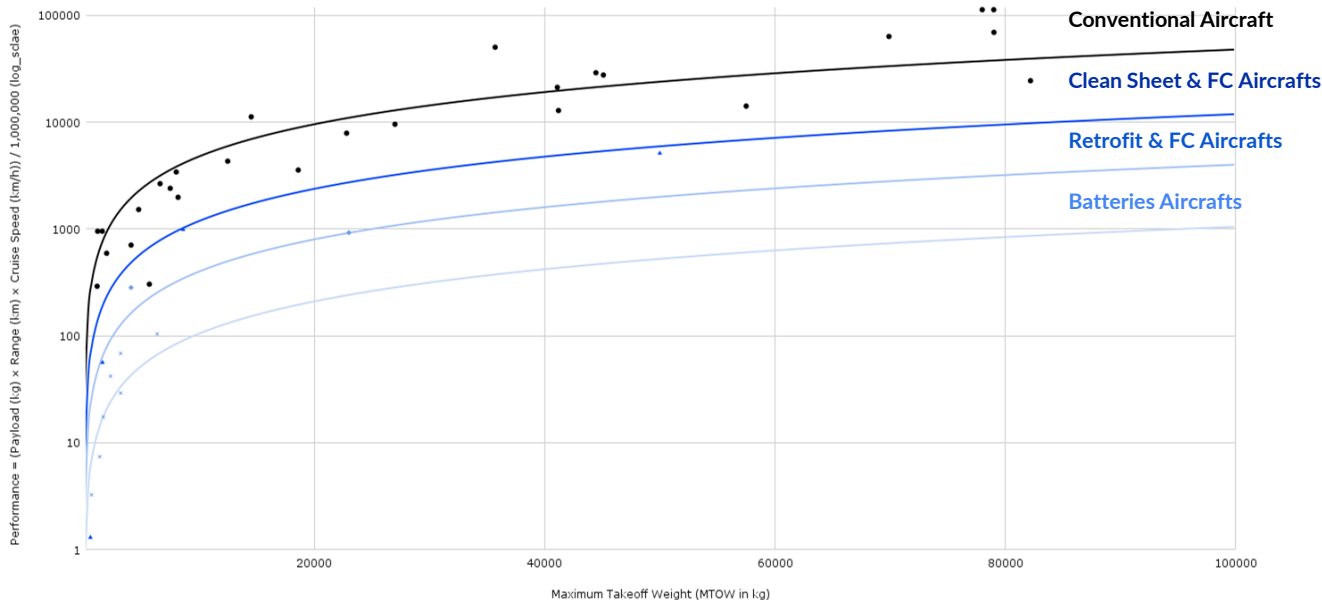




Building for Success

# Hydrogen-Electric Clean-Sheet are the best architecture

The Breguet Range



4 to 12<sub>x</sub>

More performant than battery-electric aircrafts

3<sub>x</sub>

More performant than retrofitted ones

ONE



Powertrain

# Smart Integration of Powertrain Elements

ONE



We have a unique architecture with

# 2 Patents on the TMS & Tanks position

**TANKS**

TANKS LOCATION AND INTEGRATION:  
PROVIDE MORE STORAGE AND EXTENDED SAFETY



**THERMAL MANAGEMENT SYSTEM**

INNOVATIVE THERMAL SYSTEM MANAGEMENT

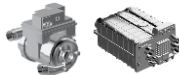
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Scaling the prototype to a

## FC system + 2 eMotors

**AIR SUPPLY  
& FUEL CELL STACK**  
SCALABLE SYSTEM BY  
MULTIPLES OF 300KW



**H2 TANKS**

7 to 15% OF  
H2 MASS FRACTION



**Scalable architecture**, cost-effective volume pricing, and patented trade secret methods protect the product's unique features and processes.

**ELECTRIC  
DUCTED  
FAN**  
(70% SYSTEM  
EFFICIENCY)

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**THERMAL MANAGEMENT  
SYSTEM**

(3.5 kW/kg FOR THE COMPLETE  
THERMAL MANAGEMENT  
SYSTEM)

**BOP  
POWER ELECTRONICS**

700 W/kg AT FC SYSTEM LEVEL



# Powertrain Main Data

## FC system + 2 eFans

### Hydrogen-Electric Powertrain

#### Power & Energy Budget

Fuel Cell Max Gross Power	4 x 360 kW
Battery Max Power	4 x 200 kW
eMotor Take Off Mechanical power	2 x 700 kW

Battery Max Energy	4 x 20 kWh
H2 Energy Storage	150 kg

Number of Tanks	6
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#### Thermal Management system

Total Thermal Load	up to 1500 kW
Fuel Cell Operating Temperatures	80 °C (Max)
Power Electronics Thermal Load	< 50 kW
Engines eMotor Thermal Load	50 kW
Power Density (system)	3.5 kW/kg

#### Physical Impact of TMS

Air Mass flow Rate (depending on the flight stage)	up to 40 kg/s
HXG air pressure drops: A/C perf @ max MFR	<1000 Pa

#### Heat exchanger

Power density	>10 kW/kg
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#### H2 tanks

7 to 15% of H2 mass fraction

#### Battery pack converter & powerbox

Scalable system to assist the fuel cell system in high power demand phases

#### Air supply & fuel cell stack

Scalable system by multiples of 300 kW

#### Electric ducted fan

(70 % system efficiency)

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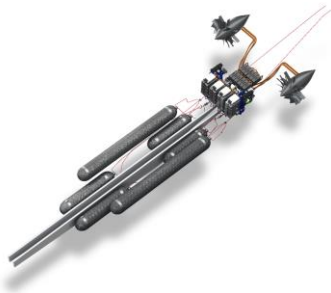


Powertrain scope

# Thermal & Environmental Systems

## Thermal management systems

FC cooling, BoP cooling,  
Battery cooling



## Aerothermal system

Air intakes, ducts,  
extraction: Air supply to  
TMS



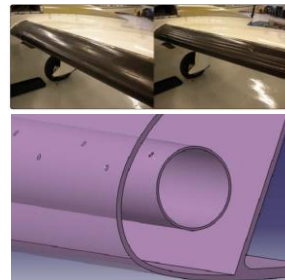
## Ground testing support

Iron bird development:  
System



## Ice Protection Systems

Wings, VTP, HTP, Duct  
lips etc...



## Environmental Control Systems

Cabin pressurization,  
Comfort, Thermal  
insulations...





Our Iterative Approach

# Innovative Prototyping

PROTOTYPE





## It's called a retrofit **We call it a perfect fit**

We have developed an 85kW flying test bench for retrofitting a 2-seater from G1 aviation. This cutting-edge aircraft propulsion system seamlessly integrates hydrogen tanks and batteries to power the propeller.

### Base specs

Max speed	130 km/h
Autonomy	20 mins
Max power generated	85 kW
Tank pressure	340 bar
MTOW	525 kg



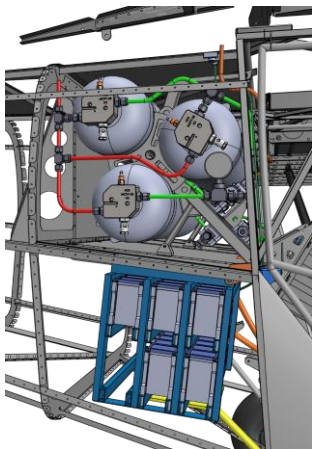


# Powertrain

## Key Elements

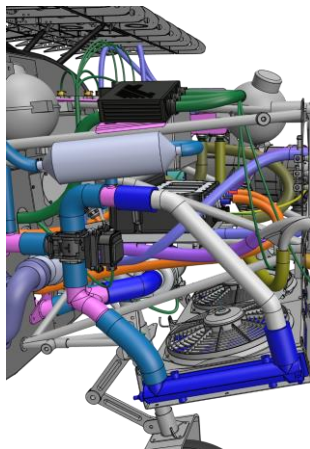
### Energy Sources

An integrated H<sub>2</sub> management system with a compact battery pack



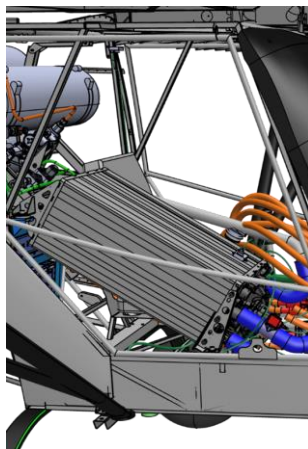
### Balance of Plant

Optimised balance of plant



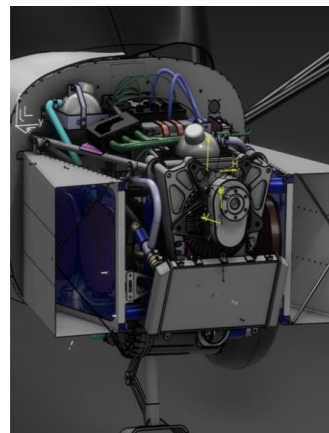
### Fuel Cell Stack

Fuel Cell Stack the core of the powertrain



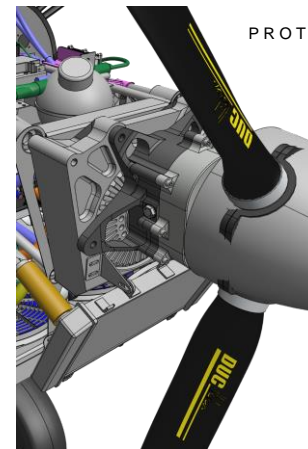
### Thermal Management System

A close integration with respect to A/C performance

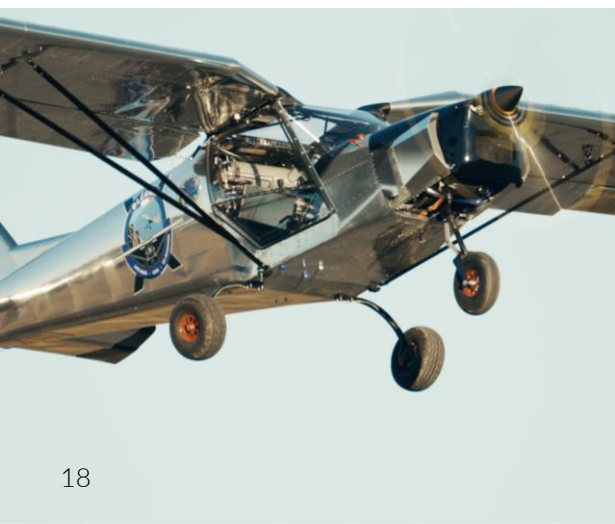


### Propeller and Gearbox

An efficiency gearbox for matching propeller requirements



PROTOTYPE



## In march, we achieved **France's first manned fully hydrogen-electric flight**

Complete test flight campaign validated in South France, with 10 takes-off including 2 complete full flights, making it France's first electric aircraft manned on fully hydrogen-electric propulsion with an hybridization ratio of  $\frac{2}{3}$  gaseous hydrogen to  $\frac{1}{3}$  batteries.

PROTOTYPE ●



Watch the movie on Youtube



Aviation will be electric

# The plan for the future of the aviation

IN FRA





Aviation will be electric.

## New Aero, a Three-step Plan

### .2040s

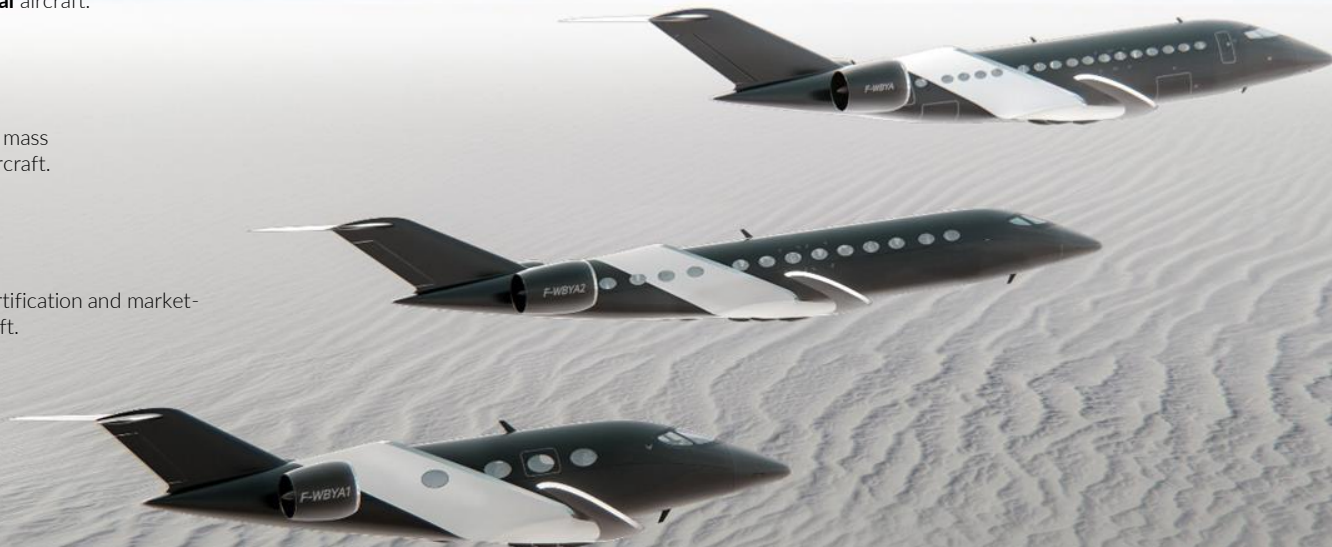
Maximizing climate impact through consolidation of scale with a **commercial** aircraft.

### .2030s

Master scale to enter the mass market with a **regional** aircraft.

### .2020s

Pioneer development, certification and market-entry of a **business** aircraft.



ONE ●



Forbes

FAST COMPANY

Bloomberg

THE WALL STREET JOURNAL  
WSJ

TE  
TechCrunch

PICTET  
1803

MCJ  
Collective  
UNLEASHING CLIMATE INNOVATION

AVIATION  
WEEK  
NETWORK

AIR&COSMOS

AIN  
AVIATION INTERNATIONAL NEWS

L'USINE  
NOUVELLE

LesEchos

Challenge

FlightGlobal

SCIENCE&VIE

## Press Coverage

Beyond Aero has garnered global media coverage, particularly in financial, economic, industry, business, and aviation outlets across Europe and the US.

Y Combinator

FEMALE  
FOUNDERS  
FUND

initialized ()



aerospace  
valley

StartAir  
UGRO  
Le Club des Stratèges de l'Industrie  
Aéronautique et Spatiale Française

WORLD  
ECONOMIC  
FORUM

First Movers  
Coalition



## Partnerships and Coalitions

Beyond Aero has actively engaged in discussions regarding the future of aviation and hydrogen regulation.

**Join Us**

Scan for Open Positions

