Hydrogen as Key Enabler

From hydrogen drones to liquid hydrogen at airports

Holger Kuhn
ZAL GmbH

ZAL Center of Applied Aeronautical Research

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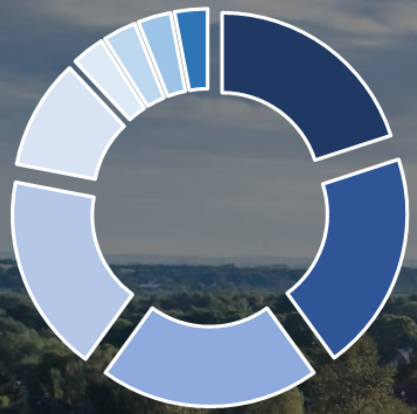
Shareholders



- 20% Free and Hanseatic City of Hamburg
- 20% Airbus Operations GmbH
- 20% Lufthansa Technik AG
- 18% ZAL Association (SMEs, Supply Chain, Start-Ups)
- 10% DLR German Aerospace Center
- 3% Technical University Hamburg
- 3% HAW University of Applied Sciences
- 3% Helmut-Schmidt-University
- 3% University of Hamburg-Harburg

Background

- **founded in 2009** on the initiative of the Free and Hanseatic City of Hamburg (FHH) based on the leading-edge cluster Hamburg Aviation
- successful Public-Private-Partnership
- status as an independent small and medium sized enterprise

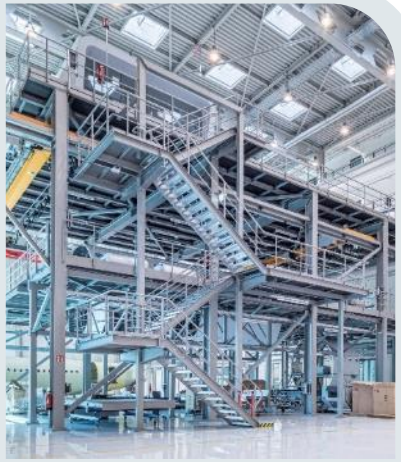
ZAL TechCenter in Numbers

• Area	~ 34,000 m²
• Workplaces	~ 800
• R&T Infrastructures	~ 13.7 M€ (+12 M€)
• Construction/financing costs	~ 82 M€

ZAL GmbH Business Areas

ZAL Research Infrastructures
Project planning and operational support in close cooperation with industry partners (e.g. Airbus or Lufthansa Technik)

- Requirements definition, planning and supplier selection
- Implementation coordination, technical approval and more



ZAL TechCenter
Leasing & building operation

Rental of laboratories, office and hangar space

- Organization of general services (e.g. reception, restaurant, maintenance, cleaning).
- Operation of central infrastructures (auditorium, meeting rooms, workshop, building equipment and devices).

ZAL Innovation Services
Expertise in 8 technology fields with a thematic focus in close cooperation with industry partners

- Funding projects: Development of competencies and expertise
- Industry projects: Concentration on thematic or technological niches

FoLuHH
Research Network Hamburg

- Building networks and events
- Initiation of R&T networks and projects with partners from industry, universities and SMEs
- Obtaining funding from European and German aeronautics research funds

ZAL Innovation Services – R&D Unit of ZAL GmbH

ZAL Center of Applied Aeronautical Research

Advanced Materials

Acoustic & Vibration

Robot-guided Additive Manufacturing

Automation

Automation Design & Evaluation

AI-enforced Robotics

Functional Prototypes for Production Environment

Data & Power Networks

Connected Aircraft Cabin & Internet of Things

Communication Technology & Distributed Systems

Fuel Cell Systems & Power Networks

Along the Hydrogen Chain

Previous Projects:

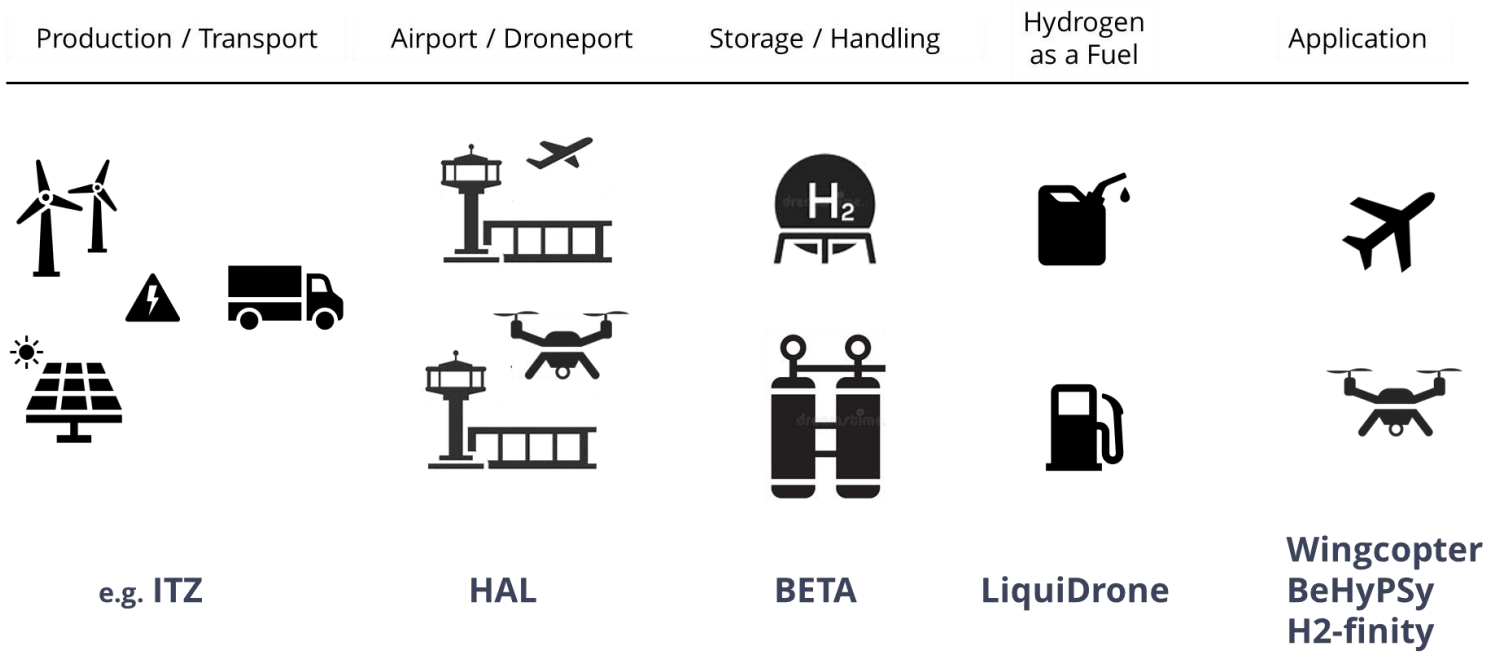
- Bilbo
- ZALbatros I/II
- ALF
- BETA
- LiquiDrone
- Hydrogen Aviation Lab
- H2-finity

Current Projects:

- Wingcopter
- BeHyPSy
- iPREFER
- HYDRO-BUNNY
- BSR Hydrogen Airport

Perspectively:

- H2-BAT



Fuel Cell & Hydrogen – selected ZAL Projects

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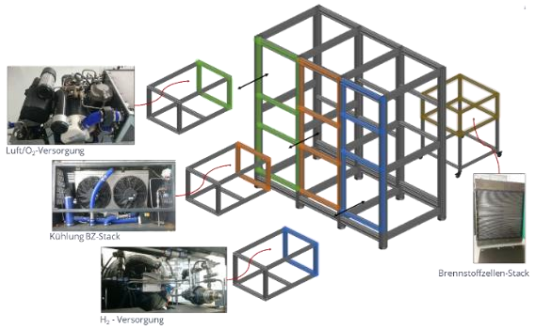
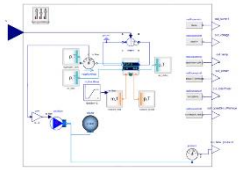
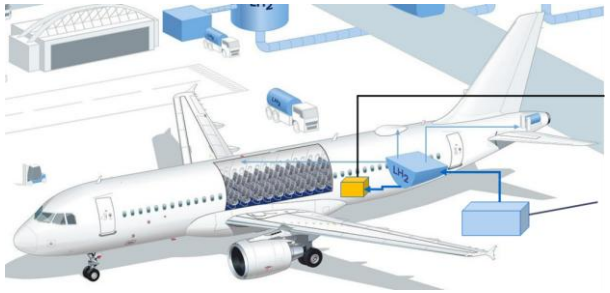


Testing and Modelling



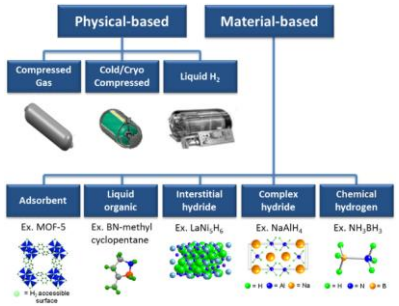
Commercial Drone OEM and Operators

Hydrogen Aviation Lab



LuFo VI-3 BeHyPSy

BETA



ILM LiquiDrone

H2-finity

Why ?

Motivation

- Usually only battery-electric propulsion systems for multicopters
  - Relatively short flight times of typically less than 1h
  - ~2 Wh/kg/min ±10% for multicopters
- „Small“ 2–/4–stroke combustion engines or turbines for larger drones (fixed wing as well as rotorcraft)

- With fuel cells we open use cases in sensitive areas AND where long flight times are mandatory

Hexacopter ZALbatros II

ZALbatros | Center of Applied Aeronautical Research

Flying testbed for UAV-applications under real operating conditions.

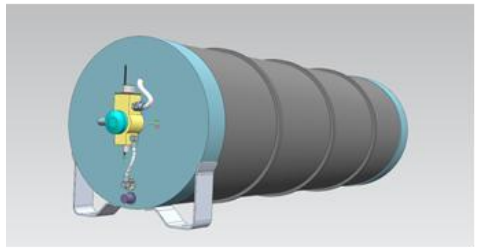
- Total Mass ~ 12 kg (in-house optimised structure)
- Payload 2 kg (increased from 500 g)
- H_2 storage Type 4, 300 bar, 7.2 L, 3.3 kg
- Flight Duration > 2 h

Successful Long Endurance Flight

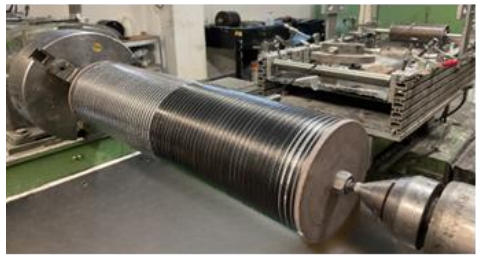
- Long endurance flight in September 2020
- Flight time ca. **2h10min**
  - Windy and turbulent conditions
- 300bar Type 4 pressure vessel
- Propulsion system
  - 2x 800W max. continuous fuel cell systems
  - 2x 1.4kW max. peak power

Project LiquiDrone

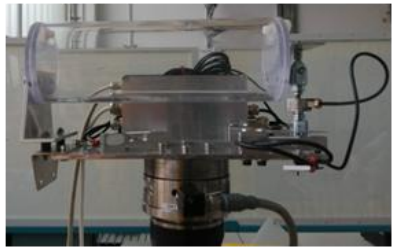
ZALbatros | Center of Applied Aeronautical Research

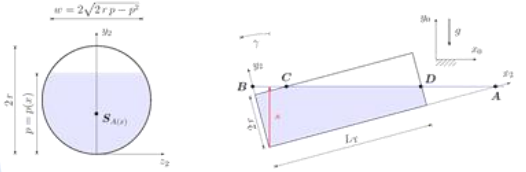


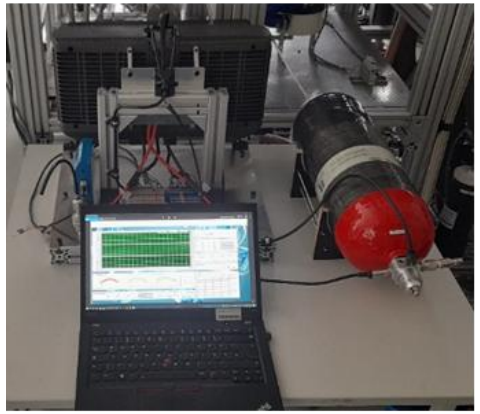
Baltic GmbH Composite Technology

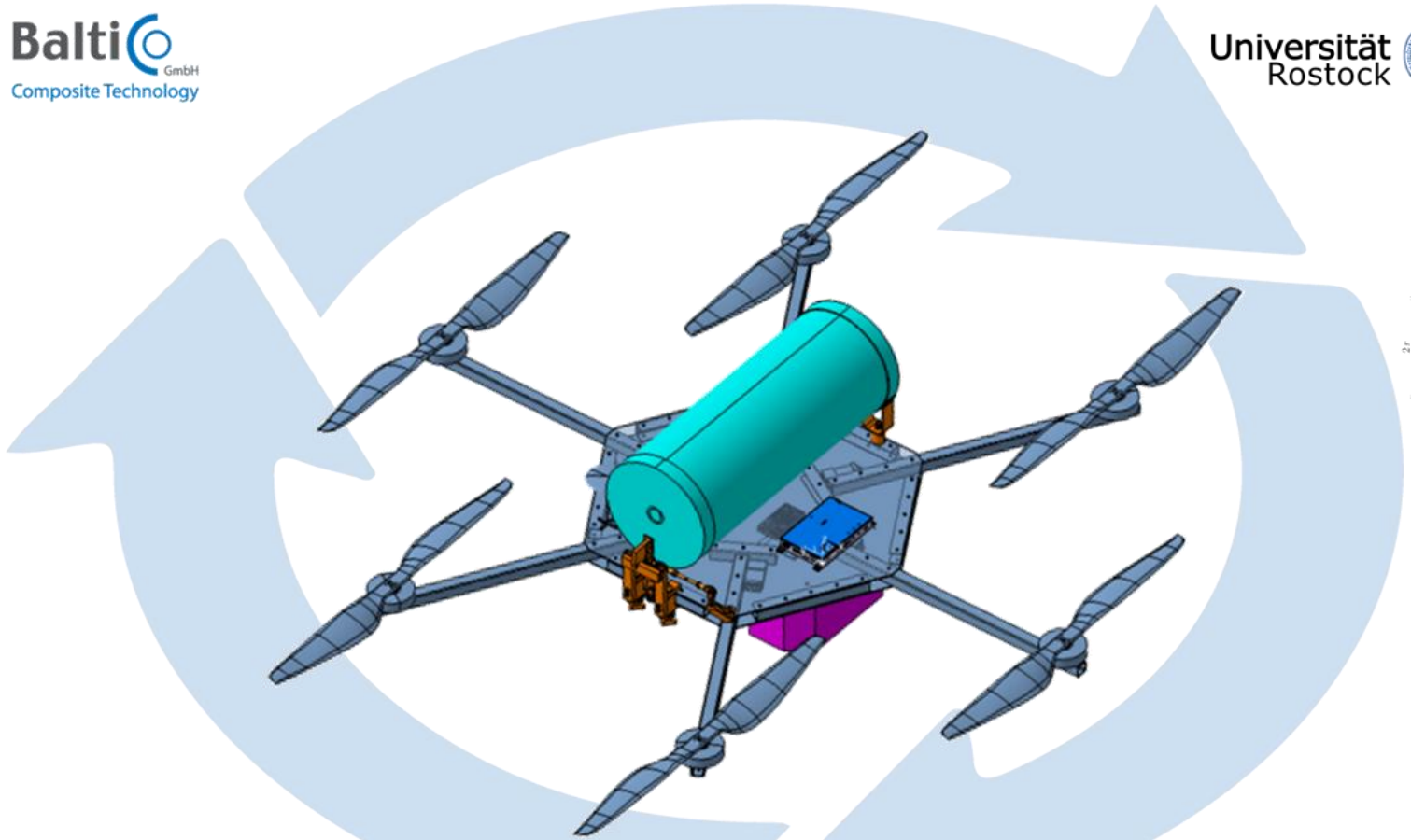


Universität Rostock

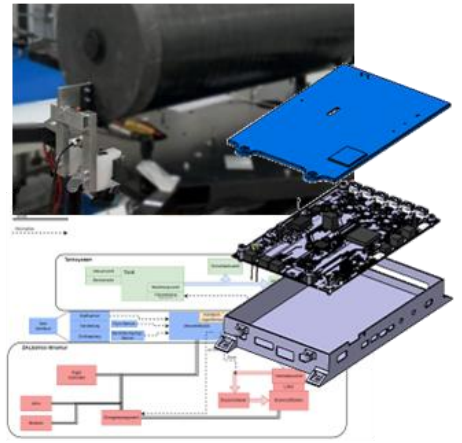








ZAL GmbH



RST

LiquiDrone – Status of Development

The First Hydrogen-Fuel Cell based Aircraft

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Maiden flight in March 2008
Boeing Phantom Works, Spain


Maiden flight in July 2009
Project of Lange Aviation and DLR

Maiden flight in May 2010
EU project ENFICA-FC

Crossing English Channel in July 2009
Gérard Thevenot

Common Design of Propulsion Systems

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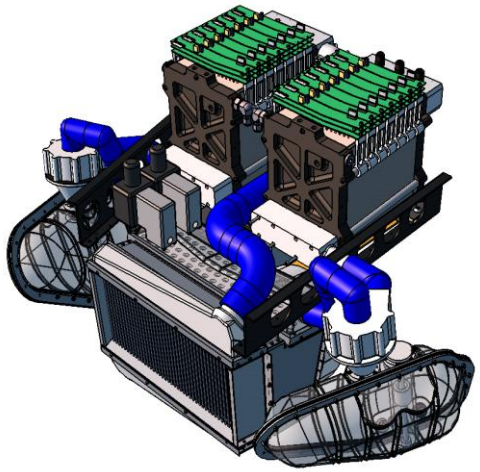
Fuel Cell System



Source: Intelligent Energy

Motor Controller

Source: MGM Compro
only as an example

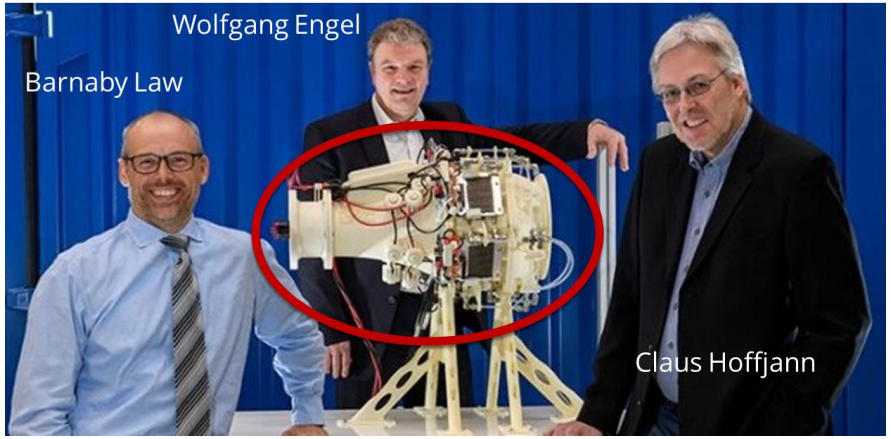
Electric Motor

Source: MGM Compro
only as an example

If one (sub-) component fails, the entire propulsion systems fails

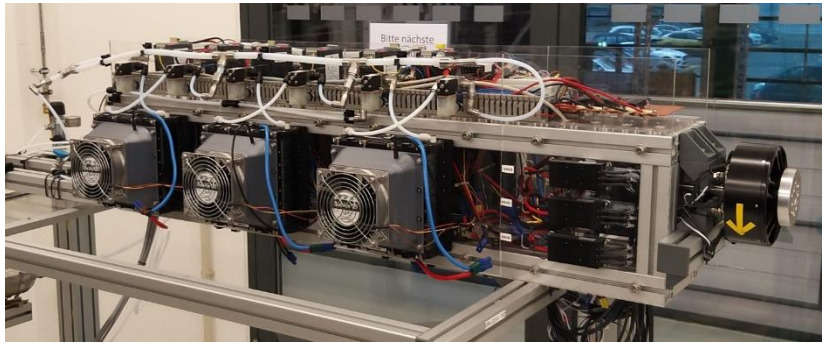
LuFo VI-3 BeHyPSy – Our Approach

Airbus H2-Torque Concept [1]

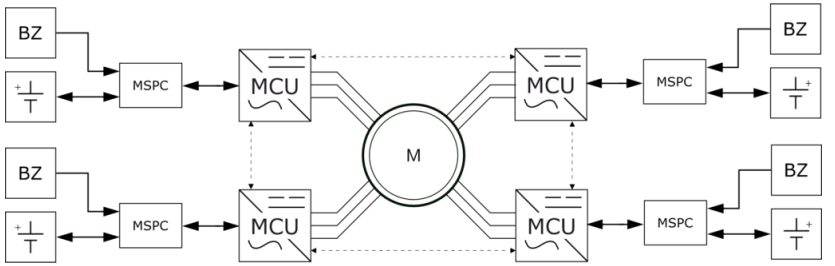


NIP Project “BETA”

Partners: Airbus, DLR, HSU, ZAL



Source: Airbus



Source: HSU

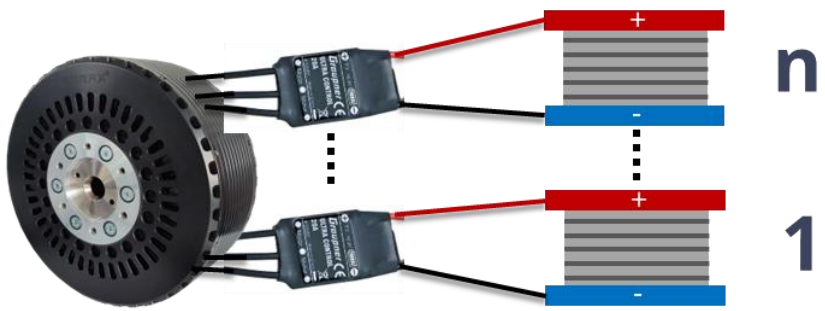
[1] German Aviation Innovation Award in the category “Reduction of emissions”, 2019

LuFo VI-3 BeHyPSy

Development, integration and testing of an innovative fuel cell-based propulsion system.

Expected Benefits of the Propulsion System

- Architecture allows for removing of liquid cooling system
  - Fully air-cooled systems and components
  - Weight reduction
  - Less maintenance and increased reliability
- Multi-phase electric motor
  - each phase is supplied by >1 fuel cell system leading to smaller fuel cells



Breezer Aircraft GmbH & Co. KG
University of Applied Science Hamburg
Helmut-Schmidt-University Hamburg
Rostock-System Technik GmbH
ZAL GmbH
Zentrum für Brennstoffzellentechnik GmbH

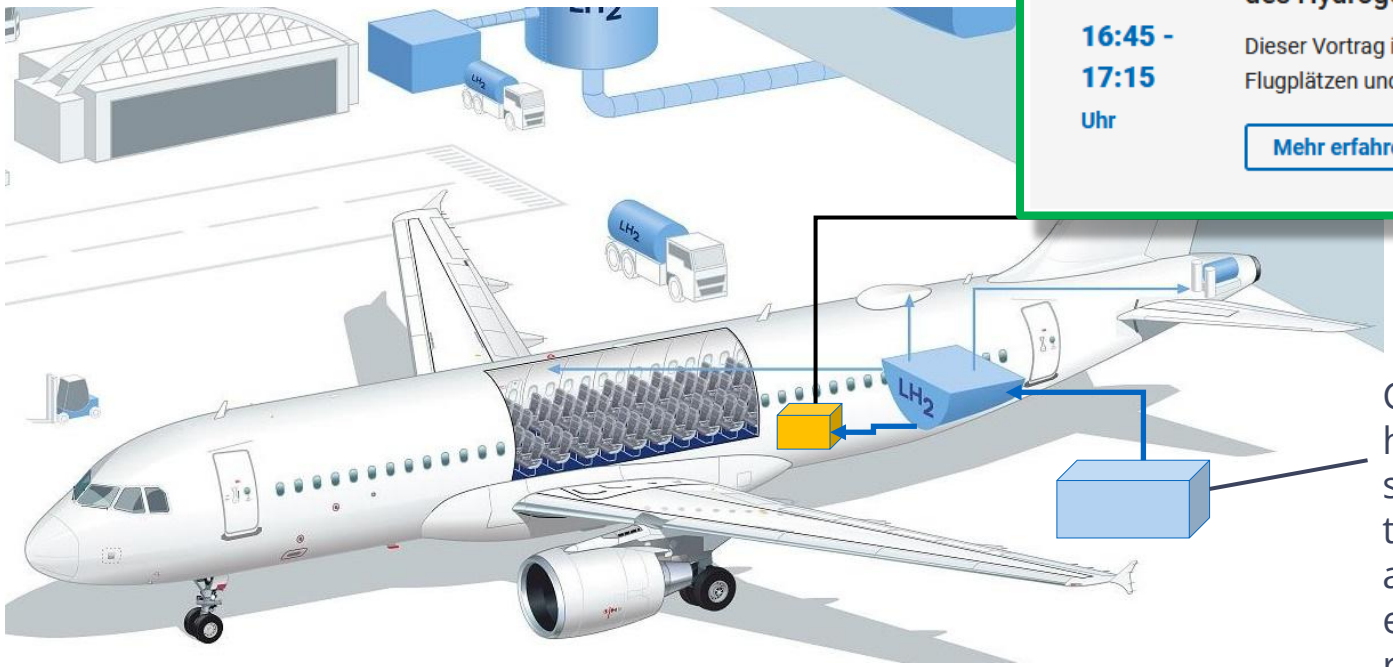
Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Project Hydrogen Aviation Lab

ZALbatros | Center of Applied Aeronautical Research

Overview

- Equipment of an A320 with an on-board liquid hydrogen tank, a fuel cell, and a ground based liquid hydrogen storage and supply unit
- Design and test of MRO and ground processes of future liquid hydrogen aircraft
- Based on the premisses of LHT at Hamburg Air
- Partner: Lufthansa Technik, DLR, ZAL, HH-Airpo



Source: Hamburg Marketing

Donnerstag
10.04.2025
16:45 - 17:15 Uhr

Inbetriebnahme einer mobilen LH2-Befüllstation im Rahmen des Hydrogen Aviation Lab Hamburg

Dieser Vortrag ist Teil der 2. Fachkonferenz über "Infrastrukturen der Zukunft an Flugplätzen und Flughäfen".

Mehr erfahren

Konferenz-Zentrum Ost, Raum London
Englisch
In den Kalender

power selected onboard systems

Ground based liquid hydrogen storage and supply unit to refill tank on-board the aircraft for experimental research

Behörde für Wirtschaft und Innovation
Lufthansa Technik
DLR
ZAL GmbH

Fuel Cell & Hydrogen Topics

ZAL Center of Applied Aeronautical Research

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