TOWARDS DECARBONISING AIR TRANSPORT: LI-ION BATTERIES TECHNOLOGIES FOR NEXT GENERATION AIRCRAFT

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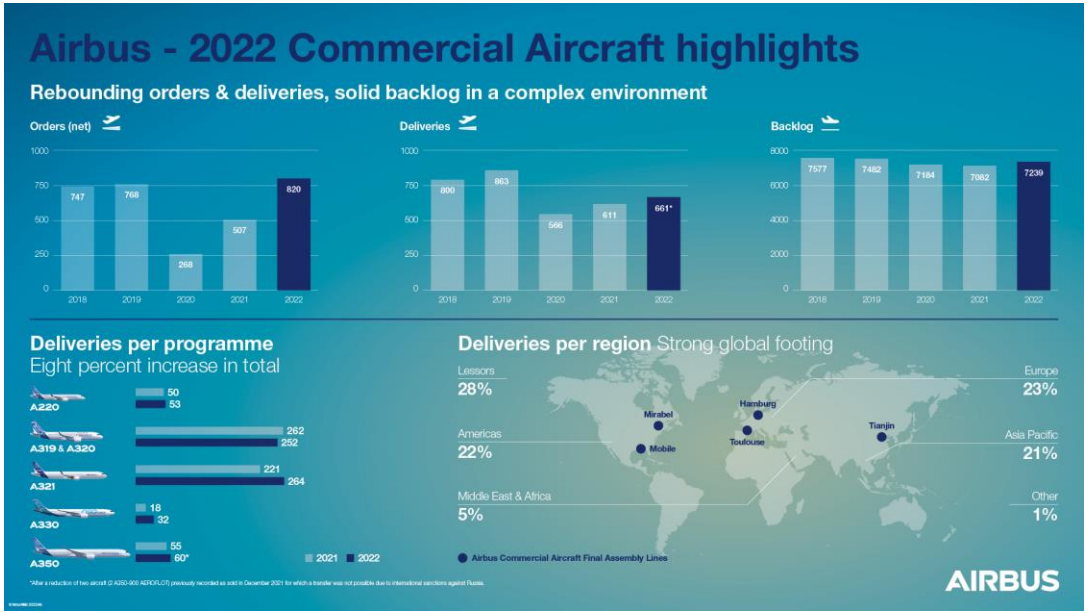
CONTEXT: TOWARDS CARBON-NEUTRAL AIR TRAVEL

Air transport is a key element of the European Industry:

Air transport demand is expected to double by 2040, growing at the steady rate of 4-5%/year (RPK). In the reference year 2022, AIRBUS outperformed Boeing by 27% on delivered aircraft units, rolling out 661 aircraft (i.e. 53 A220, 516 A320, 32 A330 and 60 A350) versus the 480 aircraft from its competitor (387 737-MAX and 93 cumulative belonging to the 747s, 767s, 777s and 787s families). Looking at the backlog orders in December 2022, AIRBUS counts 7,239 aircraft versus the 4,576 for Boeing.



Source: AIRBUS

CONTEXT: TOWARDS CARBON-NEUTRAL AIR TRAVEL

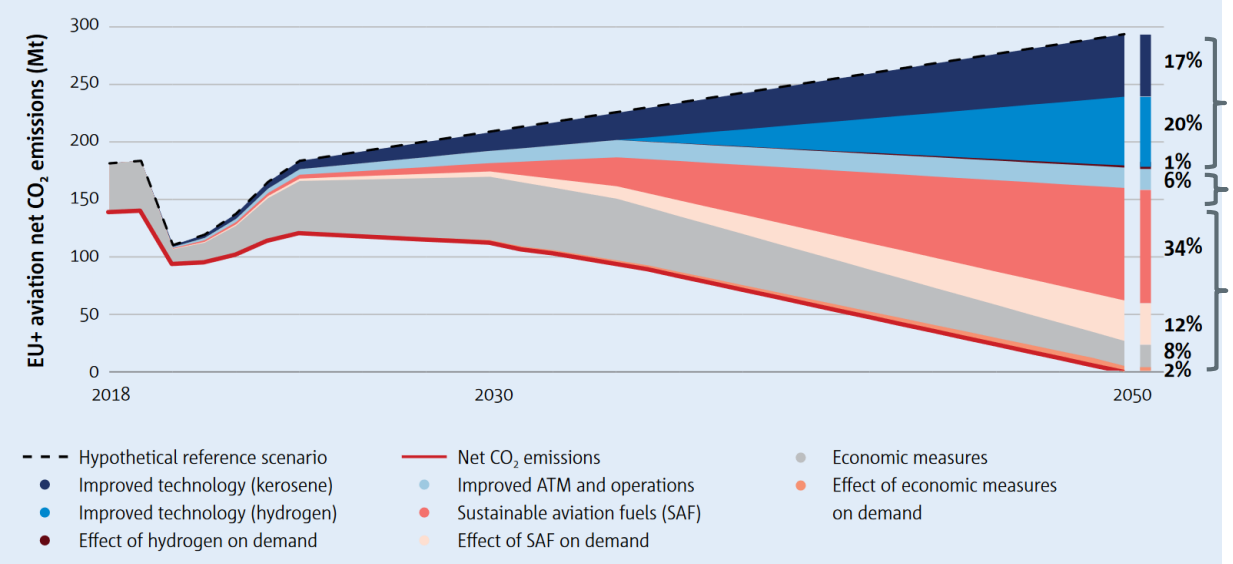
Air transport is a key element of the European Industry:

Focusing on the foreseeable future, the European aeronautic industry must be prepared to face three main challenges:

- **an increased competitiveness**, due to the challenge to the Boeing-Airbus duopoly with the market entry of the Chinese manufacturer COMAC. The C-919, certified by the Civil Aviation Administration of China in September 2022 and first flown commercially by China Eastern Airlines on December 9th, 2022, will likely acquire a non-negligible share of the internal Chinese narrowbody market by 2030. This will limit the ability to expand for AIRBUS and Boeing in the far East.
- **a strong push towards reducing airlines' operating costs**, clearly signalled by the gradual retirement of the 4-engined widebodies (i.e., A340, A380 and Boeing 747), concurrently with the engineering efforts to expand narrowbody economics on transatlantic routes (e.g., see AIRBUS efforts for the developing the A321XLR variant, with expected Entry-into-Service (EiS) in 2024).
- **an increased demand to satisfy more stringent environmental requirements and move towards a sustainable aviation,** that will call for significant fuel burn reduction, and inherent technological leaps, to achieve air transport carbon neutrality by 2050.

CONTEXT: TOWARDS CARBON-NEUTRAL AIR TRAVEL

Decarbonising air transport is not easy at all…



Improved technology (kerosene / hybrid electric / H2-burn)

Improved ATM

SAF and economic measures (i.e. CORSIA)

Source: EASA Aviation Environmental Report 2022 (EU27+UK+EFTA).

CLEAN AVIATION: STRUCTURE AND IMPLEMENTATION

AUSTRIAN INSTITUTE OF TECHNOLOGY

EU Funding:
€1.7bn
Private Funding:
> €2.4bn

Phase 1: Develop **concepts, technology options** and **trade studies**

Phase 2: Accelerate **technology maturation through integrated demonstration**

2022 — Call 1

2023 — Call 2

Call for Expression of Interest

2024 — Configuration of Phase 2

806M€ (48,5%)

2025 — Large Call (call 1)

2026 — Further Calls (call 2 & 3)

854M€ (51,5%)

+ UK contribution following HE association agreement

2027

2028 — TLR 6

2031 — CLEAN AVIATION

2035 — EIS

Clean Sky 2 Projects

2014 — **2024**

Clean Sky 2

Source: Clean Aviation JU

CLEAN AVIATION PROJECTS: PHASE 1 / CALL 1 (21 PROJECTS)

EU Funding €654 mio

HERA
Hybrid-Electric Regional Aircraft Architecture and technology integration
LEONARDO (*)

SMR ACAP
SMR Aircraft architecture and technology integration Project
AIRBUS (*)

CONCERTO
Construction Of Novel CERTification methOds and means of compliance for disruptive technologies
DASSAULT (*)

ECARE
European Clean Aviation Regional Ecosystem/synergies with regions

Hybrid Electric
Combining Innovative Airframe, Novel Systems & HE power train

HE-ART
2.150-2.850 MW Multi Hybrid Electric propulsion system for regional AiRcrafT
ROLLS-ROYCE (*)

AMBER
2250 MW Multi Power train InnovAtive for hyBrid-Electric Regional Application
GE AVIO (*)

TheMa4HERA
Thermal Management Solutions for Hybrid Electric Regional Aircraft
HONEYWELL (*)

HECATE
Electrical Distribution Solutions for Hybrid-Electric Regional Aircraft
COLLINS (*)

HERWINGT
Hybrid Electric Regional Wing Integration Novel Green Technologies
AIRBUS (*)

(*) Consortium Leader

Ultra Efficient / Short Medium Range
Combined powerplant & Airframe efficiency

HEAVEN
Ultrafan – Hydrogen & hybrid gas turbine design
ROLLS-ROYCE (*)

SWITCH
Sustainable Water-Enhanced-Turbofan (WET) Comprising Hybrid-electrics
MTU AERO ENGINES (*)

OFELIA
Open fan engine demonstrator incl. gas turbine design hybridisation for Environmental Low Impact of Aviation
SAFRAN (*)

UP WING
Ultra performance wing
AIRBUS (*)

FASTER-H2
Fuselage H2 integration & Ultra efficient empennage
AIRBUS (*)

Hydrogen Powered Aircraft
Novel concepts with H2 direct burn & fuel cell based propulsion

CAVENDISH
Consortium for the AdVent of aero-Engine Demonstration and aircraft Integration
ROLLS-ROYCE (*)

HYDEA
HYdrogen DEmonstrator for Aviation
GE AVIO (*)

NEWBORN
NExt generation high poWer fuel cells for airBORNe applications
HONEYWELL (*)

H2ELIOS
HydrogEn Lightweight & Innovative tank for zerO-emisSion aircraft
ACITURRI (*)

FLHYing Tank
HydrogEn Lightweight & Innovative tank for zerO-emisSion aircraft
PIPISTREL (*)

HYPoTrade
Hydrogen Fuel Cell Electric Power Train Demonstration
PIPISTREL (*)

Source: Clean Aviation JU

CLEAN AVIATION PROJECTS: PHASE 1, CALL 2 (8 PROJECTS)

HYBRID ELECTRIC

HERFUSE

Hybrid-Electric Regional FUSelage & Empennages

LEONARDO

ODE4HERA

Open Digital Environment for Hybrid-Electric Regional Architectures

DLR (DEUTSCHES ZENTRUM FUR LUFT – UND RAUMFAHRT)

ULTRA EFFICIENT/ SHORT MEDIUM RANGE

COMPANION

Common Platform and Advanced INstrumentation Readiness for ultra efficient propulsion demonstration

AIRBUS

AWATAR

Advanced Wing MATuration And integration

ONERA (OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES)

HYDROGEN POWERED AIRCRAFT

TROPHY

Technological Research On Propulsion by HYdrogen

SAFRAN

FAME

Fuel cell propulsion system for Aircraft Megawatt Engines

AIRBUS

HEROPS

Hydrogen-Electric ZeRo Emission Propulsion System

MTU AERO ENGINES AG

SUPPORT ACTION

CLAIM

Clean Aviation Support for Impact Monitoring DLR (DEUTSCHES ZENTRUM FUR LUFT – UND RAUMFAHRT)

EU Funding €152 mio

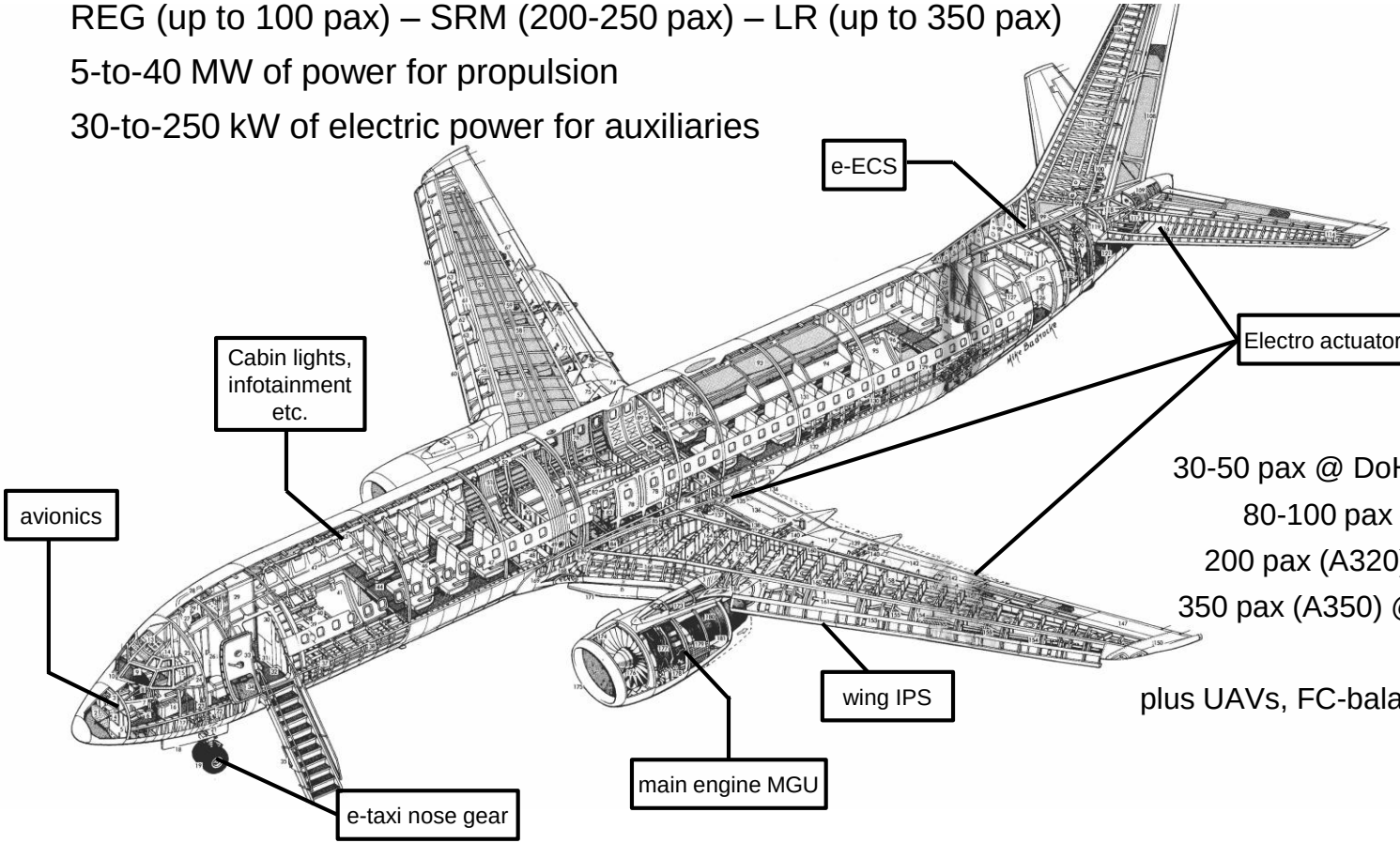
Source: Clean Aviation JU

WHERE ARE ELECTRIC SYSTEMS ON AN AIRCRAFT?

REG (up to 100 pax) – SRM (200-250 pax) – LR (up to 350 pax)

5-to-40 MW of power for propulsion

30-to-250 kW of electric power for auxiliaries



30-50 pax @ DoH of 100%-50% (1-2 MWh)

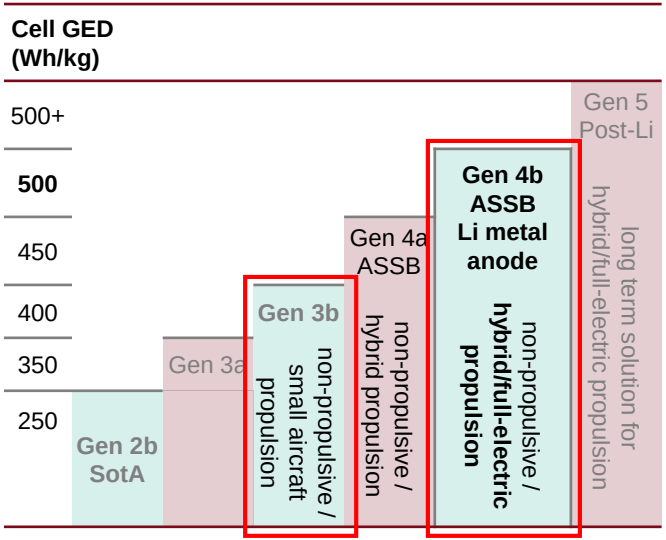
80-100 pax @ DoH of 30% (2-4 MWh)

200 pax (A320) @ DoH of 5% (2-4 MWh)

350 pax (A350) @ DoH of 2-3% (5-8 MWh)

plus UAVs, FC-balancing systems, APUs, etc.

WHAT IS AIT DOING IN BATTERIES FOR AIRCRAFT?



•Develop **ASSB** and **SB electrochemistry**

Develop **numerical tools** for **aeronautic cell-to-system simulation and design**

#1 Explore **All-Solid-State Battery** for **aeronautic applications**

#2 Develop **structural battery electrochemistry and cells:**

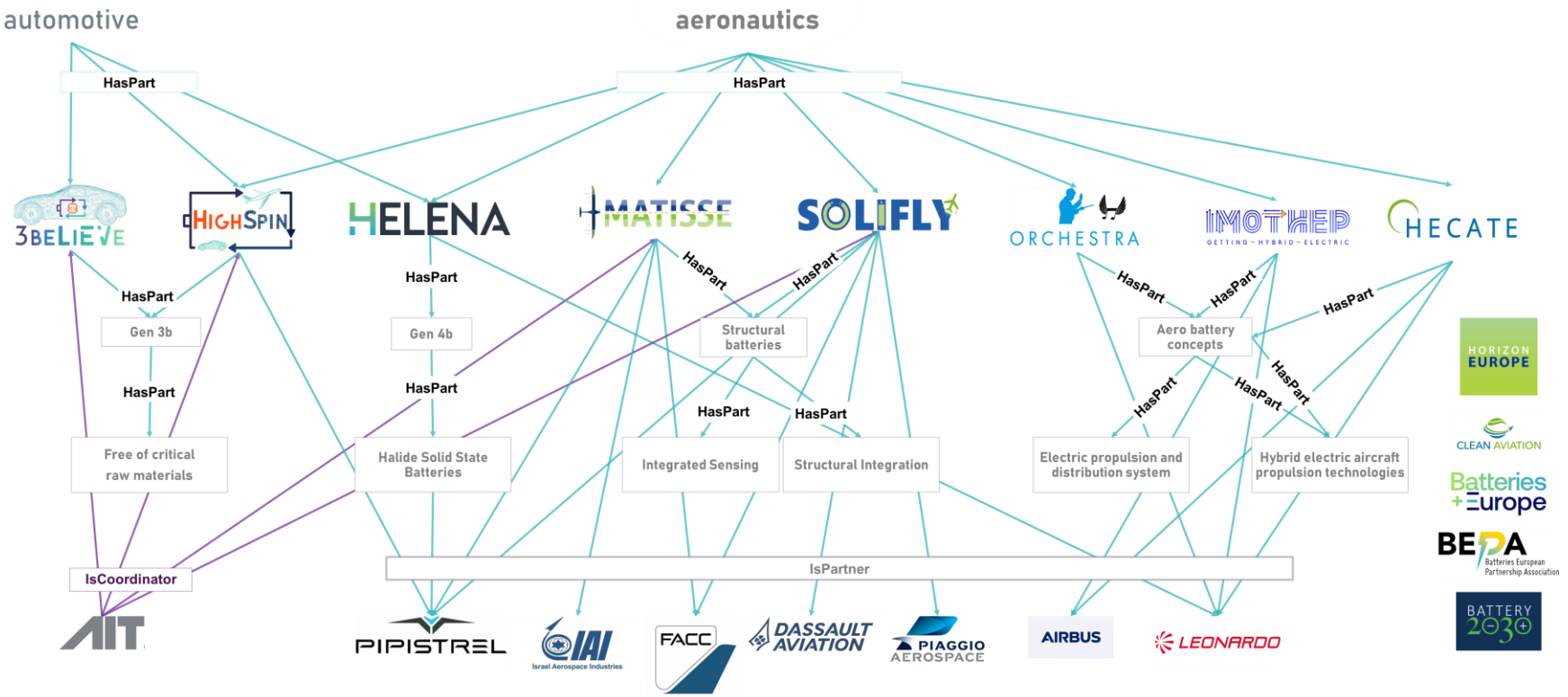
- Structural batteries = integrating energy storage and mechanical capabilities in **multifunctional components** → reducing total added weight

#3 Develop a **simulation framework** for HEA battery system concept (cell/module/packs) and **design airworthy chemistry-independent battery module/packs design with sensors**

WHAT IS AIT DOING IN BATTERIES FOR AIRCRAFT?

2021 & 2023 roadmaps

WHAT IS AIT DOING IN BATTERIES FOR AIRCRAFT?

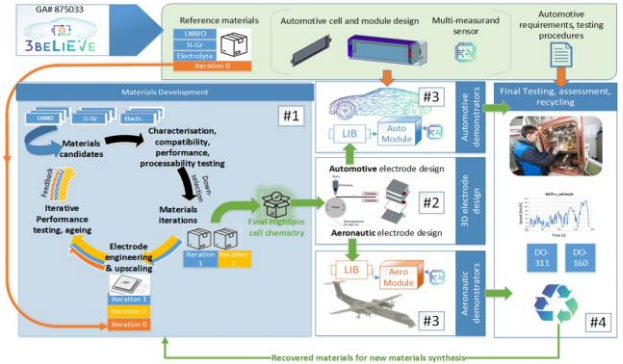


PROJECTS' HIGHLIGHTS

HIGHSPIN

Development of high-voltage Gen. 3b LNMO battery cells and modules (including sensors) for automotive and aeronautic applications.

Key partner(s): saft, PIPISTREL VERTICAL SOLUTIONS



Project data	2022-2026
Number:	101069508
Call:	HORIZON-CL5-2021-D2-01-02
Topic:	HE Cluster 5 – Destination 2
Type of Action:	RIA / TRL 6
AIT-Budget:	**1,504 k€ (out of 8.0 M€)**

AIT-Role: coordination, prototyping (pilot line) of high-voltage LNMO/Si-C cells, concept design of aeronautic modules and sensors' integration.

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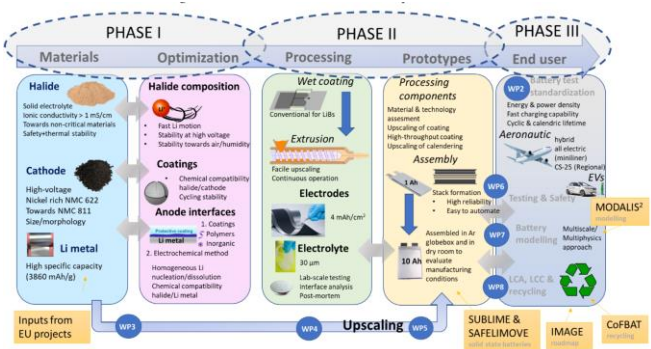
HELENA

Development of the next-generation solid-state batteries that will accelerate the transition to electric mobility

Key partner(s): LEONARDO, PIPISTREL VERTICAL SOLUTIONS



Project data	2022-2026
Number:	101069681
Call:	HORIZON-CL5-2021-D2-01-03
Topic:	HE Cluster 5 – Destination 2
Type of Action:	RIA / TRL 5
AIT-Budget:	**897 k€ (out of 8.4 M€)**

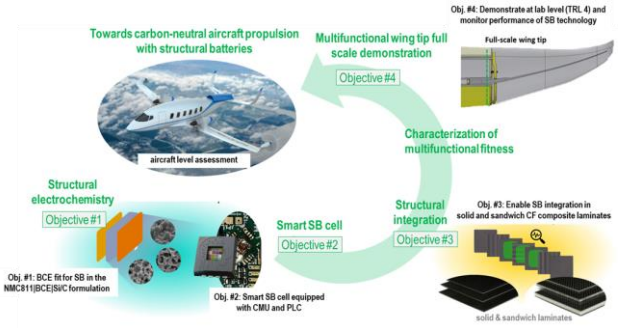
AIT-Role: development of electrodes, digital twin, testing, safety.

PROJECTS' HIGHLIGHTS

MATISSE

Development of load-bearing quasi-solid state battery cells and sensors integrated in aeronautic composite structures (i.e. Pipistrel Velis wingtip)

Key partner: PIPISTREL VERTICAL SOLUTIONS



Project data 2022-2025
Number: 101056674
Call: HORIZON-CL5-2021-D5-01-05
Topic: HE Cluster 5 – Destination 5
Type of Action: RIA / TRL 4
AIT-Budget: **1,052 k€ (out of 3.5 M€)**

AIT-Role: coordination, development and prototype of load-bearing quasi-solid state battery cells and on-cell sensors' integration.

HECATE

Hybrid electric regional aircraft power architecture.

Key partner(s): Collins Aerospace, SAFRAN, LEONARDO, AIRBUS

Project data 2023-2025
Number: 101101961
Call: HORIZON-JU-CLEAN-AVIATION-2022-01-HER-03
Type of Action: RIA / TRL 5

AIT-Budget: **490 k€ (out of 45.2 M€)**

AIT-Role: battery pack conceptualization, interface to the fuel cell system, digital twin.

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

THANK YOU!

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