



From barriers to breakthroughs: tackling aviation's top challenges

Competitiveness | Performance
Sustainability | Technology



Take Off Insights Vienna, Austria
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Executive Director
Clean Aviation



The Competitiveness Challenge

How does aviation create impact in Europe?



13.5 million jobs
4.4% of EU GDP



58% market share
of new civil aircraft
47% of global order
book
**70% of global
airspace** managed
with European ATM
technology



Strengthens
European **trade** and
strategic autonomy
**Advanced
technology** driven



Enables **mobility,**
education & research
Connects regions,
supporting EU
integration
& cohesion

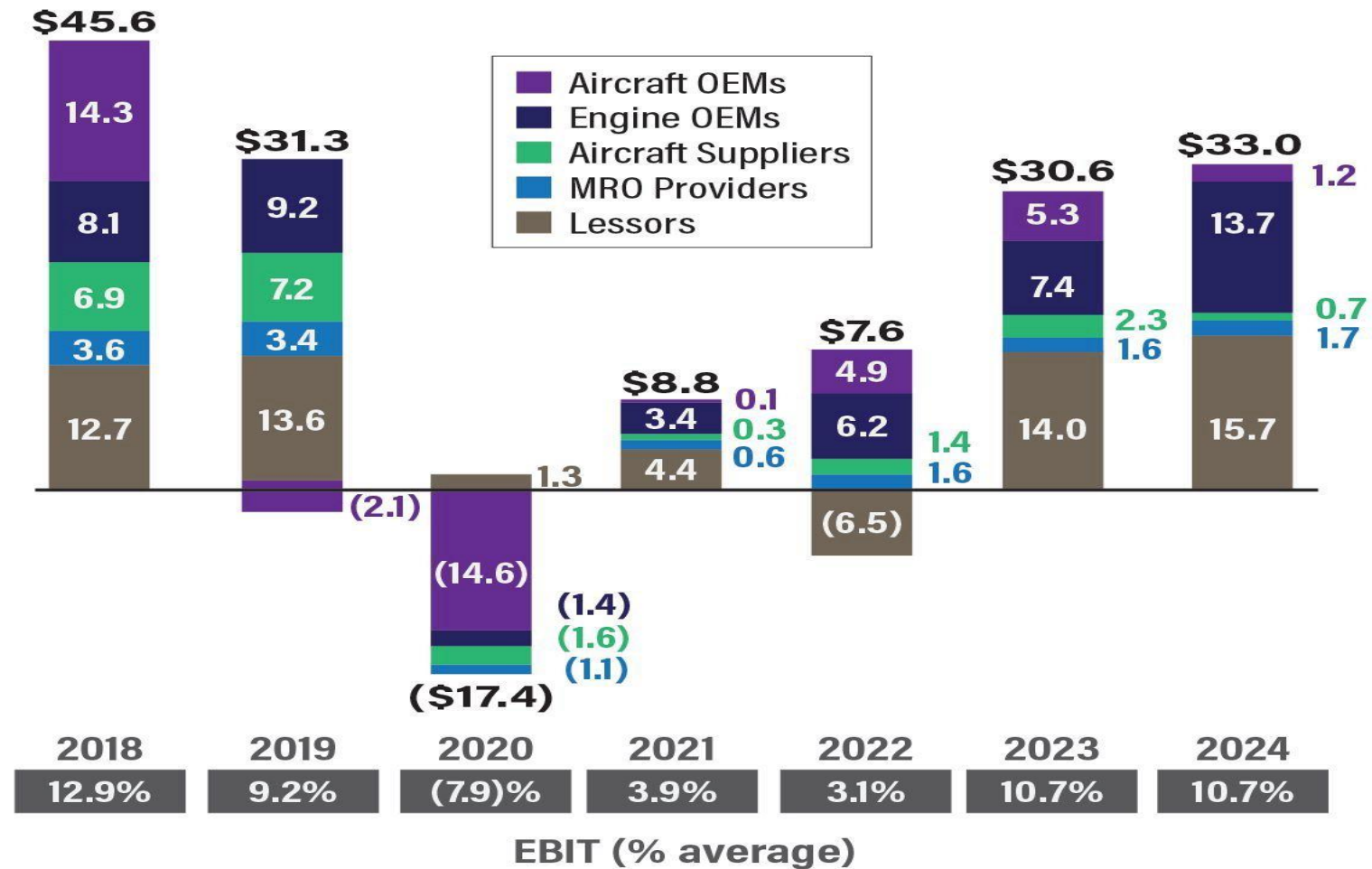
EU vs global competitors: from leading to chasing?

USA  & CHINA 

- Aggressive public **investment in R&I** (incl. aircraft demonstrator platforms) outpacing EU by wide margins
- **Energy prices 2–5x lower** than EU, boosting industrial competitiveness
- Leading in **AI, digitalisation, batteries, hydrogen and advanced manufacturing**

TAKE AWAY: EU's position is fragile unless EU boldly invests in R&I & support to market uptake

Commercial aviation's profit distribution



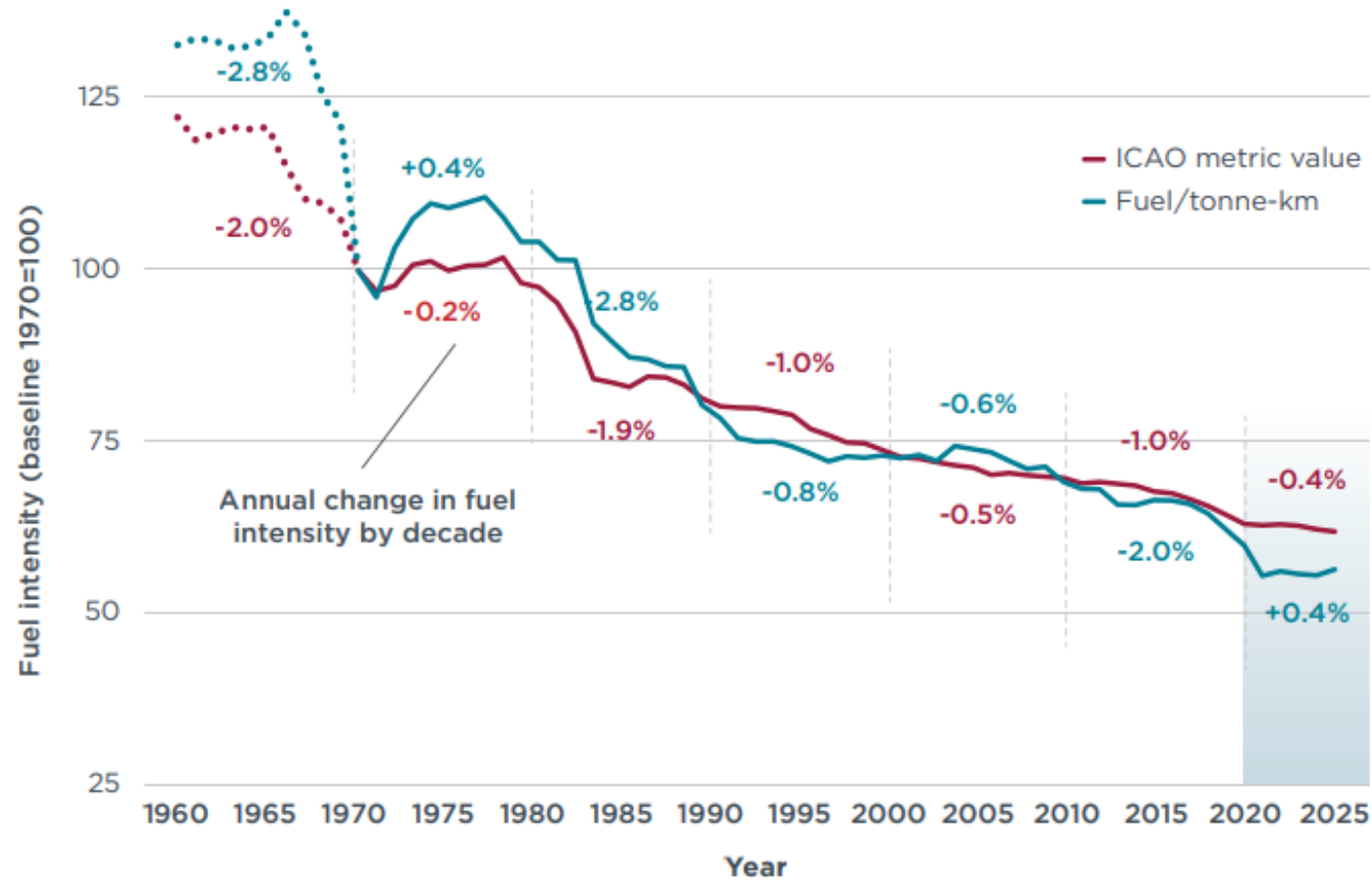


The Performance Challenge

Fuel burn trends for new commercial aircraft

Performance improvements are dependent on the introduction of newer aircraft models

Fuel burn trends for new commercial jet aircraft, 1960-2024



ICCT January 2025

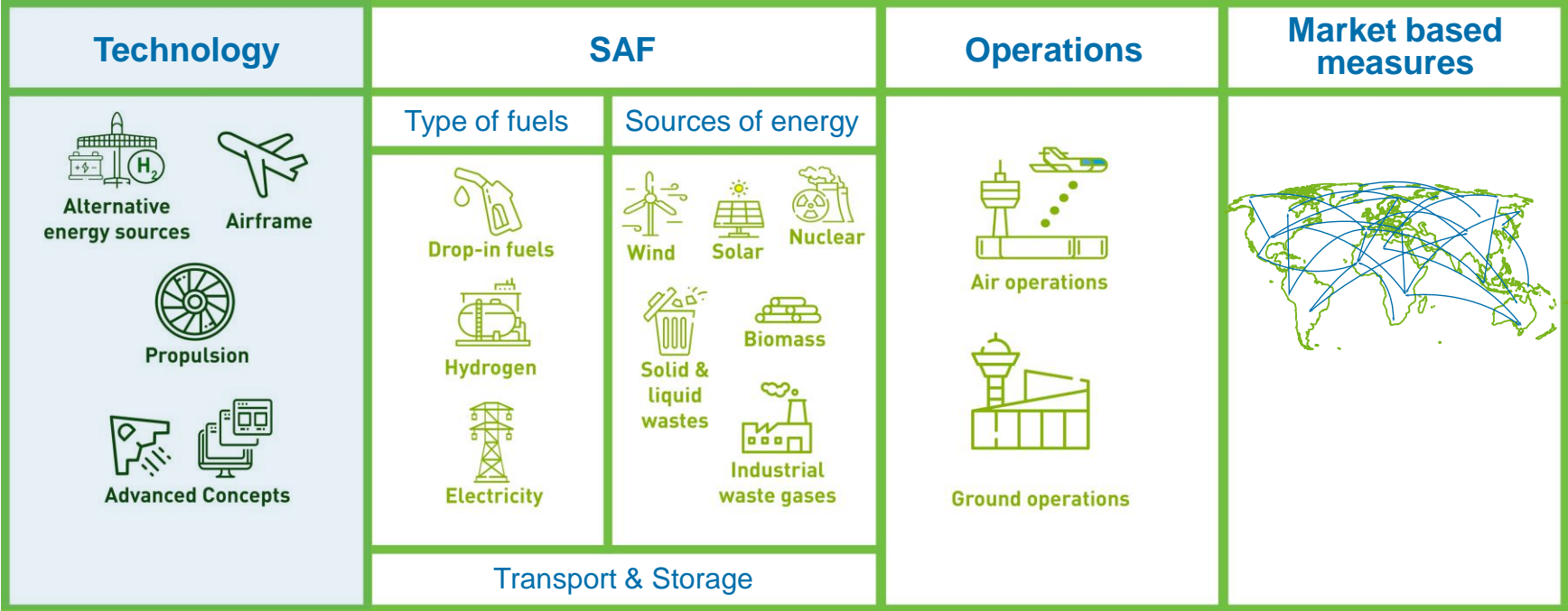


The Sustainability Challenge

The CO₂ contribution reduction panorama by 2050

ICAO WORK ON LONG-TERM ASPIRATIONAL GOAL

Breakthrough in CO₂ reduction will be triggered by disruptive technologies & SAF



34%

53%

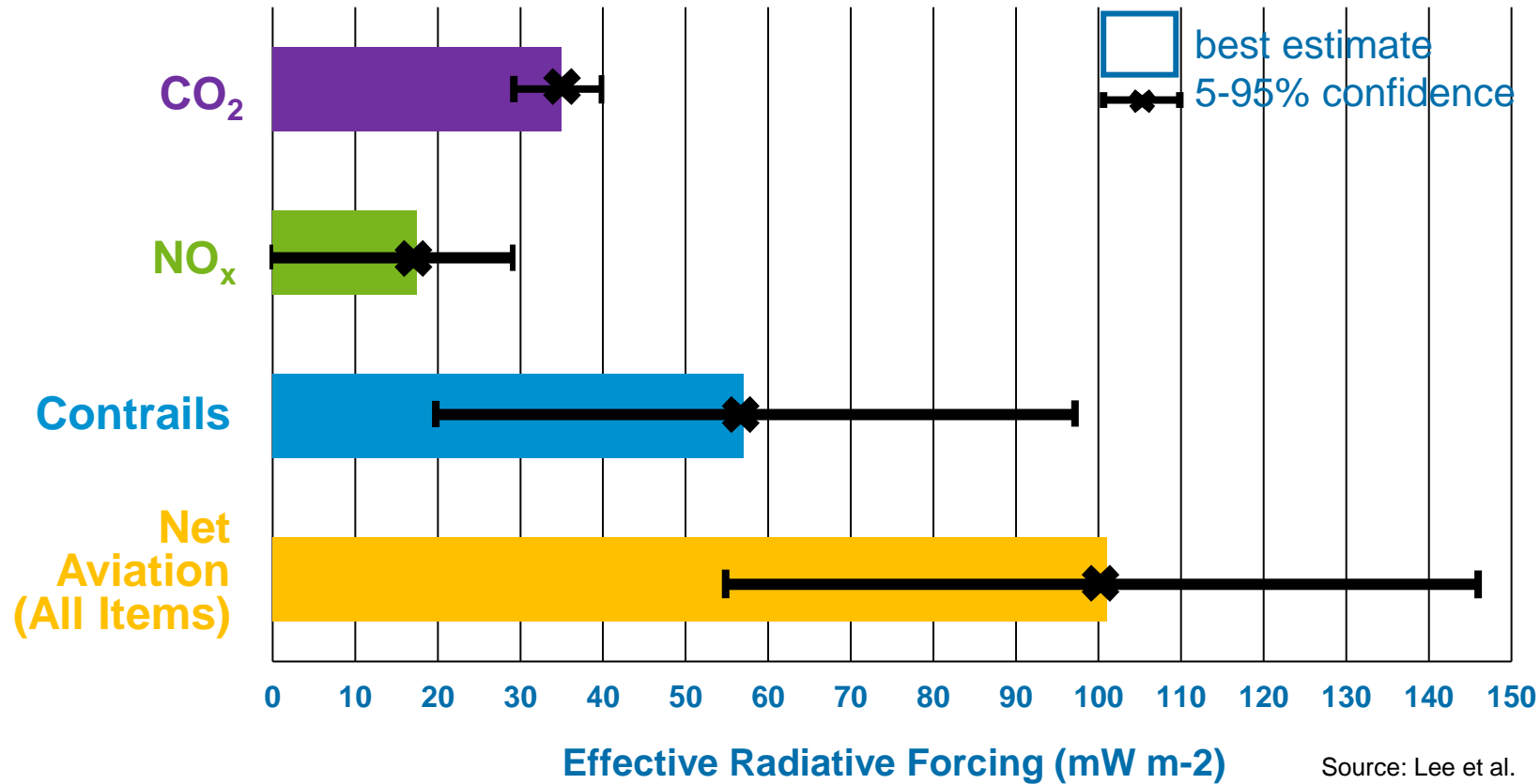
7%

6%

ATAG Waypoint 2050 (2021), Scenario 3: aspirational and aggressive technology perspective

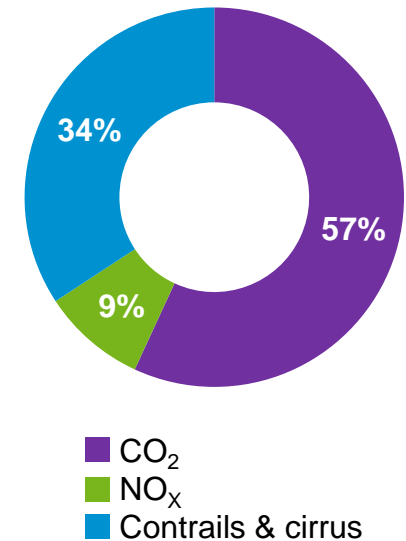
Climate Impact is NOT only about CO₂

GLOBAL AVIATION EFFECTIVE RADIATIVE FORCING (ERF) TERMS (1940 TO 2018)



























GLOBAL WARMING POTENTIAL

After 100 years



How to replace fossil kerosene?

	Environmental Impact		Costs		Scalability
	CO ₂ 	Non-CO ₂ 	Energy costs Trend towards 2050 	Aircraft & Airports 	
 SAF	 Close to Net 0	 Cleaner burn Low soot			
 LH2	 "True 0"	  Contrails risk Lower Nox Zero Nox (Fuel Cells)	 Lower cost than synfuel		
 Battery	 "True 0"	 "True 0"			

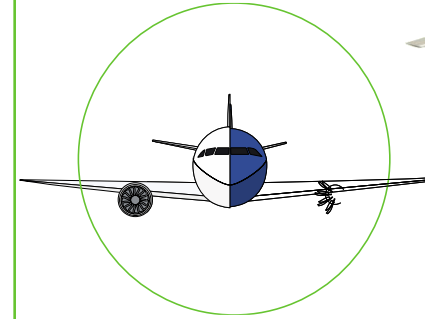
The Technology Challenge

Clean Aviation programme outlook and overview



| Clean Sky 2 Results

From technology to impact



Clean Sky 2 Achievements (1/2)



Tech Turboprop Engine



Racer Demonstrator



Clean Sky 2 Test bed 2 Maiden flight

Clean Sky 2 Achievements (2/2)



Multi Functional Fuselage Demonstrator



Ultra Fan Engine



Ultra High Propulsive Efficiency



Clean Aviation Programme Goals & Objectives

Clean Aviation: an impact driven programme

Achieve
-30%
GhG
reduction

Support
Entry-into-Service
of new aircraft
by
2035

Enable
75%
fleet replacement
by 2050


PLUS:

SAF




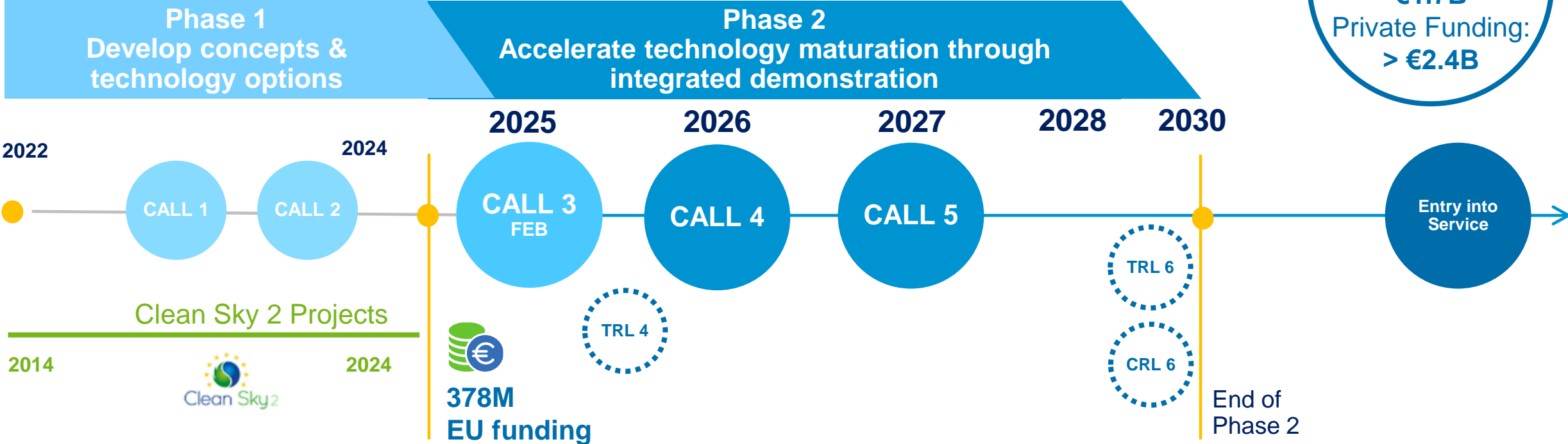
H2

Accelerating maturation & demonstration


 EU
 funding
 800M






 EU
 funding
 900M


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



Call 3: 12 projects with New Fast Track Areas

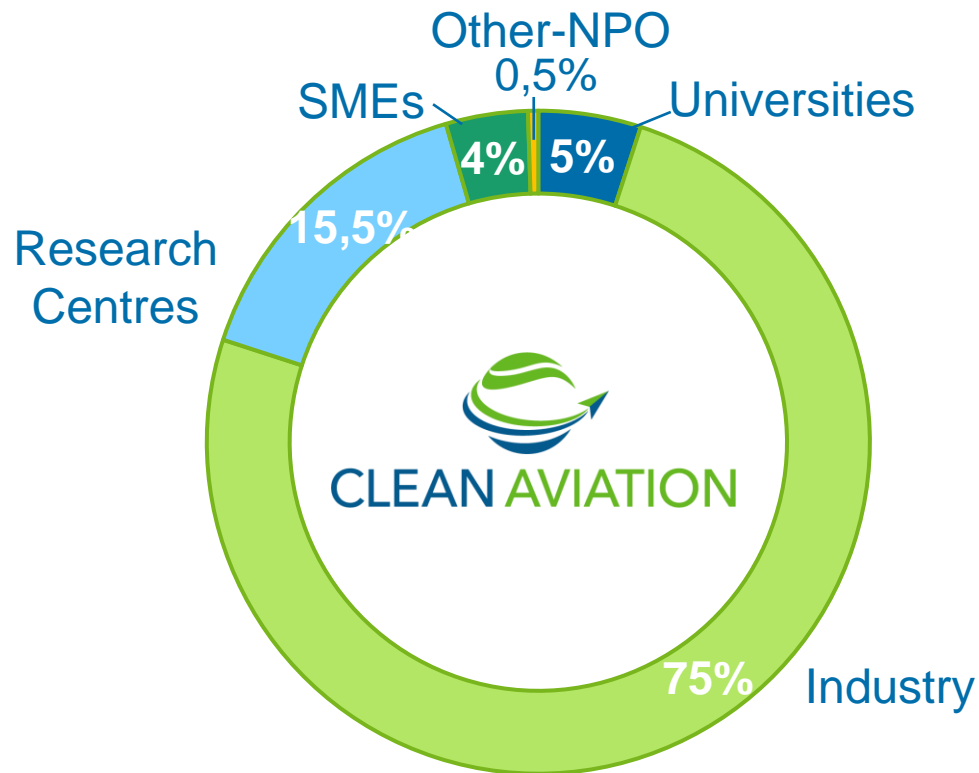

 EU € 380M
 Private € 570M

 ULTRA-EFFICIENT SHORT-MEDIUM RANGE AIRCRAFT	 ULTRA-EFFICIENT REGIONAL AIRCRAFT	 FAST-TRACK AREAS	 AIRCRAFT CONCEPT INTEGRATION & IMPACT ASSESSMENT
TAKE OFF Technology And Knowledge for European Open Fan Flight <i>SAFRAN AIRCRAFT ENGINES</i>	PHARES Powerplant Hybrid Application for REgional Segment <i>PRATT & WHITNEY CANADA CORP.</i>	CRYOSTAR Certification Roadmap to Yield an Optimal and Safety methodology of crashworthiness for an integrated cryogenic Tank for liquid hydrogen storAge on board of future aircraft <i>UNIVERSITA DEGLI STUDI DELLA CAMPANIA LUIGI VANVITELLI</i>	HERACLES Hybrid Electric Regional Aircraft Concept for Low EmissionS <i>AVIONS DE TRANSPORT REGIONAL</i>
LEIA Large scale Integration demonstrator of hybrid electrical Architecture <i>AIRBUS OPERATIONS GMBH</i>	DEMETRA Demonstrator of an Electrified Modern Efficient Transport Regional Aircraft <i>AVIONS DE TRANSPORT REGIONAL</i>	MODABAT Modular, scalable and technology-Open Design for future Aviation BATteries <i>FRAUNHOFER GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG EV</i>	ACI&I Short Medium Range - Aircraft Configuration Integration and Impact <i>AIRBUS OPERATIONS GMBH</i>
UNIFIED Ultra Novel and Innovative Fully Integrated Engine Demonstrations <i>ROLLS-ROYCE PLC</i>	OSYRYS On-board SYstems Relevant for hYbridization of Regional aircraftS <i>SAFRAN ELECTRICAL & POWER</i>	POWER4AIR Arc Fault Detection, low EMI and Reliability for Power Electronics in Electric Aircrafts <i>SKYLIFE ENGINEERING SL</i>	
		LIME Lithium based Innovation for Modular Energy <i>ASCENDANCE FLIGHT TECHNOLOGIES</i>	

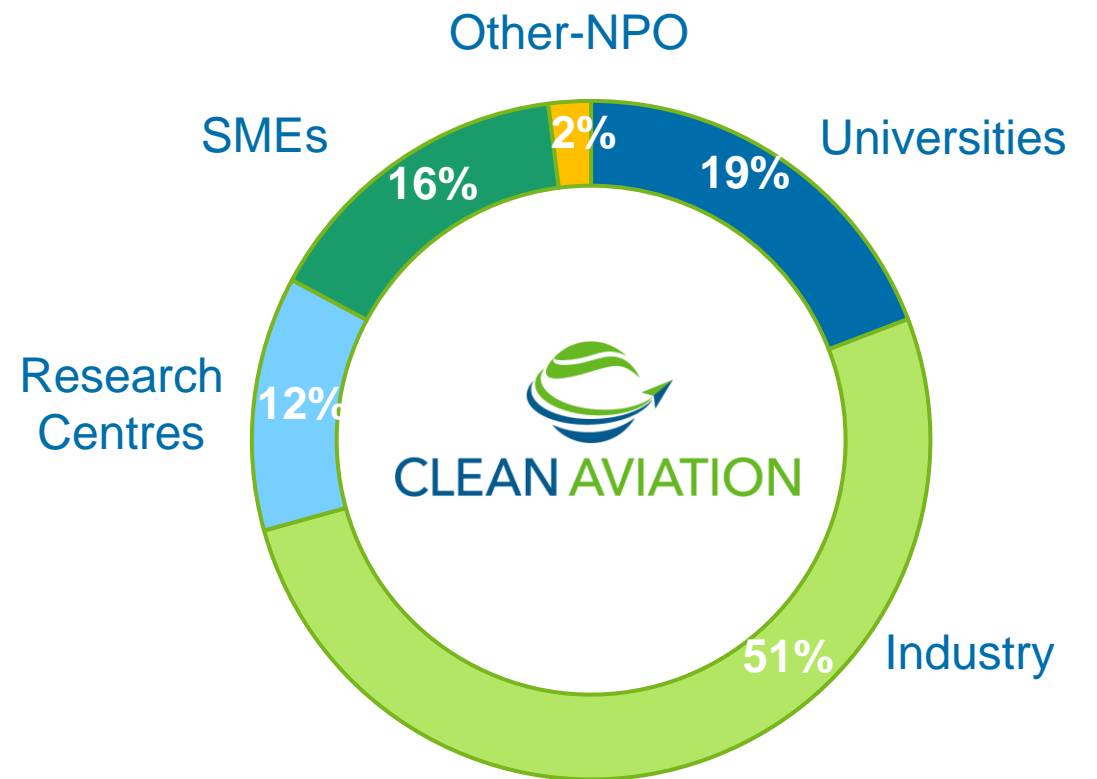
Participation in Clean Aviation

Share of budget for all participations (Call 1, 2, 3)

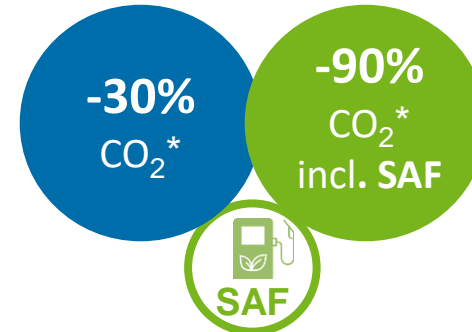
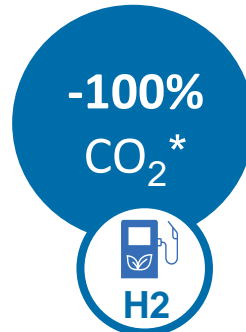
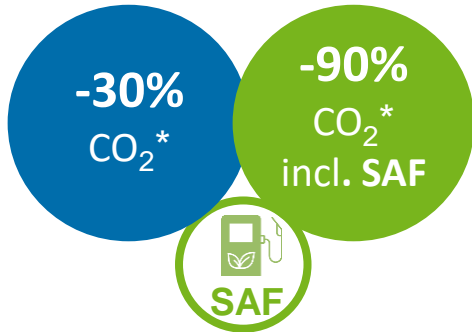
EU funding: €1.163 billion



319 single participating entities (Call 1, 2, 3)

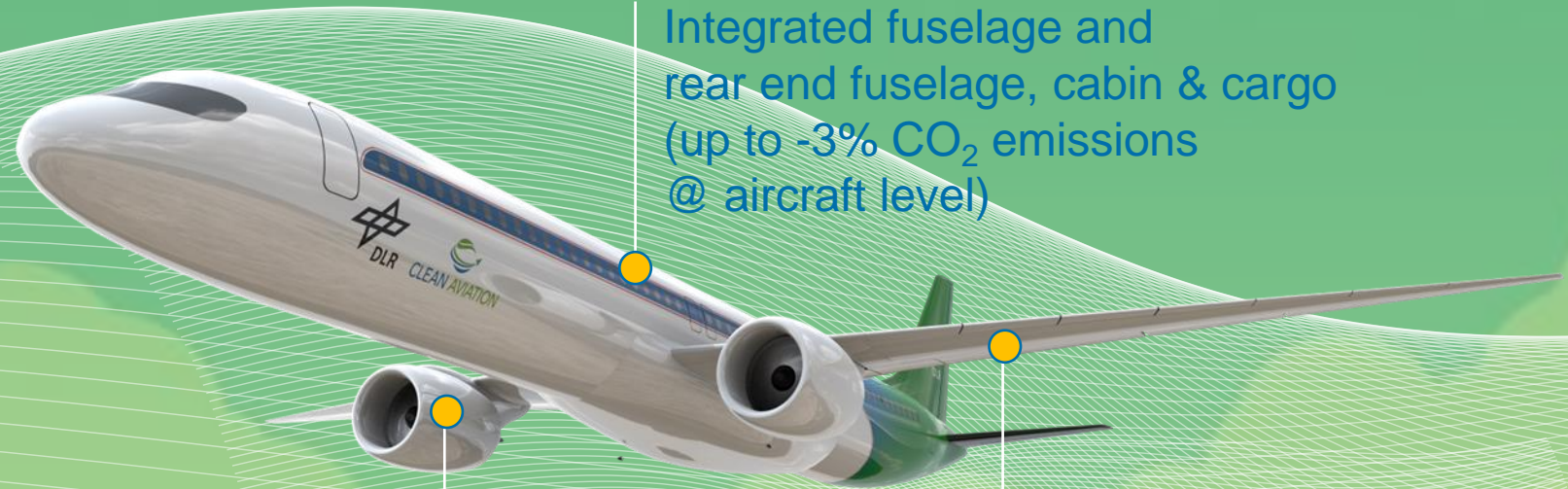


Clean Aviation's aircraft concepts



* non-CO₂ effects not yet quantified

SMR Aircraft: Main tech challenges



Integrated fuselage and rear end fuselage, cabin & cargo (up to -3% CO₂ emissions @ aircraft level)

Ultra Efficient Propulsion & Propulsion Integration (approx. -20% CO₂ emissions @ component level)

Ultra performing wing with high aspect ratio (up to -15% CO₂ emissions @ aircraft level)

Small Medium Range Technology Roadmap



Reference:
State of the Art
2020



Unducted Engine
Concept



Ducted Engine
Concepts



-20%
CO₂

Small Medium Range Technology Roadmap



Reference:
State of the Art
2020

2023 2024 2025 2026 2027 2028 2029 2030

EIS 2035

On Ground Demonstration
of a Non-Propulsive Energy
Systems Platform



Enabler
for
MEA

On Ground Demonstration of
a Optimized System Platform



2% CO2
reduction at
AC level

High rate
Industrial
system
@100p/m

Ultra-efficient RFE &
Industrial Systems

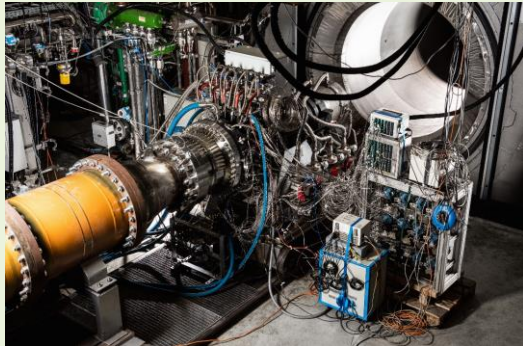


OFELIA

Efficient integrated propulsion



2023 DLR high-pressure combustion chamber test rig



2024 SESTA LAB full annular combustion test rig



2025



2026

Flight Test 2028

- Advanced compact core engine combustion technologies using both JET-A1 and SAF at critical operating conditions assessed
- Optimum open fan installation to maximise fuel burn and acoustic emissions reductions

- HP Core Technology assessed successfully at TRL4

- TRL4 on key technologies for the Open Fan Low Pressure
- First full-scale demonstrator parts manufactured for testing
- Maturation of advanced systems technologies

- TRL5 on Reduction Gear Box and Open fan architecture
- Ground test & Flight test preparation

HEAVEN

Hydrogen Engine Architecture Virtually Engineered Novelty



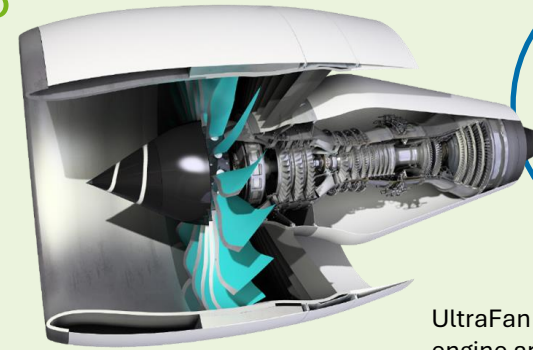
2023-24



TRL 3

Low-emission combustion test unit in the HBK5 rig with DLR and RR teams

2025-26



TRL 4/5

UltraFan SMR engine architecture

Engine PDR end of 2025

- Development of the propulsion system MBSE supporting the SMR architecture definition
- Design of the key elements of the SMR engine: Power Gearbox, Combustion system FSN
- Subsystem maturation: Fan, IPT, hybridisation

- Testing the key components for the SMR engine architecture, demonstrating TRL5 at subsystem level
- Completion of SMR engine integration studies
- Virtual PDR of the engine architecture at SMR scale, demonstrating TRL4 at system level

Regional Aircraft: Main tech challenges

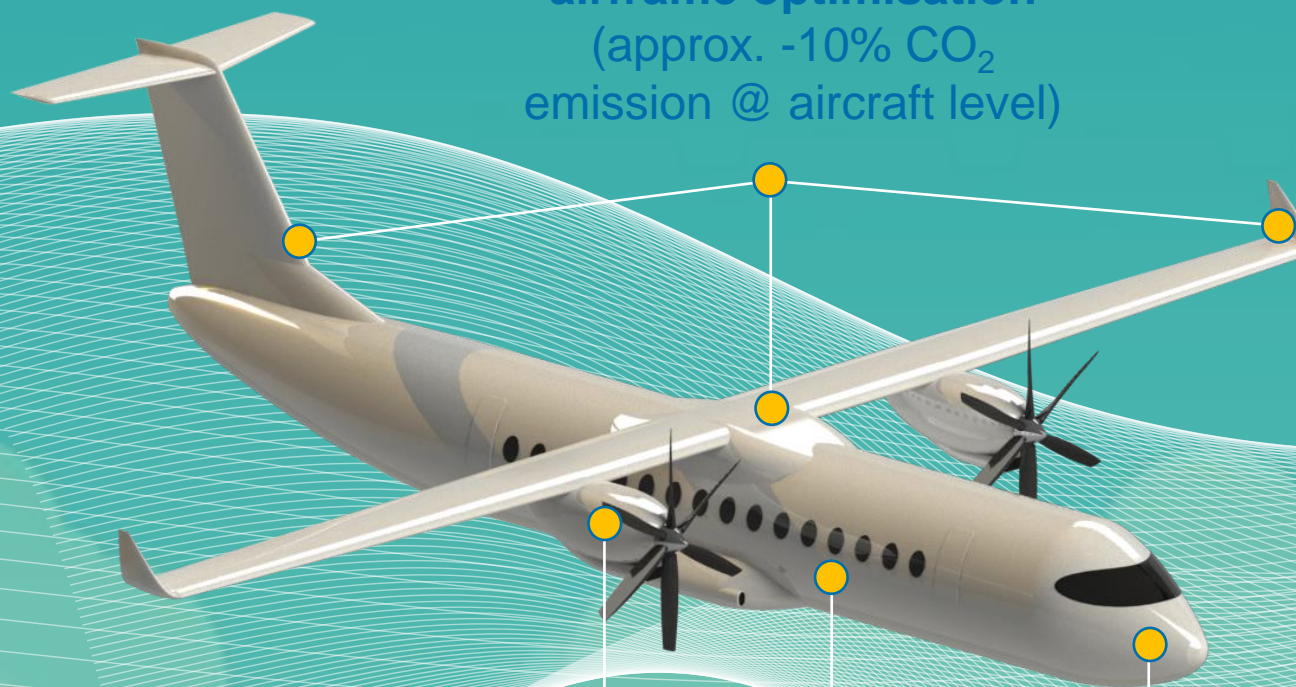


**Aerodynamic and
airframe optimisation**
(approx. -10% CO₂
emission @ aircraft level)

**Hybrid-electric
propulsion with batteries**
(approx. -20% emission
@ aircraft level)

**Advanced
cabin
solutions**

**Safety &
operability
solutions**



Ultra-Efficient Regional Technology Roadmap

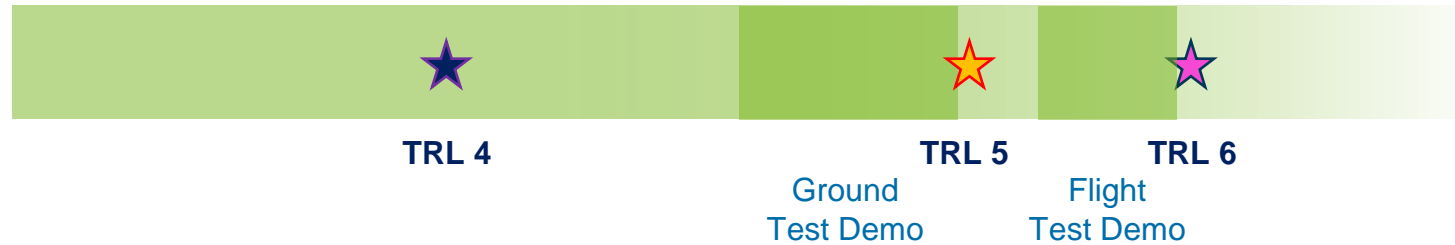


Reference:
State of the Art
2020

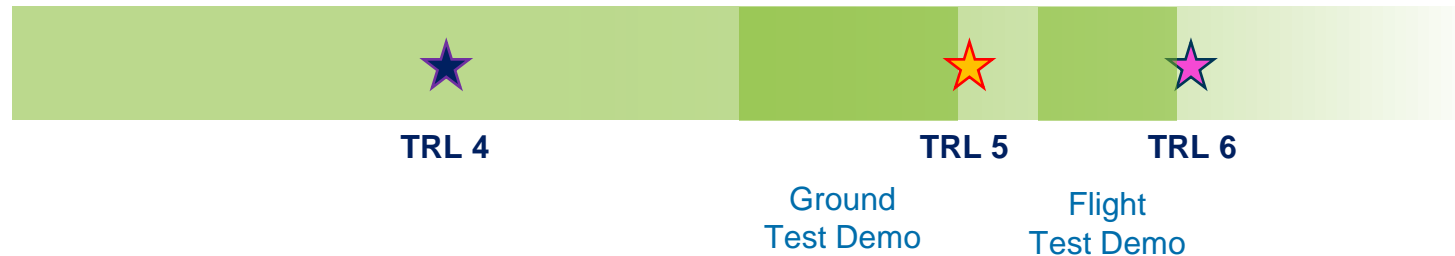
2023 2024 2025 2026 2027 2028 2029 2030

EIS 2035

Hybrid-Electric
Propulsion System
(HEPS)



Electric
distribution
& thermal
management
Systems



Advanced Airframe
(and enabling
systems)



-20%
CO₂

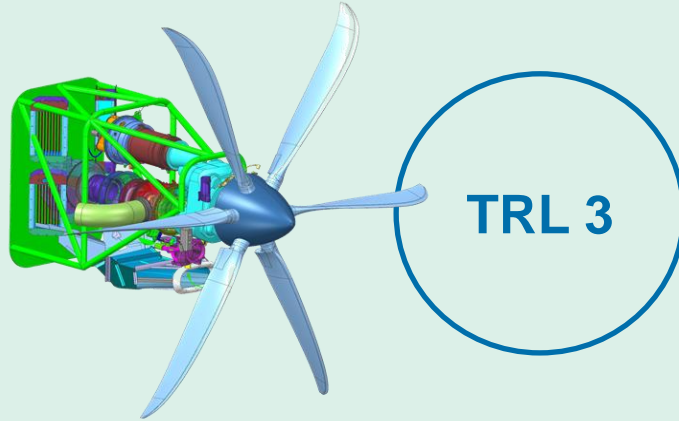
-10%
CO₂

AMBER

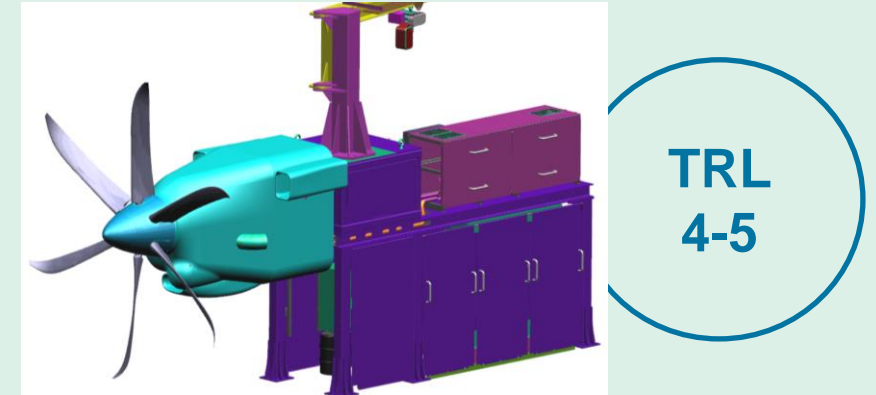
innovAtive deMonstrator for hyBrid-Electric Regional application



2023-24



2025-26



- ~2MW Hybrid electric propulsive architecture conceptual design
- Preliminary design of all key techno-bricks
- A/C integration studies and engagement with EASA
- Launch of long lead time procurements

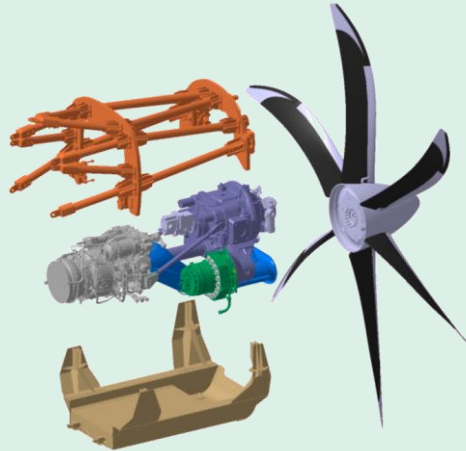
- HE Power train final design
- All key technos developed, assembled and tested
- MW-class FC and E-motor system validation
- Integration HE power train testing

HE-ART

Hybrid Electric propulsion system for regional AiRcraft



2023-24



TRL 4

2025-26



TRL 5

- System and sub-system Preliminary Design and Critical Design Review
- Components (heat exchanger, electric machine) and materials (Engine mounting systems) testing to support system design and performance validation
- Testing facility modifications started

- Complete Critical design and release drawing
- Purchase, manufacturing and testing techno-bricks
- Progress Ground Test Facility modifications and assemble the hybrid-electric propulsion system
- Testing in representative operative conditions incl. extensive hybridization rates and flight

Hydrogen aircraft: Main tech challenges



LH₂ storage:
2x higher energy density
(12 kWh/kg or gravimetric
index of 35%)

**Fuselage & empennage
technologies:**
safe installation of tank,
compliance with safety
(crashworthiness)

LH₂ distribution:
safe, reliable
management incl.
leakage

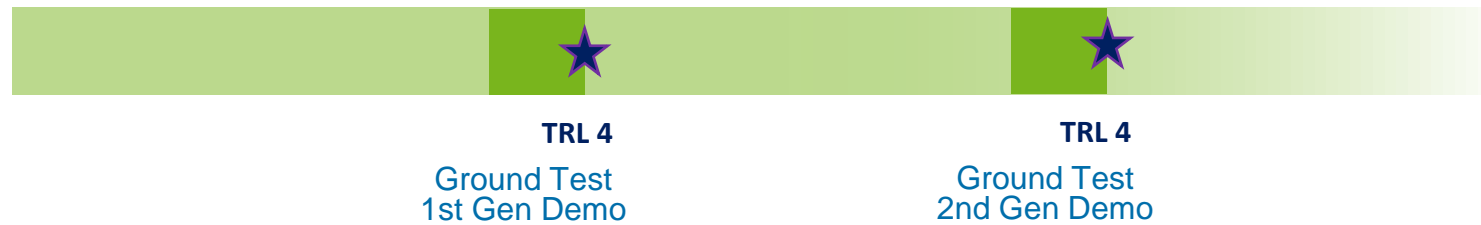
Fuel cell system:
2-3x higher power density
(2kW/kg), high life-time, low
cooling drag

H₂ turbines:
high efficiency
and low NO_x
emissions

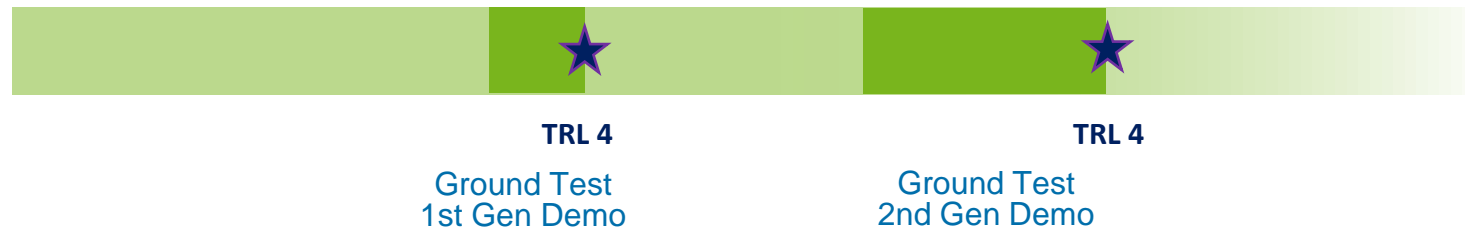
Hydrogen Powered Aircraft Technology Roadmap



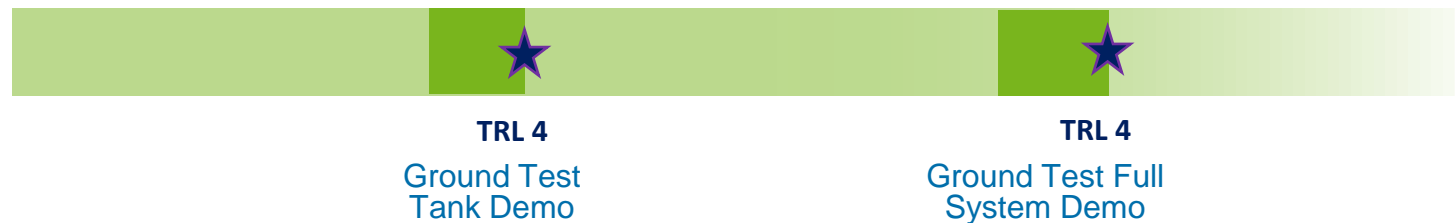
H2 combustion propulsion system



H2 fuel cell propulsion system



H2 refuelling, storage, and distribution



-100% CO₂

CAVENDISH

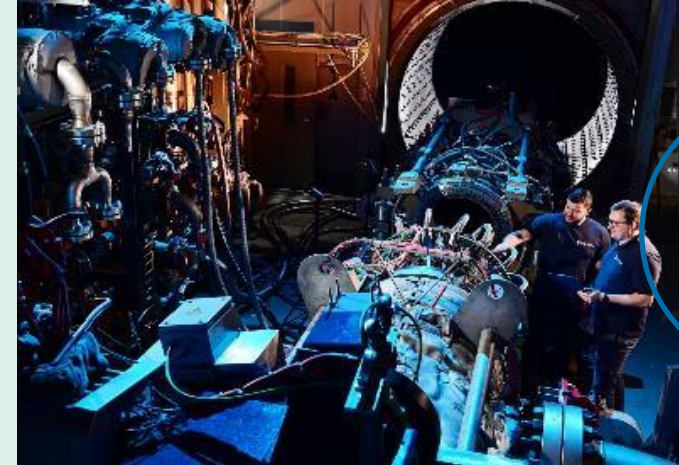
Hydrogen combustion engine demonstrator

2023-24



TRL 3

2025-26



TRL
4-5

- Full annular combustor with novel spray nozzles 100% hydrogen tested in representative engine conditions
- Initial tests performed on modern donor engine to calibrate and prepare for subsequent hydrogen tests
- Components development for full scale engine test

- Engine upgrade with novel actuation and thermal management for hydrogen
- Engine test preparation including test facility readiness, hydrogen components availability for a first test with gaseous hydrogen
- Hydrogen propulsion system aircraft installation studies and safety analysis performed

FAME

Fuel cell propulsion system for Aircraft Megawatt Engines

2024

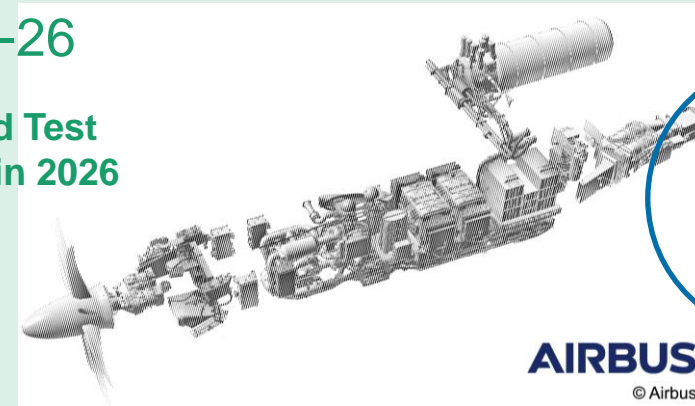


TRL 3



2025-26

Ground Test
Demo in 2026



TRL
4-5

- Top Level Aircraft Requirements defined, subsystem specifications determined
- Architecture of the ground test demonstrator finalised
- Development of key components and subsystems, with manufacturing and functional testing of the first ones

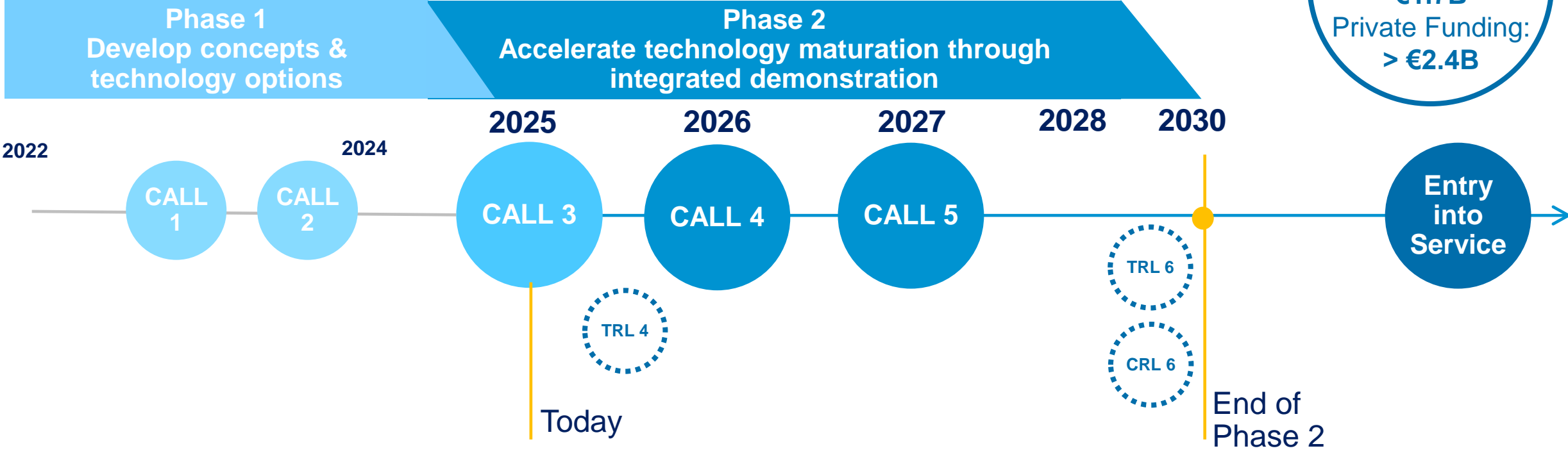
- Development of the subsystems finalised, integration into the Ground Test Demonstrator (GTD)
- 1MW Fuel Cell GTD commissioning, testing to validate TRL5 @ subsystem and TRL4 @ system level
- Design scaling and optimisation of the 2-4MW POD propulsion system, considering aircraft integration

Accelerating maturation & demonstration

EU funding 800M

EU funding 900M

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





Aviation Research & Innovation Strategy (ARIS)

AVIATION RESEARCH & INNOVATION STRATEGY

A pathway to
competitive and
sustainable aviation
supporting Europe's
sovereignty.



ARIS: handover to the European Commission

Clean aviation official recognition: Moonshot project



AVIATION RESEARCH & INNOVATION STRATEGY
A pathway to competitive and sustainable aviation supporting Europe's sovereignty

- ARIS handover to Commissioner Apostolos Tzitzikostas
- Paris Airshow, 16 June 2025
- +100 contributors



ARIS: A Strategic Roadmap for Competitive and Sustainable Aviation



Europe's aviation leadership in some areas is strong but not guaranteed



Aviation is vital to Europe's economy and sovereignty



Urgent investment in R&I is needed to stay competitive and meet climate goals



Three key areas for R&I investment:
> Aircraft Technologies
> Air Traffic Management
> Transforming Enablers

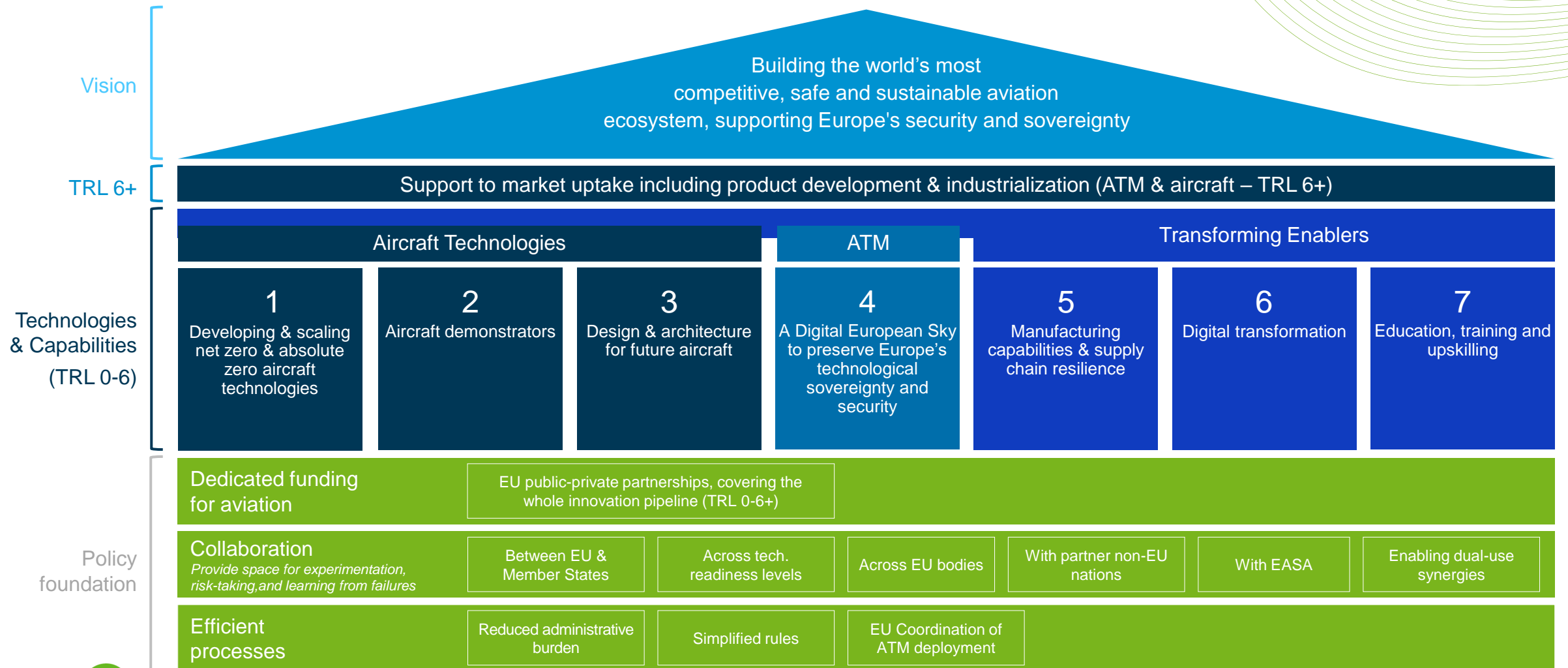


Collaboration is key: a Europe-wide R&I strategy

2028-2034 EU multiannual financial framework:

EUR 66 bn investment (of which EUR 22.5 bn at EU level) in EU aviation R&I and support to market uptake to meet competitiveness, sustainability, and sovereignty objectives

A new framework for action on European aviation



Call for action



➤ **Public & private sectors to establish a common European aviation roadmap**



➤ **EU and Member States to increase the support to aviation R&I and market uptake substantially**



➤ **Private aviation sector to deliver on its commitments**



Co-funded by
the European Union

Thank you