HYBRID-ELECTRIC AND FULL ELECTRIC ARCHITECTURES FOR LOW-EMISSION HYBRID-ELECTRIC REGIONAL [REG] AIRCRAFT

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Clean Aviation Joint Undertaking

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HYBRID-ELECTRIC AND FULL ELECTRIC ARCHITECTURES FOR LOW-EMISSION HYBRID-ELECTRIC REGIONAL [REG] AIRCRAFT

Co-funded by
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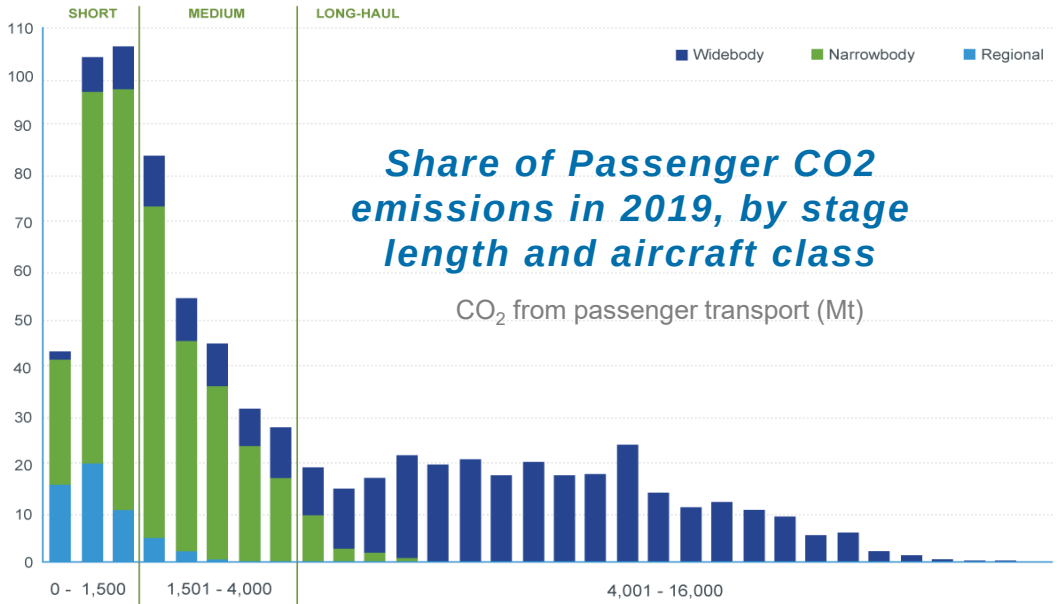
GLOBALLY,
flights < 4,000km dominate flights and emissions
Clean Aviation *Strategic Research and Innovation Agenda*

WINDOW OF OPPORTUNITY

Hybrid electric and full electric architectures	▶	Low Emission Hybrid-electric **Regional** Aircraft	▶
Disruptive technologies to enable hydrogen – powered aircraft	▶	Zero Carbon Hydrogen-powered **Short Range** Aircraft	▶
Ultra-efficient aircraft architectures	▶	Low Emission **Short / Medium Range** Commercial Aircraft	▶

Long Range Aircraft Concepts progressing towards climate neutrality



Share of Passenger CO2 emissions in 2019, by stage length and aircraft class

CO_2 from passenger transport (Mt)

With 2/3 of global emissions from flights <4000km, there is scope for technology disruption!

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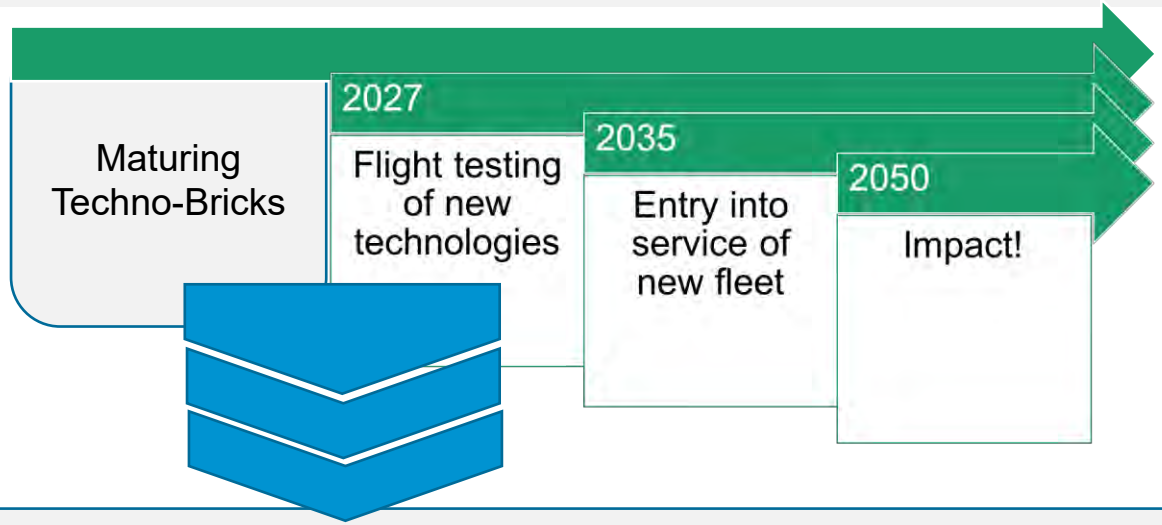
PLANNING TOWARDS NEXT GENERATION OF HE REGIONAL A/C

THE BEST WAY TO PREDICT THE FUTURE IS TO CREATE IT



Keep pushing the envelope **in all 'traditional' aeronautical** sciences

Non-traditional sciences and disciplines will need to bring key enablers

- Electrical power generation & distribution (high voltage; >>1MW)
- Thermal management
- Energy management systems enabling hybridisation
- LH2 storage & fuel systems
- Distributed systems & increased autonomy

Manufacturing system
(aim: replacing ~75% of the global fleet by 2050)

Life-cycle aspects and recyclability

Simulation, digital twin and innovative certification methods

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HYBRID REGIONAL A/C THRUST

Areas Of Intervention

AIRCRAFT ARCHITECTURE AND CONFIGURATION

HYBRID-ELECTRIC PROPULSION

ADVANCED ELECTRIC DISTRIBUTION

THERMAL MANAGEMENT

AIRFRAME INTEGRATION WING

AIRFRAME INTEGRATION FUSELAGE

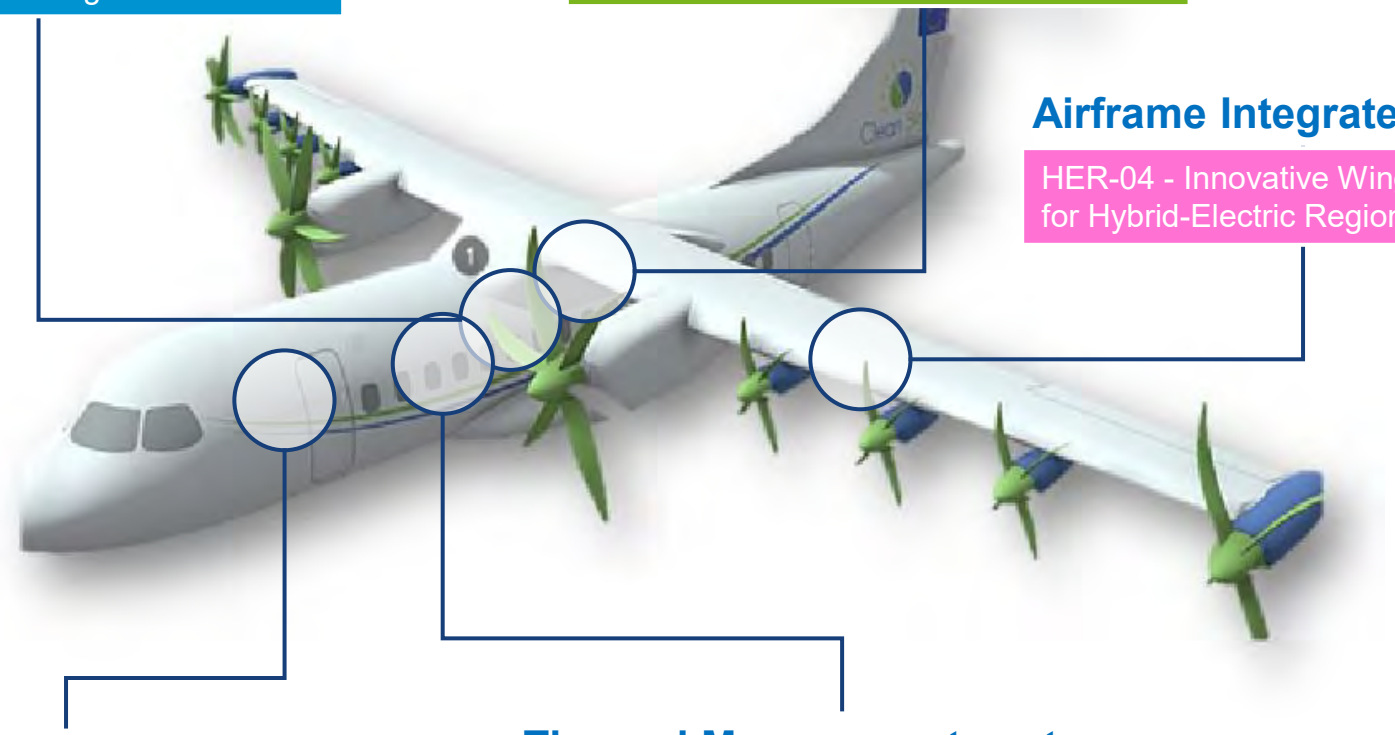
TRA-01 - Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

Hybrid Electric Power Train

HER-01 - Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

Electrical distribution system

HER-03- Electrical Distribution Solutions for Hybrid Electric Regional Aircraft



Airframe Integrated Wing

HER-04 - Innovative Wing Design for Hybrid-Electric Regional Aircraft

Airframe Integrated Fuselage

Thermal Management systems

HER-02 - Thermal Management Solutions for Hybrid-Electric Regional Aircraft

EXEMPLARY PICTURE- (ORIGIN: CS2- REG)

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HYBRID ELECTRIC POWER TRAIN

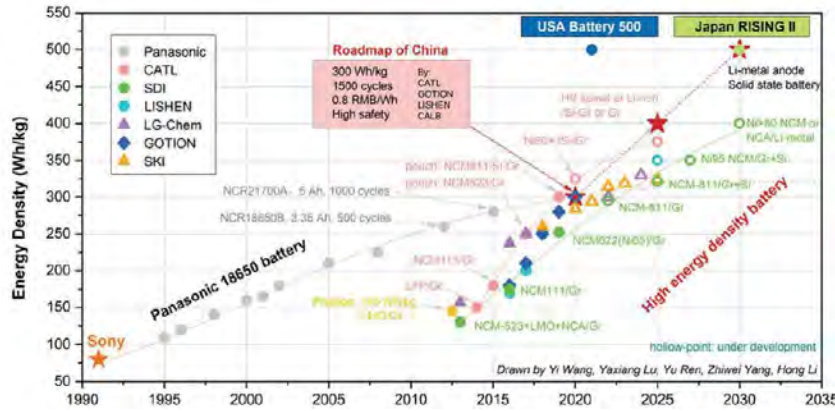
REGIONAL A/C POWER TRAIN

IS UP TO

10 TIMES

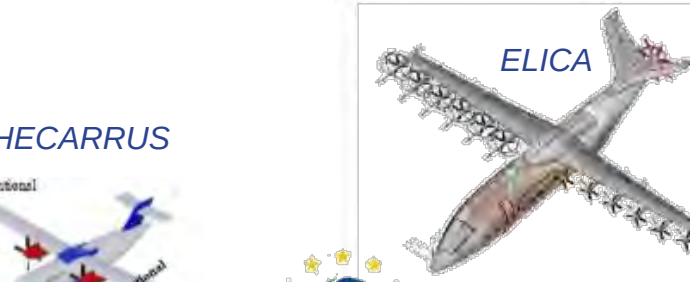
THAN THE POWER REQUIRED FOR SMALL COMMUTER AIRCRAFT.

https://twitter.com/airbuspress/status/873169639110520832



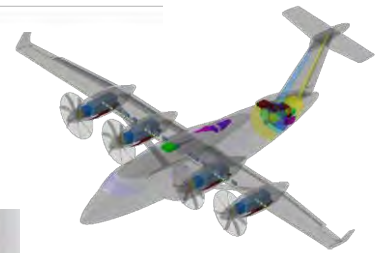
HECARRUS

ELICA



Clean Sky 2
JOINT UNDERTAKING

UNIFIER 19



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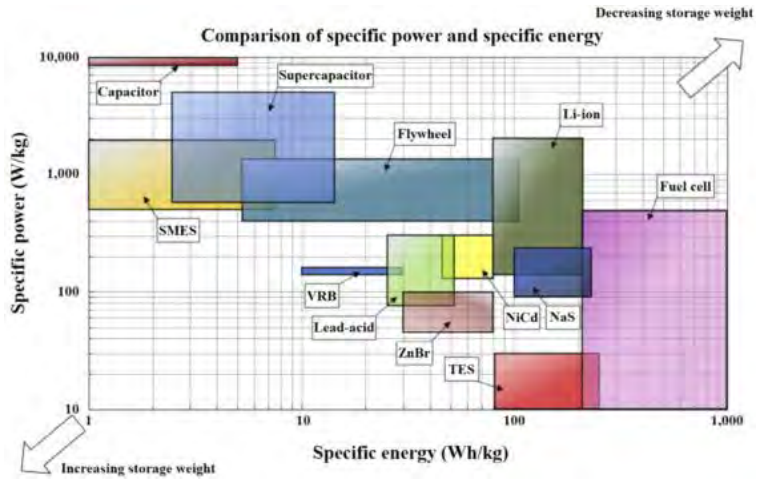

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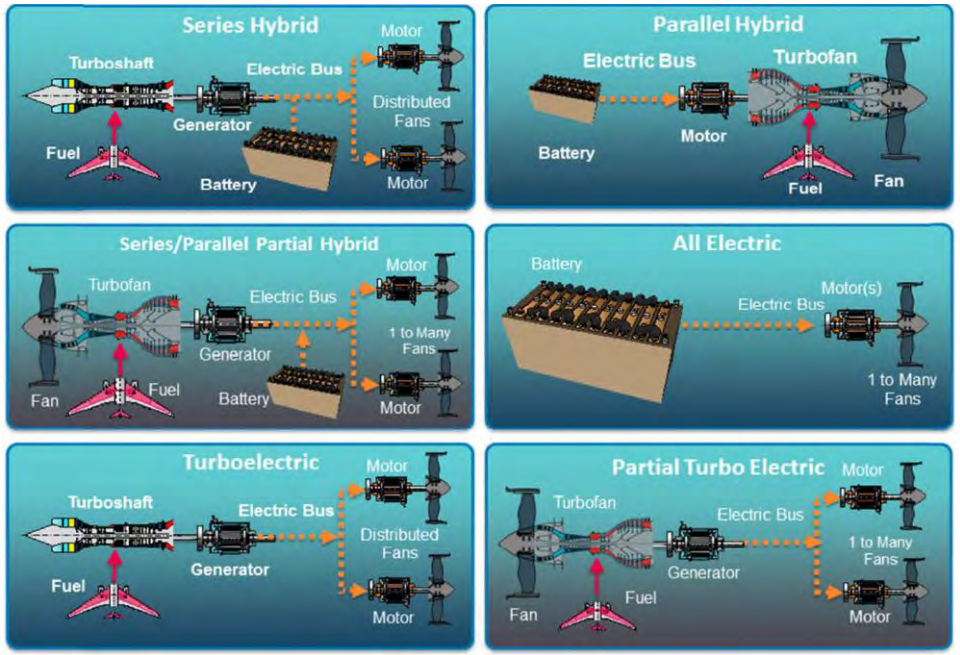
HYBRID ELECTRIC POWER TRAIN

HER-01 - Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

NO LESS THAN
30% GHG EMISSIONS
ON A TYPICAL MISSION
COMPARED TO 2020 STATE-OF-THE-ART
REFERENCE PROPULSION SYSTEM

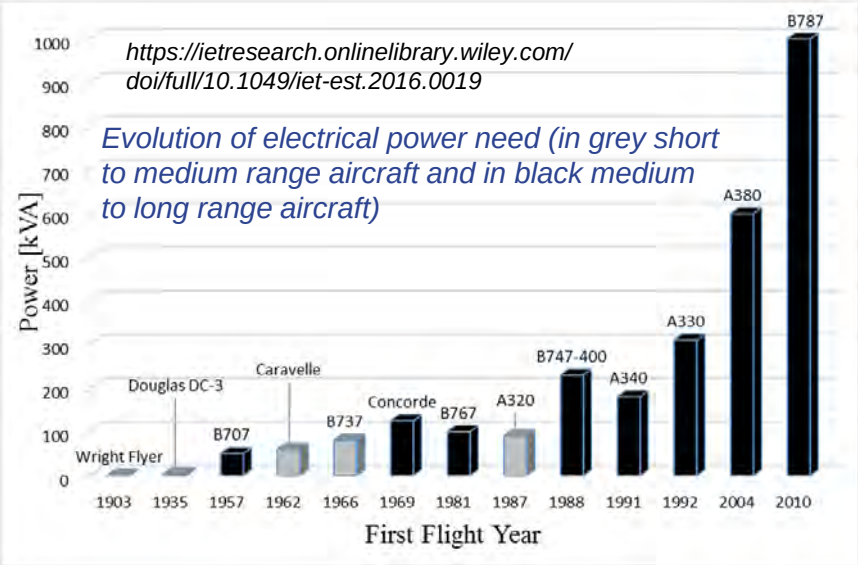
- To deliver a hybrid-electric MW propulsion system (4 to 10 Mw)
- Different propulsion and aircraft configurations should be investigated. (Minimum power-train module shall be 1 MW).
- New Hybrid propulsion power management needs to be developed.

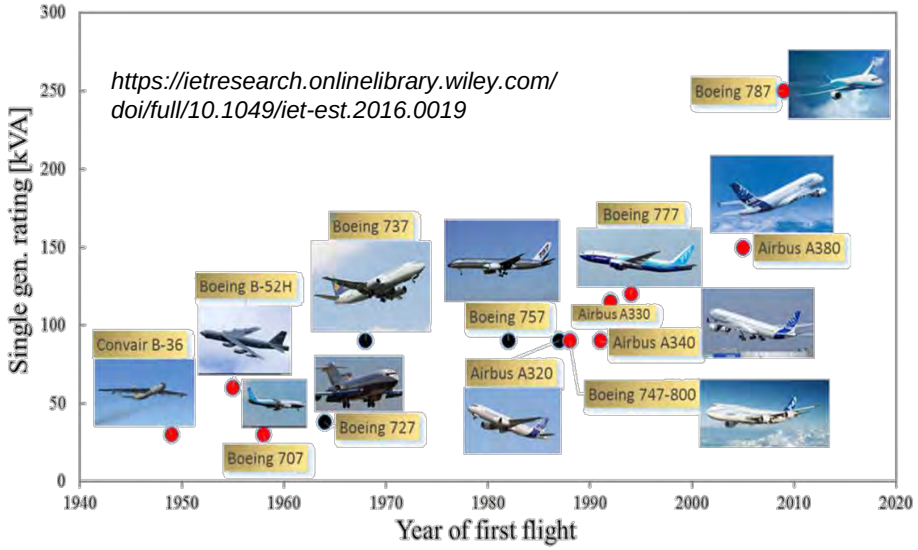


- TRL 4 or higher at overall engine level at the end of 2025

ELECTRICAL DISTRIBUTION FOR HE REG A/C

RAMPING-UP IN ELECTRICAL POWER;





CS1 and CS2 has deeply contributed to the development of more electric Aircraft related technologies:

- Electro-mechanical Actuator for movable surfaces
- Fly by wire control systems
- Electrical Ice protection system
- Electrical Landing Gears and Breaking system
- high voltage power generation and electrical distribution systems

https://www.clean-aviation.eu/electrical-aircraft-taxiing-looks-easy-with-e-tsin

https://www.clean-aviation.eu/electrifying-actuation-systems-for-greener-flights-with-reprise

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RAMPING-UP IN ELECTRICAL POWER;

ELECTRICAL DISTRIBUTION FOR HE REG A/C

HER-03- Electrical Distribution Solutions for Hybrid Electric Regional Aircraft

- To develop reliable and safe electrical distribution systems suitable for HE Multi MW Regional A/C:
  - ✓ High Voltage network (>800 volt);
  - ✓ weight penalty <20%;
- Power electronics to be designed to allow operation in unpressurized conditions, low density of the air.

⚠ Arcing,
⚠ Magnetic Interferences
⚠ insulation issues and failure effects.

- TRL 5 or higher at system level at the end of 2025

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THERMAL MANAGEMENT SYSTEM

DEVELOPING INTEGRATED THERMAL MANAGEMENT SYSTEM;

HER-02 - Thermal Management Solutions for Hybrid-Electric Regional Aircraft

- To develop a thermal management concept for a Hybrid Electric Regional Aircraft with an improved efficiency and minimum weight (weight penalty <30%)
- The concept shall identify and address all relevant heat loads (batteries and APU/ fuel cells) expected to arise because of the novel hybrid-electric propulsion architecture.
  - ✓ thermal management solutions at aircraft level, expected to be at 1 MW and beyond. (vs 50KW today)
- Proposed solutions shall seek a minimum aerodynamic drag penalty once integrated into A/C;
- Scalability (down and up) to other applications.
- TRL 5 or higher at system level at the end of 2025

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INNOVATIVE AIRFRAME

NOVEL WING AND FUSELAGE DESIGN IS KEY FOR THE SUCCESSFUL DEVELOPMENT OF HER AIRCRAFT

Clean Sky ▶
- Laminar Flow
- More efficient Aerodynamics
- Fuselage Composite
- Innovative structures.


Clean Sky 2 ▶
- Load Alleviation
- Wing Flow Control
- Innovative Wing Architecture
- Advanced Structures and Materials
- Innovative Manufacturing processes




Side FWD
Pax Cabin Demonstrator
(LDO VEL)


Clean Aviation ▶
- Innovative (Hybrid) Electric Integrated fuselage and wing Airframe



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INNOVATIVE AIRFRAME

HER-04 - Innovative Wing Design for Hybrid-Electric Regional Aircraft

NOVEL WING AND FUSELAGE DESIGN IS KEY FOR THE SUCCESSFUL DEVELOPMENT OF HER AIRCRAFT

- To deliver an innovative high efficient wing design >20% structure weight reduction at full wing level ; >15% fuel burn reduction at A/C integrated level.
- wing design need to be developed and validated in close connection with solutions and choices at aircraft, system and component level, and taking into account interdependencies.
- Demonstrate the wing design performance and maturity at TRL 5 at full wing system level at project completion via relevant tests and ground demonstration.
- Propose a qualification and certification plan linked to the proposed activities and suitable to HER aircraft.

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HE REGIONAL A/C ARCHITECTURE

TRA-01 - Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

50% FUEL BURN REDUCTION FOR TYPICAL MISSION COMPARED TO 2020 STATE-OF-THE-ART REFERENCE A/C

To develop and deliver up to a typical Preliminary Design Review (PDR) a high-potential disruptive aircraft concept taking into consideration all contributing technologies with the appropriate level of detail:

- HE REG A/C with a capacity of from 50 up to 100 seats
- sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km

Trade studies including all disciplines concerned, (e,g aerodynamics, structure, loads, weight, propulsion, systems, overall performance, operational and flight handling qualities, maintainability)

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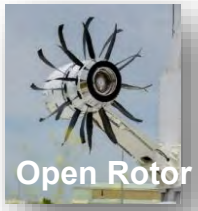
BUILDING ON CLEAN SKY 1 & 2 PROGRAMS

DRIVEN
BY THE
SUCCESS



Novel Aircraft Architecture

More Efficient Propulsion

Advanced Airframe

Testing Capabilities

Skills and Competencies

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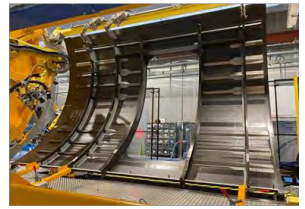

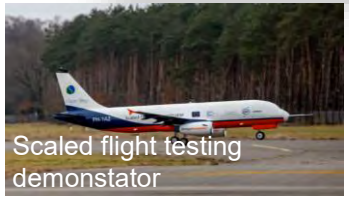

INDUSTRY MEMBERS SMES RESEARCH CENTRES UNIVERSITIES

CLEANSKY

Clean Sky 2
JOINT UNDERTAKING

European Commission

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