The future is green: the role of Clean Sky to deliver European impactful research

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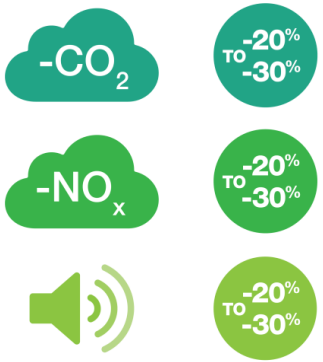
Executive Director Clean Sky

11th EASN Virtual International Conference
"Innovation in aviation & space to the satisfaction of the European citizens"

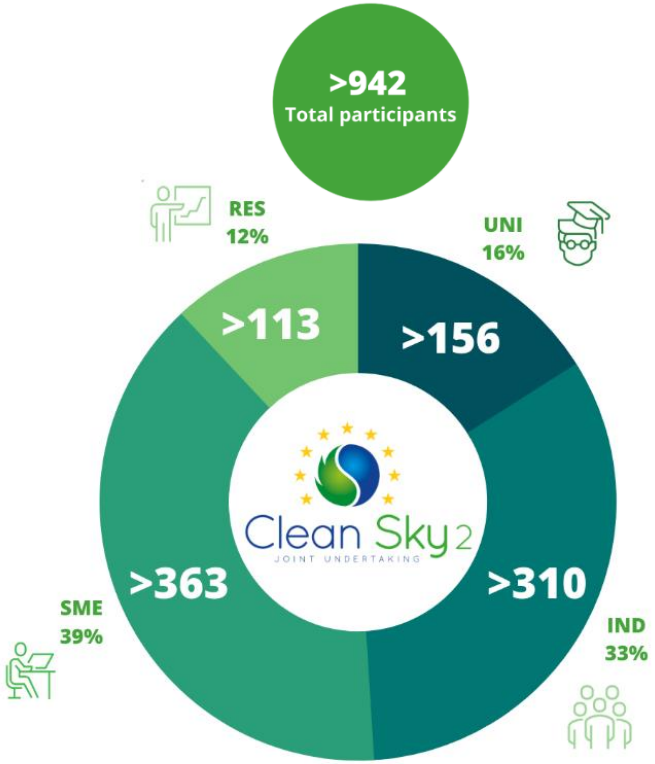
1st September 2021

Clean Sky 2: an open and inclusive PPP

Environmental Objectives*



** vs 2014 best aircraft*

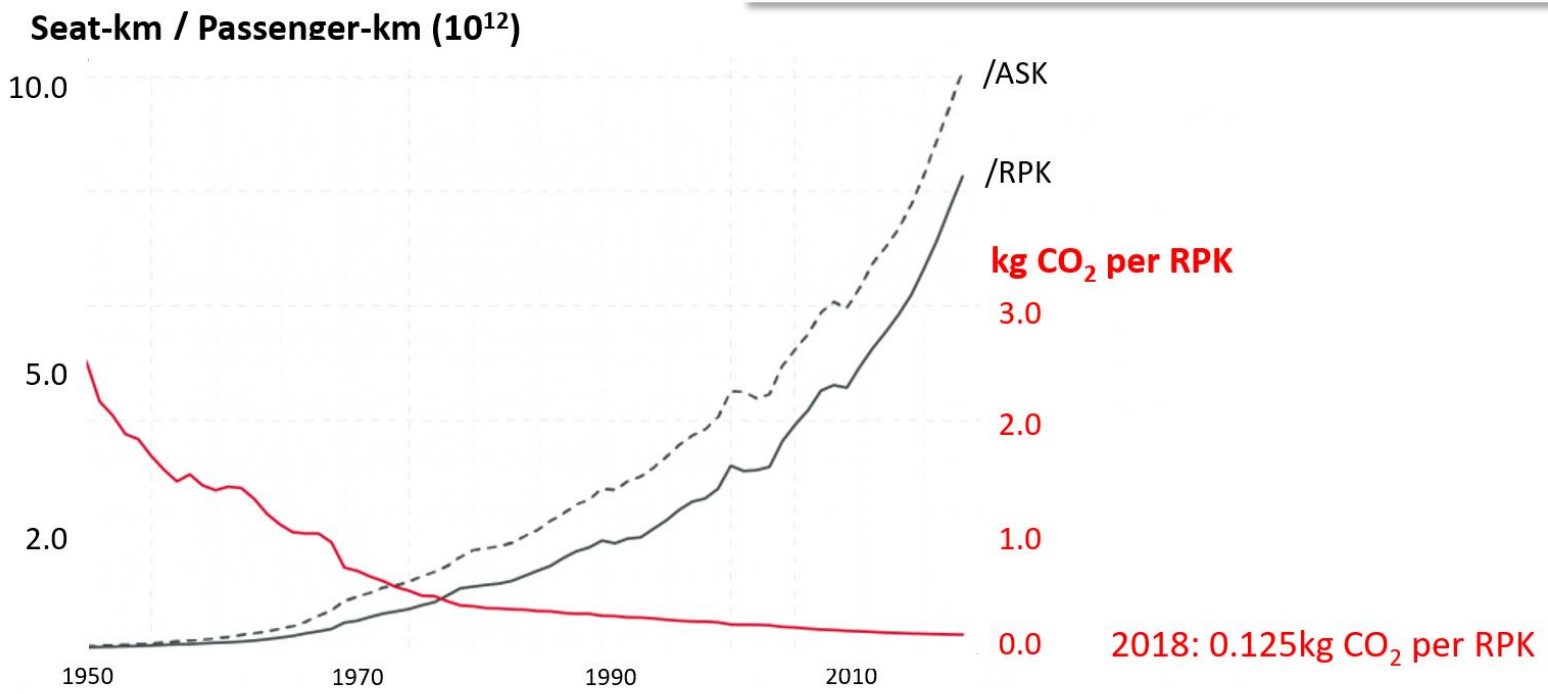


- €4 billion Public-Private Partnership programme
- Large SME participation with a high percentage being first-time EU programme participants
- Newcomers from other sectors providing key innovation impetus (e.g. automotive)
- 5000 scientists and engineers from 30 countries

Clean Sky 2 = an efficient and high-performing innovation eco-system

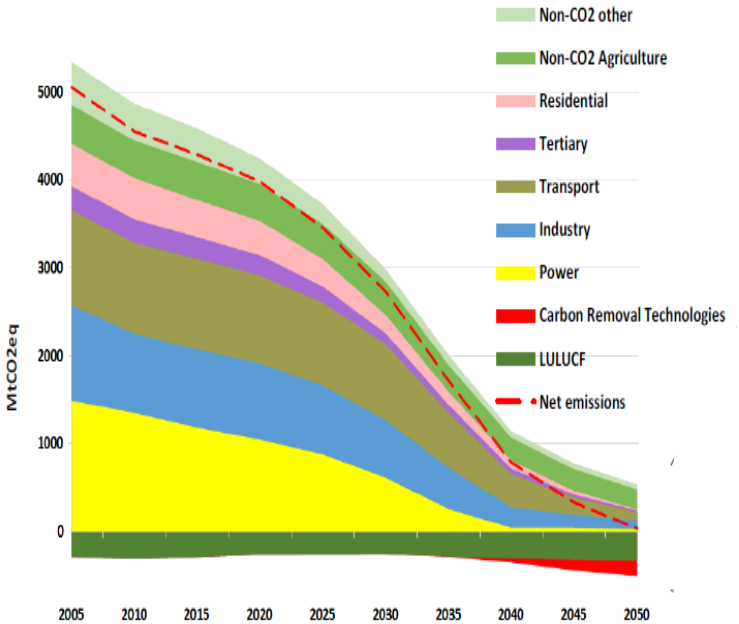
Context: great strides in aviation efficiency, but growth > gains

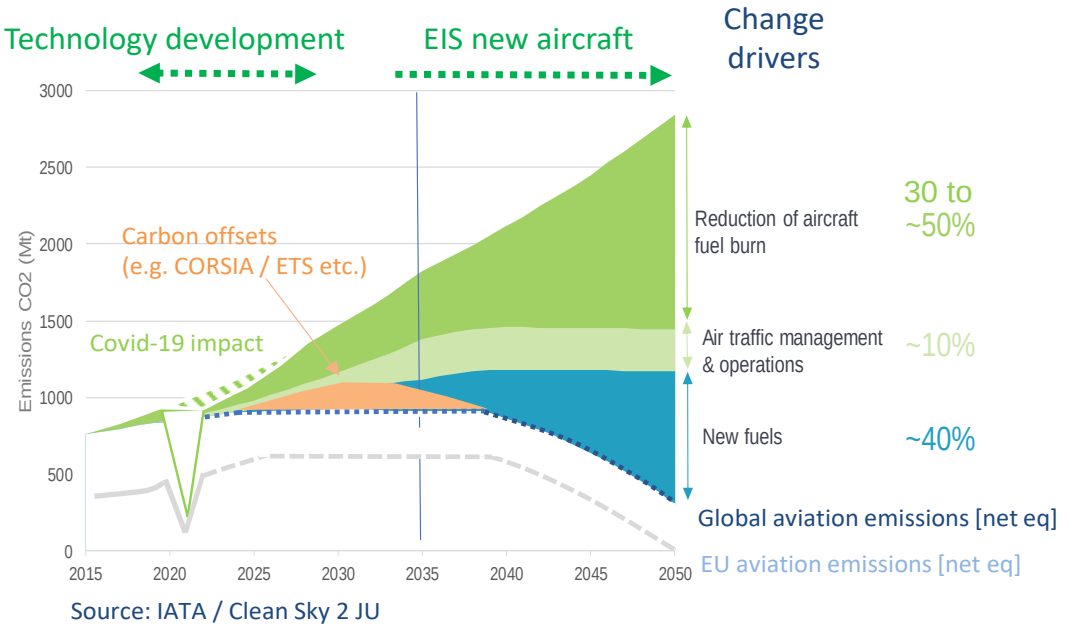
Growth has historically outpaced gains: 4.5 – 5.0% vs. 1.0 – 1.5% p/a



Source and copyright: OurWorldinData.org

The EU 1.5c scenario & the roadmap for EU aviation



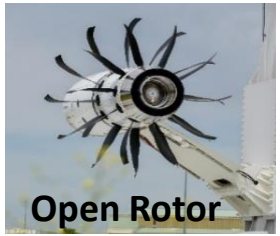


Source: IATA / Clean Sky 2 JU

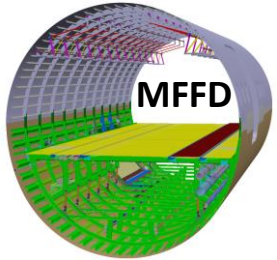
European aviation commitment to climate neutrality

European aviation research & innovation PPPs

Clean Sky



Clean Sky 2



Clean Aviation

Clean Sky, Clean Sky 2 & Clean Aviation: drivers for success

Major Clean Sky 2 demonstrators

Delivering on its commitments

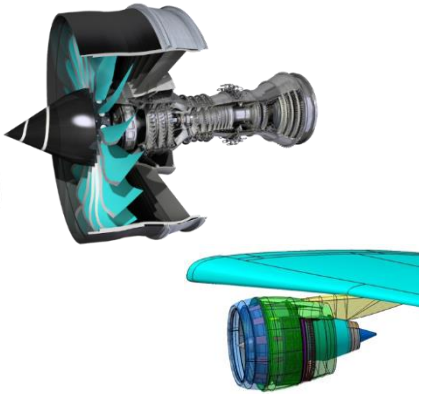
CS2: at top-of-climb and max cruise speed

- 106 demonstrators at Programme completion contributing to 34 flagship demonstrators
- 75% of programme effort reached early 2021
- Design phase completed and initiation of the testing and delivery of results phase
- 160 projects (out of 543) already closed
- 30% of demonstrators to be completed by end 2021(*)
- 2000+ dissemination activities over 2014-2021 period, of which half of them are technical papers or scientific publications
- 271 patent applications

(*) after recovery of the COVID-19 pandemic impact

Flagship demos 1 - breakthroughs in propulsion efficiency

↑ **Ultra-High Propulsive Efficiency (UHPE)** demonstrator for Short/Medium Range aircraft
TRL5 by 2023

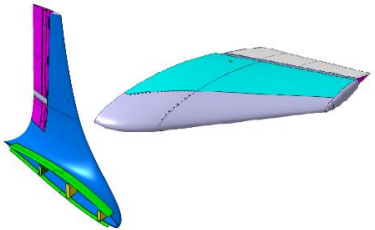


↑ **Very High Bypass Ratio Large Turbofan (VHBR)** Engine & flight test demonstration
TRL6 by 2024

↑ **Business aviation / short range Regional Turboprop** Demonstrator
TRL5 in 2019

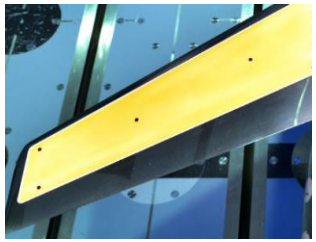
↑ **Reliable and more efficient operation of Small Turboprop** engines
TRL5 in 2020

Flagship demos 2 – wings, aerodynamics & flight dynamics



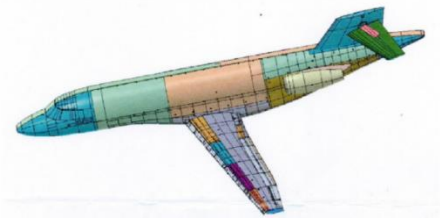
↑ Adaptive Wing Integrated Demonstrator – Flying Test Bed#1
TRL6 by 2022

↑ Integrated Technologies Demonstrator – Flying Test Bed#2
TRL6 by 2022



↑ BizJet Laminar Nacelle / NLF BJ HTP
TRL5 by 2020

↑ HLFC on tails & wing
TRL4 by 2023

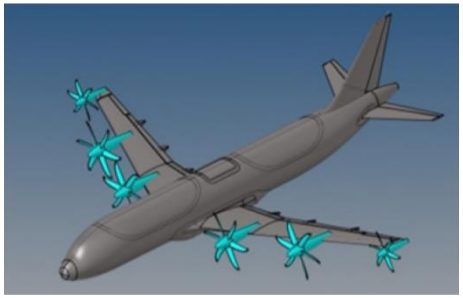


← NLF Smart Integrated Wing
TRL6 by 2022

Flagship demos 3 - novel aircraft configurations

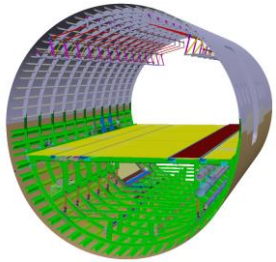
↑ RACER compound helicopter
TRL6 by 2022

↑ Next Gen Civil Tilt Rotor
TRL6 by 2023



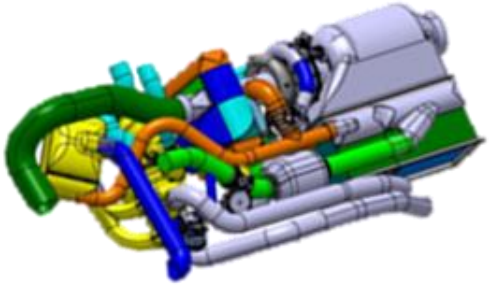
↑ Novel Aircraft & Scaled Flight Test Demo **TRL6 by 2023**

Flagship demos 4 - innovative structures

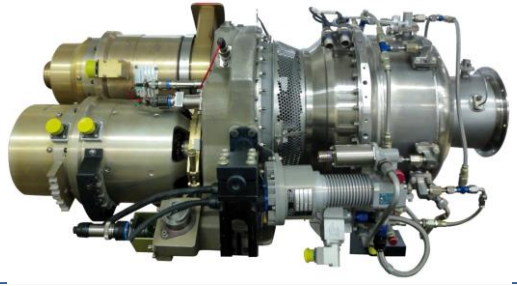


← Multi Functional Fuselage Demonstrator
TRL5 by 2023

Flagship demos 5 – non propulsive energy & control systems



↑ **Next Generation EECS Demonstrator** for large A/C
TRL6 by 2023



↑ **Non Propulsive Energy Optimization** for large Aircraft
TRL5 by 2023

Flagship demos 6 – next generation cockpit systems

↑ Disruptive/ Extended Cockpit Large Aircraft **TRL4/5 by 2023**

Technology Evaluator: 1st assessment results at mission level

MISSION LEVEL ASSESSMENT			
CONCEPT MODEL	-CO_2 [1]	-NO_x [2]	NOISE
Long Range	-13%	-38%	< -20%
Short-Medium Range	-17% to -26%	-8% to -39%	-20% to -30%
Regional	-20% to -34%	-56% to -67%	-20% to -68%
Commuter and Business Jet	-21% to -31%	-27% to -28%	-20% to -50%

Concept definition

Based on selection of technologies
> TRL3 in 2018

Concept EIS

- a few concepts EIS 2025+
- next earliest EIS is 2030 (Adv.)
- 2035+ for Ultra-Adv. concepts.

([1]) LR+ CO2 reduction (-13%) is made versus the A350-900 as reference aircraft, EIS 2015, a very highly optimized platform.

([2]) SMR++ (-8% NOx) as CROR core engine model does not yet include low NOx combustor technology, unlike SMR+ model (-39%).

Flights < 4000km dominate

Source ICCT 2019 global air transport

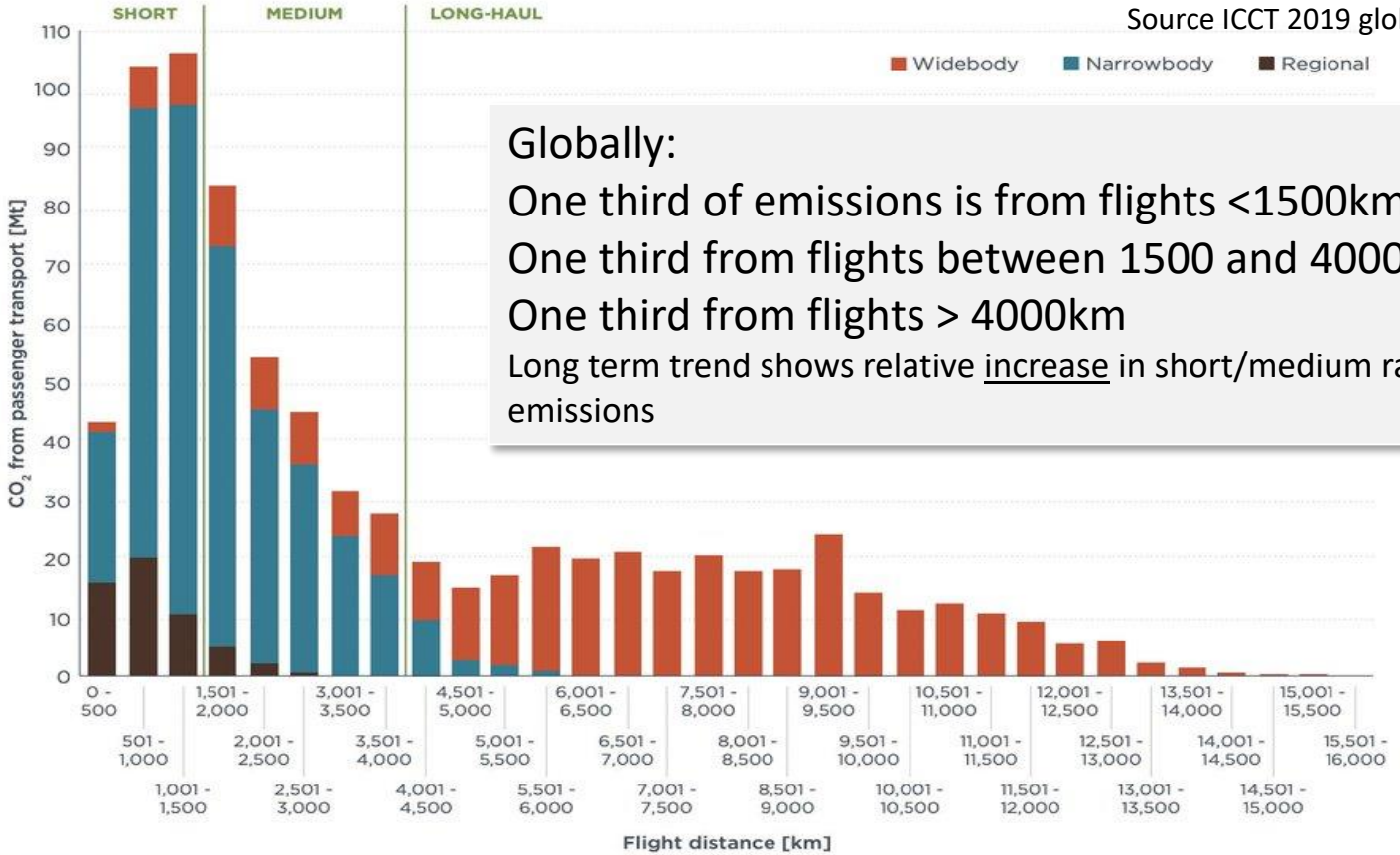


Figure 9. Share of passenger CO_2 emissions in 2019, by stage length and aircraft class

Globally:

One third of emissions is from flights <1500km

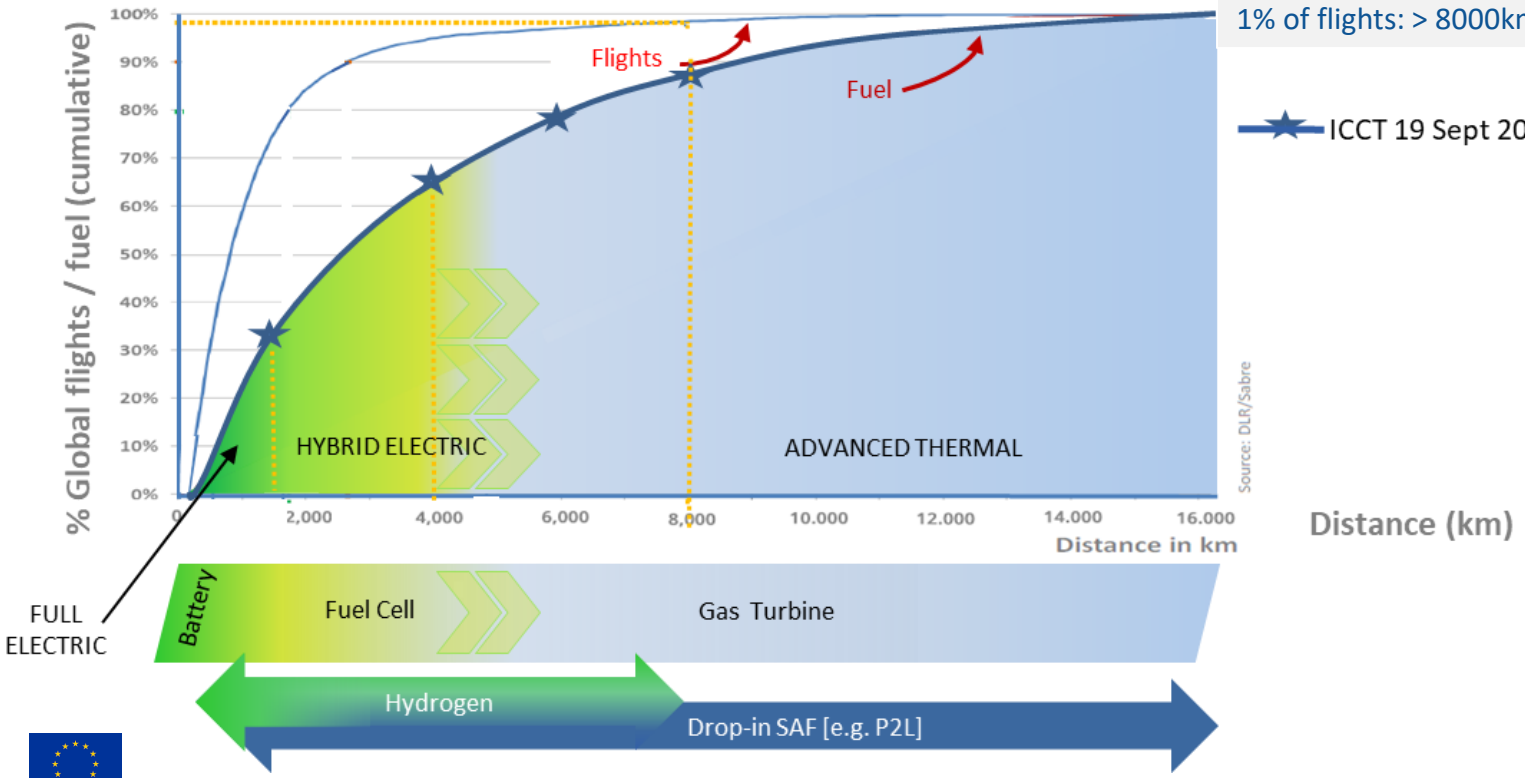
One third from flights between 1500 and 4000km

One third from flights > 4000km

Long term trend shows relative increase in short/medium range emissions

Challenge: more differentiation in aircraft and energy/fuel

90% of flights: < 3000km, = 50% of fuel used
1% of flights: > 8000km, = 20% of fuel used



Future European Partnership for Clean Aviation

Developing and demonstrating disruptive aircraft technologies for 2030s

Hybrid electric and full electric architectures

Disruptive technologies to enable hydrogen – powered aircraft

Ultra-efficient aircraft architectures

Low Emission Hybrid-electric **Regional** Aircraft

Zero Carbon Hydrogen-powered **Short Range** Aircraft

Low Emission **Short / Medium Range** Commercial Aircraft

Long Range Aircraft Concepts progressing towards climate neutrality

Flight demonstration in Clean Aviation JU and Impact by 2035

Development of disruptive technology options

Skip-a-generation leap, together with new fuels/energy

- 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
  - LH_2 storage & fuel systems
  - Distributed systems & increased autonomy

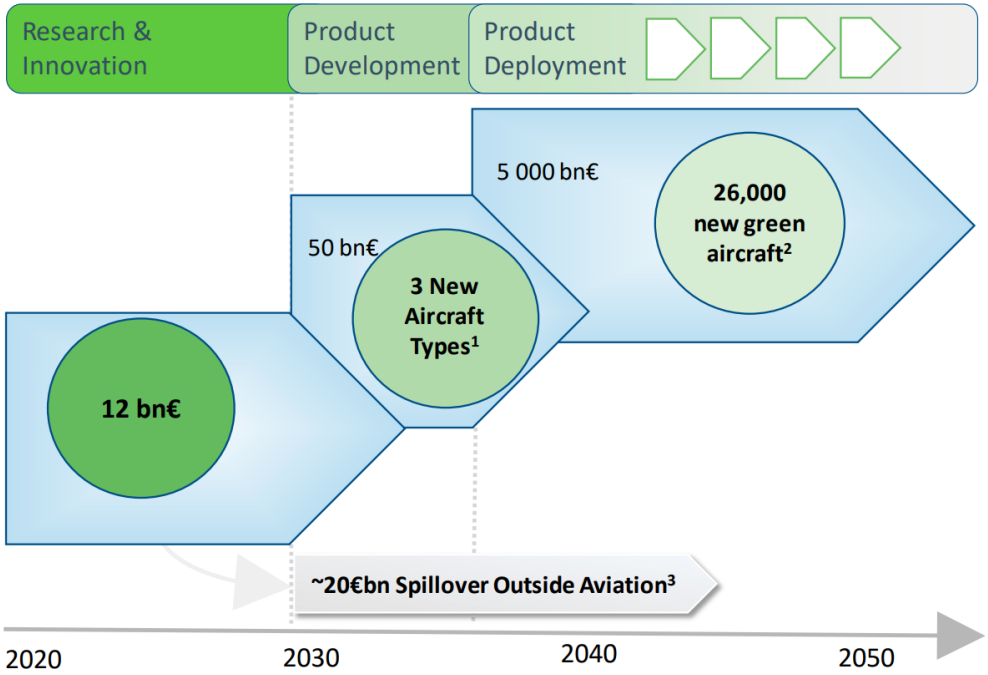
- Manufacturing system (aim: replacing ~75% of the global fleet by 2050)
- Simulation, digital twin and innovative certification methods
- Life-cycle aspects and recyclability

The most exciting technological decade for aeronautics is beginning

Shared vision for the proposed Clean Aviation Partnership

Up to 3bn€ private commitment expressed to the EC in support of the Partnership

R&I challenge, but great potential impact



1. Based on aircraft 'clean sheet' programmes covering ≥80% of passenger RPK
2. Investment covers fleet replacement only

Exceptional return on investment opportunity

European universities are the next generation of innovators!

- ✓ 156 Universities across Europe
- ✓ 767 technical and peer-reviewed published papers
- ✓ Clean Sky PhD Award

Clean Sky PhD Award 2020

Conclusions

- ✓ Clean Sky has created an efficient and high-performing aviation innovation eco-system
- ✓ Clean Aviation will build on Clean Sky & Clean Sky 2 results
- ✓ Extremely ambitious climate-neutral aviation target by 2050 requires a sector-wide commitment and execution
- ✓ Revolution in technology development and its fast and widespread deployment is mandatory: impact!
- ✓ Effective processes and an appropriate financial framework will enable the strong link throughout the innovation chain from academia and research organisations via SMEs to large industrial enterprises
- ✓ Invitation to universities to join the Clean Aviation PPP, NOW!

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