

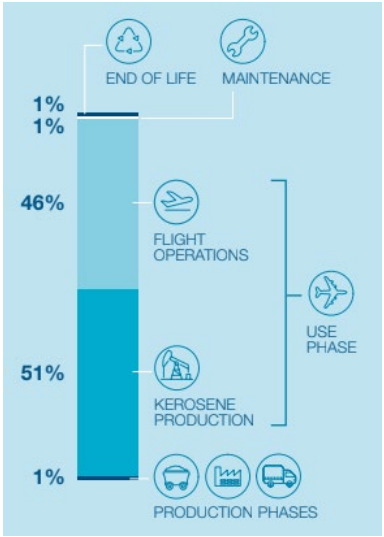
Airbus' perspectives & progress for 2050 energy landscape

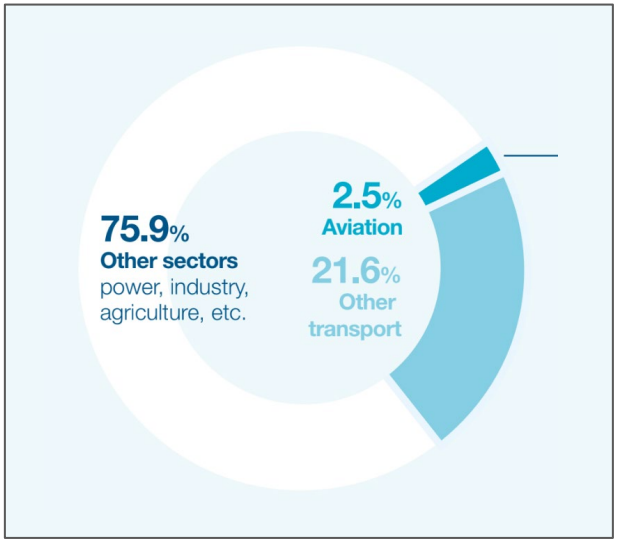
Frank HASELBACH

SVP Propulsion Engineering
Airbus SAS, Toulouse, France



Aviation and Environmental Impact - Climate change





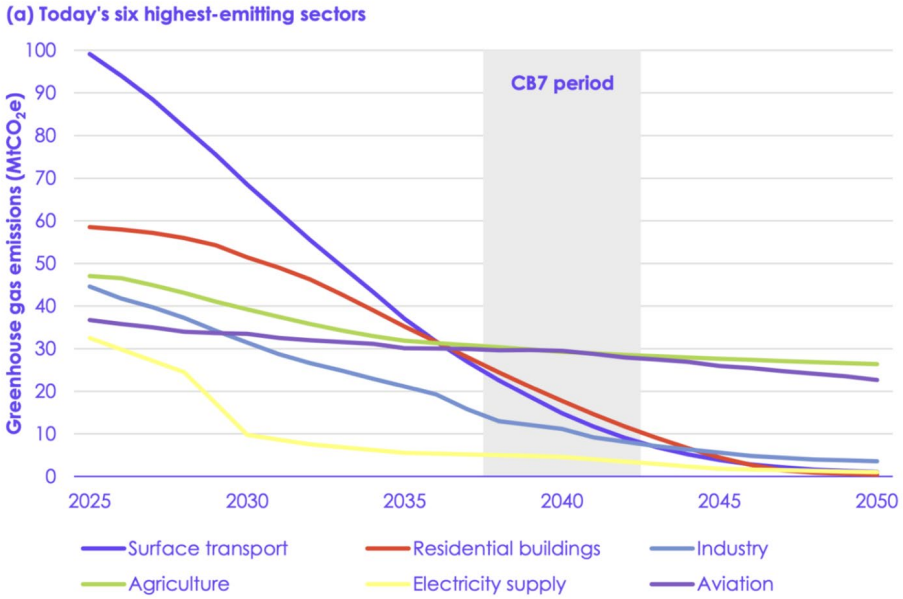
Aviation accounts for ~2.5% of global CO_2 emissions

Contrails and other non-CO2 effects increase net heating

In a world running on fossil fuel, Aviation first order impact on environment is all about climate change (CO2 & non-CO2 emissions)



Aviation and Climate Impact - UK example

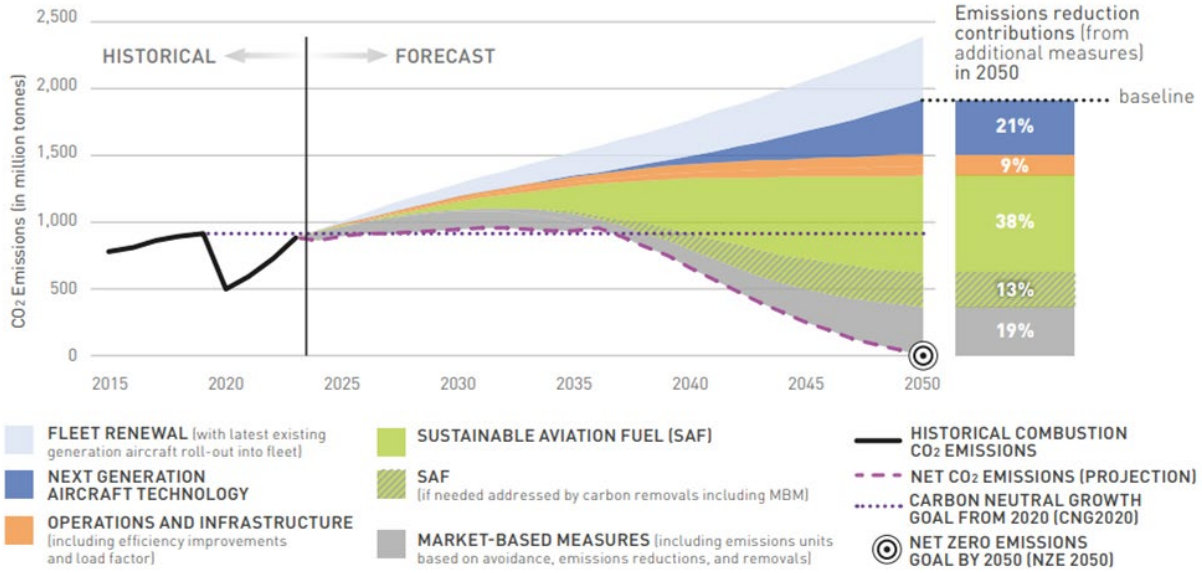


Source: *Climate Change Committee / The Seventh Carbon Budget*

Aviation could become first emitting sector in the UK by 2040



Aviation and Climate Impact - Net Zero-pathway ambition - ATAG



Source : ATAG waypoint 2050 (ATAG: Air Transport Action Group

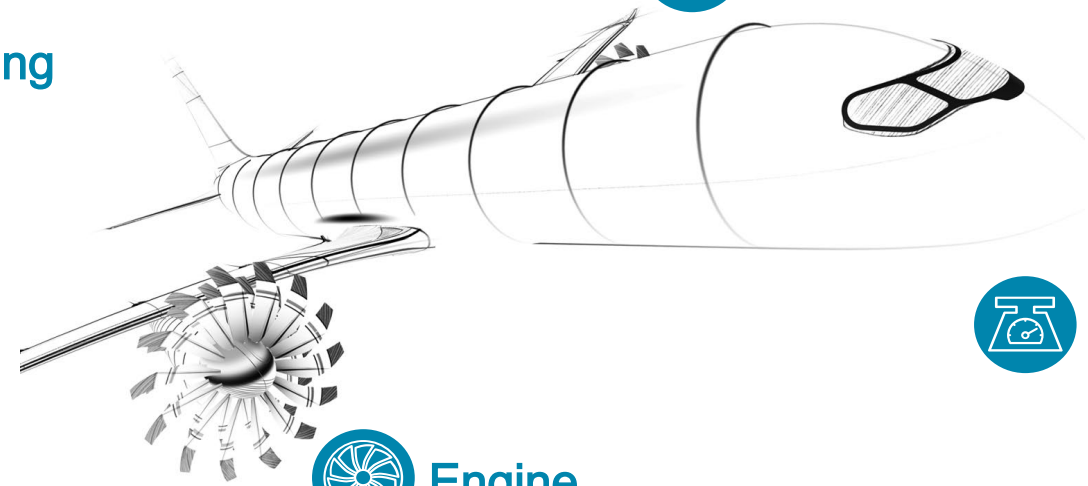
ATAG scenarii highlight the complementarity of decarbonisation levers to reach net zero by 2050



Innovating disruptive technology for NGSA

Hybridisation

Wing



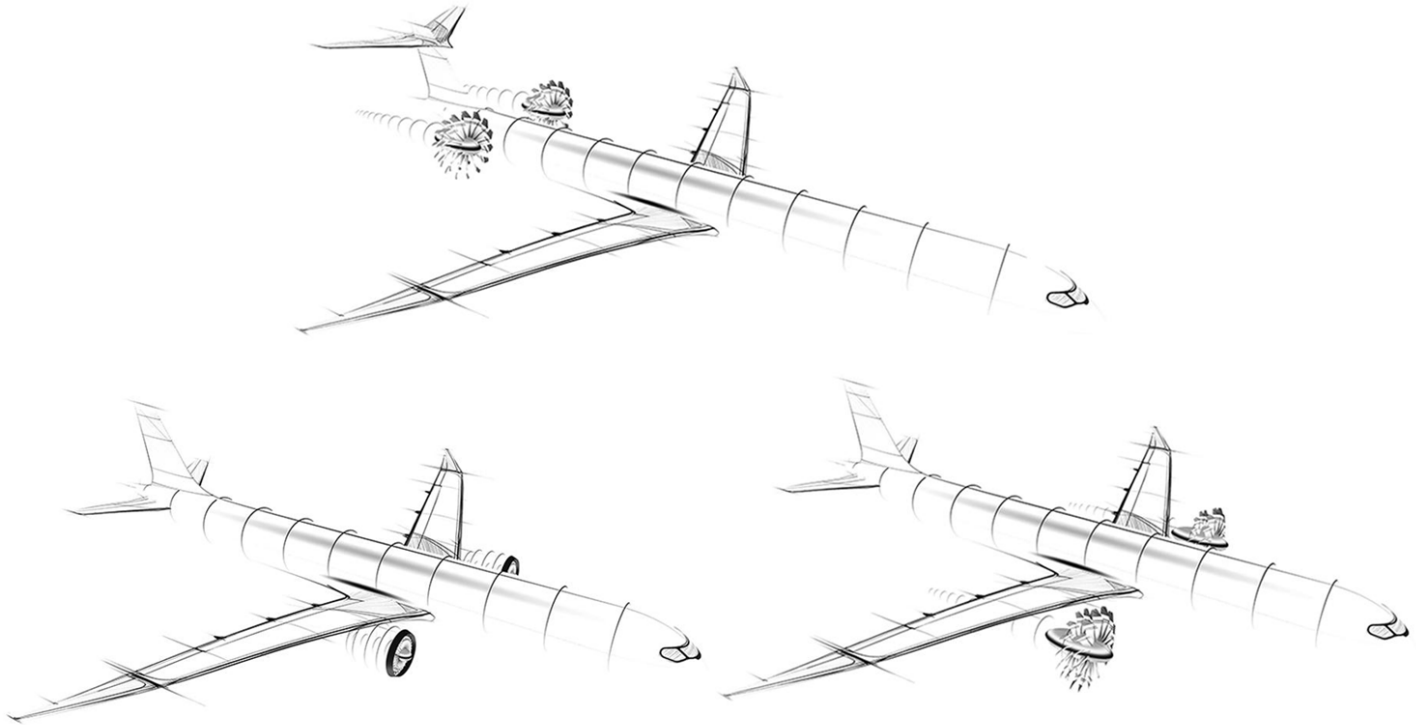
Lightweight Materials

Engine



AIRBUS

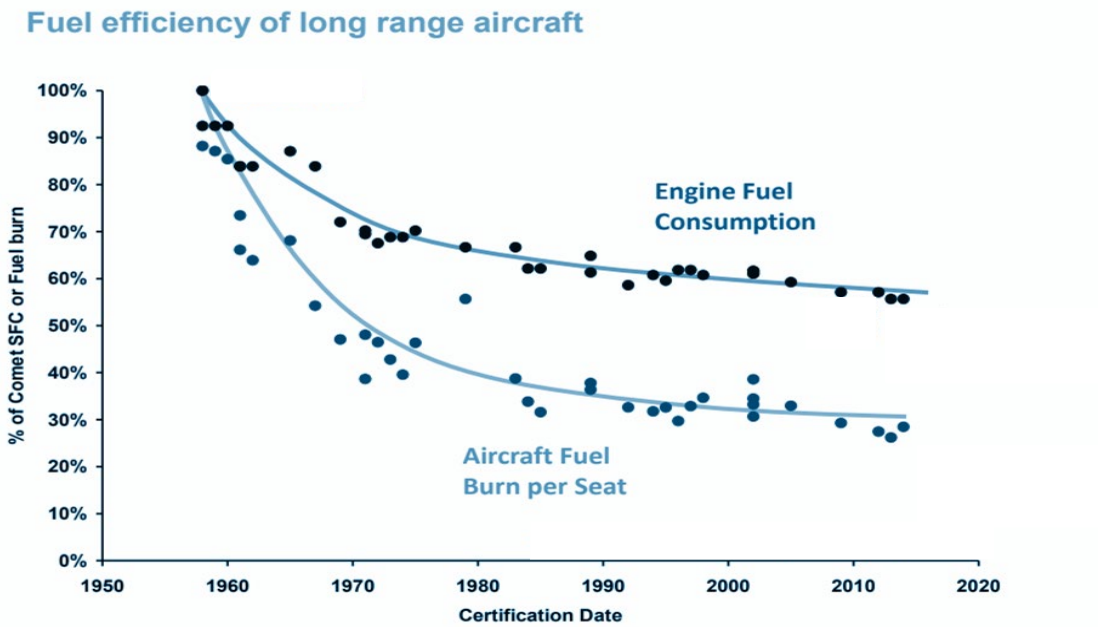
Propulsion options for NGSA





AIRBUS

Fuel efficiency - yesterday and today



Source: Peeters et al, Fuel efficiency of commercial aircraft Fuel efficiency of commercial aircraft: An overview of historical and future trends, November 2005,Amsterdam - extended with newer data



AIRBUS

The Basics

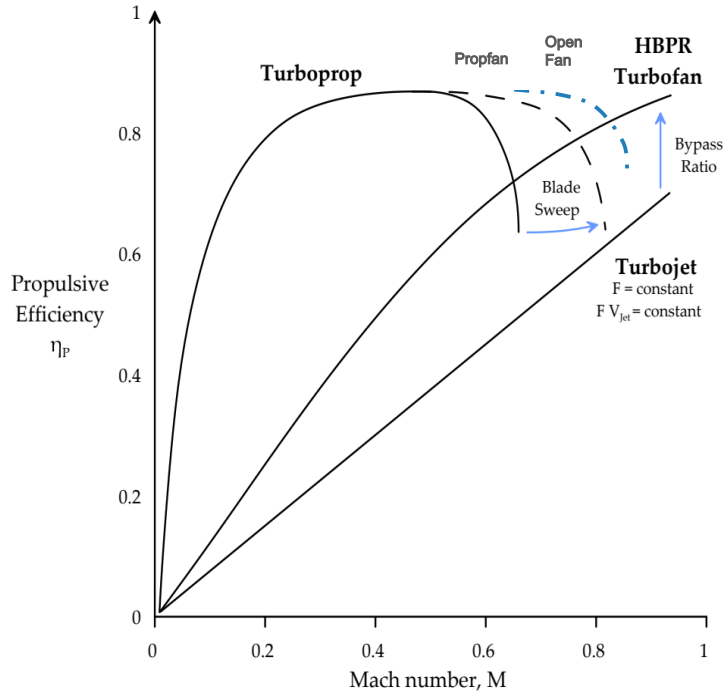
TurboFan Engine:
Thrust = Mass-flow x Delta-Velocity = w x (Ve-Vi)

Fuel Efficiency of a turbofan engine: (SFC)
Overall= thermal x transfer x propulsive

Thermal efficiency
= f(peak pressure & temps, cooling/sealing air [techno/materials], aero losses)

Transfer efficiency = f(Fan and LPT efficiency)

Propulsive efficiency = 2/(1+Ve/Vi) = f(high mass-flow and low delta V)



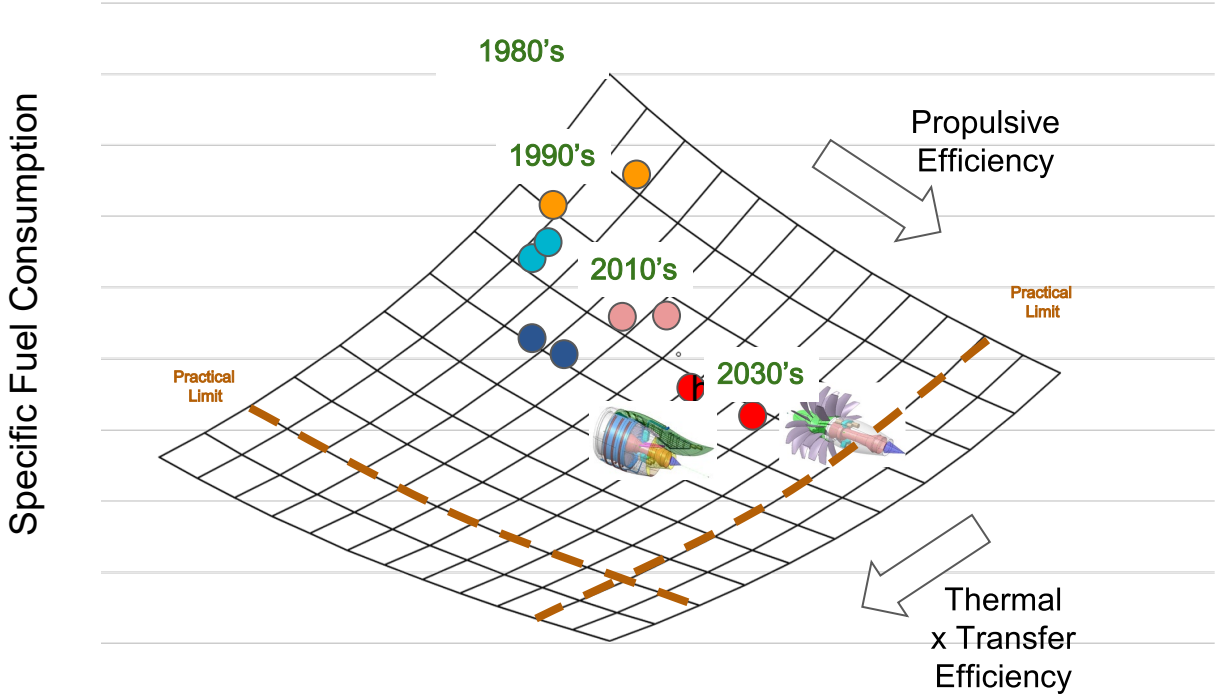
High Thermal efficiency needs high pressures & temperatures, whilst high propulsive efficiency demands large fans to grab a lot of air mass-flow and minimise delta velocity (Ve-Vi) at constant thrust.

This is why engines get bigger on the ‘cold side’ (fan diameter) and hotter & smaller in the ‘hot side’ or ‘the core’.

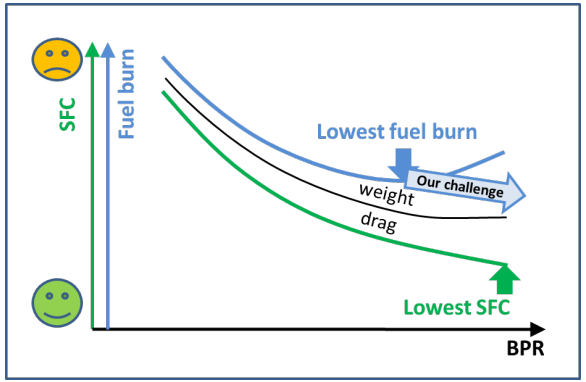


AIRBUS

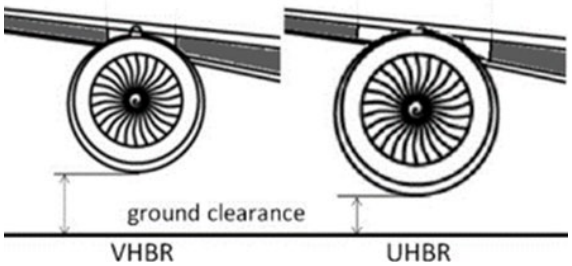
Engine physical drivers

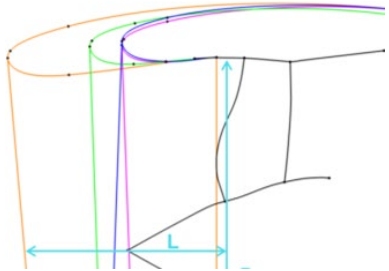


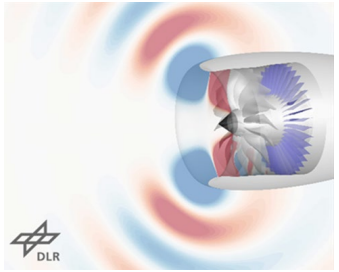
Technical challenges with larger engines











Lower Ground Clearance:
- Ground vortex ingestion
- Wing close-coupling
- Nacelle/engine strike at forward landing-gear collapse

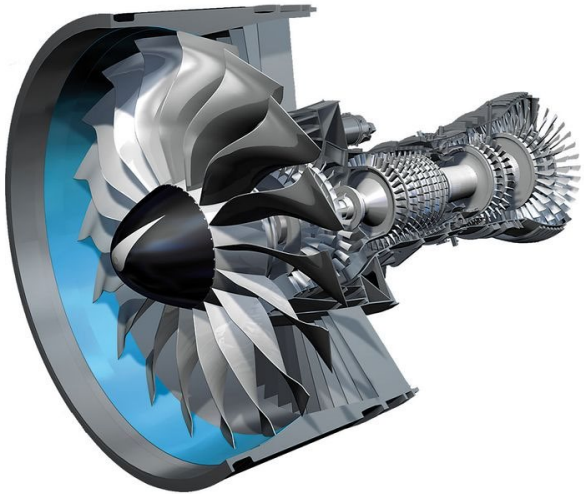
Shorter inlet:
- Pressure distortion at fan face
- Lightning strike protection
- Acoustic attenuation

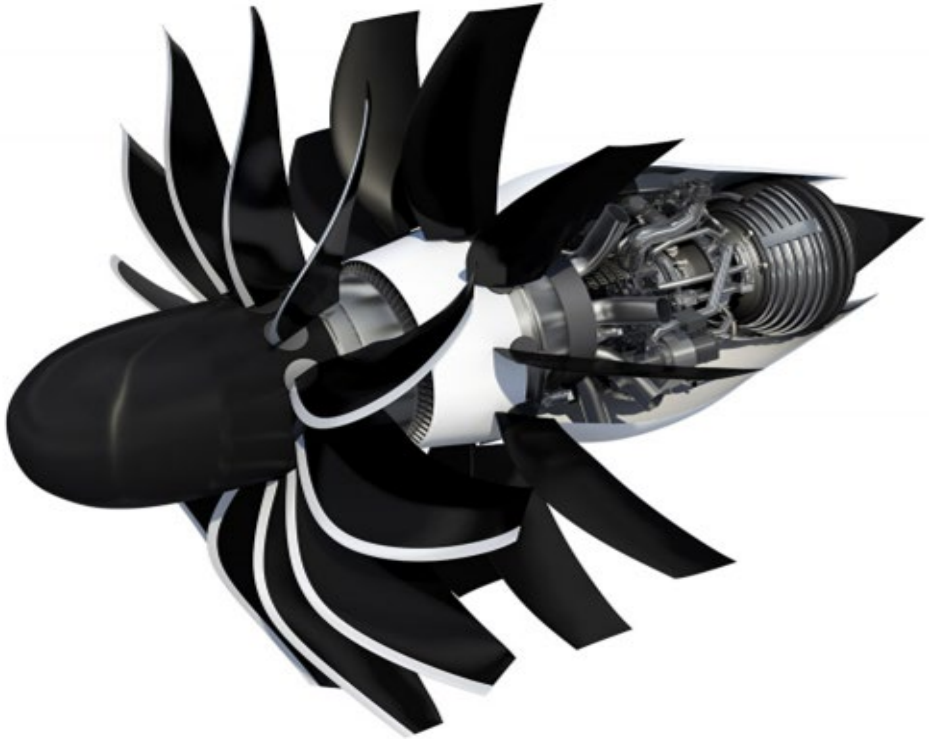
Others:
- Simulation of close coupling of engine/aircraft: acoustics and aerodynamics
- C.G. position of engine relative to aircraft C.G. => stability



AIRBUS

Future Propulsion Architectures







AIRBUS

Airbus Amber
EC_NotTechnical
US_EC_NoUScontent

A380 Propulsion Demonstrator

Open Fan Technology









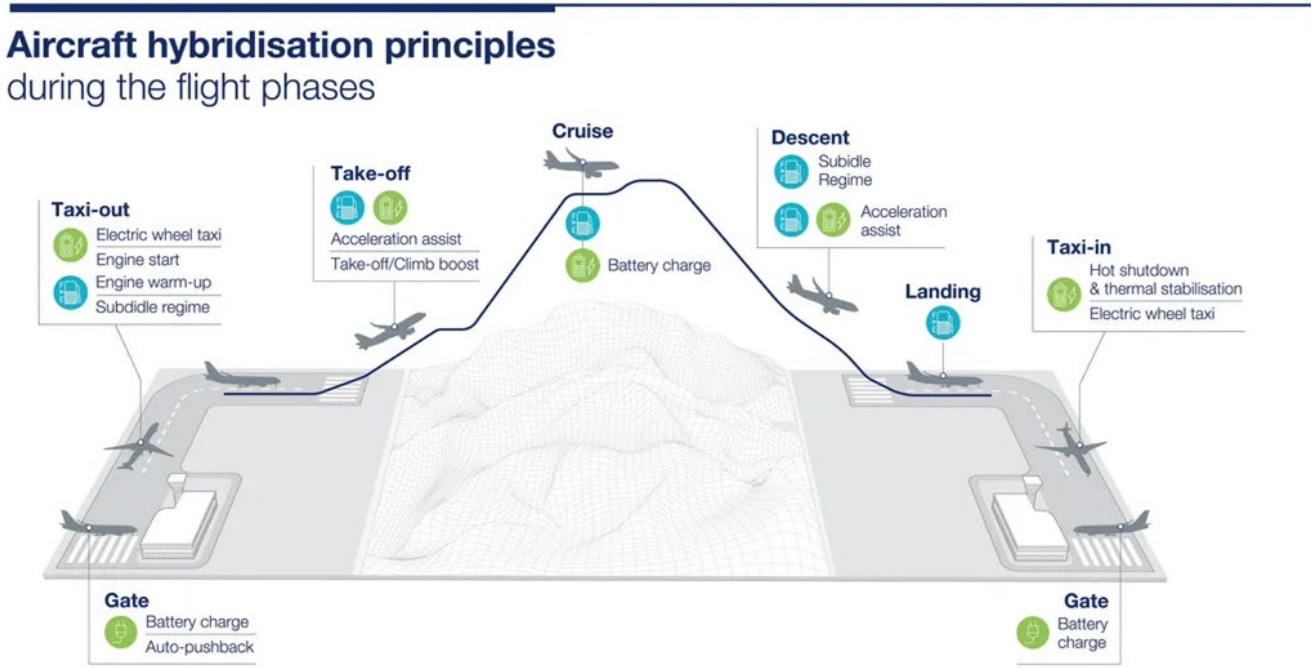
Accelerate advanced propulsion technologies through ground & flight testing

Evaluate propulsive system efficiency and performance

- Assess aircraft engine integration and aerodynamics
- Evaluate internal & external noise prediction models
- Understand the use of hybrid-electric capabilities
- Ensure compatibility with 100% Sustainable Aviation Fuel

AIRBUS

Hybridization of Propulsion Systems



Integrating traditional jet engines with electrical generators and motors will optimize energy management in the aircraft

Hybrid propulsion systems will allow to manage off-design performance more effectively



AIRBUS

Airbus Amber
EC_NotTechnical
US_EC_NoUScontent

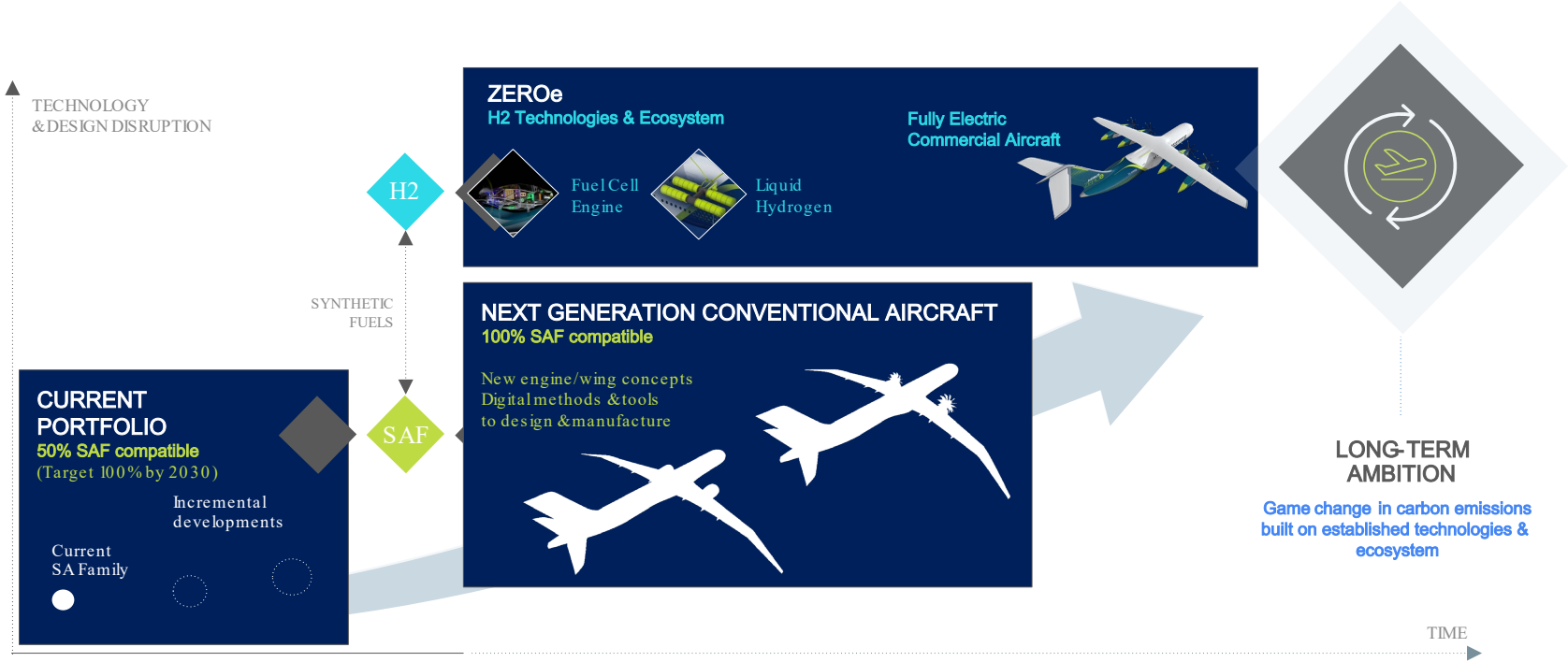
The technology quest on hydrogen



AIRBUS

Airbus Amber
EC_NotTechnical
US_EC_NoUScontent

A staged and complementary decarbonisation journey



Prepare options for a sustainable short -, medium- and long-term future for aviation
ZEROe roadmap adapted to the ecosystem development pace with a focus in the coming years on maturing technologies



AIRBUS

To conclude

- Significant challenges are there to achieve net-zero carbon emissions for aviation in the next 25 years. Availability and affordability play into it as well as technology. Consequently, it will only be achieved by a menue of solutions around fleet renewal, new aircraft technologies, sustainable fuels and operational, and, offset measures.

- The route for enhanced aircraft will comprise high aspect ratio wings, new materials, high bypass ratio engines and potentially a level of hybridisation for the shorter range aircraft.

- The next generation of fully new designed single aisle aircraft will be with us for the rest of this century, whatever we do, the technology needs to be upgradable and allow for sustainable development of the platforms, no easy task, but that’s the job.



AIRBUS