Overview of Clean Sky Technical Programme And Achievements to date

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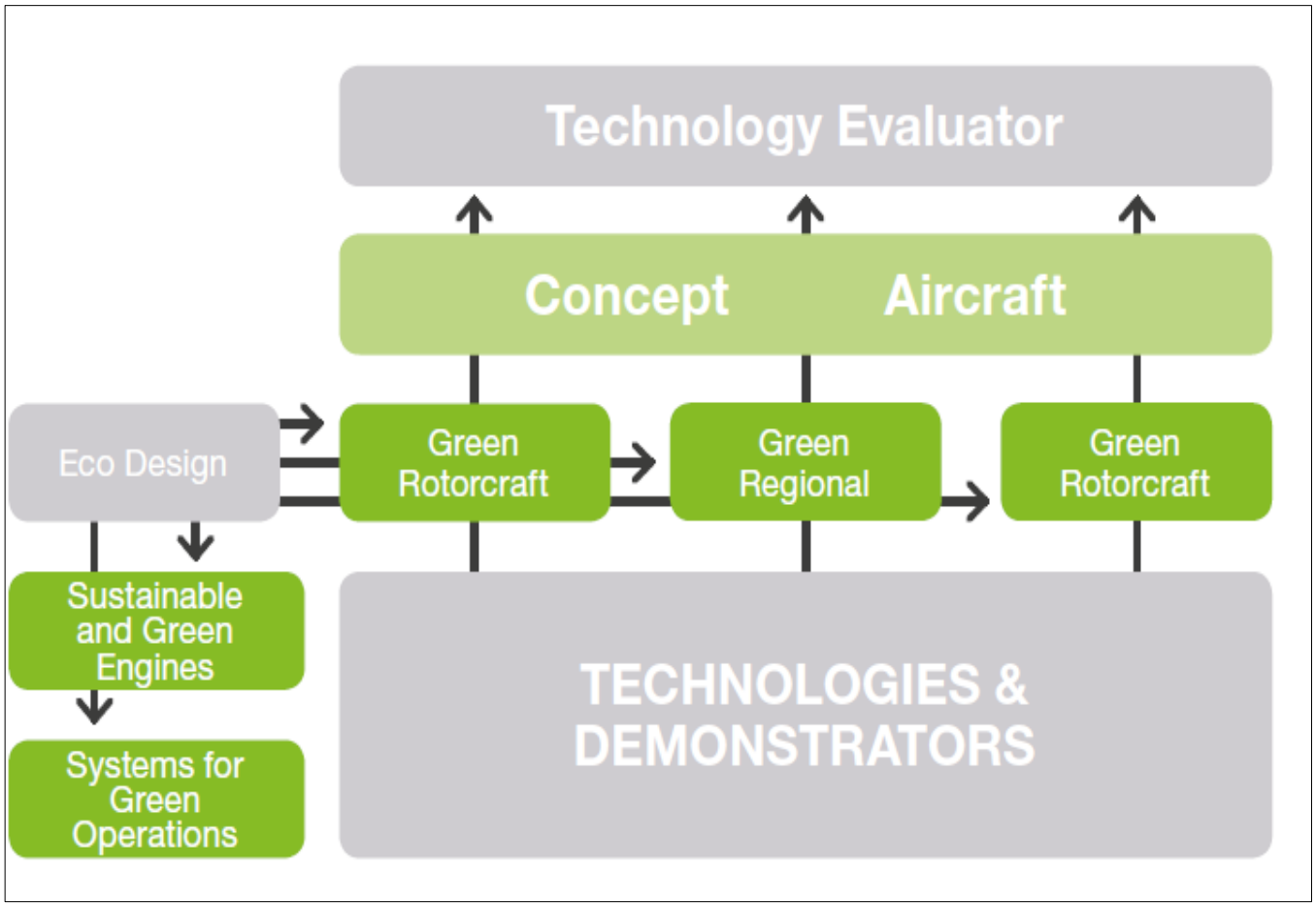
content

- Clean Sky in FP7
- Organization by Integrated Technology Demonstrators
- Development strategy
- Role of the Technology Evaluator; Concept Aircraft
- Demonstration programmes: examples of Achievements to date by segment and Further demonstration activities
- Closuring remarks

Clean Sky and ACARE

- Clean Sky is the public-private partnership founded in 2008 by the European Commission and most of the industrial leaders of European aeronautics, based on the ACARE Aviation Platform and the requirements for a Level 3 approach in FP7.
- Clean Sky is one of the major contributors to reaching the ACARE 2020 goals (compared with levels in the year 2000):
  - A 50% reduction in fuel consumption and carbon dioxide (CO_2) emissions.
  - An 80% reduction in nitrous oxides (NOX) emissions.
  - An external noise reduction of 50%.
  - Improved environmental impact of the lifecycle of aircraft and related products.

Clean Sky organization



Development strategy

- **Technologies** are selected, developed and monitored in terms of maturity or 'technology readiness level' (TRL). They were identified as the most promising in terms of potential impact on the environmental performance of future aircraft.
- **Concept aircraft** are design studies dedicated to integrating technologies into a viable conceptual configuration. Clean Sky's results are measured and reported by comparing these concept aircraft to existing aircraft and aircraft incorporating 'evolutionary technology' in the world fleet.
- **Demonstration Programmes** include physical demonstrators that integrate several technologies at a larger 'system' or aircraft level, and validate their feasibility in operating conditions. This helps to determine the actual potential of the technologies. The ultimate goal of Clean Sky is to achieve successful demonstrations in a relevant operating environment, i.e. up to TRL 6.

Conceptual aircraft

Low-sweep business jet [LSBJ] - coast-to-coast mission

Incorporating these technologies and configurations: • **Natural Laminar Flow Wing** • **U-Tail innovative empennage** • **Noise shielding Aft-Body** • **Engine with a 2020 EIS (SN)** • **Trailing arm MLG located in wing** • **Flight controls : FBW** • **Fuel fully located in wing and centre section**	

Short/medium-range (SMR) aircraft

Incorporating these technologies and configurations:
• **SFWA Natural laminar flow (NLF) wing**
• **SNECMA conceptual Counter Rotating Open Rotor (CROR)engines**
• **Rolls-Royce 3-shaft and Lean burn engines tests learning**
• **SGO MTM Optimized trajectories, in the FMS:**
  • **Adaptive- Increased Glide Slope**
  • **Multi Criteria Departure Procedures**
  • Smart Operations on Ground (being studied)
	

Conceptual aircraft and demonstrator

Green Regional Turboprop

Technologies and configurations:	
• **Advanced Metallic Material** • **Advanced Composite Materials** • **Structure Health Monitoring** • **Low Noise Landing Gear** • **Low Noise & High Efficiency High Lift Devices** • **Advanced Electrical Power Generation and Distribution System** • **Electrical Environmental Control System** • **EMA for Primary Flight Control System Actuation** • **EMA for Landing Gear Actuation** • **Mission Trajectory Management optimization**	

GRA ATR first flight, Crown Panel	**9 July 2015, TRL 5/6**
• **Innovative CFRP fuselage "crown" panel** • **Contributions from ALENIA (design), ATR (installation and operation; test aircraft); , Fraunhofer (panel instrumentation)** • **Aim of Flight test campaign was to support the development of innovative CFRP panel with embedded layer to provide additional acoustic damping** • **The expected benefits concern weight, internal noise, assembly costs and structural health monitoring**	

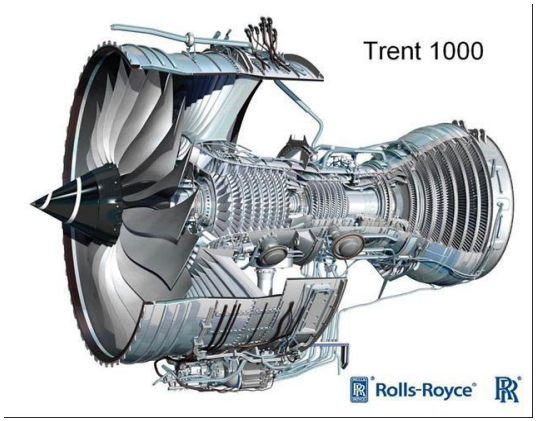
Rotorcraft demonstrators

GRC Demonstration of Helicopter Low Noise IFR Procedures	May 2015 **TRL 6**
H175 helicopter to fly **low-noise IFR approaches** to the heliport of Toulouse-Blagnac airport. The approach procedures were flown using accurate lateral and vertical guidance provided by **EGNOS** (European Geostationary Navigation Overlay Service), the European Satellite-Based Augmentation System (SBAS), and in the presence of airplane traffic simultaneously approaching and departing to/from airport runways. These helicopter-specific procedures allow achieving the **Simultaneous Non Interfering (SNI)** aircraft and rotorcraft IFR operations at a medium-size commercial airport. The low-noise procedures demonstrated noise footprint reductions of up to 50 per cent. Detailed design and integration of the procedures in Toulouse airspace was achieved by GARDEN, a *partner* project with expertise in Air Traffic Management (ATM).	

Systems demonstrators

SGO Skin heat exchanger (LSHX) – A320 ATRA FTD Sept 2014 Airbus, DLR and Liebherr	Q3-2014 **TRL5/6 passed in Dec-14**
 	As part of the development for advanced Cooling systems, a Skin heat exchanger (LSHX) has been installed on the **A320 ATRA** flying test bed of DLR for two test campaigns (September to December 2014). The SHX performances have been assessed for different Reynolds numbers, analyzing the aerodynamic data (boundary layer, heat transfer coefficient), allowing the Validation & improvement of numerical models

Engine demonstrators

SAGE6 Demonstrator - R-R	Q3-16
 	The **Lean Burn Programme** objective is to deliver a verified generic Lean Burn System against a set of validated requirements complying with regulatory and company demands for emissions and safety, and with acceptable reliability at minimum life cycle cost and weight. • The test programme is based on Trent 1000 donor engines (ALECSYS) for engine ground testing. • Emissions capability at representative future cycles has been demonstrated in a dedicated core engine experiment on the EFE vehicle (Environmentally Friendly Engine). • The programme is also envisaging a full scale **flight test campaign on a B747 flying testbed**. • The programme is scheduled to achieve Technology Readiness TRL6/MCRL4 by mid-2016.

Achievements to date

Product	Wide-body 2020	Narrow-body 2015	Regional 2020	Corporate 2020	Rotorcraft 2020
Initial targets	CO2 -30%	CO2 -20%	CO2 -40%	CO2 -30%	CO2 -30%
	NOx -60%	NOx -60%	NOx -60%	NOx -30%	NOx -60%
	Noise -20 EPNdB	Noise -15 EPNdB	Noise -20 EPNdB	Noise -10 EPNdB	Noise -10 EPNdB
Results from the 2015 TE assessment	CO2 -19%	CO2 -40%	CO2 -20%	CO2 -33%	CO2 -10 to -20%
	NOx -50%	NOx -44%	NOx -42%	NOx -34%	NOx -36 to -58%
	Noise -79%	Noise -55%	Noise -40% (-32 EPNdB)	Noise -58%	Noise -20 to -25%

The percentage reduction of the noise footprint in airport areas for same noise levels produced by currently operating fleets.

EPNdB is a measure of sound intensity level with respect to a reference value, the cumulative sound intensity level produced by an aircraft manufactured with year 2000 technology (certification values)

Clean Sky JOINT UNDERTAKING

Concluding remarks

Clean Sky has implemented the concept of the PPP / JTI designed for FP7 and the Joint Undertaking has managed the programme developed by the all members (industry, academia, research centres, SMEs).

Some successful examples of demonstrators achieved have been presented, as well the most significant demonstration activities planned by the end of Clean Sky (2016).

Some activities will be continued beyond this deadline, to 2020 and beyond by the Clean Sky 2 programme launched in June 2014.

Thank you for your attention

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