Sustainable development - Clean Sky and the technology challenges

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Title

- Short update on Clean Sky JU
- Work plans across CS1 and CS2
- Main achievements to date in CS1 and proposed development and demonstration in CS2
- Sustainable development?

Clean sky is the largest European research and innovation programme

1. Public-Private Partnership in a EU sector of excellence
2. Focused on the integrated demonstration of technologies for engines, systems and full aircraft.
3. Environmental objectives: a 20-30% reduction in CO2 and noise in comparison with the year 2000
4. A total budget of 4 Billion Euro (2014-2020), financed by the European Union and the industry.
5. Building on 600 participants in Clean Sky 1 (2008 -2016)

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 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	

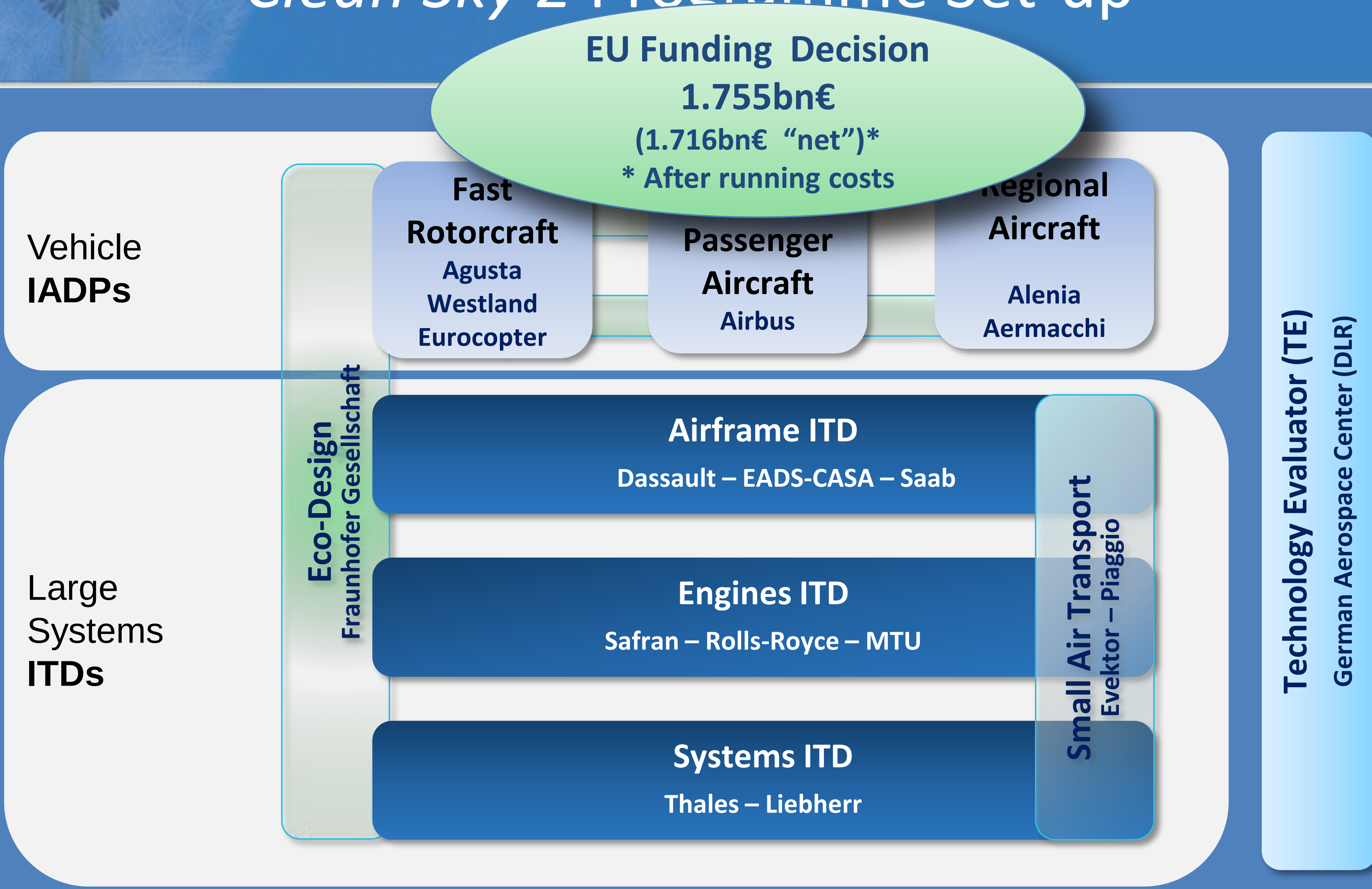
GRA ATR first flight, Crown Panel	9 July 2015, TRL 5/6
• Innovative CFRP fuselage "crown" panel • Contributions from ALENIA (design), ATR (installation and operation; test aircraft); , Fraunhofer (panel instrumentation) • Aim of Flight test campaign was to support the development of innovative CFRP panel 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).	

Clean Sky JOINT UNDERTAKING

Clean Sky 2 Programme Set-up



Building on Clean Sky, going further into integration at full aircraft level
And developing new technology streams for the next generations of aircraft

Not legally binding

From *Clean Sky* to *Clean Sky 2*

CS1 ITD Smart Fixed Wing Aircraft (SFWA)

- is a unique environment for high TRL integrated Research and Development and large scale ground and flight demonstrators
- provides the frame for well aligned objective driven R&T covering development and maturation through numerical simulation, rig demonstrators, wind tunnel testing, small and large scale test under condition relevant for operation

SFWA key technologies

- NLF – wing for large transport aircraft and bizjets
- HLFC- technologies
- CROR engine integration
- Innovative empennage for next generation bizjets
- Innovative control surfaces
- Buffet Control Technologies
- Advanced load control architectures and function
- Advanced Flight Test instrumentation

Contribute to TRL - Scale

1	2	3	4	5	6

CS2 IADP Large Passenger Aircraft (LPA)

- Will provide a platform for even more focussed large scale, highly integrated demonstrators with core partners and partners
- Build on down best candidate technologies emerging from *Clean Sky (1)* other national and EU R&T programs and additional technologies developed in *Clean Sky 2* ITDs

Clean Sky
JOINT UNDERTAKING

Setup and Implementation

Airbus with SAAB, Dassault Aviation, SNECMA and Partners

Large Passenger Aircraft Platform – Integration Topics

„Platform 1 - OAD“

Advanced Engine and Aircraft Configurations

„Platform 2 - OPD“

Innovative Physical Integration Cabin-System-Structure

„Platform 3 - OSD“

Next Gen. Electrical A/C Systems, Cockpit Systems & Avionics

TRL 4-6
Aircraft Level

Platform 1 Advanced Engine and Aircraft Configurations

WP 1.1 CROR demo engine FTD

WP 1.2 Advanced engine integration driven rear fuselage

WP 1.3 Validation of dynamically scaled flight testing

WP 1.4 Hybrid laminar flow control large scale demonstration

- HLFC large-scale specimen demonstrator in flight operation
- High speed demonstrator with hybrid laminar flow control wing

WP 1.5 Innovative Flight operations

WP 1.6 Demonstration of radical aircraft configurations

Setup and Implementation: LPA Platform 2

Airbus with, Liebherr, Fraunhofer and Partners

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TRL 4-6
Aircraft Level

Platform 2 Innovative Physical Integration Cabin-System-Structure

WP 2.1 Integrated product architecture

WP 2.2 Non specific design technologies

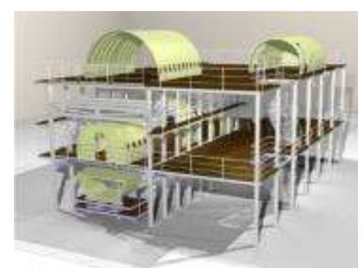
WP 2.3 Technology validation

WP 2.3.1 Multi purpose demonstrators

- Next generation fuselage, cabin & cargo functional demonstrator
- Next Generation Cabin & Cargo functional demonstrator
- Next generation lower centre fuselage structural demonstrator

WP 2.3.2 Testing generation cockpit features flight demonstration

WP 2.3.3 Pre-Production Line Technologies



Clean Sky
JOINT UNDERTAKING

Setup and Implementation: LPA Platform 3

Airbus with Thales, Liebherr, SAFRAN and Partners

Large Passenger Aircraft Platform – Integration Topics

TRL 4-6
Aircraft Level

„Platform 1 - OAD“

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Next Gen. Electrical A/C Systems, Cockpit Systems & Avionics

Platform 3 Next Gen. Electrical Aircraft A/C Systems, Cockpits & Avionics

WP 3.1 Enhanced flight operations and functions

WP 3.2 Avionic backbone technologies development and integration

WP 3.3 Integrated advanced system s and avionics demonstration

WP 3.4 Next generation cockpit ground demonstrator

WP 3.5 Next generation cockpit features flight demonstration

WP 3.6 “Pilot case” demonstrators

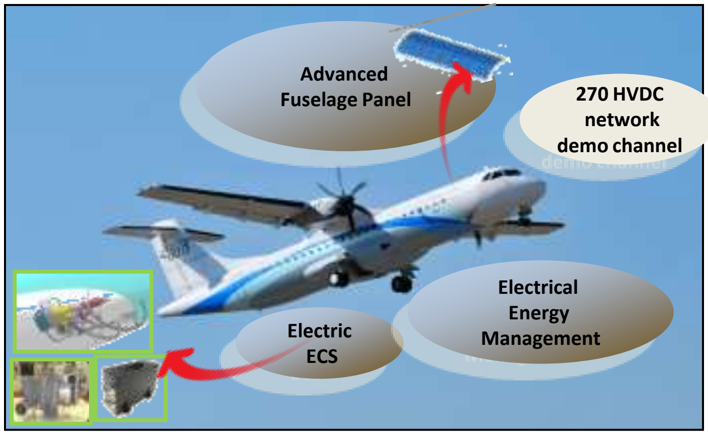
Cockpit of the future (Fenics)

Clean Sky
JOINT UNDERTAKING

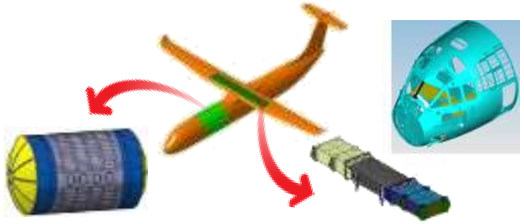
Regional Aircraft
From *Clean Sky* towards *Clean Sky 2*

- *Clean Sky GRA* demonstrators on-track for 2015 demo's:

Flight Demo on ATR-72



Ground Demonstrators



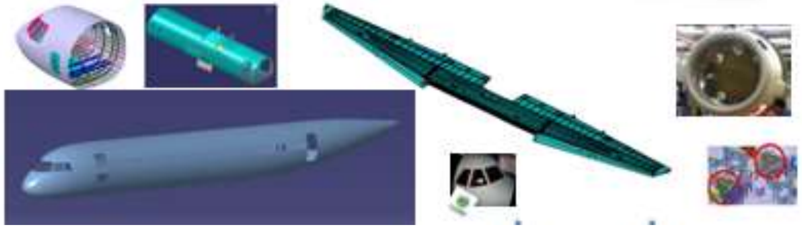
Static and Fatigue tests on:

- Fwd Fuselage Section
- Wing Box Section
- Cockpit Section

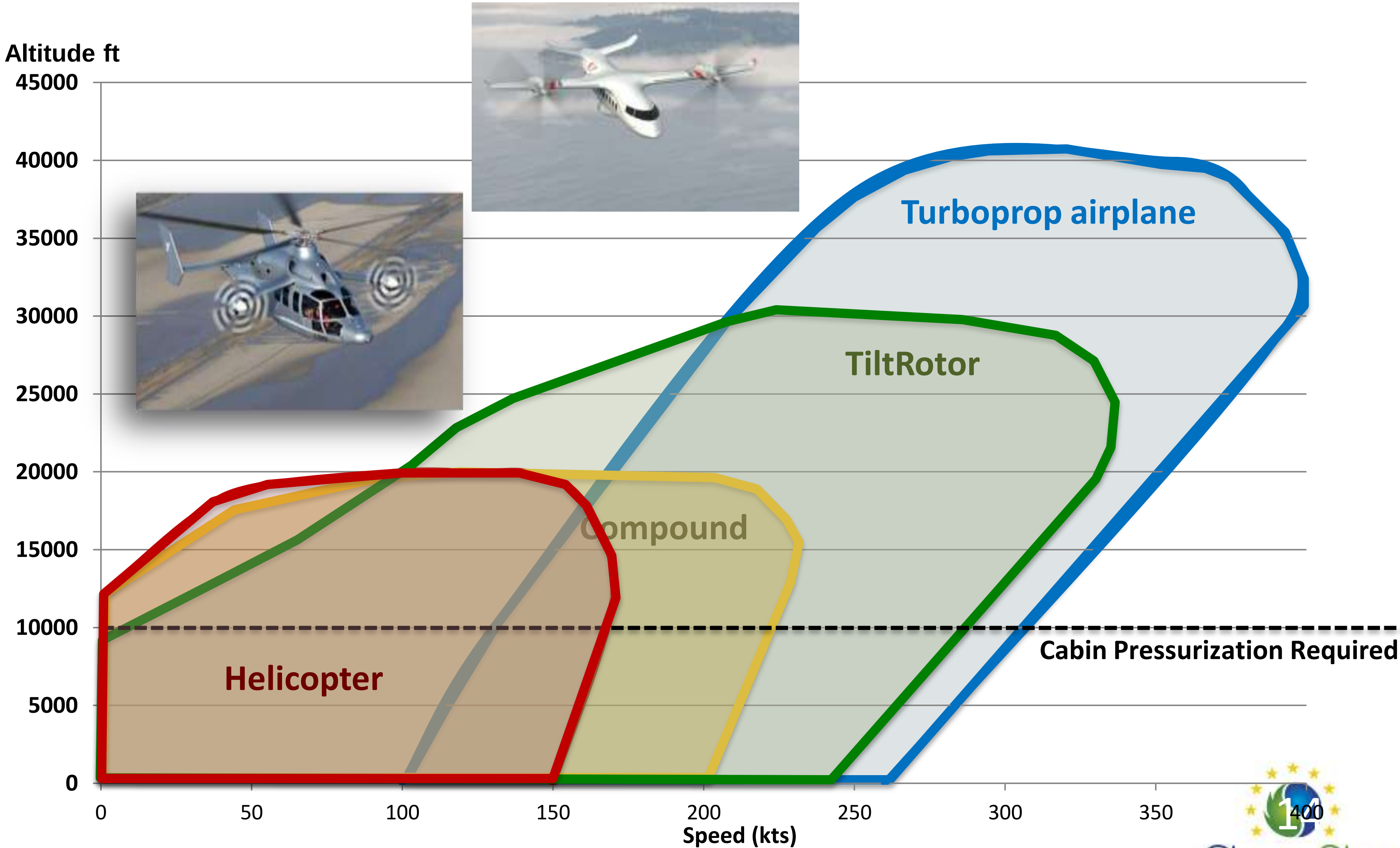
Aerodynamic & Aeroacoustic WT test

Flight Simulator

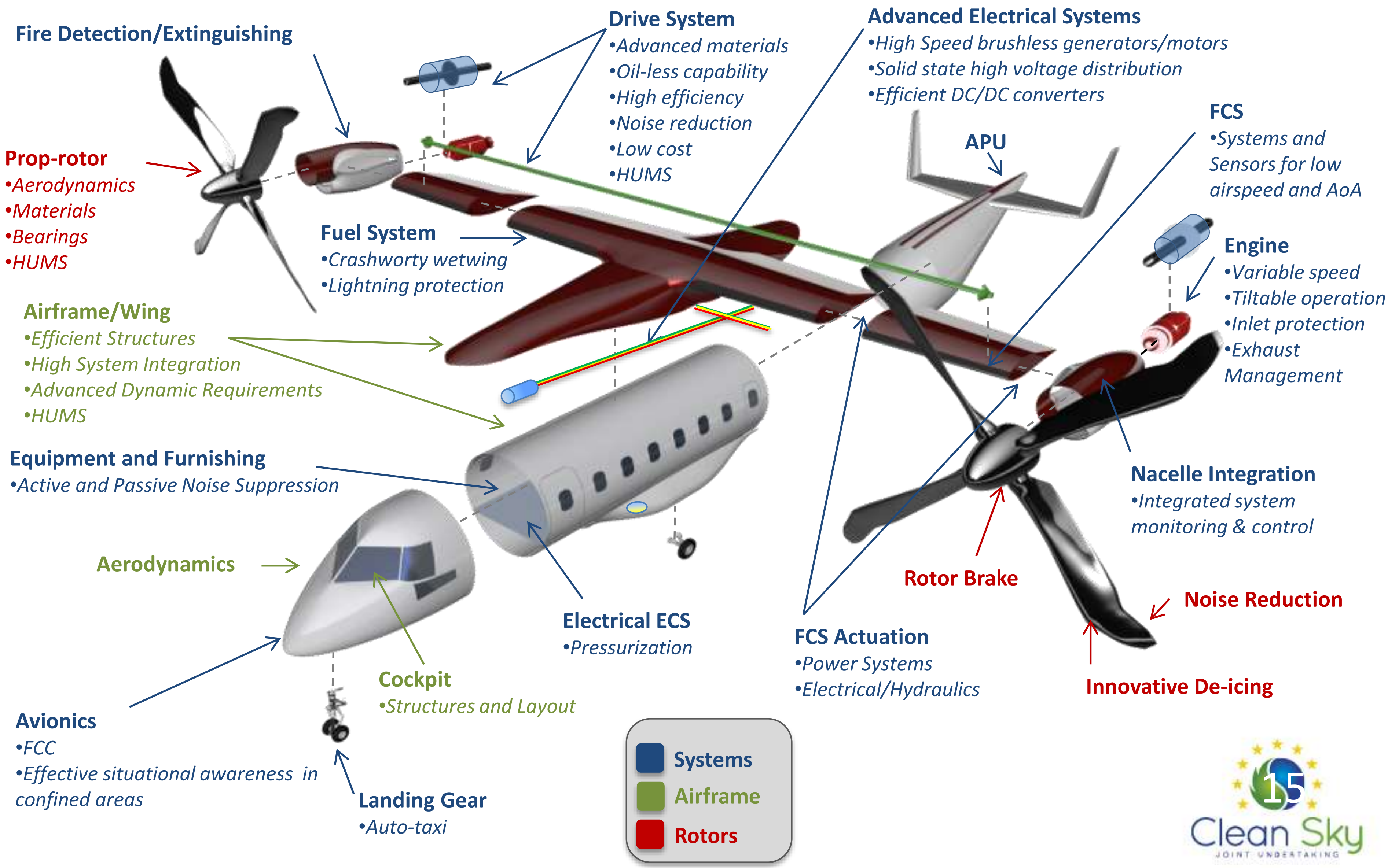
- Strong need of a much higher level of technologies integration through **Clean Sky 2 Demonstrators:**



Fast Rotorcraft IADP



NGCTR platform to advance technology



LifeRCraft Components and systems

WP1: Project management & integration activities

WP13: Validation, verification demonstration: ground tests, flying demonstrator

WP9: Actuators

WP4: Lifting rotor

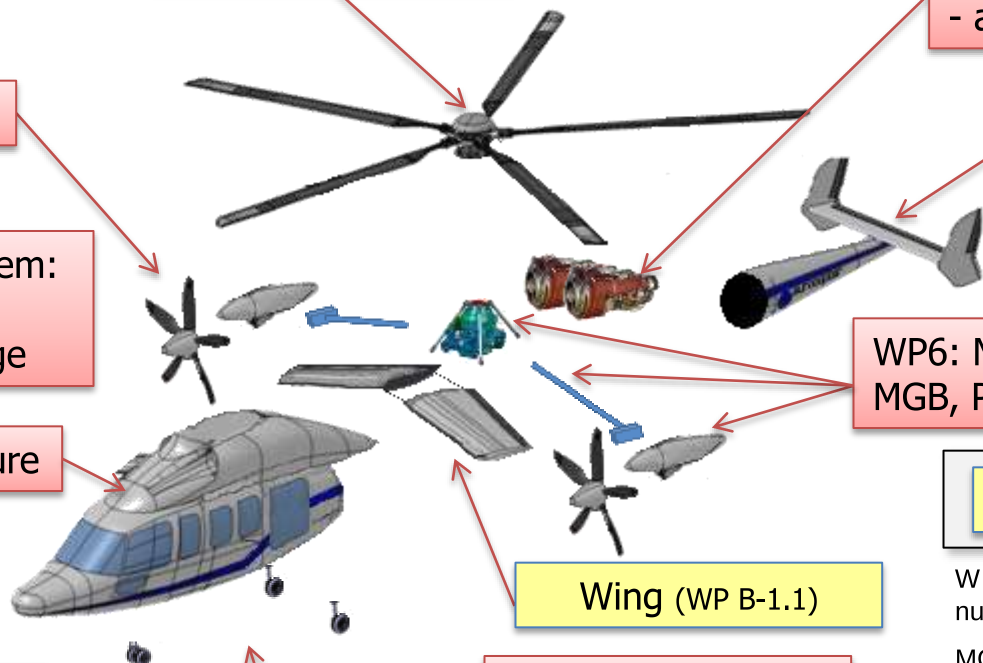
WP7: Power plant: Engines - adaptation & installation

WP5: Propellers

Tail boom & tail surfaces (WP B-4.1)

WP8: Electrical system: power generation, distribution & storage

WP6: Mechanical drive: MGB, PGB, shafts



WP2: Airframe Structure

In ITD Airframe

WP11: Cabin & Mission Equipment

Wing (WP B-1.1)

WP numbers are referring to PTP numbering – § 8. LifeRCraft

MGB: Main Gearbox
PGB: Propeller Gearbox

WP12: Flight control, AFCS, nav systems

WP3:Landing system

WP10: Avionics & Sensors

LIFERCRAFT

NB: images may not reflect actual demonstrator sizing & components (for illustration purpose only)

Airframe ITD –
Moving beyond *Clean Sky*

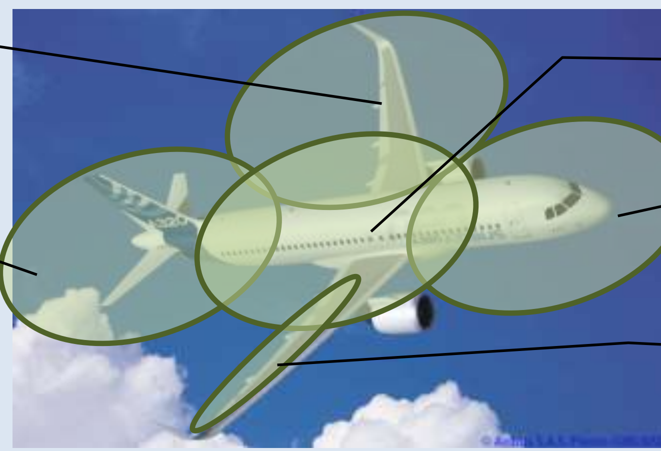
- Greener Airframe Technologies
- More Electrical a/c architectures

- More efficient wing
- Novel Propulsion Integration Strategy
- Optimized control surfaces

- Integrated Structures
- Smart high lift devices

Re-think the wing

Re-think the a/c architecture



Re-think the cabin

Re-think the fuselage

Re-think the control

Step changes in the "efficiency" of all airframe elements by the means of a systematic "re-thinking"

Airframe ITD - Key Objectives

- **Validation of integrated technologies :**
  - Innovative airframe architecture
  - Technologies for more efficient airframe : drag, weight, cost, environmental impact, passenger well-being, maintenance, servicing, …
  - Enhanced efficiency of the engineering & manufacturing process : time-to-market and competitiveness against low-cost labour countries,
  - Address a technology / innovation from modeling to certification ability
- **Support maturity gains up to TRL 6** of airframe technologies
- **De-risk innovation** with the goal of a next game changing step by 2030+
  - Support next generation business jets and general aviation directly
  - Support Large a/c, regional a/c and rotorcraft directly and through IADPs
- **Create Product differentiators**





Supporting 5 Product Segments

Engines ITD –
High-Level Objectives

- Environmental objectives for the engines ITD are to demonstrate at TRL6 the following:
  - *20-30% reduction in CO_2**
  - *Significant contribution to ACARE 2020 NO_x reduction target (-80%*)*
  - *Upto -11EPNdB per operation reduction in noise**

***relative to year 2000 baseline**

- Industrial objectives are to ensure future competitiveness of European Aero Engine industry, securing trade, employment and high technology knowledge and skills

Engines ITD –
Setup and Implementation (4)

Rolls-Royce *Clean Sky 2* activities are split into two work packages:

WP5: underlying technologies for VHBR engines with focus on the "Middle-of-Market" short range aircraft

Composites

Integration

Turbines

Transmissions

Externals & Structures

Control & Power Systems

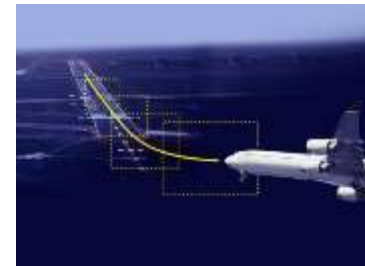
WP6: VHBR technologies for the long range airliner market with Engine Demonstrator

Rolls-Royce

Systems ITD –
From *Clean Sky* towards *Clean Sky 2*

Systems ITD follows and expands Clean Sky SGO activities

- **Management of Trajectory and Mission**
  wider, more integrated cockpit & mission demonstrations
  (and in landing gear WP for SOG)



- **Management of Aircraft Energy**
  WPs dedicated to innovative wing, electrical chain, …
  new activities will address other issues in aircraft power management.
  Clean Sky demonstrators / rigs continued in Clean Sky 2 and completed with new integration environments.

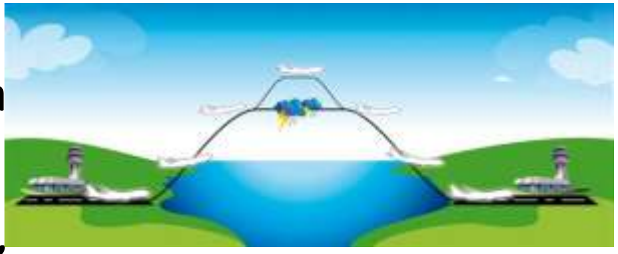
- Systems ITD will focus on demonstration and tight integration with IADPs.

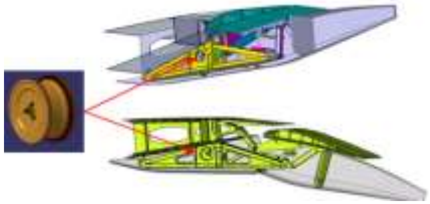
Systems ITD → **IADPs**

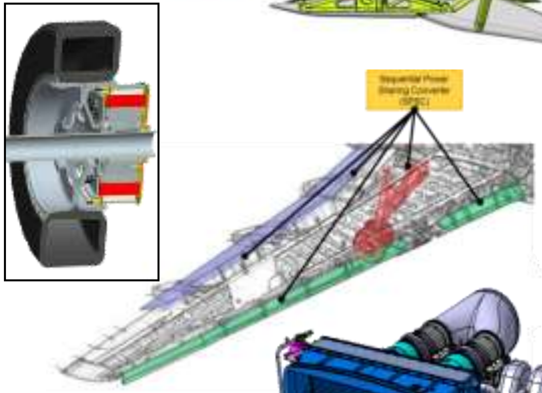
TRL up to 5 → **5/6**

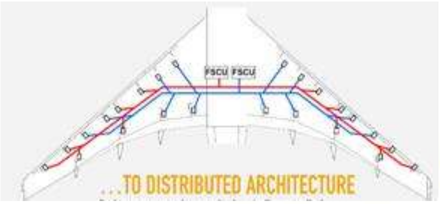
Systems ITD –
High-Level Objectives

- **Direct contributions to environmental objectives:** CO_2 emissions, fuel consumption, perceived noise, a quality, weight reduction.
- **Enablers for major innovations:** innovative engines, new aircraft configurations.
- **Enablers for air transport system optimisation:** SESAR, NextGen and *Clean Sky* for greening, improved mobility or ATS efficiency
- **Smart answers to market demands:** increase of intrinsic performance to meet new aircraft needs without a corresponding increase in weight and volume









Noise targets and research areas

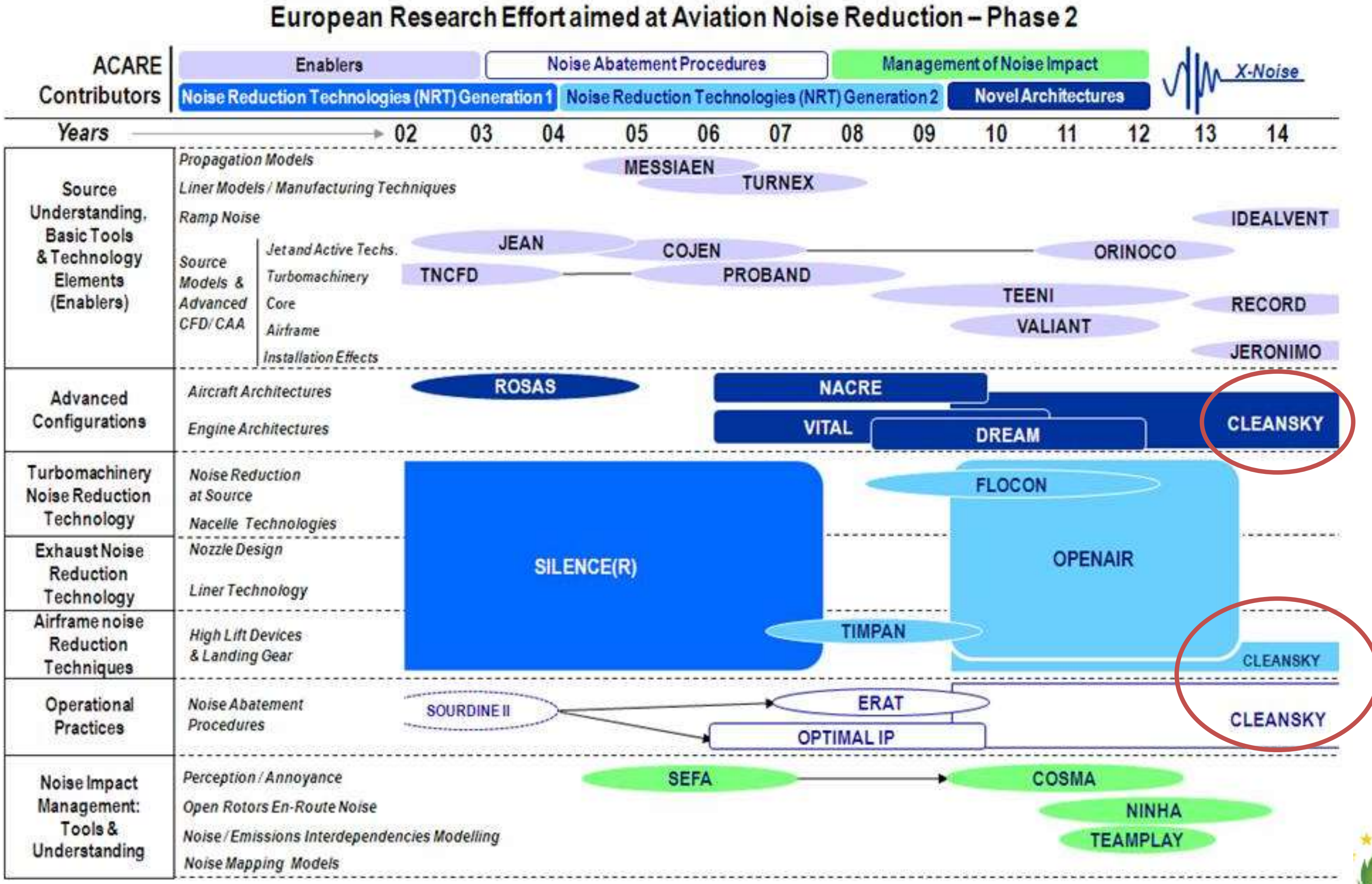
The Vision for 2020 Noise targets are translated in specific actions:

Reduce perceived noise by half	**-10 EPNdB per operation** **(on certification values/ in specific conditions)** **Reduce the area of affected people**
Eliminate noise nuisance outside airport boundaries	Threshold of 60-65 LDEN at airport boundaries (noise carpets)

With three areas of intervention:

1. **Noise reduction at source (NRT, Noise Reduction Technologies)**
2. **Noise Abatement Procedures (Management of Noise Impact)**
3. **Community Impact management (noise annoyance)**

Noise reduction research



Thank you for your attention

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