Innovation takes off: Clean Sky – towards climate-neutral aviation!

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Executive Director, Clean Sky

ATI Conference
19/11/2019
**Clean Sky 2: Key facts and figures**

**Environmental Objectives***

- **CO₂**
  - To -20% -30%

- **NOₓ**
  - To -20% -30%

- **Sound**
  - To -20% -30%

* vs today’s best aircraft

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**€4 bn Public-Private Partnership Programme**

<table>
<thead>
<tr>
<th>Industry Members</th>
<th>SMEs</th>
<th>Research Centres</th>
<th>Universities</th>
</tr>
</thead>
<tbody>
<tr>
<td>334</td>
<td>420</td>
<td>373</td>
<td>350</td>
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**Geographical and Financial Breakdown**

<table>
<thead>
<tr>
<th>Countries</th>
<th>Regions</th>
<th>MoUs</th>
<th>Grants</th>
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<tbody>
<tr>
<td>28</td>
<td>110</td>
<td>18</td>
<td>&gt;466</td>
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Clean Sky 2: major demonstrators

**Breakthroughs in Propulsion Efficiency**
- Very High Bypass Ratio (HBR) Turbofan TRL 6 - 2023
- Advanced Geared Engine Configuration (GEC and LPT technology demonstration) TRL 5 - 2022
- Advanced Propulsion System (APS) TRL 6 - 2019
- Hybrid Propulsion Ground Test Bench 2020

**Advances in Wings and Aerodynamics**
- Ultra-High Propulsive Efficiency (UHPE) TRL 5 - mid-2022
- Adaptive Wing Integrated Demonstrator Flying Test Bed 2022
- Integrated Wing Technologies Flying Test Bed 2020 & 2023
- Advanced Laminar Flow on Wings and Empennage TRL 6 - 2019
- Laminaire Virtual Test Bench 2020

**Future Cockpit and Flight Guidance Systems**
- Disruptive Cockpit Demonstrator (function validation test) 2023
- Active Regional Cockpit 2020
- Flare Enhanced Cockpit Concept 2022
- Avionics for Extended Cockpit Demonstrator - 2020
- Affordable SESAR Compliant cockpit for Small Aircraft 2020

**Novel Aircraft Configurations**
- NonGenCTR demonstrator – Next Generation Civil TRL 6 - 2019
- RACER - Rapid And Cost-Effective Rotorcraft 2020
- Regional Aircraft (low-Bld) Systems Integration – 2021
- Innovative Electrical Wing - 2021

**Optimal Passenger Environment**
- Full Scale Mock-up of Business Jet Office Centred Cabin 2021
- Innovative Cabin & Cargo Systems Technologies 2021

**More Electric Aircraft & Systems**
- Innovative Functional Cabin & Cargo Demonstration of new integrated systems 2023
- Advanced Rear End Demonstrator 2023
- Regional Aircraft Foreplane / Flex Cabin Integrated Demonstrator 2021

**Innovative Structures and Production Systems**
- Advanced Lower Center Fuselage Demonstrator 2020
- Affordable airframes for Small Air Transport 2020
- Advanced Aircraft Wing Box in Out-of-Airplane Composite CFRP 2020
UK participation in Clean Sky 2

- Total funding for Leaders: >€70 million
- Currently 4th in overall participation in calls and 5th in funding requests
- High academia participation: 5 universities in the top 10

Statistics from Calls for Core Partners 1-4 and Calls for Proposals 1-9

- Participation
  - IND: 30
  - SME: 25
  - RES: 30
  - UNI: 101

- Funding requested (m €)
  - IND: 18.9
  - SME: 7.3
  - RES: 20.4
  - UNI: 52.8

All information is based on post-evaluation outcome
• **UHBR engine demonstrator (ENG):** aiming at fuel burn reduction of 10%, leading to reduced CO$_2$, NOx emissions and noise.
  – Performed by Rolls-Royce and flight tested with Airbus

• **ReLOAD project (REG):** understanding of Load Control and Alleviation technologies to avoid excessive gust and manoeuvre loads, enabling enhanced wing design for weight savings and reduced fuel burn.
  – Coordinated by ARA (Aircraft Research Association Limited)
• CORNET project (ENG): improving understanding of engine noise in order to provide industry with new computer-based methods to predict and design quieter engines.
  – Coordinated by University of Cambridge

• PASSPORT project (AIR): to enable “right-first-time” additive manufacturing of highly optimised, light-weight parts: more efficient design-to-production cycle.
  – Coordinated by TWI Limited
Spotlight on UK projects in Clean Sky 2 (3/3)

- **SHERLOC project (AIR):** combining advanced Structural Health Monitoring (SHM) and smart repair technologies in order to develop new maintenance concepts.
  - Coordinated by Imperial College London

- **ASTRAL project (AIR):** working on structural design, manufacturing and assembly of a wing for RACER fast rotorcraft.
  - Coordinated by University of Nottingham

- **EMINEO project (SYS):** aims to provide the technology building blocks to enable the development of More Electric Aircraft
  - Coordinated by University of Nottingham
Important gains being made, but this is not enough!

Clean Sky 2 Environmental Objectives

- CO₂: -20% to -30%
- NOₓ: -20% to -30%
- Sound: -20% to -30%

vs. best aircraft in 2014

Our vision: Climate neutral Europe by 2050
Aviation growth is stronger than CO₂ reduction per RPK *

*RPK – revenue passenger kilometre
Europe’s greenhouse gas emissions trajectory

*LULUCF: Land use, land use change and forestry
Technology opportunity per product cluster

Fuel and CO₂ share in 2014

Commuter / VTOL
Up to 19 Pax
~ 500 km
- Full Electric Propulsion

Regional Short Range
Regional A/C
< 1000 km
- Hybrid Propulsion incl. Distributed Propulsion

Short Range
Single Aisle
< 3000 km
- Novel Engine Concepts / Ultra-Efficient Gas Turbines
- Innovative Aircraft Configurations
- Flight Physics, Structures/Materials and On-board Systems

Long & Medium Range
Single / Twin Aisle
> 3000 km
- Sustainable Aviation Fuels
- Eco- / Environmentally Optimised Air Transport Operations

~5%

~45%

~50%

> 90%
Different approaches will be needed per aircraft category needed

90% of flights: < 3000 km, = 50% of fuel used
10% of flights: > 3000 km, = 50% of fuel used
1% of flights: > 8000 km, = 20% of fuel used

Alternative Operations (e.g. stopovers)?

Source: DLR/Sabine

- FULL ELECT.
- HYBRID ELECT.
- ADVANCED A/C and GAS-TURBINES [R]EVOLUTION
- SAF [DROP-IN AND NON DROP-IN]
Integrated approach to upstream and demo research

➢ Upstream research in order to fill the pipeline and mature technologies
➢ Large scale demonstrators to rapidly incorporate upstream results into disruptive innovations for maximum impact
Clean Sky: leveraging synergies across Europe

CS2 ESIF Synergies: ~ €50 Mil. (plus projects at national level aligned via CS members)

New Horizon Europe partnership synergies level of ambition: ~ €3000 Mil. (via an Innovation Architecture)
The way forward

• Climate-neutrality is the *Grand Challenge* facing the sector
• We need a revolution in technology development!
• Low TRL *technology push* and high TRL *technology pull* in one programme
• Rapidly maturing, demonstrating and de-risking disruptive architectures
• Innovation Architecture with joint technology roadmaps for all actors
• Teaming up of research and policy will deliver → **impact**
• Impact will assure European aviation is fit for the future

*Courtesy DLR*  
*Courtesy ONERA*  
*Courtesy TU Delft / NLR*
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