Clean Sky 2 Information Day
Engines ITD
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Innovation Takes Off

www.cleansky.eu
From *Clean Sky* towards *Clean Sky 2*

• *Clean Sky*, through SAGE (*Sustainable And Green Engines*), is delivering significant step changes in key engine technologies along the following themes:
  – Open Rotor, Composites, Lean Burn combustors, high power gearboxes, enhanced turbines and compressors, advanced materials and improved structures

• *Clean Sky 2* is about providing and demonstrating new engine technology for the whole of the civil market

• The *Clean Sky 2* engines ITD will build on *Clean Sky* and demonstrate technology at a whole engine level
High-Level Objectives

• Environmental objectives for the engines ITD are to demonstrate at TRL6 the following:
  – 20-30% reduction in CO₂*
  – Significant contribution to ACARE 2020 NOₓ 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
### High-Level Objectives

- **Engine ITD timelines are as follows:**

<table>
<thead>
<tr>
<th>WP</th>
<th>Description</th>
<th>Year</th>
<th>Company</th>
<th>Demonstrator</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP1</td>
<td>Open Rotor Flight Test</td>
<td>2014</td>
<td>SNECMA</td>
<td>Flight Demonstrator</td>
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<tr>
<td>WP2</td>
<td>UHPE demonstrator</td>
<td>2016</td>
<td>SNECMA</td>
<td>Ground Demonstrator</td>
</tr>
<tr>
<td>WP3</td>
<td>Business Aviation Regional Turboprop</td>
<td>2018</td>
<td>TM</td>
<td>Ground Demonstrator</td>
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<tr>
<td>WP4</td>
<td>Geared engine Configuration (HPC-LPT)</td>
<td>2020</td>
<td>MTU</td>
<td>Ground Demonstrator</td>
</tr>
<tr>
<td>WP5</td>
<td>UHBR Turbofan Long Range</td>
<td>2022</td>
<td>RR</td>
<td>Flight Demonstrator</td>
</tr>
<tr>
<td>WP6</td>
<td>UHBR Turbofan Middle of Market</td>
<td></td>
<td>RR</td>
<td>Technology Demonstrator</td>
</tr>
<tr>
<td>WP7</td>
<td>Small Aircraft Engine*</td>
<td></td>
<td>TBD</td>
<td>…timescales to be defined…</td>
</tr>
</tbody>
</table>

* Core Partner Through Call
Setup and Implementation

WP4 MTU *Clean Sky 2* activities:

**Main Technology Objectives**
- Rig and Engine Testing and Validation of Compressor and Turbine technology to further reduce Emissions

**Key Technologies**
- Aerodynamic Integration
- Material Technologies
- Manufacturing Technologies

**Timeframe:** 2015 - 2021

**Potential Partner Contribution**
- Design and manufacturing of structural casings in Compression and Expansion System, test support
Rolls-Royce *Clean Sky 2* activities are split into two work packages:

**WP6:** underlying technologies for UHBR engines with focus on the “Middle-of-Market” short range aircraft

**WP5:** UHBR technologies for the long range airliner market with Engine Demonstrator
Setup and Implementation

Initial areas for participation (Work Package 6):

- Composite/Metallic/Hybrid Outlet guide vanes
- Intercase (Integrated IP/HP compressor)
- Low speed composite fan system
- Variable Cold-Nozzle System
- Integrated Nacelle
- High speed low-pressure turbine
- High speed high temperature roller/thrust/journal bearings
- System Design and Integration
- Advanced Engine Health Monitoring
- More electric engine technology (including electric pumping and actuation)
- Oil System Management

Rolls-Royce
Setup and Implementation

WP1 & WP2 SNECMA *Clean Sky 2* activities:

Main Technology Objectives

- **Geared Open Rotor**: design, build, ground and flight test on the A340 of a 2nd version carrying on SAGE 2 results
- **UHBR for SMR aircraft**: from design to ground test of an engine demo to validate LP modules & nacelle technologies

Key Technologies

- CROR blades: composite, aero-acoustics, pitch control system
- Low pressure ratio fan / variable area fan nozzle
- Low weight / low drag fixed or rotating structures and nacelle.
- High power gear box
- High efficiency LP turbine & LP compressor
- Engine / aircraft specific integration

Potential Partner participation:

- **Open Rotor (similar as Clean Sly 1)**: rotating frames, power gear box, power turbine, pitch control mechanism
- **UHBR turbofan for SMR a/c**: Fixed structures in propulsive system, low pressure turbine components, controls and systems components, shafts, bearings
Setup and Implementation

WP3 Turbomeca *Clean Sky 2* activities:

**Main Technology Objectives**
- From design to ground test of a new turboprop engine demo (1800-2000 shp) for business aviation and short range regional.
- Improvement of advanced core engine ARIDIDEN3

**Key Technologies**
- HP core small size (high pressure ratio, low NOx combustor, advanced materials on HP turbine)
- Capability to hybridise the core engine
- Advanced propeller / air inlet / gear box
- Controls, lub & hybrid actuation systems

**Potential Partner Participation :**
- Propeller
- Power gear box and accessory gear box
- Air inlet & Nacelle
- Innovative accessories (oil, bleed, starter,..)