

Light Helicopter Demonstrator with HCE (High Compression Engine)

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AIRBUS HELICOPTERS

Agenda

Project Overview

Advantages and drawback

Engine key characteristics

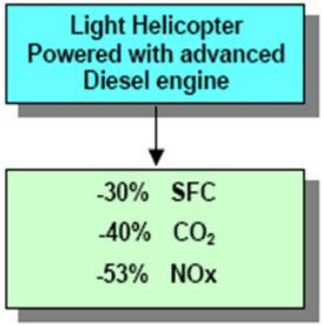
Achievements

Conclusion

Project Overview

Project launched in the frame of Cleansky Green RotorCraft (GRC) Integrated Technology Demonstrators (ITD)

- Environmental targets



  - – For H120 HCE Demonstrator, Airbus Helicopters committed on -30% Specific Fuel Consumption (SFC)

HIPE 440 Partners selected after successful Call for Proposal in February 2011

- TEOS: mechanical design, engine main parts manufacturing, assembly and testing
- AustroEngine: FADEC and harness, fuel system, airworthiness

Key dates

• KOM	June 2011
• First engine run on engine bench	March 2013
• Iron bird	Oct 2013 – Feb 2014
• Ground run	Feb – Mar 2015
• Maiden Flight	H2/2015

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) for the Clean Sky Joint Technology Initiative under grant agreement n° CSJU-GAM-GRC-2008-001.

HCE advantages and drawback (vs equivalent turboshaft)

Advantages

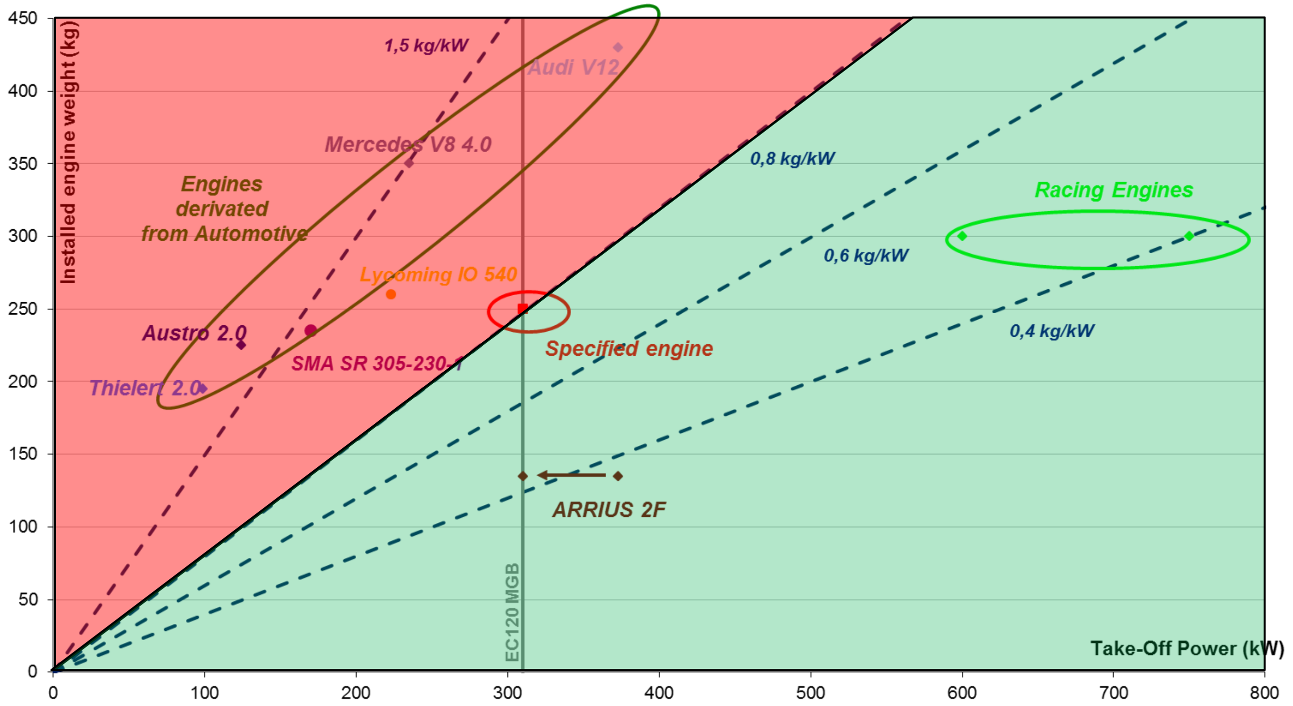
- **CO_2 emission reduced** (thanks to lower Specific Fuel Consumption) by minimum 30% and **up to 50%**
- **Performance maintained in hot** temperature **and high** altitude thanks to supercharging, whereas performance are continuously decreasing with air density for turboshafts
- **Direct Operating Costs lowered** (including fuel and maintenance)

Drawback:

- **Heavier** engine

  → need for brand new engine with installed mass/power ratio below 0,8kg/kW

Installed engine weight vs Take Off Power @ ISA - SL



kg/kW	kW/kg
0,4	2,5
0,6	1,67
0,8	1,25
1,5	0,67

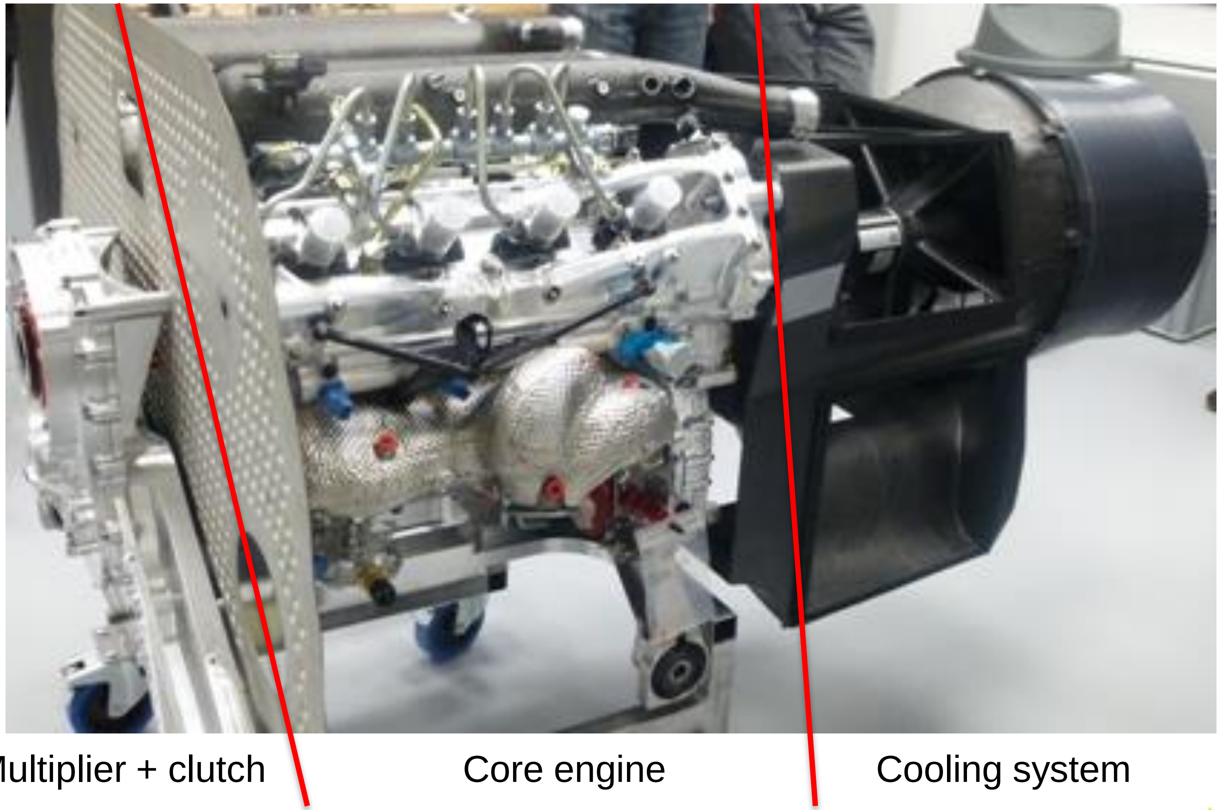
Engine key characteristics

Components and material description

- 8 cylinders in V, 4.6L capacity, 90° angle
- Fueled with Kerosene (Jet-A)
- Fully machined aluminium blocks (cylinder head, crankcase, timing drive casing…)
- Fully machined titanium conrod
- Steel pistons and liners
- Common rail direct injection (1800bar)
- Supercharged (1 turbo per cylinder bank)
- Liquid cooled
- Dual channel FADEC controlled
- Starter and generator

Mass of Core engine dry = 197kg

Installed Powerpack for serial lower than 0,8kg/kW

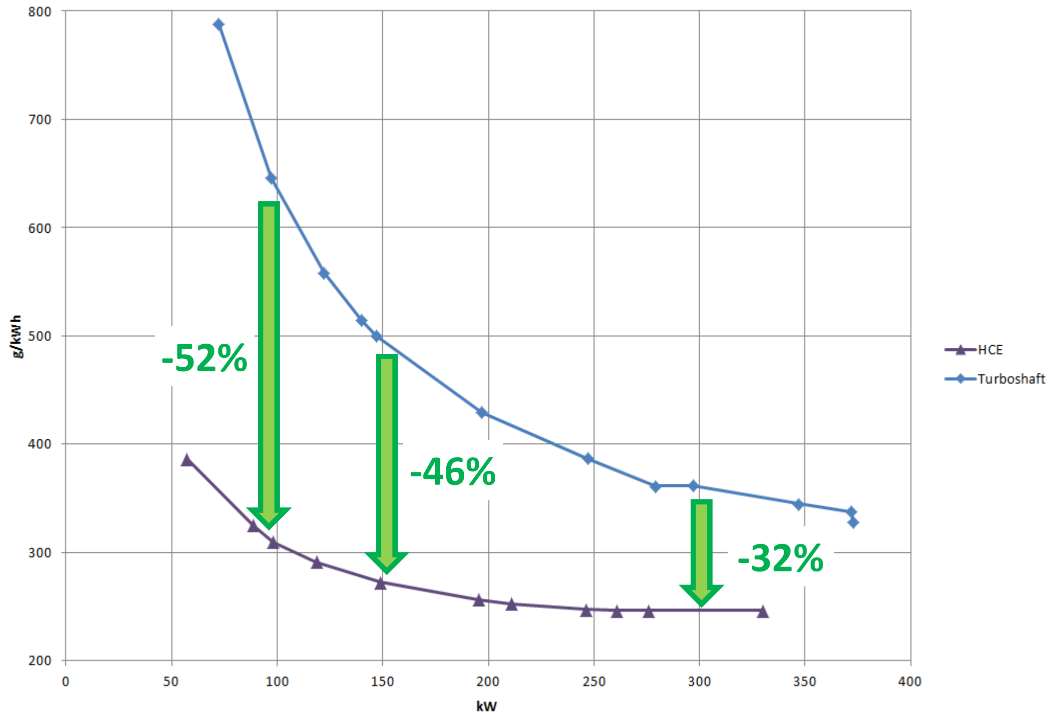


Achievements

Achievement #1: Fuel consumption

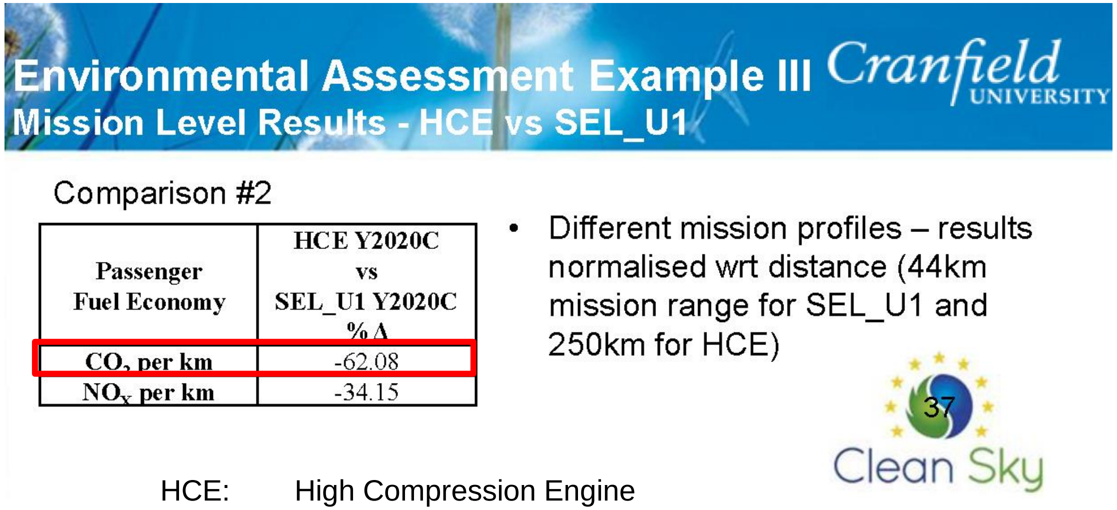
Engine bench test results

Specific fuel consumption (g/kW/h) vs power output (kW)



GRC7 assessment

Calculation done by Cranfield University, **at iso Payload** (extract)



Passenger Fuel Economy	HCE Y2020C vs SEL_U1 Y2020C % Δ
CO_2 per km	-62.08
NO_x per km	-34.15

- Different mission profiles – results normalised wrt distance (44km mission range for SEL_U1 and 250km for HCE)

HCE: High Compression Engine
SEL_U1: Single Engine Light (Model 1st Update)
Y2020C: Aircrafts evolution in 2020 with Cleansky inputs

Depending on duty cycle: up to 62% fuel saving

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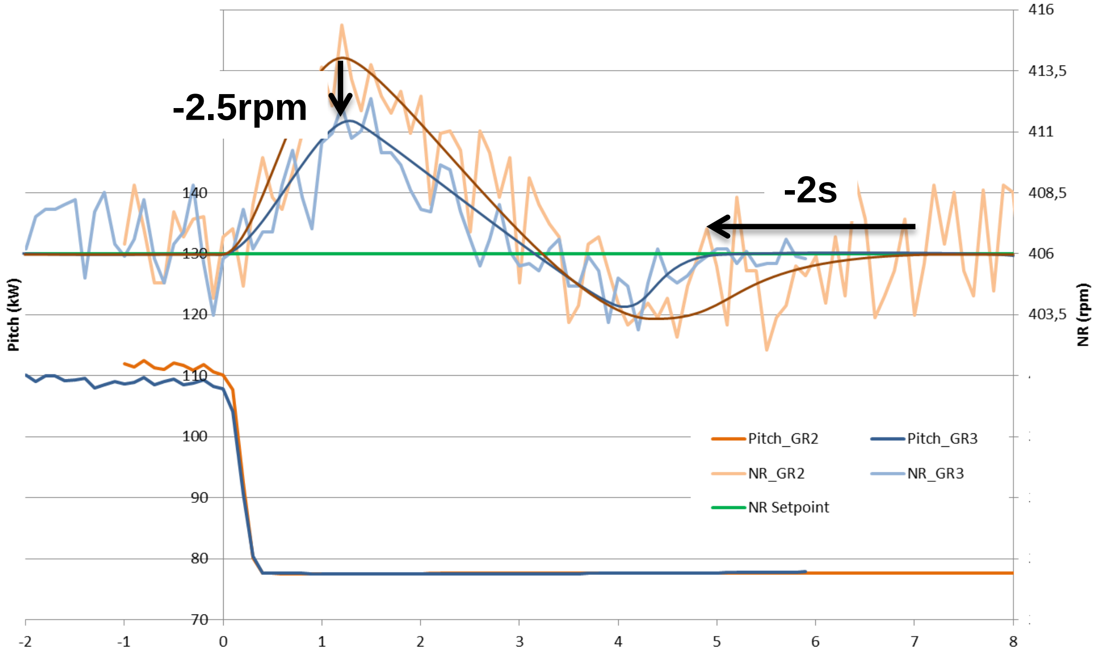
Achievement #2: Rotor speed (Nr) control

- During Ground test, the Nr control reactivity was first evaluated too slow by Flight test crew
- Nr control parameters have been improved and approved by Flight test crew
  – Ex: collective pitch decrease



Before parameters change
After parameters change

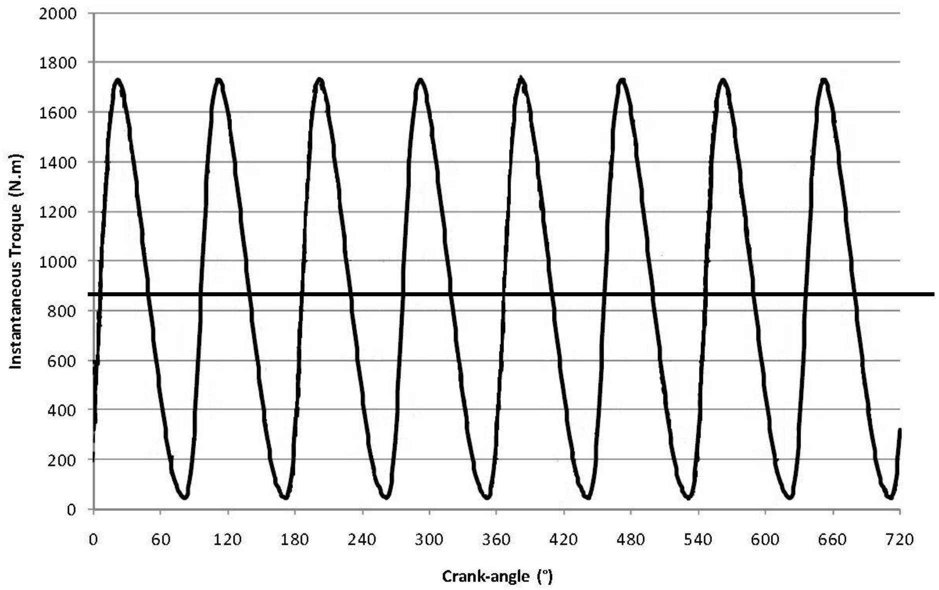
  – Same applies to collective pitch increase
- This last set of parameters will be tested during Flight tests

Stable and fast Rotor speed control

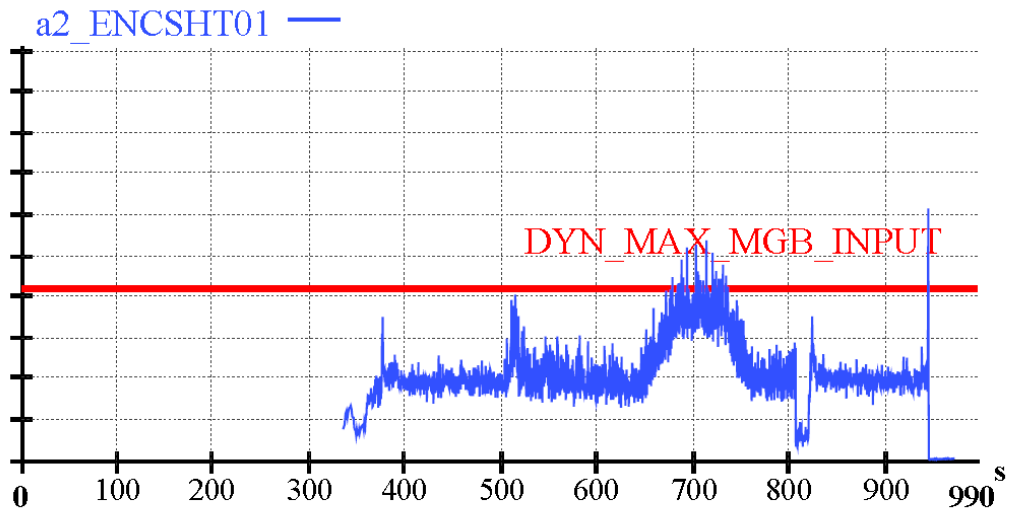
Achievement #3: Torque oscillations reduction

Due to combustion principle (non-continuous) and high rotor inertia, a torque oscillations reduction device is mandatory. The chosen solution is a lightweight torsional shaft fitted in the Core Engine, acting like a low-pass filter.

Instantaneous Torque vs Crank-Angle at Crankshaft output: **+/-100%!**



Dynamic Torque at MGB inlet during max Power



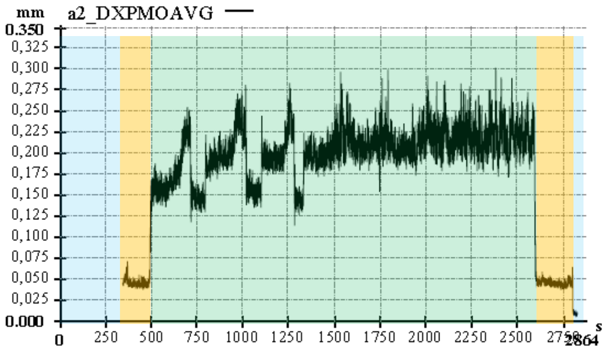
Main Gearbox standard torque oscillations limits are respected

Achievement #4: Engine movements

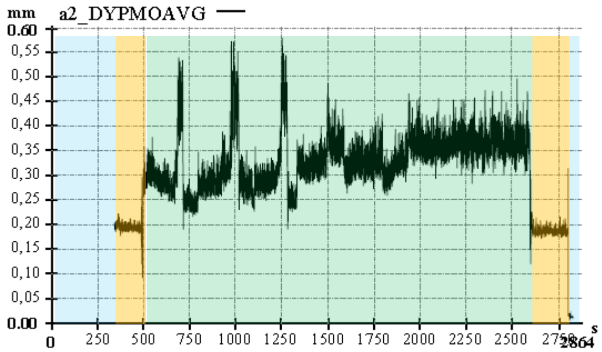
Silent blocs are installed between Powerpack and Helicopter airframe in order to:

- Limit engine movements and secure link between Powerpack and Main Gearbox
- Damp vibration from Powerpack to Helicopter (and vice-versa)

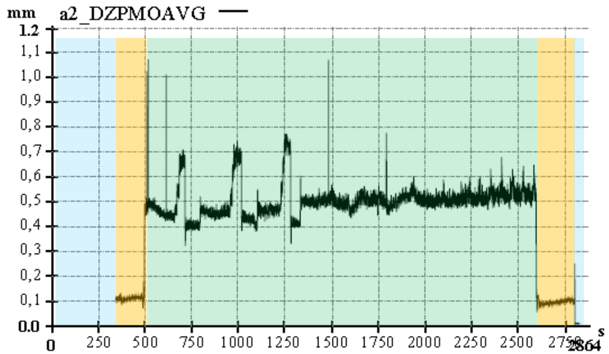
Here below is an example of engine movements measured on engine front left foot during Iron bird campaign



Along X-axis



Along Y-axis



Along Z-axis

Engine stopped
Engine at idle speed
Engine at flight speed with load steps

Engine movements are very small and vibrations well damped

Conclusion

Assuming a successful test campaign, Airbus Helicopters, AustroEngine and TEOS have started discussions for possible further development and industrialization of this engine for Fixed-Wings and Rotorcraft use

Thank you! Any question?