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CLEAN SKY

Technology Evaluator

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TE 2013 Annual Report

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1.1 PUBLISHABLE SUMMARY

This report summarizes the major achievements of the Clean Sky TE project during the year 2013. After a general overview of the TE project, which recalls the global technical objectives and the project organization, the main objectives set for this period and the achievements with respect to these objectives are reported.

From the outset, the Clean Sky (CS) Programme included the 'TE' as an essential ingredient. Clean Sky represented an unprecedented approach in European aeronautics research: a public-private partnership with a strong programmatic approach and a timeframe spanning the full European Union 7th Framework Programme duration. The level of co-investment by industry and the European Commission represented a step-change in commitment. When the case was successfully made for Clean Sky, the goal was to bring technology to maturity that could, as a set of solutions, deliver a substantial majority of the ACARE SRA[1] Goals for the Environment. These ACARE goals relate to aircraft technology available by 2020 for absorption into future product developments and are shown in Figure 1.

- CO_2 emissions reduced by 50% compared to similar and relevant 'Year 2000 aircraft'
- NOX emissions reduced by 80% compared similarly
- A halving of perceived noise compared to 2000 level performance
- Minimized life cycle impact of aircraft

From the very beginning it was recognized that successfully monitoring progress towards the ACARE goals would require a cross-cutting evaluation platform in the Clean Sky Programme. The TE was born from this need, and its composition reflects the need to pool know-how and simulation/modeling capability that exist among industry, the research establishments and academia.

The TE Approach

[1] ACARE: Advisory Council for Aeronautics Research in Europe; SRA: Strategic Research Agenda

Figure 1 : ACARE SRA Goals for the Environment

The approach that was agreed centered on 'inserting' Clean Sky conceptual aircraft into a number of evaluation scenarios.

In essence: the technologies developed, matured and demonstrated in Clean Sky's ITDs[2] are 'clustered' in coherent and mutually compatible solution-sets that define a potential future aircraft. These conceptual aircraft are 'flown' (i.e. simulation scenarios are run) and the Clean Sky configurations are compared to the most relevant benchmarks: most importantly the state-of-the-art of aircraft of similar size and role in the year 2000 (ACARE's baseline year).

The comparisons are performed at a single flight level, or 'mission'; at the level of illustrative airports; and finally across the global air transport system, or 'ATS'. So the TE approach aims to demonstrate the impact in the overall aviation system of Clean Sky's (research and technology) output by illuminating the 'pathway' from technologies to aircraft and transport system performance.

For evaluating the CS environmental benefit over the whole life cycle of the aircraft, the approach is to first perform life cycle analysis at aircraft parts level, assessing the environmental benefit between parts of reference aircraft and similar parts on conceptual aircraft. Then global results at aircraft level are obtained by up-scaling the analysis from a representative set of parts to the whole aircraft.

In the following, the present status of the CS environmental progress, which includes the latest assessments conducted by the TE in 2013, is presented.

Main environmental assessment results at end 2013:

The main results are presented hereafter at the three assessment levels

At aircraft level

Clean Sky concept aircraft	Noise area (take-off)	CO_2	NO_x
Low Sweep Bizjet (innovative Empennage)	-68%	-30%	-26%
High Sweep Bizjet	-10%	-19%	-26%
TP 90 (Regional Turbo-prop)	-71%	-30%	-34%
GTF 130 (Regional geared Turbo-fan	-76%	-20%	-34%
Short-medium range /CROR engine	-36%	-28%	N/A
Long Range /3 shaft Advanced Turbo-fan	-27%	-18%	-17%
Single Engine Light	-47%	-30%	-75%
Twin Engine Light	-49%	-26%	-74%

[2] ITD: Integrated Technology Demonstrator

Twin Engine Heavy	**NA**	**-22%**	**-47%**

Figure 2: Present status of CS environmental progress (Rotorcraft noise assessed on entire mission)

The results in Figure 2 have been obtained while performing mission level scenarios, and, for CO_2 and NO_x emissions, they can be directly compared to the ACARE targets given before.

It must be noted that not all Clean Sky technologies have already been integrated into the ITD aircraft models. Also, part of the way towards the ACARE goals should be done by SESAR, the effect of which has not been evaluated here.

At airport and global level

As mentioned, another output of the Clean Sky TE assessment methodology is that it provides results not only at mission level, where ACARE goals were set, but also at airport and global ATS levels where indicators, at least as important as the ACARE ones, for the welfare of the citizens can be estimated.

In particular, initial results have been provided concerning the decrease of noise annoyed persons and the local air quality improvement in the neighbourhood of some selected airports, for mainliners and regional aircraft. According to airports and scenarios, the population impacted by the noise levels can be decreased by 10% up to 60%. Concerning local air quality, a reduction of the emissions by about 10% has been estimated.

Predictions also report a 30-to-45% decrease of noise footprint for the considered single- and twin-engine light helicopters flying air taxi/passenger transport, police and EMS missions.

At global level, CO_2 emissions of mainliners and regional aircraft could be decreased by an average of about 17% with Clean Sky technology equipped aircraft (cf. Figure 3).

For business jets, a potential of around 30% in CO_2 reduction and 26% in NO_x reduction has been estimated.

For the rotorcraft fleets of TEL[3] and SEL[4] improvements are about 30% for the CO_2 reduction and 75% for the NO_x reduction while for the TEH[5] CO_2 is reduced by 22.3% and NOx by 47% approximately compared to the Y2000 Reference helicopters".

[3] TEL: Twin Engine Light
[4] SEL: Single Engine Light
[5] TEH: Twin Engine Heavy

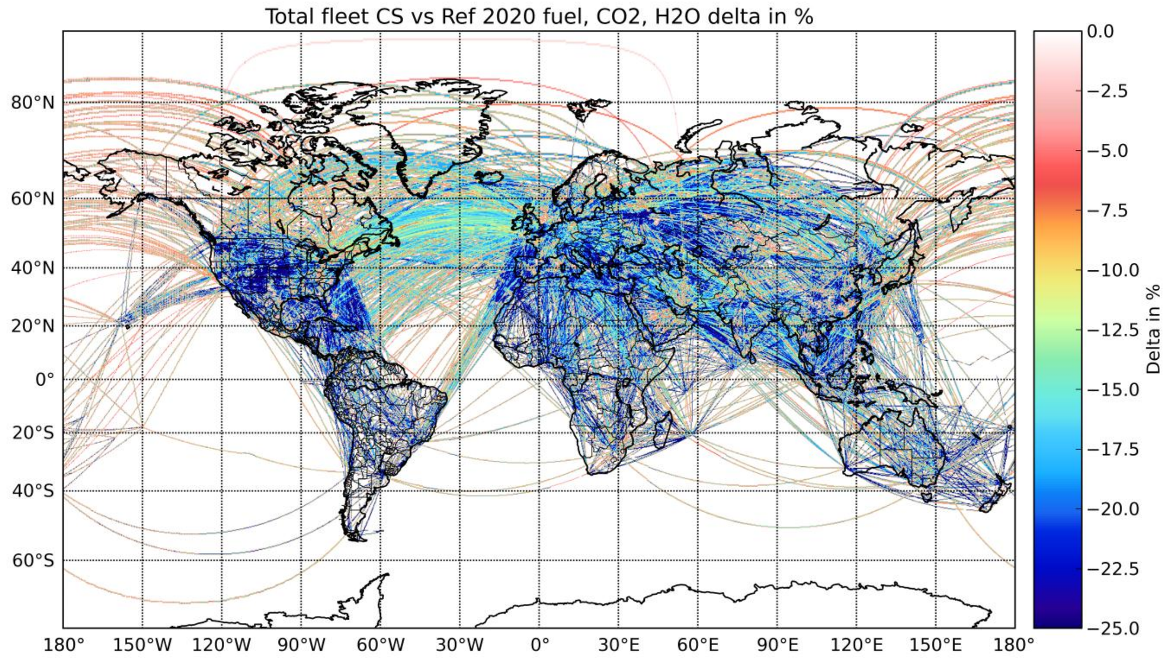

Figure 3: Emissions decrease at global fleet level (with Clean Sky aircraft 2020 fleet versus without Clean Sky aircraft 2020 fleet)

At Life Cycle Analysis level

The main objective for the LCA in 2013 was to undertake an LCA of airport ground operations. In the LCA of airport ground operations, the environmental impacts of airport ground operations which are supporting the air traffic are assessed by the method of Life Cycle Assessment (LCA). In a first step, the vehicle traffic for an Airbus A320 full-service as well as a half-service and a Dassault Falcon 2000 full-service at Frankfurt-am-Main airport is simulated with the CAST traffic simulator from Fraunhofer IML. It simulates all service operations and transport trips which are necessary and delivers the basis for the following LCA of the vehicle traffic. The LCA is performed by Fraunhofer IBP with the LCA software tool GaBi.

The CAST apron traffic simulator includes: mapping of system load, mapping of processes, mapping of traffic, analysis and illustration of results.

Summarized results are:

- The highest environmental impact of all service scenarios of the airbus A320 was assessed for a full-service in apron position.
- The share of service operations of the A320 on the total impacts is slightly higher than the share of transport trips in all scenarios in all impact categories and both ACARE goal emissions.
- The service operations of full and half-service of the A320 in both positions are dominated by the loading and unloading processes run by container/pallet transporter and container/pallet highloader. Both processes represent over 50% of all service operations of a full-service and even over 70% of all service operations of a half-service.
- The transport trips of full and half-service of the A320 in terminal position are dominated by air cargo handling, representing nearly 60% of the total impacts. In apron position

impacts are mainly caused by passenger handling by passenger busses with around 40% of the total impact while cargo handling represent around 30%.

- The total environmental impacts of the Dassault Falcon 2000 are dominated clearly by service operations with around 97%.
- The service operations impacts of the F2000 full-service are composed of the services fueling, water disposal, water supply and cleaning. The cleaning service only causes around 5-10% while the rest is equally caused by the other three services.
- The transport trips of the F2000 full-service are equally caused by passenger and cabin crew handling since they are both run with the same vehicle type on the same distance.

Further objectives were to develop the baseline airliner (A320) analysis and collect an initial specification for the reference bizjet (Cleansky reference Falcon) and to initiate the collection of data for the baseline rotorcraft. These activities are continued into 2014..

Conclusion

The evaluation of Clean Sky's progress at all three assessment levels (Aircraft, Airport, and ATS) and LCA was successfully performed in 2013. With respect to the initial CS environmental evaluation done in 2011, it is much more complete considering both the number of concept aircraft which were evaluated, and the CS technology that was integrated into the associated ITD aircraft models. Also the level of confidence in the output of the simulation increased with both the TRL of the technology developed in the ITDs, and with the level of accuracy of the ITDs aircraft models which have been developed, and which integrate these technologies.

Even if not still perfect, the linkage between ITDs and TE was significantly improved as the challenges are now better understood on both sides for either building the conceptual models or using them in various scenarios in order to assess the environmental improvements of the Clean Sky Programme.

The high level results summarized in Figure 2 confirm that TE is on the right track with respect to the objectives as initially set. Yet there are still steps to secure the final assessment in 2016; in particular going on with the integration of SGO technologies into the conceptual aircraft models, updating these models with the results of the latest demonstrations in the ITDs, and using TE tools to perform when requested environmental trade-off studies for ITDs.