2016
Annual Activity Report

In accordance with Article 20 of the Statutes of the Clean Sky 2 Joint Undertaking annexed to Council Regulation (EU) No 558/2014 and with Article 20 of the Financial Rules of the CSJU.

The annual activity report will be made publicly available after its approval by the Governing Board.

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FACTSHEET

Name	Clean Sky 2 Joint Undertaking
Objectives	a) To contribute to the finalisation of research activities initiated under Regulation (EC) No 71/2008 and to the implementation of Regulation (EU) No 1291/2013, and in particular the Smart, Green and Integrated Transport Challenge under Part III — Societal Challenges of Decision 2013/743/EU; (b) To contribute to improving the environmental impact of aeronautical technologies, including those relating to small aviation, as well as to developing a strong and globally competitive aeronautical industry and supply chain in Europe. This can be realised through speeding up the development of cleaner air transport technologies for earliest possible deployment, and in particular the integration, demonstration and validation of technologies capable of: (i) Increasing aircraft fuel efficiency, thus reducing CO2 emissions by 20 to 30 % compared to 'state-of-the-art' aircraft entering into service as from 2014; (ii) Reducing aircraft NOx and noise emissions by 20 to 30 % compared to 'state-of-the-art' aircraft entering into service as from 2014.
Founding Legal Act	Council Regulation (EU) No 558/2014 of 6 May 2014
Executive Director	Eric Dautriat until 15 September 2016; Tiit Jürimäe appointed as Interim Executive Director since 16 September 2016
Governing Board	Ric Parker, Chairman (Rolls-Royce); Composition of the Governing Board: European Commission + 16 Industrial Leaders (Agusta Westland, Airbus, Airbus Defence & Space SAU, Airbus Helicopters, Alenia Aermacchi, Dassault Aviation, DLR, Evektor, Fraunhofer, Liebherr, MTU, Piaggio Aero Industries, Rolls-Royce, SAAB, Safran, Thales Avionics) + Associates [Fokker (ED), Onera (GRA), NLR (GRC), GKN Aerospace (SAGE), University of Nottingham (SGO), Aernnova (SFWA)] + Core Partners [ITP (ENG), University of Nottingham (SYS), INCAS (FRC), Avio Aero (LPA), CIRA (REG), Meggit (AIR). CIRA (REG)].
Other bodies	States Representatives Group; Scientific Committee; ITD/IADP Steering Committees and TA Coordination Committees
Staff	42
2016 Budget	€310.5 million in commitment appropriations €287.8 million in payment appropriations
Budget implementation	98% in commitment appropriations and 90% in payment appropriations
Grants	Seven FP7 Grant agreements for Members (GAMs) - total value € 38,3 million; Nine H2020 GAMs - total value €198,3 million; 117 H2020 GAPs - total value € 98,9 million.
Strategic Research Agenda	See chapter 1 and related Annex 11
Call implementation	Number of calls launched in 2016: four [three CfP and one CP Call, of which two are closing in March 2017] Number of proposals submitted: 386 Number of eligible proposals: 381 Number of proposals retained: 114[1] Global project portfolio (since the setting up): 206[2] Number and value of tenders (if any): 1 with a value of €135.000
Participation, including SMEs	Total number of participations in funded projects: 552[3] which is made up: 24% SMEs (131 participations) 30% IND (168 participations) 20% UNI (108 participations) 26% RES (145 participations)

[1] Subject to Grant signature in the case of outstanding CPW03, CfP03 and CfP04 projects

[2] Not counting Leader actions and counting each funded proposal from Calls as one project.

[3] CfP04 results excluded, as still under GB approval procedure

Foreword

The year 2016 was a very important and busy year for the Clean Sky 2 Joint Undertaking and for the whole aeronautics sector.

Firstly, the political developments which started in 2015 with the signature of the historical Paris climate change agreement and the adoption of the European Commission's new Aviation Strategy, gained further speed in 2016 with some important milestones reached. The International Civil Aviation Organisation (ICAO) CO_2 standard for new aircraft was agreed in February, the European Commission adopted the European Strategy for Low-Emission Mobility in July, ICAO agreed on global market-based measures to control CO_2 emissions from international aviation in October, and the Paris Agreement was ratified and the Commission adopted the Accelerating Clean Energy Innovation Communication as part of the Energy Union initiative in November. The message from all these developments is clear – aviation and the whole transport sector need to do everything possible to accelerate the development and introduction of environmentally friendly products and services. It confirms that the objectives and goals already set out by the European Commission and stakeholders through the Vision 2020 of the Advisory Council for Aeronautics Research in Europe (ACARE) in 2000, and the subsequent set-up of the first-ever European Public-Private Partnership in aeronautics Clean Sky in 2008 and the decision to continue this partnership with an even higher commitment in 2014, have been significant steps in the right direction and are more important today than ever before.

Secondly, 2016 has been important for the Clean Sky programme, as the assessment of the independent internal Technology Evaluator confirmed that the technologies developed since 2008 through Clean Sky projects match the initial objectives set and have true potential to significantly reduce emissions, once introduced into the market. Even if the economic and production viability of many of these technologies still needs to be proven outside of the research phase, it has been crucial to demonstrate that 600 organisations from across Europe are pooling their knowledge and resources together in a partnership and have been able to successfully carry out a complex technology development programme.

Thirdly, 2016 was a year where two programmes – Clean Sky under FP7 and Clean Sky 2 in Horizon 2020 – were fully implemented and managed simultaneously by the Joint Undertaking and the stakeholders. It has been a great challenge for all parties as it involved, completing 15 large demonstrators to be ground- or flight-tested under the Clean Sky programme, while in parallel building up the membership and the technical work under Clean Sky 2. One of the highlights of 2016 was the large number of organisations who successfully applied to Clean Sky 2 Calls bringing the total number of entities already involved in Clean Sky 2 to more than 450 from 24 countries. It demonstrates that Clean Sky 2 has been able to build on the success of its predecessor in terms of attractiveness, openness and transparency. Equally importantly, there has been a very active participation from SMEs in 2016, which have successfully applied both for membership and through the Calls for Proposals.

Fourthly, the Clean Sky 2 JU continued in 2016 to engage actively with the European regions to

seek and build synergies with their investments through the regional funds, in particular through the European Structural and Investment Funds. With the signature of the memorandum of understanding (MoU) with Portugal, in October, the total number of signed MoUs has already reached to 12 and building on the experience of co-operation, this number is expected to increase in the coming years.

Fifthly, the Clean Sky 2 JU continued to actively engage with other European organisations involved in or linked to aeronautics research. While the good cooperation with SESAR and Fuel Cells and Hydrogen 2 Joint Undertakings was already established, the exploration of possible synergies started with the ECSEL Joint Undertaking in 2016 and is planned with the Shift2Rail Joint Undertaking in 2017. Even more importantly, a very good cooperation was set up and a Memorandum of Cooperation signed with the European Aviation Safety Agency (EASA) which is responsible for the future certification of the technologies developed under the Clean Sky programme. In addition, the Clean Sky 2 JU contributed to the first European Aviation Environmental Report which EASA released in January 2016.

Finally, 2016 also brought significant changes to the Joint Undertaking's management when two long-serving members of management – the Executive Director, Eric Dautriat, and the Head of Administration, Elizabeth Gavin – left the Joint Undertaking. Their contribution over the years to building up the Joint Undertaking and helping it operate successfully and smoothly has been highly recognised by the staff, stakeholders and all other parties. While the new Head of Administration started in November 2016, the selection of the new Executive Director is still on-going and will hopefully be finalised during 2017.

You will find in this report a more detailed summary of the 2016 achievements and challenges. What is clear from the report is that the Clean Sky 2 Joint Undertaking has proven to be the right instrument to efficiently manage a highly complex technological programme, involving a wide spectrum of actors and from various different legal frameworks.

Executive Summary

The Clean Sky 2 Joint Undertaking is a public-private partnership (PPP) responsible for managing the largest public aeronautics research programme in the EU. It is tasked with managing two R&I programmes, one each from the FP7 and H2020 framework programmes, with a total budget approaching €6 billion, half of which is from private members and partners. The Clean Sky 2 JU is the EU research and innovation instrument in this field, focusing on environmental and competitiveness objectives. The programmes are managed by the Joint Undertaking central team based in Brussels. The JU is an autonomous body set up under the legal framework of a Council Regulation and operating the grants it funds through EU financial rules and the rules of the research framework programmes. The combination of EU and private industry funding provides a flexible means to ensure stability and long term commitment from the European Union and stakeholders regarding the funding opportunities, as the two JU's lifetime covers the whole period from 2008 until 2024.

In 2016, the first Clean Sky programme had planned for the last 16 demonstrators to be flight and/ or ground tested. Most of the demonstrators were completed in 2016. Only three of the planned tests were shifted to the first half of 2017, as a result of both an optimisation campaign of company investments in additional activities and of short delays, which are usual in major aeronautics R&I programmes. Among those finalised in 2016, the following ones could be mentioned as most significant: all electric regional aircraft (A/C) (flight tested in February), electric A320 flight test demonstrator (FTD) (flight tested), rotorcraft electric tail (ground tested), the ground testing of the high speed business jet wind tunnel ground testing, wing assembly of the laminar flow BLADE wing assembly, the last two in the Smart Fixed Wing Aircraft ITD.

In the course of the preparation for these demonstrators, 119 projects were carried out by partners, selected by Calls for Proposals and funded through Grant Agreement for Partners (GAPs) and came to successful completion in 2016, feeding their results into the main demonstrators.

One of the major milestones in the first Clean Sky programme was the completion of the Technology Evaluator's final assessment. The Technology Evaluator is unique to the Clean Sky 2 JU. As an internal, independent, evaluation body, it performs an assessment at single aircraft/ helicopter level ("mission"); at airport level; and at global air transport system level, providing the comparison with respect to the targets of the key parameters of environmental impact.

The final assessment performed at end 2016 consolidated the achieved improvements in environmental impact at global level and confirmed that the initial objectives set in 2008 were achieved:

Parameter	ACARE 2020 targets (ref. Y2000)	CLEAN SKY targets (global fleet ref. Y2000)	ACHIEVED (average fleet level)
CO2 emissions	reduced by 50%	-26%	-32 %
NOx emissions	reduced by 80%	-60%	-41% [1]
NOISE	Halving of perceived noise (-10dB)	-50 – 75 %	-5 dBA [2] ➢ 50% for BizJet and rotorcraft
Life cycle impact	Minimize impact on environment	ECO Design ITD / LCA approach	LCA tools implemented

[1] up to 60% for Long Range A/C and for Rotorcraft global fleet

[2] Lden at 6 airports

In parallel, the Clean Sky 2 programme continued to build up the technical programme and the JU membership. One further Call for Core Partners was launched, which will close in March 2017. Adding to the 76 Core Partners selected in 2015, around 60 more Core Partners joined the JU membership in 2016, leading to a total membership of around 150 members from 20 countries (18 Member States and two Associated Countries). This is almost double the membership of the first Clean Sky programme and while it is a clear demonstration of attractiveness, openness and transparency, it is also bringing a higher degree of complexity and new challenges for the JU in running the programme.

Two Calls for Proposals were launched in the Clean Sky 2 programme in 2016 to continue developing and implementing the technical programme. As of early 2017, almost 300 partners will be joining the programme, of which 24% are SMEs, 32 % Research Centres and 20% Academia representing participation by 19 countries (15 Members States, two Associated Countries and two Third Countries). Together with the Members, there are already 24 countries that are active in the Clean Sky 2 programme.

In order to develop synergies with European Structural and Investment Funds, the Clean Sky 2 JU has been working with the Member States and regions in Europe looking for complementarity and cooperation opportunities. The aim is to strengthen the R&I innovation capacity and the European dimension of the Regions in aeronautics, to identify areas of technical cooperation which could complement the Clean Sky 2 programme and support its overall objectives. Twelve Memoranda of Understanding have been signed between the JU and regions by the end of 2016 (see section 1.11). Further engagement with the aviation relevant regions will be assessed against efficient monitoring of existing agreements and impact on the CS2 programme with available resources.

In 2016 the JU has been actively working on the further improvement of its financial procedures and processes (see section 4), as well as the integration of new rules emerging from the H2020 guidance and new specificities compared to FP7. The financial procedures and the workflows put in place follow the financial rules and the general control framework applicable in the Commission.

In 2016, the JU was audited by the European Court of Auditors as set out in the Statutes. The results of these audits were published in the Court's Report on the Annual Accounts 2015[4]. In its Statement of Assurance, the Court issued to the Clean Sky 2 Joint Undertaking a positive opinion on the reliability of the annual accounts and on the legality and regularity of the underlying transactions. Findings and comments raised by the Court during the two audit visits performed until June 2016 have been taken up by the JU and actions have been developed to further improve the procedures of the JU and enhance controls.

Regarding the budget management (see section 1.9), the JU manages in parallel the two Programmes Clean Sky (under FP7) and Clean Sky 2 (under H2020 Framework Programme) with a corresponding amount of commitment appropriations of €310.5 million. Of this, €302.3 million is allocated to the operational expenditures of the Clean Sky and Clean Sky 2 programmes with respectively €38.5 million and €263.8 million. The JU executed 98% through new financial commitments which represents a very high rate for both administrative and operational budget (100% and 98% respectively).

The available payment appropriations increased by 117% in 2016 to € 287.8 million compared to the previous year. Of this amount, 90% was paid out during 2016 showing a notable increase compared to 2015 (81%).

Grant Agreements for Members (GAM) for the H2020 programme were amended across 2015 and 2016. Some technical areas, like ECO and SAT were covered by a GAM for the first time in 2016. The JU continues to take advantage of the available H2020 tools and uses them to process all Grant Agreement for Partners (GAPs), while the specificities of the Grant Agreements for Members (GAMs) have required the use of the dedicated IT system so far. Nevertheless, it is foreseen that in 2017 the GAMs will also be migrated to the H2020 tools in cooperation with the Commission Common Support Centre.

In terms of calls, 2016 has been a busy year for the Joint Undertaking (see sections 1.3-1.5). The evaluation of three calls were completed, namely for the third Call for Core Partners, the third and the fourth Call for Proposals. For the latter, the adoption of the evaluation ranking list by the Governing Board was achieved in January 2017. For the two other calls, the full evaluation from assessment by the appointed experts through to Governing Board adoption was performed in-year. Finally, for two calls: the fourth Call for Core Partners and the fifth Call for Proposals, the calls were launched, but given to the closing date in March 2017 the evaluation is scheduled for Q2 2017. It is also important that for the Call for Proposal No 2, the

[4] Report on the Annual Accounts of the Clean Sky Joint Undertaking for the financial year 2015, dated 18.10.2016

JU was able to sign just over 80% of the GAPs within the eight month Time-to-Grant, hence meeting the target set. This is a significant improvement compared to the first call in 2015, as the technical issues with the H2020 tools for processing GAPs had been solved. For the third Call for Proposal, a similar good performance was achieved, with 41 out of 50 grant agreements signed before the eight month deadline.

In addition to the grant funding, the JU continues implementing and further developing procedures for estimation, reporting, certification and validation of the in-kind contributions from the private members. The total reported in-kind contribution value for 2014-2016 has already reached €483 million. Taking into account the Union contribution of €208 million allocated to the Members and Partners during this period based on their cost statements, it leads to a healthy "leverage effect" of 1:2.35 and when taking into account already certified in-kind contributions of €238 million, the certified leverage effect is 1:1.29. Details on the values of the in-kind contribution of private Members for both programmes – FP7 and H2020 - are presented in section 1.10 of this report.

Finally, a lot of effort has been made in 2016 on the communication and the dissemination (see section 2.1), particularly as the first Clean Sky programme is finishing and results are becoming available. A dedicated conference was organised in Brussels in October in cooperation with the French Aerospace Association and a totally re-worked Clean Sky website was launched to provide better information about the programme and putting a specific emphasis on the results.

1. IMPLEMENTATION OF THE ANNUAL WORK PLAN 2016

1.1. Key objectives 2016 and associated risks

Clean Sky Programme - Achievement of Objectives for 2016

As the Clean Sky programme approaches its final phase, the annual objectives are linked to the completion of the planned operational tasks, the progress towards the technologies readiness, the environmental benefits assessment, the control of expenditures, the satisfactory scheduling and outcome of calls for proposals and the further improvement of the JU's quality management and internal control system.

The overall objectives are:

- To run all the demonstrators (ground or flight demonstrators)
- To achieve the environmental targets

Objective 2016	Achieved in 2016 (Yes/ No/Comments)
Smart Fixed Wing Aircraft Natural Laminar Flow "BLADE" wing demonstrator Critical Design Review performed	Yes, including starting of final assembly
Low Sweep Bizjet Vibration Control Ground Test, Critical Design Review performed	Tests performed in 2016
Green Regional Aircraft Fuselage Barrel and Wing Box demonstrators finalised	Tests performed: Barrel testing finished. Wing box extended to Q1/17.
ATR72 Flying Test Bed, Flight Test Readiness Review performed	All electric Aircraft flight tests performed in February 2016
Rotorcraft Active blades tested on ground (wind tunnel and whirl tower preparation)	Initial flight test in December 2016
Rotorcraft Diesel engine tested on ground	Flight testing continued in 2016
Open Rotor Ground Demonstrator Critical Design Review held	Yes, start of assembly ended in 2016

The JU has implemented various tools to monitor the execution of the programme in terms of productivity, achievements, planning and risks of the operations:

- Quarterly Reports of the ITDs which inform on the resources consumption, the achievements and the resulting forecasts for level of project implementation.
- Steering Committees at ITD level with involvement of the CS project officers.
- Annual Reviews of the ITDs' performance organised by the JU with the involvement of independent experts.
- This monitoring information is summarised and reported regularly to the Governing Board.

The two tables below give respectively the list of the demonstrators and technology streams and the environmental forecasts.

FP7 Clean Sky Demonstrators and Technology streams

ITD	Demonstrator / Technology Stream
SFWA	High Speed Smart Wing Flight Demonstrator • Airbus A340-300 flight test
	Advanced load control for Smart Wing • Ground test bed for large transport aircraft • Flight test for vibration control for bizjet
	Smart Wing High Lift Trailing Edge Device • Full scale demonstrator, ground test only
	Innovative afterbody • Full scale demonstrator, ground test only
	Innovative Empennage Demonstrator • Full scale demonstrator, ground test only
GRA	Static & Fatigue Test • Full Scale Ground Demonstration
	Large scale Wind Tunnel Test Demonstration • Acoustic & Aerodynamic WT Test - Turbo Prop 90 pax • NLF wing aerodynamic & aeroelastic design WT Tests - 130 • Geared Turbo Fan configuration
	Ground Laboratory Test (COPPER BIRD and other)
	Flight Simulator on ground • Green FMS Final Demonstration on GRA Flight Simulator
	Integrated In-Flight DEMO • ATR Integrated In-Flight Test - ATR 72 FTB
	Cockpit ground demonstrators MT1 & MT2
GRC	Innovative Rotor blades, passive and active (AGF), on Ground and in Flight
	Drag reduction on Ground / in Flight
	Medium helicopter electrical system demonstrator
	Lightweight helicopter electromechanical actuation
	Electric Tail Rotor Prototype
	Diesel powered flight worthy helicopter Demonstrator
	Flightpath operational Demonstrations
	Thermoplastic composite faring demonstrator
	Thermoplastic composite tailcone demonstrator
	Surface treatments for tail gearbox and rotor mast
	Surface treatments and welding technology for intermediate gearbox
	Thermoplastic composite drive shaft for intermediate gearbox
SGO	VIRTUAL IRON BIRD
	Copper Bird® • Ground Test (Nacelle Actuation System, Power Generation and Conversion, Generators, Power Rectifiers, Electrical ECS Demonstrator, HEMAS)

ITD	Demonstrator / Technology Stream
	PROVEN (Ground test rig at Airbus Toulouse) • Flight Test (Environmental Control System Large Aircraft - Ice Protection and Ice Detection Systems) • Ground Tests (Power Generation and Conversion S/Gs, PEM - Electrical Power Distribution System/Power Centre) • Flight Tests (Thermal Management Skin Heat Exchanger) • Ground Tests (Thermal Management Vapour Cycle System including Compressor)
	AIR LAB, MOSAR & GRACE simulations
	Electric systems integration • Ground Tests (Power Generation and Conversion EDS ITD)
SAGE	Geared Open Rotor • CROR Ground Test Demonstrator
	Advanced Low Pressure System (ALPS) Demonstrator
	Geared Turbofan Demonstrator • Ground Test - Engine demonstrator based on a GTF donor engine
	Large 3-shaft Turbofan • Ground tests Demonstrator (to study aero-performance, flutter, blade integrity and bird impact capability for the composite fan system and low pressure turbine). • Flight test Demonstrator (in-flight operability of the composite fan blades). • Outdoor ground testing (to determine composite fan system flutter behaviour under cross-wind conditions and noise performance. • Icing tests (to determine ice shedding behaviour of blades and impact damage tolerances of new liners).
	Lean Burn Demonstrator • Ground Test - Lean Burn Combustion System demonstrator engine
ECO	Electrical Ground Test (Copper Bird®) • High power, High Voltage Large electrical network for validation of the All Electrical Concept for small aircraft. It includes power generation, power distribution and consumers (actuators, ECS simulation, etc.)
	Thermal Ground Test • Simulation of thermal exchanges of 3 sections of an aircraft in a representative environment. Main objective is the validation of the thermal modelling process of an overall aircraft.
	Clustered technologies airframe and equipment demonstrators • 12 demonstrators related to Airframe (e.g. fuselage panel, cabin furniture) • 6 equipment demonstrators (e.g. cables, connectors, part of air cooling unit)

Environmental forecasts

The following figures, summarised here for a limited number of air transport segments, are based on the initial estimates and have been refined during 2011-2012. For a clarification of the Concept Aircraft please refer to Appendix 2 of the Clean Sky Development Plan[5]. The ranges of potential improvements result from the groupings of technologies which are expected to reach the maturity of a successful demonstration within the programme timeframe. All environmental benefits are related to a Year 2000 reference.

Aircraft	CO_2 [%]	NO_X [%]	Noise area difference ratio at take-off (%)
Low Speed Bizjet	-30 to -40	-30 to -40	-60 to -70
Regional turboprop	-25 to -30	-25 to -30	-40 to -50
Short/ Medium Range / CROR	-25 to -35	-25 to -35	-30 to -40
Light twin engine rotorcraft	-15 to -30	-55 to -70	-40 to -50

Indicators

The FP7 Key performance Indicator results for the year 2016 are presented in Annex 7.

With regards to the monitoring of operations, the results are summarised via a dashboard on the JU level, for an efficient, quarterly reporting to the Governing Board.
The main focus of the JU programme management is now to ensure that, within the limited remaining funding to completion and despite these contingencies, the demonstrators objectives will still be reached by the end of the programme – beyond the global snapshot brought by these global figures of deliverables by ITD.

[5] CS-GB-2014-12-19 Doc9 CS Development Plan

Clean Sky 2 Programme – achievement of objectives

As the Clean Sky 2 programme faces its initial phase the annual objectives set are linked to the definition of the demonstrators, the satisfactory scheduling and outcome of calls for core partners and calls for proposals, refinement of the Technology Roadmaps, the environmental benefits assessment, and the control of expenditures.

Objective 2016	Achieved in 2016 (Yes/ No/Comments)
To refresh / refine the technical content of the overall programme in the course of the accession of the Core Partners, and ensure this is adequately incorporated in the *CS2 Joint Technical Programme, the Clean Sky 2 Development Plan* and the Grant Agreements [including any re-evaluation of elements where appropriate];	Yes Core Partners have been absorbed in GAMs from the three first waves [constituting over 80% of the membership]. The final Call for Core Partners has been launched and will close in March 2017, with grant implementation by the end of 2017, setting the membership for the duration of the programme.
To further define and refine the requirements for the Demonstration Programme – as the accession of the full complement of members through the core partner selection will involve adjustments in the schedule, scope and definition of demonstrators;	Substantially [>80%], see above. The final call for Core Partners will conclude the membership accession and the current update of the Clean Sky 2 Development Plan [aligned with the elaboration of the 2018-2019 Work Plan in July 2017] will form basis in terms of schedule, scope and deliverables expected to be stable over the 2-year Work Plan period.
To conduct Launch Reviews for 100% of technical activity commencing in the 2015-2017 period, enabling the JU to adequately test the level of definition, of preparation and resourcing geared towards each major activity. The state of play of the relevant CS projects will be a key consideration in these reviews, in order to ensure an effective and appropriate transition from CS to CS2;	Yes. All Launch Reviews held and passed – albeit some with an iterative process in order to refine the programme's demonstrator definitions.
To refine the Technology Roadmaps as elaborated in each of the sections of the CS2 Joint Technical Proposal related to the IADPs, ITDs and TAs, including where necessary a review and revision of content and priorities (for instance as a consequence of the review of former "Level 2" projects);	Yes. It should be noted the refinement of the Technology Roadmaps is ongoing and is a continuous process, captured through the update of the CS2 Development Plan. The next update of this will be in July 2017 and will constitute the first plan taking the membership accession into consideration across all Calls for Core Partners.
To implement solutions for leveraging Clean Sky 2 funding with Structural Funds;	Yes. 12 MoUs are signed as of December 2016, and already in five cases an ESIF funded project is linked to and architected to create synergies with CS1 / CS2 programmes.
To implement an effective and efficient management and governance through the CS2 Management Manual;	Partially. An audit of Clean Sky 2 related calls and grant management was held in 2016, and the findings

Objective 2016	Achieved in 2016 (Yes/ No/Comments)
	[none of which were critical] have been accepted. The CS2 specificities related to H2020 processes [now stabilised] for CfP are under finalisation in accordance with the action plan agreed.
To define and implement an appropriate model for each transverse area that allows for the transversal coordination to be executed and technical synergies to be extracted;	Substantially. SAT fully implemented. TE governance principles were adopted by the Governing Board and have implemented in an operational sense since early 2016; and the required TE participants for the first upscaling will be selected through the fifth call for proposals by April 2017. For ECO the progress remains slower but the governance model through a Terms of Reference of the coordination committee is now agreed and being implemented.
To select the programme's Core Partners as planned in four Calls for Core Partners;	Substantially [>80%]. See above first two items.
To widely disseminate the information about the Calls for Proposals (for partners), in order to reach a participation from SMEs higher than 35%. To proceed with the selection of participants through these calls;	Yes [substantially]. Participation in terms of numbers of SMEs – at 37% - exceeds 35% and even in the Calls for Core Partners to date, a surprisingly high share of successful applicants is SMEs [over 40 SMEs among the 133 members]. However the financial share is lower [at 24% of funding of CfP calls to date]. But it should be noted that this percentage constitutes a doubling of funding towards SMEs when compared to Clean Sky under FP7.
To define the reference framework for the TE (including performance levels of reference aircraft against which the progress in CS2 will be monitored); and to elaborate the assessment criteria and evaluation schedule for the TE for each technical area. To launch the CS2 TE and complete the selection of its key participants; to conduct within the timeframe of the Work Plan the first TE assessment of CS2;	Substantially. The governance principles of the TE [adopted by GB decision in December 2016], have been successfully implemented in 2016. The scope of work for the TE in the continuation of assessments beyond Clean Sky and in terms of addressing the high-level objectives set in the Clean Sky 2 JU Regulation has been agreed and is being operationalised. For socio-economic impact a CfT was launched in 2016 that will deliver first results in the first half of 2017. Further impact assessment areas [both environmental, such as climate impact, and other "species" of emissions] are under discussion. Industrial Leadership and Mobility related objectives will be addressed in a next phase and the strategy determined in the TE coordination committee and proposed to the ED and GB.
To ensure a time-to-grant no greater than eight months for the Calls for Proposal;	Yes CfP02 held in 2016 had approx. 82% of the topics concluded within the TTG – above the JU's target

Objective 2016	Achieved in 2016 (Yes/ No/Comments)
	level of 80%.
To execute at least 90% of the budget and of the relevant milestones and deliverables;	No. Budget execution approached 90%, but slightly underperforming this figure when taking early estimates into consideration. It should be noted that the full / final figures will follow in the second quarter of 2017.
To ensure a high level of technical and process integrity in the execution of the programme, including the Calls and their resulting selection of CS2 participants; and a maximum relevance of research actions performed towards the programme's goals, thus ensuring a strong positive perception of the programme throughout the mid-term assessment.	Yes. Ramp up of the programme (in terms of calls launched and participants selected) has continued at a sharp pace, accelerating further when compared to 2016. The programme technical content and roadmap will stabilise by mid-2017 as over 80% of the Core Partner content is now known and the final call closing in March 2017 will allow implementation of the final membership accessions.

Clean Sky 2 Demonstrators and Technology streams

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
Large Passenger Aircraft	**Advanced Engine Design & Integration for Large Passenger Aircraft**	CROR demo engine flight test demo
		Advanced engine integration driven fuselage ground demonstrator
		Validation of dynamically scaled integrated flight testing
Large Passenger Aircraft	**Advanced Laminar Flow Rig Reduction for Large Passenger Aircraft**	HLFC large-scale specimen demonstrator in flight operation
		High speed demonstrator with hybrid laminar flow control wing
Large Passenger Aircraft	**Innovative Aircraft Configuration and Operation**	Innovative Flight Operations Next generation cockpit and MTM functionalities
		Demonstration of advanced short-medium range aircraft configuration
Large Passenger Aircraft	**Innovative Cabin & Cargo Systems and Fuselage Structure Integration for Large Passenger Aircraft**	Full-scale advanced fully integrated fuselage cabin & cargo demonstrator
		Next generation lower centre-fuselage structural demonstrator
		Next generation large module fuselage structural demonstrator with fully integrated next generation cabin & cargo concepts and systems
Large Passenger Aircraft	**Next Generation Cockpit & Avionic Concepts and Functions for Large Passenger Aircraft**	Integrated systems and avionics demonstration Full 4D - flight capability; fully parameterized green trajectory capability
		Next Generation Cockpit ground demonstrator Development and validation suite for: - New MMI functions - Advanced IMAs

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
		- Networked data link and functions Fully integrated next generation avionics simulation & test lab
		Flight demonstration Next Generation Cockpit & flight operation features Coordinated with Systems and Equipment ITD
		"Pilot case" demonstration in flight Qualification and validation of next generation cockpit features sensible to a highly realistic environment
		Maintenance service operations enhancement demonstrator Demonstration of the technical and economic maturity and performance of a value and service oriented architecture and its enablers
Regional Aircraft	**Highly Efficient Low Noise Wing Design for Regional Aircraft**	Air Vehicle Technologies – Flying Test Bed#1 (FTB1) Low noise and high efficient HLD, NLF, Active LC&A, Innovative wing structure and systems
Regional Aircraft	**Innovative Passenger Cabin Design & Manufacturing for Regional Aircraft**	Full scale innovative Fuselage and passenger Cabin
Regional Aircraft	**Advanced for Regional Aircraft:** **1 Power Plant** **2. Flight Simulator** **3. Iron Bird**	WTT for Configuration of Next Generation Hi-Efficient Regional A/C with innovative configuration, advanced powerplant integration, efficient technologies insertion at A/C level
		Flight Simulator with new cockpit interaction concepts, advanced avionics functionalities (including pilot workload reduction), MTM (green functions in a global environment)
		Iron Bird with innovative systems integration, Next generation flight control systems (H/W and pilot in the loop)
Regional Aircraft	**Innovative Future Turboprop Technologies for Regional Aircraft**	High Lift Advanced Turboprop – Flying Test Bed#2 (FTB2)
Fast Rotorcraft: Tiltrotor	**Advanced Tilt Rotor Structural & Aero-acoustic Design**	D1: Mock-up of major airframe sections and rotor D2: Tie-down helicopter (TDH) D3: NextGenCTR flight demonstrator (ground & flight)
		D4: Prop-rotor components and assembly
Fast Rotorcraft: Tiltrotor	**Advanced Tilt Rotor Aerodynamics and Flight Physics Design**	D6: NextGenCTR's fuselage assembly
		D7: NextGenCTR's wing assembly
		D8: Engine-airframe physical integration D9: Fuel system components
Fast Rotorcraft: Tiltrotor	**Advanced Tilt Rotor Energy Management System Architectures**	D5: NextGenCTR's drive system components and assembly
		D10: intelligent electrical power system and ancillary/

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
		auxiliary components D11: Flight control & actuation systems and components
Fast Rotorcraft: Tiltrotor	**Tiltrotor Flight Demonstrator**	Tiltrotor Flight Demonstrator
Fast Rotorcraft: Compound R/C	**Innovative Compound Rotorcraft Airframe Design**	Airframe structure & landing system *NB: Wing and tail addressed in Airframe ITD dedicated WPs (1.8, 1.11)* To include: – advanced composite or hybrid metallic/composite structure using latest design and production techniques – Specific landing system architecture & kinematics
Fast Rotorcraft: Compound R/C	**Innovative Compound Rotorcraft Power Plant Design**	Lifting Rotor & Propellers Integrated design of hub cap, blades sleeves, pylon fairings, optimised for drag reduction; Rotor blade design for combined hover-high speed flight envelope and variable RPM; Propeller design optimised for best dual function trade-off (yaw control, propulsion)
		Drive train & Power Plant Engine installation optimised for power loss reduction, low weight, low aerodynamic drag, all weather operation; New mechanical architecture for high speed shafts, Main Gear Box input gears, lateral shafts, Propeller Gear boxes, optimised for high torque capability, long life, low weight. REACH-compliant materials and surface treatments
Fast Rotorcraft: Compound R/C	**Innovative Compound Rotorcraft Avionics, Utilities & Flight Control Systems**	On board energy, cabin & mission systems Implementation of innovative electrical generation & conversion, high voltage network, optimized for efficiency & low weight; advanced cabin insulation & ECS for acoustic and thermal comfort
		Flight Control, Guidance & Navigation Systems Smart flight control exploiting additional control degrees of freedom for best vehicle aerodynamic efficiency and for noise impact reduction
Fast Rotorcraft: Compound R/C	**LifeRCraft Flight Demonstrator**	LifeRCraft Flight Demonstrator Integration of all technologies on a unique large scale flight demonstrator, success & compliance with objectives validated through extensive range of ground & flight tests
Airframe	**High Performance and Energy Efficiency**	Innovative Aircraft Architecture Noise shielding, noise reduction, Overall Aircraft Design (OAD) optimisation, efficient air inlet, CROR integration, new certification process, advanced modeling
		Advanced Laminarity Laminar nacelle, flow control for engine pylons, NLF,

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
		advanced CFD, aerodynamic flow control, manufacturing and assembly technologies, accurate transition modelling, optimum shape design, HLF
		High Speed Airframe Composites (D&M), steering, wing / fuselage integration, Gust Load Alleviation, flutter control, innovative shape and structure for fuselage and cockpit, eco-efficient materials and processes
		Novel Control Gust Load Alleviation, flutter control, morphing, smart mechanism, mechanical structure, actuation, control algorithm
		Novel Travel Experience Ergonomics, cabin noise reduction, seats & crash protection, eco-friendly materials, human centred design, light weight furniture, smart galley
Airframe	**High Versatility and Cost Efficiency**	Next Generation Optimised Wing Box Composite (D&M), out of autoclave process, modern thermoplastics, wing aero-shape optimisation, morphing, advanced coatings, flow and load control, low cost and high rate production
		Optimised High Lift Configurations Turboprop integration on high wing, optimised nacelle shape, high integration of Tprop nacelle (composite/metallic), high lift wing devices, active load protection
		Advanced Integrated Structures Highly integrated cockpit structure (composite metallic, multifunctional materials), all electrical wing, electrical anti-ice for nacelle, integration of systems in nacelle, materials and manufacturing process, affordable small aircraft manufacturing, small a/c systems integration
		Advanced Fuselage Rotor-less tail for fast r/c (CFD optimisation, flow control, structural design), pressurised fuselage for fast r/c, more affordable composite fuselage, affordable and low weight cabin
Engines	**Innovative Open Rotor Engine Configurations**	Open Rotor Flight Test Ground test and flight test of a Geared Open Rotor demonstrator: - Studies and design of engine and control system update and modifications for final flight test - Manufacturing, procurement and engine assembly for ground test checking before flight Following flight tests planned in LPA IADP and test results analysis

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
Engines	**Innovative High Bypass Ratio Engine Configurations I : UHPE Concept for Short/Medium Range aircraft (Safran)**	UHPE demonstrator
Engines	**Business Aviation/Short Range Regional Turboprop Demonstrator**	Business aviation/short range regional Turboprop Demonstrator Design, development and ground testing of a new turboprop engine demonstrator for business aviation and short range regional application
Engines	**Advanced Geared Engine Configuration**	Advanced Geared Engine Configuration (HPC and LPT technology demonstration) Design, development and ground testing of an advanced geared engine demonstrator: improvement of the thermodynamic cycle efficiency and noise reduction
Engines	**Innovative High Bypass Ratio Engine Configurations II: VHBR Middle of Market Turbofan Technology (Rolls-Royce)**	VHBR Middle of Market Turbofan Technology Design, development and ground testing of a VHBR Middle of Market Turbofan
Engines	**Innovative High Bypass Ratio Engine Configurations III: VHBR engine demonstrator for the large engine market (Rolls-Royce)**	VHBR engine demonstrator for the large engine market Design, development and ground testing of a large VHBR engine demonstrator
Engines	**Small Aircraft Engine Demonstrator**	Small Aircraft Engine Demonstrators - reliable and more efficient operation of small turbine engines - light weight and fuel efficient diesel engines
Systems	**Integrated Cockpit Environment for New Functions & Operations**	Extended Cockpit Demonstrations for: – Flight Management evolutions: green technologies, SESAR, NextGen, interactive FM – Advanced functions: communications, surveillance, systems management, mission management – Cockpit Display Systems: new cockpit, HMI, EVO, etc. – IMA platform and networks

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
Systems	**Innovative and Integrated Electrical Wing Architecture and Components**	Innovative Electrical Wing Demonstrator (including ice protection) for: - New actuation architectures and concepts for new wing concepts - High integration of actuators into wing structure and EWIS constraints - Inertial sensors, drive & control electronics - New sensors concepts - Health monitoring functions, DOP - WIPS concepts for new wing architectures - Shared Power electronics and electrical power management
		Optimisation of ice protection technologies and control strategy
Systems	**Innovative Technologies and Optimised Architecture for Landing Gears**	Advanced systems for nose and main landing gears applications for: - Wing Gear and Body Gear configurations - Health Monitoring - Optimised cooling technologies for brakes - Green taxiing - Full electrical landing gear system for NLG and MLG applications - EHA and EMA technologies - Electro-Hydraulic Power Packs - Remote Electronics, shared PE modules - Innovative Drive & Control Electronics
Systems	**High Power Electrical and Conversion Architectures**	Non propulsive energy generation for: - AC and DC electrical power generation - AC and DC electrical power conversion - SG design for high availability of electrical network Integrated motor technologies, with high speed rotation and high temperature material Equipment and Systems for new aircraft generations
Systems	**Innovative Energy Management Systems Architectures**	Innovative power distribution systems, (including power management) for: - Electrical Power Centre for Large Aircraft – load management and trans-ATA optimisation - High integrated power centre for bizjet aircraft (multi ATA load management, power distribution and motor control) - Smart grid, develop & integrate breakthrough components to create a decentralised smart grid, partly in non-pressurised zone. - Electrical Power Centre – load management optimisation Health Monitoring, DOP compliant

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
Systems	**Innovative Technologies for Environmental Control System**	Next Generation EECS, Thermal management and cabin comfort for: - New generation of EECS including a global trans ATA capable to answer to the needs of load management, inerting systems, thermal management, air quality & cabin comfort - Development / optimisation of Regional A/C EECS components for full scale performance demonstration - New generation of cooling systems for additional needs of cooling
Systems	**Advanced Demonstrations Platform Design & Integration**	- Demonstration Platform – PROVEN, GETI & COPPER Bird® - To mature technologies, concepts and architectures developed in Clean Sky 2 or from other R&T programmes and integrated in Clean Sky 2 - For optimisation and validation of the thermal and electrical management between the main electrical consumers
Systems	**Small Air Transport (SAT) Innovative Systems Solutions**	Small Air Transport (SAT) Activities - Efficient operation of small aircraft with affordable health monitoring systems - More electric/electronic technologies for small aircraft - Fly-by-wire architecture for small aircraft - Affordable SESAR operation, modern cockpit and avionic solutions for small a/c - Comfortable and safe cabin for small aircraft *Note: budget has been identified for specific SAT work inside Systems. However, synergies with main demonstrators and specific work still have to be worked upon*
Systems	**Eco-Design**	Eco- Design activities Refers to Eco-Design chapter
Technology Evaluator (TE)	**A systematic overall approach to the TE process and monitoring activity**	- Progress Monitoring of *Clean Sky 2* achievements - Evaluation at Mission Level of particular ITD outputs - Impact Assessments at Airport and ATS Level
Eco-Design Transverse Activity	**An overall innovative approach and "agenda" for Eco-Design activity in the CS2 Programme**	Eco-Design activities are embedded in all IADPs and ITDs. They are detailed in Chapter 13. Thus, a dedicated funding for Eco-Design is reserved inside each IADP's and ITD's funding. The co-ordination of all Eco-Design activities will be established in the Airframe ITD. The list of technology areas and "story boards" and demonstrators will be established during the 2014-15

ITD/IADP	Technology Areas	Demonstrator / Technology Stream
		period.
Small Air Transport (SAT) Transverse Activity	**An overall innovative approach and "agenda" for Small Air Transport activity in the CS2 Programme**	Small Air Transport (SAT) activities are part of Airframe, Engines (WP7) and Systems ITDs and are detailed in Chapter 14. The co-ordination of all SAT activities will be established in the Airframe ITD. The planned demonstrators are included in the above descriptions of the Airframe, Engines and Systems ITDs.
LEGEND		
IADP/ITD/TA	***Technology Area***	***Demonstrator / Technology Stream*** *Text highlighted as indicated relates to demonstrators foreseen within the CS2 Programme for which an ex-ante Technical Evaluation by independent experts is still required. As such they are noted here as conditional - subject to a successful evaluation.*

Environmental forecast

The table below shows the environmental targets of the Clean Sky 2 programme as defined in the Joint Technical Proposal.

	Clean Sky 2 as proposed*
CO_2 and Fuel Burn	-20% to -30% (2025 / 2035)
NO_X	-20% to -40% (2025 / 2035)
Population exposed to noise / Noise footprint impact	Up to -75% (2035)

* Baseline for these figures is best available performance in 2014

These figures represent the additionality of CS2 versus the 2014 Horizon 2020 start date and allow the full completion of the original ACARE 2020 goals (with a modest delay)

Indicators

The Key Performance Indicators results for 2016 are presented in Annexes 5 to 7.

Administrative Objectives - achievement

Objective 2016	Achieved in 2016 (Yes/No/Comments)
A reliable financial management and reporting to the JU's individual stakeholders is ensured, in order to maintain the confidence of the financing parties, i.e. the European Union and the industrial members and partners of CS;	Yes. The JU has implemented various tools to monitor the execution of the programme in terms of productivity, achievements, planning and risks of the operations.
90% of GAM cost claims received are formally dealt with (validated, put on hold or refused) before end of May each year;	Yes. 100%.
100% of FP7 GAPs are formally closed by December 2016;	No. By end of December 2016, 84.9% of the GAPs were formally closed (i.e. 409 out of a total of 482 FP7 projects). *Note: The JU foresees to close all remaining GAPs by May 2017. The contingency plan put forward by the JU is to re-allocate all remaining funds (after concluding the technical and formal closure of the GAPs) to the GAM's activities which have been*

Objective 2016	Achieved in 2016 (Yes/No/Comments)
	performed during 2017 (besides the nominal GAM budget). The formal closure of GAMs, and therefore of the Clean Sky programme, is foreseen to be achieved by July 2017.
The ex-post audits on FP7 projects are performed according to the plan and show a materiality of errors lower than 2% for the total programme period. The ex-post audit strategy for H2020 projects is developed and responsibilities are allocated to the CAS and the JU.	Yes.

In accordance with the JU's procedures for planning and reporting of in-kind contributions of the private members, the Governing Board was able to adopt the additional activities plans for both 2016 and 2017.

The reporting on the 2016 plan took place using estimated data in early January 2017. Based on the information received, the reported value of the in-kind contributions arising from the operational activities (i.e. within the work plan and funded by the JU) is €131.57 million. Meanwhile the reported value of the in-kind contributions arising from the additional activities is €351.77 million. Further details and current ratio between the union funding and the private members contributions are given in section 1.10.

1.2. Research & Innovation activities

The Clean Sky 2 Joint Undertaking aims to contribute to improving the environmental impact of aeronautical technologies, including those relating to small aviation, as well as to developing a strong and globally competitive aeronautical industry and supply chain in Europe. These goals will contribute to the finalisation of research activities initiated under Regulation (EC) No 71/2008 and will support the implementation of Regulation (EU) No 1291/2013, and as such address the Smart, Green and Integrated Transport Challenge under H2020. The JU will accomplish this through the research and innovation efforts brought to work towards these goals by its private members and other participants, in particular through the integration of advanced technologies and validation through full scale demonstrators. The activity covers all main flying segments of the Air Transport System and the associated underlying technologies identified in the Strategic Research and Innovation Agenda [SRIA] for Aeronautics developed by the Advisory Council for Aviation Research in Europe [ACARE].

The Clean Sky programme today clearly demonstrates the benefits of a true PPP. After eight years of operations, the technical programme is mostly completed and the environmental performance improvements as targeted at the start have been consolidated. Stakeholder participation is at a high level, including SMEs (often their first participation in the European framework programme) and research centres and academia. Industry is increasingly using Clean Sky as the focus of their R&T programmes because of the flexibility in timing and content, and the JU has proven to be an efficient management body.

Clean Sky 2 programme is building on the success of the first Clean Sky programme and will deliver vital full-scale in-flight demonstration of novel architectures and configurations. Advanced technology inserted and demonstrated at full systems level will enable step-changes in environmental and economic performance and bring crucial competitiveness benefits to European industry. Beyond this necessary extension and continuation of Clean Sky, finishing the journey towards the original goals set by ACARE for 2020, vital steps will be made towards the more far-reaching and ambitious goals in the SRIA for 2050. This will enable the European Aviation Sector to satisfy society's needs for sustainable, competitive mobility towards 2050. As such, Clean Sky 2 will create high-skilled jobs, increase transport efficiency, sustain economic prosperity and drive environmental improvements in the global air transport system.

The Clean Sky 2 JU engages the best talent and resources in Europe and is jointly funded and governed by the European Commission and the major European aeronautics companies. It utilises the key skills and knowledge of the leading European aeronautic research establishments and academic faculties. Small and medium-size enterprises and innovative sub-sector leaders will help shape promising new supply chains.

Clean Sky Programme

The first Clean Sky Programme is built upon 6 different technical areas called Integrated Technology Demonstrators (ITDs), where preliminary studies and down-selection of work will be performed, followed by large-scale demonstrations on ground or in-flight, in order to bring innovative technologies to a maturity level where they can be applicable to new generation "green aircraft". Multiple links for coherence and data exchange will be ensured between the various ITDs.

The ITDs are:

- The Smart Fixed Wing Aircraft ITD (SFWA) focuses on active wing technologies that sense the airflow and adapt their shape as required, as well as on new aircraft configurations to optimally incorporate these novel wing concepts.
- The Green Regional Aircraft ITD (GRA) focuses on low-weight configurations and technologies using smart structures, low-noise configurations and the integration of technology developed in other ITDs, such as engines, energy management and mission and trajectory management.
- The Green Rotorcraft ITD (GRC) focuses on innovative rotor blades and engine installation for noise reduction, lower airframe drag, diesel engine and electrical systems for fuel consumption reduction and environmentally friendly flight paths.
- The Sustainable and Green Engine ITD (SAGE) integrates technologies for low noise and lightweight low pressure systems, high efficiency, low NOx and low weight core, novel configurations such as open rotors or intercoolers.
- The Systems for Green Operations ITD (SGO) focuses on all-electric aircraft equipment and systems architectures, thermal management, capabilities for "green" trajectories and mission and improved ground operations.
- The Eco-Design ITD (ED) addresses the full life cycle of materials and components, focusing on issues such as optimal use of raw materials, decreasing the use of non-renewable materials, natural resources, energy, and the emission of noxious effluents and recycling.

A Technology Evaluator is the Europe's first complete integrated tool delivering direct relationship between advanced technologies which are being developed and high-level local or global environment impact. It considers inputs from both inside and outside the Clean Sky perimeter to deliver environmental metrics and the levels of aircraft, airport and aircraft fleet level.

To integrate flight management aspects, the Clean Sky has established links with the SESAR Joint Undertaking which investigates Air Traffic Management (ATM) technologies in line with the Single European Sky initiative of the European Commission. These links are established via the Technology Evaluator, as well as via the SGO ITD that develops the avionics equipment interfacing with ATM, and via management meetings involving the relevant staff members of the two JUs (i.e. the SGO Project Officer from Clean Sky, and the two Executive Directors).
In Annex 11, a detailed description of activities and achievements by ITD and TE is provided,

with indications and explanations of significant deviations compared with initial planning, where applicable.

General information

In 2016 the Coordinating Project Officer (CPO) continued with the monitoring of the activities at overall ITD level.

The ITD Coordination meetings took place about quarterly; the dates in 2016 were: 10 March, 5 May, 13 July in London and 9 November. The standard agenda included the status of GAMs and GAPs, the evolution of budget, the preparation and feedback from the GB meetings (specifically the progress status presentations based on the ITD inputs, checked by POs and integrated by the CPO); the dissemination aspects, including discussion about IPR issues; the role and contributions from ITDs in the communication events (in 2016 it was the Farnborough Air Show and the Greener Aviation conference in October, in Brussels).

In all GB meetings (except at the last one in December) the CPO delivered a progress status of technical progress of activities in all ITDs, as a support to the Executive Director for the overall assessment of the CS programme.

In 2016 the JU attended together with the Project Officers most of the ITD Interim Progress Reviews (IPRs) and then the Final Reviews (FR) in December (missing only those in December, namely SFWA, SGO and SAGE).

- ECO FR: 5-7 April 2016 at Dassault
- TE FR: 20-21 September in Brussels
- GRC IPR: 9 June 2016 in Lublin (Poland); FR: 4-6 October 2016 in Somma Lombardo
- GRA IPR: 24 May 2016 in Pomigliano; FR: 15-17 November 2016 in Pomigliano
- SFWA IPR: 20-21 April 2016 in Bucharest; FR: 30 November-2 December 2016 in Toulouse and Tarbes
- SGO IPR: 12 April 2016 in Hamburg; FR: 6-8 December 2016 in Toulouse
- SAGE IPR: 10 May 2016 in Brussels; FR: 12-15 December 2016 in Paris

The JU staff, in particular the CPO, also attended several events delivering presentations about Clean Sky, thus contributing to the dissemination of results. The events are listed below:

Participation to external (and internal) events and delivery of presentations on Clean Sky in 2016:

- EASN Breakfast at EP and DG-RTD (16 February)
- CS General Forum, with Award to Best GAP projects (4 April)
- EASA OPTICS conference in Cologne (12-14 April)
- FEAMA Conference in Cologne (18 May)
- ILA Airshow, best PhD Award, SunJet workshop, Berlin (1-2 June)
- GeT FuTuRe workshop, Pisa, (15-16 June)
- A320 Flight Test e-FTD, Toulouse (23 June)
- Farnborough Air Show (11-15 July)

- RAeS Aerodynamic Conference, Bristol (21-22 July)
- EASA Additive Manufacturing workshop, Cologne (28-29 September)
- Greener Aviation Conference, Brussels (11-13 October)
- EASN Workshop, Porto (18-21 October)
- AirTec: Munich (26-28 October)

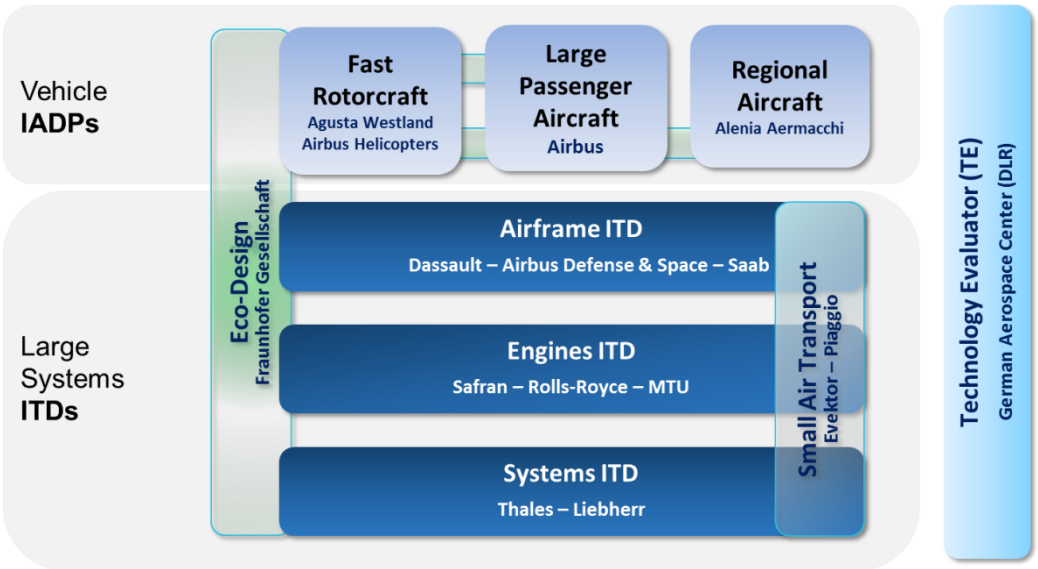
The follow-up of the workshops with EASA in 2016 resulted in the signature of a Memorandum of Cooperation in November 2016.

The links with the SESAR JU are being reinforced, via joint workshops and technical meetings held in 2016. A dedicated session about SESAR was included in the Technology Evaluator Final review in October 2016.

Clean Sky 2 Programme

Research and innovation actions delivering important technological advances started in Clean Sky are extended and continued in Clean Sky 2. New architectures, such as hybrid-electric propulsion and new vehicle configurations addressing unmet mobility needs, will be evaluated with flight demonstrators. They will be essential in order to fulfil the ambitious objectives of the renewed ACARE SRIA. Conventional aircraft configurations are approaching intrinsic performance limits, as the integration of the most recent technologies are showing diminishing returns. Therefore, the need is even greater today for industry to develop materially different, substantially more environmentally-friendly and energy efficient vehicles to meet market needs, and ensure their efficient integration in the air transport system.

Clean Sky 2 will continue to use the Integrated Technology Demonstrators (ITDs) mechanism. Its objective-driven agenda to support real market requirements providing the necessary flexibility is well suited to the needs of the major integrator companies. The new programme will also focus on reinforcing interactions between demonstrations of improved systems for a better integration into viable full vehicle architectures. The Clean Sky 2 structure involves demonstrations and simulations of several systems jointly at the full vehicle level through Innovative Aircraft Demonstrator Platforms (IADPs).
A number of key areas are coordinated across the ITDs and IADPs through Transverse Activities (TAs) where additional benefit can be brought to the programme through increased coherence, common tools and methods, and shared know-how in areas of common interest.
As in Clean Sky, a dedicated monitoring function - the Technology Evaluator (TE) - is a key function incorporated into Clean Sky 2.



Clean Sky Programme Logic and Set-up

Introduction to the IADP, ITD and TAs

Innovative Aircraft Demonstrator Platforms (IADPs) aim to carry out proof of aircraft systems, design and functions on fully representative innovative aircraft configurations in an integrated environment and close to real operational conditions. To simulate and test the interaction and impact of the various systems in the different aircraft types, the vehicle demonstration platforms cover passenger aircraft, regional aircraft and rotorcraft. The choice of demonstration platforms is geared to the most promising and appropriate market opportunities to ensure the best and most rapid exploitation of the results of Clean Sky 2. The IADP approach can uniquely provide:

- Focused, long-term commitment of project partners;
- An "integrated" approach to R&T activities and interactions among the partners;
- Stable, long-term funding and budget allocation;
- Flexibility to address topics through open Call for Proposals;
- Feedback to ITDs on experiences, challenges and barriers to be resolved longer term;
- A long-term view on innovation and appropriate solutions for a wide range of issues.

Three IADPs are defined in the CS2 programme:

- Large Passenger Aircraft [LPA] covering large commercial aircraft applications for short/medium and long range air transport needs;
- Regional Aircraft [REG] focusing on the next generation of approx. 90-seat capacity regional turboprop powered aircraft enabling high efficiency/reliability regional connections;
- Fast Rotorcraft [FRC] aiming at two new configurations of rotorcraft bridging the gap between conventional helicopters and utility/commuter fixed wing aircraft, both in speed and range/productivity.

In addition to the complex vehicle configurations, Integrated Technology Demonstrators (ITDs) will accommodate the main relevant technology streams for all air vehicle applications. They allow verified and validated technologies to be matured from their basic levels to the integration of entire functional systems. These technologies have the ability to cover quite a wide range of technology readiness levels. Each of the three ITDs covers a set of technology developments that will be brought from component level maturity up to the demonstration of overall performance at systems level, to support innovative flight vehicle configurations:

- Airframe ITD [AIR] including topics affecting the global vehicle-level design;
- Engines ITD [ENG] for all propulsion and power plant solutions;
- Systems ITD [SYS] covering all on-board systems, equipment and the interaction with the Air Transport System.

The Transverse Activities [TAs] enabled important synergies to be realised where common challenges exist across IADPs and/or ITDs, or where coordination across the IADPs and ITDs allows a cogent and coherent approach to joint and shared technical and research priorities. TAs do not form a separate IADP or ITD in themselves, but coordinate and synergise technical activity that resides as an integral part of the other IADPs and ITDs. A dedicated budget was

reserved inside the relevant IADPs and ITDs to perform these activities. TAs Leaders were nominated and coordinated each Transverse Activity. Currently, two Transverse Activities were agreed for the Clean Sky 2 programme and are specified in the Statutes of the JU:

- Eco-Design TA [ECO]: Key materials, processes and resources related innovations considering the life cycle optimisation of technologies, components and vehicles; and continuing and securing advances from Clean Sky Programme;
- Small Air Transport TA [SAT]: airframe, engines and systems technologies for small aircraft, extracting synergies where feasible with the other segments.

The technology and impact evaluation infrastructure is an essential element within Clean Sky. Impact assessments at airport and ATS level currently focused on noise and emissions will be expanded where relevant for the evaluation of the programme's delivered value. Where applicable they can include the other impacts, such as the mobility or increased productivity benefits of Clean Sky 2 concepts. The TE will also perform evaluations at an aircraft "Mission Level" to assess innovative long-term aircraft configurations.

1.3. Calls for proposals and grant information

Calls launched

In the 2016 reporting period all call-related activity was related to the Clean Sky 2 programme. The activities related to these calls [and results, where available] are reported below.

General background

Up to 40% of Clean Sky 2's available funding is allocated to its 16 Leaders and their Affiliates in the Leaders' share of the EU funding, as set out in Article 16 of the Clean Sky 2 JU Statutes. The remaining funding of at least 60% will, in accordance with Article 16 of the Clean Sky 2 JU Statutes, be awarded through competitive calls: Calls for Core Partners [Members] also referred to as the Core Partner Waves [CPW], Calls for Proposals [CfP], and where and if applicable Calls for Tender [CfT]. The amount involved in this 60% is just over €1 billion, making it alone over 25% greater than the total budget of the first Clean Sky programme and over five times the €200 million of call funding volume executed in the first Clean Sky programme under FP7. Up to 30% of the programme's funding is available for Core Partners and at least 30% will be awarded via Calls for Proposals and Calls for Tenders. Industry, SMEs, Research Organisations [ROs] and Academia are all eligible.

The roles and status of Core Partners and Partners in the Clean Sky 2 programme differ significantly. Core Partners are Members of the Joint Undertaking in the meaning of the Clean Sky 2 Regulation and are expected to make long-term commitments and contribute to the implementation of the programme over its lifetime. They are expected to bring key competences and technical contributions aligned to the programme's high-level objectives. They also contribute to the global management of the demonstrators and as such also to the activities of Partners selected via our Calls for Proposals. They make significant in-kind contributions to the programme, as set out in the Regulation. In terms of the selection process, Core Partners are selected by the Joint Undertaking via specific calls named "Calls for Core Partners." Once selected by the Joint Undertaking and accepted for membership by the Governing Board following a technical negotiation stage, Core Partners join the Grant Agreements for Members and become part of the ITD/IADP Steering Committees or TAs' Coordination Committees, contributing to its governance. Core Partners are also represented at Governing Board level via a process of co-opting and rotation at ITD/IADP level.

Conversely, Partners are awarded grants by the Joint Undertaking via Calls for Proposals [CfP]. Once selected, they are invited to perform activities in specific projects within a well-defined and more limited scope and commitment than Core Partners, via dedicated Grant Agreements for Partners. Partners' activities are monitored and managed by the JU in close collaboration with so-called Topic Managers appointed by the Members [Leaders or Core Partners], hence ensuring the alignment of actions and the convergence of technical activity towards the programme's goals.

One key difference between the Clean Sky 2 JU calls and standard H2020 calls is that there is no eligibility requirement to build a consortium with a minimum number of participants or

representing a minimum number of Member States or H2020 Associated Countries. This is based on a derogation received from the H2020 Rules for Participation, and is due to the fact that a selected entity, when starting an action in the programme, is joining an already established European level collaborative effort involving a large number and varied set of participants.

With these two call mechanisms and the related breadth of the call topics and technical scope, the CS2 programme provides opportunities for the vast bulk of the aeronautics stakeholders in the European Research Area and also allows space for newcomers, including important opportunities for "cross-over" participants from outside the sector. Getting capable new firms involved in the aeronautics sector can make an important contribution to the competitiveness of the sector and to the European economy.

Noting that there are roughly 600 participants in the original Clean Sky Programme, and that the first two full years of operations and related calls in CS2 have already led to approximately 400 participants, we expect 800 to 1000 in total over the life of the Clean Sky 2 programme. That is a strong evidence of a dynamic and open system operating in the JU and with all stakeholders.

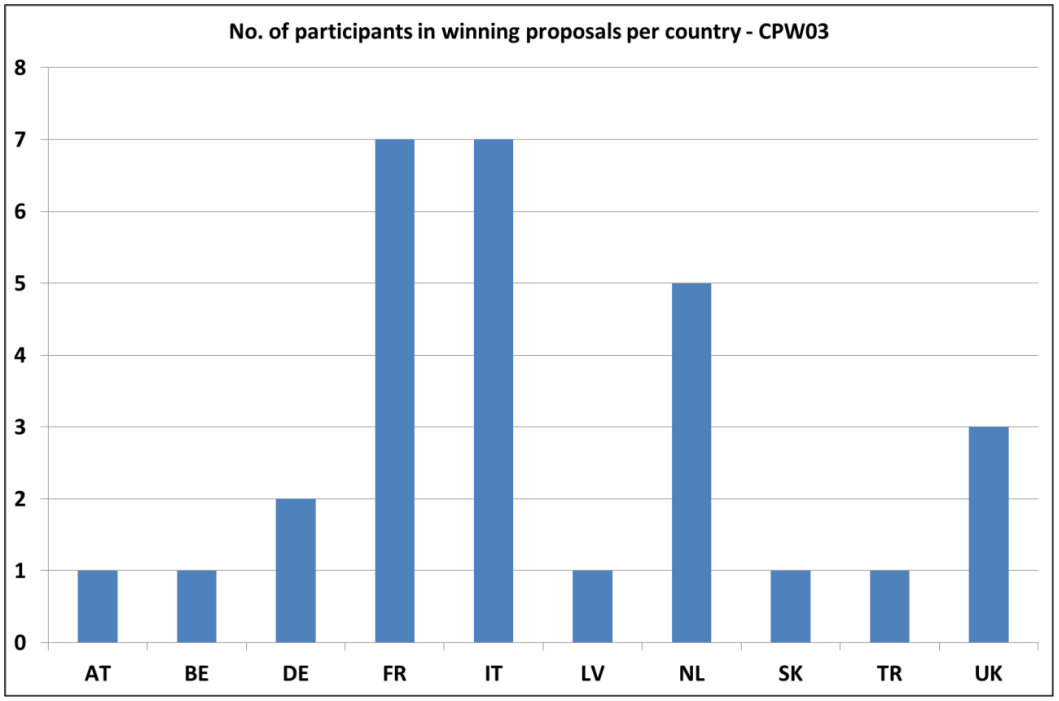
Summary of call results to date – Calls for Core Partners

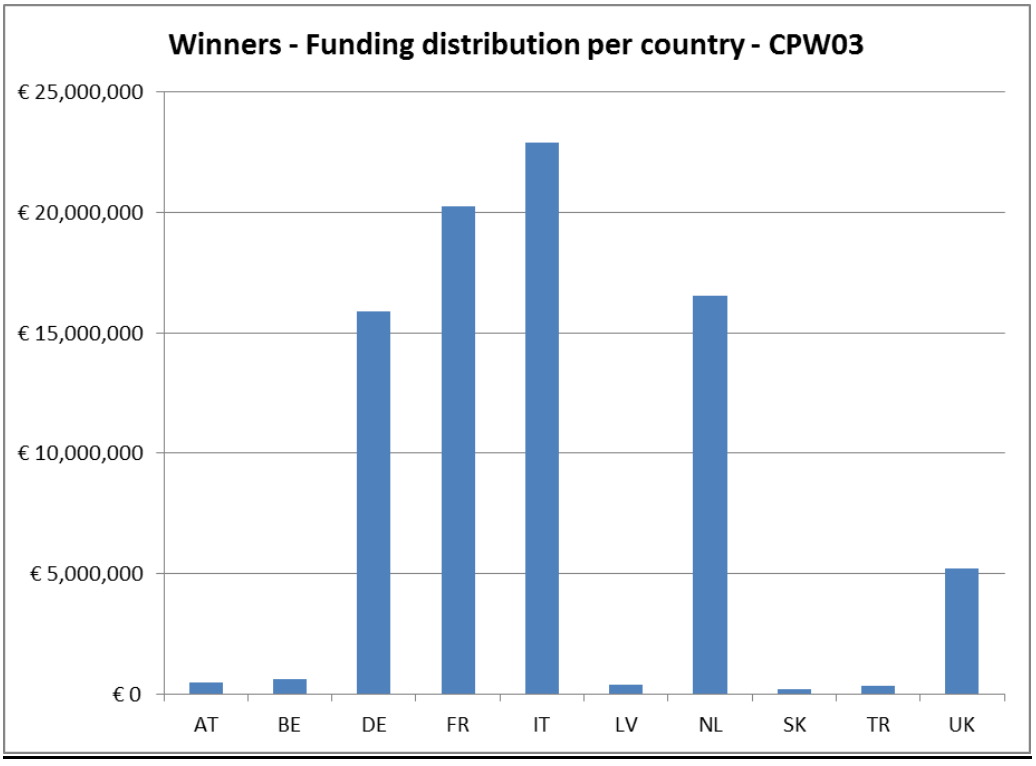
In 2016, the last of the four Core Partner calls foreseen for the programme was launched. The first two calls launched in 2015 have been implemented. The implementation of the third Call for Core Partners with 13 new Core Partners is close to completion. The negotiations for only two proposals are currently on hold due to on-going strategic discussions on the alignment of the project activities within the overall Grant Agreement for Members. The conclusion of the negotiations and hence, the final results of the call are expected by Q1 2017:

- 17 successful topics out of 22 topics published (77% success rate)
- €82.7 million of funding requested
- 13 new Members from 8 different countries
- SME participation: 21%

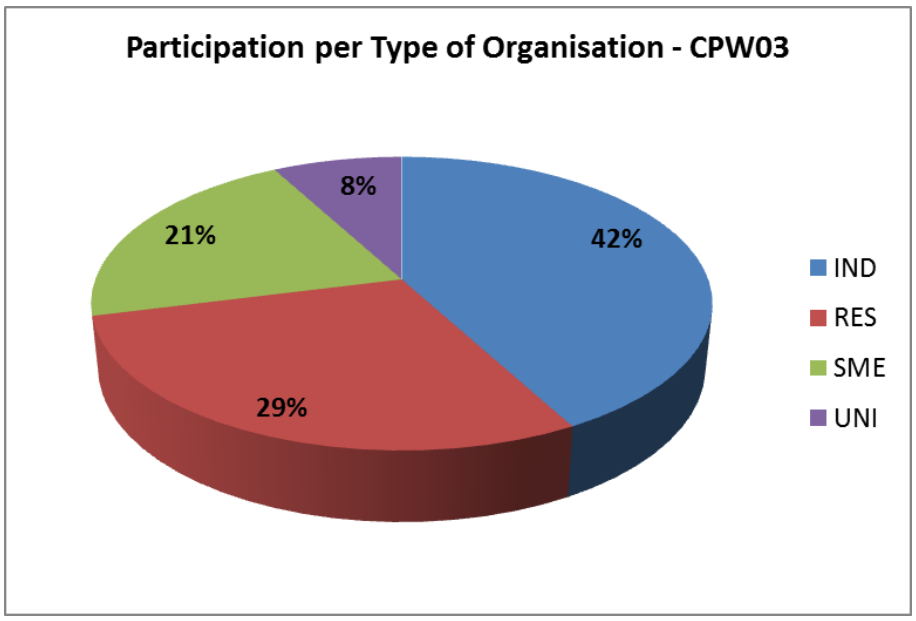
The outcome of the 3rd Call is summarised in the table and graphs here below:

Area	# Topics launched	Funding [topic ind. value m€]	# Topics failed – no proposals	# Topics failed – no proposals retained	# Topics with a proposal retained	Total requested funding m€
IADP Large Passenger Aircraft [LPA]	3	12.0	0	0	3	13.5
IADP Regional Aircraft [REG]	0	0	0	0	0	0
IADP Fast Rotorcraft [FRC]	5	25.0	1	0	4	22.7
ITD Airframe [AIR]	4	15.5	0	2	2	10.1
ITD Engines [ENG]	4	16.5	1	0	3	14.0
ITD Systems [SYS]	6	26.9	0	1	5	22.4
Small Air Transport Transverse Area [SAT]	0	0	0	0	0	0
Eco-Design Transverse Area [ECO]	0	0	0	0	0	0
Technology Evaluator	0	0	0	0	0	0
TOTAL	**22**	**95.9**	**2**	**3**	**17**	**82.7**


No. of participants in winning proposals per country - CPW03
8
7
6
5
4
3
2
1
0
AT
BE
DE
FR
IT
LV
NL
SK
TR
UK

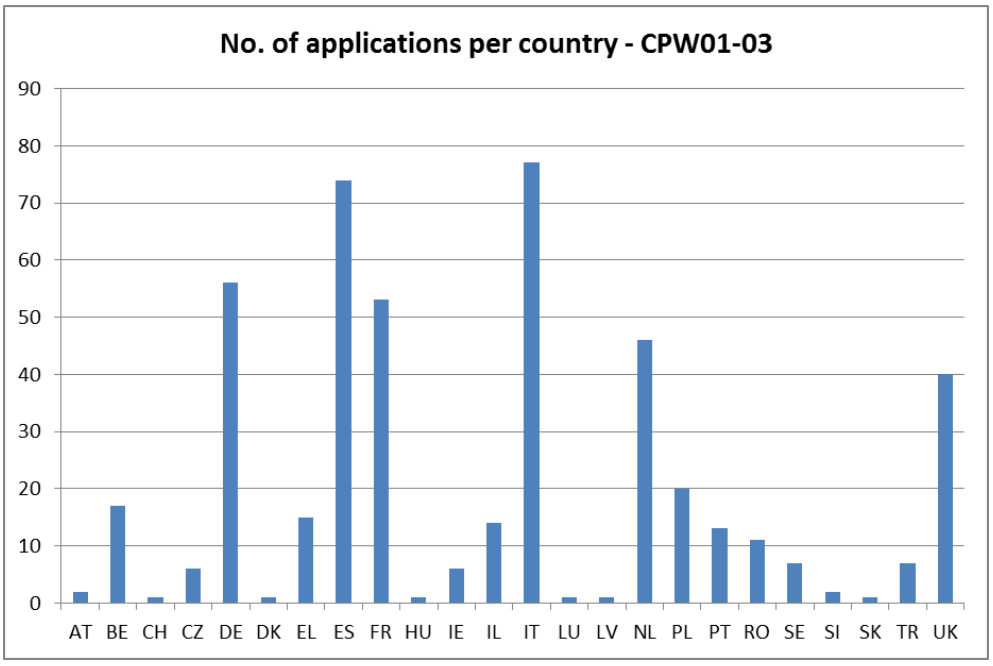

Winners - Funding distribution per country - CPW03
€ 25,000,000
€ 20,000,000
€ 15,000,000
€ 10,000,000
€ 5,000,000
€ 0
AT
BE
DE
FR
IT
LV
NL
SK
TR
UK

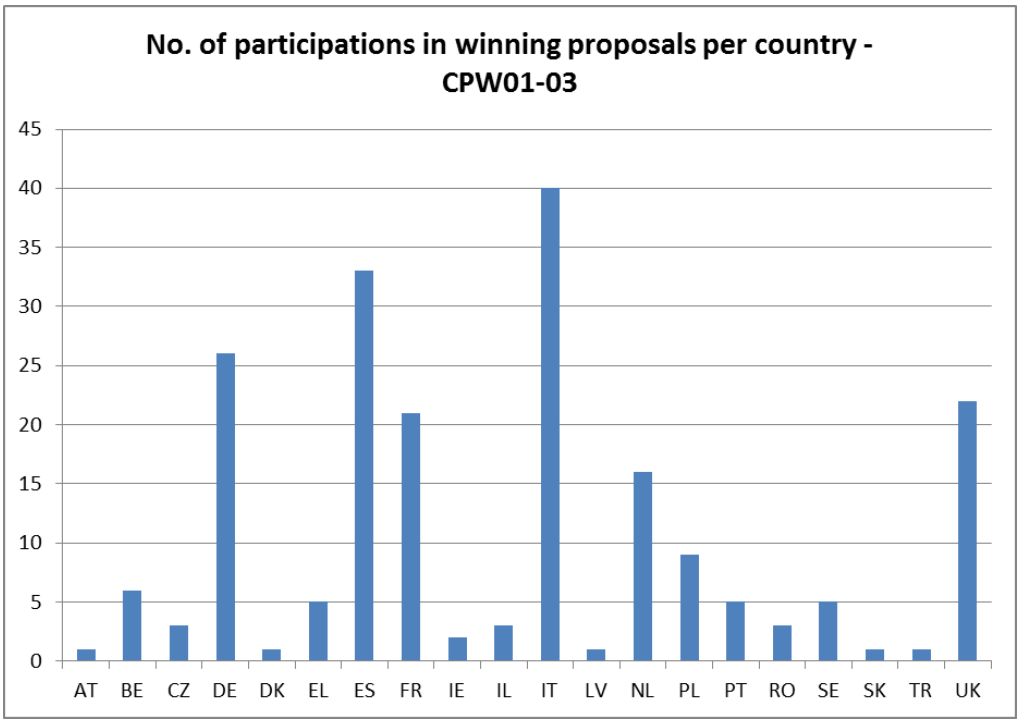
SMEs make up 21% of the participations (8 out of 38 participations in total), which is slightly lower than in the second Call for Core Partners, but for a Call for Core Partners this is again a significant participation and success for SMEs.



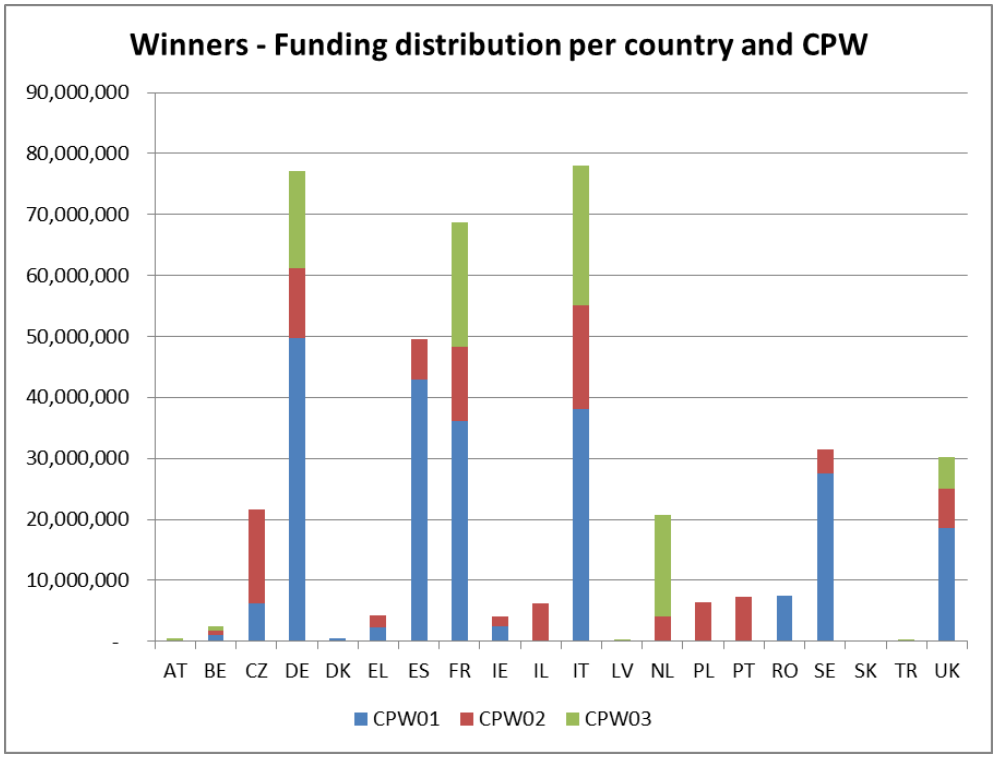
Alongside the Leaders [16 in total] those Calls for Core Partners have led to 133 Members from 20 different Member States and H2020 Associated Countries joining the Clean Sky 2 programme activities.

The cumulative results of the first three calls for Core Partners in terms of geographical distribution and typology of the winning applicants are shown below.





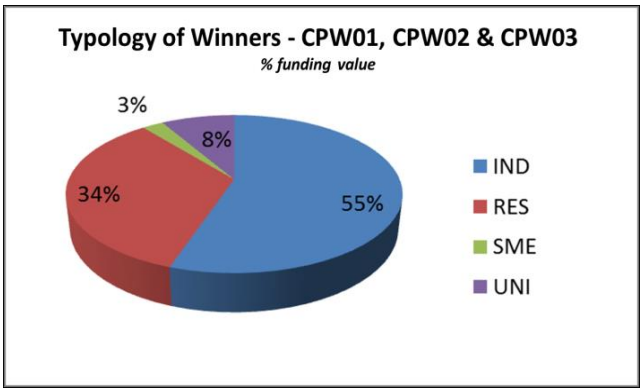
With 20 countries represented in the winning proposals' consortia, out of a total of 24 countries represented in all applications in the three calls [cumulative], the results show a good level and geographic breadth of participation. The forecast funding distribution per country and call is shown in the graphic below.

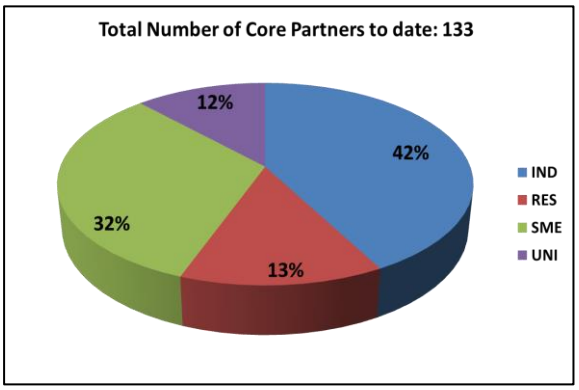


Notes:

1. All figures represent "through-to-completion" or lifetime funding estimates;

2. Allocation of foreseen funding is on the basis of the applicants' submissions of each legal entity and participant in the proposal and its geographic footprint; some differences may occur as a consequence of linked third parties' shares and amendments in the execution leading to a rebalancing between affiliates of the applicants.





It should be noted that, according to the Clean Sky programme experience and considering the size, scope of the topics and the expected typology of Members and Partners, the most appropriate calls for SMEs applicants are the Calls for Proposals [for Partners]. The limited percentage of SMEs here is however higher than the one experienced in Clean Sky programme.

The key metrics of the fourth call for Core Partners as launched in Q4/2016 is shown below:

- Call comprised of seven published topics with an indicative topic value of €54 million;
- Opening of the call in December 2016;
- Closing date of the call in March 2017;
- Evaluation is planned for April 2017;
- Adoption of the ranking lists by the Governing Board is planned by June 2017;
- Kick-off of Grant Preparation phase is planned to end by June 2017;
- Accession of new Members is planned by to end September 2017;
- Start of technical activity is planned from Q4 2017.

The breakdown of topics [no results known as this call is due for evaluation in April 2017] is depicted below:

Area	No. of topics	Indicative topic Funding (M€)
IADP Large Passenger Aircraft	3	23.65
IADP Regional Aircraft	0	0
IADP Fast Rotorcraft	1	11
ITD Airframe	0	0
ITD Engines	0	0
ITD Systems	3	19
Small Air Transport (SAT) Transverse Area	0	0
ECO Transverse Area	0	0
Technology Evaluator 2	0	0
TOTAL	**7**	**53.65**

Cumulative position of the calls for Core Partners:

By the end of 2016 the four calls for Core Partners (CPW) launched [of which three have been evaluated and are either fully implemented or in the stages of negotiation] will have covered 91% of the expected Core Partner activity and funding over the life of the programme. 133 Core Partners from 20 different countries were already selected via the first three calls. Almost one third of the Core Partners are small and medium-sized enterprises.

The fourth and final call for Core Partners launched in December 2016 will almost complete the selection process for the Clean Sky 2 Core Partners and for the membership of the JU. Roughly 9% of the total Core Partner funding remains unallocated (as contingency margin), which will allow for flexibility in the downstream management of the programme in bi or multi-annual work plans and GAMs. It is expected that at the completion of all four calls the JU will contain approximately 150 Core Partners with an overall SME participation of around 30%.

Summary of call results to date – Calls for Proposals

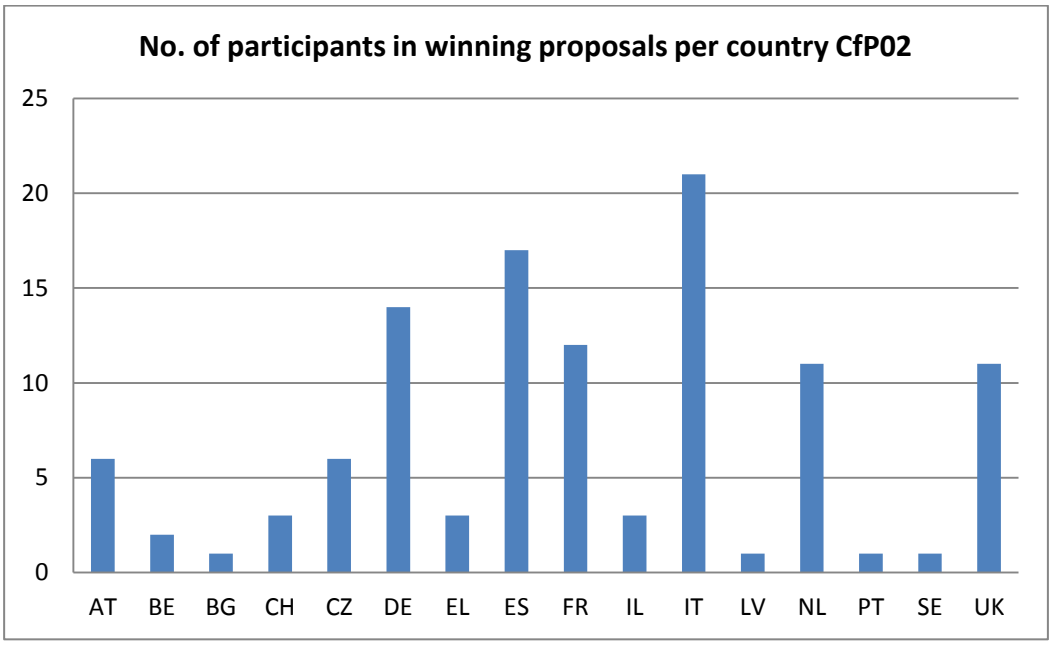
In the 30 months from the programme start, five Calls for Proposals (CfP) were launched. Details follow below for the first two calls, which are now complete in terms of grant preparation:

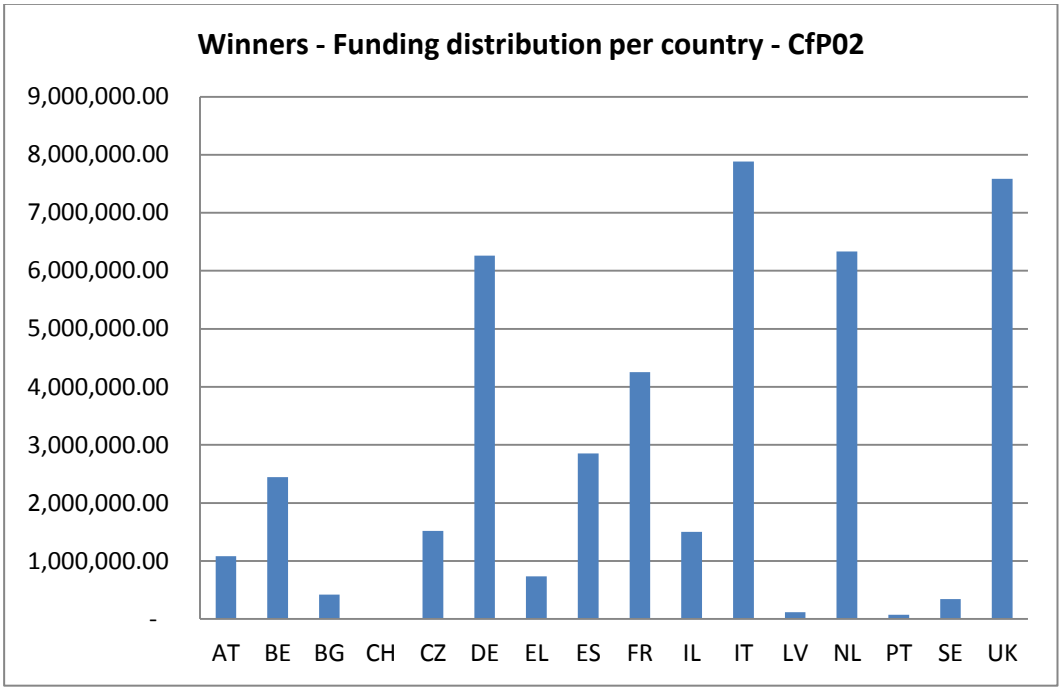
CfP01:

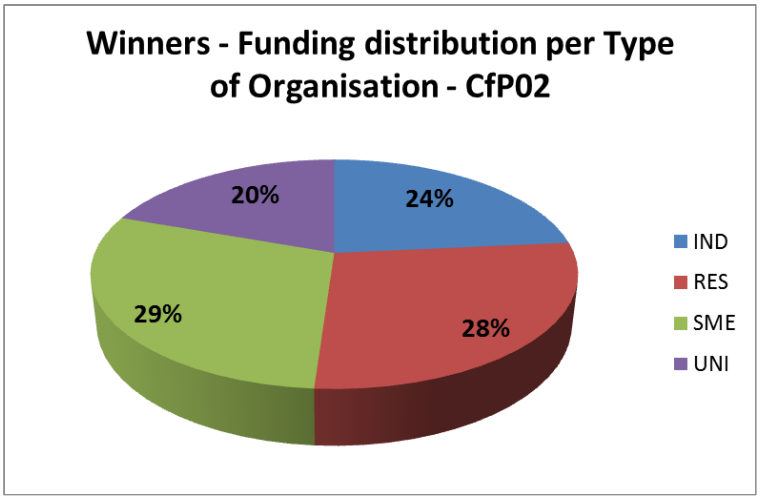
- 48 projects selected out of 53 topics published (91% success rate) with a total funding value of over €46 million;
- 113 participations from 12 different countries;
- SME participation: 21%;
- 92 Partners selected.

CfP02:

- 49 projects out of 64 topics published (77% success rate) with a total funding value of over €41 million;
- 109 participations from 16 different countries;
- SME participation: 32%
- 93 Partners selected.





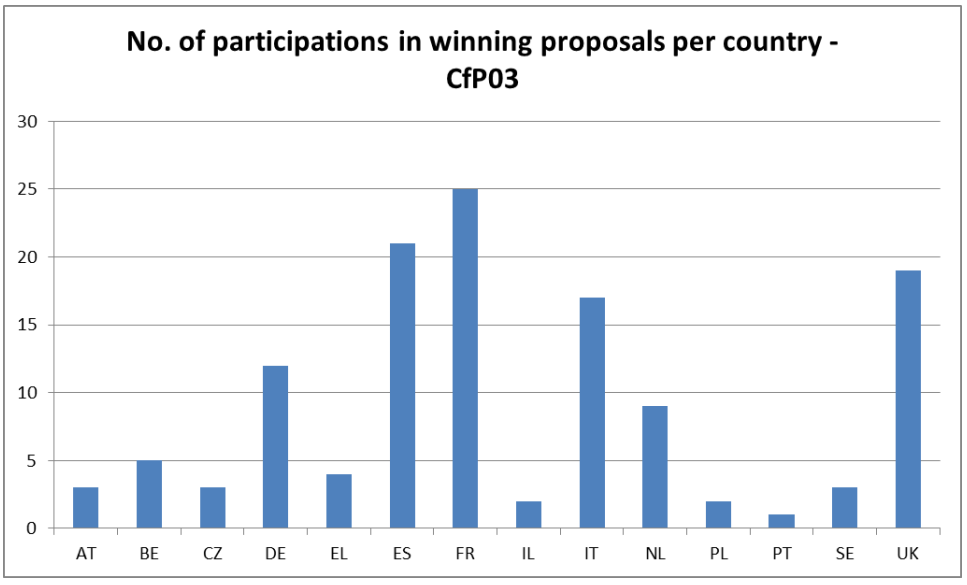


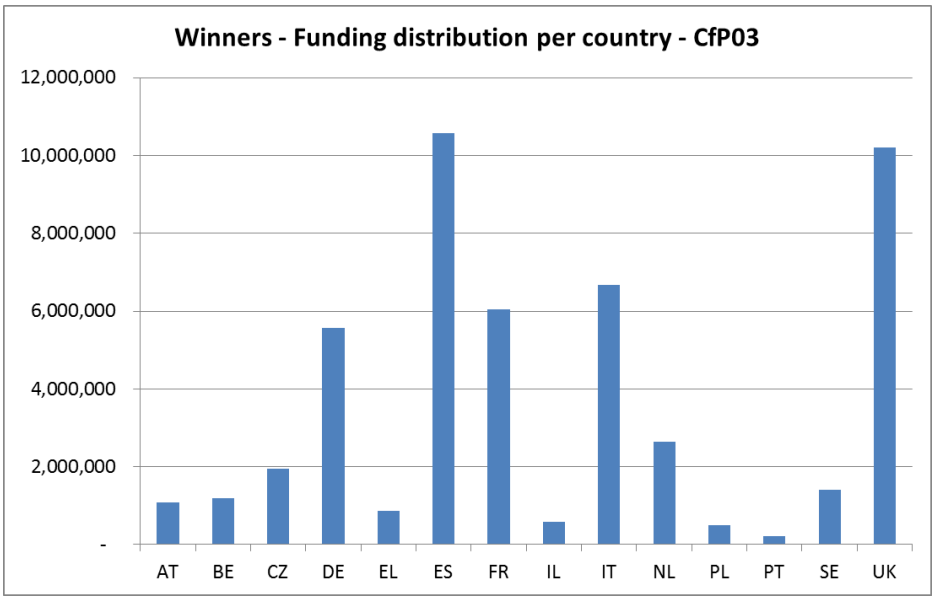
The implementation of CfP03 launched in March 2016 is still on-going. It is now certain that by the deadline for eight months - time to grant (January 2017), over 82% of the grants have been signed, achieving the KPI set and improving on the performance compared to the CfP02.

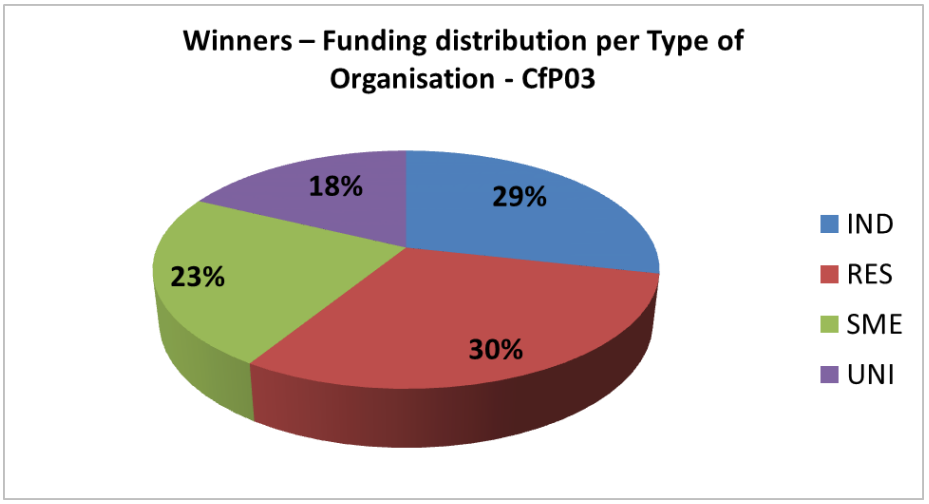
Some key figures and facts are shown below:

- 50 successful topics out of 60 topics published (83% success rate) with a total funding value of over €49 million;
- 41 grant agreements signed or close to signature (status: 31 January 2017);
- 126 participations from 14 different countries;
- SME participation: 29%;
- 105 Partners selected.

The graphics below summarise the evaluation outcome for the CfP03:

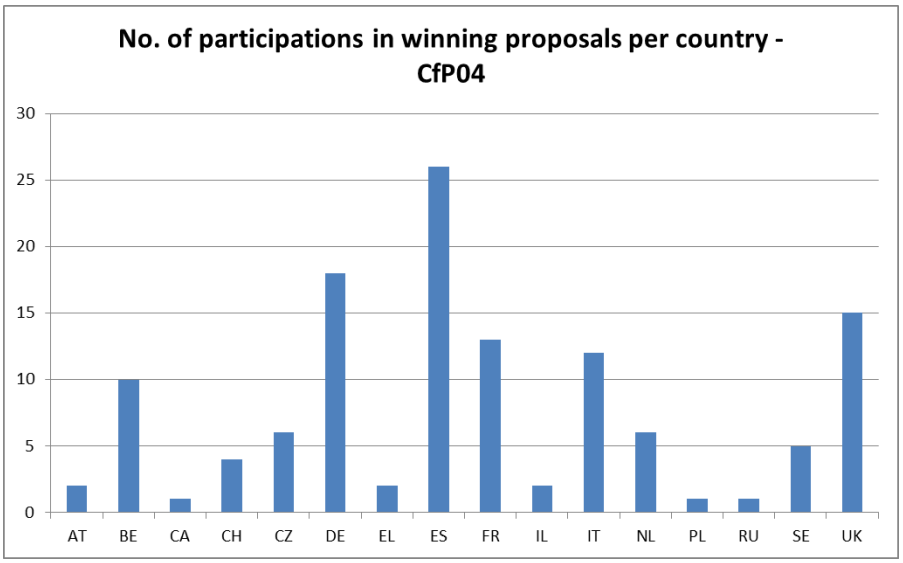


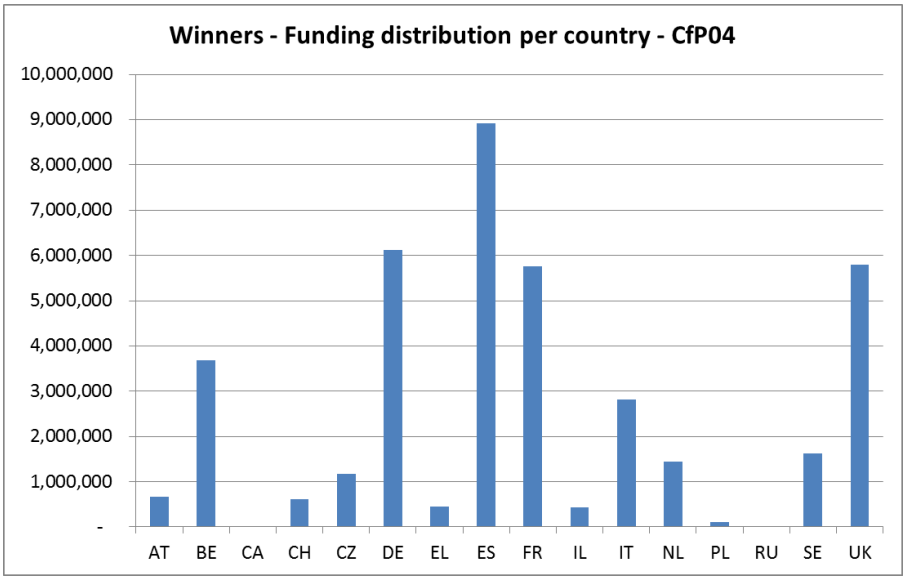


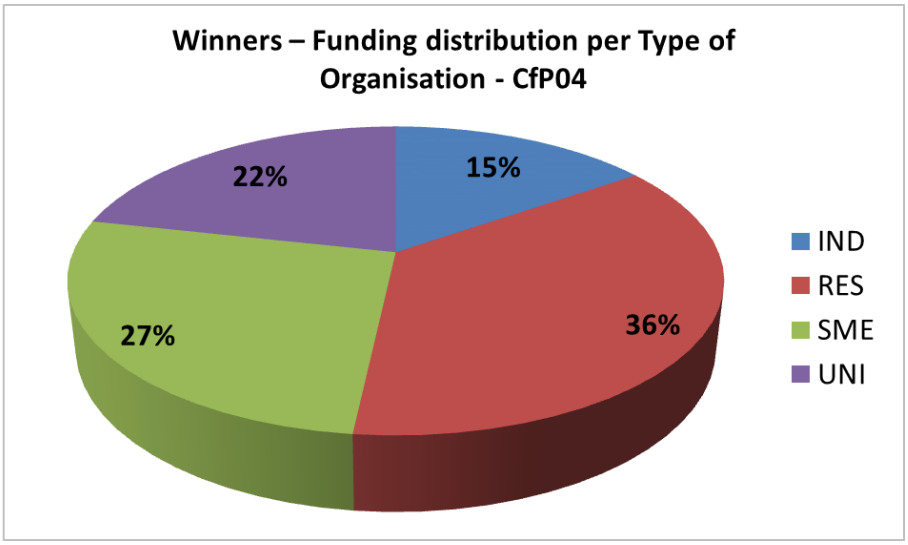


CfP04 was launched in June 2016 and proposals were evaluated in November 2016. The implementation started at the end of January 2017. Some key figures and milestones are shown below:

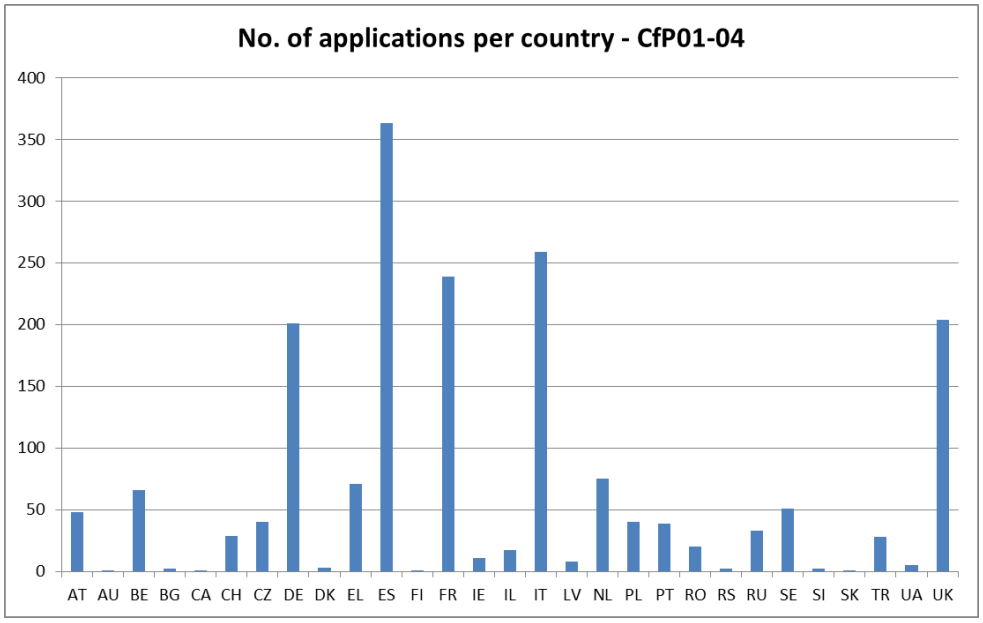
- 47 successful topics out of 57 topics published (82% success rate) with a total funding request of nearly €40 million;
- 124 participations from 16 different countries;
- SME participation: 31%;
- 104 Partners selected;
- 59 new participants to the CS2 programme;
- Kick-off of grant preparation phase: 31 Jan 2017;
- Deadline for eight months - time to grant: June 2017.

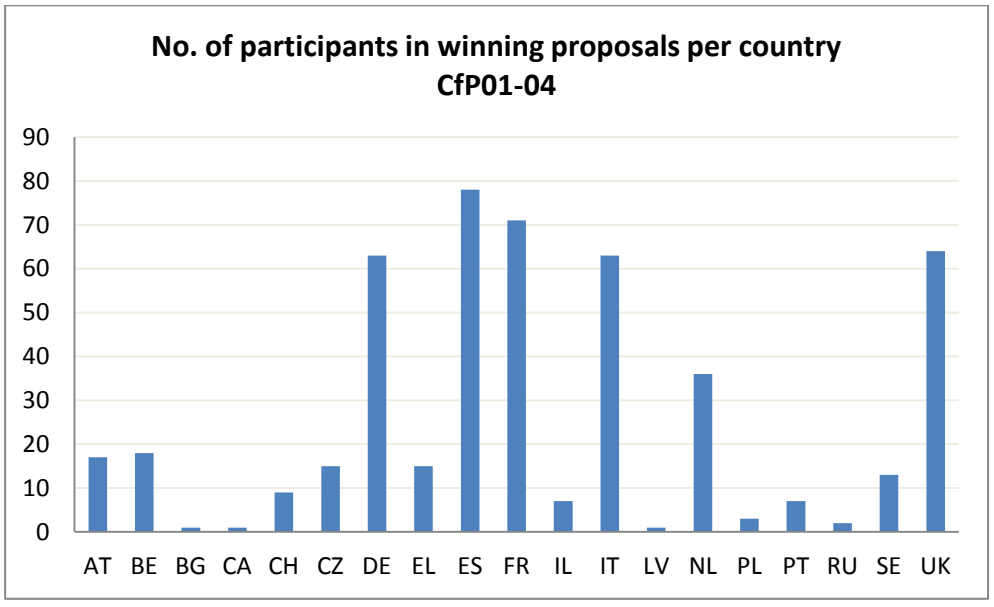

No. of participations in winning proposals per country - CfP04
30
25
20
15
10
5
0
AT
BE
CA
CH
CZ
DE
EL
ES
FR
IL
IT
NL
PL
RU
SE
UK

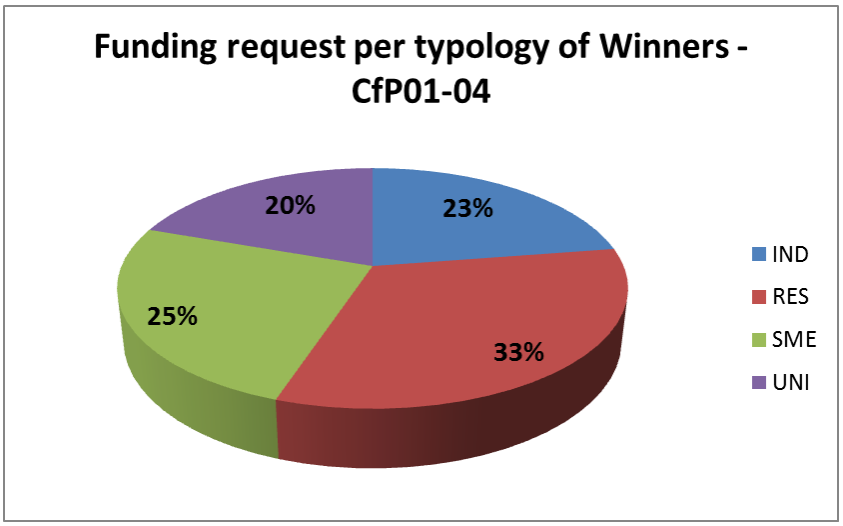

Winners - Funding distribution per country - CfP04
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
AT
BE
CA
CH
CZ
DE
EL
ES
FR
IL
IT
NL
PL
RU
SE
UK


Winners – Funding distribution per Type of Organisation - CfP04
15%
36%
27%
22%
IND
RES
SME
UNI

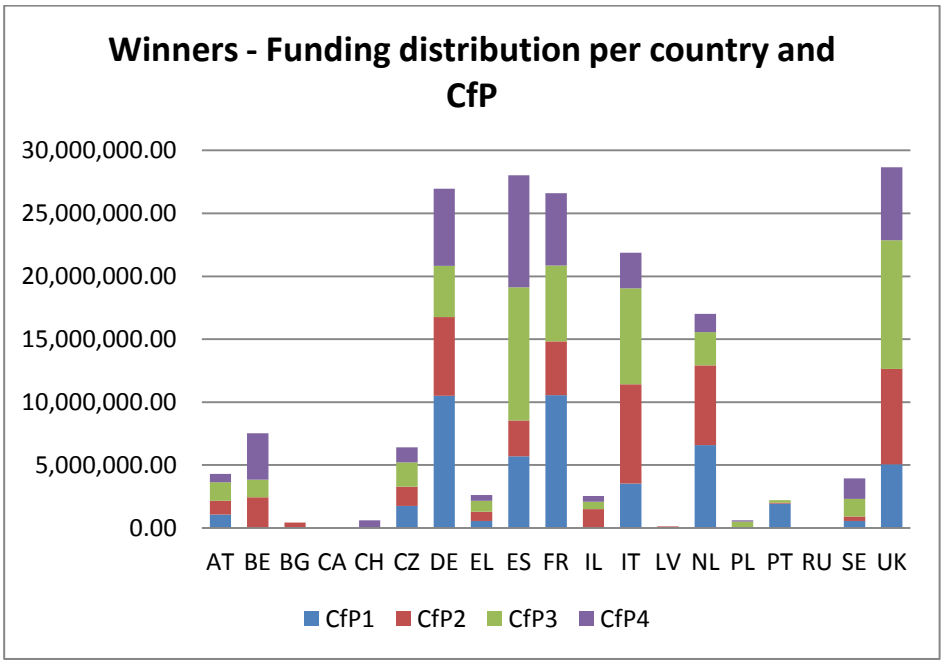
The cumulative results of the four CfPs in terms of geographical distribution and typology of the winning applicants are shown below (figures are based on the applicants' submissions of each legal entity and participation in the proposal and its geographic footprint):







With 19 countries represented in the winning proposals (15 Member States, two Associated Countries and two Third Countries), the results for Calls for Proposals show a good level and geographic breadth of participation, equally good as for Calls for Core Partners. The forecast funding distribution per country and call is shown below:



In December 2016 the 5th Call for Proposals was launched with the following key facts and figures:

- Call comprised of 5 published topics with an indicative topic value of €1.5 million;
- Opening December 2016;
- Closing date March 2017;
- Evaluation planned for April 2017;
- Adoption of the ranking lists by the Governing Board by June 2017 (tentative);

- Kick-off of Grant Preparation phase: May 2017;
- Deadline for 8 months - time to grant: November 2017.

The topics launched under this call are all related to the activities of the Technology Evaluator. No results are known as this call is due for evaluation in April 2017.

Cumulative position of the Calls for Proposals

By the end of 2016 five CfPs were launched, of which four have been evaluated and are either fully implemented or in the stage of grant preparation. These four calls are already engaging more than 290 Partners from 19 different countries with a strong SME participation in terms of participation and grants awarded: over 28% of the Partners selected, requesting 25% of the nearly €177 million EC funding launched via CfPs so far.

The overall results, in particular the SME results, are encouraging, as at least 6 more CfPs can be expected over 2017-2020 with a total funding of over €330 million.

Cumulative position of Clean Sky 2 participants

Legal entities – all duplicates removed					
Call	IND	RES	SME	UNI	Total
CP1+2+3* and CFP1+2+3	109	51	116	49	325
CfP4	13	9	27	10	59
Total	122	60	143	59	384

Note that in the statistics provided above, all duplicate entries were removed, counting each unique participant only once. Note also, that the participants stemming from CfP04 is still subject to the Governing Board adoption of the ranking lists and the subsequent grant preparation.

With 400 participants [including the 16 Leaders] the programme is well on track towards the forecast overall participation of over 800 participants over its lifetime.

1.4. Progress against KPIs / Statistics

The key performance indicators results for the year 2016 are presented in Annexes 5 to 7. The JU has taken into its scoreboard all H2020 indicators, which have been established for the entire research family by the Commission, to the extent to which they are applicable to the JU and provide meaningful results. Comments to some individual indicators are provided in the annexes or in the related section of this report. In addition, the JU is presenting more detailed results of its performance monitoring in specific areas, e.g. there are comprehensive statistics and key figures provided in the section dealing with the calls.

For CfP02, the JU was able to sign just over 80% of the GAPs within the eight month time to grant, hence, meeting the target set. This is a significant improvement compared to the first call, as the technical issues with the H2020 tools for processing GAPs have been solved. For CfP03, a similarly good performance is expected. 41 out of 50 grant agreements have been signed or are close to signature (status: 31 January 2017) before the eight month target. The remaining open GAPs require further follow-up from all parties. It can be reminded that the industrial Topic Manager role here is an additional element in the process which is not present in other H2020 calls.

1.5. Evaluation: procedures and global evaluation outcome, redress, statistics

In 2016, the evaluation of three calls was completed, namely the CPW03 and the CfP2 to CfP4. For the latter, the adoption of the evaluation ranking list by the Governing Board is still on-going. For these calls the breakdown of the selected experts by gender and nationality is shown in the table below:

Call	CPW03	CFP02	CFP03	CFP04
No. of Experts	52	94	95	99
Gender Balance [% Female]	12.0	15.9	12.6	17.2
Nationalities [%]:				
UK	13.5	11.8	9.5	14.1
Spain	15.4	9.7	6.3	11.1
Germany	9.6	16.1	14.7	15.2
France	23.1	9.7	11.6	17.2
Italy	15.4	17.2	13.7	14.1
Others	23.0	35.4	44.2	28.3
Type of Organisation[6] [%]				
Higher Education Establishments	30	17	24	33
Non-research commercial sector incl. SMEs	24	25	32	21
Consultancy firms	2	13	2	5
Public Research Centres	15	13	11	10
Private Non-profit Research Centres	2	4	2	6
Others	26	28	28	24
No. of Days claimed	249.5	526.5	515.5	443.5
No. of Observers	2	2	2	2
New wrt H2020 [%]	2	4.3	3	15
Newcomers in CS call evaluation (last 3 years) [%]	61	63	41	48

[6] Based on the total number of experts having attended the evaluation.

Highlights:

1. The JU continued its efforts to improve the experts' gender balance where possible while maintaining the level of experience and aeronautical [or similar] technical background. However, it is not seen as easily improved upon beyond this level given the specificities of the technical areas and subject matter involved.
2. The balance of nationalities of the experts is representative of the domain, and inclusive with respect to a broad representation.
3. Given the complexity of the selection of Core Partners [=Members] and the significantly larger scope of the current CS2 Calls for Proposals, it was deemed beneficial to conduct the evaluations in each case with two observers. For each of the evaluation exercises concluded and submitted to the Governing Board, the Observers' Reports - with substantial detail on the expert panel breakdown in gender and nationalities, but also on the evaluation process and set-up - have been shared with the SRG. The redress rate for 2016 remained with 1.9% at a good level and stayed below the KPI of 2%.

In addition, two more calls were launched - the CPW04 and the CfP05 - but given the closing date in March 2017, the evaluation is scheduled for Q2 2017. These two calls are not included in the statistics shown above.

1.6. Activities carried out in Grant Agreement for Members (GAM)

I. Clean Sky Programme

The key elements of technical progress in 2016 in the first Clean Sky programme are highlighted below. Further details are provided in Annex 11.

The first Clean Sky Programme is built upon six different technical areas called Integrated Technology Demonstrators (ITDs), where preliminary studies and down-selection of work will be performed, followed by large-scale demonstrations on ground or in-flight, in order to bring innovative technologies to a maturity level where they can be applicable to new generation "green aircraft". Multiple links for coherence and data exchange will be ensured between the various ITDs.

The Technology Evaluator is Europe's first complete integrated tool delivering a direct relationship between the advanced technologies being assessed and high-level local or global environment impact. It considers inputs from both inside and outside the Clean Sky perimeter to deliver environmental metrics at aircraft, airport and aircraft fleet level.

As aircraft fuel economy is also influenced by a flight trajectory management strategy, Clean Sky has established links with the SESAR Joint Undertaking which investigates Air Traffic Management (ATM) technologies in line with the Single European Sky initiative of the European Commission. These links are established via the Technology Evaluator, as well as via the SGO ITD that develops the avionics equipment interfacing with ATM, and via management meetings involving the relevant staff members of the two JUs (i.e. the SGO Project Officer from Clean Sky and the two Executive Directors).

During 2016 the links and cooperation activity with the SESAR JU were reinforced, via various joint workshops and technical meetings. Exchanges at work programme level, such as potential future topics to cooperate on and ensuring publication of both SESAR and Clean Sky TE results in the JUs communication tools has been agreed for the following year. Equally, a dedicated session about SESAR was included in the Technology Evaluator final review in October 2016. Other areas of cooperation taken into account for implementation included the assessment of the environmental performance and conducting a coordinated or joint communications report, the comparison of the development plans in Clean Sky 2 JU and SESAR JU in order to further enhance the thematic areas of cooperation, pursuing non-technical coordination on H2020, seeking further understanding of regional cooperation and sharing of best practices.
In the following subchapters, the summary description of activities and achievements by ITDs and TE is provided, with indications and explanations of significant deviations compared with initial planning, where applicable. Further details are highlighted in Annex 11.

SFWA – SMART FIXED WING AIRCRAFT

The main demonstrators of the SFWA technologies were integrated and tested, or completed in assembly, allowing the execution of the planned tests on ground and in flight. Major items are: the full-scale natural laminar flow wing, the smart flap for low speed applications, the low

speed vibration flight demonstration, and the business jet innovative after body demonstrator.

All major components for the Airbus A340-300 BLADE flight test demonstrator were delivered to the final assembly hangar in Tarbes for the preparation, maintenance, conduct and refurbishment activities for a period of two years in total. The laminar test wing articles arrived at the assembly in Vitoria (Spain) for the formal launch of assembly of the full wing in December 2016.

The ground based demonstration associated to the development of the laminar wing for large transport aircraft had already been completed in early 2015 with a number of key contributions to TRL5 to the structural concept and the leading edge high lift kinematic.

The low speed vibration load control tests for business jets performed all major simulator tests and tests with the full size Dassault Falcon ground rig. Parallel tests with advanced load control functions integrating real time loads monitoring were conducted for the Business jets configuration.

For the innovative rear empennage for business jets, the flutter test were conducted in a high speed wind tunnel test and will be a key contribution to reach TRL4. The full scale ground test with a structural mock up took place behind a Dassault Falcon 7X to obtain realistic data about the thermal, acoustic and fatigue behaviour of the advanced V-tail concept, performed the full-scale tests in mid-2016.

All major SFWA activities associated with active flow control wing technologies were completed with the final testing of the robustness of the developed actuator concepts under operational conditions.

Most significant milestones achieved in 2016:

- Review of step two tests results
- Review of WP1.3.6.5 deliverables
- End of WP review
- LSBJ low speed model manufacture completed
- HSBJ low speed model manufacture completed
- Review of the HSBJ model
- LSBJ large low speed model (F1) reviewed
- HSBJ cruise configuration wing delivery
- HSBJ high lift components delivery
- Acoustic WTT results delivery by DNW
- Final simulations of DNW acoustic tests
- Synthesis report delivery
- FRR feeder review
- Bird strike tests conducted
- Assembled starboard wing delivery to FAL
- Assembled port board wing delivery to FAL
- Delivery of aerofairing to FAL

- Entire package of metal parts for manufacturing of transition structure leading edge and trailing e.
- Part Delivery for BLADE fixed wing trailing edge
- Support to flight clearance
- Systems CDR feeder review - activity self-funded
- TRL 5 reflectometry and shadow casting
- Delivery of mid box of transition structure to FAL
- Delivery of metal parts for aileron and plastron
- Pylon efforts measurement – TRL 2
- Delivery of mini remote acquisition unit for optical sensors
- Aft body ground demonstrator: End of mock up and rig manufacturing
- Aft body ground demonstrator: Ground test completed
- Aft body wind tunnel test completed

Most significant deliverables in 2016:

- Buffet Control Techno Stream Final Report
- Final report on smart TE devices for load alleviation
- WP2.3 final report - PANEM
- Hybrid Laminar Flow Techno Stream Final Report
- Wing Movable Transition for Pressurized Air and Electrical Signals
- Fluidic Control Surfaces Techno Stream Final Report
- Load control, functions and architecture Techno Stream Final Report
- CROR Engine Integration Techno Stream Final Report
- Advanced Flight Test Instrumentation Techno Stream Final Report
- Overview end-report Port Upper Wing Cover & integrated Leading Edge design, construction and production
- Natural Laminar Wing Techno Stream Final Report
- Integration of Innovative Turbofan Engines to Bizjets Techno Stream Final Report

GRA – GREEN REGIONAL AIRCRAFT

Future green regional aircraft will have to meet demanding weight reduction, energy and aerodynamics efficiency, and a high level of operative performance, in order to be compliant with regards to pollutant emissions and noise generation levels.
The objective of the Green Regional Aircraft ITD is to mature, validate and demonstrate the technologies best fitting the environmental goals set for the regional aircraft entering the market from 2020 onwards. The project has five main domains of research, in which several new technologies are under investigation in order to entirely revisit the aircraft in all of its aspects. The GRA technological areas structure is as follows:

- GRA1 - Low Weight Configuration (LWC)
- GRA2 - Low Noise Configuration (LNC)
- GRA3 - All Electric Aircraft (AEA)
- GRA4 - Mission & Trajectory Management (MTM)
- GRA5 - New Configuration (NC)

Overview of main achievements

Low Weight Configuration domain (GRA1) activities focused on testing the Ground Demonstrators (Fuselage Section, Wing Box Section and Cockpit Section).
The major results on ground were the static and fatigue tests on Ground Demonstrators together with some functionality testing (i.e. electrical conductivity, modal analysis and acoustics). The cockpit demonstrators were further tested in Getafe.

Low Noise Configuration domain (GRA2) activities dealt with the demonstration of advanced aerodynamics (laminar flow technology), load alleviation and low airframe noise technologies tailored to 130-seat A/C and 90-seat green regional A/C, as well as acoustic tests performed on a full-scale mock-up of a Main Landing Gear low-noise configuration.
Most of the Wind Tunnel tests took place at the end of 2016.
The completion of activities in Mission and Trajectory Management domain allowed the consolidation of this domain for the final review at end of 2016.

New Configuration domain (GRA5) focused on the low-speed aerodynamic wind tunnel test campaign to estimate the performance in high lift conditions of the 130-seat aircraft configuration by testing a 1:7 complete A/C powered WT model. The last update of the A/C Simulation Models (GRASMs) for the assessment of environmental targets achievement in terms of air pollutants emissions (CO_2 & NO_X) and external noise reduction, based on experimental results and enclosing the MTM technologies, was delivered to the Technology Evaluator.

Most significant milestones achieved in 2016:

- Completion Ground Full Scale Test on One Piece Barrel and Cockpit demonstrators;
- E-ECS verification of integration on A/C on ground;
- Completion of Flight Test Demonstration (related to the More electrical configuration, with integration of the e-ECS);
- Completion of Flight Simulator Demonstration;

Most significant deliverables in 2016:

- Final Fuselage Ground Test Demonstration results;
- Final Wing Box Ground Test Demonstration results;
- Final Cockpit Ground Test Demonstration results;
- E-ECS validation in Flight Tests;
- Final GRASM models and data for the TTE final assessment

GRC – GREEN ROTORCRAFT

The Green Rotorcraft ITD gathers and structures all activities concerning the integration of technologies and their demonstration in rotorcraft platforms, supported by activities performed within the Eco-Design ITD, the Sustainable and Green Engines ITD, the Systems for Green Operations ITD and the Technology Evaluator. It combines seven domains aiming to

reduce the environmental footprint by reducing emissions and halving the perceived noise of rotorcraft for the next generation of helicopters.

The main activities for the seven domains of the GRC ITD are:

GRC1 - Innovative rotor blades activities are related to the design, manufacturing and testing of new blade configurations including both active and passive systems, and the methodology and tools necessary to carry out parametric study for global rotor benefits.

GRC2 - Reduced drag of airframe and dynamic systems activities is related to the design of optimised shapes and the manufacturing and testing of helicopter sub-parts such as the air inlet, rotor hub fairings and fuselage aft body for several rotorcraft configurations including the tilt-rotor. Passive shape optimisation approach and vortex generators will be complemented with active control systems.

GRC3 - Integration of innovative electrical systems activities is focused on new architectures for more electrical helicopters including new technologies such as electric tail rotor, brushless starter generator, electro-mechanical actuators, electric taxiing, electric regenerative rotor brake and the management of energy recovery.

GRC4 - Installation of a high compression engine on a light helicopter consists of the development of a specific high compression engine power pack demonstrator installed on a modified EC-120 helicopter.

GRC5 - Environment-friendly flight paths activities focuses on the optimisation of the helicopter flight path relying on both new procedures in take-off and landing phase (IFR based) and a new flight envelope definition to reduce noise (steep approach) and pollutant emissions. Intensive work with SESAR (Single European Sky Air Traffic Management Research), EASA (European Aviation Safety Agency) and ICAO (International Civil Aviation Organization) is ongoing, working towards introducing new solutions (operational by 2020).

GRC6 – Eco-Design Rotorcraft Demonstrators activities are related to manufacturing and testing helicopter sub-assemblies such as a double-curved fairing, a tail unit section, an intermediate gear box, a tail gear box, including the relevant input shaft which will feature REACH-compliant corrosion protection. The implementation of new eco-friendly materials and processes (thermoplastic composites and relevant forming and joining processes, metallic alloys with “green” surface protection) is also based on results from the Eco-Design ITD and earlier projects.

GRC7 - Technology Evaluator for Rotorcraft activities are related to the packaging of results obtained for the different rotorcraft subsystems and the delivery of consistent behavioural models representing the future helicopter fleet for the Technology Evaluator to assess their environmental impact as compared to the fleet operated in 2000. Six improved and more accurate behavioural models have been delivered at different levels of accuracy since 2013.

Overview of main achievements

In the Innovative rotor blades domain the design, manufacturing and testing for the integration of the Active Gurney Flap system in the rotor blade continued in 2016 with full-scale component tests. The manufacturing was completed; the whirl tower testing was replaced by the ground testing on the helicopter test bed, with successful tests achieved at the end of 2016. Flight tests will continue in 2017.

Reduced drag of airframe and dynamic systems activities concentrated on final flight test campaigns on a modified helicopter test bed in 2016. For the Integration of innovative electrical systems activities, the electric tail rotor technology testing was finalised on an AW in-house test rig, running the first phase of testing in December 2016 at Leonardo Helicopters dedicated facility.

The demonstration of the integration of a high compression engine on a light helicopter was successfully completed with flight demonstrations continuing in 2016, with several dedicated test campaigns. For the Environment-friendly flight paths the main achievement consisted of the demonstration of the VFR Low Noise procedure by an AW helicopter.

Eco-Design Rotorcraft Demonstrators activities completed the manufacturing and testing of helicopter sub-assemblies as specific helicopter demonstrators to the basic demonstration in EDA (Eco-Design for Airframe), like the AW 169 thermoplastic tailcone.

Technology Evaluator for Rotorcraft activities (GRC7) produced the latest updated models of the different conceptual helicopters and were tested on the simulation tool Phoenix, and shared with TE.

Most significant milestones:

- Final Structural tests on the thermoplastic tail cone demonstrator
- Final validation of the Tilt Rotor eco-IFR procedures by Pilot in the Loop simulations in laboratory environment (with ATC).
- Extended flight test campaign of HCE (High Compression Engine)
- Initial flight test of the Active Gurney Flap demonstrator
- Initial tests of the electric tail rotor Ground demonstrator
- Final flight test demonstration of Low-Noise VFR Approach
- Delivery of Final PhoeniX platform to the TE

Most significant deliverables:

- Synthesis report on WT measurements on a AW Heavy helicopter fuselage
- Reporting of flight test results for the demonstrator helicopter with drag reduction features
- First ground experimental testing on the AGF rotor with helicopter on ground
- Finalisation of the design of the air-Intake and exhaust of a tilt-rotor
- Finalized Report of the Design Studies for an Optimised Green Tiltrotor
- HCE full envelope flight tests campaign test report

- Flight Test Report on VFR Approach Guidance Noise Abatement Procedure flight tests
- Final Phoenix Black Box for the TE assessment of helicopter fleet

SAGE – SUSTAINABLE AND GREEN ENGINES

2016 has been another important year for SAGE as considerable progress was made. Even if most of the activities of SAGE1 and SAGE3 were terminated in 2015, a lot of activities were performed for the other four projects.

For SAGE4 and SAGE5, 2016 was the year of the disassembly of the engine demonstrators, the inspections of the different modules and parts and the analysis of the ground test results.
SAGE2 and SAGE6 continued to progress towards the start of the demonstrations with the completion of the manufacturing and delivery of all the components and a huge activity on the assembly of the engines demonstrator

The CfPs in 2016 continued to deliver some excellent achievements, which has contributed to the success of this year for the SAGE ITD.

Overview of main achievements

For SAGE1 activities were terminated in 2015 except for managing the closure of the project FAMEC (variable blade pitch angles in conjunction with an overhung rotor and the continuation of Aero and Noise Methodology Development).

For SAGE2 a concept review took place in 2012 to consider the feasibility and configuration of the open rotor demonstrator. Preliminary design studies of the open rotor integrated power plant propulsion system (IPPS) were finalised in 2013. The preliminary design reviews were completed in Q1 2014, which enabled the detailed design activities to be anticipated. The critical design reviews (CDR) were staged, with the first one for the blades done in May 2014. In 2014 and 2015, all the critical design reviews were completed.

The machining of the components started in 2014 and some major parts, such as the first blades, the front rotating frame, the polygonal rings and the pivots, were delivered in 2015 to the dedicated assembly workshop at Safran Aircraft Engines Vernon (named as of July 2016 Airbus Safran Launchers, a Joint Venture between Airbus and Safran).

The assembly of the engine started in October 2015 and continued in 2016. All the parts were delivered to the assembly workshop, allowing the assembly of all the modules to be completed. Some contingencies linked to the new engine architecture during the assembly were solved, and the whole engine assembly was launched at the end of 2016.

Concerning the Ground Test facility, the assembly of the test bench started in 2015 and all the activities, particularly the control and systems integration, were finalised in 2016.

The Ground Demonstration objectives, plan and sequences were defined in 2015. All the test

readiness reviews were successfully passed in 2016, in order to validate the detailed tests plan of the engine.

Regarding the CfPs, several projects supported the Open Rotor demonstrator and all of them were finalised in 2016.

The engine tests are planned for the first semester of 2017. For SAGE3, as far as the Low Pressure Turbine work-strand is concerned, the data obtained in the engine test campaign were analysed and the LPT components were inspected by ITP.

Three projects (Rorc, Micromech and Nesmonic) were also closed by ITP (Topic manager).

SAGE4 in 2016 completed the engine and module tear-down and hardware inspection following the successful Geared Turbofan demonstrator tests in Q4-2015. A comprehensive amount of test data was analysed and assessed. After a successfully design review in Q4-2016 the SAGE4 demonstrator activity completed its operational activity. For the incorporated technologies in HPC, LPT, TEC and engine systems, valuable knowledge from test data and hardware inspection has been generated and transferred to the technology owners in order to help implement SAGE4 technologies into future production designs. 14 projects led by MTU contributed to the SAGE4 demonstrator programme.

Avio Aero delivered three modules of the Integral Drive System for the GeT FuTuRe Rig to properly support the 2016 tests (Test Gearbox, Slave Gearbox and a complete assembled spare). The GeT FuTuRe Rig project (CfP involving a Tuscany Consortium, coordinated by the University of Pisa and supported by the SMEs AM Testing and Catarsi) completed the design, machining and assembly and sent the rig to the dedicated test facility.

SAGE4 and airframe GRA have successfully completed their input to TE. The two tests of the SAGE5 project (turboshaft demonstrator of several innovative technologies for high temperatures) were completed by the end of 2015 with a highly instrumented test in order to measure the secondary air system and high pressure components performance. First step of the demonstration had already been achieved in 2013.

During 2016 the SAGE6 lean burn system programme completed the manufacture of all components for the ground engine and the vast majority of the flight engine components. Continuing the technology development of the lean burn combustor system, three full scale combustor rig tests have been undertaken (testing altitude, ground ignition, emissions, traverse, operability and rumble). Further work was conducted for the virtual engine demonstrator by enabling the development of design and simulation systems.

Looking forward, 2017 will see the engine testing programme start, the progress through the initial functional testing and the extreme environment testing to a full flight testing on the second engine which will be installed under the wing of the Rolls-Royce Boeing 747 flying test bed.

SGO – SYSTEMS FOR GREEN OPERATIONS

The purpose of the SGO ITD was to assess, design, build and test new aircraft systems technologies and architectures in the two areas of Management of Aircraft Energy (MAE) and Management of Aircraft Trajectory and Mission (MTM). CO2 benefits were expected from both mission and trajectory and optimisation of on-board energy. Noise reductions are linked to the trajectory management for approach/landing and take-off. Additional benefits were also expected, e.g. suppression of the use of hydraulic fluids.

The SGO ITD successfully concluded its technical development in the two targeted areas by the end of 2016 achieving all the final major demonstrations.

Description of main activities

Management of Aircraft Energy (MAE)

MAE had two major objectives. The first was to develop and demonstrate the More-Electric Aircraft System Architectures (bleed-less aircraft, power by wire architectures), allowing energy users to facilitate the implementation of advanced energy management functions and architectures. The second objective was to adapt and demonstrate the control of heat exchanges (partly necessary due to the more-electric concept) and the reduction in heat waste within the whole aircraft. This was done by improving the system efficiency with respect to power electronics and advanced thermal management. In order to support those objectives, the following final project results were achieved in 2016 for each technology thread.

Electrical energy management architecture

The Power Distribution Centre ground test campaign on the Airbus Electrical Ground Test Rig “PROVEN” (campaign G3) was finalised in 2016. It demonstrated the technical feasibility of a centralised and modular management of power conversion and distribution including thermal management of the centre.

Systems using electrical power

The technology demonstration of the electrical environmental control system was completed through the e-ECS flight tests on the Airbus A320 MSN1 (pack size of 50kW electrical power) in June 2016. The flight test campaign was particularly successful, covering the complete foreseen envelope. An opportunity to extend the flight campaign with some extra robustness tests at high altitude was even made possible thanks to the collaboration of all involved teams. The development of the innovative e-ECS in SGO was successfully completed through the proof of TRL5 by the end of 2016.
Another aircraft platform targeted by the e-ECS was the Regional Aircraft application in cooperation with the GRA ITD and Alenia/ ATR. The technology was successfully demonstrated through a flight test campaign with an ATR72-600 in February and March 2016 with one e-ECS pack installed in the ATR belly fairing.
The flight test campaign of an innovative Primary Inflight Ice Detection System (PFIDS) also

took place during the year, being installed on two aircraft: an A320 and an A340. This allowed critical test data to be gathered which led to this technology passing TRL6 at the end of 2016.
For the Helicopter Electro-Mechanical Actuation System (HEMAS), final system tests took place in 2016. Several technical issues arose during the final integration stage, which limited the scope of the tests which could be performed. As a consequence, the final TRL4 at system level could not be reached within the resources of the project. Nevertheless, high value information was gathered and exchanged between SGO ITD and GRC ITD on the feasibility of an electrically actuated helicopter swash plate

Overall thermal management solutions of aircraft systems

The final target for SGO was reached in 2016 with a pre-TRL4 review of the Thermal management function solution using rapid prototype hardware in a simulated environment. This development in SGO supported the identification of innovative thermal management architectures which in the future will facilitate the implementation of advanced energy management functions.

Management of Aircraft Trajectory and Mission

MTM was based on two main concepts. First, the ability to fly a green mission from start to finish, with management of new climb, cruise and descent profiles based on aircraft performances database allowing multi-criteria optimisation (noise, gaseous emissions, fuel, and time). This also encompassed the management of weather conditions, which could negatively impact the aircraft optimum route and result in additional fuel consumption. Then, on the airfield itself, Smart Operations on Ground used new systems solutions, so as to allow aeroplanes to reduce use of main engines for taxi operation. The developed technologies reached their final demonstration stages in 2016.

Flight management & guidance algorithms and functions for climb, cruise & descent phases

In the field of FMS optimised trajectories, the departure and cruise functions achieved TRL6 in 2016, with final tests of the FMS on a representative bench. In parallel, the function targeting the final approach phase passed TRL5, taking into account some results from associated SESAR JU projects. Technologies for electrical taxi via an on-board wheel actuator system reached their final stage of maturity, with system integration tests on a large scale dynamometer.

ECO – ECO-DESIGN

The Eco-Design ITD performed within the period all the required activity to consolidate the technical results achieved during the programme's duration until the end of 2015, in particular the demonstrations performed for both EDA (Eco-Design for Airframe) and EDS (Eco-Design for Systems).

Technical tasks were completed within 2015 and an extension in 2016 was limited to reporting and management tasks. The programme demonstrated the main primary objective to contribute to improving the eco-efficiency of future aeronautical products in terms of energy reduction, use of green materials and processes, long life structures, reuse and recycling techniques, and improved electrical/thermal energy management. Good innovation potential coming from the Eco-Design ITD is a frontrunner in promoting the application of green eco-friendly technologies.

A proper link with the other ITDs was guaranteed. Efforts performed in EDA supported GRC eco-demonstrators, synergies with GRA composite structures, and TE in particular for business jet application. Links for the technologies developed in SGO and GRC were properly ensured through EDS.

A final review was held in April 2016 with a good appreciation of the project's achievements by the independent review team, including a detailed dissemination and exploitation section added to the final publishable report submitted by the ITD.

All expected milestones were reached and deliverables submitted to satisfactorily close on time the first Clean Sky ITD.

Several dissemination events were continued in 2016 by the ITD through participation in conferences and papers presented. Dedicated deliverables on the D&C plan were provided early in 2016 to update inputs from beneficiaries regarding performed and foreseen activities and to prepare the final report.

A valuable potential exists for a proper use and exploitation of results allowing beneficiaries to capitalise on technology development, demonstration and use of environmental assessment methods for the future.

An annual activity report has been finalised and submitted, cost claims finalised and accepted.

The Eco-Design ITD's seven years of activity could then be considered successfully concluded on time as the first example of Clean Sky ITD closure.

TE - TECHNOLOGY EVALUATOR

All TE Work Packages had outputs in 2016 with the global environmental assessment synthesis performed, which included:

- WP0: TE Management and Coordination
- WP1: TE Requirements and Architecture
- WP2: Models Development and Validation
- WP3: Simulation Framework Development
- WP4: Assessment of Impacts and Trade-off Studies

Highlights from each work package consisted of:

In WP0:

- Contribution to the JU communication strategy, including a workshop held in March 2016 at the JU premises;
- A draft of the annual report was released on the 15 December 2016; the full version will be released when contributions from WP1 and WP 4 are available;
- The final review meeting of the TE was held on the 20 - 21 September 2016 in Brussels.

In WP1 the update of the TRL development status, associated with the technologies, was integrated into the ITD aircraft models and its link to the TE assessments.

In WP2 the last updates of the ITD aircraft models were received and incorporated, while in WP3 the main activity was to support WP4 to operate the tool chains and carry out the TE 2016 assessments and trade-off studies and to produce the following outcomes:

- Dissemination activities ("AEGAT dissemination" and "Farnborough dissemination");
- The trade studies reported in the assessment synthesis report;
- The final assessment synthesis released in two steps as planned in 2015 through 2016 assessment synthesis reports (draft and final). A third version of this report will take into account the reviewers' recommendation.

The environmental performances achieved involve -32% CO2 and -40% NOx for the global aircraft fleet and -5 dB(A) Noise Lden in average for 6 European airports.

Next steps

The 2016 assessment synthesis final report will be released early in 2017, allowing the TE to finalise the final public communication.

II. Clean Sky 2 Programme

The structure and set-up of the Clean Sky 2 programme is highlighted in section 1.2, where the top-level breakdown of actions as set out in the GAMs is set forth. The key elements of the technical progress in 2016 are highlighted below. Further details can be found in Annex 11.

LARGE PASSENGER AIRCRAFT IADP

The Large Passenger Aircraft IADP is organised into three major work package areas, also called "Platforms":

- Platform 1: "Advanced Engine and Aircraft Configurations" providing the development environment for the integration of the most fuel efficient propulsion concepts into the airframe targeting next generation short and medium range aircraft;
- Platform 2: "Innovative Physical Integration Cabin – System – Structure" aiming to develop, mature, and demonstrate an entirely new, advanced fuselage structural concept developed in full alignment towards a next generation of cabin-cargo architecture, including systems;
- Platform 3: "Next Generation Aircraft Systems, Cockpit and Avionics" targeting a highly representative ground demonstrator to validate a Disruptive Cockpit concept to be ready for a possible launch of a future European LPA aircraft.

Six additional Core Partners were welcomed in LPA through two GAM amendments signed in June and December 2016.

LPA Platform 1 activities and progress

Three launch reviews for major technologies were performed in 2016: "CROR FTD", "UltraFan FTD" and "Active Flow Control technology on wing/pylon". For the CROR FTD engine, the assessment of different engine configurations (pusher or puller) and the alternative plans for advanced propulsion concepts were advanced. The work performed by the Core Partners focused on the power turbine and the gear box, and the development of new engineering and manufacturing processes for rotating frames. Design activities targeted advanced flight-test instrumentation and new technologies for surface pressure measurements. Numerical investigations were performed on installed CROR FTD configuration to support the eco-viability assessment. For the CROR Rear-End [ground] demonstrator, several enabling technologies were matured towards TRL2 target in 2017. At the end of 2016 Airbus took the decision to discontinue the existing CROR Rear-End development. A re-orientation was launched, in coordination with all involved partners and the JU, to develop an updated scenario reflecting the latest requirements in terms of aircraft configuration, propulsion concepts, design and manufacturing principles.

In the Scaled Flight Test demonstration work package, activities focused on defining the requirements, including the build-up of the required data input. The further composition of the partners' consortium progressed well. The associated kick-off meetings took place with the new Core Partners and the operational work has started.

In Hybrid Laminar Flow Control (HLFC), work concentrated on the preliminary structure/system/build concept of the Horizontal Tail Plane (HTP) in view of essential sub-technologies. Material tests at coupon level, system tests and manufacturing trials were performed to assess the feasibility of the proposed construction principle. The activities for the HLFC wing were started and a dedicated CPW04 topic was launched in December 2016.

Progress was made on the selection and concept development of key technologies for the integration of very large turbofan engines – UHBR Integration, such as the UltraFan FTD. The roadmap for the experimental testing and validation of Active Flow Control (AFC) applied to a wing-pylon area was elaborated. Regarding load and noise mitigation technologies, requirements were specified and concepts sketched. For the UltraFan^{TM} flight test, the flight-test clearance verification requirements have been defined. Preliminary feasibility studies were carried out concerning the Flight Test Demonstrator (FTD) supported by a demo engine positioning and loads check to assess the aircraft impact.

Reference configurations for the Advanced Aircraft Configuration investigations were defined as well as the definition of the tools suits in use. The selection and assessment process for hybrid electric aircraft concepts was continued down to higher detail level. Simulation activities on refined component models took place, as well as larger-scale subsystem testing (Hybrid Ground Demonstrator, HGD1).

LPA Platform 2 activities and progress

All launch reviews related to Platform 2 were closed in 2016. The work in Platform 2 focused mainly on the further detailed design and architecture definition of the three demonstrators.

An extended phase of concept studies took place in Next Generation Fuselage, Cabin and Systems Integration, defining and collecting the most promising future concepts for all-new advanced fuselage architectures for assessment and down-selection in 2017. Criteria for weight saving, reduction of production cost, eco-optimised life-cycle and improved efficiency during operation were addressed. Concept definition of the integrated demonstrator was started. Partners from CfP03 joined the IADP by the end of 2016 and started the work on structural energy storage technologies.

For Next generation Cabin and Cargo Functions requirements definition, concept evaluation and initial design of the demonstrator for the Movable Passenger Service Unit (MPSU) progressed. Concepts and architectures are being developed for the Environmentally Friendly Fire Protection (EFFP), in particular the fire knock-down and long-term fire suppression system based On-Board Inert Gas Generating System, conduct of modelling and Computational Fluid Dynamics (CFD) to support the architecture design phase. Activities with CfP partners kicked off in early 2016.

The demonstrator design and development, system integration and Lab/Ground tests and thermal integration to the aircraft cabin and design optimisation have been done and partially accomplished for the Fuel Cell Powered Galley (FCPG).

In Next Generation Lower Centre Fuselage, four Partners selected from open call CfP02 started development and design activities on main components in Q2/2016, contributing to next generation lower centre fuselage demonstrator concept phase.

In Non-Specific Cross Functions and interface to ITD-Airframe a key part of the action was to align and mature the definition and launch of the innovative non-specific technologies to feed into the Platform 2 demonstrators.

LPA Platform 3 activities and progress

In 2016 LPA Platform 3 activities focused on integrating three Core Partners from CPW2 into the LPA GAM and Platform 3 consortium and initiating the development of the innovative functions and technologies towards TRL4 by 2018. The WBS of Platform 3 has been updated accordingly. The launch review of the Platform 3 demonstrators took place in November 2016.

These activities have been performed in collaboration with several key systems supplier partners as well as with other aircraft manufacturers (business jet and regional aircraft). In parallel, the Maintenance Work Package ADVANCE has finalised the integration of Core Partners from Wave 01 call accelerating the work ramp up.

In Enhanced Flight Operations and Functions - Functions and systems for easier flight, high-level requirements were released for Large Aircraft and the corresponding preparation of specifications was triggered among Core Partners and Partners. This included collision avoidance on ground, speech-to-text, new navigation sensor and hybridisation, touchscreen control panel for critical applications and protective devices for flight crew.

For Functions for Efficient and Easy Systems Management (focusing on regional aircraft), the concept definition phase for the technologies for Pilot Workload Reduction was successfully closed and the final version of high-level specifications and concept-of-operations for cockpit functions was provided to the selected Core Partners.

For Functions and solutions for man-machine efficiency (focusing on the business jets), the main activities were planned and allocated to the selected Core Partners. The elaboration of high-level requirements was started for several key functions.

For Innovative Enabling Technologies on flexible communication (focusing on Modular radio avionics and ATN/IPS router activities) the planning, allocation of tasks with the selected Core Partner DECK and the definition of a first set of high level requirements was completed. A CfP Partner has been selected to work on the development of a Li-Fi (Light Fidelity, bi-directional data transmission by light) demonstrator.

In Next Generation Cockpit Functions Flight Demonstration the flight tests needed for large passenger aircraft innovative functions and technologies have been reviewed and challenged. The tests requirements have been prepared for the 2017 AHRS test campaign. A first version of the LPA enhanced cockpit functions and technologies validation and verification plan has been prepared, to enable the specification of further tests and requirements.

In Disruptive Cockpit ground demonstration, the large passenger aircraft disruptive cockpit demonstrator phase 1 scope and V&V objectives have been reviewed to prepare their specification in 2017.

For the maintenance demonstrator ADVANCE, the development of operational and business scenarios based on airline and major industry actors has been performed to support the completion of the Maintenance E2E (end to end) Architecture specification. The IHMM platform provided the aircraft and the ground segregated functions for the purpose of collecting of data. The transmission and analysis have been developed and the performance demonstrated for the first iteration loop. A CfP01 Partner was selected to support the activities concerning development of system prognostic and augmented reality solutions for maintenance execution enhancements. The Structural Health Monitoring and system prognostic solutions “use case” selection and specification have been performed. Specifications and first low scale demonstrator platforms for mobile tool solutions (augmented and virtual reality) developments have been launched.

The first functional software modules for maintenance tool applications have been developed. The backbone specification of the collaborative environment and communication infrastructure for mobile tools application has been provided.

REG – Regional Aircraft IADP

In 2016 REG technical activities were continued from the previous period and have been mainly related to the further development of technologies and down-selection, trade-off studies, definition of demonstrators and overall aircraft design.

High Efficiency Regional Aircraft [WP1]

Top Level Aircraft Requirements preliminary definition for high efficiency configurations was performed and the related deliverables issued. The definition of activities related to the structural weight saving, on-board systems, aerodynamics for Turbo Prop Aircraft configurations (both wing mounted and rear mounted) were performed. Loop 1 aerodynamics and power-plant design for the innovative configuration were performed. The innovative configuration (rear-mounted engine configuration) Loop 1 aerodynamics design and power-plant definition of deliverables were prepared.

Technologies Development [WP2]

- Adaptive Electric Wing

Contributions were provided to the development of wing structural design, innovative manufacturing processes and Air Vehicle technologies, in preparation for the Concept Review and first technology down-selection. The following main technical activities were performed: definition of Outer Wing-Box structural lay-out and development of automatic design procedures and dedicated fast tools for rapid design and trade-off studies of the wing box; completion of Liquid Resin Infusion process preliminary test trials on wing panels to validate manufacturing process simulation method; SHM damage scenario was selected and definition of the SHM strategy was completed, and preliminary specifications for hardware and software parts of the SHM system are in progress; composite technologies materials and process selection in progress for eco-compatible technologies.

The following technical activities were performed for the Wing Technologies activities: morphing concepts (Winglet, Droop Nose and Flap) and Load Alleviation system (Wing Tip) design first and second loops; NLF wing and High Lift Devices aero design first and second loops; Plasma Synthetic Jets characterisation; riblets design for wind tunnel tests; morphing concepts and LC&A actuation and control system architecture design in progress. The preparation of benchmark CAE models for the next phases of technology assessments at A/C level was completed.

- Regional Avionics

In 2016 the only active WP was Performance and Health Monitoring, dealing with the feasibility study for a Regional Integrated Vehicle Health Management system (IVHM). The main activities dealt with were: the definition of electro-mechanical actuation [EMA] contribution to IVHM in order to define the information/data coming from EMA technology applied to Landing Gear and Flight Controls; completion of high level Preliminary IVHM

Operational Scenarios, focusing on IVHM Member Systems pursued in CS2 REG (Structures – SHM Operational Scenarios; FCS and Landing Gear – EMA Operational Scenarios); definition of IVHM Functional Requirements with a specific focus for Member Systems.

- **Energy Optimised Regional Aircraft**

For all the on-board systems enabling technologies under development within this WP, preliminary verification and validation plans (technological roadmaps) as well as preliminary systems requirements were defined. The achievements related to this WP include key areas of progress made on the following systems:

- Wing Ice Protection System;
- Electrical Landing Gear;
- Thermal Management;
- Advanced EPGDS;
- Electrical ECS;
- Innovative Flight Control System.

Demonstrations

- **Flying Test Bed 1 (FTB1)**

The Flight Demonstration Programme and the preliminary flight test requirements were defined. Progresses regarding the specification and activities for the selection of the A/C as FTB1 for the experimental demonstration in flight were achieved. The upgrade definition of the wing conceptual structural design was performed.

- **Full Scale Fuselage and Pax Cabin Demonstrator**

The preliminary requirements for fuselage demonstrator architecture by design and stress, installation and electrical design, noise, vibration and interiors design, manufacturing and structural laboratory departments were defined. Main outcomes from regional fuselage barrel cost and weight trades were assessed. Fuselage demonstrator preliminary conceptual structural design was completed and conceptual structural design started.

- **Iron Bird**

The task related to Iron Bird Definition was completed. The preliminary detailed HW&SW design was defined in terms of mechanical and electrical architecture and of its main components, physical constraints for the Iron Bird, qualification requirements, flight control surfaces to be reproduced and integrated, functions and operation defining the goals and the configuration under test, simplified aircraft model(s) real-time flight condition simulation. The above topics were assessed in the “Electrical & Mechanical Preliminary Design Review” held in October 2016.

- **Integrated Technologies Demonstrator – Flying Test Bed 2 (FTB2)**

Two principal milestones were targeted in 2016: the Feasibility Design Review (achieved in March 2016) and the Preliminary Design Review, which has been slightly delayed until February 2017 due to technology maturation issues and Core Partner contributions.

The activities related to the technologies applicable to Demonstrator Flying Test Bed 2 (FTB2) during 2016 can be grouped in three sets:

- Definition of aircraft concept and evaluation of technologies: definition of the Regional Aircraft concept for the future using technologies covering an aircraft family of Regional Airliner and Regional Multi-mission. These studies are inputs to the Technology Evaluator in Clean Sky 2.
- Overall Aircraft Design Activities related to technologies applicable to FTB2 Demonstrations: the definition of the aerodynamic performance of morphing winglets, multifunctional flaps, ailerons and spoilers was done during 2016 using analytical and numerical tools.

- Integration of concepts applicable to FTB2 Demonstrator: structural, manufacturing and assembly technologies. Technologies associated with the integration of aileron and spoiler concepts in Regional FTB2 have been addressed in cooperation the leader and the new Core Partner EWIRA. The activity focused on the innovation activity definition and test planning as well as on making progress on the aileron and spoiler components design development.

- Innovation activity: most effort was put into to the test definition in order to fulfil the requirements needed for the Permit-to-Fly and at the same time, keeping most of the innovative content that was intended to be tested (especially in the ALM and Co-bonding innovative areas). Close collaboration between the leader and the airworthiness specialists was established to better deal with this topic. Initial and preliminary tests have been carried out in order to evaluate technologies capabilities. In the new assembly technologies chapter, a Jig-less concept dummy has been completed and the first validation tests were carried out.

- FTB2 Components Development: the main goals were FDR and PDR milestones. FDR was passed and the associated deliverable completed. Progress has been made in the PDR documentation deliverable which is intended to be completed by January 2017.

Technology Development & Demonstration Results [WP4]

- **Technology Assessment**

Contributions were provided to the preparatory phase of TE, in terms of agreement on integrated planning and of detailed information flow between REG IADP and the TE. Participation in the workshops organised by the TE and in meetings on TE Governance organised by JU also happened.

- **Eco-Design Assessment**

The interfaces of REG IADP with the ECO TA were discussed and elaborated. A strategy paper related to the activities with eco-design content in REG and interface with ECO TA was prepared. Contribution and participation was assured for the first ECO TA Coordination Committee.

FRC – Fast Rotorcraft IADP

The Fast Rotorcraft IADP consists of two separate demonstrators, the NextGenCTR Tiltrotor and the LifeRCraft compound helicopter. These two concepts aim to deliver superior vehicle productivity and performance, and through this, economic advantages to users.

Major Achievements in 2016

NextGenCTR - Next Generation Civil Tiltrotor Demonstrator [WP1]

A positive annual review was held in April 2016 covering the initial 18 months (2014/2015) of the vehicle definition and the future activities for the overall programme. The open approach allowed for a good interaction and feedback from the technical review team. Recommendations were made to prioritise key new technologies essential for the successful achievement of the demonstrator. The NGCTR Management team addressed these recommendations with a detailed review of the programme and alternative approaches to achieve its key objectives. During an interim review in July with the JU and technical experts, a proposal was made to focus on a reduced number of technologies demonstrating on an existing product. The proposed vehicle and system architectures were agreed. This proposal was further developed with a revised plan and a schedule presented and accepted at the formal interim review held in November.

The SRR for the original scope was achieved in January. However, the effort put into the programme's review and revision delayed the achievement of the formal milestones related to the grant preparation with CfP02 and CfP03 Partners. Revision of the schedule and use of an existing product will necessitate confirmation of the original SRR maturity in early 2017 with a System Functional Review later in the year.

Some failures for the NGCTR topics were assessed in 2016, notably for two sections of fuselage under the Airframe ITD. The grant preparation with the other successful applicants was undertaken which lead to the GAP signature in early 2017. The call topics for CfP06 and CWP04 were written and submitted, with particular emphasis on the Core Partner call for the supply of a NGCTR-TD Wing.

LifeRCraft - Compound Rotorcraft Demonstrator [WP2]

The preliminary design validation review [PDVR] for all aircraft systems and overall helicopter were successfully passed in 2016. All Core Partners were taken on-board and most of the partners to be involved in building of the demonstrator have been identified, with some already starting the work.

The negotiations with the incoming Core Partners have led to a partial redefinition of the Leader's tasks. This redefinition, combined with technical challenges which emerged during the work performed by the Leader's team, led to delays in the freezing of the interfaces. Most preliminary design reviews initially planned in 2016 should be achieved in 2017, except for Aerodynamics. This will lead to a first flight in mid-2020, instead of 2019. The updated planning

was shown during FRC Interim Progress Review.

LifeRCraft Flight Demonstrator Integration

After the completion of the last wind-tunnel tests, the Aerodynamics and Performances preliminary design review was successfully achieved in mid-2016. The LifeRCraft aerodynamic configuration is frozen.

Analysis and piloted simulation have been conducted in order to define the rotor speed law, flap laws and lateral control laws. Estimation of the aerodynamic loads has been done in order to start the sizing of aircraft components. A scale one lateral rotor has been tested without and with the wing in order to validate the performances and perform noise measurements for comparison with NACOR (ITD AIR) estimations. The main rotor forecast demonstrator has been tested in flight in order to calibrate rotor numerical model and to define the best tuning of rotor blades.

Architecture activity has been continued in order to define the installation of the system to be integrated and to define the interface concept between each component of the aircraft. A digital mock-up of the project is regularly updated to implement the data coming from the Core Partners and Partners and solve the identified interference problems. An extended enterprise network has been implemented and was working with all FRC Core Partners in early 2016.

LifeRCraft On-board Systems Integration

- Electrical system: detailed work with the partners selected for the HVDC system has started. The installation of the electrical equipment, the definition of the electrical harness architecture and the harness routing has also started.
- Avionics and sensors: selection of the architecture of the avionics and displays was determined, using off the shelf components. Integration of the avionics has started.
- Flight control, guidance and navigation: Preliminary definition has been set, based on requirements in terms of control laws particularly for the lateral rotors.

Eco-Design concept implementation for Fast Rotorcraft [WP3]

FRC and Eco-Design Leaders agreed a strategy paper for FRC. As ECO-TA scope is very wide, the consensus in FRC is to address eco-design activities in a very applied and practical manner for a few test-cases, around each demonstrator.

Technology Evaluator interface for Fast Rotorcraft [WP4]

The FRC consortium supported the JU and the TE coordinator with the establishment of a dedicated Consortium Committee aimed at coordinating TE aspects across all ITD/IADPs. In addition, the FRC consortium supported the TE coordinator by reviewing and commenting on specific TE calls released under CfP05 aimed for a) Airport and Air Transport System (ATS) impact assessments for fast rotorcraft application comprising of simulation related to fast

rotorcraft fleet and traffic scenarios at airport/heliport, city and world regions for various missions, and b) performing a forecast for all types of rotorcraft fleet and movements starting from 2015, passing by 2020/2025/2030 until 2035 with details per type of mission at country/regional/world levels.

Revisions of the initial plans for FRC demonstrators meant that the definition of the schedule and preparations for applicable scenarios for the Technology Evaluations were unable to start in 2016.

AIR – Airframe ITD

Activity Line A: High Performance & Energy Efficiency

Technology Stream A-1: Innovative Aircraft Architecture

In the *Optimal Engine Integration on Rear Fuselage* work package, a first list of concept candidates has been established. Two reference aircraft configurations were considered. The disruptive configurations have been chosen from the down-selection process. The redesign of the reference aircraft configurations has been initiated using an Overall Aircraft Design (OAD) approach.

A first selection of innovative aircraft concepts has been defined for the Novel High Speed Configuration investigations. The redesign of the reference aircraft configurations has been initiated by an OAD approach. For the Virtual Modelling for Certification, the activity focused on modelling topics.

Technology Stream A-2: Advanced Laminarity

The design and validation of a structural concept for the Laminar Nacelle for business jet (BJ) was completed. The Natural Laminar Flow (NLF) Smart Integrated Wing work package contributed to the in-flight BLADE demonstration, planned for September 2017. On-going NLF concept development continued in synergy with the preparation of BLADE. Research activities on NLF wings including validation of structural concepts were carried out.

In Extended Laminarity the development of an innovative HLFC concept applied to a vertical tail plane, the design of an innovative NLF front fuselage (including the parasitic drag reduction) and the improvement of the transition criteria in transonic conditions were started. In addition a first computation of Business Jet fuselage nose section was performed.

Technology Stream A-3: **High Speed Aircraft**

Preliminary architecture studies of the Business Jet wing root box demonstrator for the Multidisciplinary Wing continued in 2016. Design loads were elaborated to size the demonstrator. The design for the Aileron Rib-concept started and will continue in 2017.
In the Innovative Shape & Structure work package, the activity focused on the Business Jet composite central wing box demonstrator and a demonstrator panel was manufactured. The work on the design concept for an innovative aircraft door structure and its integration continued.
For the Eco-Design for Airframe, the ecoTECH project from CPW02 was fully integrated into the work package activities. The scoping of new technologies started for the selection of the most promising candidates for development. Activity related to the Re-use of Thermoplastics started, supporting the development of new processes, methods, manufacturing & recycling technologies.

Technology Stream A-4: Novel Control

For Smart Mobile Control Surfaces, the activity on the Electrical Ice Protection Systems on a Business Jet slat was carried out. For innovative movables, the implementation of the successful topic launched under CPW03 has been completed, with the activities starting as of the end of 2016.

In the Active Load Control work package, the development of a control law for gust load alleviation and flutter control functions was initiated. In addition, a load control by various means for wing application was studied for LPA application. In the frame of NACOR, activities were addressed on vibration control, flight control, gust load control and flutter control.

Technology Stream A-5: Novel Travel Experience

As part of the Ergonomic Flexible Cabin, a study of a PRM lavatory (persons with reduced mobility) has been performed. The project on "Technology evaluation of immersive technologies for in-flight applications" has been integrated and commenced. In the Office-Centred Cabin, the activity focused on the integration of the project CASTLE for the BJ cabin application. The delivery of an aircraft level specification is planned for the beginning of 2017.

Activity Line B: High Versatility and Cost Efficiency

The required coordination of activities and interdependencies between IADPs and AIR were defined and completed during 2016.

Technology Stream B-1: Next generation optimised wing

For the Wing for Lift & Incremental Mission Shaft Integration, the design of a compound rotorcraft in close cooperation with the FRC LifeRCraft demonstrator has been accomplished. First evaluations of the noise emissions were completed by Q1 2016. In conjunction with LifeRCraft team, the schedule for the Pre Design Review was agreed. Design works for the wings and lateral rotors continued. Final studies and development prior to the manufacturing of the full scale demonstrator have been performed.

In the More Affordable Composite Structures work package, the trade-off of multiple conceptual designs for small aircraft has progressed to define the selected architecture for the composite wing demonstrator. Finite Element Models for the different architectures were built for further investigation. For Material and Processes, a down-selection criterion has been defined and a screening based on most crucial parameters has been completed. To select the most appropriate technology for each structure, a weighted criteria table has been defined with dominant parameters.

In the more efficient wing technologies work package, a morphing winglets concept has been developed and a preliminary design review (PDR) was held at the end of 2016. The results are under analysis. With the Partner selected through CPW03, the activities on manufacturing tooling have started. Design requirements have been defined for the highly integrated

actuation system to control surface tabs with EMAs.
In Flow & Shape Control, the development works of the Loads Alleviation and morphing leading edge has been carried out. The definition of basic requirements of an optimised droop nose device in a composite wing has been accomplished.

Technology Stream B-2: Optimised high lift configurations

In High Wing /Large Turboprop Nacelle Configuration, the work with the Partner selected in CfP02 has started and activities have been ramped up on the integration of ice protection based on heat transport devices (Loop Heat pipes) into the engine air intake. The system specification and the top level requirements have been established.

For the High Lift Wing, the selected concept for the wing box and a multifunctional flap has been developed, with a focus on the hot stamping process and with the aim to achieve a final design during 2017. The definition of the design requirements for the highly integrated actuation system to control flaps with EMAs has been completed.

Technology Stream B-3: Advanced integrated structures

In the All Electrical Wing, the design requirements phase has been completed for the highly integrated actuation system based on Electro Mechanical Actuators (EMAs) to control aileron and spoiler, with the target to start the testing and integration phase at the end of 2017. The development of the selected integrated electrical distribution HVDC (High Voltage Direct Current) continued with the target to achieve a final design during 2017. In addition, for SATCOM and ice protection, both embedded in the structure, the design was concluded.

An innovative electro-thermal heating system based on Carbon Nano Tubes (CNT) has been further enhanced through first simulations and design concepts, regarding performance and processability. The Critical Design Review (CDR) of the ice-protection system has been performed. For the network for power supply and information system for AFC a preliminary design review (PDR) has been carried out.

The development phase for Structural Health Monitoring [SHM] system for the Advanced Integrated Cockpit started, in order to reach a level of maturity for starting test and integration phase at the end of 2017. All activities linked to Core Partners have been defined and are being deployed.

For More Affordable Small A/C Manufacturing, the scope of metal-composite joints was optimised. A first set of specimens was tested and based on the results a second batch for testing was prepared. The project from CPW02 has been fully implemented and started in 2016.

In the New Materials and Manufacturing work package, the focus of the activities was on technologies related to eco-efficient factories, assisted composite manufacturing, future leakage identification systems, integration of testing systems and automated testing technologies ramp-up. Test coupons have been manufactured using ALM technology. Quality

of manufacturing and the resulting material characteristics have been assessed. First numerical studies on structural optimisation during the manufacturing process have been performed.

Technology Stream B-4: Advanced fuselage

For the Rotor-less Tail for Fast Rotorcraft, a Preliminary Design Validation Review [PDVR] was held and was successfully passed for the Rotor-less Tail. The Preliminary Design phase was extended as a result of the updated schedule of the LifeRCraft, and therefore the PDR and its associated activities have been extended to Q2 2017. Activities related to manufacturing processes and materials were carried out as well as the engineering concurrent activities in order to ensure the manufacturing feasibility of the Rotor-less Tail Pre-Design.

The requirements for the Pressurised Fuselage for Fast Rotorcraft (front, centre and aft sections including empennage and empennage control surfaces for the NextGenCTR), plus main cockpit glazing, cockpit secondary glazing, cabin glazing, aircraft doors and emergency exit were completed, following the aircraft level System Requirement Review [SRR] in early 2016 under the FRC IADP. Negotiation with the Core Partner selected in CPW03 for tail section fuselage started.

For the More Affordable Composite Fuselage, a test matrix for Level 1 tests on specimens has been defined, and main coupons and elements designed. The tests on the specimens are in progress. Two manufacturing trials were realised and characterised; performance evaluation of eco-compatible surface treatments has been done. The selection of software and hardware for SHM technology and methodologies has been concluded. Test plans for coupons and elements have been defined as well as a maintenance strategy for an SHM-enabled fuselage.

In the context of part distortion prediction activities, developments have been focused on topology optimisation accounting for distortion and shape and lay-up optimisation accounting for distortion. In the field of metallic components it was supported by a CfP01 Partner project.

In 2016, implementation of a CfP project on composite component distortion prediction was supported.

For the Affordable Low Weight, Human Centred Cabin, the definition of the Human Centred Design Approach for related requirements and preliminary technologies has been completed. Preliminary description of technologies for green material development applicable to the cabin interiors major items including identification of most promising applications has been done, as well as the Noise & Vibration requirements and targets with description of the methodology to assess the results has been defined.

ENG – Engines ITD

A number of key Engine ITD management processes have been refined and applied to new Core Partners entering the programme. The annual review took place in Paris between the 27 - 29 September 2016.

For the Ultra-High Propulsive Efficiency (UHPE) Demonstrator for Short/ Medium Range Aircraft, a Concept Review (COR) of the Integrated Power Plant System (IPPS) has been performed in Q2 2016. The main objective of the COR was to validate the engine architecture and the engine performance cycle. Based on COR engine architecture, a first loop of engine integration has been done. The integration of all the UHPE Clean Sky 2 beneficiaries, including the Core Partners, was efficiently completed.

The activities on the Business Aviation/ Short Range Regional TP Demonstrator have ramped up as Third Parties and Core Partners have joined the demonstration programme. All specifications and requirements for this work package have been defined. The interfaces between modules and parts have been discussed and agreed and the IPPS architecture has been validated. The characterisation of the V0 propeller was successfully completed and the preliminary analysis for the propeller demonstrator has started. The work on Power & Accessory Gear Box (PAGB) has focused on the manufacturing and instrumentation. The detailed design of the PAGB is nearly completed. The detailed time schedule has been reworked: CDR is planned from Q4 2016 to Q1 2017.

In the Advanced Geared Engine Configuration work package, the activities focused on two key aspects: the compression system and the expansion system.

For the compression system, the work progressed further in 2016. The first compression system rig (Intermediate Compressor Demonstrator [ICD] Rig) will be used to advance the understanding of inter compressor ducts by obtaining measurement data and calibrating the CFD methods with this data. A detail design review of the ICD rig was performed and concluded in Q4 2016. The next project phase will consist of the hardware procurement to allow testing of the ICD rig in 2017 as planned in the project plan.

For the expansion system, the activities mainly concentrated on advanced technology development. An initial Design Review was successfully passed in Q1 2016. The conceptual implementation of the LPT technologies into the demonstrator vehicle has been confirmed and the correlating risks have been evaluated. Also the compliance with the validation needs of the developed technologies with regards to temperature and mechanical load levels has been proven and the chronological interconnection of technology projects with engine demo development has been verified.

A number of significant milestones have been achieved towards the design of the UltraFan™ architecture. The first full scale power gearbox was successfully tested on the 'attitude rig'. It will be followed by testing on the 'power rig' in 2017. Work on the second design iteration of the gearbox is progressing well.

The development of the Structural and Turbine sub-systems for the UltraFan™ demonstrator also made significant progress. Core Partners completed the experimental rig requirements for the intermediate pressure turbine (IPT) system and produced the design rules for Titanium Aluminide (both of these are key deliverables), as well as delivering a report on potential alternative intermediate compressor casing materials and continuing to work on maturing the demonstrator design solution.

For the VHBR – Large Turbofan Demonstrator, a stage zero exit gate review was successfully completed. This represents the end of the innovation and opportunity selection phase allowing the design to advance into the preliminary concept definition phase where major architectural decisions (in conjunction with airframe/engine architecture decisions with the LPA leader) will be fixed. All major roles in the organisation structure were filled in 2016 including product development managers (PDMs) for all of the required engine sub-systems.

In line with the update to the Engine Development Plan (EDP) an initial review of the verification and validation strategy for each technology stream was completed which has enabled better visibility of all the required testing both at an engine level and sub-assembly level. Additionally, the two leaders continue to work together towards the realisation of the UltraFan flight test demonstrator; this activity is being carried out within Large Passenger Aircraft IADP with a formal go/no go decision in 2017.

For the Small Aircraft Engine Demonstrator, several PDRs and CDRs were held and successfully passed. The specifications (core engine, turbocharger installation) and the design for the different engines (four and six cylinders) have converged. To initiate the first step of propeller tests with the basic propeller configuration, the engine has been installed at the Partner's facility.

In the Reliable and more efficient operation of small turbine engines work package, the activities continued on the seven sub work-packages to address technical challenges to deliver next generation turboprop engines and propeller and deliver major improvements in engine technology.

The main activities of the Eco-Design work package focused on the finalisation of the initiation phase of the Eco-Design programme inside the ENG ITD. Beside the establishment of the ENG ITD-Eco-Design strategy paper as a baseline, a detailed definition of the work scope has been initiated. A list of topics has been harmonised and condensed to four sub-work packages.

SYS – Systems ITD

For the Avionics Extended Cockpit, the mock-ups of new cockpit displays have been matured, and a first prototype of tactile control panel is available. New concepts of voice interaction have been brought to TRL3. Flight management system (FMS) functions have been further developed from their 2015 status.

Fly by trajectory concept has been further matured and the implementation of a TRL4 maturity mock-up for specific sub-functions has started.

The concept of modular inertial reference unit mechanical concept and functional breakdown was defined, and the preliminary design review was completed. The milestone to fly the first sensor suite for a future embedded vision system (EVS) in the vision and awareness simulator was passed.

The work on the modular communication platform included the refinement of the aircraft level requirements, leading to the first system architecture description being completed at the end of 2016. The activity on the Cabin and Cargo work package has not yet started. A topic has been issued with the fourth Call for Core Partners in 2016.

The wing system architectures for power and controls for the Smart Integrated Wing Demonstrator have been elaborated in the Innovative Electrical Wing work package. For the purpose of further investigation a simulation software tool was benchmarked, selected and procured. The phase one of the demonstrator setup has been defined and started, identifying the right facilities and procuring first rig components.

Technology bricks for a decentralised hydraulic power pack progressed through studies and the start of a multiple pump test rig to assess long-life characteristics of different configurations. Electro-mechanical flight control technologies for regional aircraft progressed with updated specifications. EMA’s conceptual design was frozen and the preliminary design has been started. Pre-PDR meeting has been held and validation plans have been released. A new activity covering smart active inceptor devices for the next generation of flight controls has been integrated. Master planning was set up to support flight demonstration in 2023 with FRC.

In the Landing Gear Systems, the smart motor prototype for phase one has been designed and first components ordered. The architecture trade-off studies for full electrical main landing gear extension/ retraction system started. The preliminary design and TRL3 milestone for the local hydraulic system has been achieved. The proof of concept demonstrator test setup has been completed. The integration of new Core Partners for landing gear composite structure and electrically actuated brake was completed.

First functional tests on the electromechanical retraction actuator have been successfully carried out. In addition, studies of design optimisations have been performed. TRL3 milestone has been achieved. A first set of high level requirements has been produced to trigger the activities of CfP Partner on advanced landing gear sensing and monitoring system.

In the Electrical Chain, the implementation of the Core Partner on HVDC power management centre has been completed. The development of a full digital generator control unit (GCU) started and the specifications have been released. The EDCU preliminary design review (PDR) was successfully passed, validating the architecture to enable later demonstration. Technology bricks for the power electronic module were evaluated or design has started.

In Major Loads, aircraft loads architecture activity focused on the analysis of the results of the Systems for Green Operations (SGO) large demonstrations on PROVEN and A320 (eFTD). Activities on adaptive environmental control system started with initial down-selection of chemicals of interest and definition of requirements for the air quality sensor. Test rigs are being built to assess what contaminants could be present in the air and what technologies can these contaminants to the required level. Trade-offs on new electrical ECS architectures for single-aisle were launched extending to thermal management, using experiences from Clean Sky 1 to define a Clean Sky 2 baseline in mid-2017.

For the electronic environmental control system (E-ECS) for regional aircraft, the objectives were finalised with the airframers and E-ECS technology bricks have been defined. After an Icing Wind Tunnel test campaign, the evaluation of different architectures for Wing Ice Protection System has allowed several architectures to be selected for progressing to TRL3. A new Core Partner has been integrated for the development of an Icing Detection System. The master schedule for demonstrator activities has been defined.

For the Small Air Transport Activities, a topic for a CfP was issued, following the more electrical Landing Gear trade-off definition. A Partner for the De-ice System has been integrated. A trade-off study for De-Ice Architecture for Small Aircraft was performed. The evaluation of components for the Fly by Wire Architecture for Small Aircraft progressed. The flight control computer has been identified. Another component for the flight air data was identified and it is being investigated to identify possible collaboration.

Technical content for the Core Partner on Affordable SESAR Operation, Modern Cockpit and Avionic Solutions for Small A/C has been detailed. The new Core Partner performed detailed reviews of several technologies and assessed the feasibility to integrate them into the common cockpit demonstrator. The possibilities of the final demonstration aircraft were analysed and resulting opportunities and limitation have been incorporated into the final demonstrator architecture.

The main activities on Comfortable and Safe Cabin for Small Aircraft were focused on the integration and start of two new Partners. In addition the investigation of seat belt position influence proceeded with the definition and preparation of design variations. Trade-off studies on active noise reduction in small aircraft and on assessment of noise and thermal load in small aircraft were finished.

The study of potential secondary distribution architectures is progressing in the Power Electronics work package. Requirements have been clarified and the development of simulation models progressed. For the work on Paralleled Operation of 2 Power Cores, the test bed for paralleled cores operation is being manufactured. On Improvements in Parallel

Operation of Reversible DC Sources experimental investigation is being prepared. Provisions for building a test rig are completed. Initial discussions were held on the High Current Power Module, Packaging and Printed Circuit Board (PCB) Cooling.

For Eco-Design, the activities on new alloys and composites as well as electron beam melting continued in 2016. A scroll demonstrator for out-of-high-temperature resistant aluminium was produced. The activities for the Model Tools and Simulation work package started in Q1 2016. The initial requirements of the tool-chain were delivered in Q3 2016. The core simulation environment of the MISSION framework at TRL3 was delivered including a live demonstration. Progress was also made on the development of modelling and optimisation activities with initial focus on actuation systems.

SAT – Small Air Transport Transverse Activity

The Small Air Transport Initiative represents research and technology interests of the European aircraft manufacturers of small aircraft used for passenger transport (up to 19 passengers) and for cargo transport, belonging to EASA´s CS-23 regulatory base. In 2016, the SAT GAM was signed and management activities were moved from the Airframe ITD [Interface and Cross-interaction Management] to the SAT TA. These management activities are aimed at enabling effective cooperation with ITDs to coordinate, drive and monitor the technical functions of the Transversal Activities.

The SAT Transversal Activity Coordination Committee (CC) monitors all activities developed at the level of the three involved ITDs. One of the main tasks was the implementation of the CfPs related to SAT activities in order to harmonise and have a high-level control on budget. The established rule is that the discussion is first in the CC and after its approval; the topics are transferred and executed in the ITDs.

Core Partners

During 2016 three Core Partners were integrated into SAT technical activities and CP coordinators participated in SAT coordination via SAT CC. In total, SAT has incorporated four Core Partners, and no others are expected.

Reference Aircraft Configuration

In WP 2 activities towards definition of the three reference aircraft continued. To ensure a wide range of used data/aircraft, SAT Core Partners were invited into the process and the updated document will be issued in another loop. Activities in this WP are coordinated with TE.

Advanced integration of Systems and Engine in small a/c

A small activity started at the level of the SYS ITD for electric architecture, with an open discussion with Thales for electrical generation, but the activity is not developed enough at the moment to allow a comprehensive integration study.

ECO – Eco-Design Transverse Activity

Eco-Design TA has the following general objectives:

- Expanding and enhancing the CS1 database on materials, technologies, processes and resources;
- Serve as a contact point for ITDs and IADPs regarding environmental or sustainability issues;
- Create customised Life Cycle Analysis models for current and future aircraft, covering production, operation, maintenance and end of life;
- Train the consortium in Eco-Design and provide guidance;
- Serve as a frontrunner in the aviation sector for Europe and worldwide for analysing and quantifying the environmental footprint of air transport;
- Guarantee the link between ACARE and the fulfilment of their environmental goals (CO2, NOX, environmental impacts such as global warming etc.);
- Establish global Key Performance Indicators.

Work performed and main results achieved so far

The work carried out during 2016 aimed to establish an interaction with all ITDs and IADPs through the Eco-Design coordination GAM. The intention was to identify the eco-relevant technologies with clear TRL development paths and demonstration objectives to be developed considering different and specific drivers. Screening was also based on SPD's strategy papers for Eco-TA compliance and eco content.

Transversal coordination comprised as key activities the coordination, bilateral meetings and interaction with IADPs and ITDs, and the development and approval of the Eco-Design Initial Dissemination and Communication Plan.

Eco-Design "Lead-In" Activities

Bilateral meetings with SPDs have been carried out to discuss focus areas for ecological synergy and assessment methods (VEES, EDAS synergy) with preliminary indication of technologies, processes and material development. Analysis of Eco-Design strategy papers from SPDs for eco objectives prioritisation has progressed. The technology screening, mapping, allocation, assessment and prioritisation of SPD technologies (mainly SPD AIR, SYS, ENG, REG) related to eco objectives were started with SPDs.

Eco-Design technology ramp-up

Life Value Technologies Coordination was started by structuring eco-related activities in various SPDs according to eco-themes (e.g. outline of Eco-Engine WP9 proposals for integration into future Engine ITD activity).

Eco-Architecture: investigation of SPDs proposals related to Eco-Architectural concepts (e.g. new recycling routes, new manufacturing facilities and plants) was commenced.

Assurance and Compliance: initial work started to assess eco proposals' compliance.

Eco-Design Tools and Analysis involves initial Eco-Design platform concept explanation for SPDs. Preliminary investigations on base technologies needed to implement the concept were held. An evaluation of 2D visualisation frameworks / middleware technologies plus 3D web visualisation (X3DOM) was initiated. Modelling for the VEES and EDAS Mapping and the definition and first draft of the deliverable "Socio Economic Derivative (SED)" was achieved.

TE – Technology Evaluator

In 2016 an all SPDs workshop was held in Brussels (February) followed by a series of bilateral meetings or telephone conferences with each SPD separately. In these bilateral meetings the following issues were discussed:

- TE2 general approach: timing, expected outcomes, reference and Clean Sky vehicles (TLARs and technology list).
- Status of planning: model requirements for TE2 assessments, TE2 planning, interim review requirements.
- TE2 assessments at airport and ATS level: desired outputs and metrics, required inputs.

Five topics were published in the CfP05:

- Airport Level Assessment (Fixed-wing);
- Airport and ATS Level Assessment (Rotorcraft);
- ATS Level business jet 2035 forecast;
- ATS Level Rotorcraft 2035 forecast;
- ATS Level SAT 2035 forecast.

An information day on the call took place on 30th November 2016 in Brussels for CfP05.

A Cooperation Agreement (CooA) has been prepared which will serve as the legal basis to exchange and share data among all parties involved in CS2 TE work. Additionally, an implementation agreement template has been developed and published along with the publication of the calls. Signing of the CooA is foreseen for the beginning of 2017. At the request of the JU, a proposal for global warming assessments, as part of the two major assessments in CS2, has been developed and has been presented to the SPDs.

Integrated planning

Clean Sky Programme has shown that an "integrated planning" is crucial for the successful implementation of the TE assessments. This implies the planning of the TE mission, airport and ATS assessments and the interaction with SPD models input at a higher aggregated level, and a more detailed split of the SPD models description in terms of technologies and TRL levels. Mission level assessments will be performed by the SPDs themselves which will then be collected and assembled for reporting by the TE. Airport level activities and assessments will be performed by a winner of a call. These will include airport fleet noise and emission performance assessments. Activities are expected to begin by the end of 2017. Substantial efforts have been made in 2016 to establish common grounds for the integrated planning down to the level of (major) individual technologies.

Top level aircraft requirements

A collection of the top level aircraft requirements was gathered in 2016 including reference aircrafts and Clean Sky 2 concept aircraft based on SPD planning. An aggregated list of TLAR included the following parameters: entry into service, range capability in nautical miles, cruise speed Mach number, maximum take-off weight in kg, number of passengers, engines and general configuration of the aircraft. For regional and SAT aircraft more detailed TLARs were

provided e.g. in terms of weight splits. The following aircraft is projected for CS2:

- Four large passenger aircraft: an advanced short medium range (SMR), an ultra-advanced SMR, an advanced long range aircraft, and a hybrid propulsion aircraft;
- Three regional aircraft: a conventional turboprop aircraft with 90 PAX, an innovative turboprop aircraft 130 PAX, and a regional turboprop aircraft with 50-70 PAX;
- Two fast rotorcraft: a compound and a tilt-rotor;
- Two SAT aircraft: a nine- and a 19-seater;
- One business jet: a low sweep business jet.

The reference aircraft to measure CS2 progress against the High-Level Objectives [HLOs] as defined in the Regulation are either 2015 state-of-the-art or Clean Sky technology-based. For example, for the tiltrotor no "classical" reference could be identified, but for oil platform missions a comparison in terms of passenger productivity with a Clean Sky Twin Engine Helicopter configuration could serve as a reference.

1.7. Call for Tenders

No Calls for Tenders have been launched in 2016.

1.8. Dissemination and information about projects results

Clean Sky aims at the full dissemination of the projects and technological results developed within the programme. The dissemination activities in this section are particularly addressed towards the European scientific and academic community. They play a pivotal role within Clean Sky and are at the base of the success of the programmes.

The Clean Sky programme started in 2009 and builds around six main technology platforms (wings, engines, systems, regional planes, rotorcraft and eco-design) which have produced and kept on delivering results since. More than 700 publications have been produced for the scientific and academic community and an impressive number of 186 registered patents are reported to date to the JU. They all contribute to Clean Sky's main objective: reducing the environmental footprint of aviation by 2020 and beyond.

Some of the titles of these publications and links to the different documents, events and pictures elaborating in detail on those technological results are available in Annexes 4 and 5.

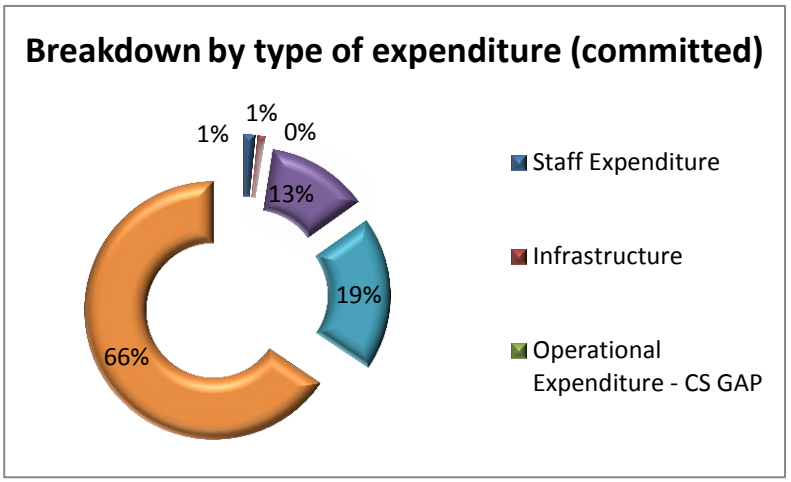
1.9. Operational budget execution

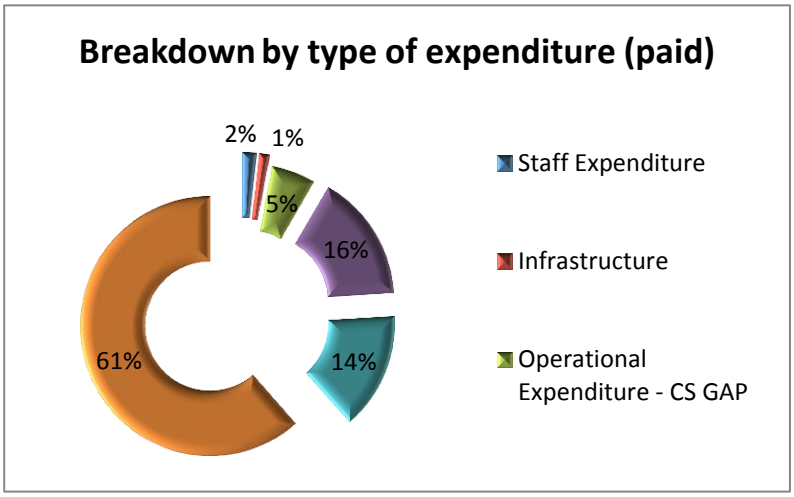
Budget management

Since 2014, the JU manages in parallel the two Programmes Clean Sky (under the seventh framework programme) and Clean Sky 2 (under the Horizon 2020 framework programme) with a corresponding amount of commitment appropriations of €310.5 million. Of this, €302.3 million is allocated to the operational expenditures of the Clean Sky and Clean Sky 2 programmes with respectively €38.5 million and €263.8 million.
The JU executed 98% through new financial commitments which represents a very high rate for both administrative and operational budget (100% and 98% respectively).

The available payment appropriations increased by 117% compared to the previous year to €287.8 million. Of this amount, 90% was paid out during 2016 showing a notable increase compared to 2015 (81%).

At a glance, a breakdown of the areas of commitment and payment is illustrated.





Facts and figures by title of the budget:

Title 3	Budget (€ m)	Executed (€ m)	% rate
CA	38.5	38.4	99.7
PA	59.0	53.2	90.2

Title 3 - Clean Sky Programme (FP7): The chapters relating to the ITD grant agreements for Members (chapters 30-36), show a very high rate of commitment (99.7%, 2.6% increase compared to 2015). This is due to the fact that 2016 is the last year of activities for the grant agreements for Members and almost the full envelope to completion of the programme is used.
On the payments side, the payment execution rate for 2016 comes up to 90.2% with 97.4% for grant agreement for members and 74.3% for grant agreement for partners.
The lower execution for GAP payment can be explained by the closure of Clean Sky programme. When the programme is reaching the end of the activities, the JU had to deal with delayed reporting from beneficiaries, but also with more complex payment files to process and generating a much lower budget consumption (190 interim/final payments for a total of €13.7 million compared to 217 interim/final payments for a total of €16 million in 2016). Consequently, the payments delayed will be processed during the first part of 2017.

***

Title 4	Budget (€ m)	Executed (€ m)	% rate
CA	263.8	257.0	97.4
PA	214.1	192.1	89.7

Title 4 – Clean Sky 2 Programme (H2020): The second and third wave of core partners acceded the GAMs before the end of 2016. The volume of core partners has been much higher than foreseen, thus it has required a significant effort and resources from the JU to efficiently manage it.

For GAPs, the remaining grant agreements from the first Call for Partners were signed, as well as all grant agreements from the second Call for Partners. During the last period of the year the JU also processed with the signature of approx. 25% of the grant agreements from the third Call for Partners which will continue in early 2017 for the remaining part. The JU also processed all pre-financing for the relevant projects.

The objective of reaching 100% of commitment appropriations consumption was almost achieved by the end of December with an execution rate of 97.4%. This was due to some core partners of the third wave that could not be included in the grant agreement for members by end of 2016, but will be further processed in the next GAM amendments in 2017.

The payment appropriations execution rate reached 89.7% with 92.0% for GAMs and 81.0% for GAPs respectively. These payment execution rates resulting in €22.0 million unused was mainly due to the following factors:

- for GAMs, the Fast Rotorcraft SPD did not take part to the second call for core partners as initially planned (but will include the selected core partners of the third wave in the next GAM amendment early 2017). In addition, as explained above, some core partners of the third wave that could not be included in the grant agreement for members. These both factors resulted in a lower pre-financing paid than planned for 2016.
- for GAPs, the third Call for Partners was finally delayed due to later validation of the call topics which resulted to a Time to Grant (TTG) shifted to early 2017 instead of end 2016.

1.10. In-kind contributions

In-kind contributions (IKC) are provided by the private members throughout the lifetime of both programmes. The details of how they do this are explained in the following sections. As set out in the Clean Sky 2 Regulation and its predecessor, they take different forms.

	H2020 (m €)	FP7 (m €)
Max. Union contribution for operational expenditure	1.716	776
Max. total EU contribution to operational cost of private members (Leaders/Core-Partners/Associates)	1.201	576
Min. expected contribution from private members to the Joint Undertaking	2.193	576
Private Members contribution for operational expenditure for funded projects – in-kind (IKOP)	1.190[7]	576
Minimum Private Members contribution for additional activities – in-kind (IKAA)	965	n.a.

FP7 programme:

According to the applicable funding scheme, the in-kind contributions stemming from FP7 grant agreements of the Clean Sky programme represent 50% of the total eligible costs incurred by the JU's Members. The validation process of the JU management is the same as for the cost claims, which is mainly based on the Certificates for Financial Statements (CFS) provided by the auditors of the Members, but also on the thorough review of the cost claims carried out by the JU's Financial Officers and Project Officers.
Likewise, the IKC of the private members in the FP7 programme is covered by the ex-post audit process established by the JU for checking the validated cost claims.

As shown in the table below, considering the information provided through the costs statements estimates submitted until the cut-off date for the Final Accounts 2016, the situation is as follows:

EC FP7 contribution[8]	588 185 723.38
Members' FP7 in–kind contribution	588 185 723.38
FP7 IKC validated by the GB (recognised in JU net assets)	554 682 257.40
FP7 IKC pending validation (liability to be validated)	33 503 465.98
Ratio FP7 Members IKC/EC contribution	1:1

[7] This figure is an estimation
[8] GAM expenditure recognised in the JU accounts financed by EC contributions for the period 2008-2016

Validated contribution per ITD:

ITD	Total private contributions validated since JU inception
ED	38 895 284.14
GRA	66 984 102.34
GRC	54 116 164.85
SAGE	143 015 605.48
SFWA	138 254 090.60
SGO	100 663 974.26
TE	12 753 035.73
TOTAL	554 682 257.40

H2020 programme:

The private members can provide their in-kind contributions in two ways under the H2020 programme: in-kind contributions from operational (JU funded) projects, i.e. unfunded share of costs on JU projects (IKOP) and in-kind contributions from implementing the so-called additional activities (IKAA).

IKOP certification and validation

According to the Clean Sky 2 JU regulation, all costs to be taken into account as IKOP must be certified. The IKOP values mentioned in the table below are based on reports and in some of the cases on accompanying certificates received from Members. As of the cut-off date of the Final Accounts 2016, the JU management has validated certified contributions to the value of €39 168 594.51. A breakdown by area of the projects is provided here:

ITDs/IAPDs	GAM 2014 – 2016 JU contribution (70% or 100%)	Reported IKOP by private members 2014-2016	Certified and validated by JU IKOP 2014-2016	Still to be certified IKOP
AIRFRAME	42 504 483.63	30 247 419.71	9 620 362.03	20 627 057.68
ECO-DESIGN TA	470 474.66	457 046.63	-	457 046.63
ENGINES	48 224 471.33	45 538 377.35	13 067 187.01	32 471 190.34
FAST ROTORCRAFT	18 818 704.41	13 863 997.19	5 298 658.81	8 565 338.38
LARGE PASSENGER AIRCRAFT	32 211 511.18	22 355 349.07	5 189 390.31	17 165 958.76
REGIONAL AIRCRAFT	9 814 687.84	6 860 889.75	800 516.68	6 060 373.07
SMALL AIR TRANSPORT	173 103.87	156 407.37	-	156 407.37
SYSTEMS	27 579 724.99	23 569 678.00	5 192 479.67	18 377 198.33
TE	193 810.00	107 451.99	-	107 451.99
TOTAL	**179 990 971.91**	**143 156 617.06**	**39 168 594.51**	

The procedures for the management of in-kind contributions have been established and further revised in 2016. The procedures and the guidance issued efficiently accommodate the private members while providing an adequate control level for the public stakeholders.

IKAA certification and validation

The IKAA value of €199 156 574.96 reported here is fully certified by the members' auditors and validated by JU management for the period 2014-2016. This value has also been provided to the Governing Board for its opinion in accordance with Article 8 (2) (j) of the Statutes of the CSJU.

The additional activities underlying the values validated by JU management to date and reported for the periods 2014 and 2016 consist of:

- Preparation of test aircrafts/platforms including infrastructure for flight testing;
- Development and testing of advanced component technologies, modeling, control systems and materials systems for the engine demonstrator programme;
- Development of accompanying manufacturing methods and techniques, e.g. for laminar wings;
- Development of supporting technologies, e.g. research and technology development of architectures, technology bricks and other enablers for systems and airframe;
- Aircraft architecture design process;
- New manufacturing and assembly techniques;
- Composite manufacturing processes;
- Activities concerning the innovative passenger cabin;
- Configuration optimisation tools;
- Development of various technologies/materials lowering operating and life cycle cost;
- Counter-Rotating Open Rotor related complementary activities;
- Landing Gears complementary activities;
- Preparation of simulated environment for integration of early developments.

The state of play of the total reported and certified contributions from private members under the H2020 programme (started in July 2014) is set out below:

Overall picture at end 2016 – for CS2 programme

Union contribution	
Union contribution paid (including pre-financing) by the JU for the Grant agreements to both private members and partners (H2020) ***covers the years 2014 - 2016***	281 870 712
Expenditures recognized by the JU for the Grant agreements with both private members and partners (H2020) ***covers the years 2014 - 2016***	202 241 015
Expenditures recognized by the JU for the Grant agreements with private members only (H2020, all claims pending validation) ***covers the years 2014 - 2016***	179 990 972
Union contribution committed by the JU for the Grant agreements with private members only (H2020) ***covers the years 2014 - 2016***	214 006 522
Contribution from private members	
Private members cash contribution (administrative costs) 2014-2016 (H2020)	6 389 514
Total **reported** in-kind contributions (H2020) (IKOP+IKAA)	494 929 407
Total **certified** in-kind contributions (H2020) (IKOP+IKAA)	238 325 170
In-kind contributions from operational projects (IKOP) **reported 2014-2016** (H2020)	143 156 617
*In-kind contributions from operational projects (IKOP) **certified and validated** 2014-2016 (H2020)*	39 168 595
In-kind contributions through additional activities **reported** (IKAA) (2014 - 2016)	351 772 790
*In-kind contributions through additional activities **certified and validated** (IKAA) (2014 - 2016)*	199 156 575
Ratios Union contribution/private contribution	
Union contribution paid (including pre-financing) to members and partners (2014 - 2016) /reported IKC and cash contribution (2014 - 2016) (H2020)	1 : 1.78
Union contribution based on expenditures recognized to members and partners (2014 - 2016) /reported IKC and cash contribution (2014 - 2016) (H2020)	1 : 2.48
Union contribution based on expenditures recognized to members and partners (2014 - 2016) /certified IKC and cash contribution (2014 - 2016) (H2020)	1 : 1.21
Union contribution based on expenditures recognized to members only (2014 - 2016) /certified IKC and cash contribution (2014 - 2016) (H2020)	1 : 1.32
Union contribution committed to members only (2014 - 2016) /reported IKC and cash contribution (2014 - 2016) (H2020)	1 : 2.34

This table shows, when looking at the precise allocation of contributions to the periods in which they were incurred, that the expected in-kind contributions provided by the private members of the Joint Undertaking (€495 million) are significantly surpassing the Union contribution to members and partners (€202 million in recognized expenditures) for these first 3 years, already with the ratio of 1:2.48. This ratio is lower than in the AAR 2015 as in 2016 more expenditure was recognized than payments made (compared with the first two years of H2020).

The CS2 regulation sets out that the total private contribution shall be at least €2.193 billion whilst receiving up to €1.755 billion as EU funding, which leads to a ratio of 1:1.26.

The table above shows different Union and private members contribution ratios depending on whether they are calculated based on the overall funding, the recognized expenditure and contribution to all stakeholders (private members and partners[9]) or to the private members only. The same applies to the private contribution which is shown both in terms of reported and certified values, taking also into account their cash contribution to the JU administrative costs.

Despite of the calculation method used, the current reporting and certification of the private contributions shows a clear trend that the private members are fully committed to deliver their contribution and that the members may finally achieve even a higher private contribution than their legal obligation set out in the CS2 regulation. The JU will continue to monitor the implementation of this obligation throughout the lifetime of the programme.

[9] Partners funded through the Calls for Proposals (GAPs) do not report in kind contributions to the JU.

1.11. Synergies with the European Structural and Investment Funds (ESIF)

The Clean Sky 2 Joint Undertaking is called by its founding Council Regulation 558/2014 of 6 May 2014 to develop close interactions with European Structural Investment Funds (ESIF) and to underpin smart specialisation efforts in the field of activities covered by the JU.

Since of 2015, it has been achieved in numbers:

The Europe 2020 strategy towards smart, sustainable and inclusive growth will make significant progress by building on the synergies between the cohesion policy – European Structural and Investment Funds (ESIF) – and the excellence objectives within Horizon 2020. The fostering of synergies between these two policy instruments aims to maximise the quantity and quality of investments, thus ensuring a higher impact of the funds. The ESIF will invest approximately €100 billion in innovation and research in the period 2014-2020.

Synergies between ESIF and Clean Sky 2 Joint Undertaking could maximise the specific added value of Smart Specialisation Strategies (S3) investments such as the capacity to effectively support aeronautics capacity building and the exploitation of research results for raising the overall social/economic impact of the European aeronautics sector.

The Clean Sky 2 Joint Undertaking therefore encourages synergies with ESIF by allowing complementary activities to be proposed by applicants to Clean Sky Calls and by amplifying the scope, adding parallel activities or continuing JU co-funded project/activities through ESIF in synergy with the Clean Sky 2 programme and its technology roadmap. The Clean Sky 2 Joint Undertaking also encourages the use of ESIF to build and enhance local capabilities and skills in fields related to the programme, in order to enhance the level of European competitiveness of stakeholders in this area.

Action plan

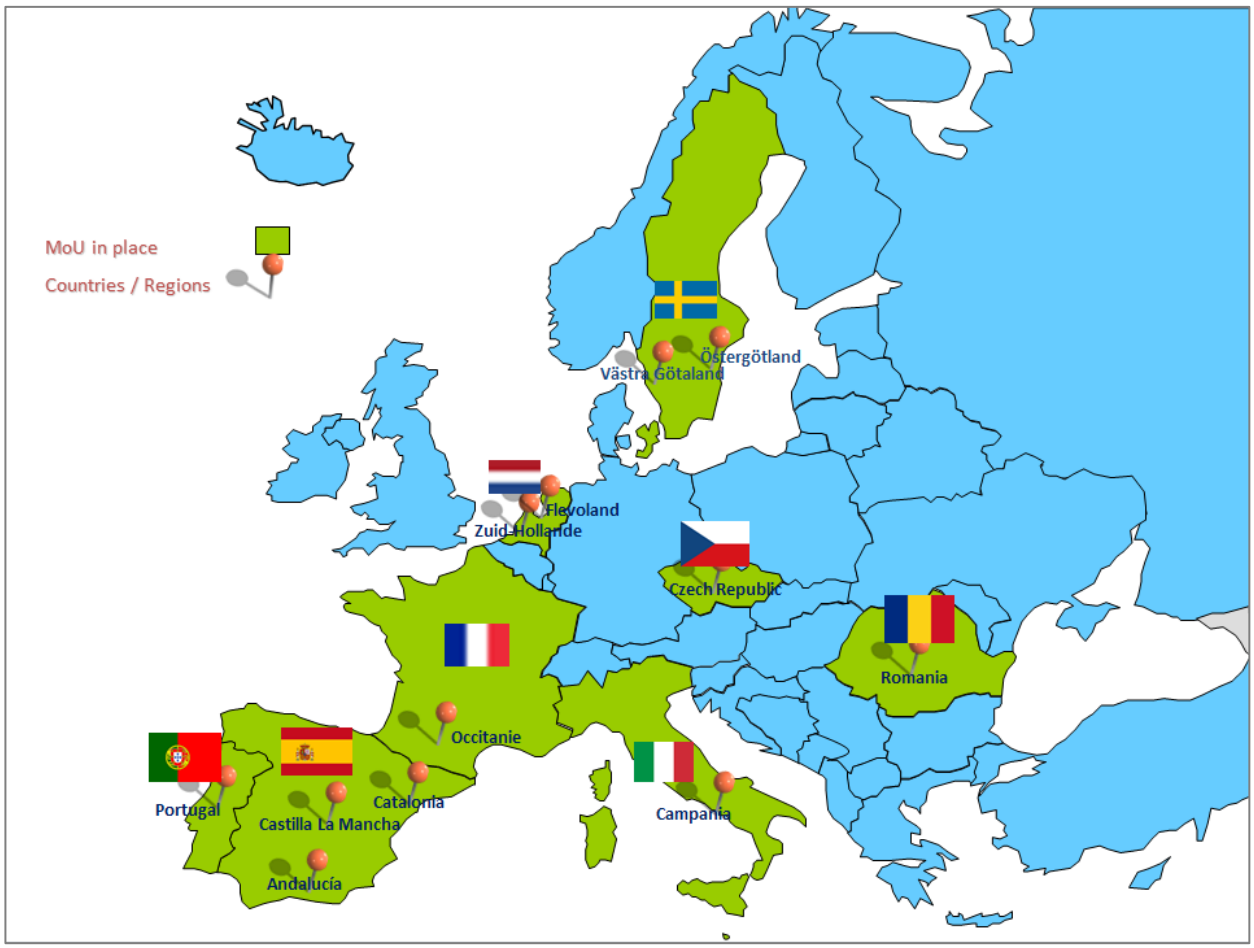
At Strategic Level, the JU had launched in 2015 and further developed in 2016 a coherent and comprehensive policy strategy and a pilot action plan on synergies, for Member States and Regions which are interested in investing ESIF into aeronautics and other related technologies in this domain. In this regard, the JU is developing close interactions with interested Member States (MS) and Regions in Europe and discussing strategies and possible cooperation via a tailor-made approach and incorporating modalities depending on the level of interest and commitment which a State/Region may decide to engage with.

While keeping the funding processes and rules of each competent authority separate, the purpose is to identify and apply mechanisms for ensuring synergies and complementarities through ESIF in pertinent research and innovation projects from a specific Member State or Region with a view to maximising its impact via the JTI framework of Clean Sky projects.

How to engage in cooperation with the CSJU - MoU

To facilitate the synergies with ESIF, JU considers that the signature of a MoU is important and effective to take a strategic approach and discuss in advance with MS and regional authorities ways to stimulate synergies based on the regional strategy/RIS3 and the applicable ESIF regional funding instruments, to identify thematic objectives or align the regional funding instruments to support possible pilot projects.

In 2016 the JU has further extended its bilateral contacts with a significant number of MS and Regions, which has brought the total signatures of MoUs to 12 by 31 December 2016 (see map below of ongoing MoU cooperation) and has also paved the way for the signature of an estimated 20 MoUs by the end of 2017.



The signing of MoUs with these MS/Regions aims to set the scene and agree the general framework of cooperation without trying to get into details. However, the signature of a MoU does not constitute an essential condition for developing synergies with JU, nor does it confer any sort of competitive advantage in the calls launched by the JU to any regional stakeholder.

Synergies scenarios

Five scenarios have been identified for driving the appropriate mechanisms for cooperation, to be adapted to the regional funding schemes envisaged under the OPs, rules and processes,

while keeping the CS programme/calls in conformity with its own rules. These scenarios are listed below:

1. **Upstream support**

ESIF support for developing capabilities/skills/infrastructures of its local stakeholders in view of planned participation to the Clean Sky calls.

2. **Parallel funding**

An applicant to Clean Sky calls proposing in parallel a separate set of ESIF "complementary activities" which may be evaluated and may be granted a "synergy label".

3. **Sequential funding / downstream support**

Clean Sky beneficiaries proposing during project implementation a continuation / spin-off / amplification of their projects.

4. **Thematic approach**

ESIF support to complement the Clean Sky programme through upstream definition in line with RIS3 priorities of appropriate R&I themes/topics, for launch in the National/Regional ESIF calls, not addressed in Clean Sky but contributing to its overall objectives.

5. **"Seal of Excellence" type – "CSJU synergy label"**

If technically appropriate, top-ranked proposals in a Clean Sky call (highly scored) could be supported by Clean Sky with a synergy label for a separate, parallel ESIF funding.

A feature common to scenarios 2, 3 and 5 is the "Clean Sky label" which may be given to the complementary activities proposed by either a successful applicant in a JU call or proposed by a JU beneficiary in course of implementation, through a JU independent evaluation process. The "Clean Sky label" can be an incentive and "guarantee of success" for MS/Regions to invest in projects, support actions, infrastructures, and facilities in favour of well-performed/running actions.

In 2016, four proposals had been awarded the quality certification of "Clean Sky 2 Synergy Label" and were highly recommended for support through the ESIF. The proposals are listed below:

1. E-Multidrill - ESIF complementary activities in the area of AIRFRAME ITD.
2. ARGOS - ESIF complementary activities/"Weight-saving design of aerospace composite propellers useful for piston engines" in the area of ENGINE ITD.
3. HEPODIS – ESIF complementary activities in the area of AIRFRAME ITD.
4. SHERLOC – TEAMS ESIF complementary activities in the area of AIRFRAME ITD.

In addition the JU was asked by some Regions under MoU to deliver a synergy assessment in relation to R&I proposals received under the regional call and thus to contribute to the regional evaluation process.

Pilot projects

In 2016, six pilot projects were financed through ESIF by some countries/regions under MoU cooperation.

A brief summary of the stage of implementation of the MoUs and pilots projects is presented below:

- **Catalonia:** the regional NUCCLI call closed in October 2016 and the Regional authorities will inform whether some proposals link to Clean Sky. Two projects (SHEAREN and DRYFORMING), "labelled" as complementary to Clean Sky in Airframe (AIR) and Engines (ENG) (sequential and parallel) were funded by the Region under NUCCLI 2015 regional call.
- **Sweden:** Two pilot projects (additive manufacturing lab and FIA) approved under calls issued by the Swedish Agency for Economic and Regional Growth as a result of the MoU between CSJU and the Region of Västra Götaland, and synergy assessment was provided by the CSJU in the context of regional evaluation process. Additionally, in the context of a joint action between the two Swedish regions of Västra Götaland and Östergötland, the project proposal SVIFFT was accepted for funding under the National ERDF Programme.
- **Midi Pyrenees** region (now Occitanie Region) launched in 2015 "Easynov", an open and competitive Regional call, with a part dedicated to aeronautics. In this framework, the FLIP2 project was funded in 2016 as the follow-up (phase 2) of the CSJU-funded "Flip" project in SGO ITD on in-flight weather forecast which could be further improved to reach a higher TRL. The JU took part in the Regional evaluation process
- **Czech Republic:** an ESIF project awarded the quality certification of "Clean Sky 2 Synergy Label" as complementary to the ARGOS CSJU project (ENGINE ITD) and was selected for funding in the context of the APLIKACE CZ call within the Operational Programme Enterprise and Innovations for Competitiveness (OP EIC).
- **Romania:** a national call was launched by the National Authority for Scientific Research and Innovation of Romania (ANCSI) in July 2016, on synergies with H2020 and Clean Sky, in particular based on the MoU – a proposal related to Clean Sky was pre-submitted in 2016 and will be evaluated in 2017.
- **Castilla-La Mancha:** the R&I call closed in September 2016, with priority and extra points to complementary projects with a Clean Sky evaluation: one proposal related to Clean Sky was submitted and is currently under evaluation.
- **Zuid-Holland:** a Regional Aerospace agenda 2016-2025 was adopted in June 2016, triggered by the signing of an MoU with JU. The Agenda highlights links to JU and lists a set of projects and proposals, some of them in synergy with Clean Sky. They are expected to suggest a pilot project before April 2017.
- **Flevoland:** in close cooperation with the province of Zuid-Holland, the Region has developed one implementation plan where the JU was asked to provide its comments and suggestions. The core of the implementation plan is to set up a comprehensive structure that allows regionally funded projects for aeronautics SMEs to be assessed in its implementation by the JU. The first potential pilot project under this scheme is a Flevoland CompoWorld innovation project developed by NLR and DTC in the area of more reliable thermoplastic component production.

The JU will continue developing the pilot phase throughout 2017-2018 in view of launching new pilot projects and identifying best practices for further MS and Regions interested to join. Some MS/Regions launched regional calls, including dedicated actions or synergies with Clean Sky. To follow up on the JU regional cooperation, the activities of the MS/Regions are recorded in the regional cooperation scoreboard, an extract of which will be published on the JU website.

Calls for Proposals

In order to enhance the synergies with ESIF, JU provides a "Guidance note" on how to include in the Calls for Proposal complementary activities which may be supported by European Structural and Investment Funds.

At the level of the Calls for Proposals, the JU received a number of complementary activities (ESIF Work Packages) linked to the CfP02. Those submitted by top-ranked applicants in the related topics were granted the synergy label which may support their application for ESIF and result in pilot projects in 2017.

Additionally, both the Core Partners and/or Partners to JU are encouraged to introduce complementary activities funded or eligible for support through ESIF which are in synergy/complementarity with the JU funded project/activities under implementation, topic area and/or contribute to the objectives of the Clean Sky 2 programme. These activities shall be submitted under separate Work Package(s) (Part C-ESIF WP) linking to the JU funded project/activities and the JU will decide whether to evaluate these activities in view of a possible synergy label depending on the level of existing cooperation with the Member State/Region concerned.

Regional mapping

To meet the purpose of identifying potential interested actors, the JU has updated in 2016 the mapping of MS and regions with a Smart Specialisation Strategy with links to the Clean Sky 2 programme's scope of activities and thus having a potential for cooperation on synergies with the JU (see table below).

This analysis was carried out based on their Smart Specialisation Strategies and information available through other sources (such as the Clean Sky States' Representative Group, the RIS3 platform, the European Commission (DG RTD and DG REGIO), the EACP and the EU-funded AirTN Network action).

The Clean Sky 2 JU - RIS3 Regional Mapping elaborated by the JU already demonstrates that many Smart Specialisation Strategies (RIS3) and Operational Programmes 2014-2020 include aeronautics or areas which correlate to the Clean Sky programme (air transport, mobility, materials, composites, engines, manufactures, CO2 reduction etc.) as thematic areas/priorities for ESIF funding.

One of the highlights of this on-going action plan is that the interest comes not only from the

more classic 'aeronautics regions' of Europe, but also from regions considering this as a potential way to increase their R&I capabilities in cross-cutting areas with possible market opportunities in aeronautics and European levels of cooperation and competitiveness of their stakeholders.

Regional participation in Clean Sky 2

The JU has also elaborated some statistics regarding the participation of the regions in CS2 calls. According to the data, by the end of 2016 59 regions out of 19 Member States have participated in CS2 winning proposals.

Dissemination and communication activities

In 2016 the JU took part in specific sessions and information meetings such as:

- JU gave a keynote speech on synergies given to the Meeting of the Directors General for Cohesion Policy of MS organised by the Dutch Presidency of the EU.
- JU participated as expert speaker to the European Parliament EPP ITRE Committee Hearing on synergies.
- JU participated as expert speaker to the European Parliament REGI Committee Hearing on synergies.
- JU participated as expert speaker to the Joint Undertakings common event on synergies at the Committee of the Regions.
- Information sessions with Regions, EACP and Business representatives' organisations to disseminate JU actions.

2. SUPPORT TO OPERATIONS

2.1. Communication activities

Communication activities are managed according to the Communication Strategy adopted by the Governing Board, and updated when necessary. A detailed Action Plan is drafted every year, identifying objectives, target audiences, messages and tools. The current 2015-2018 Strategy and its 2016 Action Plan, as endorsed by the Governing Board, served as a roadmap for the Advocacy and Communications activities of last year.

Ensuring that key figures in the European institutions are aware of the activities and achievements of Clean Sky is a particular priority, especially regarding the wide participation of diverse European actors and the programme's progress in realising its environmental objectives. In 2016 this involved regular, constructive, and positive communication including meetings and events with the European Commission, the European Parliament, and the EU Member States. In addition to this there has been a noticeable growth of interest in the Clean Sky 2 JU overall due to more Calls within the Clean Sky 2 programme.

The content and key features of Clean Sky 2 are now part of any communication activity, given the high expectations of target audiences from both the political side and from potential industrial and scientific stakeholders. The press has reported widely across Europe on the launch and main features of Clean Sky 2. In parallel, Clean Sky actively promoted the European Commission's communications on Horizon 2020 by sharing messages and referring to the EU innovation vision and policy in connection with demonstrations, events and/or news about the programme.

The key priorities in 2016 were: demonstration of successful outcomes, positive reputation, expanding networks, brand building and visibility.

To reach those objectives, the advocacy effort in place since 2014 to raise awareness of Clean Sky 2 among MEPs continued throughout 2016. The Executive Director met with several MEPs from the ITRE, TRAN and CONT committees. The meetings were followed up with detailed briefings, mailing on relevant publications, and invitations to key events in 2016 such as ILA Berlin, Farnborough Air Show and the Greener Aviation Conference.

The communications strategy for 2016 took place in two main strands: 'traditional' printed communication and digital communication. With regards to printed communication, a new version of the 'Clean Sky at a Glance' brochure was produced in March, featuring a timeline of main Demonstrators achieved and planned in Clean Sky 2. The brochure has been widely distributed at events and meetings since then.

In order to build on existing results while highlighting the spirit of the programme, a Clean Sky book - 'Innovation Takes Off' - was published in September by *Cherche Midi* publishing house. It charted the story of European aviation from its beginning to today, with a focus on how the European Union's vision and policy on excellent research and innovation led to Clean Sky as a

tool to develop innovative technologies to reduce the environmental footprint of aviation. Since its publication, some 2500 copies in English and 500 in French have been distributed across Europe.

In parallel to the Clean Sky book, 2016 saw the full revamp of the www.cleansky.eu wevsite in an effort to boost Clean Sky's digital communications. The result was an impactful new website, with EU Horizon 2020 at its heart, better showcasing achievements through pictures, videos, interactive timelines and participants' maps. An entirely new 'Aviation' section positions Clean Sky in a European and global context, and links Clean Sky's green innovative research with other important themes such as the air transport system, the organisation of commercial aviation, world competitiveness, eco-awareness and the work of ACARE.

In addition, a video was produced by Clean Sky to showcase results of the first Clean Sky programme, with footage from various demonstrations to explain how Clean Sky aims to achieve its environmental objectives through innovative technologies. This video was promoted across the Clean Sky website and social media channels. Besides the revamp of www.cleansky.eu, Clean Sky invested further in its digital strategy for communications. In particular, all social media channels (*Twitter, YouTube, LinkedIn, Flickr*) were regularly updated. Relevant and frequent messaging, more video content and further coordination with the Commission and industrial leaders led to increased traffic and wider outreach to more communities.

Other printed and digital communications included 'Skyline' magazine, which is published three times per year, and the electronic monthly E-News. Both have seen their dissemination lists enlarged and optimised due to the addition of participants in Clean Sky 2 Info Days and interested MEPs, among others. This has enabled the expansion of Clean Sky news and activities to other networks, thus improving visibility and brand support.

This visibility was enhanced through increased press coverage for Clean Sky in 2016. Articles came not only from the biggest participants in Clean Sky such as France, Germany, Italy, Spain and the UK, but also from those who have a smaller number of participants: Bulgaria, Czech Republic, Ireland, etc., as well as Russia, the USA and Canada. This shows that the interest in Clean Sky is not limited to Europe. Clean Sky was frequently highlighted in specialist aviation magazines such as Aviation Week, Air & Cosmos and Flight Global; was featured in the Financial Times, Les Echos, and El Mundo; and was the focus of dedicated pieces in The Times, British Airways' 'Business Life' magazine, and Switzerland's Sonntagszeitung.

In addition to press coverage, several videos were produced throughout the year with AeroNews TV around Clean Sky's participation in events: Clean Sky Forum, ILA Berlin, and Farnborough. These videos were displayed on the AeroNews TV website and social media, and shared by Clean Sky in order to reach as many people as possible. Clean Sky also featured in a video and article from Brussels-based news site EurActiv, following participation in a conference.

As in previous years, Clean Sky used events to raise awareness of goals and achievements among many people. The following large events took place in 2016: a dozen Clean Sky 2 Info

Days across Europe, the Clean Sky Forum on 4 April, ILA Berlin in June, Clean Sky at Farnborough Air Show in July, and the Greener Aviation Conference in October.

The Clean Sky Forum saw a range of speakers participate from the European Commission, European Parliament, and industry, and the annual Best Project from Partners Award took place. Then at ILA Berlin Clean Sky organised a conference titled 'The Science powering Clean Sky', highlighting how universities and research organisations help Clean Sky to develop technologies from ideas to reality. The conference also celebrated outstanding young researchers in the first edition of the Best Clean Sky PhD Award. The Greener Aviation Conference gathered over 300 participants and more than 100 speakers to discussing the opportunities and challenges with regards to the greening of aviation, and many presentations and roundtables looked into technological progress achieved within Clean Sky.

Clean Sky's participation at Farnborough Air Show deserves a special mention. Clean Sky presented a demonstration stand in close cooperation with the Integrated Technology Demonstrator (ITD) leaders and the support of the European Commission. Clean Sky displayed objects that represent cutting–edge technology developed to help meet the ACARE 2020 environmental goals. The hardware included an open rotor mock-up and actual blade, a composite blade for large range planes, a noise simulator, the laminar wing demonstrator mock-up, a model of a helicopter diesel engine, and equipment related to the More Electric Aircraft concept. All the hardware had already been tested and evaluated and will be part of the performing aircraft of tomorrow. The stand received hundreds of visitors, including Clean Sky Members, industry professionals, policy-makers and members of the public.

Clean Sky has also worked closely on communication with bodies such as ACARE, discussing Clean Sky results and examples for green technologies.

The Advocacy and Communications Manager is supported by a trainee, a part-time web master and a part-time assistant.

2.2. Legal and financial framework

Amendment of the Financial Rules

Background: The Regulation (EU, Euratom) No 2015/1929 amends Regulation (EU, Euratom) No 966/2012, in particular articles 60 and 209 which concern the modified the rules on external audit, discharge and annual reporting applicable to the public-private partnerships bodies referred to in Article 209 of Regulation (EU, Euratom) No 966/2012.

Based on the Commission's Decision C(2015)7554 dated 30.10.2015 amending Delegated Regulation (EU) No 110/2014 on the Model Financial Regulation for PPPs, the JU elaborated an amended version of its Financial Rules to bring them in line, where appropriate, with the modifications brought under the newly adopted delegated act.

Following the required internal Commission approval of the amended text proposed by the JU, the JU could launch by written procedure of 24 February 2016 the Board approval process of the amended Financial Rules. The Board approved the amended Financial Rules on 19 April 2016 with retroactive entry into force as from 1 January 2016.

Governance decisions

Finally, a set of Board decisions related to the set-up of the governance and functioning of the JU were adopted by the Board as listed under chapter 3.1.1 of this AAR document.

2.3. Budgetary and financial management

Facts and figures by title of the budget:

Title 1 & 2	Budget (€ m)	Executed (€ m)	% rate
CA	7.3	7.3	100
PA	9.1	7.6	83.1

Title 1 & 2 – Staff and administrative expenditures: The administrative expenditure of the JU had a very high rate of use in 2016 both for commitments and payments appropriations, showing a reliable budgetary planning for this part of the JU budget. Staff expenditure budget (Chapter 11) was mainly used for the statutory staff of the JU (42 posts as of 31.12.2016), although other external support was also hired in by the JU to cope with the increased workload (included under Chapter 12). The JU has also contracted the services of audit firms to perform the ex-post audits to beneficiaries of JU funding in 2016 (included under Chapter 28).

Initial budget, amending budget and transfers for title one and two in 2016:

	Heading of the Budget 2015	Initial Budget 18/12/2015 (Annual Budget 2016-2017) (1)	First Amending Budget 03/02/2016 (Annual Budget 2016-2017 Amendment nr1) (2)	Second Amending Budget 21/06/2016 (Annual Budget 2016-2017) (3)	Third Amending Budget 21/10/2016 (Annual Budget 2016-2017) (4)	Transfers adopted by CSJU Director (5)	Final Budget for implementation (7)=∑(1to 5)
CH 1	**STAFF EXPENDITURE - COMMITMENTS**						
CH 11	STAFF IN ACTIVE EMPLOYMENT	3.800.000	0	0	100.000	-4.422	**3.895.578**
CH12	MISCELLANEOUS EXPENDITURE ON STAFF	320.000	0	0	-113.000	60.738	**267.738**
CH 13	MISSIONS AND DUTY TRAVEL	320.000	0	0	0	-80.774	**239.226**
CH 14	SOCIOMEDICAL INFRASTRUCTURE	60.000	0	0	-15.000	14.458	**59.458**
CH 15	SOCIAL MEASURES	0	0	0	0	0	**0**
CH 17	RECEPTIONS AND EVENTS	0	0	0	0	0	**0**
	TITLE 1 - Commitment	**4.500.000**	**0**	**0**	**-28.000**	**-10.000**	**4.462.000**
CH 1	**STAFF EXPENDITURE - PAYMENTS**						
CH 11	STAFF IN ACTIVE EMPLOYMENT	3.800.000	0	0	100.000	-4.422	**3.895.578**
CH12	MISCELLANEOUS EXPENDITURE ON STAFF	320.000	140.221	0	-20.000	60.738	**500.959**
CH 13	MISSIONS AND DUTY TRAVEL	320.000	61.564	0	-1	-80.774	**300.789**
CH 14	SOCIOMEDICAL INFRASTRUCTURE	60.000	75.549	0	0	14.458	**150.007**
CH 15	SOCIAL MEASURES	0	0	0	0	0	**0**
CH 17	RECEPTIONS AND EVENTS	0	0	0	0	0	**0**
	TITLE 1 - Payment	**4.500.000**	**277.334**	**0**	**79.999**	**-10.000**	**4.847.333**

CH 2	**INFRASTRUCTURE EXPENDITURE - COMMITMENTS**	Initial Budget 18/12/2015 (Annual Budget 2016-2017) (1)	First Amending Budget 03/02/2016 (Annual Budget 2014-2015 Amendment nr1) (2)	Second Amending Budget 21/06/2016 (Annual Budget 2015-2017) (3)	Third Amending Budget 21/10/2016 (Annual Budget 2015-2017) (4)	Transfers adopted by CSJU Director (5)	Final Budget for implementation (7)=∑(1to 4)
CH 20	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	565.000	0	0	-57.401	-13.731	**493.868**
CH 21	INFORMATION TECHNOLOGY PURCHASES	160.000	0	12.062	110.707	27.443	**310.212**
CH 22	MOVABLE PROPERTY AND ASSOCIATED COSTS	10.000	0	0	-7.500	0	**2.500**
CH 23	CURRENT EXPENDITURE FOR RUNNING COSTS	55.000	0	0	-3.000	0	**52.000**
CH 24	POSTAGE AND TELECOMMUNICATIONS	40.000	0	0	0	0	**40.000**
CH 25	EXPENDITURE ON FORMAL AND OTHER MEETINGS	300.000	0	225.000	-162.744	13.452	**375.709**
CH 27	COMMUNICATION ACTIVITIES	350.000	0	0	52.000	-17.163	**384.837**
CH 28	EXTERNAL SERVICES	310.000	0	-42.622	134.631	1	**402.010**
CH 29	COSTS ASSOCIATED WITH CALLS	750.316	0	-194.440	256.124	0	**812.000**
	TITLE 2 - Commitment	**2.540.316**	**0**	**0**	**322.817**	**10.001**	**2.873.134**
CH 2	**INFRASTRUCTURE EXPENDITURE - PAYMENTS**						
CH 20	RENTAL OF BUILDINGS AND ASSOCIATED COSTS	565.000	1.098	0	-45.922	-10.985	**509.191**
CH 21	INFORMATION TECHNOLOGY PURCHASES	160.000	238.186	0	46.351	27.443	**471.980**
CH 22	MOVABLE PROPERTY AND ASSOCIATED COSTS	10.000	7.026	0	-7.500	0	**9.526**
CH 23	CURRENT EXPENDITURE FOR RUNNING COSTS	55.000	40.047	0	0	0	**95.047**
CH 24	POSTAGE AND TELECOMMUNICATIONS	40.000	3.968	0	0	0	**43.968**
CH 25	EXPENDITURE ON FORMAL AND OTHER MEETINGS	300.000	291.878	0	-124.565	10.707	**478.020**
CH 27	COMMUNICATION ACTIVITIES	350.000	324.808	0	-23.494	-17.163	**634.151**
CH 28	EXTERNAL SERVICES	310.000	587.466	0	-30.434	0	**867.032**
CH 29	COSTS ASSOCIATED WITH CALLS	750.316	291.901	0	105.563	0	**1.147.780**
	TITLE 2 - Payment	**2.540.316**	**1.786.378**	**0**	**-80.001**	**10.002**	**4.256.695**

2.4. Procurement and contracts

List of contracts signed in the year 2016 (>15.000 EURO)

Contractor	Framework contract Y/N	Tender procedure	Contract reference	Subject of the contract	Signature date	Amount (€)
Paul Sillers	N	Low value negotiation procedure	Purchase Order no CSJU/2016/59	Proof-reading services	19/04/2016	15.000,00
NETSAS	Y	Specific Contract under FSC	Specific Contract no WP N°5-2016-01 implementing FSC no CSJU.2013.OP.02	Further developments of GMT including planning module, reporting functions and other necessary features under Work Package 5	23/05/2016	49.260,00
TMAB	Y	Order Form under FSC	Order Form no 2016/68 implementing FSC no CSJU.2013.OP.01	CS Stand support at Farnborough Air Show 2016	27/05/2016	75.340,00
LUBBOCK FINE LIMITED	Y	Specific Contract under FSC	Specific Contract No CSJU/B17/2016/FP7/2013/1 implementing Framework Contract No FP7/2013/M1/1	Ex-post audit	03/08/2016	173.490,00
PKF Littlejohn	Y	Specific Contract under FSC	Specific Contract of the Clean Sky 2 Joint Undertaking No 04-01 implementing the framework contract No BUDG/15/PO/03	Audit on Clean Sky accounts	10/08/2016	57.300,00
University of Surrey	N	Middle value negotiated procedure	Service contract no DC/ CSJU.2016.NP.02	Analysis and forecast of the socio-economic impact of Clean Sky	16/09/2016	134.557,00
Marco Brusati	N	Call for Expression of Interests	CEI 2015 – 02-2016	Strategic Consultancy year 2017	14/09/2016	16.200,00

Contractor	Framework contract Y/N	Tender procedure	Contract reference	Subject of the contract	Signature date	Amount (€)
NETSAS	Y	Modification of FSC under Art. 114a(3)(a) of FR	Amendment no 1 to FWC no CSJU.2013.OP.02	GMT	20/09/2016	240.120,00
TMAB	Y	Order Form under FSC	Order Form no 2016/117 implementing FSC no CSJU.2013.OP.01	Farewell of the Executive Director	20/07/2016	19.796,70
RealDolmen	Y	Order Form under FSC	Order Form no 2016/34 implementing FSC no IMI.2014.FWC.043	GMT Server Hosting	02/03/2016	22.870,34
START PEOPLE	Y	Order Form under FSC	Order Form no 2016/132 implementing FSC no IMI.2016.FWC.018	Interim staff services	25/08/2016	30.398,27
NETSAS	Y	Specific Contract under FSC	Specific contract no WP N° 5 – 2016 – 02 implementing FSC no CSJU.2013.OP.02	Developments of the GMT 2	22/10/2016	127.260,00
EU-Turn	Y	Amendment to Specific Contract	Amendment no 1 to the Specific Contract no Lot 3/EU-Turn/04/2014 implementing FWC no CSJU.2013.OP.01	Communication assistant	16/12/2016	52,450.00
TMAB	Y	Amendment to Specific Contract	Amendment 2 to the Specific Contract no Lot 3/TMAB/01/2014 implementing FWC no CSJU.2013.OP.01	Communication - maintenance CSJU website	08/12/2016	51,300.00
Start People	Y	Order Form under FSC	Order Form no 2016/199 implementing FSC no IMI.2016.FWC.018	Interim staff services	25/11/2016	12,375.84
Start People	Y	Order Form under FSC	Order Form no 2016/200 implementing FSC no IMI.2016.FWC.018	Interim staff services	25/11/2016	25,768.18
EU-Turn	Y	Order Form under FSC	Order Form no 2016/219 implementing FSC no CSJU.2013.OP.01	Merchandise	19/12/2016	19,730.00
Bechtle	Y	Order Form under FSC	Order Form no 2016/217 implementing FSC DI/07190	IT Equipment	14/12/2016	21,989.50
Bechtle	Y	Order Form under FSC	Order Form no 2016/218 implementing FSC DI/07190	IT Equipment	20/12/2016	23,178.77

2.5. IT and logistics

In January a new “Backup-as-a-Service” solution for disaster recovery and business continuity was deployed. This daily “over-wire” backup of data to an off-site data centre replaces the system of tape drives and twice-weekly collection and archiving of physical tapes which has been in place since January 2011. This new solution is faster, more frequent, scalable and more environmentally friendly, providing better recover options.

The crucial Testa Link to EC data centres was also replaced in 2016. This significant project was several years in planning and procurement and involved large hardware replacement and a switch in service provider from Orange to T-System. A one month overlap in the two services was scheduled to ensure no risk of downtime and this was successfully implemented with no user impact.

The UPS (Uninterrupted Power Supply) in the server room was also tested and refurbished in 2016 to ensure it will perform correctly if needed in the years ahead.

The internet speed was also upgraded in September to keep pace with increasing demand.

During 2016 several more workshops were jointly held by the JTIs to plan the replacement of the core ICT equipment which dates from 2010. At the end of 2016 the results and proposal arising from these workshops were presented to the ICT Governance Committee of the JTIs.

It was then agreed that a new architecture would be installed. While primarily driven by a need to replace the servers, telephone exchange and other core ICT infrastructure, the changes also put in place the foundation for new ways of working.

In moving to an IaaS model (Infrastructure as a Service) there will be more system availability, more mobile solutions, easy scalability and better cost control with less capital investment. It also positions the JTIs to move to PaaS* and SaaS* *(Platform & Software as a Service) solutions in the future if desired.

Doing this in cooperation with the enlarged JTI family with whom Clean Sky is co-located ensures consistency and economies of scale.

In the area of software, 2016 saw deeper integration of Clean Sky processes and workflows into the tools of the European Commission, particularly those of the research family, supported by the Common Support Service. In 2016 Clean Sky also attended several presentations on the possible future adoption of EC tools such as SYSPER (for HR), ARES (Document Management) with discussion also about MIPS (Mission Management).

During 2016 Clean Sky started to use “EU-Learn”, which is a new tool providing access to online training in EC applications and registration facilities for class room training courses. EU-Learn replaced the more limited SYSLOG tool (which was not accessible to the JTIs).

Due to normal business growth, and particularly after the attacks on the Brussels transport systems, there was a big increase in demand for teleconferencing in 2016. To meet this

requirement Clean Sky activated services under an EC Framework contract for web and teleconferencing which has proven successful. Also in 2016, the JTIs evaluated equipment for possible installation of permanent video and web conferencing hardware in the common JTI meeting rooms.

On the side of logistics, a big development has been the installation of a reception desk in the Clean Sky building and security controls plus regular patrols. This is staffed by a professional security company. A building security committee representing all the JTIs has been established and this is supported by the ICT committee for the necessary equipment and data access.

2.6. Human Resources

The JU establishment plan for 2016 contained a total of 42 statutory staff (TA and CA). In 2016 the JU launched the recruitment process of five new positions. In addition to the statutory posts, the JU relies on external service providers such as the webmaster, the IT services firm shared with the other JUs, a Communications consultant, two SNEs recruited in 2016, two interims, one trainee and a strategic consultant to provide extra support to the JU where the JU staff alone cannot take further tasks.

With the influx of new staff members, the JU held information sessions on staff rules and the JU code of conduct in 2016. This was well received by staff and will be repeated in the future.

In accordance with the Decision of the Governing Board regarding the reclassification system (written procedure nr. 2016 – 04 of 15 April 2016), the JU has performed the reclassification exercise. As a result 5 staff members who were in service since 2009/2010 were reclassified.

3. GOVERNANCE

3.1. Governing Board

In 2016 the Governing Board was composed of 29 members: the Commission, with 50% of the voting rights, the 16 founding members of Clean Sky 2 Joint Undertaking and one associate representative for each of the six ITDs in the Clean Sky programme and six Core Partner representatives of the ITDs/IADPs in the Clean Sky 2 programme. In 2016 the associates were: Fokker (ED), Onera (GRA), NLR (GRC), GKN Aerospace (SAGE), University of Nottingham (SGO), and Aernnova (SFWA).
Core Partners: ITP (ENG), University of Nottingham (SYS), INCAS (FRC), Avio Aero (LPA), CIRA (REG), Meggit (AIR).

The Chairman of the Governing Board was Ric Parker (Rolls-Royce) and the Deputy Chairman was Bruno Stoufflet (Dassault Aviation).

The Clean Sky 2 Joint Undertaking Governing Board had four meetings during 2016, on:

- 1 April 2016
- 29 June 2016
- 21 October 2016
- 16 December 2016

During 2016 the Governing Board has adopted, approved or endorsed the following key documents in its meetings:

1 April 2016

- The Common Anti-Fraud Strategy Action Plan
- Provisional Annual Activity Report 2015
- Strategic Audit Plan
- TE2 Rules of procedure

29 June 2016

- Clean Sky 2 Development Plan Part A++
- Eco Design TA Rules of procedure
- Final Annual Activity Report 2015
- Opinion on the Final accounts 2015

21 October 2016

- Decision of the Governing Board approving the Amended Additional Activities Plan 2014 – 2016
- Decision of the Governing Board adopting the third Amended Bi-annual Work Plan and Budget 2016 - 2017
- Decision regarding establishing an Internal Audit Capability and approving the internal audit charter

- Decision Governing Board Decision on the request to the Commission its agreement regarding the non-application of the Commission Decisions concerning middle management staff, the function of adviser and on learning and development
- Decision on the non-application of the Commission Decision on the maximum duration for the recourse to non-permanent staff in the Commission services

16 December 2016

- Decision of the Governing Board approving the Additional Activities Plan 2017
- Decision of the Governing Board adopting the fourth Amended Bi-annual Work Plan and Budget 2016 – 2017
- Opinion on the in-kind contribution related to additional activities declared by the private members of the Clean Sky 2 Joint Undertaking for the period 2014-2015

Decisions by written procedure

The following 18 written procedures were successfully adopted:

- 2016-01 Decision on the acceptance of the in-kind contribution related to operational activities provided by the private members to the Clean Sky Joint Undertaking through the execution of the Clean Sky Programme (FP7)
- 2016-02 Decision of the Governing Board adopting the Amended Bi-annual Work Plan and Budget 2016 – 2017
- 2016-03 Decision of the Governing Board approving the Ranking Lists of the selected proposals of the Call for Proposals 2 (CfP02)
- 2016-04 Decision of the Governing Board on the application by analogy of the implementing rules on part-time work
- 2016-05 Decision of the Governing Board on adopting the revised Financial Rules of the Clean Sky 2 Joint Undertaking
- 2016-06 Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 2 membership
- 2016-07 Decision of the Governing Board approving the Ranking Lists of the selected proposals of the Call for Core Partners Wave 3 (CPW03)
- 2016-08 Decision of the Governing Board on the acceptance of the in-kind contribution related to operational activities provided by the private members to the Clean Sky Joint Undertaking through the execution of the Clean Sky Programme (FP7)
- 2016-09 Decision of the Governing Board adopting the second Amended Bi-annual Work Plan and Budget 2016 – 2017
- 2016-10 Opinion on the in-kind contribution related to additional activities declared by the Leaders and Core Partners of Clean Sky 2 Joint Undertaking for the period 2014-2015
- 2016-11 Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 2 membership
- 2016-12 Decision of the Governing Board regarding the appointment of an acting Executive Director of Clean Sky 2 Joint Undertaking
- 2016-13 Decision of the Governing Board approving the Ranking Lists of the selected proposals of the Call for Proposals 3 (CfP03)
- 2016-14 Decision of the Governing Board approving the Call texts for CfP05 and CPW04
- 2016-15 Decision of the Governing Board adopting rules on the prevention and

management of conflicts of interests applicable to the bodies of the Joint Undertaking

- 2016-16 Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 3 membership — 1st batch
- 2016-17 Decision of the Governing Board approving the Ranking Lists of the selected proposals of the Call for Proposals 4 (CfP04)
- 2016-18 Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 1 membership – 3rd batch

It can be noted that most of the decisions were adopted unanimously or very close to unanimously, showing a smooth and efficient decision-making process. Each Governing Board is prepared by a "Sherpa Group" meeting, chaired by the JU. The GB acted according to its adopted Rules of Procedures.

3.2. Executive Director

The Executive Director is the legal representative and the chief executive for the day-to-day management of the JU in accordance with the decisions of the Governing Board in line with Article 10 of the CS Statutes.

The Executive Director is supported by three managers: the Coordinating Project Officer, the Clean Sky 2 Programme Manager and the Head of Administration and Finance. One Project Officer per SPD allows the JU to play its coordination role.

The JU's management acts on the basis of its quality system documents, which are listed in the JU's Quality Manual. Interactions with the SPDs are mainly governed by the Management Manual.

In 15 September 2016, the two consecutive mandates of the Executive Director had expired. As a consequence, an Interim Executive Director was seconded from the Commission who will continue to serve as chief executive until the new selection procedure is finalised and a new Executive Director is appointed by the Governing Board.

3.3. Steering Committees

Each Integrated Technology Demonstrator (ITD) and each Innovative Aircraft Demonstration Platform (IADP) in charge of specific technology lines within the CS and CS2 programmes is governed by a Steering Committee, as described in article 11 of the Statutes. The Steering Committees are responsible for technical decisions taken within each ITD/IADP and in the TE and have met regularly in the course of 2016. The relevant Project Officer, supported when needed by the Coordinating Project Officer or the Executive Director, attends these meetings. The Executive Director in particular chairs the TE Steering Committee meetings.

Technology Evaluator and other Transverse Activities

Technology Evaluator, as a Transverse Activity, monitors and assesses the environmental and societal impact of the technological results arising from individual ITDs and IADPs across all Clean Sky activities, specifically quantifying the expected improvements on the overall noise, greenhouse

gas and air pollutants emissions from the aviation sector in future scenarios in comparison to baseline scenarios. The Executive Director chairs the TE Coordination meetings.
Eco-Design and Small Air Transport Transverse Activities are in charge of the coordination of their activities in cooperation with ITDs and IADPs.

3.4. Scientific Committee

The Scientific Committee (SciCom) is an advisory body to the Governing Board. In 2016 the Scientific Committee met four times:

- 3 March
- 31 May
- 14 September
- 23 November

The Scientific Committee was consulted on various documents and its members have been involved as reviewers in the Interim Progress Reviews, in all ITD Final Reviews in the CS1 programme, and in the first Progress Reviews for the CS2 programme.

The consolidated report from the chairman concerning all annual technical reviews performed in 2016, for both CS1 and CS2, was delivered to the Executive Director on 17 June 2016. On 24 June 2016 the Scientific Committee also delivered the "Common opinion of the Scientific Committee on the Clean Sky 2 Development Plan 2016".

3.5. States Representatives Group

The States Representative Group (SRG) is an advisory body to the Clean Sky 2 Joint Undertaking, established in accordance with Article 14 of the Council Regulation.

The SRG consists of one representative of each EU Member State and of every other country associated to the Horizon 2020 programme. It is chaired by one of these representatives. To ensure that the activities are integrated, the Executive Director and the Chairperson of the Governing Board or his representative attend the SRG meetings and the Chair of the SRG attends as an observer at the Governing Board.

During 2016 the SRG met four times:

- 2 March, Brussels
- 19 May, Amsterdam
- 7 September, Brussels
- 5 December, Brussels

The SRG continued to have a proactive and supportive role, particularly in its relations with the European Council.

The group was consulted during 2016 according to the new Regulation provisions with regard to the adoption of the Work Plan. The SRG has taken an active interest in the rules and conditions to be used for the selection of Core Partners and Partners through the Calls for Proposals and in

order to ensure and demonstrate transparency and accountability. The topic lists and descriptions were subject to recommendations before publication, which were duly taken into consideration by the JU. The SRG has received and discussed the reports about the calls evaluations from the Independent Observers.

The SRG has also been interested in monitoring the development of the different ITDs/IADPs, the calendar of major demonstration events and the maturing of the Technology Evaluator. The States representatives have continued their supportive view on the continuation of the JTI instrument under H2020.

Following the study carried out in previous years on the role and activities of the SRG, the specific actions identified were actively pursued. These related to:

- Representation from all relevant states and their attendance at meetings. Coordination with national programmes.
- Information dissemination and Info days.
- Review of the Work Plan and opinion provided to the Governing Board.
- Participation to major Clean Sky events. Involvement of SRG members in Communication activities of JU; participation of the JU Communication Officer to some meetings in order to define the communication strategy.

4. INTERNAL CONTROL FRAMEWORK

4.1. Financial Procedures

In 2016 the JU has been actively working on the further improvement of its financial procedures and processes, as well as the integration of new rules emerging from the H2020 guidance and new specificities compared to FP7. The financial procedures and the workflows put in place follow the financial rules and the general control framework applicable in the Commission.

Further awareness of beneficiaries on financial and administrative aspects was raised through the development of guidance materials and the development of the procedure for the reporting of the in-kind contributions, as well as a dedicated Financial Workshop organised on 21-22 January 2016 with the Clean Sky members of both programmes.

For Grant Agreement with Members, the JU has further developed the internal IT tool (GMT) for the reporting and validation of costs claims under FP7 and H2020 as well as in-kind contribution under H2020 only.

For Grant Agreement with Partners, the reporting and validation of costs was done via the EC IT tools for FP7 and H2020 (pre-financing payment only). In both cases, payment to beneficiaries was executed via the ABAC IT tool (EC accounting system).

4.2. Ex-ante Controls on Operational Expenditure

With a view to the start of the ex-post audits for H2020 grants, which will provide results only from the reporting year 2016 onwards, the ex-ante controls are of high importance. Therefore, the entire processes of planning, executing and monitoring the grants as described in the related internal manuals have been revised and implemented, to provide for updated process descriptions, templates, checklists and detailed guidance to the JU's private members and to the JU staff. Specific attention has been paid to the processes for monitoring the strategic programme planning, establishing the work programmes of the SPDs, monitoring the budget allocation, validation of the cost claims, approval of technical reports and dissemination and usage of research results.

The finance and operational teams have further intensified their cooperation in their day-to-day activities of initiation, verification and payments of invoices and cost claims, creation of commitments, recovery orders, validation of financial and technical reports and follow-up on other financial and administrative aspects of the projects. These activities have been conducted in a timely manner and monitored through the defined set of KPIs. Good performance has been achieved in particular regarding the time to pay, the budget implementation and work plan execution. Best practice and highest quality standards were ensured through the availability of the Clean Sky Management Manual, Manual of Financial Procedures and Quality Manual.

A specific framework for the planning, reporting and validation of the contribution stemming from Additional Activities of the JU's private members has been established and further revised in 2016.

4.3. Ex-post Control of Operational Expenditure and Error Rates identified

The results of the Ex-post audit (EPA) process represent a significant element of the Internal Control System of the JU. Besides the summary in this report, further details regarding scope and results of the FP7 and H2020 audits on annual and on accumulated level are provided in the Annual Ex-post Audit Report 2016, which is available on the website of Clean Sky 2 JU.

The main objectives of the ex-post audits are:

- Through the achievement of a number of quantitative targets, assess the legality and regularity of the validation of cost claims performed by the JU's management.
- Provide an adequate indication on the effectiveness of the related ex-ante controls.
- Provide the basis for corrective and recovery activities, if necessary.

I. Scope of EPA exercise 2016

In the year 2016, cost claims pertaining to the execution of grant agreements related to both the FP7 and H2020 programmes were subject to audits. For FP7 cost claims one new audit batch assignment has been launched in the year 2016, which is still on-going.

The scope of the assignment included 15 audits covering six FP7 Grant Agreements for Members. The audits were assigned to one external audit firm. For 12 of the 15 audits results are final.
The total audited value of this audit batch was Euro 18.021.250 (reported validated project costs) and Euro 9.010.625 (requested JU contribution).

In addition to the FP7 audits launched in the year 2016, the results of three audits stemming from the previous EPA exercises of the years 2012 and 2015 are considered in the exercise of the year 2016 (audited value Euro 19.824.112).

Table 1a:

EPA exercise 2016 FP7 Programme		
	Total value of audited project costs	Number of audits
FP7 Audits launched in 2016	18 021 250	12
FP7 Audits launched before 2016	19 824 112	3
Total FP7 audits included in EPA exercise 2016	37 845 362	15

The first H2020 batch assignment EPA 1/2016 was launched in July 2016. The scope of the assignments included six audits covering four Grant Agreements for Members. The audits were performed by the Common Audit Service of the European Commission. Final Audit Reports have been received by February 2017 for all audits of this batch. The total audited value of this H2020 audit batch was Euro 13.067.875 (reported validated project costs) and Euro 6.533.938 (requested JU contribution).

Table 1b:

EPA exercise 2016 H2020 Programme		
	Total value of audited project costs	Number of audits
H2020 Audits launched in 2016	13 067 875	6
Total H2020 audits included in EPA exercise 2016	13 067 875	6

Based on the results of the final audit reports, overpayments for FP7 and H2020 projects have been identified and corrected. Representative and residual error rates have been calculated and contribute to the Declaration of Assurance for 2016 of the Executive Director.

II. Details of the 2016 audit sample and coverage

The FP7 sample considered in the ex-post audit exercise 2016 and included in the calculation of the FP7 error rates 2016 is composed of three layers:

(A) one remaining audit stemming from the EPA exercise 2012 on GAMs not included in error rates 2012 to 2015.

(B) two remaining audits stemming from the EPA exercise 2015 on GAMs not included in 2015 error rate.

(C) 12 audits launched in August 2016 [10]

[10] The number of audits launched in the 2016 sample is higher

The sample consists of validated cost claims from GAMs stemming from projects carried out in the years 2008 to 2015.

The H2020 sample considered in the ex-post audit exercise 2016 and included in the calculation of the H2020 error rates 2016 consisted of only one layer **(D**); it is composed of one batch of six audits launched in July 2016.

For the calculation of the audit coverage, the accumulated audited value covered by the EPA exercises 2011 to 2016 is compared to the accumulated total amount of validated cost claims at the date of the closing for the Annual Accounts 2016:

Table 2a:

Accumulated FP7 audit coverage:

FP7 audits finalised		Euro
audited value from EPA exercise 2011		44 266 851
audited value from EPA exercise 2012		39 495 744
audited value from EPA exercise 2013		40 528 613
audited value from EPA exercise 2014		77 979 725
audited value from EPA exercise 2015		54 439 452
audited value from EPA exercise 2016		37 845 362
Total audited value of the years 2011 to 2016	**(a)**	294 555 745
Total audit population	**(b)**	1 252 525 304
Coverage	**(a) / (b)**	**23.5%**

The FP7 samples were established according to the methodology described in the FP7 ex-post audit strategy considering the following elements:

- Most significant cost claims (all CCs until a certain coverage starting from the biggest ones);
- Representative sample selected at random (by counting);
- Risk based sample (no beneficiary selected during 2016 on the basis of a risk assessment)

The sample taken in 2016 consisted of cost claims pertaining only to Members.

The specific audit coverage for Grant Agreements of Partners (GAPs) stemming from previous audit exercises is presented in table 2b.

Table 2b:

Accumulated audit coverage for GAPs of all EPA exercises:

audits on GAPs (FP7 programme)		EUR
audited value from EPA exercise 2012(final)		760 538
audited value from EPA exercise 2013 (final)		3 397 200
audited value from EPA exercise 2014 (final)		1 260 041
audited value from EPA exercise 2015 (final)		60 291
audited value from EPA exercise 2016 (final)		0
Total audited value of the years 2012 to 2016	**(a)**	5 478 069
Total audit population	**(b)**	158 381 792
Coverage	**(a) / (b)**	**3.5%**

For the calculation of the audit coverage of the H2020 audits the same approach is taken as described above for the FP7 indicator: the audited value covered by the EPA 2016 is compared to the accumulated total amount of validated H2020 cost claims at the end of 2016:

Table 2c:

H2020 audit coverage:

H2020 audits		EUR
Total audited value from EPA exercise 2016	**(a)**	**13 067 875**
Total audit population	**(b)**	**82 524 117**
Coverage	**(a) / (b)**	**15.84%**

The H2020 sample for 2016 was established in line with the H2020 ex-post audit strategy as specific sample for CSJU, following the common sampling methodology agreed by the majority of the JUs in the H2020 research family[11], considering the following elements:

- Representative sample
  - Most significant cost claims selected at random (the population was stratified to achieve a certain coverage of the most significant cost claims)
  - Remaining cost claims selected at random
- Risk based sample (no beneficiary selected in 2016 on the basis of a risk assessment)

The sample consisted of cost claims pertaining only to Members.

For the H2020 grant agreements no audits on GAPs have been performed by the JU yet, a population of auditable cost claims will be available at the earliest by the end of 2017.

[11] Note to DG RTD, Sampling methodology for JUs' specific representative sample in H2020 from 28.09.2016, sent by FCH JU, S2R JU, BBI JU, IMI JU, SESAR JU, ECSEL JU and CSJU.

III. External audit firms under contract

FP7 Audits have been assigned to the external auditors in batches, using an EPA framework contract of DG RTD. In 2016 specific contracts have been signed with one individual audit firm for one batch assignment as follows:

Table 3:

Audit Firms	Number of audit engagements	Number of cost claims	Audited value
Lubbock Fine	15	15	25 322 224
Total	15	15	25 322 224

H2020 ex-post audits have been carried out by the Common Audit Service (CAS) of DG RTD according to the H2020 Audit Strategy. In the year 2016 no contract with external audit firms was used by the CAS for this purpose.

IV. Quantitative audit results (indicators):

Status of audits:

Regarding the audits launched, the following summaries reflect the status at the time of this report:

Table 4a:

FP7 audits	number	share of total launched
Status of audits launched in 2016		
Total number launched	15	
Draft audit reports received (1.version)	15	100%
Pre-final reports received	12	80%
Final reports received	**12**	80%

Table 4b:

FP7 audits	number	share of total launched
Status of audits launched in 2012 to 2015		
Total number launched and remaining open for EPA 2016	3	
Draft audit reports received	3	100%
Pre-final reports received	3	100%
Final reports received	**3**	**100%**

Table 5:

H2020 audits	number	share of total launched
Status of audits launched in 2016		
Total number launched	6	
Draft audit reports received (1.version)	6	100%
Pre-final reports received	6	100%
Final reports received	**6**	**100%**

V. Adjustments and detected error rates:

The (ex-post) detected error rate is an indicator of the quality of the ex-ante controls as it gives an estimate of errors that remain undetected after the ex-ante controls have been performed.

- **FP7 Error rate**

The accumulated **(ex-post) detected error rate**[12] in favour of the CSJU identified in the audited FP7 population in all audit exercises until 2016 amounts to 3.5%. The rate represents a weighted average of the individual rates detected[13].
The corresponding rate for the individual audit exercise of the year 2016 is at 4.0%. The audit results include one risk based audit engagement.

The **representative error rate**, which indicates the error rate applicable to the entire population of FP7 cost claims before corrective measures, amounts to 3.1% for the accumulated audit results of all EPA exercises (see table 6a).

The individual annual result for the year 2016 is 3.0%. This error rate does not include risk based audits, which by definition are not part of the representative sample.

The (**ex-post) residual error rate** indicates the "net-errors" that remain in the total population after implementing corrective actions resulting from the ex-post controls including extrapolation of systematic errors to non-audited cost claims. The residual error rate is calculated according to the following formula:

$$ResER\% = \frac{(RepER\% * (P-A) - (RepERsys\% * E)}{P}$$

Taking into account the systematic adjustments proposed by the auditors in the audits performed until the year 2016, the following residual error rates are calculated:

[12] Errors actually detected in the audited sample related to the total amount of the sample
[13] According to the CSJU Audit Strategy, the average representative error rate is calculated as simple average of all individual rates detected. In our view, the result of this simple average error rate is misleading. Using a non-weighted average of all error rates discovered in each of the cost claims, irrespective of the value of the total amounts involved, would require a sufficiently big sample size and population to arrive at a meaningful representative result.

Table 6a:

Calculation of FP7 residual error rate (ResER%): Accumulated 2008 to 2016	
Total population (P) =	1 252 525 304
Audited population (A)=	262 644 799
total non-audited cost claims of audited beneficiaries (E) =	418 638 974
Representative error rate (RepER%) =	-3.09%
Systematic error rate (RepERsys%) =	-2.79%
ResER% =	-1.51%

Table 6b:

Calculation of **FP7** residual error rate (ResER%): 2016	
Total population (P) =	183 366 515
Audited population (A)=	31 336 052
total non-audited cost claims of audited beneficiaries (E) =	78 415 727
Representative error rate (RepER%) =	-3.03%
Systematic error rate (RepERsys%) =	-2.38%
ResER% =	-1.49%

The accumulated results established in the year 2016 indicate for the FP7 programme a similar low level of the total accumulated residual error rate (for GAMs and GAPS) of 1.51% as in the previous year (1.52%). This result indicates again the full achievement of the JU's objective to remain with the ex-post residual error rate below the 2% limit.

The specific result of the audit batches related to audits on GAPs has not changed significantly since last year as no new audits have been performed on projects of Partners, as presented in the following table:

Table 6c:

Calculation of FP7 accumulated residual error rate (ResER%): GAPs EPA 2012 to 2016	
Total population (P) =	158 381 792
Audited population (A)=	5 478 069
total non-audited cost claims of audited beneficiaries (E) =	6 904 661
Representative error rate (RepER%) =	-1,60%
Systematic error rate (RepERsys%) =	-1,60%
ResER% =	-1.47%

- **H2020 Error rate**

The audit results for H2020 projects stem from one audit exercise only. Therefore, no different values for annual and accumulated results are reported.

The detected **error rate**[14] in favour of the CSJU and the **representative error rate**[15] identified in the audited population for the individual audit exercise of the year 2016 amount to 1.14% for H2020 (see table 6d).

Taking into account the systematic adjustments proposed by the auditors in the audits performed in the year 2016, the following residual error rate is calculated:

Table 6d:

Calculation of H2020 residual error rate (ResER%): 2016	
Total population (P) =	82 524 117.36
Audited population (A)=	13 067 875
total non-audited cost claims of audited beneficiaries (E) =	2 032 186
Representative error rate (RepER%) =	-1.14%
Systematic error rate (RepERsys%) =	-0.39%
ResER% =	-0.95%

VI. Extrapolation

For FP7 beneficiaries, extrapolation is launched for all audits which have identified a net systematic error rate of all cost claims included in the individual audit of one beneficiary exceeding 1% (in favour of the JU).

Until June 2017, the extrapolation of systematic errors for the audit exercise 2016 pertaining to FP7 projects has been launched for six out of seven audits being subject to the extension of audit findings. This represents 98% of the total value of extrapolation identified in the audit exercise 2016.

The extension of audit findings stemming from H2020 audits is done according to common criteria for the entire H2020 Research Family[16].

In the first EPA exercise for H2020 for beneficiaries of CSJU, no extension of systematic audit findings was required for CS projects. An extension of findings was initiated in one case for other granting authorities of the H2020 programme.

[14] Errors actually detected in the audited sample related to the total amount of the sample

[15] Since all audits launched in 2016 belong to the CSJU representative sample (no risk based audits were carried out), the detected error rate corresponds to the representative error rate for the year 2016.

[16] The common criteria and harmonised implementation are currently developed by the Common Audit Service of DG RTD.

VII. Materiality

The control objective is to ensure for the CS programmes (FP7 and H2020), that the residual error rate, which represents the level of errors which remains undetected and uncorrected, does not exceed 2% of the total expense recognised until the end of the programme. 2% is therefore the materiality level set for the JU. A detailed description of the materiality criteria applied for the assessment of the audit results with a view to the assurance declaration of the Executive Director of the JU is provided in Annex 9.

VIII. Implementation of audit results

FP7 results for EPA exercise 2016:

Overpayments identified in audited cost claims pertaining to audits included in the ex-post audit exercise 2016 have been recovered during the year 2017 upon receiving Final Audit Reports by 100%. The correction of the accumulated error in audited cost claims since the beginning of the ex-post audit activity has therefore been fully implemented.

The correction of the financial effect of the detected systematic errors in unaudited cost claims pertaining to the EPA exercise 2016 has been launched in all concerned cases, i.e. 7 audits with an estimated maximum of 2 Mill Euro extrapolation value.

The finalisation of the extrapolation is still on-going as beneficiaries have requested extension of deadlines. As approximately 50% of the total extrapolation effect has been kept on hold by the JU during the ex-ante validation of the unaudited cost claims, the implementation of the extrapolation can be achieved through netting off with these amounts. The implementation will be fully settled during the final payments to the beneficiaries for the FP7 programme.

Due to the on-going extrapolation exercise of the year 2016 as described above, the accumulated rate of implementation of all audit results including detected and extrapolated errors for the EPA exercises 2011-2016 amounts to 78.8%, as shown in the table 8a.

Table 8a
FP7 Programme:

Accumulated Total corrective action for EPA exercise 2011-2016 implementation achieved				
Audited value (of audited and unaudited cost claims)	Adjustments in favour of CSJU	related overpayment	recovery of overpayment (€)	recovery rate (%)
728 094 318.05	-22 828 002.69	-11 408 765.28	-8 987 298.14	78.78%

H2020 results for EPA exercise 2016:

Overpayments identified in audited cost claims pertaining to audits included in the ex-post audit exercise 2016 for H2020 projects have been recovered during the year 2017 upon receiving Final Audit Reports by 51.3%. The JU will continue to fully correct the comparatively low representative error (1.14%) stemming from the H2020 audits within the next possible periodic payments to the concerned beneficiaries.[17]

Table 8b
H2020 Programme:

Total corrective action implemented (fully implemented in the system)				
Audited value (of audited and unaudited cost claims)	Adjustments in favour of CSJU	related overpayment	recovered overpayment (€) (i.e. adjustments booked in the system for next payment)	recovery rate (%)
15 100 061.46	-148 803.72	-104 162.60	-53 443.88	51.31%

IX. Assessment of the ex-post audit results

The ex-post audit exercises 2011 to 2016 pertain to validated cost claims for GAMs and GAPs of the years 2008 to 2015 for the FP7 and H2020 programmes. As described in the materiality criteria in the Annex to this document, the control objective of the JU is to ensure for the two individual CS programmes, that the residual error rates, which represent the remaining level of errors in payments made after corrective measures, does not exceed 2% of the total expense incurred until the end of the individual programmes.

The results of the EPA process 2016 reflect the legality and regularity of the validation process for GAM execution 2008 to 2015 for the FP7 and H2020 programmes. Thus, they do not directly relate to the entire expenditure incurred by the JU until the end of year 2016. However, the JU's EPA strategies are implemented through an on-going process, which produces accumulated results applicable to the entire expense incurred for the CS programmes until a certain point of time. At present CSJU has results for payments incurred for GAMs and GAPs 2008 to 2015. The accumulated audit coverage of the validated financial statements pertaining to GAMs and GAPs for the years 2008 to 2016 is **24%** for the FP7 programme and **16%** for the H2020 programme.

[17] According to the Article 42.3 of the H2020 GA, the recovery of detected overpayments can only be deducted "from the total eligible costs declared, for the action, in the next periodic summary financial statement or in the final summary financial statement." Therefore the JU considers the overpayments as corrected, when the related adjustments are booked in the grant management system

FP7 programme:

At the end of 2016, the indicators established from the FP7 samples, stemming from six audit exercises carried out in the years 2011 to 2016, reflect a nearly unchanged accumulated representative error in favour of the JU in the validated FP7 operational expense of **3,1%,** compared to **3.0%** for the accumulated exercises until end of 2015.

Based on the representative error rate, the accumulated residual error rate, i.e. the accumulated error stemming from the audit exercises 2011 to 2016 remaining after cleaning the population from systematic errors, amounts to **1.5%,** the same result as for the corresponding residual error rate for the EPA exercise 2016 only. Hence, in the EPA exercise 2016, the low level of the previous years is maintained.

The FP7 population of GAPs (11%) has been covered by two specific samples including cost claims of the years 2012 and 2013, which resulted in representative and residual error rates below 2% and hence did not indicate a significant risk for overpayments to Partners.

At the time of this report, the corrective measures for the six annual FP7 audit exercises carried out in the years 2011 to 2015 have been fully implemented with respect to the audited cost claims. The correction of systematic errors in unaudited cost claims pertaining to audits finalised until end of 2015 has also been fully achieved. The extrapolation of the most recent cases, related to the EPA exercise of the year 2016, is still on-going and will be implemented until the closure of the FP7 program during the course of the year 2017.

The FP7 EPA coverage and identified error rates have to be evaluated with a view to the multiannual EPA strategy, which has evolved as an on-going process during the duration of the programme from the beginning until now. Under this multi-annual aspect, we consider the accumulated results of the EPA process 2011 to 2016 relevant and appropriate to provide assurance for the operational expenditure as recognized in the Annual Accounts 2016.

H2020 programme:

The accumulated audit coverage of the validated H2020 financial statements pertaining to GAMs for the years 2014 to 2015 is **16%.**

The indicators established from the first H2020 sample covered in the current audit exercise, reflect a representative error in favour of CSJU in the validated operational expense of **-1.14%.**
Based on the representative error rate, the accumulated residual error rate, i.e. the error stemming from the audit exercise 2016 remaining after cleaning the population from systematic errors, amounts to -**0.95%.**

With a view to the moderate errors detected in the first H2020 audits we consider the level of assurance provided through these first audit results as sufficient for the reporting year 2016.

4.4. Audit of the European Court of Auditors

In 2016, the JU was audited by the European Court of Auditors as set out in the Statutes. The results of these audits were published in the Court's Report on the Annual Accounts 2015[18]. In its Statement of Assurance, the Court issued to the JU a positive opinion on the reliability of the annual accounts and on the legality and regularity of the underlying transactions.

The findings and comments raised by the Court during the two audit visits performed until June 2016 have been taken up by the JU and actions have been developed to further improve the procedures of the JU and enhance controls.

4.5. Internal Audit

The Internal Audit function of Clean Sky 2 JU has been carried out in 2016 by the Internal Audit Service of the Commission (IAS) and the Internal Audit Officer of Clean Sky 2 JU (IAO). According to Article 26 of the Clean Sky 2 Financial Rules (CSFR), the internal auditor shall advise the JU on dealing with risks, by issuing independent opinions on the quality of management and control systems and by issuing recommendations for improving the conditions of implementation of operations and promoting sound financial management.

Internal Audit Service (IAS):

In the year 2016, the IAS finalised an audit on the H2020 Grant Process (from the identification of the call topics to the signature of the grant agreement). The objective of the audit engagement was to assess the design, efficiency and effectiveness of the internal controls in place at the Clean Sky 2 JU for preparing CfPs, for submitting, evaluating and selecting proposals and preparing grant agreements under the H2020 rules in CS2. The audit did not focus on the coordination with the Common Support Centre, on the implementation of its tools and services and on performance management of the Clean Sky 2 JU activities, as this is identified as a separate cross-cutting audit topic in the SIAP 2015-2017.

As the audit did not identify any 'Very Important' issues, the IAS highlighted four areas requiring further improvement of the internal control system and issued important related recommendations. The concerned areas were:

- Topic selection and involvement of advisory bodies;
- Guidance for Project Officers on H2020 processes in the JU's internal management documents and clear assignment of roles of actors in the call process, e.g. call coordinator, responsible officer, panel chair and quality controller;
- Grant agreement preparation and adherence to time lines (internal milestones and time to grant [TTG]);
- Implementation of the feedback of Independent Observer and experts in the calls process.

The JU received the final audit report in November 2016, and has started to implement the agreed actions. The strategic audit plan of the IAS for the year 2017 remains unchanged. The agreed audit

[18] Report on the Annual Accounts of the Clean Sky Joint Undertaking for the financial year 2015, dated 18.10.2016

theme is Performance Management of the Clean Sky 2 JU activities.

At the time of this report, the IAS has not issued an annual internal audit report for the year 2016 on the implementation of the agreed actions stemming from previous years' audits and risk assessments.

According to the JU's own assessment, no very important actions due for completion before the end of 2016 remain open.

No critical residual risk levels regarding the JUs main business processes and internal controls were noted by the auditors.

Internal Audit Officer (IAO):

The IAO of the JU has summarised the main activities in the IAO's Annual Report 2016[19]. Similar to the previous years, the IAO has provided in 2016 consultancy services in order to advise the JU's management on further improving the processes and enhancing the necessary controls in the following areas:

- Ex-post audit exercises 2015 and 2016 for FP7 expenditure including the implementation of audit results
- EPA approach for H2020 expenditure
- In-kind contribution procedures
- Anti-fraud strategy

For the year 2016, the IAO confirmed to the GB that organisational independence has been upheld according to the Institute of Internal Auditors (IIA) standards. However, due to repeated involvement in management tasks in the areas listed above and also related to the Quality Management processes, the IAO declared to management and the GB about a lack of objectivity.

In the year 2016 significant risks as reported by the IAO at the end of 2015 have been reviewed. The IAO identified the following:

- five areas, for which the risks have been sufficiently mitigated during the year 2016
- five areas, which remained at significant risk level compared to the end of 2015
- two areas, for which new risks were identified during the year 2016

The following areas were reported with significant risk levels at the end of the year 2016:

- Integrated monitoring of interdependencies between FP7 ITDs, H2020 SPDs, TAs and TEs including focused risk assessment
- Multiannual budget planning – management of reallocations
- Integration of new Core Partners in the projects
- SPD performance monitoring by JU regarding actual deliverables, milestones and resources consumption versus planning

[19] Annual Report 2016 of the Internal Audit Officer, dated 25.01.2017

- Management of the H2020 In-kind Contribution (IKOP and IKAA) in line with the CS2 Regulation
- Performance monitoring and internal control coordination, with a shift to principle based internal control approach focusing on performance monitoring
- Steering of the JU following several changes in key management positions
- Management of the Pre-financing for GAMs
- Coordination of audits between the Commission and other stakeholders of the CAS in order to avoid an excessive audit burden for the common H2020 beneficiaries (the risk will require mitigation from 2018 onwards)

The JU management is aware of the above risk areas and is working on establishing adequate controls.

4.6. Risk management and conflict of interest

As one major element of its Internal Control Framework, the JU assesses and manages through a dedicated process the potential risks, which may be detrimental for achieving its objectives.
At JU level, a risk register is maintained which provides information on the description the risk, the risk type (financial, operational and reputational), the related business process and the required mitigating action.
The programme related objectives are closely monitored by the risk management within the SPDs, for which the JU has identified its requirements in its Management Manual.
The SPDs' risks, which can impact the objectives of the programme are consolidated in the CSJU risk register.

The risk management performed by the JU is fully integrated into the JU's planning and reporting cycle. It is carried out:

⇨ Throughout the planning and programming phase:
- Identification of risks in relation to the foreseen activities/objectives during the grant preparation phase. The Project officers and Programme managers' review the risks when preparing the annexes which contain the description of the work; critical and very important risks are listed together with the envisaged mitigating actions in the Annual Work Plans and in detailed JU action plans.

⇨ Throughout the execution phase:
- For each Level 1 Work Package of the programme, a risk analysis is conducted by the Work Package Manager/Work area leader regarding the technical performance (achievement of the objectives) and the schedule. The follow-up is performed during the annual reviews.
- Specific risk reviews are presented in each Governing Board meeting, during the technical progress reviews
- The annual risk review of the JU management on global programme level

⇨ As part of the reporting:
- A presentation of risks and risks management in the Annual Activity Report. Please see further below in this chapter where we refer to the risk registers.

The Recommendations for improving this risk management at operational level have been made in most reviews and have been implemented by the JU (in particular to improve the consistency across ITDs/IADPs/TAs).

The JU's Internal Audit Officer (IAO) and the Internal Audit Service of the Commission have performed independent risk assessments in 2015, which resulted in the selection of audit topics for the coming year(s) and in the identification of significant risk areas.

A summary of results from the IAO's risk assessment is reported in the Internal Auditor Officer's annual report, as mentioned above in subchapter 4.5.

The main risks for the JU relate to the operational objectives of the programmes and to some core management processes, which could have an impact on the implementation of the overall programme.

Clean Sky Programme

Critical risks:

Risk Description	Comments on mitigation of risk	Comments on mitigation of risk
The delays incurred for developing the BLADE demo could result in missing the 2016 objective	The BLADE demonstration program is based on an A340 FTB, whose problems of availability has been discussed at length; the contribution of the different actors in the supply chain (both ITD associates and Partners) to the wing parts of the demonstrator is still being finalized. The project requires a constant attention to avoid more slippage. The JU is having periodic meetings with the ITD coordinators in order to monitor the remaining activities and the related budget impact.	Plan now consolidated. Milestones and demonstrators' assembly achieved in 2016. Flight milestone confirmed in Q3-17, with option to anticipate to June. The JU is actively following the updated roadmap for the BLADE Laminar Wing demonstrator with the aircraft industry and its full supply chain members.
The initial delay and slow ramp-up of Counter Rotating Open Rotor (CROR) demo resulted in missing the 2016 deadline in CS; the feasible target remains the Ground test of the demonstrator engine (SAGE2).	Being the Ground demonstrator now confirmed end 2015, the preparatory phase for the flight testing has slowed down and shifted to CS2. The revised plan clearly shows the flight tests being postponed to CS2, after 2016.	Ground demo assembly actually started end 2016. Actual run in first semester 2017.

Risk assessment AAR 2016

Risk Description	Action Plan Summary	Comments on mitigation of risk
A late availability of ITD aircraft models for the Technology Evaluator (lack of prioritisation or lack of technical inputs) could prevent the environmental benefits assessment to be efficiently performed.	Tightly monitor the work progress on this item through the Project Officers and the GAMs. Have preliminary models implemented where needed.	TE report now finalized using the available data input from ITDs.
Conflicts of priorities may happen within industrial companies, or change of strategy, resulting in a lack of resources available for Clean Sky and delays in the completion of the activities.	Have an early warning capability through quarterly reports and alert at Governing Board level. Propose re-orientations when needed and possible.	Such conflicts have not appeared.
The "share of the pie" logic could result in a lack of focus on the major, critical activities.	Challenge the ITDs in order that they focus on optimising the global output.	Such concerns have not appeared.
Delayed closure of some work packages and therefore late	Ensure regular reporting on final cost estimations and timely	Instruction was delivered to ITDs to insert in GAMs all activities,

Risk Description	Action Plan Summary	Comments on mitigation of risk
information on final spend in some ITDs may result in delayed decision making with regard to leftover funding which could be redirected to other ITDs' needs	delivery of final reports; Immediate proposal for re-distribution of funding to ITDs allowing technical activity to proceed	not covered by nominal budget, with option to be funded at end of the program by rebalancing the actual funding used.
There is a risk that lack of pro-activity in dissemination of result may result in vague information to the end-user/interested party and therefore compromise the JU reputation	Harmonize the dissemination plans of ITDs Monitor the dissemination actions	Strong action taken of ensuring the dissemination is appropriately performed by all ITDs and reported in the Final report of the CS1 program.
The lack of experience in European Research Programmes from many Partners (SMEs) could result in a difficult and late closure process of their projects.	Reinforce the information, mainly through relevant Information Days and Web conferences; reinforce the role and the awareness of Topic Managers	Lesson learnt being collected in the closure of the GAPs, where SME participation is significant.
The ramp-up of Clean Sky 2 in parallel to final reporting of Clean Sky could result in a scattered and delayed response from the Programme office towards beneficiaries	Revise the processes and ensure adequate priorities management to cope with the closing phase of CS1 while complying with the specificities of H2020 / CS2	Allocation of Operational Unit staff (PO/PSO) to CS1/CS2 activities is balanced and monitored on a weekly basis.

Clean Sky 2 Programme

Risk assessment AAR 2016

Risk Description	Action Plan summary	Comments on mitigation of risk
Conflicts of priorities may happen within industrial companies, or change of strategy, resulting in a lack of resources available for Clean Sky 2, delays in the completion of the activities and/or a need to revise programme content.	Implement a Launch Review for each Project. Have an early warning capability through quarterly reports and alert at Governing Board level. Propose re-orientations when needed and possible. Actively use CS2DP and GAM Amendment processes to re-orientate where needed	All Launch Reviews were concluded with corrective actions agreed where needed. Overall progress has been monitored through the regular reviews [including Annual and Intermediate Progress Reviews over 2014-2015 with independent reviewers]. Where needed [on the basis of reviews or at the initiative of the IADP/ITD], revisions in schedules and work-scope have been initiated. These have been [or will be at next revision date] reflected in the CS2DP, and flowed down to WP 2017 and WP 2018-2019, with GAM Amendments where necessary. The Governing Board has been kept informed and has adopted via the CS2DP and WP the Programme

Risk Description	Action Plan summary	Comments on mitigation of risk
		adjustments that have arisen to date on this basis.
Technical setbacks in one or several IADPs / ITDs / TAs may result in under achievement of milestones and deliverables and/or a significant under-spending of annual budget.	Review each quarter and advise GB where issues arise. Re-balance the budget across ITDs/IADPs and with Partners if necessary.	Risk management and "gate management" is monitored closely through the regular reviews [including Annual and Intermediate Progress Reviews with independent reviewers], with a strong focus on building resilience into the plans. Where needed [on the basis of reviews or at the initiative of the IADP/ITD], revisions in schedules and work-scope have been initiated. These have been [or will be at next revision date] reflected in the CS2DP, and flowed down to WP 2017 and WP 2018-2019, with GAM Amendments where necessary.
The potential introduction of Clean Sky 2 in parallel to Clean Sky may result in a scattering of beneficiaries' resources, a delay in Clean Sky demonstrator's finalisation and an overload for the CS team.	Check resources and any critical dependencies in Launch Reviews. Condition the CS2 funding by ITD and by beneficiary to the actual execution of CS budgets and technical progress	All Launch Reviews were concluded with corrective actions agreed where needed. Ramp-up of CS2 resource consumption and acceleration in terms of technical activity has been very steep: indicating the stakeholders have managed successfully to "transition" to full-speed CS2 execution in the course of 2016 in nearly all IADP/ITDs. Separately, the CS team has managed closing CS1 projects while adequately monitoring key programme office CS2 responsibilities such as Calls and Grant Implementation, due in large part to the successful absorption of the Project Support Officers in the operational team.
Guidelines for Clean Sky 2 preparation documents may be not clear and/or stable enough, leading to late or incomplete IADP / ITD / TA submissions to the JU.	Have clear management plan and templates for required documentation. Revise where necessary taking "lessons learnt into consideration from 2014-15 period	Templates, forms and documentation for the grant management and call management in CS2 have been established as CS2-tailored applications of H2020 forms and documents and this has been fully implemented over 2016 [including periodic reports covering 2014-2015]. Recommendations of the Internal Auditor of the JU have

Risk Description	Action Plan summary	Comments on mitigation of risk
		been taken into consideration. The process and related pro-forma templates are in the process of final implementation in the CSMM [target Q1 2017].
Planning for cost and effort for complex, large ground and flight demonstrators (10 year programme) may lack accuracy	Each IADP / ITD to deploy an individual, tailored risk management and to completion plan. CS2DP process to highlight "through to completion" plans, budgets and risks, allowing due assessment and revision opportunities.	Risk management and "gate management" is monitored closely through the regular reviews [including Annual and Intermediate Progress Reviews with independent reviewers], with a strong focus on building resilience into the plans. Where needed [on the basis of reviews or at the initiative of the IADP/ITD], revisions in schedules and work-scope have been initiated. These have been [or will be at next revision date] reflected in the CS2DP, and flowed down to WP 2017 and WP 2018-2019, with GAM Amendments where necessary.
Negotiation processes with Core Partners may be lengthy, leading to delayed start of technical activities	Ensure appropriate guidance and instructions / training for Winners and WALs; have a close follow-up of all negotiations and early warning / escalating process for solving issues.	Core Partner negotiations have been well managed and in nearly all cases were concluded within or close to the standard H2020 Time-to-Grant [TTG], proving that the appropriate level of "sense of urgency" and process monitoring was applied.
Efforts for interfaces and cooperation of partners for flight worthy hardware and complex flight demonstrators may be initially underestimated	Have clear descriptions of work in Call texts for such activities directly related to flight worthy hardware, including requested skills and agreements. Deploy an individual, tailored risk management for interfaces of members and partners for large demonstrator activities Prepare more conservative back-up solutions in advance to mitigate the risk	Topics proposed for the Calls have been and will continue to be evaluated and revised where necessary, ensuring clarity and transparency. Follow-up from the Topic Manager side to the grant implementation and interfaces from GAP projects towards the GAM to which these grants are complementary is monitored closely by the JU's Project Officers.
Competences and resource to successfully enable flight testing may be insufficient	Clearly identify the required competences and resources and closely monitor thru PDR/CDR and milestone management. Enforce consistent and robust risk management; implement early-warning system to avoid late discovery of critical path related risks Check relevance of cost and schedule wrt airworthiness issues at Launch	All Launch Reviews have been held by end 2016. First series of Annual Reviews [covering 2014-2015] and subsequent Intermediate Progress Reviews with independent reviewers has allowed a robust check of implementation plans, in some cases leading to revisions in schedules and work-scope. These have been [or will be at next revision date]

Risk Description	Action Plan summary	Comments on mitigation of risk
	Reviews (and further reviews)	reflected in the CS2DP, and flowed down to WP 2017 and WP 2018-2019, with GAM Amendments where necessary. PDR/CDR "Gates" are monitored and where deemed necessary the JU will appoint external reviewers to observe and advise in these "gate reviews".
Some costs may be overrun, and some participants may be unable to carry on until completion.	Manage priorities: abandon non crucial technology development and integrate only the crucial ones in the demonstration. Consider the implementation of a contingency margin.	Use of the CS2DP update cycle is allowing confirmation of through-to-completion costs and work-scope refinement on a regular / annual basis; and where necessary this has been flowed down into amendments to WP and relevant GAMs.

Programme Risks on SPD level

The SPDs manage the risks inside their projects, using the methodology defined by the JU management although applying different formats; they discuss the evolution of the risks in the Steering Committees of the SPDs as a standard item. The overall responsibility for the risk management of each SPD lies with the SPD Coordinator, who receives input from the associates/core partners according to internally defined processes in the consortium.

Risks have been addressed at two levels:

- associated to the CSDP and associated technologies and demonstrators
- associated to the Annual work plans and associated to work packages and with a view to four categories of targets:
    - technical (WP, TRL & Environmental)
    - schedule
    - costs
    - input and resources planned and needed

Conflict of interest

The JU adopted in 2016 a comprehensive decision on the rules on the prevention and management of conflicts of interests applicable to the bodies of the Joint Undertaking, as presented in section 3.1. In the frame of the Internal Control management, the staff members received training on the definition of the conflict of interest and possible prevention and reporting requirements in terms of acceptance of gifts, favours or payments.

Fraud prevention and detection

The JU management pays particular attention to fraud prevention and detection. In 2016, the Governing Board adopted the Common Anti-Fraud Strategy Action Plan. Moreover, the JU staff members participated in a survey on fraud prevention and detection organised by the Commission

and coordinated internally by the Internal Audit Officer, with a special focus on fraud in research projects.
The JU takes part in and implements the preventive and corrective measures in line with the newly adopted common 'Anti-fraud strategy and anti-fraud action plan' (adopted in 2015) at EC level.

4.7. Compliance and effectiveness of Internal Control

The internal control system of the JU is governed by internal control standards, which are based on the standards for effective management developed by the Commission. Throughout the year 2016, particular efforts were directed to KPI monitoring. The time to pay and time to grants KPIs were closely followed and efforts were put in across the team to improve performance here.

Other elements of internal controls included an assessment of the JU financial procedures; updates of the Financial Circuits and review of the authorisations in place for the financial IT systems. In addition, the validation of the underlying systems providing information to the accounts continued. Actions remaining from the year 2015 were closed in 2016.

The finance team worked together to improve the underlying systems where further investment was needed while, at the same time, continuing to commit and pay from the two programme budgets to the maximum possible. The financial circuits put in place since 1 October 2014, and revised further in 2016, respect the segregation of duties and take into account the fact that the JU now runs two programmes and has some new actors entering the circuits internally.

Internal controls in Grant management

In view of the CS programme, the JU has provided a template for the final technical report to the ITDs which they shall deliver at the moment of closing their grant agreement for members. In addition, the final financial reporting is expected, which includes the distribution of funds and reporting of income that has been addressed by the JU towards the members.
New developments of GMT were completed in 2016 by which the JU made the GMT2 modules available for the planning and reporting of CS2 additional activities. The planning module for the GAMs through GMT was further implemented in 2016 making the grant management of members more efficient going forward.

Activities outside the Work plan of the JU

A specific framework for the planning, reporting and validation of the contribution stemming from Additional Activities has been established and further revised with the members during 2016.

5. MANAGEMENT ASSURANCE

5.1. Assessment of the Annual Activity Report by the Governing Board

GOVERNING BOARD OF CLEAN SKY 2 JOINT UNDERTAKING
ASSESSMENT OF THE ANNUAL ACTIVITY REPORT 2016

The Governing Board of Clean Sky 2 Joint Undertaking took note of the Annual Activity Report 2016 (Authorising Officer's report), the provisional version of which was made available on 1 March 2017 and the consolidated version on 8 June 2017.

The Board is of the opinion that the Annual Activity Report sets out the relevant highlights of the implementation of the 2016 activities of the Joint Undertaking from both an operational and administrative point of view.

The Board is pleased to note that the Clean Sky programme has achieved significant progress and results with the delivery in 2016 of a total of 13 significant demonstrators (ground and flight tested) and closing up to end December 2016 409 out of 482 FP7 projects arising from the grant agreements with partners (GAPs). It is also pleased to note that at the same time, the Clean Sky 2 programme has selected most of its Core Partners and has achieved the addition of the Partners to the programme. It welcomes the steep increase in Clean Sky 2 membership compared to Clean Sky and recognises the impacted workload associated with this for both the JU programme office and the private members.

The Board takes note of the reported assessment of the environmental benefits as updated by the Technology Evaluator. It welcomes the high-level results which demonstrate that most of the environmental objectives of the Clean Sky Programme have been fulfilled or even exceeded through the completed demonstrators.

The Board encourages the members to maintain a good rate of budget execution achieved in 2016 and to explore the ways of increasing it further. It encourages all participants to the programme to continue to meet the targets set out in the grant agreements for achievement of milestones, deliverables and optimum use of resources assigned.

The Board is pleased to note the continuous progress made with establishing the legal framework for the association of the JU with the European Structural and Investment Funds and regional cooperation. It considers this as a key element to contribute to the aim of strengthening the R&I innovation capacity and the European dimension of the regions in aeronautics while complementing the programme and supporting its overall objectives.

The Board takes note that the in-kind contributions of the private members are brought in at a good level, in particular with reference to the additional activities provided. It encourages the members to further report in-kind contributions for operational projects.

The Board takes note that the internal control system of the JU is robust and provides an adequate level of internal control. The risk management is appropriate, for technical and financial risks, and reported to the Board.

The Board encourages the private members to ensure all efforts are made to communicate and disseminate the research results in accordance with the grant agreement provisions and calls the Programme Office and the Commission to support this with efficient and appropriate tools.

The Board takes note that the JU has fulfilled its monitoring tasks through the implementation and usage of dedicated key performance indicators for the achievement of strategic research and management objectives.

The Board takes note that the ex-post audits have been duly implemented and processed. The Board welcomes the established positive result visible in the achieved accumulated error rate level assessed in the ex-post audit exercise 2016, which is well below 2%. The target of limiting the accumulated errors for the entire FP7 Clean Sky programme below 2% is achieved. Further actions to maintain the applied preventive and remedial measures as well as to initiate a robust audit process for the H2020 programme will be supported by the Board.

Done in Brussels, 6 July 2017

Bruno Stoufflet

(Signed)

Vice-Chairman of the Governing Board
Clean Sky 2 JU

5.2. Elements supporting assurance

Besides the dedicated supervisory activities of the Executive Director, the main elements supporting the assurance are:

- the reporting of the Head of Administration and Finance (who is also the Internal control coordinator of the JU)
- the reporting of the Coordinating Project Officer
- the reporting of the CS2 Programme Manager
- the reporting on the accumulated results of the ex-post audit processes from 2011 to 2016 and the related implementation
- the information received from the Data Protection Officer
- the results of audits of the European Court of Auditors to date
- the reporting of the Internal Audit Officer and the Internal Audit Service of the Commission
- the overall risk management performed in 2016 as supervised by the Executive Director
- the key performance indicators in place
- the dedicated ex-ante controls of the JU's operational expenditure
- the private members' reporting of in-kind contributions

5.3. Reservations

No reservation is entered for 2016.

5.4. Overall conclusion

Not applicable.

5.5. DECLARATION OF ASSURANCE

I, the undersigned, Tiit Jürimäe, Interim Executive Director of Clean Sky 2 Joint Undertaking

In my capacity as authorising officer by delegation

Declare that the information contained in this report gives a true and fair view[1].

State that I have reasonable assurance that the resources assigned to the activities described in this report have been used for their intended purpose and in accordance with the principles of sound financial management, and that the control procedures put in place give the necessary guarantees concerning the legality and regularity of the underlying transactions.

This reasonable assurance is based on my own judgement and on the information at my disposal, such as the results of the self-assessment, ex-ante and ex-post controls, the work of the internal audit capability, the observations of the Internal Audit Service and the lessons learnt from the reports of the Court of Auditors for years prior to the year of this declaration.

I confirm that I am not aware of anything not reported here which could harm the interests of the Joint Undertaking.

Place Brussels, date 06.07.2017

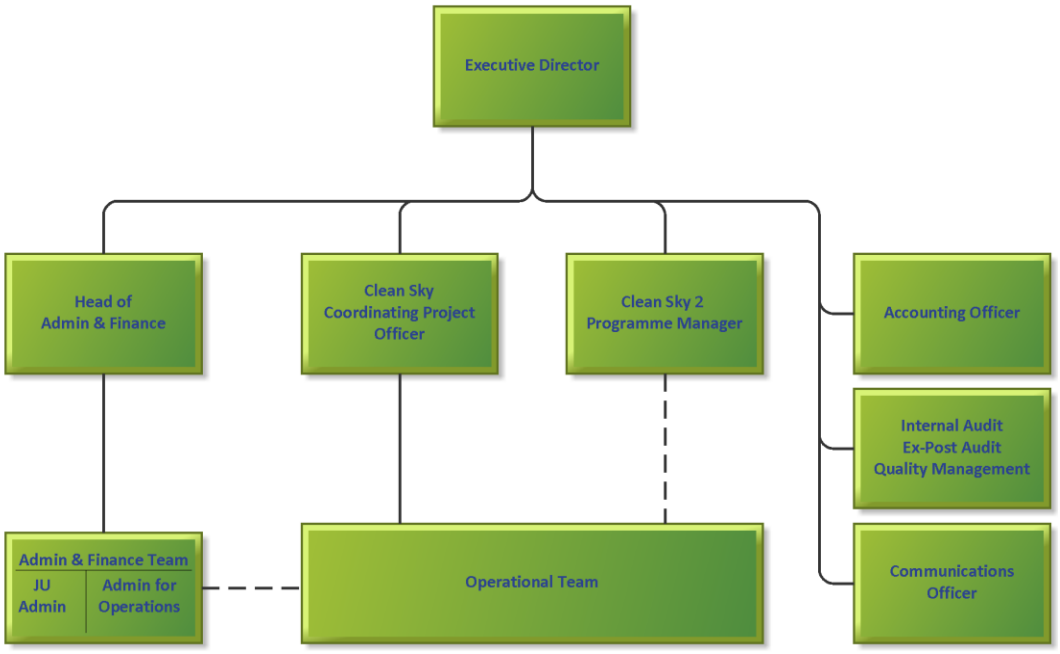
(signed)

Tiit Jürimäe

[1] True and fair in this context means a reliable, complete and correct view of the state of affairs in the Joint Undertaking.

ANNEXES

1. Organisational chart



2. Staff establishment plan

Category and grade	Staff population actually filled at 31.12.2015		Staff population actually filled at 30.12.2016	
	Official	TA	Off.	TA
AD 16				
AD 15				
AD 14		1		1 (1)
AD 13				
AD 12				
AD 11				2
AD 10		3		3
AD 9		10		10
AD 8		1		1
AD 7		5		4
AD 6		5		10
AD 5				0
Total AD		***25***		***31***
AST 11				
AST 10				
AST 9				
AST 8				
AST 7				1
AST 6		1		
AST 5				
AST 4				3
AST 3				
AST 2				
AST 1				
Total AST		***1***		***4***
TOTAL TA		**26**		**35**
CA FG IV		1		1
CA FG III		2		2
CA FG II		3		3
CA FG I				
Total CA		***6***		***6***
SNE				***2***
TOTAL (TA+CA+SNE)		**32**		**43**

(1) Seconded official from European Commission since 16/09/2016

3. Publications from projects

SFWA Contribution in Technical Conferences and Publications in Journals in 2016

Author(s)/Org.	Title / Where published / Date	Conference/ Journal
Airbus-UK	Natural Laminar Flow Industrial Challenges & The BLADE Flight Test Demonstrator; RAEs Conference, July 2016	C
NLR, TUHH	Crosstalk between wire pairs above a composite ground plane; EMC Europe 2016, September 5-9, 2016, Wroclaw, Poland	C
AI press office	Ground Based Demonstrator: Demonstrating innovation; To the trade press in the perspective of the Singapore Airshow	article
Tim Smith, GKN	Images of the Clean Sky Ground Based Demonstrator; For publication at the National Composites Centre in the UK.	Photos
ONERA, DAv	Exp. extraction of turbofan noise sources modal content; Aeroacoustics AIAA Conference @ Lyon, France, 30 May - 1 June, 2016	C
ONERA	Gust load alleviation: a sub/transonic wind tunnel experiment validation of a 2D aeroelastic airfoil; Journal IEEE transactions on Control Systems Techn.	J
DAv, ONERA	Ground test for vibration control demonstrator; MOVIC & RASD 2016, 3-6 July 2016, Southampton	C
AERNNOVA, ETSIAE- UPM	Effect of an aerodynamic rudder improvement on transport aircraft lateral- Greener Aviation Conference 2016, Brussels, 11-13 Oct 2016	C
Airbus UK	The Industrial Challenges of Natural Laminar Flow and The BLADE Flight Test Demonstrator; Royal Aero Society conference in July 2016	C
NLR	Harness Derating Test Facility for Thermal Testing of Aerospace Harnesses; ESA/ESTEC Conference, Noordwijk, 12-14 October 2016	C
Dassault Aviation	Design and test of innovative after bodies for bizjets; Greener Aviation Conference 2016, Brussels, 11-13 October 2016	C
Dassault Aviation	Design, Manufacturing & Testing at ETW of a Laminar Wing Business Jet Model at High Re Number; Greener Aviation Conference 2016, Brussels	C
Airbus UK	The Natural Laminar Flow Flight Test of the BLADE Project of Clean Sky; Advanced Engineering Show 2016, 2-3 Nov.2016 in Birmingham	C
DLR	Investigations of Bird Strike on a Front Composite CROR-Aerofoil; International Journal of Crashworthiness	J
Onera	A new frequency-domain subspace algorithm with restricted poles location through LMI regions and its application to a wind tunnel test; International Journal of Control, September 2016, 1-28	J
Aircraft Research Assoc.LtD	ENITEP: Experimental & numerical investigation of turbulent boundary layer effects on noise propagation in high speed conditions; Greener Aviation Conference 2016, Brussels, 11-13 October 2016	C
Airbus	Clean Sky SFWA – Installation of natural laminar wings to be tested onto A340-300 Airbus flight lab; Greener Aviation Conference 2016, Brussels	C
Onera	Research activities of ONERA on laminar wings in the framework of JTIClean Sky: transition prediction; Greener Aviation Conference 2016	C
Onera	Research activities of ONERA on laminar wings in the framework of JTI Clean Sky: transition control; Greener Aviation Conference 2016	C
ISAE	In-flight PIV for CROR flight test demonstration; Greener Aviation Conference	C
Onera	Toward a better correlation between Z49 and aeroelastic computations; Greener Aviation Conference 2016, Brussels, 11-13 October 2016	C
DLR	Structural Investigations on a Front Composite CROR-Blade Aerofoil; Greener Aviation Conference 2016, Brussels, 11-13 October 2016	C
DLR	Adaptive wing: Investigations of passive wing technologies for loads reduction in the Clean Sky SFWA project; Greener Aviation Conference 2016	C
Onera	Experimental investigation & control of gust load response in transonic flow; Greener Aviation Conference 2016, Brussels, 11-13 October 2016	C
LMSM	Micro camera system for understanding the typical level of insect contamination on drag; Greener Aviation Conference 2016, Brussels	C

GRC Contribution in Technical Conferences and Publications in Journals in 2016

GAP	Title	Author(s)	Where/when	
COMROTAG	Rotorcraft Applications of Active Gurney Flap Investigated within the Clean-Sky Project COMROTAG	Wienczyslaw Stalewski	41st European Rotorcraft Forum 2015, Proceedings	DLR- Bonn
COMROTAG	Flow Control on Helicopter-Rotor Blades via Active Gurney Flap	Wienczyslaw Stalewski	Proceedings of The 30th Congress of the International Council of Aeronautical Sciences ICAS2016	ICAS
MORALI	Aeroacoustic Validation of the Free Wake Method FIRST on the basis of an EC145-T2 Main Rotor in Descent Flight MORALI	Patrick Kranzinger	42nd European Rotorcraft Forum	5-8 September 2016, Lille
MORALI	Aeroacoustic Validation of the Free Wake Method FIRST on the basis of an EC145-T2 Main Rotor in Descent Flight	Patrick Kranzinger and Manuel Keßler and Ewald Krämer.	42nd European Rotorcraft Forum	5- September 2016, Lille
ROD	Robustness and Limits of Vortex Generator Effectiveness in Helicopter Drag Reduction	A. Zanotti, G. Droandi, F. Auteri, G. Gibertini, A. Le Pape		Journal of the American Helicopter Society, Vol. 61, p.1-20,
ROD	Wind-tunnel tests of a heavy-class helicopter optimised for drag reduction	A. Zanotti, G. Droandi, G. Gibertini, D. Grassi, G. Campanardi, F. Auteri, A. Aceti, A. Le Pape		The Aeronautical Journal, pp. 1-22,
ROD	Drag and Drop, Aerospace Testing International, Showcase	G. Gibertini	2016	
HERRB	Effective Practices for the Concept Design of Electromechanical Systems	Booker, J. D., Lock, R., Williamson, S. & Freire Gomez, J.	Journal of Engineering, Design and Technology, 14, 3	
HERRB	Multi-Physics Experimental Investigation into Stator-Housing Contact Interface,	Simpson, N., Wrobel, R., Booker, J. D. & Mellor, P. H.	8th IET International Conference on Power Electronics, Machines and Drives	19 – 21 April, Glasgow
HERRB	Effects of Insulation Ageing on the Conductive Heat Transfer from the Winding Body into Machine Periphery/Stator Core Pack	Williamson, S. J., Wrobel, R., Booker, J. D., Yon, J. & Mellor, P. H.	8th IET International Conference on Power Electronics, Machines and Drives	19-21 April, Glasgow
TESTHEMAS	Counter-load simulation rig and ground test bench for helicopter electro-mechanical actuators	Joseba Lasa	R3ASC	TECNALIA-TOULOUSE
TESTHEMAS	International machine-tool exhibition 2016	TECNALIA	June 2016	Bilbao
	H120 HCE demonstration	Airbus Helicopters	42nd European Rotorcraft Forum	5-8 September 2016, Lille
	H120 HCE demonstration	Airbus Helicopters	Greener Aviation	11 October 2016, Brussels
Manoeuvres	Numerical Characterisation of Helicopter Noise Hemispheres	Gennaretti M., Serafini J., Bernardini G., Castorrini A., De Matteis G., Avanzini G.	Aerospace Science and Technology	

Manoeuvres	Innovative Helicopter In-Flight Noise Monitoring Enabled by Rotor State Measurements	Trainelli L., Gennaretti M., Bernardini G., Rolando A., Riboldi C. E. D., Redaelli M., Riviello L., Scandroglio A.	Noise Mapping	
Manoeuvres	Developing a Novel Contactless Sensor for Helicopter Rotor State Measurement	Cordisco P., Liu R., Redaelli M., Riviello L., Rolando A., Rossi F., Trainelli L., Vigoni E., Zappa E.	10-12, May 2016, Nuremburg	36th European Telemetry and Test Conference ETC2016,
Manoeuvres	Innovative Rotor-State Measurements Enabling Helicopter In-Flight Noise 19Monitoring and Enhanced Attitude Control	Trainelli L., Cordisco P., Gennaretti M., Grassetti R., Lovera M., Redaelli M., Rolando A., Zappa E	17-19 May 2016, West Palm Beach, FL, USA	American Helicopter Society International 72nd Annual Forum,
Manoeuvres	Contactless Rotor Flapping Sensor Design, Implementation and Testing	Cigada A., Colombo A., Cordisco P., Ferrario A., Grassetti R., Manzoni S., Redaelli M., Rolando A., Terraneo M., Trainelli L., Vigoni E., Zappa E.	17-19 May 2016, West Palm Beach, FL, USA	American Helicopter Society International 72nd Annual Forum,
Manoeuvres	Real Time Contactless Sensor for Helicopter Blade Angle Measurement	Zappa E., Trainelli L., Liu R., Rolando A., Rossi F., Cordisco P., Vigoni E., Redaelli M.	22-23 June 2016, Florence	3rd IEEE International Workshop on Metrology for Aerospace,
Manoeuvres	Development and Testing of Innovative Solutions for Helicopter In-flight Noise Monitoring and Enhanced Control Based on Rotor State Measurements	Trainelli L., Gennaretti M., Lovera M., Zappa E., Rolando A., Cordisco P., Grassetti R., Redaelli M.	42° European Rotorcraft Forum	September 5-8, 2016 – Lille
Manoeuvres	Experimental/Numerical Acoustic Correlation of Helicopter Unsteady Manoeuvres	Gennaretti M., Bernardini G., Hartjes S., Scandroglio A., Riviello L., Paolone E.	42° European Rotorcraft Forum	5-8 September 2016, Lille
Manoeuvres	A Novel Contactless Sensor for Helicopter Blade Motion In-flight Measurements	Zappa E., Trainelli L., Cordisco P., Vigoni E., Rolando A. , Redaelli M. , Rossi F., Liu R.	42° European Rotorcraft Forum	5-8 September 2016, Lille
Manoeuvres	Demonstration and Testing of the Pilot Acoustic Indicator on a Helicopter Flight Simulator	Rolando A., Rossi F., Trainelli L., Leonello D., Maisano G., Redaelli M.	42° European Rotorcraft Forum	5-8 September 2016, Lille
Manoeuvres	The pilot acoustic indicator: A way for a quieter flight-	Matteo Redaelli	AW newsletter-	autumn 2016
Manoeuvres	Smart Plastics 2016	Vita Imperiale	Smart Plastics 2016 -Milan	28-29 June 2016
Manoeuvres	Clean Sky Green Rotorcraft New Technologies Maximising Noise And Emissions Benefits	J.Stevens(NLR), C.Smith (AW), V.Pachidis (CU), L.Thevenot (AHsas), Rd'Ippolito (NOESIS)	42nd European Rotorcraft Forum	5-8 September 2016, Lille
Manoeuvres	Clean Sky Technology Evaluator Green Rotorcraft Mission Environmental Performance Analysis	(J.Ortiz-Carreteo) Cranfield University (TE),J.Stevens (NLR), C.Smith (AW), L.Thevenot (AHsas), Rd'Ippolito (NOESIS)	3AF AEGATS 2016	12 April 2016

4. Patents from projects

The total number of registered patents in the period 2008-2015 is 155. Three additional patents were successfully registered in the period 1 January 2016 – 31 July 2016. Furthermore, 28 additional requests for patents are currently under preparation and the success of the application has to be checked in 2017.

The final assessment for the period 2008-2016 will be made at the time when the final publishable reports will be delivered by the private members during 2017.

Synthesis of available data

	ECO	SGO	SFWA	SAGE	GRA	GRC	TE	Total Patents
2008-2015	6	31	26	72	5	15	0	155
2016	0	0	0	2	0	1	0	3
2008-2016 Potential patents	23	3	0	2	0	0	0	28
Total number of expected patents 2008-2016								**186**

	Patents registered
	Patents under registration

5. Scoreboard of Horizon 2020 and common KPIs

Description	Targets	2016 Results	Comments
H2020 Results			
Budget implementation/execution	CA >100% PA >95%	Total CA: 97% Total PA: 90% Operational CA: 97% Operational PA: 90% Admin CA: 100% Admin PA: 90%	
SME participation -financial contribution	17.5%	13.5%	13,5% is in line with the overall H2020 objective of 20% as 7% of the budget in H2020 is directly allocated to SMEs through its dedicated SME Instrument
Time to grant (TTG) (< 8 months from call deadline to signature)	80%	82%	Second CfP; result of CfP1 had been 80%
Redress after evaluations	<2% of proposals	1.9%	
Time to pay (payments made on time)	85%	87%	Operational and admin payments;
Vacancy rate	0%	2%	

Description	ITD	Dissemination 2009-2016	Patents 2009-2016
Dissemination and usage of results FP7	ECO	216	24
	GRA	156	5
	GRC	140	13
	SAGE	64	87
	SFWA	96	26
	SGO	177	31
	TE	25	-
	Total JU	874[20]	186
Communication results	- Large events - Press coverage - Web releases Social media	8 215 articles 47 news releases	The results are presented for FP7 and H2020

[20] Includes peer review papers, technical papers, master theses', oral presentations to workshops, conferences and exhibitions

	- Twitter - LinkedIn - YouTube - Flickr - Web traffic: - Visitors - Page views - Videos Publications - Printed - Digital -	81 tweets with 683 followers 61 News with 1712 followers 13 videos 132 photos 128.454 414.464 5 14 5 9	

6. Indicators for monitoring cross-cutting issues

Description	Targets	2016 Results	Comments
H2020 Results			
Country distribution (EU Member States and Associate Countries	EU 28: 95% Associates: 5%	EU28 > 98%	measured in numbers; in terms of contribution, the result would be close to 100% for participants from the EU 28
Gender balance - Advisors and experts	no target	Female participation rates: 14.7% in evaluations 12% in annual reviews 10% in technical reviews 17% in the SciCom 10% in the PCC	
Innovation Actions (IAs)	Leaders: 100% Core Partners: 100% Partners: 70%	GAMs: 100% CFP projects awarded (CFP01): IA % of projects = 65 % IA % in funding = 62 %	
Horizon 2020 beneficiaries from the private for profit sector - number of participants	75%	GAMs: 73% CFP (CFP01): = 49 %	The same indicator referring to the financial contribution is 82% for GAMs
PPPs leverage effect		€495 million €238 million	Value of the reported estimates AAs and IKOP Value of the reported and certified AAs and IKOP

Description	Targets	2016 Results	Comments
Union contribution based on expenditures recognized to members and partners (2014 - 2016) /reported IKC and cash contribution (2014 - 2016) (H2020)	no target	1 : 2.48	Ratio with reported IKC. See related in-kind contribution chapter 1.10
Union contribution based on expenditures recognized to to members and partners (2014 - 2016) / certified IKC and cash contribution(2014 - 2016) (H2020)	no target	1 : 1.32	Ratio with certified IKC. See related in-kind contribution chapter 1.10
Distribution of Proposal evaluators by country	<33% from one country	28 countries in total; Amongst them highest % for Germany (14.7%), France (13.9%), Italy (13.7%), UK (12.2%), Spain (9.7%) Greece (6.2%). Non-EU nationalities: 4.5%, out of which Turkey (1.7%), Israel (0.7%)	
Distribution of proposal evaluators by type of organisation	<66% from one sector	Higher Education Establishments: 24% Non-research commercial sector including SMEs: 28% Consulting firms: 8.2% Public Research Centres: 16% Private Non-profit Research Centres: 4%	
Ethics efficiency (time from information letter sent until final clearance)	undetected cases: 0 45 days	0% clearance time < 45 days	
Residual error rate	<2%	0.95%	
Ex-post audit coverage	20%	16%	

7. Scoreboard of KPIs specific to Clean Sky 2 Joint Undertaking

Description	Targets	2016 Results	Comments
H2020 results			
Call topics success rate	> 90%	80%	
Launch reviews		100%	Percentage of total major demo activity where Launch Reviews held and resulting in agreed launch of major projects. All launch reviews closed in 2016.
Achievements of ITDs – deliverables versus plan	100%	67%	
Budget consumption of ITDs versus plan	100%	75%	
FP7 Results			
SME share - value	> 35%	35%	
SME share - numbers	> 40%	36%	
SME share in CFPs - numbers	>40%	41%	
Demonstration activities	15	13	Core demonstration activities performed in 2016
Patent applications and patents awarded		186	Accumulated number for FP7 programme (provisional number)
Dissemination and usage of results FP7		874	Accumulated number for FP7 programme
Achievements of ITDs – deliverables versus plan	100%	85%	
Budget consumption of ITDs versus plan	100%	93%	
Accumulated residual error rate	<2%	1,51%	
Ex-post audit coverage	20%	24%	

8. Final accounts

The main tables of the Final Accounts 2016 of the CSJU are comprised of the Balance Sheet, the Statement on Financial Performance, the Statement of changes in Net Assets and the Cash Flow Analysis. A detailed explanation to assets and liabilities of the JU and to the economic result of the year 2016 is provided in the Notes to the Final Accounts, which form part of the Final Accounts document itself.

Economic Outturn

The Statement on Financial Performance presents the economic result of the JU in the reporting period (1 January 2016 – 31 December 2016).

The most substantial components are the operational expenses incurred in-cash and in-kind for implementing the aeronautical research programmes funded by the JU. The operating expenses ("administrative expenses") cover the running costs of the JU.

As a result of the specific accounting rules applied by JU, the funds received from the Commission and from the other members of the JU are shown as Contributions received from members in the Net Assets of the Balance Sheet and not as revenue in the economic outturn.

The Non-exchange revenues represent adjustments for contributions from members previously recognised in the Net Assets due to subsequent changes in already validated cost claims (e.g. through ex-post audits) and miscellaneous administrative revenues.

The financial income mainly comprises of interest earned by the JU from Commission funds and late payment interest paid to the JU, which is added to the global budget envelop of the two CS programmes in line with the CS Financial Rules.

Balance Sheet

The balance sheet reflects the financial position of the CSJU as of the 31 December 2016. Assets comprise mainly of cash in bank balances, pre-financing incurred for the execution of the grant agreements and fixed assets; liabilities include the "Net Assets" on the one side, and current liabilities like amounts payable, accruals and provisions on the other side.

The bank balance of the JU has substantially decreased compared to 2015 (2015: €62.0 million, 2016: €37.5 million).

The main fixed asset item is the internally developed grant management tool (GMT).

The balance of the Net Assets at the end of the reporting period present the accumulated contribution received by the JU from its members (the Commission, industry and research organisations), which has not yet been received for funding the research programme.

The Net Assets in the Balance Sheet of the JU's Final Accounts 2016 show a negative balance of €53.4 million.

The main element derives from the non-validated member in-kind contribution. The reported 2016 operational expenses are already booked on the Economic Outturn (EOA) while only a part of the related in-kind contribution has been approved by the Governing Board and recognised in the Net Assets of the CSJU. Also, some cost claims related to previous periods have not been validated by management at the date of the preparation of the Final Accounts ("on-hold" claims not meeting with all the reporting requirements) which are recognised in the EOA but not yet in the Net Assets.

Another element of the negative net assets is the EU financial contribution which shows a negative

balance for the first Clean Sky programme (FP7). The JU calls in the financial contribution according to its payment needs. The 2016 operational expenses are already included in the economic outturn, while in 2016 the JU had to pay (and requested from the EU as financial contribution) only the pre-financing for the 2016 GAMs. The remaining financial contribution related to the 2016 operational expenses will be requested in 2017.

The in-kind contributions for those cost claims not yet approved by the Governing Board are reflected in the liabilities of the Balance sheet as “contributions to be validated”. Following validation of cost claims by management and approval by the Governing Board later in 2017, these in-kind contributions will be transferred to the Net Assets of the JU. Therefore, the current status of the Net Assets has to be considered as transitional.

The negative Net Assets do not indicate any risk of solvency, but are the consequence of the accounting method applied according to the specific accounting rules and guidance provided by the Commission for Joint Undertakings.

BALANCE SHEET			
ASSETS		**31/12/2016**	**31/12/2015**
A. NON CURRENT ASSETS			
Tangible fixed assets (net)	**3.3.1**	67 198.00	92 841.00
Intangible fixed assets (net)		287 658.00	360 297.00
TOTAL NON-CURRENT ASSETS		**354 856.00**	**453 138.00**
B. CURRENT ASSETS			
Short-term pre-financing		**83 001 228.84**	**66 145 099.47**
Short-term pre-financing Clean Sky JU		83 001 228.84	66 145 099.47
Short-term receivables		**3 669 573.61**	**1 458 354.87**
Short term receivables - recoveries from members and partners	**3.3.2**	3 516 708.74	1 300 849.88
Other short term receivables		11 492.01	19 560.42
Deferred charges and accrued income		141 372.86	137 944.57
Cash and cash equivalents		**37 473 202.93**	**62 014 184.00**
TOTAL CURRENT ASSETS		**124 144 005.38**	**129 617 638.34**
TOTAL ASSETS		**124,498,861.38**	**130 070 776.34**

LIABILITIES		**31/12/2016**	**31/12/2015**
C. NET ASSETS			
Contributions received from Members (EU & industry)	**3.3.3**	1 106 272 402.68	880 377 359.79
Contributions in kind received from Members (Industry)		593 850 851.90	501 609 427.16
Contributions used during previous years		(1 426 044 906.45)	(1 167 029 929.46)
Contributions used during the year (EOA)		(327 427 518.59)	(259 014 976.99)
TOTAL NET ASSETS		**(53 349 170.46)**	**(44 058 119.50)**

D. CURRENT LIABILITIES			
Members contribution to be validated	**3.3.4**	**137 491 488.54**	**96 404 102.97**
Accounts payable and accrued charges		**39 965 841.74**	**77 674 496.26**
Amounts payable - consolidated entities		539 723.38	0.00
Amounts payable - beneficiaries and suppliers		17 165 135.93	28 792 017.98
Amounts payable - other		66 623.91	0.00
Accrued charges		22 194 358.52	48 882 478.28
Provision for risks and charges - short term		**390 701.56**	**50 296.61**
Provision for risks and charges - short term		390 701.56	50 296.61
TOTAL CURRENT LIABILITIES		**177 848 031.84**	**174 128 895.84**
TOTAL LIABILITIES		**124 498 861.38**	**130 070 776.34**

ECONOMIC OUTTURN ACCOUNT			
	Ref.	**2016**	**2015**
REVENUES			
NON-EXCHANGE REVENUES	**3.4.1**		
Other revenue		4 137 530.78	2 491 754.60
Exchange gains		815.35	890.66
TOTAL NON-EXCHANGE REVENUES		**4 138 346.13**	**2 492 645.26**
OPERATIONAL EXPENSES	**3.4.2**		
Operational expenses funded by CSJU in cash		189 117 143.44	147 965 382.55
Operational expenses contributed in kind by members		135 212 442.02	106 528 418.42
TOTAL OPERATIONAL EXPENSES		**324 329 585.46**	**254 493 800.97**
OPERATING EXPENSES	**3.4.3**		
Administrative expenses	**3.4.3.1**		
Staff expenses		3 904 700.07	3 370 166.05
Depreciation & amortisation of fixed assets		181 219.21	131 311.83
Rent of building		493 901.58	555 456.63
Rent of furniture		0.00	0.00
Office suppliers & maintenance		7 946.63	12 995.33
Communication & publications		549 120.06	319 192.96
Transport expenses		5 883.56	4 466.87
Recruitment costs		31 940.30	6 820.41
Training costs		4 812.50	11 884.95
Missions		195 800.30	275 472.62
Experts and related expenditures		1 085 781.47	1 273 195.65
IT costs - external service		186 051.47	160 838.75
Other external service provider		585 940.17	994 574.07
Provisions for other liabilities		0.00	0.00
Total administrative expenses		**7 233 097.32**	**7 116 376.12**
Other operating expenses	**3.4.3.2**		
Exchange losses		821.55	613.47
Total other operating expenses		**821.55**	**613.47**
TOTAL OPERATING EXPENSES		**7 233 918.87**	**7 116 989.59**
OPERATING RESULT		**(327 425 158.20)**	**(259 118 145.30)**
FINANCIAL INCOME	**3.4.4.1**		
Bank interest on pre-financing from EU		6 968.14	91 763.59
Interest on late payment (income)		326.12	785.54
Interests on pre-financing given to Members		976.84	22 676.42
Total financial income		**8 271.10**	**115 225.55**
FINANCIAL EXPENSES	**3.4.4.2**		
Financial expenses		10 631.49	12 057.24
Total financial expenses		**10631.49**	**12057.24**
FINANCIAL RESULT		**(2360.39)**	**(103168.31)**
ECONOMIC RESULT OF THE YEAR		**(327 427 518.59)**	**(259 014 976.99)**

Changes in Net Assets and Liabilities	EURO	EURO
Net Assets		
Balance as of 31 December 2015		**(44 058 119.50)**
Contributions received from members during the year 2016:		
EC Clean Sky Programme (FP7) (cash)	37 195 367.00	
EC Clean Sky 2 Programme (H2020) (cash)	184 839 733.00	
Other members Clean Sky Programme (FP7) (cash)	1 007 848.18	
Other members Clean Sky 2 Programme (H2020) (cash)	2 852 094.71	
Other members contributions in kind from 2008-2016 validated in 2016	92 241 424.74	
Total contributions in 2016		**318 136 467.63**
Economic Outturn for 2016		**(327 427 518.59)**
Balance as of 31 December 2016		**(53 349 170.46)**

CASH-FLOW

31.12.2016

Cash Flows from operating activities	
Surplus/(deficit) from operating activities	**(327 427 518.59)**
Adjustments	
Depreciation and amortisation	181 219.21
Increase/(decrease) in Provisions for risks and liabilities	340 404.95
(Increase)/decrease in Stock	
(Increase)/decrease in Short term pre-financing	(16 856 129.37)
(Increase)/decrease in Short term Receivables	(2 211 218.74)
Increase/(decrease) in Long term liabilities	
Increase/(decrease) in Payables and Accruals	(37 708 654.52)
(Gains)/losses on sale of Property, plant and equipment	
Extraordinary items	
Net Cash Flow from operating activities	**(383 681 897.06)**

Cash Flows from investing activities	
Acquisition of tangible and intangible fixed assets	(82 937.21)
Proceeds from tangible and intangible fixed assets	0.00
Extraordinary items	0.00
Net Cash Flow from investing activities	**(82 937.21)**

Financing activities	
In cash contributions from Members (EC & Industry)	225 895 042.89
In kind expense contribution from Members	135 212 442.02
Reduction in members' contributions due to rejected and negative claims	(1 883 631.71)
Extraordinary items	0.00
Net Cash Flow from financing activities	**359 223 853.20**

Net increase/(decrease) in cash and cash equivalents	(24 540 981.07)
Cash and cash equivalents at the beginning of the period	62 014 184.00
Cash and cash equivalents at the end of the period	**37 473 202.93**

9. Materiality criteria

This annex provides a detailed explanation on how the CSJU defines the materiality threshold as a basis for determining significant weaknesses that should be subject to a reservation to the annual declaration of assurance of the Executive Director.

Deficiencies leading to reservations should fall within the scope of the declaration of assurance, which confirms:

- A true and fair view provided in the AAR and including the Annual Accounts
- Sound financial management applied
- Legality and regularity of underlying transactions

As a result of its multiannual nature, the effectiveness of the JU's controls can only be fully measured and assessed at the final stages of the programme's lifetime, once the ex-post audit strategy has been fully implemented and systematic errors have been detected and corrected.

The control objective is to ensure for the CS programmes (FP7 and H2020), that the residual error rate, which represents the level of errors which remains undetected and uncorrected, does not exceed 2% of the total expense recognised until the end of the programme (see explanations to the weighted average residual error rate underneath).
This objective is to be (re)assessed annually, in view of the results of indicators for the ex-ante controls and of the results of the implementation of the ex-post audit strategy, taking into account both the frequency and importance of the errors found as well as a cost-benefit analysis of the effort needed to detect and correct them.

Notwithstanding the multiannual span of the control strategy, the Executive Director is required to sign a statement of assurance for each financial year. In order to determine whether to qualify this statement of assurance with a reservation, the effectiveness of the control systems in place needs to be assessed not only for the year of reference but also with a multiannual perspective, to determine whether it is possible to reasonably conclude that the control objectives will be met in the future as foreseen. In view of the crucial role of ex-post audits, this assessment needs to check in particular, whether the scope and results of the ex-post audits carried out until the end of the reporting period are sufficient and adequate to meet the multiannual control strategy goals.

Effectiveness of controls

The basis to determine the effectiveness of the controls in place is the cumulative level of error expressed as percentage of errors in favour of the JU, detected by ex-post audits measured with respect to the amounts accepted after ex-ante controls.

However, to take into account the impact of the ex-post audit controls, this error level is to be adjusted by subtracting:

- Errors detected and corrected as a result of the implementation of audit conclusions

- Errors corrected as a result of the extrapolation of audit results to non-audited cost claims issued by the same beneficiary

This results in a residual error rate, which is calculated in accordance with the following method:

1) REPRESENTATIVE ERROR RATE

As a starting point for the calculation of the residual error rate, the representative error rate will be established as a weighted average error rate identified for an audited representative sample.

The weighted average error rate (WAER) will be calculated according to the following formula:

$$WAER\% = \frac{\sum (er)}{A} = RepER\%$$

Where:

$\sum$ **(er)** = sum of all individual errors of the sample (in value). Only the errors in favour of the JU will be taken into consideration.

n = sample size

A = total amount of the audited sample expressed in €.

2) RESIDUAL ERROR RATE

The formula for the residual error rate below shows, how much error is left in the auditable population after implementing the outcome of ex-post controls. Indeed, the outcome of ex-post controls will allow for the correction of (1) all errors in audited amounts, and (2) of systematic errors on the non-audited amounts of audited beneficiaries (i.e. extrapolation).

$$ResER\% = \frac{(RepER\% * (P-A) - (RepERsys\% * E)}{P}$$

Where:

ResER% = residual error rate, expressed as a percentage.

RepER% = representative error rate, or error rate detected in the representative sample, in the form of the Weighted Average Error Rate, expressed as a percentage and calculated as described above (WAER%).

RepERsys% = systematic portion of the RepER% (the RepER% is composed of complementary portions reflecting the proportion of systematic and non-systematic errors detected) expressed as a percentage.

P = total amount of the auditable population of cost claims in €

A = total amount of the audited sample expressed in €.

E = total non-audited amounts of all audited beneficiaries. This will consist of all non-audited cost statements for all audited beneficiaries (whether extrapolation has been launched or not).

This calculation will be performed on a point-in-time basis, i.e. all the figures will be provided as of a certain date for the specific annual audit exercise actually performed.
However, in order to arrive at a meaningful residual error rate for the entire cumulative period covered by ex-post audits during the execution of each of the two CS programmes, the weighted average residual error rate (WAvResER%) shall be calculated for the whole duration of the programme until the end of each audit period according to the standard formula for a weighted average (sum of weighted terms (=term multiplied by weighting factor in relation to the population in value (p)) divided by the total number of terms) as follows:

$$\textbf{WAvResER\%} = \frac{\sum_{i=1}^{n} (\text{Res ER}_i * p_i)}{\sum_{i=1}^{n} p_i}$$

The control objective is to ensure, that the residual error rate of the overall population (recognised operational expense) is below 2% at the end of each of the CS programmes.

If the residual error rate is less than 2%, no reservation would be made.

If the residual error rate is between 2 and 5% an additional evaluation needs to be made of both quantitative and qualitative elements in order to make a judgment of the significance of these results. An assessment needs to be made with reference to the achievement of the overall control objective considering the mitigating measures in place.
An additional correction effect could be considered in the assessment of the legality and regularity of the transactions of CSJU through implementation of audit results outside of the specific JU sample. The CRS or risk based samples of the CAS may cover additional CS cost claims, which are not part of the specific sample of the JU. Furthermore, errors could be corrected through extension of systematic audit findings on unaudited JU cost claims, which do not stem from JU representative audits.

$$\textbf{AddErCorr\%} = \frac{\sum \textbf{(AddErDet)} + \sum \textbf{(AddErSyst)}}{P}$$

$\sum$ **(AddErDet) =** error detected outside of the specific JU sample (samples of the CAS)

$\sum$ **(AddErSyst) =** financial effect of extension of systematic audit findings on unaudited JU cost claims, which do not stem from JU representative audits.

In case the residual error rate is higher than 5%, a reservation needs to be made and an additional action plan should be drawn up.

These thresholds are consistent with those retained by the Commission and the Court of Auditors for their annual assessment of the effectiveness of the controls systems operated by the Commission. The alignment of criteria is intended to contribute to clarity and consistence within the FP7 programme and the H2020 programme.

In case it turns out, that an adequate calculation of the residual error rate during or at the end of the programmes is not possible, for reasons not involving control deficiencies but due to e.g. a limited number of auditable cost claims, the likely exposure to errors needs to be estimated quantitatively by other means. The relative impact on the Declaration of Assurance would be then considered by analysing the available information on qualitative grounds and considering evidence from other sources.

Adequacy of the scope

The quantity and adequacy of the (cumulative) audit effort carried out until the end of each year is to be measured by comparing the planned with the actual volume of audits completed.
The data is to be shown per year and cumulated, in line with the current AAR presentation of error rates.

The Executive Director should form a qualitative opinion to determine whether deviations from the plan are of such significance that they seriously endanger the achievement of the control objective for the programmes. In such case, he would be expected to qualify his annual statement of assurance with a reservation.

A multiannual control strategy requires a multiannual perspective to assurance

It is not sufficient to assess the effectiveness of controls only during the period of reference to decide, whether the statement of assurance should be qualified with a reservation, because the control objective is set in the future. The analysis must also include an assessment of the likely performance of the controls in subsequent years and give adequate consideration to the risks identified and the preventive and remedial measures in place. This would then result in an assessment of the likelihood that the control objective will be met in the future.

10. Results of technical review

Clean Sky Scientific Committee
A summary of Intermediate Reviews of
Clean Sky 2 programme (03/2017)

1. ORGANISATION AND PERCEPTION OF THE REVIEW PROCESS

The review process in Clean Sky 2 has been adopted from Clean Sky. There it was implemented successfully from the first year onwards and continuously developed over the lifetime of Clean Sky JU, ITDs and reviewers reported unanimously a high level of trust, fairness, and collaborative spirit in performing the review process. Valuable guidance was generated and implemented supporting the success of the programme.

Consequently, the process was transferred to Clean Sky 2 where the same scheme on annual reviews and light follow-up reviews 6 months later was applied.

Compared to the final phase of Clean Sky, the role and meaning of the reviews in the early stage of Clean Sky 2 is of very different nature. While reviews in CS served the purpose of supporting the ITDs in finishing their activities in time with maximum achievement, the CS2 reviews will support the shaping and detailed planning of the new programme. In this context the reviewers consider the intermediate reviews as being equally important as the annual reviews to allow a quick but smooth ramp up and an efficient alignment of the activities towards the CS2 targets.

While the review process in CS2 appears as being as effective and efficient as it was in CS, still some room for improvement has been identified. Instruments like Technology Watch or the Joint Integrated Master Plan (both adopted e.g. in CS GRA) have provided insights into technology roadmaps and the opportunity to better identify delays and risk areas, and also to monitor progress. It is recommended to harmonize the review standards across all SPDs.

2. ADMINISTRATION AND MANAGEMENT

For CS2 a high quality in respect of project management is evident across all SPDs. Financial aspects are assessed and reported during annual reviews across all ITDs in an open and transparent manner. In most reviews, the resource spending was compared to progress achieved as an important indicator for project management.

However, as the CS2 programme still is in the ramp up phase some significant deviations in spending compared to the planning have been recognized. In some cases the cause for these deviations seems to lie, either in incomplete SPD compositions (core partners not yet on board) or in the unavailability of human resources. It is recommended to take measures that sufficient qualified staff is available and to provide a report at the next AR. Senior management involvement is required. In addition a strong need for further consolidation and shaping of the programme is recognized to avoid further accumulations of delays.

3. OVERVIEW TECHNICAL PROGRESS IN CS2

As the initial annual reviews were carried out in the first semester of 2016, a set of intermediate reviews was carried out end of 2016 across most SPDs.

In the annual reviews the need of further shaping and alignment of content across all SPDs had been identified. Such re-alignment was requested in order to improve the chance of identifying and managing synergies between related technology developments. Now, most SPDs have taken up the recommendations pro-actively and significant progress has been observed. ECO and TE are still in the definition phase and no technical activities have been carried out in the reporting period.

As mentioned above, in some SPDs the resource consumption is below expectation. In light of the ongoing interim evaluation of H2020 and CS2 the impression should be avoided, that the planned funding is not fully required for achieving the CS2 objectives. In addition measures should be taken to ensure that the critical demonstration timeline can be met. More details are provided for the SPDs individually.

ENG

There are still delays to a number of deliverables which could impact the 2017 plan. It is clear there is significant effort to recover delays. Core partners are in place and now working to integrated programme timelines and activities.

The time table for early major demonstration of RR Advanced Core (ENG5) has slipped into Q1/Q2 2017 but explanations were positive. This is a key element of UltraFanTM ground and flight test.
Observations from the SAGE programme final review indicate that major demonstration timelines are underestimated at programme definition and during the early stages of delivery. This could be considered as requiring additional independent review activity undertaken by the CSJU as there is little time at planned reviews to do the necessary detailed questioning and analysis. For ENG there are considerable technical challenges aligned to major ground and flight test demonstration.

The programme will achieve (as did SAGE) significant demonstrable contributions beyond the state of the art strengthening the EC position in aerospace. The original work plan objectives align to current activities which rightly are focused on demonstration with its necessary challenging and tight timescales. Future development plans and aligned CfP's should introduce the necessary focus on future lower TRL technology developments.

REG

The recommendations from the reviewers from the annual review meeting in May 2016 have been well followed up and sufficiently considered.

Still underspending has been observed raising concerns in terms of the further planning. It is recommended to revise the resource consumption planning vs. the work plan.

For the Transition from GRA CS to REG CS2 it was recognised that the technology road-map should be better outlined. The starting readiness level of the technologies delivered and developed in CS1 should be discussed at greater extent. The mismatch between the TRL attained in CS1 and the

assumed initial TRL should be explained in a convincing way.

In the technical Work Packages the “advanced multifunctional CFRP for aircraft fuselage barrel” needs more clarification. The logic in REG to only address a CFRP fuselage concept is seen as a limiting factor. As cost aspects will be the main driver for a new Regional Aircraft concept, a metallic fuselage concept will still have major advantages.

The newly proposed concept by Airbus DS, to concentrate on a future Regional Aircraft concept which will cover 2 family aspects (a Regional airline market and a Multi-Mission market) has been appreciated by the reviewers. The reviewers would like to see the future requirements of this Multi-Mission concept in more detail. Some further activities like e.g. developing winglets with some movables for load control on the wingtip are not presented convincingly. The reviewers are strongly disagreeing, that such a solution could bring any benefit, especially in a civil certification, where the movable controls on the winglet will lead due to civil certification requirements to an increase in loads and therefore to a weight increase.

For the regional avionics a major redefinition of the perimeter of work was recommended. Still the information presented during the IPR did not provide a clear picture of the strategy and the master-planning of this activity. Although a reduced and more realistic scope seems to be defined, it has not been presented convincingly yet.

FRC

As there are two distinct flying demonstrators because of commercial confidentiality issues the two reviews were held separately with each of the lead companies (FRC1 Leonardo, FRC2 Airbus Helicopters).

For FRC1 a revised programme has been delivered. However, the implementation will require senior management commitment. The programme needs to accelerate PDR and CDR phases in 2017 / 2018 to ensure the planned flight test is achieved within the CS2 timeline as offered in the plan. Contracted core partners (FRC / Airframe) and CfP’s will be critical. In terms of technical delivery the programme appears to be up to 24 months behind planning.

Significant risks in revised plan are evident. It is recommended to accelerate the PDR / CDR time line and insert formal CSJU review gates to release future grant funding.

In FRC2 significant resource issues within Airbus Helicopters aligned have been observed. However, the review confirmed strong management support with key resource available. Programme management is effective at this stage but momentum must continue to counteract delays. In addition details of internal management process and key performance indicators are required in future reviews to confirm confidence that core partner / partner inputs are in place, which are critical to demonstrator delivery timescales.

LPA

LPA IADP is a large, ambitious project led by Airbus that comprises three platforms: Platform 1 (advanced engine and aircraft configuration), Platform 2 (innovative physical integration of fuselage-cabin-system-structure) and Platform 3 (next generation aircraft systems, cockpit systems and avionics). The project management team are experienced, with key members having

been involved in previous research projects. Good progress has been made in the first year, although certain WPs have been developed to a much greater extent than others.

It was evident from the recent IPR meeting (16 November 2016) that LPA Platform 1 is generally well on track – the one exception is work package (WP) 1.2. The currently-planned WP 1.2 activities (fuselage rear end demonstrator for the integration of the CROR engines) will be ramped down and the entire WP re-scoped. The rationale for this action was that the "present configuration and associated structure principle is no longer seen as the preferred solution". The process of reorienting WP 1.2 activities has commenced and a preliminary timetable established to revise the work plan. It was recommended by the reviewer that a new deliverable be established to record the rationale for this decision, the lessons learnt and to summarise the technological progress made within the current scope of the work.

A key milestone for LPA Platform 1 is the CROR engine economic viability decision gate, which is planned for June 2017. The planning of activities for WP 1.1 (CROR Engine Demonstrator) may be significantly impacted by the outcome of this decision gate.

For LPA 2 the priorities and the schedule have slightly changed. These changes are appreciated by the reviewers as they support the re-adjustment of research activities towards 2 possible implementation dates: a 2020 timeline for short term benefits and a 2025 more long term timeline. Consequently an additional push for receiving a first set of results in 2020 is expected.

From within the three major ground demonstrators most significant innovation will be presented through the WP 2.3 Lower Centre Fuselage demonstrator. If successful, this bears the potential for becoming a game changer for the next SA-aircraft.

As a very clear strategy has been provided for WP 2.3 (Lower Centre Fuselage), the reviewers suggest developing a similar clear vision for the new structural concept of WP 2.1, the 2030 cabin concept and a new "Future Factory" concept compared to today's manufacturing processes.

In Platform 3 good progress has been observed, as well. The reviewers consider a maximum link with EASA and SESAR as being crucial for a later deployment of the developments. As related developments in the cockpit domain are foreseen in several SPDs for different platforms (regional, business jets, small a/c) it is recommended to cross fertilize the different activities. A complementary definition of work programme appears of specific importance for LPA 3 and REG.

In addition, significant contributions have been developed in European Projects like ACROSS and ALICIA, national funded programmes like LUFO and the NASA Single Pilot Cockpit Program. Such pre-existing knowledge should be intensively used.

SYS

SYSTEMS is ramping up its activities. The achievements as well as the resource consumption are behind planning, which was recognized as being over-ambitious. Adjustments in planning are required.

In WP 1 good progress is observed. The close interaction with SESAR and EASA is appreciated.
For WP 3 still some responses to questions raised by the reviewers need to be discussed. For work on actuators a strong exchange across the SPDs is recommended as related activities are spread

across CS2. For some other activities the planned progress beyond the state of the art remains unclear. This is especially valid for the activities related to enhanced and synthetic vision (WP 1.3.5). A deeper analysis of the proposed work has been launched and will be closed in Q2 2017 by the reviewers.

A major concern has been identified in WP 100.3 targeting at developing and demonstrating an integrated modelling, simulation, design and optimization framework for aircraft systems and subsystems. A convincing buy-in from user (i.e. industry) is not visible. There may be a significant risk that the envisaged development will not deliver the expected impact due to deficiencies in exploitation and deployment inside CS2. The expected harmonisation in tools and models may potentially not materialize.

For launching further activities on ECO it is recommended to deliver a consolidated and well aligned planning.

AIR

This general split of activities in the2 two big platforms HPE, HVC differentiates tasks towards LPA (mainly Airbus and Dassault) and the rest of the other IADPs. The reviewers anticipate the rationale behind. However, more effort is requested to identify common technologies to be developed and maturated for further exploitation. For several specific topics (e.g. birdstrike) possible synergies have been identified and also ways of implementation indicated. The key issue is to ensure that duplication of effort is minimized and where similar activities are taking place in two or more WPs that this is done in a synergistic, complementary manner with a strong understanding of what is being done elsewhere.

The presentation of progress along Technology Stream (TS) in the same format made it much easier for the reviewers to understand the content of each TS and to assess the current project status and the progress made. It is strongly recommended that this approach be adopted for subsequent review meetings.

An overall demonstrator plan has been presented, where for each IADP and TA (LPA, REG, FRC, SAT), all the technology inputs from AIR ITD have been summarized. The very well-structured presentations for this review meeting facilitated a deeper understanding of the project interfaces. The reviewers however suggested a deeper analysis at the next Annual Review Meeting looking into the different technologies in more detail and ensuring the complementarity of the different tasks.

SAT

At the Annual Review Meeting (13 May 2016) there appeared to be a lack of direction as to how the planned activities and demonstrators could apply to a reference 19-seat aeroplane. At the IPR meeting (4 November 2016), however, this became much clearer and better aligned with the Work Plan.

The reviewers raised questions related to the omission of research activity concerning hybrid electric propulsion within SAT (i.e. application to aeroplanes with 19 seats or fewer) in the Annual Review Meeting. Subsequently, a recommendation was made for its inclusion in the Technical Review Report (27 June 2016). It is understood that the subject is under investigation and remains

highlighted for future discussions. Hybrid-electric propulsion activities (including the development of a state-of-the-art test facility) are taking place in LPA WP 1.6.2; however, this is outside of SAT. Still the reviewers believe that a further investigation in that area is highly relevant for the target a/c of SAT.

ECO TA
n.a

TE
n.a

4. SPECIFIC ITEMS

4.1 INTERNAL AND EXTERNAL LINKS

In general, it is felt that cross-SPD links are maturing. Still, some more balancing and refinement appears necessary to avoid overlaps and to simplify interfaces between SPDs. Links to external bodies have been established. A series of meetings with EASA discussing relevant technical developments has been launched by the JU. It appears to be well accepted at EASA level and is well utilised by CS2 to early identify and mitigate potential hurdles in exploitation and deployment.

With SESAR increasing coordination is taking place. In this area the momentum should be maintained to ensure an efficient synchronisation of defining relevant functions and operational concepts for Air Traffic Management (ATM).
For the major demonstration programmes, where national or private company funding is included, an indication of these areas should be included in the review.

4.2 RISK MANAGEMENT

It is generally felt that the risk management has become embedded appropriately in the planning and execution of the major deliverables. However, the risk management processes should be harmonized across all platforms and the interdependencies should be monitored.

4.3 CFPs

So far the CfP process appears appropriate. A front loading of CfPs (like it is practiced in SYSTEMS) is recommended as it ensures early delivery of required results and avoids scheduling pressure towards the end of CS2. In the case of SAT the CfPs should be spread over the whole programme to avoid overloading the leaders.

4.4 TRL PROCESS

When transitioning from CS to CS2 in some cases the TRL roadmap revealed some downgrading of TRLs for some functions and technologies leading to a re-start of low TRL research and development in some areas. The underlying rationale and the perspective deserve more explanation.

4.5 TARGETS AND REFERENCE AIRCRAFT

For CS2 additional targets beyond environmental savings have been defined. Here a more detailed methodology of assessing those performance indicators as well as the metrics are required as well as a proper definition of the reference aircraft and scenarios. It is recommended to urgently elaborate on these issues.

5. FUTURE ACTIONS

First dissemination activities are reported. However, the prospective planning of dissemination activities and the clear definition of dissemination targets was initially not sufficiently elaborated in some SPDs. The CS2 SPD D&E plan containing recommendations from the Scientific Committee appears as being a good step forward.

In terms of exploitation opportunities, a more standardised procedure for early identification of exploitation opportunities is recommended.

The introduction of new technologies including new manufacturing elements requires certification. Airworthiness and certification issues, and associated progress, should be more visible in the development plan with clear links if necessary to the IADP's who may act as the focus. This activity is a crucial element to future exploitation. Similarly, in addition to TRL's, assessed Manufacturing Readiness Levels should be included in programme plans. This provides an element to support assessment of European competitiveness, one of the key metrics of CS2.
At European level a Coordination and Support Action (CSA) has been issued building up an inventory of aerospace research infrastructure across Europe and developing recommendations for exploitation. It is recommended that the SPDs contribute to this process.

Brussels, March 2017

Prof. Dr. Peter Hecker

Chairman of the Scientific Committee

11. Members achievement through GAM

CLEAN SKY PROGRAMME - REMINDER OF RESEARCH OBJECTIVES

→ SFWA - Smart Fixed Wing Aircraft ITD

The objectives of the year 2016 have been globally successfully and reached for all still active Technology Streams and related work packages.

BLADE (*), the Natural Laminar Flow (NLF) wing for large A/C, is on track. Outer NLF-wing-sections are installed and the Flight Test Instrumentation (FTI) and installation of outer wing components is underway. There is a slight delay on the first A/C power-on, which is not scheduled anymore for early January 2017, however this delay is not critical with respect to the planning.

The analysis of NLF wing for Low Sweep BizJet has confirmed a significant drag reduction of ~13%. Further maturation of this technology towards maturity levels five and six will be supported by Clean Sky 2.

Concerning flow, loads and vibration control, the 2016 objectives have been reached thought the flight test for BizJets (based on the Ground Vibration Demonstrator outcomes). The work will be continued in Clean Sky 2 based on the results obtained in SFWA with the flow control actuator physical integration demonstrated trough the Integrated Active Component Demonstrator (IACD).

In the SHIELD (**) project (U-tail configuration) outstanding achievements in noise shielding efficiency have been demonstrated with the ground tests at Istres of a model manufactured in Romania. These tests demonstrated the successful end of chain of preparatory designs of the configuration as well as complex models and tests at Onera on Low Sweep BizJet (LSBJ) for aero-elasticity and on High Sweep Bizjet (HSBJ) for high speed aerodynamic performance.

For the Counter Rotating Open Rotor (CROR), engine integration, the technical feasibility has been confirmed and economic viability improved, in particular via the Un-ducted Single Fan concept that has been tested at DNW in 2016.

As expected, 2016 has seen very good progress on in-flight measurement techniques for CROR or even generic engine installation such as the Z-Damper in-flight pylon loads measurement from MAG SOAR, as well as on laminar wing testing, such as reflectometry by 5micron, Infra-Red (IR) and hot films measurements from Onera & DLR.

(*) Breakthrough Laminar Aircraft Demonstrator in Europe
(**) Aft Body Demonstrator for Low Sweep Bizjet

Detailed Activities

TS Natural Laminar Flow Wing
For Short Range Large Aircraft, we can note the following achievements:

- All components for the wings assembly have been delivered as well as associated tooling. Their installation is ongoing and on track.
- Working party and wings join up: electrical systems, hydraulics, fuel and FTI installation on track, Vertical Tail Plane Pod (including 4K and IR Cameras) and Cabin installation completed. GKN wing 100% bolted and SAAB wing 100% drilled.

- Nominal progress on flight test request and flight clearance activity: the wing bending tests have been demonstrated to be unnecessary, loads exceedance conclusive study and successful bird strike tests by SAAB.
- FTI on very good tracks with, as for example, validation of the reflectometry measurement technique (developed by 5micron) on the first SAAB dummy Upper Cover.
- Slight delay for the first A/C FTI power on, now planned for beginning of January 2017. The first flight test campaign is still planned for end of August / early September 2017 with flight domain opening, laminarity identification and surface imperfection assessment.

For Low Sweep Bizjets, the results of ETW tests highlighted a good correlation between anticipated and measured performances of the two laminar wings and the U-shaped Horizontal Tail Plane which will support the convergence of the design of the LSBJ configuration and prepare future business jet design.

TS Fluidic Control Surfaces

For Bizjets, due to severe difficulties during the model manufacturing by Revoind (EULOSAM CfP project), the low speed wind tunnel tests for smart flap concept on LSBJ have been cancelled. As for the integration of flow and loads control systems via mechanical or fluidic actuator, the validation, including electrical wiring, thermal and electromagnetic aspects these have been performed via the Integrated Active Component Demonstrator (IACD). In parallel, a virtual Electrical Power Control Unit (EPCU) demonstrator has been successfully designed showing the interest of a dual in line actuator architecture for redundancy purposes.

The objective of the partial demonstrator is to validate the capability of a dual in line motor in performing the needed torque and speed for a high lift application in normal and abnormal conditions.

TS Loads Control Function & Architectures

Based on the successful Ground Vibration Demonstrator on Falcon 7X for Bizjets the route to flight test has been defined with a continuation in Clean Sky 2. In the frame of innovative devices for load control, the final report (key deliverable) for smart Trailing Edge devices for load alleviation has been completed.

TS Buffet Control

The final report on buffet characterisation and control has been delivered, including necessary further steps towards higher maturity and industrial applications.

TS CROR Engine Integration

- 2016 objectives have been reached: technical feasibility has been confirmed and economic viability improved and pursued in Clean Sky 2.
- For aerodynamics and acoustics impacts, completion of the remaining de-risking activities (via ENITEP, ACctiom projects from CfP's, as well as blade design and deformation studies) and progress on economic viability via engine architecture trades for weight reduction and increase of propulsion efficiency. In that frame, the acoustic characterisation has been completed via a wind tunnel test at DNW for an Un-ducted Single Fan concept. The results analysis will feed the decision gate by mid-2017 for a flight demonstrator plan under the Clean Sky 2 frame.
- In terms of safety and certificability, completion of Propeller Blade Release threat reduction studies and selection of the most promising hybrid armour concepts (via IMPSHIELD and IMPTEST CfP projects)
- In the frame of future flight tests, very good results obtained by MAG SOAR (Z-DAMPER CfP) for the demonstration in lab scale of an in-flight vibration and loads damping system.

TS Integration of Innovative Turbofan Engines to Bizjets

- For LSBJ, based on DNW acoustic tests results and to Onera's post-processing, the acoustic simulations showed very promising results on shielding effects and will be compared with the ground test (SHIELD project) in Clean Sky 2. A full scale aft-Body and test rig (SHIELD) were successfully designed and manufactured by INCAS and Avioane Craiova in 2016 and has led to promising results in terms of

acoustic shielding, thermal and acoustic fatigue. Model manufacturing and complex instrumentation for High Speed flutter tests at S2MA have been successfully performed.

- For HSBJ Aerodynamic performance, the complete clean model assembly has been reviewed at Onera (Lille) at the end of September 2016. The high-speed wind tunnel tests have been performed with important results in particular on air intake distortion. The analysis will be further detailed under the Clean Sky 2 frame. The LSBJ and HSBJ global results will be summarised in the frame of the TS final report.

TS Advanced Flight Test Instrumentation

The OPTIMAL (OPTImized Model for Accurately measured in-flight Loads) CfP project was highly challenging. Despite huge efforts, the requested accuracy for in-flight pylon loads measurement could not be reached. All other CROR related in-flight measurement techniques have been successfully developed such as PIV for pylon wake flow characterization, Image Pattern Correlation Technique (IPCT) for rotor blade shape measurements, autonomous wireless sensor nodes.

All BLADE related measurement techniques have been also successfully developed, such as non-intrusive external waviness by reflectometry, internal waviness, IR visualisation and wing shape deformation via an innovative Inertial Measurement Unit developed by Safran, as well optical sensors for strain and temperature measurements.

List of key deliverables

Key Del.	Nature*	Deliverable Title	Status
D01-2016	R	Buffet Control Techno Stream Final Report	available (draft)
D02-2016	R	Final report on smart TE devices for load alleviation	available
D03-2016	R	WP2.3 final report - PANEM	available
D04-2016	R	Hybrid Laminar Flow Techno Stream Final Report	available
D05-2016	HW	Wing Movable Transition for Pressurized Air and Electrical Signals	available
D06-2016	R	Fluidic Control Surfaces Techno Stream Final Report	available
D07-2016	R	Load control, functions and architecture Techno Stream Final Report	available (draft)
D08-2016	R	CROR Engine Integration Techno Stream Final Report	not yet delivered
D09-2016	R	Advanced Flight Test Instrumentation Techno Stream Final Report	not yet delivered
D10-2016	R	Overview end-report Port Upper Wing Cover & integrated Leading Edge design, construction and production	available
D11-2016	R	Natural Laminar Wing Techno Stream Final Report	available (draft)
D12-2016	R	Integration of Innovative Turbofan Engines to Bizjets Techno Stream Final Report	available (draft)

* R=Report, Hw=Hardware

List of Milestones

Reference	Milestone Title	Due Date	Status
M1.3.6-7	Review of step two tests results	Jun-16	achieved
M1.3.6-8	Review of WP1.3.6.5 deliverables	Jun-16	achieved
M1.3.6-9	End of WP review	Dec-16	re-scheduled
M2.1.3.20	LSBJ low speed model manufacture complete	May-16	cancelled
M2.1.3.24	HSBJ low speed model manufacture complete	Sep-16	achieved
M2.1.3.32A	Review of the HSBJ model	Sep-16	achieved
M213-44	LSBJ large low speed model (F1) review	Jun-16	cancelled
M213-45	HSBJ cruise configuration wing delivery	Aug-16	achieved
M213-46	HSBJ High lift components delivery	Nov-16	achieved
CROR-2016-2	Acoustic WTT results delivery by DNW (CfP)	Nov-16	achieved
M2.2.4-7	Final simulations of DNW acoustic tests	Sep-16	achieved
M2.2.5-1	Synthesis report delivery	Dec-16	overdue
M3.1.2-2	FRR Feeder review	Apr-17	re-scheduled
M3.1.3-23	Bird Strike Tests conducted	Apr-16	achieved
M3.1.3-26	Assembled starboard wing delivery to FAL	Jul-16	achieved
M3.1.3-27	Assembled portboard wing delivery to FAL	Jul-16	achieved
M3.1.3-28	Delivery of Aerofairing to FAL	Jul-16	achieved
M313-29	Entire package of metal parts for manufacturing of Transition Structure Leading Edge &Trailing E.	Jun-16	achieved
M3.1.3-30	Part Delivery for BLADE fixed wing trailing edge	Jun-16	achieved
M3.1.4-2	Support to Flight Clearance	Dec-16	achieved
M3.1.6-1	Systems CDR Feeder Review → activity self-funded	Mar-16	achieved
AFTI-2013-1	TRL 5 Reflectometry & Shadow casting	Aug-16	achieved
M3.1.9-01	Delivery of Mid Box of Transition Structure to FAL	Apr-16	achieved
M3.1.9-02	Delivery of metal parts for Aileron & Plastron	Oct-16	achieved
AFTI-2012-5	Pylon efforts measurement – TRL 2	Mar-16	achieved
AFTI 2015-1	Delivery of Mini remote acquisition unit for optical sensors	Nov-16	achieved
M3.5.2.4	Aft body ground demonstrator: End of mock up and rig manufacturing	Jun-16	achieved
M3.5.2.5	Aft body ground demonstrator: Ground test completed	Nov-16	achieved
M3.5.7-4	Aft body wind tunnel test completed	Oct-16	achieved

→ GRA – Green Regional Aircraft ITD

The year 2016 has seen the finalisation phase of manufacturing, assembling and testing of the GRA Flight and Ground integrated technology Demonstrators, supported by significant range of laboratory tests, devoted to Permit-to-Fly issuance.

The original Programme Master Phasing Plan has been fulfilled in terms of research targets, mostly at TRL 4, 5 and 6 as monitored and controlled through the "technology watch" plan, and furthermore implementing all Panel recommendations.

GRA ITD performance has been improved towards the ACARE targets: GRA Aircraft Simulation Model for Reference (Year 2000 Technology) 130 pax A/C, based on 3rd activities loop including the MTM technology, delivered to TE.

Ground Demonstration policy was implemented by phasing CS-to-CS2 transition by demonstrators (timeframe 2014-2017), ensuring optimal use of the funding available for research: both GRA and REG IADP started to be managed through an unique Integrated Risk Management Plan (RMP), since REG follows and partly builds up on the results obtained by GRA. This transition allows the finalisation of research activities initiated under Regulation (EC) No 71/2008. For the timeframe 2014-2017, whereas the two programmes are going to be implemented in parallel, CS-to-CS2 cross-fertilisation will be realised through many of GRA demonstrators to be utilised for the selected technologies continued development.

To improve the effectiveness of programme's strategies, GRA adapted its policy to the changing market requirements and requested an extra budget in order to finalize by 2016 the Cockpit demonstrator, controlled by Airbus-DS, the Environmental Control System equipment for flight testing, provided by Liebherr and the extension of ATR 72-600 MSN098 A/C availability, provided by ATR.

GRA ITD final demonstrations throughout the year:

- ✓ GRA All Electric Aircraft Flying Demonstration (by ATR, LEONARDO-FINMECCANICA and LTS) on February 2016;
- ✓ Morphing Flap Ground demonstration through a full-scale mechanical prototype by Università di Napoli "Federico II" on February 2016;
- ✓ Test Set-Up & LGS-EMA on Copper Bird® on May 2016;
- ✓ One Piece Barrel demonstrator structural & vibro-acoustic tests (by LEONARDO-FINMECCANICA) on September 2016;
- ✓ Gust Load Alleviation WT demo (by PoliMI) on October 2016;
- ✓ GTF A/C Aerodynamic & Aeroacoustic WT demo (by ESICAPIA/EASIER Consortia) on October - November 2016;
- ✓ NFL and Load Control WT Demonstration (by ETRIOLLA Consortium) on November 2016;
- ✓ MT1 & MT2 Cockpit Test Articles demo (by Airbus D&S) on December 2016;
- ✓ Wing Box assembled (by LEONARDO-FINMECCANICA and AirGreen Cluster) and tests started on December 2016;
- ✓ TP A/C Aerodynamic & Aeroacoustic low speed WT demo (by LOSITA/WITTINESS Consortia) started on December 2016;
- ✓ Low-Noise Main Landing Gear Full scale WT model (by ARTIC Consortium) expected by January 2017 and WT Tests cancelled (ref.: JU decision as per one ARTIC's Partner failure).

Thirty-five scientific (peer reviewed) publications and technical papers were disseminated worldwide throughout the year.

A few of the Green Regional Aircraft communications highlights throughout the year included:

- ✓ Clean Sky Forum, Brussels;
- ✓ GRA exhibition hardware at ILA Berlin Air Show, Berlin, Germany;

- ✓ GRA exhibition hardware Farnborough Air Show, Farnborough;
- ✓ Greener Aviation 2016, Brussels.

0. Management

Milestone status: no significant milestones have been planned for year 2016.
Key Deliverables status: no. of key deliverables due in 2016: 1
No. of key deliverables issued that are due at the end of 2016: 1
No. of key deliverables pending by the end of 2016: 0

1. Low Weight Configuration (LWC)

In 2016, the main activities in the frame of LWC domain concerned:

- The In-flight demonstration:
  - Analyses and correlations of acquired vibro-acoutic data measured during flights by accelerometers and microphones installed on both metallic and composite crown panel configurations of ATR 72 MSN098 have been executed;
  - Confirmation of a high damping performance of composite technology by measuring 0.25 average Damping Loss Factor at 16000 ft altitude;
  - Strain analyses and correlations of data acquired during flights by strain gages and fibre optic sensors have been executed;
  - Analyses and correlations of acquired piezo electric patches measurements for impact detection have been executed before and then the impacts (undamaged and damaged configuration).

- The On-Ground Fuselage demonstration:
  - Final assembling of the two composite pressure bulkheads (one with man hole access) to composite One Piece Barrel has been completed;
  - Acoustic test for evaluation of acoustic transmission loss has been executed by installing 22-loudspeakers array (around barrel) and 20 microphones;
  - Vibration tests for evaluation of the Damping Loss Factor has been executed by installing two shakers and 150 accelerometers;
  - Preliminary acoustic analysis for internal noise evaluation and preliminary modal and damping analyses for dynamical behaviour characterisation have been performed;
  - Instrumentation of the composite fuselage demonstrator for pressurisation test has been completed with conventional strain gauges, optical fibres (FOBR and FOBG) and piezoelectric actuators/sensors for SHM;
  - Three tool drop impacts have been executed on bottom side and three hail impacts have been executed on crown side of the composite OPB to obtain BVIDs;
  - NDI have been performed on impacted locations before pressurisation test start;
  - Strain acquisitions by the strain gages have been performed at pressurisation fatigue cycles 0, 923, 3030, 3855, 4200, 8280 and 9486 when a failure occurred to the metallic circumferential joints between OPB composite skin and composite AFT pressure bulkhead causing the stop of the test;
  - Strain analysis has been performed showing acquired values at each fatigue cycle compatible with the applied load. Preliminary analyses of the failure have been executed;
  - During the pressurisation test, acquisitions by Optical Backscatter Reflectometry technology for distributed fibre-optic strain and temperature sensing have been performed at pressurisation cycle 6030;
  - Acquisitions by piezoelectric sensors installed on crown and bottom sides of composite fuselage have been executed after failure at cycle 9486;
  - Weight comparison between Composite and Aluminium configurations at section level extracted from Fuselage Sec. 13 has been performed;

- About the On-Ground Inner Wing Box demonstration:
  - The composite stiffened upper panel of inner wing box demonstrator has been rebuilt to solve geometrical discrepancies found with respect to the design;
  - The manufacturing of two metallic dummy structures and two metallic tension fittings for the left and right sides of demonstrator has been completed;
  - Instrumentation of whole test article has been completed by installing strain gauges and piezoelectric sensors;
  - The assembling of inner wing box has been completed;
  - The installation of composite test article on test rig and the assembling of metallic tension fittings and dummies structures have been completed;
  - Tool drop impacts and respective NDI have been executed;
  - Cables connection and tests set-up have been completed;
  - Structural tests has started with a preliminary strains and loads survey up to 50% of fatigue load;
  - Needed actions to constrain a slight "z" rotation of demonstrator have started.

- About the On-Ground Cockpit demonstration:
  - Vibro-acoustic tests have been performed on composite cockpit demonstrator MT2 for the following configurations:
    - Baseline configuration;
    - Baseline + window enhancements under "state of the art" techniques;
    - Baseline + window enhancements + interferometry (cameras DIC & laser Vibrio meter).
  - Static Test has been executed on cockpit MT2 up to the following loads:
    - 1.21 LL (pressure bulkhead failure);
    - Ultimate Load (UL);
    - Damage tolerance (VID + 1/3fatigue) + LL ;
  - Dynamic and vibro-acoustic test results on GRA-MT1 & MT2 have been described;
  - Analysis results of low energy impact & static testing have been executed;
  - EMC Test has been executed on MT2 and to be completed on MT1;
  - Weight benefits of cockpit have been evaluated;

- About the Outer Wing Box technological demonstrator:
  - Manufacturing of composite front and rear spars and metallic ribs has been completed;
  - Assembly of wing box has started.

Milestone status:
4 (out of 5) planned milestones have been successfully achieved:
- ✓ GRA1 - Fuselage Ground Demo Test article availability: March 2016;
- ✓ GRA1 - TRR Full Scale Demonstrator: April 2016;
- ✓ GRA1 - Completion Ground Full Scale Test (OPB): September 2016
- ✓ GRA1 - Completion Ground Full Scale Test (Cockpit MT2): December 2016.
- ✓ GRA1 - Completion Ground Wing Box Test: Wing Box GD has been delayed due to the dimensional check, executed on the manufactured Upper Panel, showed some discrepancies in terms of skin curvature and stringers position with respect to design requirements; test started in December 2016.

Key Deliverables status:
No. of key deliverables due in 2016: 9
No. of key deliverables issued in 2016: 8
No. of key deliverables pending by the end of 2016 and to be delivered by January 2017: 1

2. Low Noise Configuration (LNC)

In 2016 the main activities in the framework of LNC domain were concerning Wind Tunnel and Ground Demonstrations in the field of Advanced Aerodynamics, Load Control & Alleviation and Low Airframe Noise technologies, tailored to future GTF 130-seat and TP 90-seat green regional A/C configurations. The mentioned activities are briefly presented below.

- GTF 130-seat A/C / NLF wing
  - Data analysis and reporting about the WT demo (November 2015) of aerodynamic and aero-acoustic performances of the drop nose on a half-wing 1:6 (2.6m span) model – by FhG.
  - Data analysis and reporting of the ground demo (December 2015) of the gust load alleviation control system architecture, through a test rig inserted in a realistic HW/SW environment (aileron actuator and control electronics, primary flight control unit implementing relevant control laws, sensors, simulated A/C dynamics, etc.) – by Leonardo-Finmeccanica.
  - Ground demo of the morphing flap through a full-scale (3.6m span) mechanical prototype, sized to inner half panel of the outboard (tapered, swept) flap. This novel architecture, based on the smart actuation compliant mechanism (SACM) concept, is conceived to enable dual-morphing functions: i) controlled overall flap camber variation to enhance high-lift performance in take-off/ approach/ landing configurations (flap deflected) and ii) actuation of T/E tab as load control device in high-speed (climb/ cruise/ descent) configuration (flap stowed). The demonstration was regarding: a) functionality tests to assess the flap capability of matching target shapes relative to the two morphing modes under simulated aerodynamic loads and ii) structural tests to assess the flap capability in withstanding static limit loads – by AirGreen (UniNA).
  - Further activities, in the frame of projects under CfP supported and monitored by Leonardo-Finmeccanica as relevant topic manager, concerning other technologies demonstrations:
    - WT demo (November 2016) of transonic NLF wing in cruise (Mach 0.74) and off-design conditions (Mach 0.70, 0.78) and of load control performances in steady conditions at given points (Mach 0.42) of the flight envelope on a half-wing 1:3 (≈5.7m span) model - ETRIOLLA project (CfP GRA-02-019).
    - WT demo (October 2016) of gust load alleviation strategy on 1:6 (≈2.5m span) aero-servo-elastic A/C half-model, with flexible wing reproducing by aero-elastic scaling the full-size wing structural response under gust excitation loads, active control movables (aileron, elevator) and control system implementing relevant control laws - GLAMOUR project (CfP GRA-02-22).
    - WT demo (October – November 2016) of aircraft low-speed aerodynamic performances (high-lift in take-off and landing, S&C derivatives) and aero-acoustic impact (assessment of noise sources and HLD low-noise solutions) on a complete A/C powered 1:7 (≈4.9m span) model - ESICAPIA/ EASIER projects (CfPs GRA-05-007/-008) in synergy with NC domain.

- TP 90-seat A/C
  - Further activities, in the frame of projects under CfP supported and monitored by Leonardo-Finmeccanica as relevant Topic Manager, concerning following technologies demonstrations:
  - WT demo (scheduled at the end of January 2017) of aircraft low-speed aerodynamic performances (high-lift in take-off and landing, S&C derivatives) and of aero-acoustic impact (assessment of noise sources and HLD low-noise solutions) on a complete A/C powered 1:6.5 (≈4.9m span) model. - LOSITA and WITTINESS projects (CfPs GRA-02-020/-025); status: WT model under final manufacturing/ assembly phase.
  - WT demo of low-noise main landing gear (including combination of down-selected technologies) on a full-scale model of the installed configuration (gear, bay, doors, part of fuselage) - ARTIC project (CfP GRA-02-021); status: WT model manufacturing in progress; tests cancelled (model not released in the due time).

The document dealing with the overall reporting of the activities performed and the assessment of main results achieved in the frame of the LNC domain project has been updated accordingly, covering most of the relevant work programme, i.e.: enabling technologies development, applications studies and up-to-date demonstrations.

Work Package LNC has met most of its goals in 2016 with exception of LOSITA/ WITTINESS and ARTIC projects related technologies demonstrations.

Milestones status:
2 (of 3) planned milestones have been successfully achieved:

- ✓ GRA2 - NLF wing 1:3 Wind Tunnel model (HW) (ETRIOLLA CfP project): September 2016;
- ✓ GRA2 - WTT First Complete Aerodynamic Test: November 2016;
- ✓ GRA2 - WTT Demo Large Scale 90 Pax: further small delay in the models manufacturing caused the postponement of the concerned test.

Key Deliverables status:
No. of key deliverables due in 2016: 5
No. of key deliverables issued in 2016: 4
No. of key deliverables pending by the end of 2016 and to be delivered by January 2017: 1

3. All Electrical Aircraft (AEA)

In 2016 the main activities in the framework of AEA domain concerned:

- ✓ Successful completion of the iSSE CfP project with the release and validation of the Improved Shared Simulation Environment tool implementing higher quality software features for the integrated simulation of the on-board systems models;

- ✓ Successful completion of the "Application studies" achieved by:
  - Performing the Electrical Power Generation (EPG) equipment TRL assessment reaching TRL5 following the completion of tests on the COPPER BIRD Electrical Test Rig;
  - Performing the Electrical Environmental Control System (E-ECS) main technologies TRL assessment reaching TRL5 for the Power Electronic (PE) and TRL4 for the Electrical Motor Compressor (MTC), followed by the equipment integration and completion of the tests on A/C demonstrator;
  - Completing the single channel RIG and reproducing the A/C Electrical Demo Channel architecture, the tests to validate the Saber Simulation Models of the Demo Channel and verifying the system power quality and the energy management concept.
  - Manufactory and delivery of the Ground Test Bench of the FCS Electro-Mechanical Actuator (FCS EMA, "FLIGHT EMA" CfP projects).
  - Validation of the FCS Electro-Mechanical Actuator (FCS EMA, "FLIGHT EMA") and the LGS Electro-Mechanical Actuator (LGS EMA, "ARMLIGHT" CfP projects) following completion of the equipment test on the COPPER BIRD Electrical Test Rig and on the A/C demonstrator.

- ✓ Successful completion of the "Preparation of flight Demonstration for AEA" achieved by:
  - All parts manufactured and FTI purchased for systems and structural modifications to be implemented on the A/C demonstrator; Electrical Environmental Control System (E-ECS), Electrical Energy Management (E- EM), New Electrical Power Generation for Demo Supply Channel, EMAs Loads and associated test Bench Test introduction on-board, FTI.
  - Manufactory and delivery of the Flight Test Bench of the FCS Electro-Mechanical Actuator (FCS EMA, "FLIGHT EMA" CfP);
  - Completion of the installation on demo A/C of all the experimental equipment, components and parts.

- Release of the A/C ground test requirements and procedures for the validation of the analyses as well as for on-ground verification of the demonstrator configuration;
- Documentation for the flight clearance of the modified aircraft.

✓ Successful completion of the "Flight Demonstration" achieved by:
- Release of the Modified Demo Aircraft and achieved the experimental Permit to Fly (PtF);
- Ground and Flight Test Campaign completed;
- Ground/Flight Test data recorded;
- Ground and Flight Test Data assessment performed.
- A/C Modified & Refurbished.

✓ Successful completion of the "Analysis & Reporting" achieved by:
- Performing the E-ECS Technologies TRL5 Review;
- Performing the EPG Technologies TRL5 Review;
- GRA AEA activities final assessments.

Milestones status:
3 (out of 3) planned milestones have been successfully achieved:
- ✓ GRA3 - E-ECS verification of integration on A/C on ground: January 2016.
- ✓ GRA3 - Completion of Flight Test Demonstration: February 2016.
- ✓ GRA3 - E-ECS for Regional A/C Completion Demonstration: February 2016

Key Deliverables status:
No. of key deliverables due in 2016: 2
No. of key deliverables issued in 2016: 2
No. of key deliverables pending by the end of 2016: 0

4. Mission and Trajectory Management (MTM)

No technical activities planned in 2016: this area closed its activities in 2015.

5. New Configurations

In 2016 the main activities in the frame of NC domain concerned:
- Update of the Aircraft Simulation Model for the Reference A/Cs 90 pax configuration to Technology Evaluator – (step descent trajectories have been considered for 2000 year A/C);
- Update of the Aircraft Simulation Model for the Reference A/Cs 130 pax configuration to Technology Evaluator – step descent trajectories have been considered for 2000 year A/C);
- Update of technology domains contributions to green features of 90 and 130 seats configurations;
- Support to TE in the activities concerning "Airport Level" in the final design loop.
- Assessment of the optimized OR acoustic installation effect.

Milestones status:
1 (out of 1) planned milestone has been successfully achieved:
- ✓ GRA5 - WTT Demo Large Scale 130 Pax ("ESICAPIA/EASIER" projects under CfP): November 2016

Key Deliverables status:
No. of key deliverables due in 2016: 3
No. of key deliverables issued in 2016: 3
No. of key deliverables pending by the end of 2016: 0

→ GRC – Green Rotorcraft ITD

Overview of work performed and results achieved

1) Innovative Rotor Blades (GRC1):

Active Gurney Flap

- Model Rotor tasks completed on schedule;
- 2D Dynamic test work at CIRA started on target in May 2016. Preliminary test data was gathered before the test, which had to be stopped due to fatigue cracks of the specimen's end plates. Repairs were completed and testing restarted in December 2016. Work will continue and be completed in early 2017 (CIRA self-funded);
- Flight blades have been manufactured;
- The Preliminary ground-run has been performed successfully on a demonstrator aircraft.

Active Twist Blade

- Blade segment was successfully de-moulded and all actuators are operable;
- Geometry of the blade segment evaluated with an optical measurement system;
- Test stand for the characterisation of active twist performance was set up;
- Detailed construction of the load introduction components for the mechanical test has been generated.

Passive optimised Blade

- Manufacturing of the blades for whirl tower testing has been completed;
- Whirl tower testing took place. The testing has been processed according to the test order, apart from the thrust measurement;
- Preparations for flight testing started after the helicopter was available. The first flight has been performed revealing excellent performance and comfort characteristics.

Overview of deliverables and milestones

Ref. No.	Title	Partner	Date
D1.1.3-3	Active Twist Test Specimen Ready	DLR	July 2016
D1.4.5-1	Passive Blade Whirl Tower Test Report	AH-D	December 2016
D1.5.1-2	Summary report on active rotor flight test	AWL	Q2 2017
D1.5.2-1	Passive Blade Flight Test Report	AH-D	Q2 2017

Ref. No.	Title	Partner	Date
M1.1.3-3	Active Twist Blade TRL Review	DLR	Re-scheduled March 2017 through technical problems
M1.4.5-1	Passive Blade TRL Review	AH-D	Rescheduled March 2017
M1.5.2-1	Bluecopter demonstrator featuring the POB ready for flight	AH-D	August 2016

2) Drag reduction of airframe and non-lifting rotating systems (GRC2):

The highly instrumented EC135 prototype (BLUECOPTER) featuring the static version of the new side air-intake was grounded and maintained. The ground and flight tests have restarted at the beginning of August with the demonstrator mounting the POB of GRC1. Two new side intakes (TP11), a semi-static one comprising a ramp on the engine cowling, forward w.r.t. the air intake side opening, and a new plenum, and a dynamic one, mounting a scoop on the ramp of the semi static intake have been flight tested until end of the 2016. The flight test data analysis will be conducted in January 2017.

Heavy Helicopter Fuselage with active flow control (TP5) wind tunnel tests have been successfully completed on 10 June at a RUAG Aviation facility in Emmen, Switzerland. The Synthesis report on WT measurements has been completed in 2016 while the final TRL4 review and the deliverable validation shall occur until end of January 2017.

Overview of deliverables and milestones

Ref. No.	Title	Partner	Date	Release
D2.3.6-1	Summary on the flight test results for the AH light H/C with the new air intake.	AHD	September 2016	In preparation

3) **Innovative Electrical Systems, (GRC3):**

The continued evaluation of novel electrical technologies includes the ongoing detail prototype bench testing of the ELETAD radial topology Electric Tail Rotor motor and the HEMAS Flight Control Actuator system. In particular, HERRB, ELETAD and REGENESYS projects have all been completed on schedule, and final reports from the respective consortium leaders have been submitted.

REGENESYS	Final Report completed,
HERRB	Final Report in preparation
ELETAD	Final Report completed
ETR	Test Report yet to be written as tests are still ongoing (estimated availability: June 2017)

Testing of the ETR machine has been successfully carried out in Yeovil and Cascina Costa throughout 2016 and is ongoing.

Overview of deliverables and milestones

Ref. No.	Title	Partner	Date
D3.5.2.4	HEMAS Final Report	AH-SAS	Re-planned for June 2017
D3.4.2.7	Power Converter & Energy Storage Qualification Test Report (Final Report)	AWL	Sep 2016
D3.5.3.4.4	HERRB Integrated System Analysis (Final Report)	AWL	Sep 2016

Ref. No.	Title	Partner	Date
M3.5.2 T5	TRL Assessment 4<5 Main Rotor Actuators	AH-SAS	Re-planned for June 2017

4) Light Helicopter equipped with HCE (GRC4):

In the period from May to August 2016, flight tests on an EC120 helicopter in hot conditions (up to 32°C) have been achieved, confirming the right sizing of the cooling system and clearing the last technical risk identified at the beginning of the project.

Overview of deliverables and milestones

Ref. No.	Title	Partner	Date
D4.13-2	Final technical synthesis, including exploitation of all flight and engine bench tests NOTE: this deliverable include D4.12.5-1 and D4.13-1	AH-SAS	Dec 2016

5) Environmentally friendly flight paths (GRC5):

Main 2016 achievements are summarised below:
TP1A:

- In-Flight demo of MANOEUVRES blade attitude contactless sensor successfully completed
- PITL demonstration of MANOEUVRES Pilot Acoustic Indicator completed.
- Completed the post-processing of Pilot in the loop simulation data of helicopter eco VFR procedures.

TP1B:

- Final pilot-in-the-loop simulations of Tilt-Rotor LN trajectories completed in March 2016.
- Pilot in the loop data analysis and final reporting on-going (last technical task).

TP2A:

- Helicopter IFR routes tested in-flight with AW139 prototype in synergy with SESAR JU.
- Completed the Pilot-in-the-loop testing of Helicopter eco IFR procedures in VMC and ICM condition (foggy weather).

TP2B:

- Final data post-processing of Tilt Rotor insertion into Malpensa air traffic with ATS completed. Simulation experimental campaign was successfully completed in 2015 using engineering simulator AWARE with Tilt Rotor model and Air Traffic Control emulation platform. TP2B completed its activities.

TP6.1:

- Detailed and flexible noise abatement guidelines for FLM operational section proposed;
- Optimised procedures rated as “normal procedure” by test pilots.

The technology product GRC5-TP6.1 is completed: only final TRL gate has to be confirmed.

TP6.2:

- Inflight testing of the head down version of pilot display simultaneously with the acoustic testing: done;
- Inflight testing of the Helmet Mounted Display with a separate test: done;
- TRL 6 gate considered not fully achieved, because measured benefit of optimized procedure 13% vs. 30% of expected benefit.

The technology product GRC5-TP6.2 is completed and DLR have finished its technical activities in GRC5.

TP11:

- OM5-TP11.3.6 reached TEM LNP formally transferred to GRC7;
- GRC5 provided low-noise-procedure information to GRC7 for all requested weight classes; TEL(U2), SEL(U2) and TEM(U1);
- No further GRC5 delivery is expected by GRC7. GRC5 will have to check and approve the outputs of the TE's final assessment for the SELU2/TELU2 and TEMU1 to ensure results are in line with expectations.

Overview of deliverables and milestones

Ref. No.	Deliverable title	Partner	Date
D5-TP1.11.2A	PITL verification results of T/R eco-VFR procedures	NLR	Jun-16
D5-TP1.5.2	Acoustic Benefit of LN trajectories	LH	Nov-16
D5-TP6.2.4	Flight test campaign on EC135-ACT/FHS (DLR)	DLR	Jan-16

Ref. No.	Milestone title	Partner	Date
M5-TP1.0.1	In-Flight demo of Manoeuvres blade attitude contactless sensor	LH	Apr-16
M5-TP2.4.2	H/C eco-IFR procedure implementation on full-scale realistic problems	LH	Re-planned Q1 2017
M5-TP6.1.11	VFR approach guidance verified by test pilots	AH-D	Jan-16

6) ECO-Design demonstrators for Rotorcraft (GRC6):

- GRC6.1 final report deliverable completed
- GRC6.2 tail boom assembly completed and tested by PZL in Q1, evaluation report being compiled
- GRC6.2 roof panel:
    - Raw material full scale article delivered
    - Full scale tool manufacturing with completion at the end of May
    - PoF activities identified
        - Flight demo instrumentation definition
        - Test Flight activities
    - FAI test card finalised
    - Flight tests conducted in December

The monolithic co-melted component has been manufactured, installed in the AW139 prototype and put in flight in Q4.

Overview of deliverables and milestones for KPI

Ref. No.	Deliverable title	Partner	Date
D6.2.3.1	Tail cone demonstrator test report	PZL	June 2016

Ref. No.	Milestone title	Partner	Date
M6.1.8	Evaluation and verification with objectives performed	AHD	March 2016

Technology Evaluator for Rotorcraft (GRC7):

As a result of external influences, major delays have occurred which have affected the platform delivery during period eight. As all issues identified are now solved, the first stage of period nine from January to April has showed positive signs of recovery and delivery of the TELU2-B,R,C, TEMU1-C, SELU2-C Phoenix platforms to the TE.

The period May to August 2016 provided another stage with significant progress made by the GRC7/TE team to get the GRC7 Programme/Plan back on track and final completion.

An update of the High Compression Engine (HCEU1-C) Phoenix platform (V8.1) has made excellent progress. Version 8.1 GRC7's final platform was delivered to the Technology Evaluator on 5 July 2016 (a month after planned delivery).

The TE has received the delivered platforms and integrated all versions into their framework. The results have been generated for all weight classes and circulated by GRC7 to the GRC(i) leads. In parallel GRC7 (NLR) have performed trade-off studies intended to gain an appreciation of the individual GRC contributions and to highlight conceptual missions that further enhance the benefits of the GRC(i) technologies. Approvals for all aspects have been gained from the GRC(i) leads, industry partners, JU community and Steering Committee. GRC7 and the Technology Evaluator (TE) presented the concluding version of the results at the Final Review in Vergiate, October 2016, with further dissemination at the ERF and 3AF AEGATS in 2016.

The follow up recommendations from the reviewers requested that the trade-off study results could be regrouped into Airframe, Engine and System 'technology families'. In response, the revised study was completed as advised and a closing report was sent to all the reviewers before year end.

Quarter 4 of Period 9 saw the issue of all GRC7 and TE documents and any outstanding subjects / questions answered.

Overview of deliverables and milestones

Ref. No.	Deliverable title	Type	Date
D7.3.3-2 & (Internal M7.3.3-2)	TEMU1 – Medium Twin Engine Generic Helicopter Models – EUROPA, TM Engine and HELENA data representing: Year 2020+ Conceptual (Contributors: GRC(i)s, AWL, LH, AH-sas, AH-D, NLR, CIRA, DLR, ONERA, CU, SAGE5) → V7.1 (this has been changed to V 6.1)	Data Package	29/02/2016
D7.3.1-3 & (Internal M7.3.1-3)	SEL U2 - Single Engine Light Generic Helicopter Models – EUROPA, TM Engine and HELENA data representing: Year 2020+ Conceptual (Contributors: GRC(i), CU, SAGE5)→ V7.1	Data Package	25/03/2016
D7.3.6-2	D7.3.6-2 – HCE U1 –High Compression Single Engine Generic Helicopter Models – EUROPA, TM Engine and HELENA data representing: •Year 2020+ Conceptual (Contributors: GRC(i), SISW) à V8.1	Data Package	30/06/2016

Ref. No.	Milestone title	Decision	Date
M7.2.6-9	Integration of PhoeniX Black Box V7.1 in (TE) Platform TELU2 B,R & C and SEL U2 (TEH U1,TEMU1) TEM U1 (delivered as V6.1 early ahead of TELU2-C)	Delivery of Phoenix platform v7.1 to the TE	31/03/2016
M7.2.6-10	Integration of PhoeniX Black Box V8.1 in (TE) Platform HCE U1 (SEL U2, TEH U1, TEL U2,TEM U1)	Delivery of Phoenix platform v8.1 to the TE	31/05/2016

→ SAGE – Sustainable and Green Engine ITD

The year 2016 has been another important year for SAGE with considerable progress made. Although most of the activities of SAGE1 and SAGE3 were finalised in 2015, a lot of activities were performed for the four others projects.

For SAGE4 and SAGE5, 2016 was the year of the disassembly of the engine demonstrators, the inspections of the different modules and parts as well as the analysis of the ground tests results. SAGE2 and SAGE6 has continued to progress towards the start of the demonstrations with the completion of the manufacturing and delivery of all the component and a huge activity on the assembly of the engines demonstrator.

The CfPs in 2016 continue to deliver some excellent achievements, which have contributed to a successful year for the SAGE ITD.

For Project SAGE1 activities were finalised in 2015 except for managing the closure of the CfP project FAMEC.

For SAGE2, a concept review took place in 2012 to consider the feasibility and configuration of the Open Rotor demonstrator. Preliminary design studies of the Open Rotor Integrated Powerplant Propulsion System (IPPS) were finalised in 2013. The preliminary design reviews have been completed in Q1 2014. This enabled to anticipate the detailed design activities. The critical design reviews (CDR) has also been staged with the first one for the blades completed on May 2014. In 2014 and 2015, all the critical design reviews were complete.

The machining of the components started in 2014 and some major parts, such as the first blades, the front rotating frame, the polygonal rings and the pivots, were delivered in 2015 to the dedicated assembly workshop at Safran Aircraft Engines Vernon (known from July 2016 as Airbus Safran Launchers, a Joint Venture between Airbus and Safran).

The assembly of the engine started in October 2015 and continued in 2016. All the parts were delivered to the assembly workshop, which has allowed the end assembly of all the modules. Some contingencies linked to the new engine architecture during the assembly were solved, and the whole engine assembly was launched at end of 2016. As for the Ground Test facility, the assembly of the test bench started in 2015 and all the activities, particularly the control & systems integration were finalised in 2016.

The Ground Demonstration objectives, plan and sequences have been defined in 2015. All the Test Readiness Reviews have been passed successfully in 2016, in order to validate the detailed test plan of the engine.

In the CfPs, several projects were running to support the Open Rotor demonstrator, and all of them have been finalised in 2016. The engine tests are planned for the first semester of 2017.

For SAGE3, as far as the Low Pressure Turbine work-strand is concerned, the data obtained in the engine test campaign was analysed and the LPT components were inspected by ITP. Three CfP projects (RORC, MICROMECH and NESMONIC) were closed also by ITP (topic manager).

SAGE4 in 2016 completed the engine and module tear down and hardware inspection following the

successful Geared Turbofan demonstrator test in Q4-2015. A comprehensive amount of test data was analysed and assessed and with a successfully design review DR6 in Q4-2016 the SAGE4 demonstrator activity completed the operational activity. For the incorporated technologies in HPC, LPT, TEC and engine systems valuable learnings from test data and hardware inspection have been generated and transferred to the technology owners in order to help implement SAGE4 technologies into future production designs.

On technology development side learning form Impulse Mistuning technology has been verified with complementary component testing continued in 2016, in order to mature and allow implementation of this technology in the next possible production design. The analytical and mechanical studies as well as the testing of advanced OAS cavity design continued until mid-2016 to improve component integrity.

In total 14 CfP projects lead by MTU have contributed to the Clean Sky SAGE4 demonstrator programme. AFOOT for advanced Forging of optimized Turbine Casing and SIMCHAIN, Material Simulation of Additive Manufacturing process did successfully complete its operational activities within 2016, with AFOOT providing all financial and audit certificates in completion, SIMCHAIN is going to complete the administrative documentation by 31 March 2017.

Avio Aero delivered three modules of the Integral Drive System for the Get Future Rig to properly support the 2016 test (Test Gearbox, Slave Gearbox and a complete assembled spare). The GeT FuTuRe Rig project (CfP involving a Tuscany Consortium, coordinated by the University of Pisa, supported by the SME's AM Testing and Catarsi) has completed the design, machining and assembly and has sent the rig to the dedicated test facility. In parallel with the IDS and the GeT FuTuRe Rig design and procurement, the technology maturation activities have progressed, leveraging the CfP projects (e.g. HIPSGEAR).

SAGE4 and the Airframe GRA have successfully completed their input to TE. The final TE results are proving all high level objectives for SAGE4 (and GRA) were met. In summary, the SAGE 4 Geared Turbofan project successfully completed its operations in 2016 within the Clean Sky timeframe and has achieved very satisfying results, in view of environmental and technological objectives supporting future engine programmes, as well as strengthening the competitiveness of the European aeronautical industry.

The aim of the project SAGE 5 is to demonstrate several innovative technologies at high temperature. The first step of the demonstration was achieved in 2013 which aimed to test the engine demonstrator at partial TET temperature (Built 1), in order to demonstrate the innovative architecture and reduce risk on core engine components prior to continuing at the high TET target (build 2). The built of two tests campaign was completed at the end 2015 by a highly instrumented test, in order to measure the secondary air system and HP components performance. In 2016 the engine was disassembled and the strip inspection has been performed which showed the engine parts had good behaviour. Up to 350 measurements have been recorded during the test and the analysis has been completed. It allowed the verification of the secondary air system and the HP turbine performance and compared it with the prediction model. The final test report has been completed which allowed for the completion of the engine demonstration. One CfP project concerning telemetric measurement in harsh condition has been completed with partial rig test performed by the consortium and prototypes assembly at the end of 2016.

In 2016, the SAGE6 lean burn system programme completed the manufacture of all components for the ground engine and the vast majority of the flight engine components. The built of the ground

engine started and the core combustion module with the majority of the new technology was also completed. The fan case built started, but unfortunately due to the unavailability of the built and test support capability, the high production was loaded at the Rolls-Royce facilities. The ALECSYS engine is currently awaiting a committed final assembly and test slot. The flight engine has been stripped to modules and is awaiting rebuild in the new lean burn configuration.

Continuing the technology development of the lean burn combustor system, three full scale combustor rig tests have been undertaken, though: altitude and ground ignition testing; emissions; traverse and operability testing, and finally, rumble testing. Additional work has also been undertaken to better understand the fuel injector flow field in the combustor by utilising the smaller rig facilities and using laser diagnostics to visualise the flow field.

Major developments were made in simulating, assessing and defining engine performance effects from the technology which included: functional modelling and refinement of the engine control laws for all the variables from the technology. The safety cases and future engine cycles were also assessed.

The new controls system have progressed significantly with the: software for the ALECSys ground test engine completed and delivered; development of software for the ALECSys flight test engine; manufacture and delivery of all control hardware units for the ground engine, as well as testing on controls rigs which also continued apace simulating transient effects.

Additional work was also conducted for the virtual engine demonstrator by enabling the development of design and simulation systems. In 2016, the virtual engine design systems were improved through better automated testing for preliminary whole engine design, updated simulation for turbine sub-system design, as well as applying a different testing approach for the simulation of thermo-mechanical behaviour in a high fidelity virtual engine. The mechanical simulation has been improved through utilising a more efficient high performance computing, in order to further understand the whole engines behaviour. Faster geometry creation and identification are now also used during engine concept and development stages.

As we look forward to 2017, we will see the engine testing programme start and progress through initial functional testing and extreme environment testing to a full flight testing on the second engine, which will be installed under the wing of the Rolls-Royce Boeing 747 flying test bed.

→ SGO – Systems for Green Operations ITD

Overview

The purpose of the SGO ITD was to assess, design, build and test up new aircraft systems technologies and architectures in the two areas of Management of Aircraft Energy (MAE), and Management of Aircraft Trajectory and Mission (MTM). The CO_2 benefits were expected both from mission and trajectory, as well as optimisation of on-board energy. The noise reductions are linked to the trajectory management, for approach/landing on the one hand and take off on the other hand. Additional benefits were also expected, e.g. suppression in the use of hydraulic fluids. The SGO ITD successfully concluded its technical development at the end 2016, with the final major demonstrations in both targeted areas.

Description of main activities

Management of Aircraft Energy (MAE)

MAE aimed to achieve two major objectives. Firstly, to develop and demonstrate More Electric Aircraft System Architectures (bleedless aircraft, power by wire architectures), involving energy users to facilitate the implementation of advanced energy management functions and architectures. Secondly, to adapt and demonstrate the control of heat exchanges (partly necessary due to the more-electric concept) and reduction in heat waste within the whole aircraft through improved system efficiency, with respect to power electronics and advanced thermal management.
In order to support the objectives, the following final project results were achieved in 2016 for each technology thread:

- Electrical energy management architecture :
    - The Power Distribution Centre ground test campaign on the Airbus Electrical Ground Test Rig “PROVEN” (campaign G3) was finalised in 2016. It demonstrated the technical feasibility of a centralised and modular management of power conversion and distribution including thermal management of the centre.
- Systems using electrical power (ice protection, environmental control systems, etc.)
    - The technology demonstration of the electrical environmental control system was completed through the e-ECS flight tests on the Airbus A320 MSN1 (pack size of 50kW electrical power) in June 2016. The flight test campaign has been particularly successful, covering the complete foreseen envelop. An opportunity to extend the flight campaign with some extra robustness test at high altitude was even made possible thanks to the collaboration of all involved teams. The development of the innovative e-ECS in SGO has been successfully completed through the proof of TRL5 end of 2016.
    - Another aircraft platform targeted by the e-ECS was the Regional Aircraft application in cooperation with the GRA ITD and Alenia/ATR. The technology has been successfully demonstrated through a flight test campaign with an ATR72-600 in February and in March 2016 with one eECS pack installed in the ATR belly fairing.
    - The flight test campaign of an innovative Primary Inflight Ice Detection System (PFIDS) also took place during the year, taking the opportunity to install it on two aircraft: the A320 and the A340. This allowed the gathering of critical test data which led to the pass to TRL6 for this technology at the end of 2016.

- For the Helicopter Electro-Mechanical Actuation System (HEMAS) the final system tests took place in 2016. Several technical issues have arisen during the final integration stage, which limited the scope of the tests which could be performed. As a consequence, the final TRL4 at system level could not be reached within the resources of the project. Nevertheless, high value information have been gathered and exchanged between SGO and GRC ITD on the feasibility of an electrically actuated helicopter swash plate.

- Overall thermal management solutions of aircraft systems:
  - The final target for SGO was reached in 2016 with a pre-TRL4 review of the Thermal management function solution using rapid prototype hardware in a simulated environment. This development in SGO supported the identification of innovative thermal management architectures which in the future will facilitate the implementation of advanced energy management functions.

Management of Aircraft Trajectory and Mission

MTM was based on two main concepts. First, the ability to fly a green mission from start to finish, with management of new climb, cruise and descent profiles, based on aircraft performances database allowing multi-criteria optimisation (noise, gaseous emissions, fuel and time). This also encompassed the management of weather conditions, which could negatively impact the aircraft optimum route and result in additional fuel consumption. In addition, on the airfield itself, Smart Operations on Ground used new systems solutions, allowing aeroplanes to reduce the use of main engines for taxi operation.

The developed technologies reached their final demonstration stages in 2016:

- Flight management and guidance algorithms and functions for climb, cruise and descent phases:
  - In the field of FMS Optimised trajectories, the departure and cruise functions achieved TRL6 in 2016, with final tests of the FMS on a representative bench. In parallel, the function targeting the final approach phase passed TRL5, taking into account some results from associated SESAR projects.
  - Technologies for electrical taxi via an on-board wheel actuator system reached their final stage of maturity, with system integration tests on a large scale dynamometer.

→ ECO – Eco-Design ITD

The Eco Design ITD performed in the 2016 period all the required activity to consolidate the technical results achieved throughout the programme duration (until end of 2015), in particular the demonstration performed at both EDA (Eco Design for Airframe) and EDS (Eco Design for Systems).

The technical tasks were completed within 2015, with an extension in 2016 limited to reporting and management tasks. The programme demonstrated the its primary objectives (to contribute to improving the eco-efficiency of future aeronautical products in terms of energy reduction, the use of green materials and processes, long life structures, reuse and recycling techniques and improved electrical/thermal energy management). The innovative potential coming from the Eco Design ITD makes it well placed to be a frontrunner in promoting the application of green eco-friendly technologies.

In the terms of the Eco-Design for airframe (EDA), most of the eco-technologies have reached the intended level of maturation to support a future implementation into new products. The 80 technologies, applicable to different aircraft parts, were developed at TRL5 and out of 50, 18 were integrated into demonstrators representing around 40 aircraft parts.

The technology development and demonstration were supported by the detailed environmental assessment performed through the developed database and eco design tools.

The EDA as its end has brought important outputs in terms of new eco technologies and tools, with increased potential to contribute to reducing the environmental impact of aeronautical parts through their lifecycle.

In Eco-Design for Systems (EDS) the activity has proceeded towards the consolidation of the electrical and thermal modelling tools which together with the economic model aimed to evaluate the more novel electrical aircraft architectures, mostly for the More Electrical future business jet.

The Electrical Test Bench (ETB) was able to reproduce generic and regional aircraft architecture, while the Thermal Test Bench (TTB) integrated three business jet fuselage sections and an aircraft calorimeter to reproduce extreme environmental conditions which represents a distinctive achievement towards its usage in the next research framework.

A large number of demonstrators have benefited from the work performed by the 69 GAPs, including a large number of SME who completed on time and have focused on the specific Eco design ITD technology areas. In general, the very good outcomes came from GAPs, in line with the ITD schedule and objectives. This was made possible by the excellent level of cooperation developed among the consortia, topic managers and the JU.

A proper link with the other ITDs was also guaranteed, such as the effort performed in EDA concerning the support to GRC Eco demonstrators, synergies with GRA composite structures and TE, in particular for business jet application. The link for technologies developed in SGO and GRC was also properly ensured through EDS.

A final review was held from 5 to 7 April 2016, where good appreciation of the projects achievements was shown by the independent review team. A detailed dissemination and exploitation section which was then added to the final publishable report submitted by the ITD.

All the expected milestones were reached and deliverables were submitted to ensure the satisfactory and timely closure of the first Clean Sky programme.

The management aspects have been properly addressed, which has promoted a very good level of cooperation among the 41 beneficiaries, in order to finalise the programme.

The preparation and management of the main meetings have been ensured to monitor the progress of the programme and address any issues. The final Steering Committee meetings and PMCs were held in 2016 to coordinate the technical consolidation and the programme finalisation. In addition to the excellent results, an efficient use of resources was also ensured in the end by the Eco Design beneficiaries and partners.

Eco Design participation was ensured at several dissemination events took place throughout 2016, (including presentation of papers). The dedicated deliverables in the D&C plan were provided in early 2016, to update the inputs from beneficiaries regarding the performed and foreseen activities, as well as preparing for the final report.

A valuable potential exists for the use and exploitation of results allowing beneficiaries to capitalise on technology development, demonstration and use of environmental assessment methods for the future.

Main achieved milestones:
- Final review (5-7 April 2016)

Management deliverables:
- Dissemination and Communication plan
- 2015 Final review
- Final report

Technical deliverables consolidation:
- EDA General synthesis (WPA2, A5, A6)
- EDA Application studies and eco statements finalisation
- EDS General synthesis (WPS1, S2, S3, S4)

The annual activity report and cost claims have been submitted and accepted. The Eco Design ITD's seven year of activity could now be considered the first example of a Clean Sky ITD that has successfully concluded on time.

The Eco Design technologies and demonstrators confirmed their strong potential in contributing to the ACARE agenda and H2020 objectives, in particular with the wide set of EDA investigated materials, processes, green manufacturing and repairs improvements: both on metallic and composites aircraft components and recycling. The LCA database and tools developed represent a key step for beneficiaries in the path to demonstrate eco-compliance in the aeronautical sector and to position the EU at the forefront in this area.

The demonstration in the frame of EDS (ETB and TTB) was also of equal importance to make available at the end a common platform and tools to investigate future advanced more electrical aircraft technologies.

The achievements provide a valuable backdrop for the development of the Eco design Transverse activity in Clean Sky 2.

→ TE – Technology Evaluator

All TE Work Packages had activities and deliverables in 2016:

- WP0: TE Management and Coordination
- WP1: TE Requirements and Architecture
- WP2: Models Development and Validation
- WP3: Simulation Framework Development
- WP4: Assessment of Impacts and Trade-off Studies

In 2016 the global environmental assessment synthesis was performed as planned.
In WP0:

- Two amendments (9 and 10) to the TE GAM for the 2016 period were prepared, sent and approved by the JU. Also the DJU 0.1-12 "Updates GAM 2016" was released.
- The DJU 0.1-13 "2015 annual report" was released and the milestone "M1 - 2015 annual report" was reached;
- Contribution to the JU communication strategy was performed, including a workshop held in March 2016 at the JU facility;
- A draft of the "DJU 0.1-14 2016 annual report" was released on the 15 December 2016, the full version will be released when the contribution from WP1 and WP4 will be available;
- The final review meeting of the TE was held from 20 to 21 September 2016, in Brussels.

In WP1, throughout 2016 the main activity was to update the TE technical planning until the end of the project. This planning indicates the TRL development status associated with the technologies integrated into the ITD aircraft models and its linkage and timing to the TE assessments. A part of this is also the linkage between the ITD aircraft models and demonstration activities of the ITDs. The DJU 1.1-4-6 "Overview of ITDS a/c models and TRL progress" was released.

In WP2, the last updates of the ITD aircraft models were received (ITTE 2.1-4-AWEC1 2015 Phoenix TEL U2, ITTE 2.1-5-AWEC1 2016 Phoenix SELU2-TEMU1 with Rmems, ITTE 2.1-5-AWEC2 2016 Phoenix HCEU1 with Rmems) and so the milestone "M2 - Reception of all ITD r/c models and LCA inputs for 2016 assessment" was reached.

In WP3 the main activity in 2016 was focused to support WP4 to operate the tool chains and carry out the TE 2016 assessments and trade-off studies. In addition to the main tasks, background activity to maintain and improve the platforms was done (at three levels of assessment and with the TE-IS (i.e. managing configurations and versions of all TE data and software used for the assessment).

In WP4:

- Several dissemination activities were performed, including the one reported in the DJU 4.7-3 "AEGAT dissemination" and DJU 4.7-4 "Farnborough dissemination"
- The trade studies have been finalised and are reported in the assessment synthesis report.
- The final assessment synthesis have been released in two step as planned in 2015 through "DJU 4.6-5.1 2016 assessment Synthesis report V1" and "DJU 4.6-5.2 2016 assessment Synthesis report final", allowing the milestone "M3 - 2016 assessment Synthesis report final" to be reached.
- It was decided and agreed in amendment 10 of the GAM to plan a third version of this report to update in order to take into account the reviewers' recommendations.

The environmental performances can be summarised as follows:

- -32 % CO2 and -40% NOx for the global aircraft fleet
- -5 dB(A) Noise Lden in average for 6 European airports

For large commercial aircraft, the advanced concept platform using a Contra Rotating Open Rotor

(CROR) and a 'smart' laminar-flow wing presents a very promising CO_2 improvement and a positive perceived noise result.

In regional aircraft, substantial improvements in environmental performance in terms of CO_2 and especially outstanding Noise Area reduction are confirmed.

In the business jet sector, a novel, radical redesign of the empennage shows very substantial benefits in shielding from engine noise in operation at low altitude: halving of noise footprint on take-off can be achieved.

In rotorcraft, within the various rotorcraft class and type of missions, improvements in noise footprint and emissions have been demonstrated. In the range of innovative technologies that have been developed for the various rotorcraft platforms, it is possible to come close to or even supersede the targets.

The following table is the final assessment of the Technology Evaluator, as consolidated at the end pf 2016 as an overall outcome of the first Clean Sky programme.

Clean Sky objectives at global feet level[21]	CO_2 Δ	-26%				
	NO_x Δ	-60%				
	Noise[22] Δ	-50% to -75%				
Vehicle	Metric	Long range[23]	Short Medium range[24]	Regional	Business aircraft	Rotorcraft
Results from the TE mission level assessment	CO_2 Δ	-19%	-41%	Up to -27%[25]	Up to -32%[26]	Up to -58%[27]
	NO_x Δ	-39%	-42%	Up to -46%[28]	Up to -32%[29]	Up to -64%[30]
	Noise area Δ	-67%	-68%	Up to -86%[31]	Up to -50%[32]	over -50%[33]
	Noise Δ	-5.7 dB	-5.1 dB	Up to -15.7 dB[34]	-5.5 dB[35]	Not relevant
Assessment	Metric	Mainliners and Regional fleet			Business fleet	Rotorcraft fleet
Results from the TE airport level assessment	CO_2 Δ	-30% to -40%			Not available	-10% to -20%
	NO_x Δ	-40% to -45%			Not available	-30% to -65%
	Noise area Δ	-35% to -70%			Not available	Up to -75%
Results from the TE global fleet level assessment	CO_2 Δ	-32%			20%	-16%[36]
	NO_x Δ	-40%			28%	-45%

[21] The NOx objective of 60% has not been reached. Although various new technologies (developed in- and outside Clean Sky) have contributed to a significant better NOx performance, a lot of the improvements are lost due to the higher OPR (Operating Pressure Ratio) and higher temperature of modern, more fuel efficient engines. The NOx performance is very cycle dependent so in another lower OPR future cycle then the 60% achievement would have been possible.
[22] The percentage value shows the reduction of the noise footprint obtained from less noise emission and trajectories optimisation in areas surrounding airports and landing spots for same noise levels produced by currently operating fleets.
[23] Average value for 1000 to 7000NM, noise level 75 dB take-off
[24] Average value for 500 to 2600NM, noise level 75 dB take-off
[25] Average value 300 to 1000NM for GTF130
[26] Average value 800 to 2900NM for Low Sweep Business Jet
[27] High Compression Engine rotorcraft, passenger & training missions
[28] Average value 100 to 500NM for TP90
[29] Average value 800 to 2900NM for Low Sweep Business Jet
[30] High Compression Engine rotorcraft, passenger & training missions
[31] Average value 100 to 500NM for GTF130, noise level 75 dB take-off
[32] Average value 800 to 2900NM for Low Sweep Business Jet, noise level 55 dB take-off
[33] Single Engine Light rotorcraft, passenger mission
[34] Average value 100 to 500NM for GTF130, noise level 75 dB take-off
[35] Average value 800 to 2900NM for Low Sweep Business Jet, noise level 55 dB take-off
[36] This fleet does not comprise HCE rotorcraft. This is also applicable for the NOx value.

Next steps

A final version of the “DJU 0.1-14 2016 annual report” will be released as soon as the last contributions will be made available.

The DJU 4.6-5.3 “2016 assessment Synthesis report final (update)” will be released in early 2017, allowing the TE to finalize the DJU 4.7-5 “Final public communication” and thus reach the last milestone “M4 - Final public communication”.

→ LPA – Large Passenger Aircraft IADP

In essence, building upon the positive experience of the Clean Sky Smart Fixed Wings Project (SWFA), the Large Passenger Aircraft IADP operational activities started in July 2014, in all three major work packages also called "Platforms":

- Platform 1: "Advanced Engine and Aircraft Configurations" will provide the development environment for the integration of the most fuel efficient propulsion concepts into the airframe targeting next generation short and medium range aircraft, the CROR engine and the Ultra-High Bypass Ratio (UHBR) turbofan;
- Platform 2: "Innovative Physical Integration Cabin – System – Structure" is aiming to develop, mature, and demonstrate an entirely new, advanced fuselage structural concept developed in full alignment towards a next generation of cabin-cargo architecture, including all relevant principle aircraft systems;
- Platform 3: "Next Generation Aircraft Systems, Cockpit and Avionics" the ultimate objective is to build a highly representative ground demonstrator to validate a Disruptive Cockpit concept to be ready for a possible launch of a future European LPA aircraft. Although a Disruptive Cockpit is the main target of Platform 3, some of the technologies that may be resolved may find an earlier application. These technologies spin-offs would therefore be candidates for an incremental development of the existing family of commercial aeroplanes. In addition, Advanced systems maintenance activities are also part of Platform 3.

The purpose and intention of the LPA technical work programme in all three platforms is to prepare and conduct research and technology development, with a focus to mature and validate technologies with the potential of high improvement and which have already reached elevated maturity typically based on integrated ground and flight demonstrators of large or full scale. In Common for all the three Platforms, 2016 was the conducting of diverse demonstrator launch reviews which contributed to a major Annual Progress meeting and individual intermediate progress reviews. Six additional Core Partners acceded to the LPA programme as outcome of the second call for Core Partners and two more acceded as outcome of the third call.

LPA Platform 1 activities and progress of work in 2016

Three Launch Reviews for major technologies were performed in 2016, "CROR FTD" (WP1.1.1/1.1.3), "UltraFan™ FTD" (WP1.5.2/WP1.6.4) and "Active Flow Control technology on wing/pylon" in (WP1.5.3). For the CROR engine the assessment of different engine configurations (open-rotor pusher or puller configuration) and alternative plans for advanced propulsion concepts were pushed forward in 2016. The work by the Core Partners concentrated on the compilation of development plans for the power turbine and the gear box, the development of new engineering and manufacturing processes for rotating frames. Design activities were performed targeting advanced flight-test instrumentation and new technologies for surface pressure measurements. Numerical investigations were performed on installed CROR FTD configuration to support the eco-viability assessment.

For the CROR rear-end demonstrator several enabling technologies were matured towards TRL2 level target in 2017. At the end of 2016, Airbus took the decision to stop with the existing CROR rear-end configuration. A short-term re-orientation phase was launched in coordination with all involved partners and the CSJU in order to come up with an updated scenario reflecting the latest requirements in terms of aircraft configuration, propulsion concepts, design and manufacturing principles.

In the Scaled Flight Test demonstration work package (WP1.3) activities focused on defining the requirements for scaled demonstrators including the build-up of the required data input. The further composition of the partner consortium progressed well, associated kick-off meetings with new core partners took place and operational work has started.

In WP1.4 Hybrid Laminar Flow Control demonstrators (HLFC) work in 2016 concentrated on the definition of preliminary structure/system/build concept of the HLFC Horizontal Tail Plan (HTP) considering the essential sub-technologies. In addition, material tests at coupon level, system tests and manufacturing trials have been performed to assess the feasibility of the proposed construction principle. The activities for the HLFC wing have started and a dedicated CPW04 topic was launched in December 2016.

In WP1.5 progress has been made on the selection and concept development of essential technology bricks to facilitate the integration of very large turbofan engines. The roadmap for the experimental testing and validation of Active Flow Control (AFC) applied on wing-pylon has been elaborated. In the terms of load and noise mitigation technologies, requirements have been specified and concepts sketched.

In WP1.6 the reference configurations for advanced aircraft configuration investigations have been defined as well as the definition of the tools suits in use. The selection and assessment process of promising hybrid electric aircraft concepts have been continued down to higher detail level. The Simulation activities on refined component models took place as well as larger-scale subsystem testing (Hybrid Ground Demonstrator, HGD1). For the UltraFan^{TM} flight test, the flight-test clearance verification requirements have been defined. Preliminary feasibility studies were carried out for the Flight Test Demonstrator (FTD) which was supported by a demo engine positioning and loads check in order to assess the aircraft impact.

Major milestones accomplished in 2016 (Platform 1):

- The Launch Review of the CROR FTD (WP1.1), kick-off for related work packages.
- CROR Rear-end (WP1.2) the test matrices at coupon scale for impact and residual strength studies as well as the modelling strategy for fatigue loading were defined.
- The assessment of new configuration for Scaled Flight Testing (WP1.3) was performed.
- For HLFC on Tails (WP1.4) the suction panel concept and joining strategy for the leading edge are selected.
- The Launch Review of the UltraFan^{TM} FTD (WP1.5.2) was performed. Rolls-Royce and Airbus have consolidated the development plan of the Long Range engine including the characterisation of challenges. Rolls-Royce delivered the initial demonstrator data pack, the Halon replacement agent discharge testing was also completed.
- Launch Review of the Active Flow Control at engine/pylon (WP1.5.3)
  Options for hybrid electric systems for the Hybrid Power Bench Development & Testing (WP1.6.2) were defined.

Major deliverables accomplished in 2016 (Platform 1):

- Updated development plan (version April 2017) for all demonstrators and corresponding enabling technologies considering all future Call-for-proposal Partner activities.
- Topics for Call for Core Partners as well as Call-for-proposal Partners submitted and/or launched for all waves in 2016.
- Delivery of TRL2 contributions on fuselage shielding, vibro-acoustic characterisation and aeroelasticity / flutter analysis For CROR Rear-end (WP1.2).
- The preliminary proposal of suction chamber layout for structural design was delivered for HLFC on tails (WP1.4), the suction panel concept and joining strategy for the leading edge were selected. The demonstrator technology road maps for the UltraFan FTD (WP1.5.2) was

delivered, TRL4 for the Halon replacement was documented. The experimental testing roadmap for AFC on wing/pylon (WP1.5.3) is available.

- The baseline engine architecture for a single aisle aircraft concept ("entry into service 2035") is defined (WP1.6.1).
  Preliminary trade studies on the electrical assessment and integration into gas turbine and propulsors were delivered for Hybrid Power Bench Development & Testing (WP1.6.2).

LPA Platform 2 activities and progress of work

Throughout 2016, the work in Platform 2 was mainly focused on the detailed design and architecture definition of the 3 demonstrators.

An extended concept phase of concept studies took place In WP2.1 "Next Generation Fuselage, Cabin and Systems Integration" throughout 2016, with defining and collecting the most promising future concepts for an all new, advanced fuselage architectures for assessment and down selection in 2017. The full scope of criteria on weight saving, reduction of production cost, Eco optimized lifecycle and improved efficiency during operation was addressed. The concept for an integrated demonstrator design had started to be defined in 2016 and will end in 2017. The Partners emerging from CfP03 were joining at the end of 2016 to start work on structural energy storage technologies.

For WP2.2 Next generation Cabin and Cargo Functions the requirements definition, the concept evaluation and initial design of the technology concept demonstrator (Micro-PSU) for the Movable Passenger Service Unit (MPSU) has started and achieved in main aspects. The Concepts and architectures are being developed for the Environmentally Friendly Fire Protection (EFFP), in particular the fire knock-down and long term fire suppression system based On-Board Inert Gas Generating System, conduct of modelling and Computational Fluid Dynamics (CFD) to support the architecture design phase. The Activities with Call for Proposal partners kicked off early 2016.

The demonstrator design and development, system integration and Lab/Ground tests and thermal integration to the aircraft cabin and design optimisation have been conducted and are partially accomplished for the Fuel Cell Powered Galley (FCPG).

In WP2.3 "Next Generation Lower Centre Fuselage" demonstrator, four Partners selected from open call CfP#02 started development and design activities on main components in Q2/2016 are contributing to the next generation lower centre fuselage demonstrator concept phase.

In WP2.4 "Non Specific Cross Functions" and interface to ITD-Airframe, a key part of the action was to align and mature the definition as well the launch of the innovative non-specific technologies to feed into the platform 2 demonstrators.

The definition of demonstrator needs in the area of material & processes, but also interfacing with associated activities in ITD Airframe: Assemblies technology development, continuation of innovative high performance blind fastener technology, development of innovative structural test conditions with optimised lead time with a focus on thermal stress analysis integration and predictive virtual testing activities which started in 2016 in association with Partners joining the programmes.

Major milestones accomplished in 2016 (Platform 2):

- "Demonstrator Launch Reviews" for all Platform 2 activities
- Requirements defined, Kick-off concept phase and first concept review (WP2.1)
- Critical design review of components (WP2.2)
- Concept freeze, requirements review and concept review (WP2.2)
- Engineering Qualification Program Plan (WP2.2)

Major deliverables accomplished in 2016 (Platform 2):

- Requirement document (WP2.1)
- Enabler Selection List (WP2.1)
- Preliminary Document on future fuselage architecture (WP2.1)
- Preliminary Document on material options (WP2.1)
- MPSU Requirements Definition Document (WP2.2)
- Fire Suppression Concepts Document (WP2.2)
- Fuel Cell Galley Requirements Document (WP2.2)
- Experimental Process and Trials Definition (WP2.2) delayed
- Wing integration (WP2.3)

LPA Platform 3 activities and progress of work

In 2016 the IADP LPA Platform 3 activities have been focusing upon integrating three Core Partners from Wave 2 into the LPA GAM and Platform 3 consortium, as well initiating the development of the Innovative functions and technologies towards a TRL4 by 2018. The WBS of Platform 3 has been updated accordingly.

These activities have been be performed in collaboration with several key systems suppliers partners, as well as with other aircraft manufacturers (business jet and regional aircraft). In parallel, the Maintenance Work Package ADVANCE has finalised the integration of Partners from Wave 01 call and has accelerated the corresponding ramp up.

The launch review of the Platform 3 demonstrators has taken place in November 2016.

In WP3.1 Enhanced flight operations and functions “Functions and systems for easier flight”, high level requirements have been released for the Large Aircraft, and the corresponding specifications preparation has been triggered among Core Partners and Partners. This included collision avoidance on ground, speech-to-text, new navigation sensor and hybridisation, touchscreen control panel for critical applications and protective device for flight crew.

For “Functions for Efficient and Easy Systems Management” the concept definition phase for the technologies for Pilot Workload Reduction, focusing on the Regional Aircraft, has been achieved by delivering the final version of high level specifications and concept of operation for cockpit functions to the selected Core Partners. This included in particular the enhancement of light weight eye vision, procedure automation, pilot data acquisition prognosis and diagnosis system, voice command and the aircraft monitoring chain for ground support.

For “Functions and solutions for man-machine efficiency”, the focusing on the business jet application, where the main activities have been planned and allocated to the selected Core Partners, where a high level requirement elaboration has started for the following functions multimodality and voice to system, head worn display, approach stabilisation assistant, new navigation sensor and hybridisation and pilot state monitoring

For WP3.2 Innovative enabling technologies activities on “flexible communication” in 2016 have focused on Modular radio avionics and ATN/IPS router activities planning, as well as allocation with the selected core Partner DECK, and a first set of high level requirements. The main activities on Avionic components update & security were related to the plan and to allocate activities to the selected Core Partners, specification of the targeted features required for business jet have started. A CfP-Partner has been selected to work on the development of a Li-Fi (Light Fidelity, bi directional data transmission by light) demonstrator.

In WP3.3 Next generation cockpit functions flight demonstration the flight tests needs for large passenger aircraft innovative functions and technologies have been reviewed, challenged, and the tests requirements have been prepared for the 2017 AHRS test campaign.

In WP3.4 Regional Aircraft Active Cockpit demonstration with innovative functions & technologies a first version of the Large passenger aircraft Enhanced cockpit functions and technologies Validation & Verification (V&V) plan has been prepared, to enable the specification of further tests and tests means requirements

In WP3.5 Disruptive cockpit ground demonstration the large passenger aircraft disruptive cockpit demonstrator phase 1 scope and V&V objectives have been reviewed to prepare their specification in 2017.

For WP3.6 ADVANCE the development of operational and business scenarios based on airline and major industry actors has been performed to support the completion of the Maintenance E2E (end to end) Architecture specification.

The IHMM platform provided the aircraft and ground segregated functions for data collecting. Transmission and analysis has been developed and its performance demonstrated for the first iteration loop.

A CfP01 Partner has finally been selected to support the activities concerning development of system prognostic and augmented reality solutions for maintenance execution enhancements. The Structure Health Monitoring and system prognostic solutions use case selection and specification have been performed. Specifications and first low scale demonstrator platforms for mobile tool solutions (augmented and virtual reality) developments have been launched.

First functional software modules for maintenance tool applications have been developed. The backbone specification of the collaborative environment and communication infrastructure for mobile tools application has been provided.

Major milestones accomplished in 2016 (Platform 3):

- Kick-off meeting with Core Partners on "Pilot Workload Reduction technologies" (REACTOR topic)
- Concept Solution Review for Cockpit Workload Reduction technologies
- LPA Platform 3 ADVANCE (WP3.6) demonstrators launch review
- Official start of Cockpit Utilities Management System - UBBICK activities
- Kick off DECK activities with HWL during dedicated meeting
- Platform 3 demonstrators launch review

Major deliverables accomplished in 2016 (Platform 3):

- AHRS Specification (WP3.1.1)
- Oxygen mask system requirements (WP3.1.1)
- Final version of High Level Requirements Documents for Pilot Workload Technologies agreed with REACTOR Core Partner. It will be the project baseline. (WP3.1.2)
- High Level preliminary test plan for Pilot Workload Reduction Technologies (WP3.1.2).
- Topic for CfP Wave 04 and Wave 05 (WP3.1.2 et WP3.4)
- Preliminary high level requirements specifying scope and expectations for ATN/IPS, issue 1 (WP3.2.1)
- Description of Active Cockpit Demonstrator Architecture & capabilities. "As is" description before capture of new technologies simulation requirements (WP3.4)
- Maintenance Planning and Optimisation SOA and Requirements (WP3.6) with a technical report of the IHMM specification including the description of use cases and those selected

for the TRL4 demonstrator, the description of the IHMM Architecture, the specification of the IHMM TRL4 demonstrators

- Global Prognostic Solutions: Step 1 concept development (step 1) (WP3.6.2)

→ REG – Regional Aircraft IADP

As per Work Plan 2016-2017, during 2016 technical activities have been seamless continued from the previous period and have been mainly related to: further development of technologies and down-selection; trade-off studies; definition of demonstrators; Overall Aircraft Design (conceptual design, flight physics, architecture definition, etc.). Such activities have been performed by the Leaders: Leonardo-Finmeccanica Aircraft Division (FNM-VEL), Airbus DS, Liebherr and by the Core Partners (AIRGREEN 2 and ASTIB all along the year; EWIRA and IRON in the second half of the year) who are providing key contributions towards the maturation of relevant technologies and the definition of the full scale integrated demonstrators.

Hereafter it is reported a brief description of management and technical activities performed during 2016 as well as the status of deliverables/milestones w.r.t the REG GAM 2016-2017 Amendment 4.

WP0 - Management

Main activities performed during 2016:

- Program Coordination: interface with CSJU, coordination of interfaces with other SPDs; continuous coordination between FNM-VEL and Airbus DS; coordination with Core Partners; management activities for the completion of transition from GRA and Risk assessment integrated with GRA. Technical and financial reporting for 2015 activities; periodic reporting for 2016 activities;
- Completion by FNM-VEL of subcontracting documents “Administrative Support” so as to have a seamless continuation of Arttic service support during 2016 and 2017;
- FNM-VEL activities related to System Engineering Management Plan and IT tools and methods;
- Preparation of the REG GAM 2016-2017 Amendment 4 (covering years 2016 and 2017);
- Management activities related to the preparation of Topic Descriptions for Call for Proposals;
- Preparation and organisation of meetings: two Launch Reviews, the first annual review, the first Intermediate Progress Review as well as 5 Steering Committees held during 2016.

All planned deliverables of this WP were completed during 2016.

WP1 - High Efficiency Regional Aircraft

Main activities performed during 2016 by Leonardo-Finmeccanica Aircraft Division and by the Core Partner IRON in the second half of 2016:

Top Level Aircraft Requirements preliminary definition for both high efficiency configurations was performed and subsequently the relative deliverable (D1.2.1-02/04) was issued.

Definition activities for technologies targets related to structural weight saving, on-board systems, aerodynamics for both Turbo Prop Aircraft configuration (wing mounted and rear mounted) and of Reference Aircraft for the Turboprop conventional configuration were performed. Moreover, a preliminary design loop (loop 0) for sizing and performance estimation for both the innovative a/c architecture and the conventional one was finalized. Consequently the following deliverables have been issued: D1.2.2-03; D1.1.1-11; D1.3.1-01.

Loop 1 aerodynamics and power-plant design for the innovative configuration were performed and Innovative configuration (rear-mounted engine configuration) Loop1 aerodynamics design (D-1.1.1-18) and power-plant definition (D-1.1.2-01) deliverables were prepared.

The reference aircraft configuration definition for both conventional and the innovative configurations were re-planned in 2017 due to the fact that the decision inhering to the reference platform is still in progress.

WP2 - Technologies Development

Main activities performed during 2016 by FNM-VEL, as well as those performed by the Core Partners Airgreen2 (AG2) in WP 2.1, ASTIB in WP 2.3 and 3.4, IRON in WP 2.3.6, are described hereafter.

- **WP 2.1 Adaptive Electric Wing**

Contributions to the development of wing structural design, innovative manufacturing processes and Air Vehicle technologies, in preparation to the concept review and first technology down selection, were provided. Within the WP2.1.1, the following main technical activities were performed: (AG2) definition of outer WB structural lay-out and development of automatic design procedures and dedicated fast tools for rapid design and trade-off studies of the wing box; (FNM-VEL) completion of the liquid resin infusion process preliminary test trials on wing panels to validate manufacturing process simulation method; SHM damage scenario was selected and definition of the SHM strategy was completed (AG2 and FNM-VEL), preliminary specifications for hardware and software parts of the SHM system are in progress (AG2); composite technologies materials and process selection in progress for eco compatibles technologies (FNM-VEL).

For the wing technologies activities (WP 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.6) the following technical activities were performed (AG2): morphing concepts (winglet, droop nose and flap) and load alleviation system (wing tip) design 1st and 2nd loops; NLF wing and high lift devices aero design 1st and 2nd loops; plasma synthetic jets characterisation; riblets design for wind tunnel tests; morphing concepts and LC&A actuation and control system architecture design in progress. Preparation of benchmark CAE models for next phases technology assessments at A/C level has been completed (FNM-VEL).

The planned milestone M2.1-02 “liquid resin infusion test trials” (FNM-VEL) was achieved on-schedule and the related deliverable D2.1-05 was issued. The planned milestone M2.1-03 “Adaptive Wing Concepts – Technology First Down Selection contributions” (AG2) was achieved on-schedule and the related deliverables D2.1-06 (winglet concept) and D2.1-07 (wing tip concept) were issued. The deviations from the initial plan for WP2.1 were the following: Deliverable D2.1-04 (AG2) “Operational requirements for the integrated design platform wing” was shifted from late 2016 to early 2017; wing technologies concepts Review session was re-planned from end 2016 to early 2017.

- **WP 2.2 Regional Avionics**

In 2016 the only active WP was the WP2.2.3 “Performance and Health Monitoring”, dealing with the feasibility study for a regional integrated vehicle health management system (IVHM). Main activities performed by FNM-VEL with contributions from ASTIB dealt with: Definition of EMA contribution to IVHM in coordination with POLITO (ASTIB) in order to define the information/ data coming from EMA technology applied to Landing Gear and FCS; completion of high level preliminary IVHM operational scenarios, focusing on IVHM member systems pursued in CS2 REG (Structures – SHM operational scenarios; FCS and landing gear – EMA operational scenarios); definition of IVHM functional requirements with a specific focus for member systems, definition of IVHM architecture. There were no deviations with respect to the planning.

- **WP 2.3 Energy Optimized Regional Aircraft**

For all the on-board systems enabling technologies under development within WP2.3, preliminary verification and validation plans (technological roadmaps) as well as preliminary systems

requirements were defined during 2016. Relevant associated deliverable D-2.3-01 and milestone M-2.3-01 were issued/ achieved. More in details, the major 2016 achievements are listed below:

- Wing Ice Protection System (WP 2.3.1): issuing of trade-off document for existing enabling technologies and preparation of CfP topic for development of WIPS demonstrator to be tested in ice wind tunnel.
- Electrical Landing Gear (WP 2.3.2): preparation of Electrical Landing Gear System design document, as well as EMA's and ECU's specification, opening the system PDR phase in Dec. 2016.
- Thermal Management (WP 2.3.3): issuing of thermal aircraft architecture and technology selection document, as well as preliminary Verification & Validation Plan.
- Advanced EPGDS (WP 2.3.4): starting of ASPIRE project (Sep. 2016) relevant to Smart Grid Network conversion technology to be validated on Iron Bird ground demonstrator.
- Electrical ECS (WP 2.3.5): Preparation of E-ECS state of the art technologies and E-ECS technology bricks including assessment of TRL and roadmaps by Liebherr, based on FNM-VEL requirements inputs.
- Innovative Propeller (WP 2.3.6): Milestone M2.3.6-01 "Design Review" with a preliminary presentation of propeller design tools and process has been performed by the IRON consortium.
- WP 2.4 Innovative FCS

Preliminary FCS architecture and Winglet/Wingtip EMA preliminary requirements were defined. ASTIB consortium issued deliverable D-2.4-02 "Review of EMA technology Roadmap" and started Prognostic Health Monitoring (PHM) activities issuing the deliverable D-2.4-01 "Review of technology Roadmap for EMA Health Monitoring"; then, this first part of PHM activity was finalized with the issue of the output "Feature identification for EMAs Health Monitoring". Support to AG2 in trade off studies in order to define installation requirement for Winglet/Wingtip EMAs was provided. Negotiation phase with TAIRA Partner (selected for the topic related to Aileron Actuation Subsystem) was concluded.

- **WP 2.4 Innovative FCS**

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WP3 - Demonstrations

Main activities performed by Leonardo-Aircraft Division during 2016 are described hereafter for WPs 3.1 to 3.4. Activities performed by AG2 in WP3.1 and ASTIB in WP 3.4 are also included in this description. Then, the description of activities performed by Airbus DS and EWIRA within WP3.5 is provided.

- **WP 3.1 Flying Test Bed #1 (FTB1)**

The Flight Demonstration Program and the preliminary Flight test requirements were defined. Progresses regarding the specification and activities for the selection of the A/C as FTB#1 for the experimental demonstration in flight were achieved. The upgrade definition of the wing conceptual structural design was performed. The following deliverables have been completed: D3.1.1-01: Demo

A/C Flight Test Requirements - Work Plan; D3.1.1-02: Wing structural concept design upgrade document.

- **WP 3.2 Full Scale Fuselage and Pax Cabin Demonstrator**

The preliminary requirements for Fuselage demonstrator architecture by design and stress, installation and electrical design, noise, vibration and interiors design, manufacturing and structural laboratory departments were defined. Main outcomes from regional fuselage barrel cost a weight trades were assessed. Fuselage demonstrator preliminary conceptual structural design was completed and conceptual structural design started.

Deliverable D3.2.1-01 "Fuselage demonstrator preliminary requirements and conceptual structural design" was issued.

- **WP 3.4 Iron Bird**

The task related to "Iron Bird Definition was completed. The preliminary detailed HW&SW design was defined in terms of mechanical and electrical architecture and of its main components, physical constraints for the iron bird, qualification requirements, flight control surfaces to be reproduced and integrated, functions and operation defining the goals and the configuration under test, simplified aircraft model(s) real-time flight condition simulation. The above topics were assessed in the "Electrical & Mechanical preliminary Design review" held on October 2016.
All targets scheduled in the GAM 2016-2017 were achieved. All synthesized from the issuance of the deliverable (D3.4.2-01 "Iron Bird Electrical & Mechanical preliminary design review report") and the achievement of the milestone (M3.4.2-01 "Iron Bird Preliminary Architecture - Electrical & Mechanical"). Therefore, the closure of the task T3.4.2-01 "Iron Bird HW & SW Overall Preliminary Design" was reached as planned.

- **WP 3.5 Integrated Technologies Demonstrator – Flying Test Bed 2 (FTB2)**

Main activities performed by Airbus DS during 2016, and by EWIRA during the second half of the year, are described hereafter.

Regarding Airbus DS activities within this Work Package, two principal milestones were targeted in 2016: the Feasibility Design Review, achieved in March 2016, and the Preliminary Design Review, that has been slightly delayed until February 2017 due to technology maturation issues and Core Partner contributions.

The activities related to the technologies applicable to Demonstrator Flyting Test Bed 2 (FTB2) during 2016 can be grouped in three sets:

- Definition of Airbus DS (CASA) REGIONAL aircraft concept and evaluation of technologies proposed in CS2.

Airbus DS has worked in REGIONAL IADP in the definition of the Regional aircraft concept for the future using technologies covering an aircraft family of Regional Airliner and Regional Multimission. These studies are inputs to the Technology Evaluator ITD in Clean Sky 2.

- Overall Aircraft Design Activities related to technologies applicable to FTB2 Demonstration

The definition of the aerodynamic performance of morphing winglets, multifunctional flaps, ailerons and spoilers has been done during 2016 using analytical and numerical tools. Two Partners (ReLoad and POLITE) have joined the project and their contribution will be in the experimental validation of aerodynamic concepts in forthcoming wind tunnel test campaigns. The affordable Flight by Wire (FCS) architecture is proposed and first analyses of control and handling qualities are on course

(D3.5.2-11 MLA and GLA Implementation Analysis, expected by the end of January 2017)

- Integration of concepts applicable to FTB2 demonstrator: structural, manufacturing and assembly technologies.

Technologies associated to the integration of aileron and spoiler concepts in Regional FTB2 have been addressed in cooperation between Airbus DS and the new Core Partner EWIRA: (D3.5.1-14: Aileron integration and outer external wing box trailing edge PDR Structural Design and Installations and D3.5.1-15: Spoiler integration and inner external wing trailing edge PDR Structural Design and Installations Report).

EWIRA activity was focused on the innovation activity definition and test planning as well as in making progress in the aileron and spoiler components design development:

- Innovation activity: Most effort was related with the test definition in order to fulfil the requirements needed for the PtF, and at the same time keep most of the innovative content that was intended to test (especially in the ALM and Co-bonding innovative areas). It has been established a close collaboration with Airbus DS and airworthiness specialists to better deal with this topic. Initial and preliminary tests have been carried out in order to evaluate technologies capabilities. In the new assembly technologies chapter, a Jig-Less concept dummy has been completed and first validation tests already carried out.
- FTB2 Components Development: Main goals in the year were FDR and PDR milestones. FDR was passed in the year and the associated D3.5.1-46 completed. Progress is been done in the PDR documentation D3.5.1-47 which is intended to be completed by January 2017.

WP4 - Technologies Development & Demonstration Results

- **WP4.1 - Technology Assessment**

- Contribution to the preparatory phase of TE, in terms of agreement on integrated planning and of detailed information flow between R-IADP and the TE;
- Participation to the Workshops organized by the TE and to meetings on TE Governance organized by JU;
- Participation to the first TE Coordination Committee.

- **WP4.2 – Eco Design Assessment**

- Interactions with Fraunhofer to discuss in details the interfaces of REG IADP with the ECO TA;
- A strategy paper related to the activities with eco-design content in REG and interface with ECO TA was prepared;
- Contribution and participation assured for the first ECO TA Coordination Committee.

2016 Key deliverables

ID	TITLE	DUE DATE	STATUS
D0.1-2016	Amendment of GAM 2016-2017 Annexes 1,2 for Inclusion of Core Partners Wave 2	May-16	Issued
D0.2-2016	Final Inputs for Work Plan 2017-2018	Nov-16	Issued
D0.3-2016	Annual Report 2015	Mar-16	Issued

ID	TITLE	DUE DATE	STATUS
D0-5-2016	REG IADP Dissemination and Exploitation Management Plan	Dec-16	Issued
D1.1.1-18	Aerodynamic dataset for the innovative initial configuration -- Loop 1	Nov-16	Re-scheduled by end of Jan 17
D1.1.1-19	Performance for the innovative initial configuration -- Loop 1	Nov-16	Re-scheduled Q1 2017
D1.3.1-01	Definition of technologies targets for the conventional initial configuration -- Loop 1	Oct-16	Issued
D2.1-05	Manufacturing of test trilas realized with resin liquid infusion process to be applied to outer wing stiffened panels	Dec-16	Issued
D2.1-06	Morphing WL architecture and conceptual design	Dec-16	Issued
D2.1-07	Innovative Wing Tip conceptual design	Dec-16	Issued
D2.2.3-2	Collection of IVHM functional requirements, incl. P/HM function	Jun-16	Issued
D2.3-01	Collection of on-board system technologies preliminary verification and validation plan for Regional A/C	Dec-16	Issued
D2.4-01	Review of technologies road map for EMA PHM	Apr-16	Issued
D2.4-02	Preliminary Specification for Winglet/Wingtip EMA	Dec-16	Re-scheduled Q1-2017
D3.1.1-02	Wing structural concept design upgrade document	Dec-16	Issued
D3.2.1-01	Fuselage demonstrator preliminary requirement and conceptual structural design	Sept-16	Issued
D3.4.2-01	Iron Bird Electrical and Mechanical preliminary design review report (ASTIB-CERTIA)	Oct-16	Issued
D3.5.1-46	Technical documentation supporting FDR for Inner External Wingbox, Aileron, Spoiler	Jul-16	Issued
D3.5.1-47	Technical documentation supporting PDR for Inner External Wingbox, Aileron, Spoiler	Oct-16	Re-scheduled Jan 17
D3.5.3-11	MLA and GLA Analysis	Dec-16	Re-scheduled Jan 17
D3.5.4-13	CAD Methods and interchange for FTB#2 Design	Jun-16	Issued
D3.5.1-20	System Safety Assessment of Regional FTB#2	Jun-16	Issued

2016 Key milestones

ID	TITLE	DUE DATE	STATUS
M0.1-2016	Launch Review with AG2 and ASTIB	Jan-16	Achieved
M0.2-2016	Launch Review with CPW02 for FTB#2	Apr-16	Achieved
M0.3-2016	Annual Review	Jun-16	Achieved
M1.2.1-01	TLARs for the conventional initial platform -- Loop 1 (linked to D1.2.1-02 / D1.2.1-04)	May-16	Achieved

ID	TITLE	DUE DATE	STATUS
M1.3.1-01	Definition of technologies targets for the conventional initial configuration -- Loop 1	Oct-16	Achieved
M2.1-2	Liquid resin infusion test trials (linked with the emission of D2.1.05)	Dec-16	Achieved
M2.1-3	Adaptive Wing Concepts - Technology First Down Selection contributions	Dec-16	Achieved
M2.3-01	Collection of available on-board systems preliminary specification/requirements	Dec-16	Achieved
M3.4.2-01	Iron Bird Preliminary Architecture (Electrical and Mechanical)	Oct-16	Achieved
M3.5-03	FDR for Inner External Wingbox, Aileron, Spoiler	Jul-16	Achieved
M3.5-04	PDR for Inner External Wingbox, Aileron, Spoiler	Oct-16	Re-scheduled Jan 2017
M3.5.4-01	Regional FTB2 PDR	Nov-16	Re-scheduled Feb 2017

→ FRC – Fast Rotorcraft IADP

General Scope

The Fast Rotorcraft consists of two separate demonstrators, the NextGenCTR tiltrotor (leader: Leonardo Helicopters) and the LifeRCraft compound helicopter (leader: Airbus Helicopters). These two fast rotorcraft concepts aim to deliver superior vehicle productivity and performance, and through this economic advantage to users.

The NextGenCTR is dedicated to design, build and fly innovative next generation civil tiltrotor technologies on a flying demonstrator, the configuration of which will go beyond current architectures of this type of aircraft. This tiltrotor concept will involve tilting proprotors mounted in fixed nacelles at the tips of relatively short wings. These wings will have a fixed inboard portion and a tilting outboard portion next to the nacelle. The tilting portion will move in coordination with the proprotors, to minimize rotor downwash impingement in hover and increase efficiency. Demonstration activities will aim at validating the architecture, technologies/systems and operational concepts. They will show significant improvement with respect to current Tiltrotors. The NextGenCTR project will continue to develop some technologies initiated in the Green Rotorcraft ITD in Clean Sky. New specific activities will also be launched in Clean Sky 2 in particular concerning drag reduction of the proprotor, airframe fuselage and wing. In Clean Sky, noise reduction is mainly addressed through the optimisation of flight trajectories. In Clean Sky 2 transversal subjects will cover new research areas, validating them at full scale and in real operational conditions.

The LifeRCraft project aims at demonstrating the compound rotorcraft configuration, implementing and combining cutting-edge technologies from the ending Clean Sky programme, and opening up new mobility roles that neither conventional helicopters nor fixed wing aircraft can currently cover. The compound concept will involve the use of forward propulsion through lateral rotors mounted on short wings, complementing the main rotor which provides vertical lift and hovering capability. A large scale flightworthy demonstrator, embodying the new European compound rotorcraft architecture, will be designed, integrated and flight tested. This demonstrator will allow reaching the TRL 6 at full-aircraft level in 2020. The individual technologies of the Clean Sky Programme (Green Rotorcraft, Systems for Green Operations and Eco-Design ITDs) aiming at reducing gas emission, noise impact and promoting a greener life cycle will be further matured and integrated in this LifeRCraft demonstration.

Major Achievements

WP 0: Consortium Management.

The FRC consortium management task was assured by Airbus Helicopters during the initial period of 2016, with responsibility passing to Leonardo Helicopters at the end of June. The main activities were;

- The completion and agreement of the 2016/2017 GAM;
- Generation of the 2015 period technical report, quarterly reports and mid-year assessment report.
- Preparing and organizing the first Annual Review and two Steering Committee meetings;
- Managing the finances of the consortium;
- Input to the CS2DP;
- On-going support to the overall JU management activity.

WP1 – NextGenCTR - Next Generation Civil Tiltrotor Demonstrator

Main WP1 achievements in 2016:

- Completion of the planned SRR
- D1.1: Preliminary Design Requirements and Objectives completed
- D1.3: Vehicle Technical Specification_1 (VTS_1)
- Revised plan to address Annual Review recommendations

WP1.1 – NGCTR Management and Coordination

A positive Annual Review was held in April covering the initial eighteen months (2014/2015) vehicle definition period of the programme and the future activities for the overall eight year duration. The open approach allowed good interaction and feedback from the technical review team. As a result it was concluded that tight schedule and initial difficulties securing partnerships, when associated to the ambition of the initially proposed design, required more focused delivery to ensure the key objectives are achieved. Recommendations were made to prioritise key new technologies essential for successful achievement of the demonstrator. Complementary new technologies providing side benefits to the programme but presenting a risk of readiness for first flight could be introduced at a later date, substituting initial off the shelf solutions.

The NGCTR Management team addressed these recommendations by a detailed review of the programme and alternative approaches to achieve its key objectives. At an interim review in July with the JU and technical experts, a proposal to concentrate on a reduced number of technologies demonstrating on an existing product the essence of the proposed vehicle and system architectures was made and agreed in principle. This was further developed with a revised plan and schedule presented and accepted at the formal interim review held in November.

WP 1.2 - Air Vehicle Design and Development

The SRR for the original scope was achieved in January (M1.1), but concentration on the programme review and revision delayed achievement of formal milestones relating to contracting CfP02 and CfP03 Partners (M1.2/M1.5). This will now happen in early 2017. Revision to the schedule and use of an existing product will necessitate confirmation of the original SRR maturity in early 2017 with a System Functional Review (M1.3) later in the year.

There were some failures against NGCTR Call topics assessed in 2016, notably that for two sections of fuselage under the Airframe ITD. Negotiation with successful bidders was undertaken that will lead to GAP initiation in early 2017. Call fiches for CfP06 and CWP04 were written and submitted, with particular emphasis on the Core Partner call for supply of a NGCTR-TD Wing that is essential to achieve the required level of partner participation.

WP1.3 – Aircraft Final assembly

Activity during 2016 was limited to Industrial Engineering input into design and trade-off studies.

WP1.4 - Aircraft Test and Demonstration

There was no activity associated with WP1.4 during 2016

WP2 – LifeRCraft - Compound Rotorcraft Demonstrator

Main WP2 achievements in 2016:

PDVR for all aircraft system and helicopter PVDR have been successfully passed in 2016.

All Core Partners are now on-board. Most of the partner contributing to build the demonstrator have started to work or are identified. Topic descriptions for Call for partner n°6 have been prepared: it includes mainly:

- Lateral rotor noise prediction
- Emergency exists and foot steps

- Lateral rotor declutching
- Fuel system detail development
- Assembly tooling
- Flight tests instrumentation

ROMAERO is now part of the RoRCraft consortium (Leader INCAS), replacing IAR Brasov to manufacture LifeRCraft fuselage. New Core Partners consortia from CPW03 are the following:

- ANGELA: design, manufacturing and testing of LifeRCraft Landing Gear. Leader CIRA;
- ARTEMIS: design, manufacturing and testing of LifeRCraft Main Gear Box. Leader GE Avio.
- COSTAR: design, manufacturing and testing of LifeRCraft actuators. Leader PROTOM;
- EFFAR: design, manufacturing and testing of LifeRCraft electrical harness. Leader LATELEC.

Negotiations with incoming Core Partners lead to a partial redefinition of Leader's tasks. This redefinition, combined with technical hard points which emerged during work performed by Leader's team, led to delays in the freezing of interfaces. Most preliminary design reviews initially planned in 2016 should be achieved in 2017, except Aerodynamics. This leads to a first flight mid-2020, instead of in 2019.

Updated planning was shown during FRC Interim Progress Review.

WP 2A - LifeRCraft Flight Demonstrator Integration

- As mentioned, after completion of the last wind-tunnel tests, Aerodynamics and Performances Preliminary Design Review was successfully achieved mid-2016. LifeRCraft aerodynamic configuration is frozen.
- Analysis and piloted simulation have been conducted in order to define the rotor speed law, flap laws and lateral control laws.
- Estimation of the aerodynamic loads has been done in order to start the sizing of aircraft components.
- A scale 1 lateral rotor has been tests without and with the wing in order to validate the performances and perform noise measurements for comparison with NACOR (ITD AIR) estimations.
- The Main rotor forecast the demonstrator has been tested in flight in order to calibrate rotor numerical model and to define the best tuning of rotor blades.
- Architecture activity has been continued in order to define the installation of the all system to be integrated and to define the interface concept between each components of the aircraft. Digital mock-up of the project is permanently updated to implement the data coming from the Core-partners and the partners and solve the identified interference problems.
- "Extended enterprise" network has been implemented and is working with all FRC Core-Partners part of the project in early 2016.

WP 2B - LifeRCraft Airframe Integration

- Main activity in 2016 was to define the main interfaces with the fuselage and to prepare the activity of the partner to be involved in this WP.
- Start of the activity of the partner in charge of the doors: following some difficulties encountered by the partner, it has been decided to redefine the scope of its activity and to prepare an additional topic within the Call n°6.
- Negotiation with the partner selected for the canopy have started, but unfortunately failed.

WP 2B.2: Airframe Structure

In the frame of "Rotorcraft Fuselage Manufacturing for LifeRCraft Demonstrator" Project (RoRCraft) (WP 2B2.5), Romanian Cluster (RoC) had the following achievements in 2016:

- The design of the Fuselage Structure made important steps from PDVR toward the final shape, due to the intense collaboration between RoC, AHD and AH. RoC design responds to the Fuselage Specification requirements and takes in account the current existing interfaces.
- RoC successfully succeeded to transfer 100% of the Plateau design activities in its own facilities in Romania. The established communication means for transferring information between partners are currently used at full capacity.
- The important materials for the Fuselage manufacturing was choose and approved by AHD. This achievement leads to another important accomplished objective: weight and CG measurement and tracking.
- RoC developed and tested its own software tool for weight and CG measurement, based on VPM Fuselage Structure definition. We are now able to track the weight evolution and to take corrective actions by discovering very exactly (up to the part level) the problematic areas.
- The building philosophy task was started, having a very good image of how the Fuselage parts will be assembled together. The assembly procedure is updated in parallel with the evolution of interfaces and structure design.
- RoC succeeded to integrate a powerful core of design and stress engineers that are currently working on the allocated areas of the Fuselage structure.

WB 2B.3 Landing Gear System

The project Angela started on 1 December 2016. During 2016 the following achievements have been reached:

- Kick Off meeting.
- L/G Requirements analysis.
- L/G Risk opportunity analysis.
- L/G Development Plan.
- Final scheduling.

In addition, the L/G conceptual studies started and the preliminary DMUs were prepared in order to verify the interfaces with the LifeRcraft airframe.

- The project is in line with the final scheduling
- Milestone achieved 15/12/2016 KoM;
- Deliverables prepared: DNR1.1: Kick off Meeting Synthesis
- No deviation is expected for the next steps.

- **WP 2B.11: Cabin & Mission Equipment**

Cabin configuration has been validated in a scale mock-up in accordance with the reference missions.

Mission equipment's necessary to perform reference mission have been identified.

<u>WP 2C - LifeRCraft Dynamic Assembly Integration</u>

WP 2C.4: Lifting rotor

Rotor head fairing has been studied on the basis of the selected rotor head.

Configuration of the main rotor actuators and dynamic suspension configuration has been frozen.

WP 2C.5: Lateral rotor

Work started with the lateral rotor supplier (MT Propeller) to design the rotors and their actuation system.

Scale 1 rotor has been tested in wind-tunnel.

WP 2C.6: Mechanical Drive

Pre-design of MGB has been continued in order to define the volume and the interfaces to prepare the co-development activity with ARTEMIS (Avio Aero).Definition of interface with lateral gearboxes has continued with Avio Aero (Mobility Discovery). After selection of the partner to develop the MGB tests rig adaptation, the negotiation with MUTR consortium (VZLU leader) has been completed and the specification of the rig has been prepared.

Regarding Avio Aero activities, during 2016 the following main activities have been performed:

- Analysis and discussion of Lateral Gearbox (LGB) technical requirements
- Trade-off analysis (mechanical layout, weight, material)
- Interface definition (preliminary, for critical interfaces)
- Launch of HSIS (High Speed Inlet Stage) concept design
- Support to the launch of system integration
- Launch of material database improvement activity
- Launch of the development of an improved SW to optimize grinding and cutting parameters for spiral bevel gears.
- Launch of a LGB weight reduction campaign.
- Launch and execution of collaborative contract with PoliTo University in support of technology maturation.
- Support to Consortium Review and Meeting, weekly call with leader.
- Various AH / AA team co-location to ensure a consistent system development aligned with leader progress and objectives.

As result, main 2016 achievements can be summarized as follows:

- Lateral Gearbox concept design finalisation
- Definition of a preliminary BoM
- Definition of technology maturation plan
- Definition of actions aimed to decrease the system weight, to be further assessed and implemented in 2017

WP 2C.7 Power Plant

- Engine has been selected and contract with engine manufacturer has been negotiated.
- Preliminary design of engine integration has started and engine air inlet design has been optimized thanks CFD studies.
- Negotiation with the partner to be in charge of the engine compartment has been done and detail requirement for him has been prepared.

WP 2C.9 Actuation System

The definition of the architecture of the flight control actuation has been done and the specification of the actuators to be developed by the Core-partner (selected within the CWP03) prepared.

The negotiation with the Core-partner has been concluded.

In the frame of the topic “Innovative Actuators for Compound Rotorcraft Flight Control”, the COSTAR Consortium shall:

- Design, develop, manufacture, test, and qualify up to flight clearance, EMAs to implement the automatic control for the primary and secondary flight controls of the compound rotorcraft.

The purpose of these smart actuators is to allow the interface with the Automatic Flight Control Computers of the rotorcraft;

- Design, develop, manufacture, test and qualify EMA for the main rotor actuation chain by means of the Automatic Flight Control Computers.

The major achievements in 2016 are as follows:

- Pre- KOM held on 21 and 22 September
- Official starting of the COSTAR Project on 1 December 2016
- KOM arranged on 15 December Issue for AH WAL acceptance of the COSTAR deliverables:
  - TRL 4 Declaration
  - Risk Assessment and Mitigation plan
  - Weight Report

The activities performed on the first month of the project by the COSTAR Consortium are summarized as follows:

- The harmonisation of the procedures between Protom and Triumph (partners of the COSTAR consortium) and Airbus Helicopters.
- The preliminary design of the Flap actuators to anticipate as much as possible the issue of reliable CAD models of this type of actuators to put AH in position to perform the preliminary installation studies.

The Flap actuators requirement assessment activity, started with the issue of the preliminary specification of the actuators and currently in progress to capture all the requirements defined by the specification.

WP 2D - LifeRCraft On-board Systems Integration

WP 2D.8 Electrical system

Detailed work with the partners selected for the HVDC system has started: specifications and definition of interfaces. The installation of the electrical equipment's, the definition of the electrical harness architecture and the harness routing has started. The negotiation with the Core Partner (selected in the CPW03) who will be in charge of the harness development was finalised.

WP 2D.10 Avionics and sensors

Selection of the architecture of the avionics and display using of the shelf components and integration of the avionics has started.

WP 2D.12 Flight control, guidance and navigation

Flight control preliminary definition according to the requirements in term of control laws particularly for the lateral rotors. Preparation of the topic description for the Flight Management system, the partner has been selected within the CfP04.

WP3 - Eco-Design Concept Implementation for Fast Rotorcraft

The activities, still in progress, allowed liaising with Fraunhofer, so as to have a better understanding of ECO-TA expectations. FRC Leaders agreed an Eco-Design Strategy Paper for FRC. As ECO-TA scope is very wide, consensus in FRC is to address Eco-Design activities in a very applied and practical manner to a few test-cases around each demonstrator. We presented this approach to ECO-TA.

WP4 - Technology Evaluator Interface for Fast Rotorcraft

The FRC consortium supported the JU and TE coordinator with the establishment of a dedicated Consortium Committee aimed at coordinating TE aspects across all ITD/IADPs. In addition, the FRC consortium supported the TE coordinator by review and comment against specific TE calls released

under CfP05 aimed at; a) Airport and Air Transport System (ATS) impact assessments for fast rotorcraft application comprising of simulation related to fast rotorcraft fleet and traffic scenarios at airport/heliport, city and world regions for various missions, b) performing a forecast for all types of rotorcraft fleet and movements starting from 2015, passing by 2020/2025/2030 until 2035 with detail per type of mission at country/region/world levels.
Revisions to initial plans for both FRC demonstrators has meant that the definition of schedule and preparations for applicable scenarios for the Technology Evaluations were unable to start in 2016 (M4.1/M4.2).

→ AIR – Airframe ITD

The Airframe ITD targets significant gains in the following areas:

- Introducing innovative/ disruptive configurations enabling a step-change in terms of efficiency,
- Developing more efficient wings,
- Developing fuselages with optimized usage of volume and minimized weight, cost and environmental impact,
- Developing an enhanced technology base in a transverse approach towards airframe efficiency to feed the demonstrators on synergetic domains (e.g.: Efficient wing technologies, hybrid laminar flow technologies, new production and recycling techniques).

Due to the large scope of technologies undertaken by the Airframe ITD, addressing the full range of aeronautical portfolio (large passenger aircraft, regional aircraft, rotorcraft, business jet and small transport aircraft), the ITD is structured around two major Activity Lines:

- Activity Line HPE: Demonstration of airframe technologies focused toward high performance and energy efficiency. Related technology streams are noted “A” hereafter.
- Activity Line HVC: Demonstration of airframe technologies focused toward high versatility and cost efficiency. Related technology streams are noted “B” hereafter.

Activity Line A: High Performance & Energy Efficiency

Technology Stream A-0: Management and interface

On WP A-0.1 (Overall Management): the main activity was the general management of the HPE project and the support to CASA for the coordination of the ITD and for the transversal activity e.g. to support focused work on partner projects (DAv, SAAB).

In WP A-0.2, DAv participated to workshops dedicated to the selection of new aircraft concepts to be studied through the NACOR project. The design of a first aircraft project with use of innovative technologies has been initiated (DAv).

In WP A-0.4: the link between AIRFRAME and the ECO TA T0.1 transversal synthesis has been clarified. A support has been delivered to Eco-Design activities performed in HPE and especially in WP A-3.4, for which this work package represents a synergetic complement (FhG).

Technology Stream A-1: Innovative Aircraft Architecture

On WP A-1.1 (Optimal engine integration on rear fuselage) a first list of concept candidates was established. Two reference aircraft configurations were considered: one BJ (LSBJ 2000) and one transport. The disruptive configurations have been chosen from the down-selection process. The redesign of the reference aircraft configurations has been initiated using an OAD approach (NACOR – ONERA & DLR).

On WP A-1.2 (UHBR and CROR configuration) the activity was focused on the contribution to the TRL3 happening in LPA, Platform 1, WP 1.5.2 with further maturation of enabling technologies up to pre-TRL3.

On WP A-1.3 (Novel High Speed Configuration), in parallel to WP A-1.1, a first selection of innovative aircraft concepts has been defined be chosen from the down-selection process based upon workshops with AI, DAv, DLR & ONERA experts. The redesign of the reference aircraft configurations has been initiated using an OAD approach (NACOR – ONERA & DLR).

On WP A-1.4 (Virtual Modelling for Certification) the activity has been focused on three modelling topics. A state-of-the-art has been conducted on the "criteria for rapid dynamic" and on the "safety of composite fuel tank (lighting)" topics. A specification has been produced for a human thermal model to be integrated to the cabin modelling (DAv). Applicable modelling methods for the simulation of thermal aircraft architectures were described and compared with respect to their scales in time and space as well as their parameter identification procedures (FhG).

Technology Stream A-2: Advanced Laminarity

On WP A-2.1 (Laminar nacelle) the design and validation of a structural concept of laminar nacelle for BJ has been carried out with the partner Safran Nacelles of the CfP01 BALANCE project. A BJ nacelle aeroshape has been provided by DAv (DAv, NACOR – ONERA & DLR).

On WP A-2.2 (NLF smart integrated wing), in complement to Clean Sky 1 SFWA-ITD the WP contributed to the in-flight BLADE demonstration now planned by September 2017 (AIB). In addition, the on-going NLF concept development continued in synergy with preparation of BLADE (SAAB). In the frame of NACOR, research activities on NLF wings including validation of structural concept was carried out (NACOR – ONERA & DLR).

WP A-2.3 Extended laminarity: DAv will develop an innovative HLFC concept applied to a vertical tail plane, design innovative NLF front fuselage (including the parasitic drag reduction) and improve transition criteria in transonic conditions (DAv). In the frame of NACOR, a first computation of BJ fuselage nose section proved by DAv has been performed (DAv, ON). The development of HLFC concept continued (DLR) and technologies to fill gap on the wing were investigated (FhG).

Technology Stream A-3: **High Speed Aircraft**

On WP A-3.1 (Multidisciplinary wing): preliminary architecture studies of the BJ Wing root box demonstrator continued on 2016. Design loads were elaborated to size the demonstrator (DAv). The design for the Aileron Rib-concept started on 2016 and continues on 2017 (SAAB).

On WP A-3.2 (Tailored front fuselage), a topic related to laminated and panoramic BJ cabin windows failed in CfP03. A topic on "bigger cockpit windshields with trade-off between "plugged" design and "load-bearing" design" has been prepared for CfP06 (DAv).

On WP A-3.3 (Innovative shape & structure), BJ composite central wing box demonstrator continued and a panel demonstrator was manufactured (DAv). The work on the design concept for an innovative aircraft door structure and its integration continued (SAAB).

On WP A-3.4 (Eco-Design for airframe), the ecoTECH project from CPW02 was fully integrated to the WP activities. The scoping of new technologies started for the selection of the most promising candidates for development (ecoTECH, DAv, FhG). Re-use of Thermoplastics activities started on supporting the development of new processes, methods, manufacturing & recycling technologies in the RESET project (AIB).

Technology Stream A-4: Novel Control

On **WP A-4.1** (Smart Mobile Control Surfaces), activity of the Electrical Ice Protection Systems on a BJ slat was carried out (GAINS, DAv). For innovative movables, the topic issued for CPW03 led to the selection of the MANTA project for a start of activity end of 2016 (AIB, SAAB, DAv).
On **WP A-4.2** (Active load control), the development of control law for gust load alleviation and flutter control functions was initiated (DAv). In addition, load control by various means for wing application was studied for LPA application (AIB). In the frame of NACOR, activities were addressed on vibration control, flight control, gust load control and flutter control (ON, DLR).

Technology Stream A-5: Novel Travel Experience

On **WP A-5.1** (Ergonomic Flexible Cabin), a study of a PRM lavatory has been carried out. For the immersive cabin services, the project on "Technology evaluation of immersive technologies for in-flight applications" has been integrated (AIB)**.**
On **WP A-5.2** (Office Centred Cabin), the activity was focused on the integration of the project CASTLE from CPW02 for the BJ cabin application. An aircraft level specification is to be delivered beginning of 2017 (DAv).

Activity Line B: High Versatility and Cost Efficiency

Technology Stream B-0: Management & Interface

On WP B-0.1 (Overall Management), general and transversal management activities and coordination of the ITD has been carried out (CASA - Airbus Defence and Space S.A.U.) On WP B-0.2 (SAT OAD & Config. Mgt), the planned activities have been moved into GAM SAT (EVE, PAI). On WP B-0.3 (Rotorcraft OAD & Config. Mgt), coordination between FRC and AIRFRAME has been done, as well as the follow-on of Partner project dealing with LifeRCraft doors calls (AH-D, AH-E, FNM-HD). On WP B-0.4 (Regional OAD & Config. Mgt), management and coordination activities related with the interdependencies between REG IADP and AIR ITD have been performed (CASA, FNM-VEL). On WP B-0.5 (Eco-Design TA Link): the work package aims at coordinating and ensuring within the ITD Airframe B data provision to the eco-design. Transverse Activity for Eco Design Assessment has been performed (FhG).

Technology Stream B-1: Next generation optimized wing

On WP B-1.1 (Wing for lift & incremental mission shaft integration), the design of a compound rotorcraft, in close cooperation with the FR-IADP LifeRCraft demonstrator has been carried out. Noise emission 1st evaluations have been done by March 2016. Pre Design Review schedule decision has been taken end of 2016, with the LifeRCraft team. Design works for the wings and lateral rotors continued (NACOR). Final studies and development prior to the manufacturing of the full scale demonstrator has been performed (OUTCOME).

On WP B-1.2 (More affordable composite structures), trade-off of multiple conceptual designs for small aircraft has progressed in order to define the selected architecture for the composite wing demonstrator. Finite Element Models for the different architectures were built. For Material and Processes, a down selection criterion has been defined. Screening based on most crucial parameters such as Tg, viscosity and toughness and other dominant criteria such as cost, toughness, experience has been completed. After down-selection of a limited number of materials, specimen manufacture

and specimen testing will be carried out to choose most favourable material systems for the wing demonstrator. In order to select the most appropriate technology for each structure, a weighted criteria table has been defined with dominant parameters such as labor costs, tooling costs, lay up speed, maturity, versatility, ecology and others. (PAI, OPTICOMS)

On WP B-1.3 (More efficient Wing technologies), morphing winglets concept has been developed and PDR has been held by end of 2016. The results are under analyses. Manufacturing tooling activities with Partner Selected in CfP03 has started (OUTCOME). Design requirements have been defined for the highly integrated actuation system to control surface tabs with EMAs (CASA).

On WP B-1.4 (Flow & shape control): development works of the Loads Alleviation and morphing leading edge in collaboration with FhG has been carried out (CASA).
Basic requirements of optimized droop nose device in a composite wing studied have been defined (FhG).

Basic studies in AFLoNext show that flow control at wing trailing edges is a powerful mean to improve the wing performance. Airbus supported, with industrial aspects, the work of the partner who focused on design concepts for space efficient flow control actuation architectures. (AIB)

Technology Stream B-2: Optimized high lift configurations

On WP B-2.1 (High wing / large Turboprop nacelle configuration), with respect to technology line of Integration of ice protection based on heat transport devices (Loop Heat pipes) into the engine air intake, work with the partner selected in CfP02 (PIPS) has started, KOM performed, and activities have been ramped up. System Specification and Top Level Requirements have been established (CASA).

On WP B-2.2 (High lift wing), the selected concept for wing box and multifunctional flap developed, in collaboration with OUTCOME that focused on the Hot Stamping process and the moulds employed, with the aim to achieve a PDR by end 2016 and final design during 2017. The activity to define the design requirements for the highly integrated actuation system to control Flaps with EMAs finished (CASA).

Technology Stream B-3: Advanced integrated structures

On WP B-3.1 (Advanced integration of system in nacelle), no significant activities have been performed as activities are planned to start in 2018 (FNM-VEL).
On WP B-3.2 (All electrical wing), the highly integrated actuation system based on EMAs to control aileron and spoiler finished the design requirements phase, with the target to start testing and integration phase at the end of 2017. The development of the selected integrated electrical distribution HVDC (High Voltage Direct Current) continued with the target to achieve a final design during 2017. In addition, for SATCOM and Ice protection both embedded in the structure, the design was concluded (CASA).

An innovative electro-thermal heating system based on Carbon Nano Tubes (CNT) has been further enhanced (first simulations and design concepts) regarding performance and process ability. CDR of the ice-protection system has been performed. For the network for power supply and information system for AFC a preliminary design review (PDR) has been carried out (FhG).

On WP B-3.3 (Advanced integrated cockpit), Structural Health Monitoring System (SHMS) started the

development phase, to reach a level of maturity for starting test and integration phase at the end of 2017. All activities linked with Core Partner PASSARO have been selected and ramp-up deployed (CASA).

Processes and materials developments oriented to LPA demonstrators have been reinforced with 3 Projects: NEODAMP "New Enhanced Acoustic Damping Composite Materials" for new enhanced composite material; NEWCORT "Novel Processes and Equipment in Composite Repair Technology" for new structural bonded repair of monolithic composite airframe; and SimCoDeq " Simulation tool development for a composite manufacturing process default prediction integrated into a quality control system" related to on line NDT (AIB).

Surveys on the simulation of different materials subjected to extreme conditions (including bird-strike and hail / debris impact and lightning strike) have been performed. In parallel, lightning strike test facilities and ice impact test facilities will be adapted to meet the requirements. Birdstrike analyses for LifeRCraft canopy, windshields and cowlings have been conducted (FhG).

On WP B-3.4 (More affordable small A/C manufacturing), the scope of joints metal-composite was optimized and pinpointed in 2016. Specimens will then be designed and tested to assess basic mechanical and electromagnetic behaviour of these joints. In WP B 3.4.3 first set of specimens was tested and based on reached results second batch for testing was prepared. Within 2017 a first demonstrator produced with developed technology will be finalized. Project SAT-AM (CPW2) started (EVE).

On WP B-3.6 (New materials and manufacturing), the activities dealing with technologies related to eco-efficient factories, assisted composite manufacturing, future leakage identification systems, integration of testing systems on iDMU and automated testing technologies ramp-up have been performed (CASA).

All-test coupons have been manufactured using ALM technology. Quality of manufacturing and the resulting material characteristics have been assessed. First numerical studies on structural optimisation during the manufacturing process are performed (FhG).

Technology Stream B-4: Advanced fuselage

On WP B-4.1 (Rotor-less Tail for Fast Rotorcraft), PDVR was held end of January and was successfully passed for the Rotorless Tail development with the participation of AH-E together its CP (engineering support) and with LifeRCraft team. The Preliminary Design phase has been extended as result of the updated schedule of the LifeRCraft, and therefore the PDR and its associated activities have been extended till Q2 2017. Detailed Design phase will be started and developed by AH-E and CP (OUTCOME) from Q2 2017and will finish during the following year 2018 with the CDR completion, KoM for OLFITT project (Prototype Manufacturing Tooling) has been held on 13rd December. Thus, Manufacturing tooling activities have been started (AH-E).

NACOR refined the design of the horizontal stabilizer and fins including flaps based on the activities started in 2015 (NACOR).

During 2016 activities related to support to AH-E with the studies about manufacturing processes and materials were carried out as well as the engineering concurrent activities in order to ensure the manufacturing feasibility of the Rotorless Tail Pre-Design (OUTCOME).
On WP B-4.2 (Pressurized Fuselage for Fast Rotorcraft): following the aircraft level system

requirement review (SRR) in early 2016 under the FRC IADP, FNM-HD were completing the requirements definition for the pressurized fuselage (front, centre and aft sections including empennage and empennage control surfaces) plus main cockpit glazing, cockpit secondary glazing, cabin glazing; aircraft doors and emergency exit. Negotiation with Core Partner selected in CPW3 for tail section fuselage started. (FNM-HD)

On WP B-4.3 (More affordable composite fuselage), Test matrix for Level 1 tests on specimens has been defined, main coupons and elements designed, tests on specimens in progress, 2 manufacturing trials realized and characterized, performance evaluation of eco-compatible surface treatments done (FNM-VEL).

Manufacturing trial is finalized for coupons made by different processes and materials, web-portal for SHERLOC project has been developed for public access, test plan for coupons finalized. HPC based platform architecture is defined. Selection of software and hardware for SHM technology and methodologies has been completed. Test plans for coupon and elements have been defined as well as maintenance strategy for a SHM enabled fuselage. 11 deliverables have been completed in 2016 (SHERLOC).

In the context of part distortion prediction activities, developments have been focused on topology optimisation accounting for distortion and shape and lay-up optimisation accounting for distortion. In the field of metallic component it was supported by a new project named DISTORTION "Design against distortion of metallic aerospace parts based on combination of numerical modelling activities and topology optimisation". In 2016, implementation of a call for proposals on composite component distortion prediction was supported (AIB).

On WP B-4.4 (Affordable low weight, human centred cabin), Human Centred Design Approach definition for related requirements and preliminary technologies has been completed. Preliminary description of technologies for green material development applicable to the cabin interiors major items including identification of most promising applications has been done, as well as definition of the Noise & Vibration requirements and Targets with description of the methodology to assess the results (FNM-VEL).

Main Airframe Deliverables

WP	TITLE	Submission date
D-A-1.1.1-17.1	Initial concept down selection of the integrated engine architecture	12/12/2016
D-A-1.3.1-18.1	Initial concept down selection of the novel a/c configuration	12/12/2016
D-A-2.1.1-17.1	NLF nacelle concept	30/06/2016
D-A-3.3-1.1	Conceptual study of the metallic door demonstrator	04/01/2016
D-A-3.3-1.2	BJ Composite Central Wing Box Panel Demonstrator CDR Report	21/04/2016
D-A-3.4-1.1	Definition of material characterisation for Eco-Design	14/06/2016
D-A-5.1.1-8.5	Demonstrator of 37" PRM Lavatory Module	31/03/2016
D-B-0.1-26	2016 IPR	28/11/2016
D-B-0.4-2	Specific a/c requirements General design affecting FNM-VEL AIRFRAME activities	14/07/2016
D-B-1.1.1-1	pre PDR Wing	29/02/2016
D-B-3.4.2-4	Report on loading of reference specimens	30/04/2016
D-B-4.3.3-1	Main coupons and elements drawings	29/11/2016

WP	TITLE	Submission date
D-B-4.3.6-1	Structural requirements for fuselage design	31/03/2016
D-B-4.4.1-01	Key Cabin Drivers for Passenger/Crew Comfort,	22/12/2015
D-B-4.4-1	HCDA Requirements Definition and related technologies	19/12/2016

Main Airframe Milestones

WP	TITLE	Submission date
M-A-1.1.1-17.1	First down selection of the integrated engine architecture	05/04/2016
M-A-1.3.1-18.1	First down selection of the novel a/c configuration	30/06/2016
M-A-1.2.1-4.5	UHBR enabling integration technologies TRL2	31/07/2016
M-A-2.2.1.1	Industrial requirements for NLF Wing Manufacturing	30/03/2016
M-A-3.3-1.2	BJ Composite central Wing Box Panel Demonstrator CDR	23/03/2016
M-A-4.1.1.5-20.2	Review of wave 1 Materials	06/07/2016
M-A-5.2.1.1-43.1	Presentation of methodology to define key cabin drivers and requirements definition for BJ	22/09/2016
M-B-0.1-3	2015 Annual Review	11/05/2016
M-B-1.1.1-1	PVDR Wing	27/01/2016
M.B-2.2.1.1-2	Feasibility Design Review	10/03/2016
M-B-4.3.6-1	Structural requirements for fuselage design	31/03/2016
M-B-3.2.4-1	FDR HVDC	08/03/2016
M-B-3.4.2-2	Decision on scope of contemporary specimen for testing	01/06/2016
M-B-3.6.8.2-1	Robot Candidate selected	31/07/2016
M-B-4.1.1-1-1	Rotorless Tail PDVR	29/01/2016
M-B-4.3.6-2	HPC based platform architecture definition	27/09/2016
M-B-4.4-1	HCDA Requirements definition	19/12/2016

→ ENG – Engines ITD

Work Package 0: Engine ITD Management (RR/Safran/MTU)

2016 has been a year where the management of the Engines ITD was operated efficiently based on the processes set-up in 2015, allowing members of the ITD to deliver their various commitments to the Clean Sky 2 programme. A number of key management processes have been refined and applied to new Core Partners entering the programme. This includes the management of:

- Steering Committee Meetings
- GAM and GAM updates
- Calls for Proposals and Calls for Core Partners
- Deliverable and milestone status tracking, including a ECM process for deliverable submission
- The Engines ITD's information management and sharing system via SharePoint

Two GAM updates were completed in 2016. The fourth GAM amendment (Amendment 4) was concluded with the integration of CPW02 and Fraunhofer into the Engines ITD GAM, allowing the implementation of a new Work Package ECO (WP9). The fifth GAM amendment (Amendment 5) was focused on the accession of Core Partners from Call for Core Partner Wave 3, as well as the re-baselining of some Work Packages. This amendment was performed on GMT2, by all the beneficiaries. Several iterations and a significant effort were deployed to reach successfully the objective of an integration of the GAM through GMT2 with respect to the programme schedule.

In 2016 the Engines ITD supported the evaluation of proposals in response to CPW03, which has 4 topics worth €16.5 million. 2016 also saw the negotiation and conclusion of the negotiation with Core Partners from CPW02 and CPW03. It is also the year where the Engines ITD published 9 topics in CPW04 worth €8.3 million, and prepared a further 14 topics worth €15.7 million in CfP06.

The Engines ITD welcomes the following new beneficiaries: Onera, NLR, MT-Propeller, EGILE, DMP, Akira, Price Induction (CPW02); University of Nottingham, ANSYS, GEMTC (CPW03) and the following new third parties third parties: GE Polska, AVIA, ACAB, GASL (CPW02); SLCA (CPW03) via their accession into the ITD. Fraunhofer also joins for WP9 (ECO). Two launch meetings were successfully held in Brussels with the new Core Partners on the 11 May and 8 November 2016.

The 2016 Engines ITD Annual Review was hosted by Safran Aircraft Engines in Paris between the 27 and 29 September 2016. It was attended by four expert reviewers and the JU as well as two SAT expert reviewers (remotely), along with a good attendance from all the beneficiaries of the Engines ITD. Key successes include demonstrable and effective interaction between the engine manufacturers and air-framers, as well as a presentation of the progresses towards the integration of the transverse activities (SAT, TE and ECO) within the Engine ITD and the general openness in which information was shared by the various beneficiaries during the review.

Work Package 2 - Ultra High Propulsive Efficiency (UHPE) Demonstrator for Short / Medium Range aircraft (Safran Aircraft Engines)

2016 was dedicated to perform the UHPE COR (Concept Review) and to prepare the preliminary design phase, in order to prepare the PDR.

The IPPS COR has been performed in July 2016. The main objective of the COR (Concept Review) was

to validate the engine architecture & the engine performance cycle. During the COR, some recommendations have been issued. Many of these are relative to the maturation level of the architecture of transmission system and PGB integration. These recommendations have to be closed before the UHPE PDR.

Post IPPS COR, the main tasks was to perform the modules or beneficiaries COR, to close the COR recommendations and to start the preliminary design phase preparation with all the beneficiaries. Based on the Engine Architecture validated during the COR, Module CORs have been performed. In particular the System COR has been realized in October.

The IPPS COR results (in particular engine architecture, engine cycle & UHPE first cross-section) were shared with UHPE Clean Sky 2 beneficiaries. Then first CORs with the beneficiaries have been performed.

Based on IPPS COR engine architecture, a first loop of engine integration has been done. This loop represents an important task to identify the 1st data to start preliminary design preparation:

- 1st integration studies, in particular relative to PGB
- Preliminary Cross-section taking into account all these integration studies
- 1st thermomechanical modelling and calculation
- 1st Engine Dynamic modelling and loads calculation

In term of UHPE project organisation, this has been significantly deployed in 2016 allowing the efficient integration of all the UHPE Clean Sky 2 beneficiaries, including the Core Partners. Documentation for Project Management was set up and shared with all the beneficiaries.

Regarding Core Partnership, GE DE and Safran AE successfully acceded for the technology maturation and delivery of modules and subsystems for the UHPE demonstrator: Turbine Vane Frame, HP Core and engine control adaptation.

Regarding Calls for Partners, FAG has successfully acceded and started activity in 2016 for the technology maturation and delivery of the bearings of the UHPE demonstrator.

Work Package 3 - Business Aviation / Short Range Regional TP Demonstrator (Safran Helicopter Engines)

2016 is a major year in WP3 activities as it has marked the entry into force of the third parties and core partners (CPW02). Safran Transmission System and Safran Systems Aerostructures have both entered WP3 as third parties. Two consortia of core partners have also joined Safran Helicopter Engine to participate to the demonstration programme.

The company DMP leads one consortium, named NEWGENPAGB (KOM held 09/09/2016). The participants and their main activities are listed hereafter:

- DMP, to manufacture and deliver all parts of the Power & Accessory Gear Box (PAGB) demonstrator
- Price Induction to instrument the parts of the PAGB and do the assembly
- Akira, to design and manufacture an advanced instrumented test rig dedicated to the PAGB module

Safran Transmission Systems and DMP co-lead the sub-work package Power & Accessory Gear Box (PAGB) module (WP3.3). Safran Transmission Systems is responsible for the design of the PAGB.

Safran Transmission Systems and DMP share the responsibility of delivering the PAGB modules.

ONERA leads the second consortium where the company MT-Propeller and the NLR participate. This consortium, namely ANTARES (KOM held 26/09/2016), is involved mainly in WP3.4 (Propeller module) and WP3.5 (Air inlet & Nacelle). ONERA is the leader of these two sub-work packages. The mission of the ANTARES consortium is:

- to design and manufacture an optimised propeller together with advanced propeller controls
- to optimise the nacelle aerolines of the demonstrator
- to deliver a fully instrumented mock-up of the nacelle and air intake for wind tunnel testing
- to assess CO2 emissions using an advanced measurement system and
- to assess the engine ignition system performance by performing a dedicated test campaign.

Nevertheless the difficult economic context of the helicopter market has forced Safran Helicopter Engines to globally reduce the level of R&T activities in 2016. Among the various projects in concern, WP3 has suffered a major budget shift from 2016 - 2017 to 2018 - 2019.

As a consequence, most of the studies dedicated to the Gas Turbine components have been postponed. Safran Helicopter Engines has concentrated the effort on the topics dedicated to the integration (both mechanics and controls) as well as on activities linked with the various partners and core partners: air intake, engine lighting system, IPPS controls, oil circuit, engine mounts, nacelle aerolines.

Safran Helicopter Engines has thus completed all specifications and requirements for the WP3 players. The interfaces between modules and parts have been discussed and agreed and the IPPS architecture has been validated. ANTARES core partners have fully characterized the V0 propeller and started preliminary analysis for the propeller demonstrator. NewgenPAGB core partners have worked on PAGB manufacturing and instrumentation, together with SafranTS and SafranHE. SafranTS has nearly completed the detailed design of the PAGB.

Following KOM with core partners and the new context for the project, the detailed time schedule has been reworked. The major change is the shift of the CDR from December 2016 to March 2017 and the shift of the FETT from mid-2018 to mid-2019.

Work Package 4 – Adv. Geared Engine Configuration (HPC-LPT) (MTU)

The compression system work progressed further in 2016. The first compression system rig (ICD Rig) will be used to advance the understanding of inter compressor ducts by obtaining measurement data and calibrating the CFD methods with this data.
The detail design of the ICD Rig was performed consisting of the following tasks among others:

- Design of the rig and rig systems:
  - Annulus definition
  - Control and monitoring system
  - Design of elements with variable geometry
  - Design of bleed system and bleed air flows
  - Design of the air system
  - Structure-mechanical system
  - Overall design and installation drawing

- Interfaces definition, documentation and agreement.
- Assembly concept definition
- Component design:
  - Design with parts list and material selection
  - Manufacturing processes selection for components
  - Blading on the basis of detailed calculation methods
  - Demonstration of compliance with safety requirements
  - Supplier selection and lead times of materials, forgings and components
- Risk assessment and risk management plan

The detail design phase was concluded with the Design Review 5 (End of design phase) on 12 December. The next project phase will consist of the hardware procurement to allow testing of the ICD rig in 2017 as planned in the project plan. The MTU deliverables for 2016, D4.2.1.2 and D4.2.4.2 were completed.

In 2016, the expansion system activities mainly concentrated on advanced technology development:

- Advanced Shape Optimisation
- Fast Sensitivity Analysis
- High Temperature Rotor Material
- Brush Seal Application for High-Speed-LPTs

In line with MTU's technology development process an initial Design review DR1 has been successfully passed in February. The conceptual implementation of the LPT technologies into the demonstrator vehicle has been confirmed and the correlating risks have been evaluated. Also the compliance with the validation needs of the developed technologies in regards to temperature and mechanical load levels has been proven and the chronologically interconnection of technology projects with engine demo development has been verified. Based on initial 3D models the general arrangement of the demonstrator ITD / TCF interfaces have been derived and aligned with the partner GKN.

MTU's CfP01 topic AlloxITD has been started while other topics in consecutive waves are submitted and in their respective stages.

Work Package 5 – VHBR – Middle of Market Technology (Rolls-Royce)

In 2016 a number of significant milestones have been achieved towards the design of an UltraFan™ architecture. On the power gearbox, in the middle of 2016 Rolls-Royce successfully commissioned the test facility building and attitude rig at the Rolls-Royce Deutschland site; this was an incredible achievement in less than two years since construction work started in January 2015. This facility, part funded by the Brandenburg State government, in turn enabled Rolls-Royce to achieve another major milestone when on 1 September it successfully tested the first full scale power gearbox on the 'attitude rig'. The thrust level of the Rolls-Royce power gearbox is significantly in excess of existing aerospace experience, so this represents a key first learning step and will be followed by testing on the 'power rig' in 2017. The design of the second design iteration of gearbox is progressing well in Rolls-Royce Deutschland, Dahlewitz with Rolls-Royce UK supporting the effort; parts are now being sourced.

Rolls-Royce along with its core partners continued to make significant progress throughout 2016 in the development of the Structural and Turbine sub-systems for the UltraFan™ demonstrator. ITP (core partner for the Intermediate Pressure Turbine (IPT) sub-system) completed the experimental

rig requirements for the intermediate pressure turbine (IPT) system and produced the design rules for Titanium Aluminide (next generation IPT material) both of these are key deliverables. GKN (core partner for the Structural sub-system) delivered a report on potential alternative intermediate compressor casing materials and continues to work closely with Rolls-Royce to mature the demonstrator design solution; in both cases the supply of the UltraFan™ demonstrator hardware will be delivered in WP6.

Work Package 6 – VHBR – Large Turbofan Demonstrator (Rolls-Royce)

2016 built on the considerable successes of 2014 and 2015 during which conceptual engine studies were completed, trade studies undertaken and whole-engine architectural options down-selected (in conjunction with the LPA IADP) in order to define the demonstrator sized for a future large passenger aircraft. In 2016, Rolls-Royce completed a Stage 0 Exit gate review which is one of 6 major gates required as part of the company's Product Introduction and Lifecycle management process. This represents the end of the innovation and opportunity selection phase allowing the design to advance into the preliminary concept definition phase where major architectural decisions (in conjunction with airframe/engine architecture decisions with Airbus as part of LPA IADP) will be fixed. The University of Nottingham acceded as a core partner in WP6 to deliver a demonstration of CFD capability in the simulation of air-oil flow in complex aero-engine bearing chambers.

All major roles in the organisation structure were filled in 2016 including product development managers (PDMs) for all of the required engine sub-systems. These individuals will be accountable for delivering the design and make of components for their specific area and ensure that any interfaces are appropriately managed. These include, Combustion and Turbine (this includes an interface into ITP, core partner responsible for delivering the intermediate pressure turbine), Power Transmissions and Structures (this includes an interface into GKN, core partner responsible for delivering the intermediate compressor case), Externals, Controls and Fan and Compressor. In addition roles were filled for the Chief Design Engineer (accountable for whole engine integration), Chief Development Engineer (accountable for engine development/validation), Airframe Integration Manager, accountable for managing the relationship with Airbus.

2016 saw an up-issue of the development/validation plan; this plan, known as the Engine Development Plan (EDP), includes a definition of the number of engines required to achieve TRL6 including ground and flight tests. In line with this update to the EDP an initial review of the verification and validation strategy for each technology stream was completed which has enabled better visibility of all the required testing both at an engine level and sub-assembly level. Rolls-Royce continues to review the infrastructure modification requirements to test this type and scale of engine. Additionally Rolls-Royce and Airbus continue to work together towards the realisation of the UltraFan flight test demonstrator; this activity being carried out within Large Passenger Aircraft IADP with a formal go/no go decision in 2017.

Work Package 7 – Small Aircraft Engine Demonstrator

2016 has been the effective launch of 5 partners (CfPs). The sixth partner has also been selected in 2016 with a kick-off planned for beginning 2017.

- WP7.1: Convergence on the four cylinder upgraded core engine specification and design of the majority of parts. The PDR has been passed and the CDR has been partially passed (cylinder, crankcase) and should be completed in 2017 with the cylinder head.
- WP7.2: Convergence on the turbocharger specification. PDR has been passed except for one specific item, which would be integrated in the oncoming CDR.
- WP7.3: The engine has been installed at the partner facility to initiate the first step of

propeller tests with the basic propeller configuration.

- WP7.4: Convergence on the specification for the 6 cylinder engine, architecture design, choice of technologies and a PDR has been hold. The Digital Mock up is available for the WP7.5.
- WP7.5: Convergence on the engine installation specification and on the WP7.4 interdependent schedule.
- WP7.6: The partner has been selected to provide an Engine Control System adapted for WP7.4/WP7.5.

Work Package 8 – Reliable and more efficient operation of small turbine engines

The aim of WP8 is to address technical challenges to deliver next generation turboprop engines and propeller and deliver major improvements in engine technology such as fuel efficiency, the extension of service life between overhauls and the reduction of noise footprint. The activities carried out from July 2015 are divided in seven sub work-packages. A summary of how the activities progressed in 2016 is reported below.

WP8.0 aimed at delivering the System Specification of the Target Engine. The engine requirements, related to the green aircraft 19-seater have been issued and reviewed by the JU and the independent reviewers.

WP8.1 objectives were to complete the engine concept studies and to define the engine modules requirements. In 2016 the steady-state performance modelling of the engine was finalized and transient performance modelling activities have started as well. Based on the requirements from WP8.0, which have been issued in the second half of 2016, another engine cycle concept has also been studied in order to assess potential benefit in terms of cost and fuel efficiency. Convergence on the target engine requirements is expected to be achieved in 2017 through further iterations between PAI and the MAESTRO consortium.

WP8.2 aimed to complete both the Concept Design of the enhanced Reduction Gearbox and the initial low-noise propeller design. In the first part of 2016, an enhanced RGB design has started; in parallel a baseline propeller and a low-noise propeller were designed for a generic BGA aircraft in advance of receiving the final aircraft specifications from PAI. In the second part of the year, new aircraft specifications were received by PAI, and the baseline propeller blade was re-designed to meet the new requirements. On the identified RGB architecture and layout sensitivity to RGB gear ratio was performed to assess potential impact of different gear ratio requirement coming from the on-going re-design of the propeller. A trade study to achieve a new low-noise propeller is currently under way for the new thrust and power requirements.

In WP8.3, the MAESTRO aero teams advanced with the detailed aero design of this next-generation turboprop engine compressor. For each airfoil, numerous design iterations were performed between Aerodynamics and Aeromechanics until a final design was achieved. A DDR concluded the detailed design phase for the blading and, following the airfoil release, the aero team continued supporting the mechanical design team to ensure the final mechanical axial/centrifugal compressor design was compliant with the aerodynamic, aeromechanical and operability requirements. In parallel, the preparation of the compressor rig test facility (TTF in mid-2017) has also been advanced (e.g. instrumentation of the axial/centrifugal compressor, test programme, test monitoring, data reduction procedures, etc.).

WP8.4 aimed at completing the Full ANNular Test on the MAESTRO reverse flow combustor. In 2016,

the detailed design of the ultra-compact combustor module and the new high pressure rig has been delivered. After the test facility was set up and the combustor assembled onto the new rig, the test campaign on the MAESTRO combustor has been performed. The rig commissioning has been followed by the combustion test campaign, through which the actual combustor performance can be assessed against the predictions from the design studies.

Within WP8.5, focusing on power turbine and exhaust, in 2016 the aero and mechanical optimisation was finished confirming that a) aero efficiency targets were achieved; b) the design is mechanically and aero-mechanically feasible. The exhaust design was finalized together with power turbine (the two systems were optimized together) and the scaled model tests of the exhaust duct were performed to prove aerodynamic efficiency (low loss level) of the duct under significantly changing exhaust gas swirl conditions that are expected in turboprop engine during different phases of operation. The HPT-PT transition duct test was laid out, the vendor was selected and the test stand design started. The test layout passed initial aero review.

WP8.6 aimed to ensure that all activities and objectives within the project were carried out successfully according to the contractual obligations and technical requirements. All the activities were focused on the management and coordination of the consortium (Project Management Committees, Technical Coordination Committees and Risk Management) and on the dissemination, exploitation and communication activities.

Work Package 9 – ECO Design

The ecoDesign link to “big impact technologies” provides the ability to fully quantify the actual eco-benefit of such technologies throughout the life cycle of the product. Materials, processes and resources employed for aero-engines are generally of very high ecologic and economic values, so the industry must assess and understand the full *ecolonomic* (i.e. ecologic and economic) impact of introducing such technologies to ensure that they are environmentally and economically sustainable throughout the entire life cycle of the product.

The main activities of this work package in 2016 comprised the finalisation of the initiation phase of the EITD-ECO Design programme. Beside the establishment of the EITD-eco-Design Strategy Paper as baseline, a detailed definition of the work scope has been initiated. The content of WP9 derived from a variety of topics proposed by EITD Leaders and Core Partners. An original long list of topics has been harmonised and condensed to four sub-work packages. These topics have been evaluated by ecoDesign on a competitive basis (ECO relevance incl. value for money).

WP9.1 Additive Manufacturing (SAF)
WP9.2 Recycling & re-using of composites (SAF)
WP9.3 Recycling & re-using of specialised metallic materials (RRUK)
WP9.4 Advanced engine manufacturing & production processes (FhG)

Furthermore the integration of Core Partners has been supported by the introduction of adequate test cases into mentioned sub-work package activities. Core Partners proposed test cases were commonly discussed and finally evaluated with FhG in a dedicated workshop on Sep 14, 2016. At the end a total of 11 test cases found their way into the WP9 topics.

Accompanied by regular WP9 meetings and conferences, detailed descriptions of work for each sub-work package have been established and were the basis for WP9 in GAM Amendment 5.

→ SYS – Systems ITD

WP1 Avionics Extended Cockpit

Mock-ups of new cockpit displays have been matured, and a first prototype of tactile control panel is available. New concepts of voice interaction brought to TRL3. FMS functions have been further developed from the 2015 status. Fly by Trajectory concept has been further matured and the implementation of a TRL4 maturity mock-up for specific sub-functions has started. The concept of modular Inertial Reference Unit mechanical concept and functional breakdown was defined, and the Preliminary design review was completed. The milestone to fly the first sensor suite for a future EVS system in the vision and awareness simulator was passed. Work on the modular communication platform included the refinement of the aircraft level requirements, leading to the first system architecture description completed end of 2016.

WP2 Cabin & Cargo

This WP was not started yet. A Call for Core Partner has been issued with CPW04 in 2016.

WP3 Innovative Electrical wing

Wing system architectures for Power and Controls to be used with the Smart Integrated Wing Demonstrator have been elaborated. For the purpose of further investigation a simulation software tool was benchmarked, selected and procured. The phase one of demonstrator setup has been defined and started, identifying the right facilities and procuring first rig components. Technology bricks for de-centralised Hydraulic Power Pack progressed thru studies and the start of a multiple pump test rig to assess long-life characteristics of different configurations. Electro-mechanical flight control technologies for regional A/C progressed with updated specifications. EMA's conceptual design was frozen and preliminary design has been started. Pre-PDR meeting has been held. Validation plans have been released. A new activity covering Smart Active Inceptor Devices for the next generation of flight controls has been integrated. Master planning was set-up to support flight demonstration in 2023 with the Fast Rotor Craft. Several Calls for Partners have been proposed or already negotiated to support the various activities.

WP4 Landing Gear Systems

The Smart Motor prototype for phase 1 has been designed and first components ordered. The architecture trade-off studies for full Electrical Main Landing Gear Extension/Retraction System started. In 2016 system trade studies and the preliminary design and TRL3 milestone for the local hydraulic system has been achieved. The proof of concept demonstrator test setup has been completed. The integration of new Core Partners (Wave 3) for LG composite structure and electrically actuated brake was completed. In 2016 first functional tests on the electromechanical retraction actuator have been carried out successfully. In addition studies of design optimisations have been performed. TRL3 milestone has been achieved. A first set of high level requirements has been produced to trigger the activities of a new Partner (Wave 02) on Advanced Landing Gear Sensing and Monitoring System.

WP5 Electrical chain

Activities on Aircraft electrical architecture consisted in architecture optimisation and trade-off to define Architecture and requirements. A new Core Partner for HVDC Power Management Centre

was integrated. For Power Generation, the GCU full digital development started, with the release of specifications. A Core Partner and some CfP topics were released. Energy management activities covered trade-off studies on weight benefits. EDCU PDR was passed, validating the architecture to enable later demonstration. For Power Electronic Module, preliminary semiconductor characterisation and testing to assess performance were completed. In addition, development of generic input filter design methods and tools, development of motion control technological bricks were addressed.

WP6 Major Loads

Activity about A/C loads architecture consisted in analysing the results of the SGO large demonstrations on PROVEN and A320 (eFTD). The new Core Partner AECS and a new Partner were launched. Activities about adaptive environmental control system started with initial down selection of chemicals of interest and definition of requirements for the air quality sensor. Test rigs are being built to assess what contaminants could be present in the air and what technologies can these contaminants to the required level. Trade-offs on new electrical ECS architectures for Single-Aisle was launched extending to thermal management, based on Clean Sky programme experience to define CS2 baseline in mid- 2017. For the EECS for R/A, the objectives were finalised with the airframer. E-ECS technology bricks have been defined. After an Icing Wind Tunnel test campaign, the evaluation of different architectures for Wing Ice Protection System has allowed to select several architectures to TRL3. A new Core Partner has been integrated for the development of an Icing Detection System. The master schedule for demonstrator activities has been defined.

WP7 Small Air Transport Activities

Following the more electrical Landing Gear trade-off definition, a Call for Partner was issued to identify a Partner on this topic. A Partner for the De-ice System has been integrated. Trade off study for De-Ice Architecture for Small Aircraft is being performed. The evaluation of components for the Fly by Wire Architecture for Small Aircraft progressed. The flight control computer has been identified. Another component for the flight air data was identified and it is being investigated to identify possible collaboration. Technical content for the Core Partner on Affordable SESAR Operation, Modern Cockpit and Avionic Solutions for Small A/C has been detailed. The new Core Partner performed detailed reviews of several technologies and assessed the feasibility to integrate them into the common cockpit demonstrator. The possibilities of the final demonstration aircraft were analysed and resulting opportunities and limitation have been incorporated into the final demonstrator architecture. The main activities on Comfortable and Safe Cabin for Small Aircraft were focused on the integration and start of two new Partners. In addition the investigation of seat belt position influence proceeded with the definition and preparation of design variations. Trade-off studies on active noise reduction in small aircraft and on assessment of noise and thermal load in small aircraft were finished.

WP100.1 – Power Electronics

The study of potential secondary distribution architectures is progressing. Requirements have been clarified. The development of simulation models progressed. For the work on Paralleled Operation of 2 Power Cores the test bed for paralleled cores operation is being manufactured. On Improvements in Parallel Operation of Reversible DC Sources experimental investigation is being prepared. Provisions as for building a test rig are completed. Initial discussions were held on the High Current Power Module, Packaging and PCB Cooling.

WP100.2 – ECO Design
The activities about new alloys and composites as well as electron beam melting continued in 2016. Scroll demonstrator out of high temperature resistant aluminum was produced. New Partners were introduced. Four further CfP topics were prepared. All activities were started with ITD Leaders Budget since no Eco Design funding are guaranteed yet.

WP100.3 – Model tools and simulation
The kick-off for the work package was held in February 2016. The initial requirements of the tool-chain were delivered in Q3 2016. The core simulation environment of the MISSION framework at TRL-3 was delivered. This included a live demonstration in Brussels. The team progressed with the development of modelling and optimisation activities with initial focus on actuation systems.

Major milestones and results:

WP1 – Avionics Extended Cockpit
- Definition of Extended Cockpit needs, architecture and functional specification
- Concept of Cockpit definition bench available
- Prototype of Large Integrated Multifunction Display (tactile)
- TRL3 for 'Touch to talk' tactile & voice interaction concept.

WP3 – Innovative Electrical Wing
- Start of test rig operations for long-life EHA pumps.
- Preliminary design reviews passed for Flight Control System components for RA-IADP FTB2.
- Definition of Smart Integrated Wing Demonstrator set-up

WP4 – Landing Gear System
- Launch of Smart Braking EMA design
- Main landing Gear Concept Review (CR), Preliminary Design Review (PDR) and TRL3
- TRL3 of Local Hydraulic Actuation System concept for Nose Landing Gear
- Introduction of new Partners and Core Partners for Landing Gear System innovations

WP5 – Electrical Chain
- Core Partner on HVDC Power Management Centre implemented
- Launch of the GCU full digital development (specification released)
- EDCU Preliminary Design Review (PDR)
- Technology bricks evaluation or design started

WP6 – Major Loads
- WP 6.0.2 Adaptive environmental control system WP kicked off in Q4.
- TRL3 EWIPS in November 2016

WP7 – Small Air Transport
- Technical specification on Affordable Health Monitoring System defined
- General architecture of Electrical Power Generation and Distribution defined
- Two critical Fly by wire components identified
- Analysis of the state-of-the-art constraints, method and tools of cabin systems completed
- Trade-off study on Electrical Landing Gear architecture for SAT competed

WP100.3 – Modeling tools and simulation
- Initial tool-chain requirements captured
- TRL-3 for the core simulation environment of the framework achieved

→ SAT – Small Air Transport Transverse Activity

The Small Air Transport Initiative (SAT) in Clean Sky 2 represents research and technology interests of European aircraft manufacturers of small aircraft used for passenger transport (up to 19 passengers) and for cargo transport, belonging to EASA´s CS-23 regulatory base. In 2016, the SAT GAM was established and management activities were moved to WP 1 Management from ITD Airframe, WP B 0.2 Interface & Cross-interaction Management.

WP 1 – Management

The main activity in WP 1 was to manage the SAT TA and in cooperation with ITDs to coordinate, drive and monitor the technical functions of the Transversal Activities. The main expression of this factual management is the SAT TA CC (SAT Transversal Activity Coordination Committee) where all the activities developed at level of the different ITD's are moved at the global level of SAT. One of the main points was the implementation of CfPs related to the SAT activities in order to harmonize and have a high level control on budget. The established rule is that the discussion is inner CMC and after approval the CfP is passed to ITD's.

In 2016 four Coordination Committee meetings (CCM) were organized and issued related minutes of meeting:

- 03.02.2016, Warszawa, Poland
- 12.05.2016, Sevilla, Spain
- 05.10.2016, Kunovice, Czech Republic
- 06.12.2016, Torino, Italy

Core Partners
During 2016 three Core partners were integrated into SAT technical activities and CP coordinators participated on SAT coordination via SAT CCM. In total, SAT has added four Core Partners.

WP 2 - Reference Aircraft Configuration
In WP 2 activities towards definition of the three reference aircraft continued. To ensure a wide range of used data/aircraft, SAT Core Partners were invited into process and updated document will be issued in another loop. Activities in this WP are coordinated with TE.

WP 3 - Advanced integration of Systems and Engine in small a/c
A small activity started at the level of ITD for electric, with an open discussion with Thales for Electrical generation, but the activity is not at the moment full developed in order to allow a comprehensive integration study. An increase in activities is planned for the next period.

→ ECO – Eco Design Transverse Activity

Summary of the context and overall objectives of the project

Eco-Design TA follows the following main general objectives:

- Expanding and enhancing the database of CS1 by introducing data on materials, technologies, processes and resources;
- Serve as a contact point for ITDs and IADPs regarding environmental or sustainable issues;
- Create customized LCA models for current and future aircraft, covering production, operation, maintenance and end of life;
- Train the consortium in Eco-Design and provide guidance;
- Serve as a frontrunner in the aviation sector for Europe and worldwide for analysing and quantifying environmental footprint of air transport;
- Guarantee the link between ACARE and the fulfilment of their environmental goals (CO2, NOX, Environmental impacts such as global warming etc.);
- Establish global Key Performance Indicators (KPI).

Work performed and main results achieved

Major achievements at work package level

The work carried out during 2016 aimed to establish an interaction with all ITDs and IADPs trough the Eco Design coordination GAM. The intention was to identify the eco relevant technologies with clear TRL development path and demonstration objectives to be developed considering different and specific drivers. Screening was also based on SPD's strategy papers for Eco TA compliance and eco content.

T0 – Transversal coordination - Key activities

- Coordination management meetings;
- Eco TA GAM signed between JU and Fraunhofer (official starting date April 2016);
- Bilateral meetings with SPDs to identify the Eco-Design activities and the strategy;
- Interaction with SPDs for initial GAM updates with main deliverables and milestones and interaction links;
- Internal regularly meetings;
- Explanation of the Eco-Design concept and workflow with each SPD;
- Development and approval of Eco Coordination Committee Rules of Procedures and first Eco TA Committee;
- Set-up of Hyperwave organisation structure and work/storage space as well as interaction with SPDs;
- Initial dissemination and communication plan;
- Work carried out related to the deliverable D-0.1-01 High Level Strategy and Eco-Objectives;
- Initial record of potential technologies;
- Preparation of contractual and governance documentation;
- Support to CSJU for the evolution of the CSMM and CSDP documents.

T1.0 Lead-In Activities

- Bilateral meetings with SPDs have been carried out to discuss focus areas for ecological synergy and assessment methods (VEES, EDAS synergy) with preliminary indication of technologies, processes and material development.

- Analysis of Eco Design strategy papers from SPDs for eco objectives prioritisation.
- Technology screening, mapping, allocation, assessment and prioritisation of SPD technologies (mainly SPD AIR, SYS, ENG, REG) related to eco objectives were started with SPDs
- CfP and core partner calls analysed for eco themes

T2.0 Life Value Technologies

- Coordination started by structuring eco related activities in various SPDs according to eco-themes (e.g. outline of Eco-Engine WP9 proposals for integration into future Engine-ITD activity).

T3.0 Eco Architecture

- Investigation of SPDs proposals related to Eco-Architectural concepts (e.g. new recycling routes, new manufacturing facilities and plants)

T4.0 Assurance and Compliance

- Initial work started to assess Eco proposals compliance

T5.0 Eco Statements – Design for Environment

- Main work was based on setting up criteria related to environmental, economic and social relevance for CS2 added value;
- Discussion started with involvement of SPDs to collect feedback and improve criteria definition for Eco activity;
- Work carried out related to the deliverable D-0.1-02 Criteria for Eco TA activity.

T6.0 Eco-Design Tools and Analysis

- Initial Eco design platform concept explanation for SPDs;
- Preliminary investigations on base technologies needed to implements the concept:
  - Evaluation of 2D Visualisation frameworks / middleware technologies
  - 3D web visualisation (X3DOM)
  - Ontology Modelling for the VEES and EDAS Mapping
- Definition and first draft of the deliverable Socio Economic Derivative (SED);
- Work carried out related to the Deliverable D-0.1-03 Draft LCS flow logic Report;
- Started discussion with SPDs on Data collection regarding current and future materials, processes and technologies.

Main Events

Meetings and T-cons have been carried out to identify SPDs strategies, Eco-Design topics, optimisation in SPDs WBS throughout 2016:

- Preparation, organisation and holding of management meetings (preliminary Eco CC and 1st Eco CCM):
  - 10 May 2016: Provisional CCM; Frankfort; Airport centre
  - 24 October 2016: 1st Eco CCM; Brussels; JU
- Coordination Meetings with SPDs:
  - EcoTA/JU/SPD, different meetings
  - Engines:
    - Engine ITD Eco Workshop (Brussels)
    - Technical sessions
    - Steering Committee Meetings

        - WP9 test case Workshop (Brussels)
    - Systems:
        - Different telephone conferences
    - Airframe:
        - WP 3.4 + ECOTECH Kick-off, Paris
        - AIR-Eco TA Meeting: Technical consolidation, Brussels
    - Large Passenger Aircraft:
        - Different telephone conferences
    - Regional
        - Different telephone conferences
    - Rotorcraft
        - Telephone Conference

Deliverables

Del. no.	Deliverable name	Delivery date from Annex 1	Actual delivery date	Forecast if not submitted on time	Status
D-0.1-01	High level strategy and Eco objectives	30.09.2016	15.12.2016	-	A01 submitted, Request for revision
D-0.1-02	Criteria for Eco TA activity	30.06.2016	15.12.2016	-	A01 submitted, Request for revision
D-0.1-03	LCA flow logic	30.09.2016	15.12.2016	-	A01 submitted, Request for revision
D-0.3-01	Dissemination & Comm. Plan	30.09.2016	-	25.01.2017	Not submitted
D-4.1-01	Trade off synthesis report	30.09.2016	-	12.01.2017	Not submitted
D-1.0-01	Technology List and eco-objectives	15.12.2016	-	12.01.2017	Not submitted
D-6.2-01	SED Definition	15.12.2016	-	12.01.2017	Not submitted
D-2.0-01	Synthesis Report	15.12.2016	-	12.01.2017	Not submitted

Milestones

Milest. no.	Milestone title	Delivery date from Annex 1	Means of verification	Achieved	Forecast if not submitted on time
M-0.1-1	CC Meeting	30.09.2016	One day f2f meeting Brussels (24.10.2016)	yes	-
M-0.2-1	Initial Eco Activity	30.09.2016	Assessment of strategy papers	no	Q1 2017
M-0.2-02	First MPR Workshop	30.09.2016	Workshop conducted	no	Q2 2017
M-6.3-01	Requirement Workshop	30.09.2016	Workshop conducted	no	Q3 2017
M-0.1-2	Launch Review	15.12.2016	Launch review conducted	no	Q2 2017
M-1.2-01	Initial Tech Mapping Process finalised	15.12.2016	VEES and EDAS mapping delivered by SPDs	no	Q1 2017

→ TE – Technology Evaluator

In 2016 the main activities were performed in work-packages 0, 1, 3 and 5.

WP0: Management and interaction with SPDs:
In 2016 an all SPDs workshop was held in Brussels (February) followed by a series of bilateral meetings or telephone conferences with each SPD separately. In these bilateral meetings the following issues were discussed:

- TE2 general approach: timing, expected outcomes, reference and Clean Sky vehicles (TLARs and technology list);
- Status Clean Sky 2 planning: model requirements for TE2 assessments, TE2 planning, Clean Sky interim review requirements;
- TE2 assessments at airport and ATS level: desired outputs and metrics, required inputs.

Five topics were published in the CfP05:

- Airport Level Assessment (Fixed-wing);
- Airport and ATS Level Assessment (Rotorcraft);
- ATS Level business jet 2035 forecast;
- ATS Level Rotorcraft 2035 forecast;
- ATS Level SAT 2035 forecast.

An information day on the call took place on 30 November in Brussels.

A Cooperation Agreement (CooA) has been prepared which will serve as the legal basis to exchanging and sharing data among all parties involved into TE2 work. Additionally, an implementation agreement template has been developed and published along with the publication of the calls. Signing of the CooA is foreseen for the beginning of 2017. At the request of the JU a proposal for global warming assessments as part of the two major assessments in CS2 has been developed which has been presented to SPDs and TAs. The TE2 also participated in the FRC annual review meeting in April 2016.

WP1: Integrated planning:
Clean Sky programme has shown that an “integrated planning” is crucial for the successful implementation of the TE assessments. This implies the planning of the TE mission, airport and ATS assessments and the interaction with SPD models input at a higher aggregated level and a more detailed split of the SPD models description in terms of technologies and TRL levels. Unlike in Clean Sky 1 the Mission level assessments will be performed by the SPDs themselves which will then be collected and assembled for reporting by the TE. Airport level activities and assessments will be performed by a winner of a call. These will include airport fleet noise and emission performance. Activities are expected to begin by end of 2017. ATS level assessments and activities encompass mainliner´s fleet and Movement 2035 Forecasts and 2050 scenarios, flight schedules, mobility and economic assessments. For the time being Aircraft models from the SPDs will cover a wide range of aircraft in terms of size and fleet segment including Small Air Transport, business jet, regional, large passenger and fast rotorcraft. The overall planning for the duration of the programme is characterised by the two general assessments as major milestones in 2020 and at the end of Clean Sky 2 (see figure).

Substantial efforts have been made to establish common grounds for the integrated planning down to the level of (major) individual technologies. The TE expects more input from the SPDs in 2017.

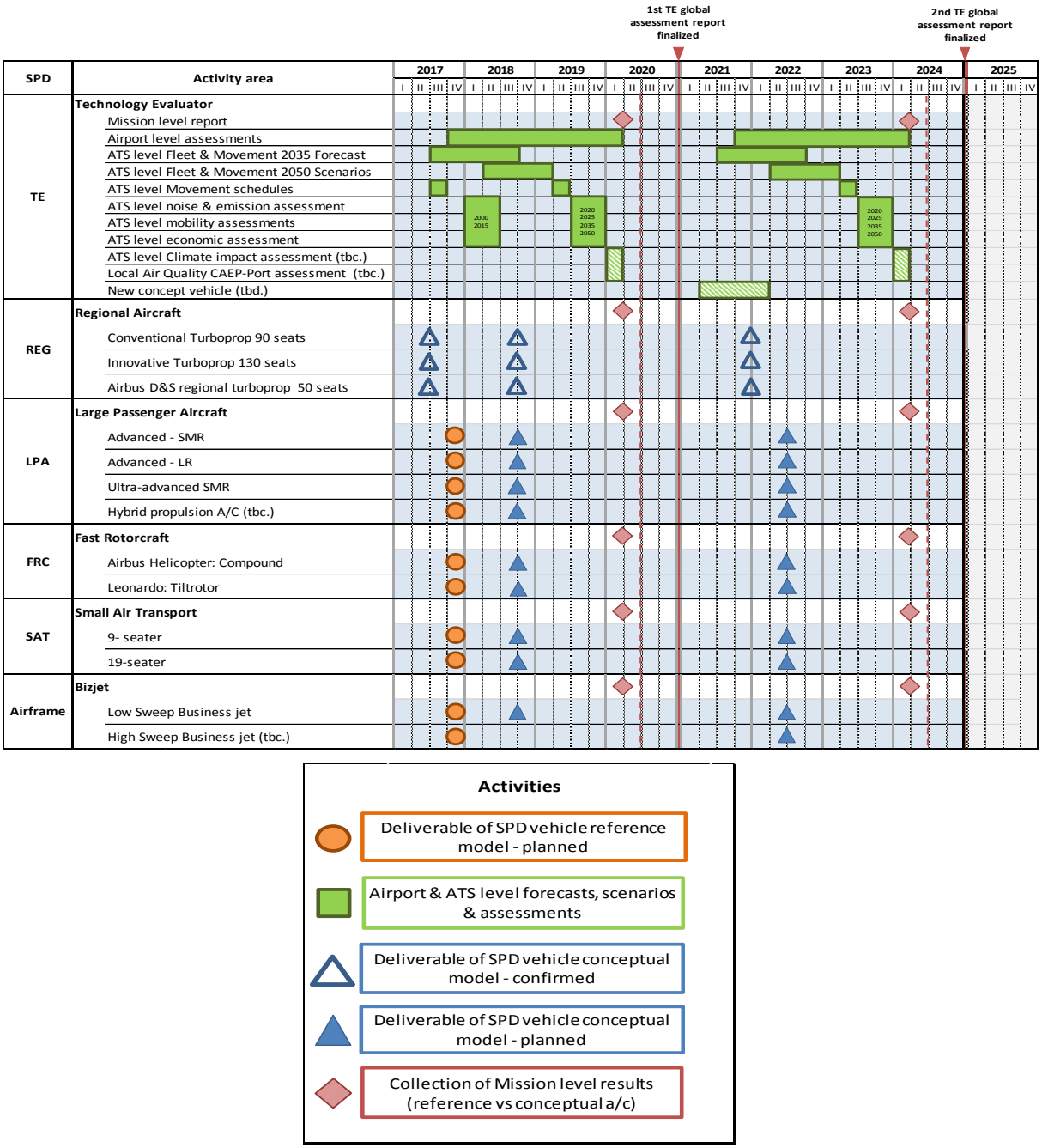

Figure 1: Overview of the integrated planning of the CS2 TE for the duration of the programme.

WP3: Top level aircraft requirements

A collection of the top level aircraft requirements was gathered in 2016 including reference aircrafts and Clean Sky 2 concept aircraft based on SPD planning. An aggregated list of TLAR included the following parameters: entry into service, range capability in nautical miles, cruise speed mach number, maximum take-off weight in kg, number of passengers, engines and general configuration of the aircraft. For regional and SAT aircraft more detailed TLARs were provided e.g. in terms of weight splits. The following aircraft are projected for CS2:

– Four large passenger aircraft: an advanced short medium range (SMR), an ultra-advanced SMR, an advanced long range aircraft, and a hybrid propulsion aircraft;

- Three regional aircraft: a conventional turboprop aircraft with 90 PAX, an innovative turboprop aircraft 130 PAX, and a regional turboprop aircraft with 50-70 PAX;
- Two fast rotorcraft: a compound and a tilt-rotor;
- Two SAT aircraft: a nine and a 19 seater;
- One business jet: a low sweep business jet.

The reference aircraft are either 2015 state of the art or Clean Sky technology based. For example for the tiltrotor no "classical" reference could be identified, but for oil platform missions, a comparison in terms of passenger productivity with a Clean Sky Twin Engine Helicopter configuration could serve as reference.

WP5: ATS level

In the CS2 TE assessment timeframes will cover the years 2035 up to 2050. For that purpose, realistic insertion scenarios of Clean Sky aircraft into future fleets are required by means of fleet models. The existing DLR model is being adapted to these requirements by performing the following steps:

- Demand modelling: forecast of passenger demand in progressively higher aggregated granularity (total passenger volume ⇨ passenger volume between countries and regions ⇨ passenger volume between cities ⇨ passenger volume between airports)
- Modelling of retirement curves of aircrafts ⇨ modelling of survival probability of given aircraft in the forecasted year ⇨ interim result: available aircrafts in the forecasted year
- Modelling of the productivity of aircrafts ⇨ determination of the possible transport offer in terms of flown distance or available seat km ⇨ determination of the demanded aircraft through the aircraft assignment model
- Aircraft assignment model to forecast annual flight schedules (number of flights for any given airport pair) using as input the baseline fleet (2015) configuration in terms of aircraft types, passenger volume between airport pairs and the surviving aircraft for the forecast year. It will then determine how many Clean Sky aircraft will be inserted in the forecasted year fleet.

In a first step generic aircraft retirement curves have been defined using historical fleet data (c.f. figure depicting a generic aircraft retirement curve combining historic usage development of 27 types of narrow body aircrafts based on data ranging from 1965 to 2015).

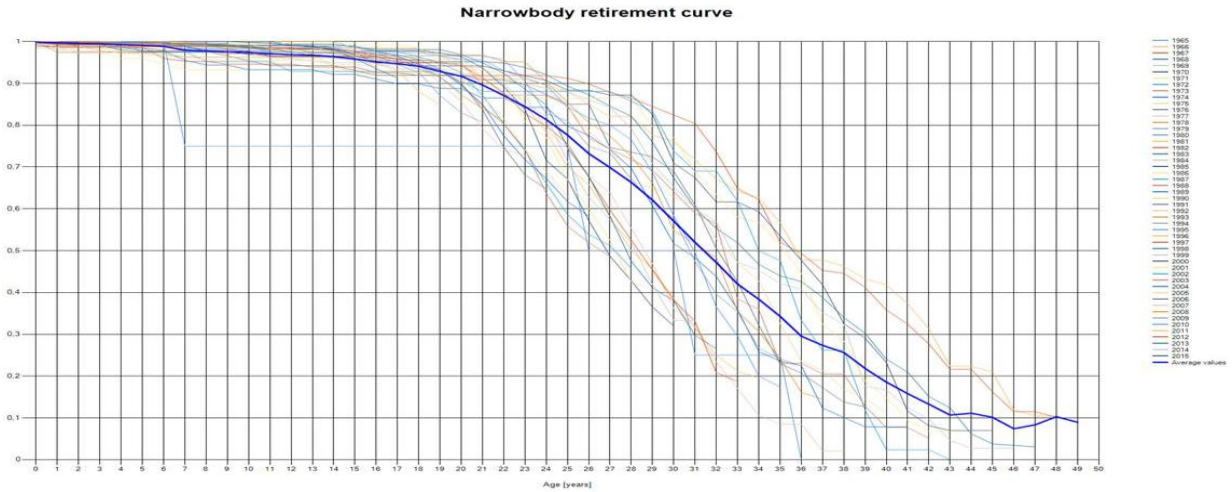

Figure 2: Generic aircraft retirement curve combining historic usage development of 27 types of narrow body aircrafts based on data ranging from 1965 to 2015.

12. List of acronyms

AAR: Annual activity report
AB: Annual Budget
A/C: Aircraft
ACARE: Advisory Council for Aeronautics Research in Europe
ATM: Air Traffic Management
CA: Commitment Appropriations
CDR: Critical Design Review
CfP: Call for Proposals
CfT: Call for Tender
CROR: Counter Rotating Open Rotor
EC: European Commission
ECO: Eco-Design
EDA: Eco-Design for Airframe
GAM: Grant Agreement for Members
GAP: Grant Agreement for Partners
GRA: Green Regional Aircraft
GRC: Green Rotorcraft
IAO: Internal Audit Officer
ITD: Integrative Technology Demonstrator
IADP: Innovative Aircraft Demonstrator Platform
JU: Joint Undertaking
JTP: Joint Technical Programme
PA: Payment Appropriations
PDR: Preliminary Design Review
QPR: Quarterly Progress Report
SAGE: Sustainable and Green Energy
SESAR: Single European Sky Air Traffic Management Research
SFWA: Smart Fixed Wing Aircraft
SGO: Systems for Green Operation
SPD: System & Platform Demonstrator
TA: Transversal Activity
TE: Technology Evaluator
ToP: Type of Action
TP: Technology Products
TRL: Technology Readiness Level
WP: Work Package