In accordance with Article 8 (k) and Article 20 of the Statutes as annexed to Council Regulation (EU) No 558/2014 of 6 May 2014 establishing the Clean Sky 2 Joint Undertaking, the undersigned, Ric Parker, Chairman of the Governing Board hereby approves the above referenced document.

Done in Brussels on 1st April 2016

Ric Parker
Chairman of the Governing Board
Clean Sky 2 Joint Undertaking
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

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<thead>
<tr>
<th>Name</th>
<th>Clean Sky 2 Joint Undertaking</th>
</tr>
</thead>
</table>
| **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. |
| Executive Director    | Eric Dautriat |
| 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, Aernnova SAU, Alenia Aermacchi, Dassault Aviation, DLR, Evonik, Fraunhofer, Liebherr, MTU, Piaggio Aero Industries, Rolls-Royce, SAAB, Safran, Thales Avionics); + Associates: Fokker (ED), CIRA PLUS Cluster (GRA), NLR (GR), University of Nottingham (SGO), Aernnova (GRC), GKN Aerospace (SAGE ITD), University of Nottingham (SGO), Aernnova (SFWA).  
Core Partners: ITP (ENG), University of Nottingham (SYS), INCAS (FRC), Avio Aero (LPA), CIRA (REG), Meggit (AIR). |
| Other bodies          | States Representatives Group; Scientific Committee; ITD Steering Committees |
| Staff                 | 42 |
| **2015 Budget**       | €440.7 million in commitment appropriations  
€245.9 million in payment appropriations |
| Budget implementation | 99.5% in commitment appropriations and 81% in payment appropriations |
| Grants                | 7 FP7 Grant agreements for Members (GAMs) - total value €67,41 million; 7 H2020 GAMs - total value €58,8 million; 19 FP7 Grant Agreements for Partners (GAPs)- total value €9 million; 31 H2020 GAPs - total value €27,9 million. |
| Strategic Research Agenda | See chapter 1 and related Annex 9 |
| Call implementation   | Number of calls launched in 2015: 2  
Number of proposals submitted: 232  
Number of eligible proposals: 230  
Number of proposals funded: 681  
Global project portfolio (since the setting up): 1442  
Number and value of tenders (if any): none |
| Participation, including SMEs | Total number of participations in funded projects: 282 of which  
18% of SMEs (52 SME participations)  
55% of private for profit/large companies (154 participations) |

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1 Subject to Grant signature, as CPW02 is subject to Member accession in April 2016 and CIP02 Grant Preparation underway from March 2016.  
2 Not counting Leader actions and counting each funded proposal from Calls 2014-15 as one project.
FOREWORD

As we look back over the past 12 months, and in particular at the 2015 work plan, many achievements can be noted – all arising from a joint effort from the various actors involved in the Clean Sky 2 JU. While the successful technical start of Clean Sky 2 programme ‘took off’, the Clean Sky programme witnessed the first significant set of grant agreements arriving at their end with more than 10 demonstrators being closed during the year. The technologies and output from these projects were delivered to the various ITDs and fed the overall Clean Sky ‘system’ as planned. It was also the first full year that the JU had to manage two programmes, with very different legal basis and different compositions at the same time.

Below is a summary of these achievements and challenges. For sure there are more to come. What is clear from the report which follows is that the JU is the right instrument to efficiently manage such a spectrum of actors and despite different legal frameworks.

The JU team increased during the year and at industry level, further resources were applied in some member companies to cope with the extra work arising from the take-off of Clean Sky 2 programme while keeping an eye on the continuous output expected from Clean Sky programme. The Commission also played its role through the Common Support Centre for Horizon 2020 where, this new structure and way of working becomes more established. For sure, there is plenty to do at all sides to continue the good start. For the most part these have been identified by the end of 2015 and are set out here in summary form. The JU looks forward to continuing to deliver on the objectives set in the Regulation while also responding to the increasing interest shown by new entrants to the programmes and to other external actors in the regions who recognize the importance of establishing synergies with the JTI objectives and programmes. The JU is fully aware of the challenges which lie ahead but, as in 2015, will deliver on its work plans going forward at the right time and level expected.

EXECUTIVE SUMMARY

Clean Sky 2 JU is tasked with managing 2 research programmes, one each from the FP7 and H2020 framework programmes. Clean Sky 2 JU is the EU 2020 framework and coordinating research and innovation instrument in this field, for environment and competitiveness objectives. The programme is managed, together with the industry by the Joint Undertaking with its premises in Brussels. The JU is an autonomous entity set up under the legal framework of a Council Regulation and operating the grants it funds through the EU financial rules and the rules of the framework programmes. It is a Public-Private Partnership (’PPP’) responsible for administrating the largest aeronautics research budget in the EU. The combination of EU funding through the European Commission and the private industry provides a flexible means to ensure stability and longer term commitment from the European Union to the industry with regard to funding opportunities as the JU’s lifetime covers the period all the way from 2008 until 2024.

2015 saw the first full year for the JU to run the 2 programmes simultaneously. Indeed, Clean Sky programme witnessed the delivery of more than 10 significant demonstrators (ground and flight tested) and managed to close 106 projects arising from the grant agreements with partners (GAPs). The Clean Sky 2 programme delivered its first set of core partners and partners
for the programme. In total 76 new core partners joined the programme as a result of the first Call for Core partners bringing the membership of this programme to an already higher level than in Clean Sky (66 Associates). For sure, this will be the new challenge for the JU to manage so many actors including many new players in Clean Sky 2 JU activities.

The JU also launched the 2nd call for core partners and the 2nd call for proposals. 2015 was therefore, an extremely busy year for the programme office, but also for the industry participating in one or both programmes. As work packages were defined and launch reviews were held for CS2 projects, the Clean Sky programme continued to ensure a consistent delivery of the right level of research relating to the technologies set out in the Clean Sky Development Plan. Significant parts or complete demonstrators were delivered and went through tests. Among many examples: several wind tunnel test campaigns using dedicated model, rig testing of engine demonstrators (SAGE4 Geared Turbofan and SAGE 5 Turboshaft), flight testing of new operational procedures (Low noise abatement for helicopters) or new configurations (Diesel powered light helicopter; ATR 72 flying test bed with major structural modifications), start of assembly of the BLADE demonstrators for laminar wing of such achievements.

The assessment of the environmental benefits was updated by the Technology evaluator. The main results to date are provided in the following table:

<table>
<thead>
<tr>
<th>Product</th>
<th>Wide-body 2020</th>
<th>Narrow body 2015</th>
<th>Regional 2020</th>
<th>Corporate 2020</th>
<th>Rotorcraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>objectives at</td>
<td>26% (Global</td>
<td>60% (Global</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>global fleet</td>
<td>fleet level)</td>
<td>fleet level)</td>
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<tr>
<td>level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Results from</td>
<td>-19%</td>
<td>-40%</td>
<td>-30%</td>
<td>-33%</td>
<td>-20%</td>
</tr>
<tr>
<td>the 2015 TE</td>
<td>-50%</td>
<td>-44%</td>
<td>-34%</td>
<td>-34%</td>
<td>-58%</td>
</tr>
<tr>
<td>assessment</td>
<td>-79%</td>
<td>-55%</td>
<td>-71%</td>
<td>-58%</td>
<td>-25%</td>
</tr>
<tr>
<td>Summary table</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>of the Clean</td>
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<tr>
<td>Sky Programme</td>
<td></td>
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<td></td>
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<tr>
<td>objectives and</td>
<td></td>
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<tr>
<td>results per</td>
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</tr>
<tr>
<td>date</td>
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</tr>
</tbody>
</table>

2015 saw the JU manage its highest budget to date, up 192% from 2014 overall with 440.7m in commitment appropriations and up to 166% from 2014 overall with 245.9 m in payment appropriations. The challenge in managing this lay in the different states of maturity of the programmes where a concentration of effort on dealing with the many reported GAPs was needed while in CS2, becoming accustomed to the new way of working for the CS2 first call related GAPs implied a steep learning curve despite the foreseen preparations taking place in parallel. The JU takes advantage of the available H2020 tools where possible and processes all GAPs through this means. Meanwhile the Grant management tool for members’ grant agreements went through further developments assisting in the overall efficient management objective.

The challenges ahead are many first call related GAPs implied a steep he JU will continue to be in this situation until at least the end of 2017 after the technical activities of the Clean Sky

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3 Ref. CS-GB-2014-12-19 Doc9 CS Development
programme end (i.e.31/12/16). It is continuously assessing the steps needed to be prepared for this closure while simultaneously keeping an eye on the needed actions to continue the healthy start of activities in the Clean Sky 2 programme.

Not wishing to stand still and taking into account the provisions of the CS2 regulation, dealing with synergies with European Structural and Investment funds, Clean Sky has launched part of activities in the Clean Sky 2 programme into the new way of work of the Member States and Regions in Europe. 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 Programme and support its overall objectives. The outcome of this work produced 6 signed Memoranda of understanding between the JU and some regions (see section 1.1.11). The JU wishes to continue this work as much as possible taking into account its current capacity to do so.

The execution of the first grant agreements under the H2020 programme started in July 2014 and continued until end 2015. As set out in the regulation, the JU worked a lot on the procedures for the estimation, reporting and certification and validation of the in-kind contributions from the private members. Details on the values of the in-kind contribution of private Members for both programs – FP7 and H2020 - are presented in section 1.1.10 of this report. The total provisional value of the private sector contribution for the Clean Sky programmes accumulated until end of 2015 to 486.4 m€ for FP7 and 198m€ for H2020.

Contributions to the Joint Technology Initiative, which are not linked to the statutory tasks of the JU, i.e. the "Additional Activities", have been planned by the ITD and IADP leaders for 2014 and 2015 and the planned values have been approved by the Governing Board, as it is foreseen in the Regulation. The JU will process in the first half of 2016, the certificates relating to the funded and unfunded activities, the latter which contributes to the validation of the private contribution to the JU.

The internal control system of the JU underwent the annual cycle of audits and based on the results to date, the JU is reaching an adequate level of internal control. The IAS audit on dissemination was closed in late 2015 and the JU has reported on this to the governing board in December 2015 (see section 3.1.1). With the recruitment of a GAP coordinator, the JU looks forward to achieving the necessary ‘Time to pay’ and ‘time to grant’ targets of H2020. Indeed the JU can report a noted improvement in the overall JU time to pay statistic for 2015 (see section 4 and Annex 5).

Looking ahead, the JU will continue to face challenges to handle both programmes at an adequate level. The private members will also have to face this task and try to attribute the right resources at the right moments of 2016 and 2017 to achieve the ambitious work plan 2016-2017. As the first programme faces its final phase, the JU will have only more reasons to celebrate its first successes with the further delivery and testing of demonstrators. The communication and dissemination of these research results will receive further attention and effort from JU staff in order to ensure the right messages pass at the right moment to the right audience. Clean Sky 2 will continue to ramp up and even more core partners and partners will join and work for the programme. 2016 will see the next update of the CS2 Development plan and this will set out the best reference point for the overall programme objectives and related schedule and cost. It is without doubt that the JU will need to remain as efficient and well
organised as ever if it is to cope with all challenges ahead.
1. IMPLEMENTATION OF THE ANNUAL WORK PLAN 2015

1.1.1. Key objectives 2015 and associated risks

Clean Sky Programme - Achievement of Objectives for 2015

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.

<table>
<thead>
<tr>
<th>Objective 2015</th>
<th>Achieved in 2015 (Yes/No/Comments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Fixed Wing Aircraft Natural Laminar Flow “BLADE” wing demonstrator Critical Design Review performed</td>
<td>Yes</td>
</tr>
<tr>
<td>Low Sweep Bizjet Vibration Control Ground Test, Critical Design Review performed</td>
<td>Yes. May 2015</td>
</tr>
<tr>
<td>Green Regional Aircraft Fuselage Barrel and Wing Box demonstrators finalized</td>
<td>Partially, to be completed in 2016</td>
</tr>
<tr>
<td>ATR72 Flying Test Bed, Flight Test Readiness Review performed</td>
<td>Yes, flight test in July 2015</td>
</tr>
<tr>
<td>Rotorcraft Active blades tested on ground (wind tunnel and whirl tower preparation)</td>
<td>Partially, wind tunnel testing; flight test in 2016</td>
</tr>
<tr>
<td>Rotorcraft Diesel engine tested on ground</td>
<td>Yes. November 2015</td>
</tr>
<tr>
<td>Open Rotor Ground Demonstrator Critical Design Review held</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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 summarized 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:
## Clean Sky Demonstrators and Technology streams

<table>
<thead>
<tr>
<th>ITD</th>
<th>Demonstrator / Technology Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SFWA</strong></td>
<td>High Speed Smart Wing Flight Demonstrator</td>
</tr>
<tr>
<td></td>
<td>● Airbus A340-300 flight test</td>
</tr>
<tr>
<td></td>
<td><strong>Advanced load control for Smart Wing</strong></td>
</tr>
<tr>
<td></td>
<td>● Ground test bed for large transport aircraft</td>
</tr>
<tr>
<td></td>
<td>● Flight test for vibration control for bizjet</td>
</tr>
<tr>
<td></td>
<td><strong>Smart Wing High Lift Trailing Edge Device</strong></td>
</tr>
<tr>
<td></td>
<td>● Full scale demonstrator, ground test only</td>
</tr>
<tr>
<td></td>
<td><strong>Innovative afterbody</strong></td>
</tr>
<tr>
<td></td>
<td>● Full scale demonstrator, ground test only</td>
</tr>
<tr>
<td></td>
<td><strong>Innovative Empennage Demonstrator</strong></td>
</tr>
<tr>
<td></td>
<td>● Full scale demonstrator, ground test only</td>
</tr>
<tr>
<td><strong>GRA</strong></td>
<td>Static &amp; Fatigue Test</td>
</tr>
<tr>
<td></td>
<td>● Full Scale Ground Demonstration</td>
</tr>
<tr>
<td></td>
<td><strong>Large scale Wind Tunnel Test Demonstration</strong></td>
</tr>
<tr>
<td></td>
<td>● Acoustic &amp; Aerodynamic WT Test - Turbo Prop 90 pax</td>
</tr>
<tr>
<td></td>
<td>● NLF wing aerodynamic &amp; aeroelastic design WT Tests - 130</td>
</tr>
<tr>
<td></td>
<td>● Geared Turbo Fan configuration</td>
</tr>
<tr>
<td></td>
<td><strong>Ground Laboratory Test (COPPER BIRD and other)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Flight Simulator on ground</strong></td>
</tr>
<tr>
<td></td>
<td>● Green FMS Final Demonstration on GRA Flight Simulator</td>
</tr>
<tr>
<td></td>
<td><strong>Integrated In-Flight DEMO</strong></td>
</tr>
<tr>
<td></td>
<td>● ATR Integrated In-Flight Test - ATR 72 FTB</td>
</tr>
<tr>
<td></td>
<td><strong>Cockpit ground demonstrators MT1 &amp; MT2</strong></td>
</tr>
<tr>
<td><strong>GRC</strong></td>
<td>Innovative Rotor blades, passive and active (AGF), on Ground and in Flight</td>
</tr>
<tr>
<td></td>
<td><strong>Drag reduction on Ground / in Flight</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Medium helicopter electrical system demonstrator</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Lightweight helicopter electromechanical actuation</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Electric Tail Rotor Prototype</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Diesel powered flight worthy helicopter Demonstrator</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Flightpath operational Demonstrations</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thermoplastic composite fairing demonstrator</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thermoplastic composite tailcone demonstrator</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Surface treatments for tail gearbox and rotor mast</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Surface treatments and welding technology for intermediate gearbox</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thermoplastic composite drive shaft for intermediate gearbox</strong></td>
</tr>
<tr>
<td><strong>SGO</strong></td>
<td>VIRTUAL IRON BIRD</td>
</tr>
<tr>
<td></td>
<td><strong>COPPER BIRD</strong></td>
</tr>
<tr>
<td></td>
<td>● Ground Test (Nacelle Actuation System, Power Generation and Conversion, Generators, Power Rectifiers, Electrical ECS Demonstrator, HEMAS )</td>
</tr>
<tr>
<td>ITD</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| PROVEN       | - 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 Center)  
- 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 Turbopfan Demonstrator  
- Ground Test - Engine demonstrator based on a GTF donor engine  
 Large 3-shaft Turbopfan  
- 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 modeling 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, summarized 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\(^4\). 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.

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>CO(_2) [%]</th>
<th>NO(_X) [%]</th>
<th>Noise area difference ratio at take-off (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Speed Bizjet</td>
<td>-30 to -40</td>
<td>-30 to -40</td>
<td>-60 to -70</td>
</tr>
<tr>
<td>Regional turboprop</td>
<td>-25 to -30</td>
<td>-25 to -30</td>
<td>-40 to -50</td>
</tr>
<tr>
<td>Short/ Medium Range / CROR</td>
<td>-25 to -35</td>
<td>-25 to -35</td>
<td>-30 to -40</td>
</tr>
<tr>
<td>Light twin engine rotorcraft</td>
<td>-15 to -30</td>
<td>-55 to -70</td>
<td>-40 to -50</td>
</tr>
</tbody>
</table>

**Indicators**

The FP7 Key performance Indicator results for the year 2015 are presented in Annex 5.

**Clean Sky 2 Programme – achievement of objectives**

As the Clean Sky 2 Programme faces its initials 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.

<table>
<thead>
<tr>
<th>Objective 2015</th>
<th>Achieved in 2015 (Yes/ No/Comments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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 <em>CS2 Joint Technical Programme, the Clean Sky 2 Development Plan</em> and the Grant Agreements [including any re-evaluation of elements where appropriate];</td>
<td>Yes [All 1st Wave Core Partners have been absorbed in GAMs. Final JTP v5 was „frozen“ in April 2015 and further updates now follow via the CS2 Development Plan.]</td>
</tr>
<tr>
<td>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;</td>
<td>Partially [this objective is due for completion on the closing of all Core Partner Waves [end 2016]. With the accession of the 1st Wave and the grant implementation of the 2nd Wave progressing the 2016 CS2 Development Plan will provide a significant update to the demonstrator programme.]</td>
</tr>
<tr>
<td>To conduct Launch Reviews for 100% of technical activity commencing in the 2015-2017 period, enabling the JU to adequately test the level of</td>
<td>Partially [substantially]. Over 80% of the Launch Reviews were successfully conducted, with the final reviews [mostly LPA and (4) CS-GB-2014-12-19 Doc9 CS Development Plan]</td>
</tr>
<tr>
<td>Objective 2015</td>
<td>Achieved in 2015 (Yes/ No/Comments)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>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;</td>
<td>agreed with the JU in terms of scheduling] in 1st half of 2016. Only programme areas with a low activity and a ramp-up in 2nd half 2016 or later have been scheduled for Launch Reviews in 1st half 2016, the remainder all held in 2015.</td>
</tr>
<tr>
<td>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);</td>
<td>Yes. Level 2 project analysis was completed and in a number of cases an additional technical evaluation held to encompass activities absorbed in the Programme. It should be noted the refinement of the Technology Roadmaps is ongoing and a continuous process captured through the annual update of the CS2 Development Plan.</td>
</tr>
<tr>
<td>To implement solutions for leveraging Clean Sky 2 funding with Structural Funds;</td>
<td>Yes. 8 MoUs are signed as of Early 2016, and already in two cases and ESIF funded project is linked to and architected to create synergies with CS1 / CS2 Programmes.</td>
</tr>
<tr>
<td>To implement an effective and efficient management and governance through the Clean Sky 2 Management Manual;</td>
<td>Partially. The CS2 specificities related to GAMs, Development Plan and Launch Reviews were implemented. Further incorporation of H2020 processes [now stabilising] for CfP and for the Transverse Activities remains an outstanding action.</td>
</tr>
<tr>
<td>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;</td>
<td>Partially. SAT fully implemented. TE governance principles were adopted by the Governing Board and are being implemented in an operational sense early 2016. For ECO the progress has been slower with the content generation and governance model not sufficiently converged between the TA and SPDs.</td>
</tr>
<tr>
<td>To select the Programme’s Core Partners as planned in four Calls for Core Partners;</td>
<td>Partially. [substantially] This objective is not for 2015 as such: the master schedule for Core Partner selection having always a series of calls or „waves” spread across 2014/15/16. 1st Wave of the Core Partner selection and absorption into Grant Agreements fully implemented. Negotiation and accession of the 2nd Wave is on track. 3rd Wave will be evaluated April 2016: on schedule. 4th Wave will be launched with a small delay in the 4th quarter of 2016: this in order to ensure any failed topics in the first three waves are reviewed for possible re-launch and to have a stable budget envelope for the 4th Wave.</td>
</tr>
<tr>
<td>To widely disseminate the information about the</td>
<td>Partially.</td>
</tr>
</tbody>
</table>

"CS-GB-2016-04-01 Provisional AAR 2015"
| Objective 2015                                                                 Uri
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>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;</td>
</tr>
<tr>
<td>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;</td>
</tr>
<tr>
<td>To ensure a time-to-grant no greater than 8 months for the Calls for Proposal;</td>
</tr>
<tr>
<td>To execute at least 90% of the budget and of the relevant milestones and deliverables;</td>
</tr>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>
Objective 2015

Achieved in 2015 (Yes/ No/Comments)
The programme technical content and roadmap will stabilize over 2016 as by Quarter 3 over 90% of the Core Partner content will be implemented in terms of selection of members and grant agreements accession.

Clean Sky 2 Demonstrators and Technology streams

<table>
<thead>
<tr>
<th>ITD/IADP</th>
<th>Technology Areas</th>
<th>Demonstrator / Technology Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Passenger Aircraft</td>
<td>Advanced Engine Design &amp; Integration for Large Passenger Aircraft</td>
<td>CROR demo engine flight test demo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced engine integration driven fuselage ground demonstrator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Validation of dynamically scaled integrated flight testing</td>
</tr>
<tr>
<td>Large Passenger Aircraft</td>
<td>Advanced Laminar Flow Rig Reduction for Large Passenger Aircraft</td>
<td>HLFC large-scale specimen demonstrator in flight operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High speed demonstrator with hybrid laminar flow control wing</td>
</tr>
<tr>
<td>Large Passenger Aircraft</td>
<td>Innovative Aircraft Configuration and Operation</td>
<td>Innovative Flight Operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next generation cockpit and MTM functionalities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demonstration of advanced short-medium range aircraft configuration</td>
</tr>
<tr>
<td>Large Passenger Aircraft</td>
<td>Innovative Cabin &amp; Cargo Systems and Fuselage Structure Integration for Large Passenger Aircraft</td>
<td>Full-scale advanced fully integrated fuselage cabin &amp; cargo demonstrator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next generation lower centre-fuselage structural demonstrator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next generation large module fuselage structural demonstrator with fully integrated next generation cabin &amp; cargo concepts and systems</td>
</tr>
<tr>
<td>Large Passenger Aircraft</td>
<td>Next Generation Cockpit &amp; Avionic Concepts and Functions for Large Passenger Aircraft</td>
<td>Integrated systems and avionics demonstration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full 4D - flight capability; fully parameterized green trajectory capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next Generation Cockpit ground demonstrator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development and validation suite for:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- New MMI functions</td>
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<td></td>
<td>- Advanced IMA’s</td>
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<tr>
<td></td>
<td></td>
<td>- Networked data link and functions</td>
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<tr>
<td></td>
<td></td>
<td>Fully integrated next generation avionics simulation &amp; test lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flight demonstration Next Generation Cockpit &amp; flight operation features</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coordinated with Systems and Equipment ITD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Pilot case” demonstration in flight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qualification and validation of next generation cockpit features sensible to a highly realistic environment</td>
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<tr>
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<td>Maintenance service operations enhancement demonstrator</td>
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<tr>
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<td></td>
<td>Demonstration of the technical and economic maturity and performance of a value and service oriented architecture and its enablers</td>
</tr>
<tr>
<td>ITD/IADP</td>
<td>Technology Areas</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Regional Aircraft</td>
<td>Highly Efficient Low Noise Wing Design for Regional Aircraft</td>
<td>Air Vehicle Technologies – Flying Test Bed#1 (FTB1) Low noise and high efficient HLD, NLF, Active LC&amp;A, Innovative wing structure and systems</td>
</tr>
<tr>
<td>Regional Aircraft</td>
<td>Innovative Passenger Cabin Design &amp; Manufacturing for Regional Aircraft</td>
<td>Full scale innovative Fuselage and passenger Cabin</td>
</tr>
<tr>
<td>Regional Aircraft</td>
<td>Innovative Future Turboprop Technologies for Regional Aircraft</td>
<td>High Lift Advanced Turboprop – Flying Test Bed#2 (FTB2)</td>
</tr>
<tr>
<td>Fast Rotorcraft: Tiltrotor</td>
<td>Tiltrotor Flight Demonstrator</td>
<td>Tiltrotor Flight Demonstrator</td>
</tr>
<tr>
<td>Fast Rotorcraft: Compound R/C</td>
<td>Innovative Compound Rotorcraft Airframe Design</td>
<td>Airframe structure &amp; 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 &amp; kinematics</td>
</tr>
<tr>
<td>Fast Rotorcraft: Compound R/C</td>
<td>Innovative Compound Rotorcraft Power Plant Design</td>
<td>Lifting Rotor &amp; Propellers Integrated design of hub cap, blades sleeves, pylon fairings, optimized for drag reduction; Rotor blade design</td>
</tr>
<tr>
<td>ITD/IADP</td>
<td>Technology Areas</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>for combined hover-high speed flight envelope and variable RPM; Propeller design optimized for best dual function trade-off (yaw control, propulsion);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drive train &amp; Power Plant Engine installation optimized 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, optimized for high torque capability, long life, low weight. REACh-compliant materials and surface treatments.</td>
</tr>
<tr>
<td>Fast Rotorcraft: Compound R/C</td>
<td>LifeRCraft Flight Demonstrator</td>
<td>LifeRCraft Flight Demonstrator Integration of all technologies on a unique large scale flight demonstrator, success &amp; compliance with objectives validated through extensive range of ground &amp; flight tests</td>
</tr>
<tr>
<td>Airframe</td>
<td>High Performance and Energy Efficiency</td>
<td>Innovative Aircraft Architecture Noise shielding, noise reduction, Overall Aircraft Design (OAD) optimisation, efficient air inlet, CROR integration, new certification process, advanced modeling</td>
</tr>
<tr>
<td>Airframe</td>
<td>High Versatility and Next Generation Optimized Wing Box</td>
<td>Advanced Laminarity Laminar nacelle, flow control for engine pylons, NLF, advanced CFD, aerodynamic flow control, manufacturing and assembly technologies, accurate transition modelling, optimum shape design, HLF</td>
</tr>
<tr>
<td>Airframe</td>
<td>High Performance and Energy Efficiency</td>
<td>High Speed Airframe Composites (D&amp;M), steering, wing / fuselage integration, Gust Load Alleviation, flutter control, innovative shape and structure for fuselage and cockpit, eco-efficient materials and processes</td>
</tr>
<tr>
<td>Airframe</td>
<td>High Versatility and Next Generation Optimized Wing Box</td>
<td>Novel Control Gust Load Alleviation, flutter control, morphing, smart mechanism, mechanical structure, actuation, control algorithm</td>
</tr>
<tr>
<td>Airframe</td>
<td>High Versatility and Next Generation Optimized Wing Box</td>
<td>Novel Travel Experience Ergonomics, cabin noise reduction, seats &amp; crash protection, eco-friendly materials, human centered design, light weight furniture, smart galley</td>
</tr>
<tr>
<td>ITD/IADP</td>
<td>Technology Areas</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td></td>
<td><strong>Cost Efficiency</strong></td>
<td>Composite (D&amp;M), out of autoclave process, modern thermoplastics, wing aero-shape optimisation, morphing, advanced coatings, flow and load control, low cost and high rate production</td>
</tr>
<tr>
<td></td>
<td><strong>Optimized High Lift Configurations</strong></td>
<td>Turboprop integration on high wing, optimised nacelle shape, high integration of Tprop nacelle (composite/metallic), high lift wing devices, active load protection</td>
</tr>
<tr>
<td></td>
<td><strong>Advanced Integrated Structures</strong></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td><strong>Advanced Fuselage</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td><strong>Innovative Open Rotor Engine Configurations</strong></td>
<td>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 on flight test planned in LPA IADP and test results analysis</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td><strong>Innovative High Bypass Ratio Engine Configurations I : UHPE Concept for Short/Medium Range aircraft (Safran)</strong></td>
<td>UHPE demonstrator</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td><strong>Business Aviation/Short Range Regional Turboprop Demonstrator</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td><strong>Advanced Geared Engine Configuration</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td><strong>Innovative High Bypass Ratio Engine</strong></td>
<td>VHBR Middle of Market Turbofan Technology Design, development and ground testing of a VHBR</td>
</tr>
<tr>
<td>ITD/IADP</td>
<td>Technology Areas</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>----------</td>
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<td>----------------------------------</td>
</tr>
<tr>
<td><strong>Engines</strong></td>
<td>Configurations II: VHBR Middle of Market Turbofan Technology (Rolls-Royce)</td>
<td>Middle of Market Turbofan</td>
</tr>
<tr>
<td>Engines</td>
<td>Innovative High Bypass Ratio Engine Configurations III: VHBR engine demonstrator for the large engine market (Rolls-Royce)</td>
<td>VHBR engine demonstrator for the large engine market Design, development and ground testing of a large VHBR engine demonstrator</td>
</tr>
<tr>
<td>Engines</td>
<td>Small Aircraft Engine Demonstrator</td>
<td>Small Aircraft Engine Demonstrators - reliable and more efficient operation of small turbine engines - light weight and fuel efficient diesel engines</td>
</tr>
<tr>
<td>Systems</td>
<td>Innovative and Integrated Electrical Wing Architecture and Components</td>
<td>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 &amp; control electronics  - New sensors concepts  - Health monitoring functions, DOP  - WIPS concepts for new wing architectures  - Shared Power electronics and electrical power management  Optimization of ice protection technologies and control strategy</td>
</tr>
<tr>
<td>ITD/IADP</td>
<td>Technology Areas</td>
<td>Demonstrator / Technology Stream</td>
</tr>
<tr>
<td>----------</td>
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<td>----------------------------------</td>
</tr>
</tbody>
</table>
| **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 optimization  
- High integrated power center for bizjet aircraft (multi ATA load management, power distribution and motor control)  
- Smart grid, develop & integrate breakthrough components to create a decentralized smart grid, partly in non-pressurized zone.  
- Electrical Power Centre – load management optimization  
Health Monitoring, DOP compliant |
| **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 visible to answer the needs for 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 & CUPPER Bird®  
- To mature technologies, concepts and architectures developed in Clean Sky 2 or from other R&T programs and integrated in Clean Sky 2  
- For optimization 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
<table>
<thead>
<tr>
<th>ITD/IADP</th>
<th>Technology Areas</th>
<th>Demonstrator / Technology Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems</td>
<td>ECO Design</td>
<td>ECO Design activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refers to ECO Design chapter</td>
</tr>
<tr>
<td>Technology</td>
<td>A systematic overall approach to the TE process and monitoring activity</td>
<td>- Progress Monitoring of Clean Sky 2 achievements</td>
</tr>
<tr>
<td>Evaluator (TE)</td>
<td></td>
<td>- Evaluation at Mission Level of particular ITD outputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Impact Assessments at Airport and ATS Level</td>
</tr>
<tr>
<td>Eco-Design</td>
<td>An overall innovative approach and &quot;agenda&quot; for Eco-Design activity in the CS2</td>
<td>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 period.</td>
</tr>
<tr>
<td>Transverse</td>
<td>Programme</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Air</td>
<td>An overall innovative approach and &quot;agenda&quot; for Small Air Transport activity in the</td>
<td>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.</td>
</tr>
<tr>
<td>Transport (SAT)</td>
<td>CS2 Programme</td>
<td></td>
</tr>
<tr>
<td>Transverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
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</tbody>
</table>

**LEGEND**

- **IADP/IADP**
  - **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.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Clean Sky 2 as proposed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ and Fuel Burn</td>
<td>-20% to -30% (2025 / 2035)</td>
</tr>
<tr>
<td>NOₓ</td>
<td>-20% to -40% (2025 / 2035)</td>
</tr>
<tr>
<td>Population exposed to noise / Noise footprint impact</td>
<td>Up to -75% (2035)</td>
</tr>
</tbody>
</table>

* 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 2015 are presented in Annex 5.

~ ~ ~

Administrative Objectives - achievement

<table>
<thead>
<tr>
<th>Objective 2015</th>
<th>Achieved in 2015 (Yes/ No/Comments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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;</td>
<td>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.</td>
</tr>
<tr>
<td>90% of GAM cost claims received are formally dealt with (validated, put on hold or refused) before end of May each year;</td>
<td>Yes. 100%</td>
</tr>
<tr>
<td>40% of FP7 GAPs are formally closed by June 2015;</td>
<td>Yes. By end of June 2015 43% of the GAPs were formally closed (i.e. 206 closed FP7 projects out of a total of 482 FP7 projects, 106 closed in 2015 only).</td>
</tr>
<tr>
<td>The ex-post audits on FP7 projects are performed</td>
<td>Yes.</td>
</tr>
<tr>
<td>Objective 2015</td>
<td>Achieved in 2015 (Yes/ No/Comments)</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

In accordance with the JU’s draft procedures for planning and reporting of in-kind contributions of the private members, the GB was able to adopt an Additional activities plan for both 2014 and 2015 to date. The reporting on the 2015 plan took place using estimated data in early January 2016. Based on the information received (the values of which are not yet certified), the estimated value of the in-kind contributions arising from the operational activities (i.e. within the work plan and funded by the JU) is 49 m€. Meanwhile the estimated value of the in-kind contributions arising from the Additional activities is 156 m€. This brings the total in-kind contribution to 205 m€ for 2015. When this is compared to the annual budget for 2015 activities within the Grant agreements for members of 59 m€, the leverage effect indicator is a ratio of 1 : 3.47.

1.1.2. Research & Innovation activities

The CSJU 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 aims will contribute to the finalization 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 bear 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 Public Private Partnership (PPP). After seven years of operations, the technical programme is largely on track, and the environmental performance gains targeted are all within reach. Stakeholder participation is high, including SMEs (often with first time participation with respect to the Framework Programme). 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 will build on the success of Clean Sky 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 utilizes the key skills and knowledge of the leading European aeronautic research establishments and academic faculties. Small and medium-size enterprise and innovative sub-sector leaders will help shape promising new supply chains.

**Clean Sky Programme**

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 Small Fixed Wing Aircraft ITD (SFWA), focused 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), focused 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), focused 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 will be the first available European complete integrated tool delivering direct relationship between advanced technologies, still under development, 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 CSJU 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. for Clean Sky, the SGO Project Officer, up to the two Executive Directors).

In Annex 9, 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 2015 the Coordinating Project Officer (CPO) continued with the monitoring of the activities at overall ITD level.

The ITD Coordination meetings were maintained, about bi-monthly; the dates in 2015 were: 21 January, 10 March, 11 May, 7 July, 17 September and 11 December. The standard agenda included the status of GAMs and GAPs, the evolution of budget, the preparation and feed-back 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 2015 it was the Paris Air Show and the Aerodays in London).

In all GB meetings the CPO delivered a Progress status of technical progress of activities in all ITDs, as a support to the ED for the overall assessment of the CS programme.

In 2015 the JU attended together with the Project Officers all the ITD Annual reviews:
- TE, on 19-20 March 2015 in Brussels;
- SFWA, from 14 to 16 April 2015, in Merignac (Bordeaux) (hosted by Dassault)
- ECO, on 22-23 April 2015 in Biarritz, hosted by Fraunhofer
- GRC, on 19-20 May 2015 in Albacete Spain, hosted by Airbus Helicopters
- GRA, on 9-11 June 2015, in Pomigliano at Alenia.
- SAGE, on 22-26 June 2015, in Turin hosted by AVIO.
- SGO, on 1-3 July 2015 in Colombes, hosted by Labinal Power System;

The so-called Interim Progress Reviews were also held in the second semester of 2015, limited to one day, to review the implementation in the ITDs of the recommendations from experts.

At the end of the year, a revision of the CSDP was prepared and finalized for approval of the GB at its last meeting in 2014.

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 in the
Communication chapter.

The follow-up of the workshop with EASA of October 2014, being monitored at each ITD Coordinators meeting was also discussed in a few meetings with the new Director of Strategy and Safety. The impact of the new policy of EASA on research and their potential involvement in Clean Sky activities should be finalized early 2016.

As mentioned above, also the links with the SESAR JU were reinforced; in December 2015 a renewed Memorandum of Cooperation was signed and several joint workshops / technical meetings are planned from beginning of 2016.

**Clean Sky 2 Programme**

Research and innovation actions undertaken in Clean Sky and delivering important technological advances will be 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 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 today is even greater 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 will involve demonstrations and simulations of several systems jointly at the full vehicle level through Innovative Aircraft Demonstrator Platforms (IADPs).

A number of key areas will be coordinated across the ITDs and IADPs through Transverse Activities [TA] 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 in Clean Sky 2.
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, vehicle demonstration platforms are covering 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 to 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 the maturing of verified and validated technologies from their basic levels to the
integration of entire functional systems. They have the ability to cover quite a wide range of technology readiness levels. Each of the three ITDs orientates 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 the innovative flight vehicle configurations:

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

The Transverse Activities [TAs] enable important synergies to be realized where common challenges exist across IADPs and/or ITDs; or where co-ordination 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 synergize technical activity that resides as an integral part of the other IADPs and ITDs. A dedicated budget is reserved inside the concerned IADPs and ITDs to perform these activities. Transverse Leaders are nominated and coordinate each Transverse Activity. Currently two Transverse Activities are agreed for Clean Sky 2 Programme and are specified in the Statutes of the CSJU:

- ECO-Design TA [ECO]: Key materials, processes and resources related innovations considering the life cycle optimization 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 the Clean Sky PPP and will be continued via the Technology Evaluator. Impact Assessments such as 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 on aircraft “Mission Level” to assess innovative long term aircraft configurations.
1.1.3. Calls for proposals and grant information

Calls launched within the Clean Sky 2 Programme

In the reporting period 2015 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 to the Clean Sky 2 Programme Call activity
Up to 40% of Clean Sky 2’s available funding is ring-fenced for 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 then – and also 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 [Partners] [CfP] and where and if applicable Calls for Tender [CfT]. The amount involved in this 60% is over €1 billion, making it alone over 25% greater than the total budget of the first Clean Sky Programme and just over five times the call funding volume of the original 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 Organizations [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 CfPs. They contribute significant in-kind to the Programme in order to meet the minimum level of in-kind contributions to be brought to the Programme by the Members as set in the Regulation. In terms of 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] which follow the H2020 rules. 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 H2020 [applicable in both CS2 call types and in continuation of a successful methodology in Clean Sky Programme under FP7] 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 commencing actions 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 will provide opportunity for the vast bulk of the aeronautics industry in the European Research Area, and also allow for 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 there are roughly 600 participants in the original Clean Sky Programme, for Clean Sky 2 we expect 800 - 1000. That is ample 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
With Clean Sky 2 now operating for approximately 18 months, three of the four Core Partner Calls that are foreseen for the Programme have been launched. The first Call has been fully implemented:

- 29 published topics with an expected lifetime funding value of €233m5i
- Opening July 2014;
- Closing date November 2014;
- Adoption of the ranking lists by the Governing Board February 2015;
- Adoption of new Members [June and September 2015];
- Accession to the appropriate Grant Agreement for Members [August thru November 2015].

Alongside the Leaders [16 in total] this first of four planned Calls for Core Partners has already led to 75 new Members representing 13 Member States joining the Clean Sky 2 Programme activities.

Some key facts and figures are set out below:

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5 Estimated through-to-completion funding values for Core Partners are provided on the basis of the best estimate of the overall programme funding allocations across the actions. The subsequent grant agreement values are always limited to the period of the valid Work Plan of the Clean Sky 2 JU and amended and extended with subsequent WP updates.
The second Call for Core Partners has passed the adoption phase of ranking lists and is now underway in terms of technical negotiation and grant preparation, with an expected start date of new Core Partners in the second quarter of 2016. Key facts and figures:

- 17 published topics with an expected lifetime funding value of €102m6
- Opening April 2015;
- Closing date July 2015
- Adoption of the ranking lists by the Governing Board Dec 2015;
- Adoption of new Members expected from April 2016
- Accession to the appropriate Grant Agreement for Members expected from May 2016.

Some key facts and figures of the 2\textsuperscript{nd} Call for Core Partners:

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of topics launched</th>
<th>Funding [topic ind. value k€]</th>
<th># Topics failed – no proposals</th>
<th># Topics failed – no proposals retained</th>
<th># Topics with a proposal retained</th>
<th>Total requested funding k€</th>
</tr>
</thead>
<tbody>
<tr>
<td>IADP Large Passenger Aircraft [LPA]</td>
<td>8</td>
<td>53.0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>72.9</td>
</tr>
<tr>
<td>IADP Regional Aircraft [REG]</td>
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<td>18.0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>15.5</td>
</tr>
<tr>
<td>IADP Fast Rotorcraft [FRC]</td>
<td>2</td>
<td>14.0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>16.0</td>
</tr>
<tr>
<td>ITD Airframe [AIR]</td>
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<td>43.5</td>
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<td>47.5</td>
</tr>
<tr>
<td>ITD Engines [ENG]</td>
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<td>0</td>
<td>7</td>
<td>70.0</td>
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<tr>
<td>ITD Systems [SYS]</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>11.4</td>
</tr>
<tr>
<td>Small Air Transport Transverse Area [SAT]</td>
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<td>Eco-Design Transverse Area [ECO]</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>203.0</td>
<td>1</td>
<td>2</td>
<td>27</td>
<td>233.4</td>
</tr>
</tbody>
</table>

Highlights in terms of the outcome of the Call

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\(^6\) Estimated through-to-completion funding values for Core Partners are provided on the basis of the best estimate of the overall programme funding allocations across the actions. The subsequent grant agreement values are always limited to the period of the valid Work Plan of the Clean Sky 2 JU and amended and extended with subsequent WP updates
• 79 new “participations” through 17 Topics from 66 participants [leading to approx. 50 potential new members when eliminating duplicates] involved in the winning proposals. [Approximately 120 Members resulting from CPW1+2]
• Average = 4.6 participants/proposal.
• 23 SME participations from 21 SMEs. Behind one PT SME acting as cluster leader there are 8 more. So nearly 30 SMEs were successful in this call
• SME requested funding [subject to successful negotiations] is almost 17.5m€ which is over 17% of the total requested funding.
• 4 new Member States and H2020 Associated Countries positioned to become [directly] represented in the Membership: PL [involved indirectly via CPW1 but not directly], PT, NL, IL. Meaning 16 member states + associated countries poised to become involved in/via Core Partners as a consequence of the first two Calls for Core Partners.

The cumulative results of the two first Calls for Core Partners in terms of geographical distribution and typology of the winning applicants are shown below.
With 16 countries represented in the winning proposals’ consortia, out of a total of 22 countries represented in the two calls [cumulative], the results show an encouraging level and geographic breadth of participation. The forecast funding distribution follows.

Notes:
1. Figures all represent “through-to-completion” or lifetime funding estimates;
2. Allocation of foreseen funding is on 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.

NB. It should be noted that, according to the Clean Sky Programme experience, the size and scope of the topics, and also to the expected typology of Members and Partners, the most appropriate calls for SMEs are the Calls for Proposals, for Partners. The limited percentage of SMEs here is however higher than the one experienced in Clean Sky Programme Associates, and as mentioned above, the second call for Core Partners (CPW02) resulted in a significant participation and success for SMEs.

A third Call for Core Partners was launched in October 2015. Its key metrics follow here below:

- Call comprised of 22 published topics with an indicative topic value of €96m
- Opening Oct. 2015;
- Closing date Feb. 2016;
- Evaluation planned for April 2016;
- Adoption of the ranking lists by the Governing Board tentatively by May 2016;
- Kick-off of Grant Preparation phase: June 2016;
- Accession of new Members tentatively: September 2016;
- Start of technical activity from Q4 2016.

The breakdown of topics [no results known as this call is due for evaluation in April 2016]:

**Typology of Winners - CPW01 and CPW02**

<table>
<thead>
<tr>
<th>% funding value</th>
<th>IND</th>
<th>RES</th>
<th>SME</th>
<th>UNI</th>
</tr>
</thead>
<tbody>
<tr>
<td>58%</td>
<td>29%</td>
<td>5%</td>
<td>8%</td>
<td></td>
</tr>
</tbody>
</table>

**Typology of Winners - CPW01 and CPW02**

<table>
<thead>
<tr>
<th>% funding value</th>
<th>IND</th>
<th>RES</th>
<th>SME</th>
<th>UNI</th>
</tr>
</thead>
<tbody>
<tr>
<td>58%</td>
<td>29%</td>
<td>5%</td>
<td>8%</td>
<td></td>
</tr>
</tbody>
</table>
By the end of 2015 the three Calls for Core Partners launched [of which two have been evaluated and are either fully implemented or in the stages of negotiation, will have “locked in” over 80% of the expected Core Partner activity and funding over the life of the programme. A fourth and final Call for Core Partners is foreseen in 2016, and this should complete the selection process for the Clean Sky 2 Core Partners and for the membership, on time with respect to the planning made at the Programme’s start. The 4th Call for Core Partners is expected to contain roughly another 10-12% of the Core Partner funding, which will allow for flexibility in the downstream management of the Programme in bi- or multi-annual work plans and GAMs.

**Summary of Call results to date – Calls for Proposals**

In the 18 months from the Programme commencement two Calls for Proposals were launched: Details follow below for the first of these calls, which is now nearly complete in terms of grant preparation.

- Call comprised of 53 published topics with an indicative topic value of €48m
- Opening 16 Dec. 2014;
- Closing date 31 March 2014;
- Adoption of the ranking lists by the Governing Board July 2015;
- Kick-off of Grant Preparation phase: Aug. 2015
- Deadline for 8 month Time to Grant [TTG]: end Nov. 2015;

TTG performance in this first call was 61% after 9 months, albeit with no grants successfully completed inside the 8 months’ target. This was due in large part to the system and process immaturity at the start of grant preparation, with many corrections and interventions needed to correct errors or implement work-arounds. Nonetheless a strong improvement in the TTG performance is deemed necessary and corrective action is already partially in place for the 2nd Call for Proposals, with the overall process including all CS2 specificities expected to be mature.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of topics</th>
<th>Funding* (M€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IADP Large Passenger Aircraft</td>
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<tr>
<td>IADP Regional Aircraft</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IADP Fast Rotorcraft</td>
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<td>25</td>
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<tr>
<td>ITD Airframe</td>
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<td>15,5</td>
</tr>
<tr>
<td>ITD Engines</td>
<td>4</td>
<td>16,5</td>
</tr>
<tr>
<td>ITD Systems</td>
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<td>26,9</td>
</tr>
<tr>
<td>Small Air Transport (SAT) Transverse Area</td>
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<tr>
<td>ECO Transverse Area</td>
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</tr>
<tr>
<td>Technology Evaluator 2</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22</strong></td>
<td><strong>95,9</strong></td>
</tr>
</tbody>
</table>
from the 3\textsuperscript{rd} Call for Proposals in 2016.

Results of this 1\textsuperscript{st} call are very encouraging in terms of the level of applications. After only one Call for Proposals [Partners] of a likely total of 12 115 Partner-level participants were selected [and nearly 500 applied, demonstrating a healthy interest].

Some key facts and figures are shown below:

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of topics launched</th>
<th>Funding [topic ind. value k€]</th>
<th># Topics failed – no proposals retained</th>
<th># Topics failed – no proposals retained</th>
<th># Topics with a proposal retained</th>
<th>Total requested funding k€</th>
</tr>
</thead>
<tbody>
<tr>
<td>IADP Large Passenger Aircraft [LPA]</td>
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<td>14.9</td>
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<td>0</td>
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<td>14.1</td>
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<tr>
<td>IADP Regional Aircraft [REG]</td>
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<td>0.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>IADP Fast Rotorcraft [FRC]</td>
<td>8</td>
<td>4.4</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>4.2</td>
</tr>
<tr>
<td>ITD Airframe [AIR]</td>
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<td>9.8</td>
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<tr>
<td>ITD Engines [ENG]</td>
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<td>0</td>
<td>10</td>
<td>14.4</td>
</tr>
<tr>
<td>ITD Systems [SYS]</td>
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<td>1</td>
<td>7</td>
<td>4.1</td>
</tr>
<tr>
<td>Small Air Transport Transverse Area [SAT]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eco-Design Tranverse Area [ECO]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Technology Evaluator [TE2]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>48.0</td>
<td>3</td>
<td>1</td>
<td>49</td>
<td>47.8</td>
</tr>
</tbody>
</table>

After the approval of the ranking lists and the technical alignment in the grant preparation in this call, two top-ranked proposals failed to reach a successful outcome and a subsequent grant. The grant preparation is now underway for the second-ranked proposals. These results are included in the statistics shown below [in terms of geographic spread and typology of winners].

The results of this 1\textsuperscript{st} call in terms of geographical distribution and typology of the winning applicants are shown below.
The results show a strong performance from the Research Organizations and Academia, who
together for instance will receive over 60% of the funding related to the Research and Innovation Actions [RIA] topics launched in the call. Even in the Innovation Actions [IA] launched in this call, the combined share of these two segments was a surprising 49%. This clearly dispels any perceptions that Clean Sky 2 would in any way be prohibitively “high-TRL” or “Industry focused”.

Separately however, the first results of this first CfP in the area of SME participation at 19% overall [RIA and IA] were lower than expected and somewhat disappointing. It was agreed to re-emphasize the opportunity for SMEs in Clean Sky 2 via all communication channels, and with the support of the SRG. The JU will monitor this closely in the upcoming calls [2nd and 3rd CfP] and determine whether further remedial action would be necessary. As can be seen in the preliminary results of the 2nd Call for Proposals [below], a notable improvement seems already present. This will continue to be monitored closely in 2016 and where necessary corrective action proposed.

The 2nd Call for Proposals [CfP] was launched in 2015, with key figures and milestones as set out below

- Call comprised of 64 published topics with an indicative topic value of nearly €58m
- Opening July 2015;
- Closing date Nov. 2015;
- Adoption of the ranking lists by the Governing Board is expected by Feb. 2016;
- Kick-off of Grant Preparation phase: March 2016;
- Deadline for 8 month Time to Grant [TTG]: July 2016;

As the call results are at this time still under the GB approval procedure, further results will follow in the next Annual Activity Report. At the closing of this call in November 2015 the following – encouraging – levels of participation were noted. The significant increase in SME proposal participation is encouraging, although still somewhat below shares seen in the Clean Sky CfPs under FP7.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Nbr of entities</th>
<th>Nbr of participations</th>
<th>% funding request</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND</td>
<td>62</td>
<td>73</td>
<td>20%</td>
</tr>
<tr>
<td>RES</td>
<td>62</td>
<td>120</td>
<td>27%</td>
</tr>
<tr>
<td>SME</td>
<td>108</td>
<td>131</td>
<td>31%</td>
</tr>
<tr>
<td>UNI</td>
<td>77</td>
<td>126</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>309</strong></td>
<td><strong>450</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Notwithstanding the ambition to further encourage access to the CS2 calls, any perception that Clean Sky is a “closed shop” is clearly dispelled by these facts and figures.
1.1.4. Progress against KPIs / Statistics (Annex 5)

The Key performance Indicator results for the year 2015 are presented in Annex 5. 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 they are applicable to the JU and provide meaningful results. Comments to some individual indicators are provided in the table in the annex or in the related section of the report, to which the indicators refer. 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 proposals and the following evaluation process for Partners and Core Partners.

The JU uses the H2020 tools for processing GAPs. As the first call went through these systems some technical issues were encountered when processing the first batch of grant agreements which delayed the grant process by some weeks. It is hoped that these issues will no longer raise any problems for the following calls. The JU missed the 8 month deadline by a number of days in many cases; 63% of GAPs were signed within 9 months. The remaining open GAPs required closer and earlier follow up from all parties. It can be reminded that the topic manager role here is an additional element in the process which is not present in other H2020 calls.

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

In the reporting year [2015] one evaluation started in 2014 was completed with the adoption of the evaluation ranking list by the Governing Board, namely for the first Call for Core Partners. For two other calls, namely the first Call for Proposals and the second Call for Core Partners, the full evaluation from assessment by the appointed experts through to Governing Board adoption were performed in-year. For the second Call for Proposals the proposal evaluation was commenced in December 2016, but completed in January 2016, with the Governing Board approval of the ranking lists expected by end of February 2016.

Finally, for one call: the third Call for Core Partners, the call was launched, but given to the closing date in February 2016 the evaluation is scheduled for Q2 2016. This latter call is not included in the statistics shown below.

For all calls with the majority of activity in 2015 the breakdown of experts selected in gender and nationality is shown below. [Note: for the latest call shown the final number of days to be claimed by the experts is as yet unknown].

<table>
<thead>
<tr>
<th>Call</th>
<th>CPW01</th>
<th>CPW02</th>
<th>CFP01</th>
<th>CFP02</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Experts</td>
<td>34.0</td>
<td>59.0</td>
<td>76.0</td>
<td>94.0</td>
</tr>
<tr>
<td>Gender Balance [% Female]</td>
<td>6.3</td>
<td>22.0</td>
<td>23.6</td>
<td>15.9</td>
</tr>
</tbody>
</table>
| Nationalities [%]:
  | UK    | 16.7  | 5.1   | 6.6   | 11.8  |
  | Spain  | 14.3  | 13.6  | 10.5  | 9.7   |
  | Germany | 11.9  | 13.6  | 11.8  | 16.1  |
  | France | 11.9  | 16.9  | 11.8  | 9.7   |
  | Italy  | 9.5   | 11.9  | 13.2  | 17.2  |
Highlights:

1. After the first Call for Core Partners, efforts were redoubled to address the experts’ gender balance, where possible and where maintaining the level of experience and aeronautical [or similar] technical background. The resulting share [female experts] exceeds previous gender balance performance in the CSJU; however it is not seen as easily improved upon beyond this level given the specificities of the technical areas and subject matter involved

2. We are confident 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. Over the calls fully evaluated [with the procedure completed] the redress rate was 1.98%. This is well within the KPIs agreed.

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

I. Clean Sky programme

Below the key elements of technical progress in 2015 in the Clean Sky Programme are highlighted. Further details are highlighted in Annex 9.

The original 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 Small Fixed Wing Aircraft ITD (SFWA), focused 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), focused 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), focused 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.

The Technology Evaluator, started to be the first available European complete integrated tool delivering direct relationship between 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 and the levels of aircraft, airport and aircraft fleet level.

As aircraft fuel economy is also influenced by a flight trajectory management strategy, CSJU 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. for Clean Sky, the SGO Project Officer, up to the two Executive Directors).

In the following subchapters, the summary description of activities and achievements by ITD and TE is provided, with indications and explanations of significant deviations compared with initial planning, where applicable. Further details are highlighted in Annex 9.

**SFWA – SMART FIXED WING AIRCRAFT**

The preparation of the main demonstrators of the SFWA technologies were completed, consisting of performing tests on large ground and flight demonstrators, such as the natural laminar flow wing, the smart flap for low speed applications, 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 at the final assembly hangar in Tarbes, for the preparation, maintenance, conduct and refurbishment activities for a period of, in total, two years. The laminar test wing articles arrived at the assembly in Vitoria (Spain) for the formal launch of assembly of the full wing in December.

The ground based demonstration associated to the development of the laminar wing for large
transport aircraft was concluded 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 is planned to take place behind a Dassault Falcon 7X to obtain realistic data about the thermal, acoustic and fatigue behaviour of the advanced V-tail concept, is now prepared for full-scale tests mid-2016.

CROR activities are now shifted to CS2 for the FTD; some technology assessments have been completed as planned, including analyses of available wind tunnel test data.

All major SFWA activities associate to 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 2015:
- Dedicated dock and hangar ready to host the BLADE test aircraft;
- Start of the final assembly of the BLADE Airbus A340-300 test aircraft with all major components;
- Integration of Laminar wing test results for large passenger aircraft into a next generation short range aircraft concept;
- Completing of Low Speed Business Jet “Smart Flap” ground test campaign;
- Completing of simulator tests for active load control functions large transport aircraft;
- Completing of simulator tests for vibration control tests for business jets;
- Completing of buffet control technology wind tunnel tests;
- Completing of CROR shielding concept studies for primary structures;
- Completing of smart flap demonstrator structural integration;
- Completing of mid-scale validation wind tunnel tests of active flow control concept.

Most significant deliverables in 2015:
- Delivery of the Port and Starboard laminar wing test articles for final assembly of the BLADE demonstrator wing.
- Wing diffusion zones, aero-fairings, wing tip pods and plasterons delivered on dock at BLADE final assembly line;
- Delivered of all major components for BLADE flight test instrumentation to final assembly line;
- Completing of the Smart Flap Low Speed Business-Jet (LSBJ) high Reynolds number aero performance tests. Completing and analysis of the Wind tunnel tests;
- Completing of the CROR related impact & trajectory tests, preliminary results available;
- Definition of the in-flight PIV diagnostic concept for CROR demo-engine flight test, integration concept for test aircraft available;
- Completing of the Innovative Bizjet afterbody wind tunnel flutter test preliminary results available;
- PANEM model of CROR-powered short and medium range transport aircraft including key system features from SGO-ITD updated with recent results accomplished in SFWA.
GRA – GREEN REGIONAL AIRCRAFT

Future green regional aircraft will have to meet demanding weight reduction, energy and aerodynamics efficiency, a high level of operative performance, in order to be compliant regards to pollutant emissions and noise generation levels. 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 in the years 2015 - 2020. The project has 5 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 in 2015

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 acoustic).

Structural and Systems modifications were successfully applied and flight tested on the ATR 72 (in July 2015): the new composite stiffened panel replaced the standard aluminum panel in the fuselage crown area.

The Cockpit demonstrators were displayed during the GRA Interim Progress Review in December 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.

Some WTT took place as planned, while for some advanced model the execution of the projects performed by Partners was affected by delays, still being resolved at end of 2015.

In addition, mechanical tests on a full-scale prototype of the morphing flap sized to the half-outboard flap of the 130-seat A/C were successfully completed, including Ground demo of LC&A (Load Control and Alleviation) system architecture through a representative test rig.

Most of the activities performed in Mission and Trajectory Management domain concentrated the final Flight Simulation Demonstration test according to the defined procedure. The overall assessment of the domain project results, collecting pilot feedback and environmental benefit due to the implementation of green FMS functions, were conducted. Demonstration of the Green FMS (Flight Management System), using a realistic Regional Flight Simulator, was completed.

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 (still under development at end of 2015). The updated A/C Simulation Models (GRASMs) for the assessment of environmental targets achievement in terms of air pollutants emission (CO₂ & NOₓ) and external noise reduction, based on experimental results and enclosing the MTM Technologies, was delivered to the Technology Evaluator.

Most significant milestones achieved in 2015:

- Completion Ground Full Scale Test;
- E-ECS verification of integration on A/C on ground;
- Completion of Flight Test Demonstration (related to the structural modification);
- Completion of Flight Simulator Demonstration;

Most significant deliverables in 2015:

- Fuselage Ground Test Demonstration results;
- Wing Box Ground Test Demonstration results;
- Cockpit Ground Test Demonstration results;
- E-ECS rack available;
- Systems FTI kit available;
- Flight test Engineering Station available;
- ATR (MSN098) modified A/C (ready for the first test campaign);
- Ground demonstrators of morphing flap and of LC&A system architecture and relevant tests results;
- Final MTM Report based on Simulation Test execution;
- GRASM (TP90 pax and GTF 130 pax A/C of Design Loop 3 and with MTM Technologies).

**GRC – GREEN ROTORCRAFT**

The Green Rotorcraft ITD gathers and structures all activities concerning the integration of technologies and the demonstration on 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 at reducing the environmental footprint by reducing emissions and halving the rotorcraft perceived noise for the next helicopter generation.

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, 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 in 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 both on new procedures in take-off and landing phase (IFR based) and new flight envelope definition to reduce noise (steep approach) and pollutant emissions. An intensive work with SESAR (Single European Sky Air Traffic Management Research), EASA (European Aviation Safety Agency) and ICAO (International Civil Aviation Organization) is active to introduce new solutions operational by 2020.

**GRC6 - EcoDesign 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 EcoDesign 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 behavioural models were delivered at different level of accuracy since 2013.

**Overview of main achievements in 2015**

In the **Innovative rotor blades** the design, manufacturing and testing for the integration of the Active Gurney Flap system in the rotor blade continued in 2015, with component tests and scaled models testing in wind tunnel. The active twist concept was further developed, with the manufacturing of the specimen, the bench testing and the final test report. The passive blade design was finished by the CDR, while the manufacturing and whirl tower testing will be completed in 2016.

**Reduced drag of airframe and dynamic systems activities** concentrated on activities performed by Partners, mainly based on Wind tunnel test campaigns to validate performance predictions all along the programme. Flight test campaigns on modified helicopter also took place in 2015. For the **Integration of innovative electrical systems activities**, the main changes in 2015 related to the decision to not use the Copper Bird electric test bench, concentrating on the available internal tests rigs. The electric tail rotor technology testing was finalized on a AW in-house test rig.

The demonstration of integration of a high compression Engine on a Light Helicopter was successfully completed with flight demonstrations in early 2015. The assessment of the test campaign results and further tests options were discussed at the end of 2015.

For the **Environment-friendly flight paths** the main achievement consisted of the demonstration of the IFR Low Noise procedure in May 2015 at Marseille airport.

**EcoDesign Rotorcraft Demonstrators activities** continued the manufacturing and testing helicopter sub-assemblies as specific helicopter demonstrators to the basic demonstration in EDA (Eco Design for Airframe).

**Technology Evaluator for Rotorcraft activities** produced the updated models of the different
Conceptual helicopters and were tested on the simulation tool Phoenix, and shared with TE.

Most significant milestones achieved in 2015:

- Wind-tunnel test of the optimised GRC2 common platform
- Tilt Rotor eco-IFR procedures validated by Pilot in the Loop simulations in laboratory environment (with ATC).
- Completion of HCE (High Compression Engine) flight test campaign
- Final flight test demonstration of Low-Noise VFR Approach Guidance on EC145
- Delivery of Final PhoeniX platform to the TE

Most significant deliverables achieved in 2015:

- Synthesis report on WT measurements on a AW Heavy helicopter fuselage
- Summary on the flight test results for the AH light helicopter featuring the new rotor head and fuselage fairings.
- Summary on the flight test results for the AH light H/C with the new air intake.
- Test report on wind tunnel experimental campaign of oscillating AGF airfoil in dynamic stall conditions
- Tooling ready for manufacturing (Rotor blade innovative shape)
- Synthesis report on the design of the air-Intake and exhaust of a tilt-rotor
- Synthesis Report of the Design Studies for an Optimised Green Tiltrotor
- HCE initial flight tests campaign test report
- Synthesis report of flight demonstration at Toulouse-Blagnac
- Phoenix Black Box V6.1 for TE – TEH U1 / Phoenix Black Box V7.1 for TE – TEL U2
- Light Twin Engine Helicopter Models – EUROPA, TM Engine and HELENA V7.1
- Heavy Twin Engine Helicopter Models – EUROPA, TM Engine and HELENA V6.1

SAGE – SUSTAINABLE AND GREEN ENGINES

2015 represented a significant year of progress with respect to the planned demonstrators in SAGE, namely the 3-Shaft Turbofan, the Geared Turbofan, the Turboshaft and the Lean Burn.

Overview of main achievements in 2015

SAGE 1 continued the focus on the 4 themes still active: Open Rotor (OR) Design Fast CFD; Component Integrity; Forced Response and Noise. The activities were performed mostly by academic partners and consisted in the development of codes to provide a fast capability to analyse and understand the steady and unsteady aerodynamics of installed open rotors, to provide the capability for impact engineering with composite materials for open rotor designs feature variable blade pitch angles in conjunction with an overhung rotor and the continuation of Aero and Noise Methodology Development.

SAGE 2 - The Geared Open Rotor Demonstrator project aims at assessing the open rotor architecture feasibility and environmental benefits. The activities performed concentrated on the adaptation of the existing gas generator and a rig for technology validation and integration demonstration, the development of enabling manufacturing technologies and materials necessary to deliver the engine technologies for demonstration to deliver and install a demonstrator at the ground test facility (initial planning Q4 2015 updated planning moved to
2016), and, on the basis of prediction and test data obtained from the engine, to assess the improvements in gaseous and noise emissions that may result from a production open rotor propulsion system. After the Critical Design Review in 2014, the assembly and instrumentation and the delivery of the SAGE2 demonstrator to the ground test facility started. The ground test facility (Open test Bench) started construction at end 2014 and continued in 2015.

Considerable progress was made in all elements of the working programme of Project SAGE 3 in 2015.

The Composite Fan System demonstration focused on the ALPS CFS1 Outdoor Fan Blade Damage Test with composite fan blades being successfully completed at Stennis-USA on-schedule and hence hitting a very high value Milestone for this Project. Fan Blade Tip rub data were acquired and submitted to support future engine designs. ALPS CFS2 engine testing, involving flutter, blade tip clearance, and air intake acoustic impedance testing was delayed to 2016. Another very significant Milestone for the entire composite fan system development programme was achieved the planned Trailing Blade Integrity test completed in Q2 2015. The annulus filler TRL6 review has been successfully completed.

As far as the Low Pressure Turbine work-strand is concerned, the engine testing demonstration was completed and good quality data were collected.

In 2015, SAGE4 has successfully completed engine assembly and engine testing. In total 107 hrs and 500 cycles of engine testing have been accumulated. The engine test data have been evaluated online during the test campaign and a pre-assessment of the mechanical behaviour of the hardware has been performed via borescope inspection.

With the accomplished engine test programme and the assessment up to now, all the incorporated technologies in HPC, LPT and TEC module have successfully demonstrated their capability at engine conditions.

Also the SAGE 4 partner companies like GKN and Meggitt have evaluated the test data out of the engine test campaign. SAGE 4 partner AVIO made significant progress in building a new test facility for gear boxes (CfP Project GeT FuTuRe). Also the manufacturing, instrumentation and assembly of the Integrated Drive System test hardware has been completed. The test activities are planned to start at the beginning of 2016.

The first step of the demonstration SAGE 5 was already achieved in 2013, aiming at testing the engine demonstrator at partial TET temperature (Built 1). Built 2 first engine test occurred mid-2014, testing the engine in all operating range at ISA sea level, to confirm that the fix implemented to solve vibration issues were successful. Engine performance test has been recorded and analysed. The engine models have been updated with test data. The global target of 15% reduction in fuel consumption has been confirmed. The built 2 test campaign was completed in 2015 by a highly instrumented test in order to measure the secondary air system and HP components performance. The engine investigation and final test report will be completed beginning 2016.

SAGE 6 made significant progress turning the lean burn development programme from the concept and design phase into hardware manufacture and engine build. All schemes for the first lean burn demonstrator engine (ALECSys Advanced Low Emissions Combustion System)
have been released and the engine is technically sealed. Key hardware has been received which enabled build start of the Trent1000 based ground test engine in October. The second ALECSys engine is planned for installation on the RR B747 flying testbed for flight testing in the second half of 2016.

Most significant milestones achieved in 2015:

**SAGE1**
- Open Rotor Component Integrity (Composite damage model available);
- Open Rotor Forced Response (Technical Report);
- Open Rotor Component Integrity;
- Open Rotor Forced Response;

**SAGE2**
- Start of the assembly of the demonstrator;

**SAGE3**
- Composite Fan System Pass to Test of the ALPS CFS2 composite fan system (including composite fan case) demonstrator.
- Low Pressure Turbine Demonstrator Pass to Test. Pass to Test of ALPS LPT1 build for ground demonstration of low pressure turbine technologies

**SAGE4**

**SAGE5**
- Finalisation of results analysis of demonstration on Built 2

**SAGE6**
- First Engine Run.

Most significant deliverables in 2015:

**SAGE1**
- Open Rotor Design Fast CFD Solver (Update Report);
- Open Rotor Component Integrity (Update Report);
- Open Rotor Forced Response (Update Report);
- Noise (Update Report);

**SAGE2**
- Mounts test report;
- Demonstrator ready for test;

**SAGE3**
- Final Parts to Stores for Composite Fancase demonstration. Delivery of final parts for build of the ALPS CFS2 engine
• Final Parts to Stores for Low Pressure Turbine demonstration. Delivery of final parts for build of the ALPS LPT1 engine

SAGE4
• GTF demonstrator ground test report. *Delivery of post-test reports;*

SAGE5
• Finalisation of results analysis of demonstrators performed

SAGE6
• Engine ready to test.

SGO – SYSTEMS FOR GREEN OPERATIONS

The “Systems for Green Operations” ITD is focused on the development and demonstration of innovative technologies for *Management of Aircraft Energy*, dealing with electrical systems for fixed and rotary wing aircraft, and *Management of Trajectory and Mission*, addressing the optimisation of all flight phases from an environmental point of view.

Overview of main achievements in 2015

In early 2015 the large scale integration test of electrical systems was completed on PROVEN Airbus test bench. In addition to the completion of electrical system testing, a thermal test rig was introduced for thermal management hardware i.e. the VCS hardware and the thermal load management function.

The PFIDS innovative Ice detection system reached TRL5 in 2015 by dedicated flight test.

The maturity demonstration of the electrical environmental control system will be completed preparing for the e-ECS flight tests (reduced pack size of 50kW) to be performed in 2016.

The electrical ECS demonstrator for the Regional Aircraft application was matured on ground reaching TRL4 beginning of 2015. The flight test for this system, initially planned on the ATR 72 FTB at mid-2015, was postponed to early 2016.

The development of the HEMAS hardware for the helicopter architecture continued; however, the initial plan for tests in cooperation with the GRC ITD on the COPPER Bird was replaced by rig testing at partners facilities.

In the field of FMS Optimised trajectories, the optimized steps in cruise, reached TRL5, with tests in simulated environment. In parallel, the MCDP function targeting the take-off and final approach phase was assessed with the involvement of an airline. Finally, all the 3 functions performed integration tests in an FMS prototype to confirm industrial feasibility; the tests finalization for the TRL6 activities is planned in 2016.

The Flight Management and guidance function were flight tested on board a Cessna Citation aircraft.

The final tests of integrated new weather radar algorithms and trajectory optimisation functions on GRA regional aircraft simulator was completed, providing technical results to achieve TRL5.

Technologies for electrical taxi via an on-board wheel actuator system was tested in a full scale dynamometer bench.

Main results – validated during TRL gates - and expected gains were consolidated for transfer to the vehicle ITDs for further tests and/or integration in Concept Aircraft models, and finally
transferred to the Technology Evaluator for consolidation and full assessment of environmental gains obtained by Clean Sky research.
In the field of mission optimisation functions, further coordination with SESAR was pursued, in order to ensure consistency of the Clean Sky functions with the future evolutions of the Air Traffic Management system.

Most significant milestones achieved in 2015:

- TRL4 E-ECS for Regional A/C
- TRL4 ECS mid-size pack (large aircraft)
- TRL5 50KW Power electronics for E- ECS (large aircraft)
- TRL3 Helicopter electro-mechanical actuation system HEMAS
- TRL5 WIPS System - Electromechanical Deicing System
- TRL5 Vapour Cycle System
- TRL5 Primary in Flight Ice Detection System
- TRL5 On-board Optimisation (Q-AI)
- TRL5 Multi step Cruise function

Most significant deliverables in 2015:

- PFIDS Delivery for flight tests
- Vapour cycle system for thermal bench tests
- Mid-Size pack, pack controller, power electronics and associated cooling system to large aircraft
- ECS Release of Equipment for Flight Test Demonstrator in GRA
- Preliminary Report on HEMAS final tests results
- Flight Test results for Time and Energy Management function (MPG-TEMO: Final report cycle 2)
- Final Test results of A-WxR and Q-AI ground test in Regional simulator
- Multi step cruise function FMS implementation report
- Smart Operation on ground System Ground test report

ECO – ECO DESIGN

Eco-Design ITD is organized in the two major areas of EDA (Eco-Design for Airframe) and EDS [Eco-Design for Systems (small aircraft)].

The EDA part of the Eco-Design ITD is meant to tackle the environmental issues by focusing on the following challenges:

1. To identify and mature environmentally sound (“green”) materials and processes for a/c production.
2. To identify and mature environmentally sound (“green”) materials and processes for a/c maintenance and use processes.
3. To improve the field of end-of-life a/c operations after several decades of operation, including reuse, recyclability and disposal (“elimination”) issues.
4. To provide means for an eco-design process in order to minimize the overall environmental impact of a/c production, use/maintenance and disposal.
It is important to remark that 2015 was the last operational year of Eco Design ITD.

**Overview of main achievements in 2015**

Eco-Design ITD is organized in the two major areas of EDA (Eco-Design for Airframe) and EDS [Eco-Design for Systems (small aircraft)].

In 2015, the work performed in the frame of **EDA** was related to the following Work Packages:

- WP A.3 Application Studies,
- WP A.6 Lifecycle Ground Demonstration.

In WP A.3, WP A.3.1.1 (Evaluation Tools), A.3.1.3 (Final Eco-Statement) produced the final synthesis

- In WP A.3.1.1 the finalisation of the database for the new technologies by using results from the ground demonstrations.
- In WP A.3.1.3, the finalisation of eco-statement of new technologies.

Ground demonstration activities continued for the equipment (A.6.2) as well as for the equipped airframe demonstrators (A.6.1).

The EDA part was finalised to produce conclusion on new technologies (feasibility, interest and final TRL). Data were passed to the TE for aircraft/mission level final assessment.

The work in the frame of EDS part of the Eco-Design ITD consisted mainly in finalizing the characterization of the business jet sub-systems architectures (WP S.2).

The work within WP S.2 continued at the level of the bizjet architecture trade-off (S.2.6) supported by modelling activities (S.2.5) and ground tests results.

The ground electrical tests on the Electrical Test bench COPPER Bird (WP S.3) and thermal tests on the TTB Thermal Test Bench (WP S.4) were completed including results analysis and validation.

**Most significant milestones achieved in 2015:**

- Final results of demonstrations to TRL 6 - Equipped airframe
- Final results of demonstrations to TRL 6 - Equipment
- General synthesis of WP S.2
- General synthesis of WP S.3
- General synthesis of WP S.4

**Most significant deliverables in 2015:**

- Dissemination & Communication Plan (update)
- Eco-Statement Final Report
- Equipped Airframe demonstration: Synthesis Report
- Airframe demonstrators: final results
- Equipment demonstrators Synthesis Report
- Application studies Final Synthesis Report
- Thermal bench conclusions and recommendations
- Final Review
- General synthesis of WP S.4
- General synthesis of WP S.2
- General synthesis of WP S.3
The closing phase and final review of Eco Design ITD will take place in the first quarter of 2016.

**TE - TECHNOLOGY EVALUATOR**

The TE performed in 2015 a global environmental Clean Sky Assessment, based on its set of dedicated tools, in order to monitor the environmental progress brought by ITDs’ technology outputs, and in order to ensure a consistent technical assessment approach with respect to the environmental objectives. This 2015 Assessment considered all segments of commercial aviation, ranging from large and regional aircraft to helicopters and business jets. This environmental impact assessment update was done, as in the previous TE assessments, at three complementary levels:

- Mission level, considering one single aircraft flying a set of typical missions. For fixed-wing aircraft, missions are defined in terms of a set of representative ranges. In case of helicopters, typical missions will be specifically defined;
- Airport (operations) level, for instance around an airport, considering all departing and arriving flights on a single (representative) day
- Global air transport system level, considering the global aircraft and rotorcraft fleet.

The TE will continue its Clean Sky technology evaluation task based on environmental metrics, in order to reach the contractual CS final assessment in 2016. These updates of the ITD a/c models result from the integration in these models of new and higher TRL level technologies. Also, from one assessment to the next one, more complex scenario were introduced (more airports, taking into account SESAR, updating forecasts). All these global or partial assessments aim to help secure the final TE Assessment which is planned for the end of 2016.

To support all assessments and trade-off studies, the TE system is being upgraded every year, following an incremental procedure, on the basis of user’s feedback, in order to get it both more powerful and easy to use.

**Overview of main achievements in 2015**

An updates assessment was produced, including improved ITDs a/c models, updated airport, ATS scenario, and LCA scenario; trade-off studies and an updated TE system.

This objective is detailed by Work Packages as follows:

**WP1: Planning**
- planning updates of the global and partial TE assessments as well as trade-off studies, taking into account the major ITDs demonstration and TRL achievements

**WP2: Models**
- Large aircraft: 2015 PANEM update (bizjet/mainliners): integration of new or updated functionalities as required
- Regional aircraft: 2015 GRASM update: integration of new or updated functionalities as required

WP3: TE system
- Updated TE computer system: TE-IS and 3 platforms simulation framework

WP4: TE assessments
- TE global assessment in June 2015, including PANEM, GRASM and PHOENIX models updates
- Mission level: Mission assessments defined, including development/updates of ITD models
- Airport level: Airport assessments according to specification defined at end of 2014 including updates of and new airports and updated ITD models
- ATS level: ATS assessments according to specification defined at end of 2014 including updates of forecasts / traffic scenarios and updated ITD models
- LCA: LCA analysis for production phase for CleanSky reference and concept aircraft/rotorcraft

Most significant deliverables in 2015:
- End 2015: provisional TE assessment report

Most significant deliverables in 2015:
- Mid Feb 2015: 2014 TE Annual report
- End 2015: provisional TE assessment report issued
II. Clean Sky 2 Programme

Below the key elements of technical progress in 2015 in the Clean Sky 2 Programme are highlighted. Further details are highlighted in Annex 9.

LARGE PASSENGER AIRCRAFT IADP

The key focus of activities in 2015 was on completion of the technical management structure. The implementation of Wave 1 Core Partners and their activities into the 2015 Work Plan was achieved. The establishment of a detailed work plan for 2016 and 2017, including the planning of the engagement of further Core Partners and Partners to be selected through open calls was made. A strong ramp up of R&T activities occurred, details of which in Annex 9.

Major milestones accomplished in 2015
• Endorsement of updated Project Development Plan for CROR FTD;
• Target design and manufacturing process for the Hybrid Laminar Flow Control (HLFC);
• Economic analysis of the V&V strategy for UHBR engine integration on a flying testbed;
• Selection of Partners for the ADVANCE End-to-End [E2E] maintenance demonstrators.

Major deliverables accomplished in 2015:
• Concept Study and related dossier for Non-Propulsive Energy (NPE) for LPA / biz jets;
• Several elements on the HLFC;
• Deliverables related to Energy Storage specification, design, and hardware;
• Concept preparation of Multifunctional & Lower Centre Fuselage, Cabin & Cargo demos
• High level requirements definition initiated for an A320 aircraft platform;
• The body landing gear architecture;
• Intermediate scenario analysis for the “E2E” maintenance concept;
• Preliminary Integrated Health Monitoring & Management evaluation/demonstration plan;
• Structural Health Monitoring use case analysis;
• Concept development of System prognostics for “E2E” maintenance concept;

REGIONAL IADP

Activities performed during the year 2015 included a detailed definition of technical activities for the IADP. This was further consolidated into work-packages with the contributions from relevant Core Partners selected in Wave 1. Support was provided for the selection of Core Partners Wave 2 who will start their activities in 2016.

Major milestones accomplished in 2015
• First wing structural conceptual design [FTB1]

Major deliverables accomplished in 2015:
• TLAR High-Efficiency Regional aircraft requirements [“loop 0”] [FTB1];
• WTT models specification [FTB1];
• FTB1 preliminary requirements [FTB1];
• Aerodynamic concept definitions of FTB2;
• Preliminary flutter analysis [FTB2].
FASTROTORCRAFT IADP

The Fast Rotorcraft IADP [FRC] consists of two separate demonstrators, the NextGenCTR tiltrotor and the LifeRCraft compound helicopter. These two fast rotorcraft concepts aim to deliver superior vehicle productivity and performance, and through this economic advantage to users. The main activities in 2015 were on the preliminary scoping and sizing of the demonstrators, the building of the consortia via the Core Partner and Partner calls and the elaboration of the work breakdown structures for the two major programme elements and demonstrators.

Major milestones and deliverables accomplished in 2015 in NextGen CTR

- Preliminary Design Requirements and Objectives;
- Vehicle Technical Specification-v1;
- Preliminary Requirement Review;
- System Concept Review;
- System Requirement Review;
- Drive Systems Trade Studies.

Major milestones and deliverables accomplished in 2015 in LifeRCraft:

- Negotiation with Core Partners selected from CPW1 completed; Activities started in July;
- Grant preparation with 8 partners/consortia from CfP1 nearly completed by end 2015;
- Topics defined and launched in successive calls for Core Partners [Wave 2/3] and CfP;
- LifeRCraft feasibility study concluded and general programme specification frozen;
- Preliminary design started; 2 WTT campaigns performed and one prepared by end 2015.

AIRFRAME ITD

Due to the large scope of technologies undertaken by the Airframe ITD [AIR] (addressing Large Passenger Aircraft, Regional Aircraft, Rotorcraft, Business Jets and Small Transport Aircraft), the ITD is structured around 2 major Activity Lines:

A. Demonstration of airframe technologies focused toward High Performance & Energy Efficiency; Related Technology Streams are identified with a “A” hereafter.
B. Demonstration of airframe technologies focused toward High Versatility and Cost Efficiency. Related Technology Streams are identified with a “B” hereafter.

Overall, the main activities concerned the elaboration of the ITD’s set-up and completion of the Launch Reviews. The input to calls for Core Partners and CfP for 2015-16 was prepared.

A: High Performance & Energy Efficiency

Work started in all major WPs: Innovative Aircraft Architecture, Advanced Laminarity, High Speed Aircraft, Novel Control, Novel Travel Experience.

A reference bizjet aircraft was defined to assess CS2 innovative technologies. This concerns a typical business jet with Year 2015 technologies (DAv). FhG started the collection of technology proposals for the planned demonstrator “hybrid seating cushion” and technologies for the other demonstrators in airframe with FhG participation.
B: High Versatility and Cost Efficiency
Work started in all major WPs: Next generation optimized wing, Optimized high lift configurations, Advanced integrated structures, Advanced fuselage,

Major milestones accomplished in 2015
• Selected Technologies for SAT high-lift devices [A]

Major deliverables accomplished in 2015:
• GAINS Programme Plan (anti-ice technologies) [A]
• GAINS Dissemination and exploitation Plan [A]
• Report on demands imposed on connections by Regulations [B]
• SAT Diesel engine installation studies [B]
• SAT Report on loading and environmental demands imposed on typical connections [B]
• SAT Report on riveted/bolted structures [B]
• SAT Technologies trade off studies [B]
• ASTRAL (next-generation optimized wing related) Communications Plan

ENGINE ITD

The management of the Engines ITD [ENG] was established and rapidly matured and stabilized. 2015 also saw the conclusion of the negotiation with Core Partners from “Call for Core Partners Wave #1”, as well as the negotiations with Partners from CfP01.
All major work-packages saw a ramp-up and acceleration towards a healthy and ambitious rate of activity. These are:
• UHPE Demonstrator for Short / Medium Range aircraft (Snecma)
• Business Aviation / Short Range Regional TP Demonstrator (Turbomeca)
• Adv. Geared Engine Configuration (HPC-LPT) (MTU)
• VHBR – Middle of Market Technology (Rolls-Royce)
• VHBR – Large Turbofan Demonstrator (Rolls-Royce)
• Small Aircraft Engine Demonstrator
• Reliable and more efficient operation of small turbine engines

Major milestones and deliverables accomplished in 2015
• UHPE PPS Concept defined and assessed including trade studies on 4 different types of Core Engine (Snecma)
• Preliminary Design Review for Advanced Turboprop (Turbomeca)
• Compression and Expansion System Concept Design (MTU)
• Ultrafan Requirements set and Scaling Studies completed (Rolls-Royce)
• Selection of Partners and Kick-Off for WP7 projects (SMA)
• Axial compressor stages aerodynamic Concept Design Review completed (WP8.3), Ultra-Compact Combustor Module Concept & Preliminary Design Review completed (WP8.4), Initial Power Turbine tech. Requirements and High-swirl exhaust optimization completed (WP8.5) – (GE Avio)

SYSTEMS ITD
Activities performed during the year 2015 included a detailed definition of technical activities for the ITD. This was further consolidated into work-packages with the contributions from relevant Core Partners selected in Wave 1. Support was provided for the selection of Core Partners Wave 2 who will start their activities in 2016. All major work-packages with the exception of WP2 – Cabin & Cargo were activated in 2015.

Major milestones and results accomplished in 2015

WP1 – Avionics Extended Cockpit
• Definition of Extended Cockpit needs, architecture and functional specification
• Mock-up of Small Integrated Multifunction Display (tactile)
• Fly-by-Trajectory concept initial mock-up
• Initial Cockpit Demonstrator version

WP3 – Innovative Electrical Wing
• Preliminary requirements analysis for Flight Control System testing activities for RA-IADP FTB2)
• Preliminary Wing system architecture and definition for large aircraft
• System concept and design criteria for autonomous Electro-Hydrostatic Actuation

WP4 – Landing Gear System
• Launch of Smart Braking EMA design
• Main landing Gear Concept Review (CR), Preliminary Design Review (PDR) and TRL3
• EMA R/E actuator

WP6 – Major Loads
• Reduced scale Icing Wing Tunnel test campaign performed

WP7 – Small Air Transport
• Several reports summarizing the state-of-the-art tools and methods to address cabin systems for passenger comfort and safety (heat, noise control, seat crashworthiness, …)

WP100.2 – ECO Design
• Development of new painting process without chrome

1.1.7. Call for tenders

No Calls for Tenders have been launched in 2015.

1.1.8. 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 keep 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 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.

1.1.9. **Operational budget execution**

**Budget management in general:**

Since 2014, the JU manages in parallel the two Programmes Clean Sky (under 7th Framework Programme) and Clean Sky 2 (under H2020 Framework Programme) with a corresponding amount of commitment appropriations of €440.7 Million. Compared to 2014, this represented a 192% increase of available commitment appropriations. Of this, it executed 99.5% through new financial commitments which represents the best performance of the JU in terms of budget execution.

The available payment appropriations increased by 166% compared to the previous year to 245.9m€. Of this amount, 81% was paid out during 2015.

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

![Breakdown by type of expenditure (paid)](image-url)
Facts and figures by title of the budget:

<table>
<thead>
<tr>
<th>Title 3</th>
<th>Budget (m €)</th>
<th>Executed (m €)</th>
<th>% rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>75,5</td>
<td>73,4</td>
<td>97,1</td>
</tr>
<tr>
<td>PA</td>
<td>118,2</td>
<td>109,4</td>
<td>92,5</td>
</tr>
</tbody>
</table>

**Title 3 - Clean Sky Programme (FP7):** The chapters relating to the ITD grant agreements for Members (chapters 30-36), show a high rate of commitment (97.1%, 2.1% increase compared to 2014). In the case of chapter 30, the Smart Fixed Wing and Green Regional Aircraft ITD did not commit the amount originally foreseen due to a change of planning and distribution of funds among members. The other CS Programme activities were executed in accordance with the original planning.

On the payments side, the payment execution rate for 2015 comes up to 92.5% (exactly the same rate as in 2014). The JU maintained a similar high execution rate of GAM payment of 98% compared to 2014 (98.5%).

The JU could not execute more than 75% of the GAP payment while it reached 84% in 2014. The 7 m€ that could not be executed in 2015 for the GAP was the consequence of three main factors:

- In 2015 the last GAP projects were signed and 19 pre-financing payments were executed for a total amount of 6m€ (75 pre-financings for a total of 28m€ in 2014)
- As we are reaching the end of the activities, the JU received more and more interim and final payments, thus more complex to process and generating a much lower budget consumption (217 interim/final payments for a total of 16m€ in 2015 compared to 199 interim/final payments for €14 million in 2014);
- 82 GAP projects were amended with the extension of the end date later in 2015 or to 2016 which had an effect on the 2015 payment appropriations consumption.

***
Title 4 – Clean Sky 2 Programme (H2020): The first wave of core partners acceded the GAMs before year end 2015, which given the higher than expected volume of core partners, required a significant effort and resources from the JU to administrate. In addition, the extension 2016-2017 Grant agreements for members of CS2 and the majority of grant agreements from the first Call for Partners were signed. The JU also processed all pre-financing for the relevant projects.

This objective of commitment appropriations consumption was largely reached by the end of December with an execution rate of 100%.

The payment appropriations execution rate of 68.5% with €32 million unused was the consequence of two main factors:

- The CS2 GAM extension 2016-2017 was signed with the Engine and Regional SPDs and not with the Fast Rotorcraft ITD as initially planned (20m€ not consumed)
- Not all the Partners from CfP01 with signed GAPs in December had a pre-financing paid (10m€) due to the fact that some of the projects starting dates are in 2016 which prevented the JU from paying the corresponding pre-financing (see H2020 Programme rule not to pay the pre-financing more than 10 days before the starting date).

1.1.10. In-kind contributions

In-kind contributions (IKC) are provided by CSJU 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.

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 mainly based on the Certificates provided by the auditors of the Members, but also on the thorough review of the cost claims carried out by the JUs Financial Officers and Project Officers.

The IKC of the private members in the FP7 programme is covered by the ex-post audit process of the JU.

As shown in the table below, considering the information provided through the costs statements submitted and validated until the end of 2015, the situation is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Budget (m €)</th>
<th>Executed (m €)</th>
<th>% rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>357,3</td>
<td>357,3</td>
<td>100</td>
</tr>
<tr>
<td>PA</td>
<td>101,2</td>
<td>69,3</td>
<td>68,5</td>
</tr>
</tbody>
</table>

| EC FP7 contribution    | 550.133.482,25 |
| Members’ FP7 in –kind contribution | 550.133.482,25 |
| FP7 IKC validated by the GB (recognized in CSJU net assets) | 477.377.638,43 |
| FP7 IKC pending validation (Liability to be validated) | 72.755.843,82 |
| Ratio FP7 Members IKC/ EC contribution | 1:1 |
Validated contribution per ITD:

<table>
<thead>
<tr>
<th>ITD</th>
<th>Total private contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED</td>
<td>35.123.438,86</td>
</tr>
<tr>
<td>GRA</td>
<td>59.172.767,99</td>
</tr>
<tr>
<td>GRC</td>
<td>42.018.778,50</td>
</tr>
<tr>
<td>SAGE</td>
<td>114.289.354,64</td>
</tr>
<tr>
<td>SFWA</td>
<td>125.933.863,02</td>
</tr>
<tr>
<td>SGO</td>
<td>89.882.329,80</td>
</tr>
<tr>
<td>TE</td>
<td>10.957.105,62</td>
</tr>
<tr>
<td>TOTAL</td>
<td>477.377.638,43</td>
</tr>
</tbody>
</table>

H2020 programme

The private members can provide their in-kind contributions in two ways under the H2020 programme, In-kind from operational (JU funded) projects, i.e. costs on JU projects which are not funded by the JU through the H2020 eligibility criteria (IKOP) and in-kind contributions from implementing the so-called additional activities (IKAA). The state of play of the reported contributions from private members under the H2020 programme (started in July 2014) are set out below:

Overall picture at end 2015 – 18 months after the launch of H2020 and CS2 programme:

| Union contribution committed by the JU for the Grant agreements with private members (H2020) covers the years 2014 & 2015 | 95,248,924 |
| Recognised GAM expenditure (JU contribution) in the JU accounts (all claims pending validation covers 2014 & 2015 ) (H2020) | 65.795.286,55 |
| In-kind contributions validated by the Governing Board (recognized in the net assets of the JU accounts ) (H2020) | n.a. |
| In-kind contributions to be validated (recognized as liability in the JU accounts until the GB validates - covers 2014 & 2015) (H2020) | 49.075.580,88 |
| In-kind contributions declared through additional activities (2014 & 2015) | 236.940.000 |
| Total in-kind contributions (H2020) | 286.015.580,88 |

Validated contribution per SPD:

<table>
<thead>
<tr>
<th>ITDs/IAPDs</th>
<th>EC contribution</th>
<th>IKOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIRFRAME</td>
<td>17.363.800,95</td>
<td>9.722.636,10</td>
</tr>
<tr>
<td>ENGINES</td>
<td>14.547.007,40</td>
<td>12.493.790,27</td>
</tr>
<tr>
<td>FAST ROTORCRAFT</td>
<td>8.006.854,14</td>
<td>6.835.057,93</td>
</tr>
<tr>
<td>LARGE PASSENGER AIRCRAFT</td>
<td>11.385.218,57</td>
<td>6.081.161,49</td>
</tr>
<tr>
<td>REGIONAL AIRCRAFT</td>
<td>2.857.172,47</td>
<td>3.661.752,54</td>
</tr>
<tr>
<td>SYSTEMS</td>
<td>11.557.429,89</td>
<td>10.247.838,42</td>
</tr>
<tr>
<td>TE</td>
<td>77.803,14</td>
<td>33.344,14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>65.795.286,55</td>
<td>49.075.580,88</td>
</tr>
<tr>
<td>Ratio H2020 private contribution/total project costs</td>
<td>1: 0,75</td>
<td></td>
</tr>
</tbody>
</table>
**Point to note:**

The IKOP and IKAA reported under H2020 Programme are based on reports received from Members and are still under verification by the Joint Undertaking. Therefore the full amount is in the status “pending validation” (for IKOP, booked as “liability to be validated”). This table shows that the estimated in-kind contributions provided by the private members of the Joint Undertaking will significantly surpass the Union contribution for this first period already.

The additional activities underlying these values comprise 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 optimization 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

**On global level:**

<table>
<thead>
<tr>
<th>Total Commitment</th>
<th>2.193.750.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulated values of reported IKOP</td>
<td>49.075.580,88</td>
</tr>
<tr>
<td>Accumulated values of reported IKAA</td>
<td>236.940.000</td>
</tr>
<tr>
<td>Total accumulated value of reported IKC</td>
<td>286.015.580,88</td>
</tr>
</tbody>
</table>
1.1.11. Synergies with the European Structural and Investment Funds (ESIF)

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

Article 20 of the Horizon 2020 Regulation and Article 37 of the H2020 Rules for Participation encourage synergies between Horizon 2020 and other European Union funds, such as ESIF and the Clean Sky 2 Joint Undertaking (CSJU) is called by its founding Council Regulation n° 558/2014 of 6th of May 2014 to develop close interactions with ESIF to underpin smart specialization efforts in the field of activities covered by the CSJU.

To this effect, the CSJU has started in 2015 to encourage synergies with ESIF by allowing complementary activities to be proposed by the applicants to its calls for proposals and by encouraging amplification of the scope, addition of parallel activities or continuation of CSJU co-funded project/activities through ESIF in synergy with the Clean Sky 2 Programme and its technology roadmap. The CSJU encourages the use of ESIF also to build and enhance local capabilities and skills in the fields related to the Programme to enhance the level of European competitiveness of stakeholders in the area.

The CSJU Action Plan

In view of the above, the CSJU has launched in 2015 an action plan on synergies and has developed close interactions with some interested Regions or Member States (according to who is the Managing Authority for Structural Funds) in Europe to discuss strategies and possible cooperation via a tailored made approach and incorporating modalities depending on the level of interest and commitment which a Regional or National Authority may decide to engage with. The aim of such cooperation 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 Programme and support its overall objectives; and to globally achieve a leverage effect from synergies between ESIF and the Clean Sky funding. While keeping well separate the funding processes and rules of each competent authority, the purpose is to identify and apply mechanisms for ensuring complementarity and synergies through ESIF in the most relevant research and innovation projects from a certain Member State or Region in view of maximizing its impact via the JTI framework of CSJU projects.

The Regional Mapping

With the purpose of identifying potential interested actors, the CSJU has developed in 2015 a mapping of MS and Regions with a potential on synergies with the CSJU related activities based on their Smart Specializations (RIS3) priorities and other information available through the State Representative Group, the RIS3 platform, the European Commission (DG RTD and DG REGIO), the EC supported AirTN Network action.

The mapping shows that many Smart Specializations (RIS3) and ESIF Operational Programmes 2014-2020 include aeronautics or areas correlated to the Clean Sky Programme (air transport, mobility, materials, composites, engines, manufactures, CO2 reduction etc.) as thematic areas/priorities for ESIF funding. It should be noted that in the 2015 phase of the action plan, the interest raised to the CSJU came not only from the more classic “aeronautics Regions” in Europe but also from Regions involved in horizontal themes having an interest for aeronautics (e.g. materials) or considering this as a potential to increase their capabilities in R&I and...
underpin their RSI3 efforts also in other areas with possible market uptake in aeronautics and to increase the European level of cooperation and competitiveness of their stakeholders.

**Bilateral cooperation with the CSJU**

In the year 2015 the CSJU has activated bilateral institutional contacts with a significant number of MS and Regions which has brought to the establishment of over 20 contacts and negotiations, to the signature of 6 MoUs with a pilot duration of 2-3 years (as listed in the table below) and which has paved the way to the signature of an estimate of 15 MoU in 2016.

- MoU with Midi-Pyrénées Region (FR) in February 2015
- MoU with Andalucía (ES) in July 2015
- MoU with Cataluña (ES) in August 2015
- MoU with România (at National level) in July 2015
- MoU with Campania in October 2015
- MoU with Flevoland (NL) in November 2015

The CJU will continue developing the pilot-phase across 2016-2017 with a limited number of MS/Regions in view of launching the first pilot projects in 2016 and identifying best practices for further MS and Regions interested to join.

The signature of a MoU which is based on a template elaborated by the CSJU does not confer any sort of competitive advantage in the calls launched by the CSJU to any regional stakeholder. But with a wider view to the growth of this sector through Innovation, the CSJU considers, as part of its policy and vision on synergies, 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.

**The High Level Scenarios for Cooperation on Synergies**

The CSJU has elaborated in 2015 some guidance material for the National and Regional Authorities in charge of ESIF planning and ESIF Managing Authorities which is available on a dedicated section created in the CSJU website. The guidance provides a general overview on synergies and in particular the high level scenarios for cooperation on synergies elaborated by the CSJU and identify which could fit within their regional strategy and context in terms of local capabilities and level of participation or interest of stakeholders to the Programme and its calls. The CSJU has elaborated a specific guidance note for calls for proposals on how to include as part of the proposal “complementary activities” which may be supported by ESIF and which are separately evaluated by the CSJU.

The CSJU took part to specific sessions and information meetings organized by the Regions, EACP and Business representatives’ organizations to disseminate his action plan and a dedicated workshop on synergies with ESIF was organized at the Paris Airshow (Le Bourget) in July 2015. The CSJU has disseminated the action also to Members of the European Parliament from several Parliamentary Committees in view of involving them in some Regional action plans and contributing to the policy development on synergies.

**Pilot Projects**

Pilot projects are expected in the year 2016; however by end of 2015 some first results were achieved which will contribute to the CSJU policy development and internal process in the field. The regional call “Easynov” which was launched in November 2015 by the Midi Pyrénées
Region in cooperation with the CSJU, the call is consistent with the high-level objectives of the Clean Sky 2 Programme and integrates a full set of thematic areas proposed by the CSJU in consultation with the relevant Leaders in the areas of systems and avionics. At the level of the calls for proposals, the CSJU received a number of complementary activities (ESIF Work Packages) linked to the 2nd call for proposal launched in 2015 which will be separately evaluated by the CSJU in 2016 and which may result in some pilot projects in terms of parallel ESIF funded synergy activities. The results will be integrated and disseminated through the website.

**CSJU Management**

In terms of internal process, the activities performed in the area of synergies with ESIF are managed by the Legal Manager and Strategic Advisor of the CSJU under the direct supervision of the Executive Director. A Sub-WG was established in 2015 at SRG level specific to synergies with ESIF and a constant update on the action plan on synergies with ESIF was provided in 2015 to the Governing Board as part of the Executive Director Management Report.
2. SUPPORT TO OPERATIONS

2.1.1. 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 2015 Action Plan, as endorsed by the Governing Board served as road map 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 2015 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 JU overall due to the first Calls within the Clean Sky 2 Programme.

The advocacy effort initiated in 2014 to raise the awareness of Clean Sky 2 among MEPs was intensified in 2015. On top of some 25 meetings by the Executive Director with MEPs from the ITRE, TRAN and BUDG CONT, Clean Sky was invited to hearings organised by the European Parliament on the future of Aeronautics and COP 21, ahead of the Ministerial talks on climate change in December 2015. The meetings and hearings were followed up with detailed briefings, mailing on relevant publications, and invitations to key events.

In addition to the single Clean Sky advocacy strategy towards the European Parliament, Clean Sky joined forces with the other Joint Undertakings to participate in the Innovation Summit organised at the European Parliament in December 2015. The Joint Undertakings took the opportunity to anticipate some of the findings of their respective socio-economic studies, which will be, as regards Clean Sky, complemented and deepened in the future.

The content and key features of Clean Sky 2 are now part of any communication activity, given the high expectations from target audiences both on 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.

Press coverage spreads across different EU Member States including Spain, France, UK, Belgium, and others (La Tribune, Les Echos, l’Echo, El Pais, europapress.es, Il Sole 24 Ore, Time magazine, Flight International and the aviation special of The Times daily). US-based weekly Aviation Week features Clean Sky news regularly. In addition to these Clean Sky features in printed media, reported at each Clean Sky Governing Board, Clean Sky was covered by Brussels-based EU news portal Euractiv on Le Bourget and Aerodays. In 2015 Clean Sky also participated in video productions for BBC Future and AeroNews TV covering clean skies and Aerodays 2015 respectively.

The other key priorities in 2015 were: demonstration of successful outcomes, brand building and visibility, positive reputation, and expanding networks.
With regards to successful outcomes, 2015 was a year marked by several innovation landmarks such as the first flight test of the high-compression engine demonstrator aircraft, the geared turbofan demonstrator, and the ATR (regional aircraft) in-flight Demonstrator for a composite fuselage panel. In addition, the two flagship projects of Clean Sky, the breakthrough Laminar Aircraft Demonstrator and the Open Rotor made significant progress towards testing, and Clean Sky organised events and raised awareness about those Demonstrators. In doing so and indeed throughout all of 2015, Clean Sky actively promoted the European Commission’s communications on Horizon 2020 by sharing messages and referring to the EU innovation vision and policy whenever a Demonstrator took place.

To build the brand and acquire a positive reputation for excellent research, Clean Sky invested further in its digital strategy for communications: the Clean Sky website www.cleansky.eu has seen its content improved and updated more regularly, and traffic has steadily increased. The social media channels (Twitter, YouTube, LinkedIn, Flickr) were completed revamped and updated. Relevant and frequent messaging, more video content and further coordination with the Commission and industrial leaders led to increased traffic and reach out to more communities. Additionally, a digital survey was sent to all the SMEs who applied to Clean Sky (regardless of the outcome) to ask their feedback on a wide array of aspects of the programme. The findings were presented to the Governing Board at its December meeting and have been relayed back to participants.

The digital strategy was run in parallel to more traditional communications tools such as “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 Information Days and interested MEPs, among others. This has enabled the expansion of our news and activities to other networks, thus improving visibility and brand support.

The following large events took place in 2015: a dozen of Clean Sky 2 Information Days across Europe, the Clean Sky Forum on 17 March, Clean Sky at the Paris Air Show (Le Bourget) in June, and Aerodays 2015 in London in October.

The “Clean Sky Forum”, with more than 300 participants, allowed for three round tables involving high-level speakers from the Clean Sky beneficiaries, authorities and other stakeholders. Awards to the 3 best Projects were delivered by the JU.

Clean Sky’s participation in Le Bourget and Aerodays also deserve a special mention. At Aerodays Clean Sky contributed to the conferences with dozens of speakers and displayed a Demo Stand which was visited by many policy-makers as well as the public. At the Paris Air Show, 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
In addition to large events and air shows, Clean Sky management and staff delivered presentations at the events, which are presented further in Annex 4.

A particular attention was brought to a workshop co-organized by Clean Sky and the JTI “Fuel Cells and Hydrogen” about the use of fuel cells in aviation, in Lampoldshausen on September 15th. Gathering players of aeronautical manufacturing and from the sector of hydrogen, its purpose was to set the scene for a future collaboration between the two JUs. This workshop was quite encouraging, and coordinated projects could be concretized in 2016.
2.1.2. Legal and financial framework

Changes of the EU Financial Rules


These new rules are directly applicable to the CSJU as of 01/01/16 since the CSJU Financial Rules refer to Title V of the general FR.

Amendment of the CSJU Financial Rules – status at 31/12/15
By Regulation (EU, Euratom) No 2015/1929, the Model Financial Regulation for PPPs was amended in order to align it with the amended provisions of articles 60 and 209 of Regulation (EU, Euratom) No 966/2012 which 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 a revision of its Financial Rules to bring them in line, where appropriate, with the modifications brought under the newly adopted delegated act. An annotated draft of the revised Financial Rules was officially sent for approval on 26/11/2015 to DG BUDG of the Commission. Upon receipt of the Commission internal approval, the CSJU should be able to launch the Board approval process of the amended Financial Rules by March 2016. The draft amended text envisaged the entry into force retroactively with effective date as of 01/01/2016.

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

2.1.3. Budgetary and financial management

Facts and figures by title of the budget:

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<th>Title 1 &amp; 2</th>
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Title 1 & 2 – Staff and administrative expenditures: The administrative expenditure of the JU had a very high rate of use in 2015 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 (36 posts as of 31.12.2015), although other external support was also hired in by the JU to cope with the increased workload (Chapter 12 used). The JU has also contracted the services of audit firms to perform the ex-post audits to beneficiaries of JU funding in 2015 (Chapter 28).

Initial budget, amending budget and transfers for Title 1 & 2 in 2015:

Evolution of the Statement of Expenditure 2015 All Programmes (EUR) (fund sources C1 and C2)

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### 2.1.4. Procurement and contracts

List of contracts signed in the year 2015 (>15.000 EURO)

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<td>Specific Contract</td>
<td>Development and finalisation of GMT 2 Module for the submission and validation of the 2014 costs (validation workflow, use of resources, reports, upload of documents) and the development of the calculation module for ex-post error rate, under Work Package 5</td>
<td>05/05/2015</td>
<td>41.040</td>
</tr>
<tr>
<td>NETSAS</td>
<td>Y</td>
<td>Specific Contract</td>
<td>Further developments of GMT 2 including planning module, reporting functions and other necessary features under Work Package 5</td>
<td>12/08/2015</td>
<td>99.180</td>
</tr>
<tr>
<td>PKF Little John</td>
<td>Y</td>
<td>Amendment to Specific Contract</td>
<td>Ex-post audit services</td>
<td>06/08/2015</td>
<td>66.692</td>
</tr>
<tr>
<td>KPMG</td>
<td>Y</td>
<td>Amendment to Specific Contract</td>
<td>Ex-post audit services</td>
<td>06/08/2015</td>
<td>54.752</td>
</tr>
<tr>
<td>M. Brusati</td>
<td>N</td>
<td>Call for Expression of Interest</td>
<td>Strategic Consultancy year 2015</td>
<td>01/07/2015</td>
<td>35.000</td>
</tr>
<tr>
<td>TMAB</td>
<td>Y</td>
<td>Specific Contract</td>
<td>Communication - Clean Sky Stand support at Aerodays Airshow in London</td>
<td>08/09/2015</td>
<td>36.675</td>
</tr>
<tr>
<td>TMAB</td>
<td>Y</td>
<td>Amendment to Specific Contract</td>
<td>Communication - maintenance of the CSJU website</td>
<td>15/12/2015</td>
<td>51.300</td>
</tr>
<tr>
<td>EU-Turn</td>
<td>Y</td>
<td>Amendment to Specific Contract</td>
<td>Communication assistance</td>
<td>15/12/2015</td>
<td>52.450</td>
</tr>
<tr>
<td>TMAB</td>
<td>Y</td>
<td>Specific Contract</td>
<td>Design and implementation of Clean Sky new web site</td>
<td>15/12/2015</td>
<td>57.950</td>
</tr>
<tr>
<td>Le Cherche Midi Editeur</td>
<td>N</td>
<td>Negotiated Procedure</td>
<td>Production of the dissemination materials – “Clean Sky Results Book”</td>
<td>18/12/2015</td>
<td>60.000</td>
</tr>
<tr>
<td>M. Brusati</td>
<td>N</td>
<td>Call for Expression of Interest</td>
<td>Strategic Consultancy for the year 2016</td>
<td>10/12/2015</td>
<td>67.400</td>
</tr>
<tr>
<td>TMAB</td>
<td>Y</td>
<td>Order Form</td>
<td>Clean Sky Forum 2016 Organisation support</td>
<td>15/12/2015</td>
<td>54.881</td>
</tr>
</tbody>
</table>
2.1.5. IT and logistics

The year 2015 began with significant changes for ICT in CSJU. On 1\textsuperscript{st} of January a new framework contract was signed with the ICT service provider for an expanded catalogue of services and unified support and connectivity. This will better support the CSJU expansion both in size and duration as Clean Sky 2 extends and widens our mandate into the years ahead. In May, the JU switched to a new internet provider (telenet) with increased bandwidth.

From January 2015, the JU began the process of adopting the H2020 Grant Management Tools of the European Commission. Many meetings followed over several months while we adapted the tools and templates, ran tests and trained the staff. One of the many benefits of the new system is that it is paperless and supports electronic signatures. It is also fully integrated with our accounting system (ABAC) and with the proposal submission and evaluation systems.

With a large team effort, the JU implemented the system and electronically signed and pre-financed the first grant agreements before the end of 2015.

During 2015 CSJU migrated the payment of evaluators to a paperless / e-signature system with integration to ABAC. Given that the JU contracts and pays several hundred evaluators each year - this is a significant improvement.

On the hardware side the JTIs together upgraded their infrastructure and incorporated 2 new JTIs (Shift-to-Rail & Bio-Based Industries) into their shared environment. They also conducted several workshops with technical architects to develop a vision for the future because in 2016, they will have to make decisions about upgrading or replacing our ICT infrastructure and there are many new options on the market (e.g. cloud solutions).

In 2015 the JTIs also adopted the new Common IT Security Policy and continued to implement measures to keep pace with the ever evolving IT risks. CSJU joined more EC framework contracts to provide access procurement channels for future needs when identified.

CSJU took the delivery of heavy equipment and did preparatory work for the sTesta to TestaNG migration for the secure connection to the European Commission environment.

2.2. Human Resources

The JU establishment plan for 2015 contained a total of 42 posts. Five new posts were added to bring the number to this 42 in 2015. In total, since the beginning of the new programme, the JU received 18 new posts. Out of these 18, 12 positions were recruited at the beginning in 2015. At year end, the JU had recruited 15 out of the 18 new positions while 2 of the previous posts were also vacant due to staff turnover. In addition to the statutory posts, the JU relies on external service providers such as the webmaster; IT services firm, a Communications consultant and a Strategic consultant to provide extra support to the JU where JU staff alone cannot take further tasks. In mid-2015, the contracts with JU members ended (i.e. placement of member staff within the JU as provided in the financial rules of the JU) and no new support from Members was contracted.
With the influx of many new staff members, the JU held information sessions on staff rules and JU code of conduct in 2015. This was well received by staff and will be repeated in future. In addition, the JU had its team event in December which was fully attended by all staff and this contributed to the positive outlook of the entire team.

Finally, 2015 was the first year of implementation of the reclassification exercise. 3 staff members were reclassified.
3. GOVERNANCE

3.1.1. Governing Board

In 2015 the Governing Board was composed of 25 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 6 ITDs in Clean Sky Programme and one Core Partner representative for 2 of the 6 ITDs/IADPs in the Clean Sky 2 Programme. In 2015, the Associates were: Fokker (ED), CIRA PLUS Cluster (GRA), NLR (GRC), GKN Aerospace (SAGE ITD), University of Nottingham (SGO), Aernnova (SFWA); and the Core Partners were: ITP (SYS), INCAS (FRC).

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

The CSJU Governing Board had 4 meetings during 2015, on:
- 25 March 2015
- 23 June 2015
- 24 September 2015
- 18 December 2015

During 2015 the Governing Board has adopted, approved or endorsed the following key documents in its meetings:

25 March 2015
- Provisional Annual Activity Report 2014
- Strategic Audit Plan
- Work Plan and Budget 2014 - 2015 Amendment Nr. 2
- Mission charter of the Internal Audit Service of the Commission

23 June 2015
- Clean Sky 2 Development Plan
- Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 1 membership – 1st batch
- Final Annual Activity Report 2014
- Work Plan and Budget 2015 - 2017
- Call for Proposals 02 Call text

24 September 2015
- Decision of the Governing Board regarding the acceptance of the Core Partners' Wave 1 membership – 2nd batch
- Call for Partners 03 Call text
- Work Plan and Budget 2015 – 2017 Amendment Nr. 1
- AIPN Delegation
- Decision of the Governing Board of the Clean Sky 2 Joint Undertaking on the contract renewal of the Accounting officer
- Decision of the Governing Board on the secondment of national experts

18 December 2015

- 2016 – 2017 Bi-annual Work Plan and Budget
- Additional Activities Plan 2016

It can be noted that most of the decisions have been adopted unanimously or very close to unanimity, 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.

The following 5 written procedures were successfully adopted:

- 2015 – 01 Opinion on the validation of the in-kind contribution provided by non-EC members to the Clean Sky 2 JU through the execution of the Clean Sky Programme (FP7) Grant Agreements 2008-2014
- 2015 – 02 Decision regarding the Governing Board’s opinion on the Final Accounts and Budgetary Implementation Report 2014 of the CSJU
- 2015 – 05 Decision of the Governing Board approving the Ranking Lists of the selected proposals of the Call for Proposals 1 (CFP01)
- 2015 – 06 Decision of the Governing Board of Clean Sky 2 Joint Undertaking on HR Decisions (Decision for agencies laying down general provisions for implementing Article 43 of the Staff Regulations and implementing the first paragraph of Article 44 of the Staff Regulations for temporary staff; Decision on measures concerning unpaid leave for temporary and contract staff; Decision laying down general implementing provisions on the procedure governing the engagement and use of temporary staff under Article 2(ff) of the Conditions of Employment of Other Servants of the European Union).

3.1.2. Executive Director

The Executive Director is the legal representative and the chief executive for the day-to-day management of the CSJU 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.
3.1.3. **Steering Committees**

Each Integrated Technology Demonstrator (ITD) and each Innovative Aircraft Demonstration Platforms (IADP) is 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 2015. 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.

3.1.4. **Scientific Committee**

The Scientific Committee (SciCom) is an advisory body to the Governing Board. In 2015 the Scientific Committee met 4 times:

- 15 January 215
- 5 May 2015
- 18 September 2015
- 10 December 2015

The Scientific Committee was consulted on various documents as a Committee; his members have been involved as reviewers in most Interim Progress and Annual Reviews of the ITDs in CS1, and in some reviews for CS2.

In the SciCom meeting of September 2015, the final Terms of Reference of the committee were approved. Also the consolidated report from the chairman about all Annual Technical Reviews performed in 2015 was delivered to Executive Director to be forwarded to next GB on 24/09/2015.

3.1.5. **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 each other country associated to 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 2015 the SRG met 4 times:
- 18 March 2015
- 3 June 2015
- 21 October 2015
- 2 December 2015

and was represented at the Governing Board meetings. The SRG continued to have a proactive and supportive role particularly in its relations with the European Council.

The Group has been consulted during 2015 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 topics lists and descriptions were subject to recommendations, before the publication, 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 programs.
- 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

4.1.1. Financial Procedures

In 2015 the JU has been actively working on the 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; development of the procedure for the reporting of the in kind contributions, as well as a dedicated Financial Workshop organized.
on 15 January 2015 with the Clean Sky members.

For Grant Agreement with Members, the CSJU has further developed the internal IT tool (GMT) for the reporting and validation of costs claims under FP7 and H2020.

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

4.1.2. Ex ante Controls on Operational Expenditure

During the year 2015 the internal JU procedures for managing the H2020 grants were finalized. 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.

The entire processes of planning, executing and monitoring the grants as described in the related internal manuals have been revised and provide now for updated process descriptions, templates, check lists and detailed guidance to the JU’s private members and to the JU staff. Specific attention has been put on the processes for monitoring the strategic programme planning, establishing the work programs 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 following 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 Manual of Financial Procedures, Clean Sky Management Manual 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 drafted.

4.1.3. 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 summarizing presentation in the AAR, further details regarding scope and results of the audits on annual and on accumulated level from the beginning of the FP7 programme are provided in the Annual Ex-post Audit Report 2015, 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 2015**

In the year 2015, cost claims pertaining to the execution of grant agreements related to the FP7 programme were subject to audits. For the H2020 grant agreements no audits have been performed by the JU yet, as the final validation of the first H2020 cost claims by the JU will be done from March 2016 onwards only. Hence, a population of auditable cost claims will be available only by middle of 2016.

For FP7 cost claims, on the basis of the Clean Sky Ex-post audit Strategy, as adopted by the CS Governing Board, two new audit batch assignments have been launched in the year 2015, which are still on-going.

The scope of the assignments included 12 audits covering 6 Grant Agreements for Members. The audits were assigned to two external audit firms. For 9 of the 12 audits, draft audit reports have been received until today, 3 are still outstanding. Results of the audits are partially final, partially only preliminary, since the reports are still in a draft stage.

In addition to the audits launched in the year 2015, the results of 7 audits stemming from the previous EPA exercises of the years 2012 and 2014 are considered in the exercise of the year 2015.

**Table 1a:**

<table>
<thead>
<tr>
<th>EPA exercise 2015</th>
<th>Total value of audited project costs</th>
<th>Number of audits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audits launched in 2015</td>
<td>36.189.794</td>
<td>9</td>
</tr>
<tr>
<td>Audits launched before 2015</td>
<td>9.152.224</td>
<td>7</td>
</tr>
<tr>
<td>Total audits included in EPA exercise 2015</td>
<td>45.342.018</td>
<td>16</td>
</tr>
</tbody>
</table>

Considering the preliminary status of a significant part of the audit reports, the assessment of the reported adjustments and findings of the external auditors, as well as the calculation of error rates, is preliminary. The error rates will be updated until the closing of the Final Accounts 2015.

Based on the results of the pre-final or final audit reports, extrapolation of systematic errors will be calculated until approximately April 2016. Conclusions on necessary recoveries of finally validated errors are scheduled for May.

Final representative and residual error rates will be calculated based on the Final Audit Reports and will contribute to the final Declaration of Assurance for 2015 of the Executive Director.
II. Details of the 2015 audit sample and coverage

The sample considered in the ex-post audit exercise 2015 and included in the calculation of the error rates 2015 is composed of four parts:

(A) 3 remaining audits stemming from the EPA exercise 2012 not included in error rates 2012 to 2014

(B) 1 remaining audit stemming from the EPA exercise 2013 on GAPs not included in 2013 or 2014 error rate

(C) 1 remaining audit stemming from the EPA exercise 2013 on GAMs not included in 2013 or 2014 error rates

(D) 2 remaining audit stemming from the EPA exercise 2014 on GAMs not included in 2014 error rates

(E) 9 audits launched in July 2015 with provisional audit results

For the calculation of the audit coverage, the accumulated audited value covered by the EPA exercises 2011 to 2015 is compared to the accumulated total amount of validated cost claims at the date of the closing for the Provisional Accounts 2015.

Table 2a: Accumulated audit coverage based on audits fully or provisionally finalised:

<table>
<thead>
<tr>
<th>Audits provisionally and fully finalised</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>audited value from EPA exercise 2011 (final)</td>
<td>44,266,850.86</td>
</tr>
<tr>
<td>audited value from EPA exercise 2012(final)</td>
<td>39,495,743.74</td>
</tr>
<tr>
<td>audited value from EPA exercise 2013 (final)</td>
<td>40,528,612.74</td>
</tr>
<tr>
<td>audited value from EPA exercise 2014 (final)</td>
<td>77,979,724.64</td>
</tr>
<tr>
<td>audited value from EPA exercise 2015 (pre-final)</td>
<td>45,342,018.59</td>
</tr>
<tr>
<td>Total audited value of the years 2011 to 2015 (a)</td>
<td>247,612,950.57</td>
</tr>
<tr>
<td>Total audit population (b)</td>
<td>1,069,158,788.47</td>
</tr>
<tr>
<td>Coverage (a) / (b)</td>
<td>23.16%</td>
</tr>
</tbody>
</table>

This indicator will change still until the Final Accounts and Final AAR 2015.

The samples were established according to the methodology described in the 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 (2 beneficiaries have been selected on the basis of a risk assessment)

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7 The following description of the sample refers only to audits with sufficiently final audit results, which are included in the calculation of the error rates. The sample of audits launched is higher in numbers and values.
The sample consisted mainly of cost claims pertaining to Members; however one remaining GAP from the specific audit on Partners, which had been launched in the year 2013, has been included in the results of the EPA exercise 2015.

The following summary reflects the audits performed on GAPs:

**Table 2b: Accumulated audit coverage for GAPs of all EPA exercises based on audits finalised:**

<table>
<thead>
<tr>
<th>Audits on GAPs finalised</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>audited value from EPA exercise 2012 (final)</td>
<td>760,537.50</td>
</tr>
<tr>
<td>audited value from EPA exercise 2013 (final)</td>
<td>3,397,199.68</td>
</tr>
<tr>
<td>audited value from EPA exercise 2014 (final)</td>
<td>1,260,041.25</td>
</tr>
<tr>
<td>Audited value from EPA exercise 2015 (pre-final)</td>
<td>60,290.61</td>
</tr>
<tr>
<td>Total audited value of the years 2012 to 2015</td>
<td>5,478,069.04</td>
</tr>
<tr>
<td>Total audit population of validated cost claims of Partners</td>
<td>114,403,511.45</td>
</tr>
<tr>
<td>Coverage</td>
<td>5%</td>
</tr>
</tbody>
</table>

**III. External audit firms under contract**

Audits have been assigned to the external auditors in line with the EPA framework contract in batches. In 2015 specific contracts have been signed with 2 individual audit firms for 2 batch assignments as follows:

**Table 3a:**

<table>
<thead>
<tr>
<th>Audit Firms</th>
<th>Number of audit engagements</th>
<th>Number of claims of cost</th>
<th>Audited value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPMG Germany</td>
<td>6</td>
<td>9</td>
<td>10,924,962.04</td>
</tr>
<tr>
<td>PKF Littlejohn UK</td>
<td>6</td>
<td>20</td>
<td>54,142,644.44</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>29</td>
<td>65,067,606.48</td>
</tr>
</tbody>
</table>
IV. Quantitative audit results (indicators):

Status of audits:

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

Table 4:

<table>
<thead>
<tr>
<th>Status of audits launched in 2015</th>
<th>number</th>
<th>share of total launched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number launched</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Draft audit reports received (1.version)</td>
<td>9</td>
<td>75%</td>
</tr>
<tr>
<td>Pre-final reports received</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Final reports received</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 5:

<table>
<thead>
<tr>
<th>Status of audits launched in 2012 to 2014</th>
<th>number</th>
<th>share of total launched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number launched and remaining open for EPA 2015</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Draft audit reports received</td>
<td>7</td>
<td>100%</td>
</tr>
<tr>
<td>Pre-final reports received</td>
<td>3</td>
<td>43%</td>
</tr>
<tr>
<td>Final reports received</td>
<td>2</td>
<td>29%</td>
</tr>
</tbody>
</table>

V. Adjustments and detected error rates:

Because of the preliminary status of the audit results, the level of all error rates as stated in the following may still change until the closing of the EPA exercise 2015, which is the closing date for the Annual Accounts 2015 in the beginning of May 2016.

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.

The audit reports available at present include the preliminary results of 1 risk based audit engagement.

The accumulated (ex-post) detected error rate\(^8\) in favour of the CSJU identified so far in the audited population amounts to -2.89\%, (see table 6). The rate represents a weighted average of the individual rates detected\(^9\). The corresponding rate for the individual audit exercise of the year 2015 is currently at -1.97\%.

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\(^8\) Errors actually detected in the audited sample related to the total amount of the sample

\(^9\) 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
The **representative error rate**, which indicates the error rate applicable on the entire population of cost claims before corrective measures, at the moment amounts for the accumulated audit results of all EPA exercises performed so far to -2.45%; the individual annual result for the year 2015 is -2.07%. This error rate does not include risk based audits, which were 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:

\[
ResER% = \frac{(RepER\% \cdot (P-A) - (RepERsys\% \cdot E)}{P}
\]

Taking into account the systematic adjustments proposed by the auditors in the audits performed in the year 2015 so far, the following provisional residual error rates are calculated:

**Table 7a:**

<table>
<thead>
<tr>
<th>Calculation of residual error rate (ResER%): Accumulated 2008 to 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population (P) = 1.069.158.788,47</td>
</tr>
<tr>
<td>Audited population (A)= 229.121.315,04</td>
</tr>
<tr>
<td>total non-audited cost claims of audited beneficiaries (E ) = 363.257.542,93</td>
</tr>
<tr>
<td>Representative error rate (RepER%) = -2,45%</td>
</tr>
<tr>
<td>Systematic error rate (RepERsys%) = -2,08%</td>
</tr>
<tr>
<td>ResER% = -1,22%</td>
</tr>
</tbody>
</table>

**Table 7b:**

<table>
<thead>
<tr>
<th>Calculation of residual error rate (ResER%): 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population (P) = 287.805.375,72</td>
</tr>
<tr>
<td>Audited population (A)= 43.060.130,35</td>
</tr>
<tr>
<td>total non-audited cost claims of audited beneficiaries (E ) = 82.112.084,44</td>
</tr>
<tr>
<td>Representative error rate (RepER%) = -2,07%</td>
</tr>
<tr>
<td>Systematic error rate (RepERsys%) = -1,62%</td>
</tr>
<tr>
<td>ResER% = -1,30%</td>
</tr>
</tbody>
</table>

---

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.
The preliminary results established in the year 2015 indicate a similar low level of the total accumulated residual error rate (for GAMs and GAPS) of 1.22% compared to 1.14% in the previous year.

The specific result of the audit batches related to audits on GAPS indicates a residual error rate of 1.43% (compared to 1.18% until end of 2014) as presented in the following table:

| Table 7c: Calculation of accumulated residual error rate (ResER%): GAPS EPA 2012 to 2015 |
|-----------------------------------------------|-----------------------------------------------|
| Total population (P) = 114.403.511,45         | Audited population (A)= 5.478.068,95          |
| total non-audited cost claims of audited beneficiaries (E ) = 6.925.713,75 | Representative error rate (RepER%) = -1.60% |
| Systematic error rate (RepERsys%) = -1.60%   | ResER% = -1.43%                               |

VI. **Extrapolation**

The extrapolation of systematic errors for the audit exercise 2015 will be launched during the months February to April 2016 for all beneficiaries, for which audits 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). The process will be started once the pre-final audit reports have been agreed with the audit firms. The extrapolation for the audit exercise 2014 is finalised, see section IV. **Implementation of audit results.**

VII. **Materiality**

Specific materiality thresholds have been agreed with the audit firms. Overall materiality for the qualification of the auditors’ opinion is 2% of total audited value of cost claims included in the audit report. As a preliminary result based on the first versions of the DARs and some PARs, 13 out of 20 opinions have been qualified by the auditors because of material adjustments (over 2% of respective total declared costs audited).

VIII. **Implementation of audit results**

Overpayments identified in the ex-post audits carried out in the year 2014 have been recovered during the year 2015 directly from the audited beneficiaries. Likewise, the financial effect of the extrapolation of systematic errors detected in the ex-post audits 2014 on unaudited cost claims has been recovered. As already reported in detail in the Final EPAR 2014, overpayments identified in the EPA exercise 2014 had been nearly

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10 The percentage of the detected errors being considered for qualifying the opinion does not distinguish errors in favour of the JU and in favour of the beneficiary. Hence, opinions are also qualified in cases of errors in favour of beneficiaries above the threshold.
fully recovered until the closure of the JU’s Final Accounts 2014. The recovery rate has meanwhile improved further from 97.4% to 99.6%.

### Table 8:

<table>
<thead>
<tr>
<th>Audited value (of audited and unaudited cost claims)</th>
<th>Adjustments in favor of CSJU per audit reports</th>
<th>related overpayment</th>
<th>recovery of overpayment - Euro</th>
<th>recovery rate for overpayment - (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro 227,022,947,93</td>
<td>Euro -3,845,725,05</td>
<td>Euro -1,927,017,11</td>
<td>Euro -1,918,513,25</td>
<td>99,56%</td>
</tr>
</tbody>
</table>

The same effort will be undertaken for the implementation of the results of the EPA 2015, starting with the first recoveries in March 2016.

### IX. Assessment of the ex-post audit results

Summary and input for the Assurance declaration of the Executive Director in the AAR 2015 (version February 2016):

The present preliminary results of the ex-post audit exercises 2011 to 2015 pertain to validated cost claims for FP7 GAMs and GAPs of the years 2008 to 2014. As described in the materiality criteria in the Annex of the AAR, the control objective of the JU is to ensure for the CS FP7 programme, that the residual error rate, which represents 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 programme.

Up to now, the accumulated audit coverage of the validated financial statements pertaining to GAMs and GAPs for the years 2008 to 2014 is 23%.

The indicators established from the sample covered in 5 annual audit exercises carried out in the years 2011 to 2015, reflect a representative error in favor of the JU in the validated operational expense of -2,45% (compared to -3.70% for the accumulated exercises 2011 to 2014). For the time being, this error rate cannot be considered truly representative, as not all results from the selected sample of the year 2015 are final.

At this preliminary stage, the residual error rate can only be calculated by assuming (1) the representative validity of the detected error and (2) a full recovery including the extrapolation. In this scenario, the accumulated error stemming from the audit exercises 2011 to 2015 remaining after cleaning the population from systematic errors would amount to -1,22%, the corresponding residual error rate for the EPA exercise 2015 only would be -1,30%.
The population of GAPs is covered by two specific samples (5%), which resulted in a representative error rate of -1.60%. The related residual error rate established only for grant agreements with Partners remains nearly unchanged compared to the previous year and lies presently at -1.43% (previous year: -1.18%). The results available at present do not indicate a significant risk for undetected overpayments to Partners.

The corrective measures for the first 4 annual audit exercises, carried out in the years 2011 to 2014, have been fully implemented.

Due to the specific situation of the CSJU with its named beneficiaries receiving 75% of the entire operational funds, of the FP7 programme and with a view to the comparatively high share of systematic errors detected so far (RepERSys% = -2.08% versus RepER% = -2.45%), the potential for excluding errors from non-audited cost claims has been high.

By sharing the information on systematic and non-systematic errors detected in the EPA process with the Financial Officers of the JU in a timely way, the quality of the ex-ante validation of cost claims for GAMs is continuously improved.

The results of the EPA process 2015 reflect the legality and regularity of the validation process for GAM execution 2008 to 2014. Thus, they do not directly relate to the entire expenditure incurred by the JU until the end of year 2015. However, the JU’s EPA strategy is implemented through an ongoing process, which produces accumulated results applicable to the entire expense incurred for the CS programme (FP7) until a certain point of time. At present we have results for payments incurred for GAMs and GAPs 2008 to 2014. The EPA coverage and identified error rates have to be evaluated with a view to the multiannual EPA strategy, which has evolved as an ongoing 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 2015 relevant and appropriate to provide assurance for the operational expenditure related to FP7 grants as recognized in the Provisional Accounts 2015.

The preliminary operational expense incurred by the JU for H2020 grants have not yet been covered by ex-post audits. As the values reported up to now are not yet validated by the JU and final payments for the first multiannual GAMs (for 2014 to 2015) are still pending potential errors can still be corrected ex ante during the validation process in the year 2016.

The audit approach for the H2020 grants of Clean Sky 2 JU has been established together with the CSC of DG RTD and is reflected in the H2020 audit strategy, which is applicable for the entire Research family. Audits for Clean Sky 2 JU will start in the second half of 2016 and will provide individual assurance for the H2020 programme execution of Clean Sky 2 JU.

Due to the preliminary nature of the EPA results 2015 a new assessment of updated audit results needs to be performed for the final version of the AAR 2015 and the related Declaration of Assurance.
4.1.4. Audit of the European Court of Auditors

In 2015, 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 2014. In its Statement of Assurance, the Court issued to the CSJU a positive opinion on the reliability of the annual accounts and on the legality and regularity of the underlying transactions.

In its comments, the Court mentions in the report the utilisation rate for commitment appropriations was 93.9%, while the rate for payment appropriations was 90.2% (87.7% for 2013), adding that these improved implementation rates are explained by the quicker granting process.

Findings and comments raised by the Court during the 2 audit visits performed until June 2015, in particular regarding ex-ante controls for grant payments, have been taken up by the JU and actions have been developed to further improve the procedures of the JU and enhance controls.

In respect of the Court’s recommendation regarding the payment time limits, the JU has taken measures in order to avoid payments to be processed late, especially in the area of Grant Agreements for Partners, which have been identified as being the principal cause of this issue. In particular, the JU has introduced a more effective workflow for the validation of Partners’ financial statements by enhancing the collaboration between Operational and Finance Units; has implemented the European Commission “single submission procedure” (for technical and financial reports) and is performing monthly monitoring of the time to pay for grant agreements in place. Since then a major improvement of the time to pay indicator has been registered.

In respect of the Court’s recommendation regarding further improvement of the dissemination of FP7 research results and appropriate reporting through performance indicators also for the H2020 programme, the JU has established an action plan which foresees the creation of a repository of research results on Clean Sky website, the harmonization of the reporting in the Annual Activity Report 2015 regarding dissemination of results with European Commission and use of common H2020 Key Performance Indicators and developing a reporting/dissemination module in our local system Grant Management Tool.

4.1.5. Internal Audit

The Internal Audit function of Clean Sky 2 JU has been carried out in 2015 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 CSJU on dealing with risks, by issuing independent opinions on the quality of

11 Report on the Annual Accounts of the Clean Sky Joint Undertaking for the financial year 2014, dated 06.10.2015
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 2015 the IAS finalised an audit on the use and dissemination of results of EU funded research in Clean Sky 2 JU. The scope of the audit did not comprise of checking the appropriate volume of dissemination of results by the JU’s beneficiaries but focused only on the JU’s monitoring process. The auditors concluded that despite recognised efforts the JU has not yet implemented a fully effective and efficient monitoring system regarding the use and dissemination of research results by its beneficiaries. One very important issue has been stated by the IAS in its final report, dealing with the monitoring of the dissemination of research results of the JU’s Members. The related recommendation requires from the JU management to improve the guidance and templates regarding the plans for the use and dissemination of research results, the Members’ reporting on their implementation and the adequate assessment of the plans and reports by the JU.

Despite the acceptance of the IAS recommendations, the JU has objected to the classification of the recommendation above as very important, as the detected control weakness is neither detrimental to the process of the grant management nor to the actual dissemination of research results itself. Until the date of this report, the JU’s Members and Partners have successfully disseminated to the scientific community and the JU stakeholders more than 700 publications concerning the achieved research results of the FP7 programme. For further information, we refer to section 1.1.8 of this report.

The JU received the final audit report end of January 2016, but due to the very long period, which elapsed between the fieldwork and the receipt of the audit report, it had started to develop several appropriate actions already before the end of the audit. The implementation of the actions to improve the monitoring process will continue during the year 2016.

The strategic audit plan of the IAS for the years 2016 to 2017 remains unchanged. Possible audit themes are (1) H2020 Grant process (from the identification of the call topics to the signature of the grant agreement), (2) Performance management of the Cleansky2JU activities and (3) Coordination with CSC and implementation of CSC tools and services.

At the time of this report, the IAS has not issued an annual internal audit report for the year 2015 on the implementation of agreed actions stemming from previous years’ audits and risk assessments. Until now, the IAS has not indicated critical residual risk levels regarding the JUs main business processes and internal controls. According to the JUs’ own assessment no very important actions except for the one issued beginning of 2016 remain open at the time of this report.
Internal Audit Officer (IAO):

The IAO of the JU has summarised her main activities in the IAO’s Annual Report 2015\textsuperscript{12}.

Similar to the previous years, the IAO has provided in 2015 consultancy services in order to advise the JU’s management on further improving the processes and enhancing the necessary controls in the following areas:

- Risk management of the JU
- Ex-post audit exercises 2014 and 2015 for FP7 expenditure including implementation of audit results
- EPA approach for H2020 expenditure
- In-kind contribution procedures
- Anti-fraud strategy

For the year 2015, the IAO confirmed to the GB her organisational independence according to the IIA standards. However, due to repeated involvement in management tasks in the areas listed above, the IAO declared to management and GB a lack of objectivity.

A risk assessment has been performed by the IAO at the end of 2015 and areas with significant residual risks have been pointed out to the management of CSJU. The status of the agreed actions to mitigate significant management risks identified in previous risk assessments and audits have been taken into consideration.

As a result of the risk assessment carried out in 2015, the IAO concluded that the following processes still present significant residual risk levels of the JU:

- homogenous risk assessment on SPD level
- Certification and Validation of In-kind contribution for H2020 funded projects (IKOP) and Additional Activities (AA) for H2020 programme reporting
- Effective and efficient cooperation with the Common Support Centre of DG RTD (CSC)
- Integration of new Core Partners in the projects
- Integrated monitoring of interdependencies between FP7 ITDs, H2020 SPDs, TAs and TEs including focused risk assessment
- Multiannual budget planning in H2020 grants – management of reallocations
- SPD performance monitoring by JU regarding actual deliverables, milestones and resources consumption versus planning
- End of programme management - reporting and dissemination of research results
- Antifraud measures – prevention and detection; enabling data-sharing with DG RTD
- H2020 ex-post audit process of the JU carried out by the Common Audit Service

\textsuperscript{12} Annual Report 2015 of the Internal Audit Officer, dated 29.01.2016
Performance monitoring and internal control coordination

The JU management is aware of the above risk areas and is in the process of developing mitigating actions. More details are provided in the IAO’s Annual Report 2015. As the job profile of the IAO is expected to change in the year 2016 from being the Internal Audit Capability to a global audit function, which focuses on audit, internal control and quality management, a Strategic Internal Audit Plan of the IAO as prepared in the previous years has not been established for the year 2016.

### 4.1.6. Risk management and Conflict of Interest

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Action Plan Summary from Work Plan 2015</th>
<th>Comments on mitigation of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS Programme:</td>
<td>Tightly monitor the work progress on this item through the Project Officers and the GAMs. Have preliminary models implemented where needed.</td>
<td>No longer applicable to 2016. TE inputs for final report are already available at end 2015</td>
</tr>
<tr>
<td>A late availability of ITD aircraft models for the Technology Evaluator (lack of prioritization or lack of technical inputs) could prevent the environmental benefits assessment to be efficiently performed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>Have an early warning capability through quarterly reports and alert at Governing Board level. Propose re-orientations when needed and possible.</td>
<td>The risk could be mitigated in 2015. Continued monitoring will be required and is in place</td>
</tr>
<tr>
<td>The “share of the pie” logic could result in a lack of focus on the major, critical activities.</td>
<td>Challenge the ITDs in order that they focus on optimising the global output.</td>
<td>The risk could be mitigated in 2015. Continued monitoring will be required and is in place</td>
</tr>
<tr>
<td>Technical setbacks in one or several ITDs may result in a significant under-spending of annual budget.</td>
<td>Re-balance the budget across ITDs and with Partners if necessary at mid-year, according to the 2nd quarterly reports.</td>
<td>Monitoring continues on a quarterly basis in 2016. Rebalancing occurring firstly inside ITD, to protect the achievements. In case of under execution, propose release of funding back to JU.</td>
</tr>
<tr>
<td>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.</td>
<td>Harmonize the dissemination plans of ITDs Monitor the dissemination actions.</td>
<td>In progress and to be continued and finalized in Q1-16 as part of the CSC / JU cooperation.</td>
</tr>
<tr>
<td>The lack of experience in</td>
<td>Reinforce the information,</td>
<td>The risk did not materialize.</td>
</tr>
<tr>
<td>Risk Description</td>
<td>Action Plan Summary from Work Plan 2015</td>
<td>Comments on mitigation of risk</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>European Research Programmes from many Partners (SMEs) could result in a difficult and late closure process of their projects.</td>
<td>mainly through relevant Information Days and Web conferences; reinforce the role and the awareness of Topic Managers</td>
<td>No evidence of such risk in the projects performed by SMEs. The closure of GAPs is followed on a case by case approach for all partners.</td>
</tr>
<tr>
<td>The potential introduction of Clean Sky 2 in parallel to Clean Sky could result in a scattering of beneficiaries’ resources and a delay in Clean Sky demonstrator’s finalisation.</td>
<td>Condition the CS2 funding by SPD/TAs and by beneficiary to the actual execution of CS budgets and technical progress</td>
<td>No suspension of CS2 funding with a few to the finalisation of CS demonstrators became necessary in 2015. The CS1 demonstrators were monitored independently and allocation of resources was always checked for consistency with objectives. Continued monitoring is in place.</td>
</tr>
<tr>
<td>The potential introduction of Clean Sky 2 in parallel to Clean Sky could result in an unbearable overload for the JU team, if not preceded by a staff increase as requested.</td>
<td>Proceed as quickly as possible to the recruitment of the right level of staff. Revise the processes to cope with the closing phase of CS1 while complying with the specificities of H2020 / CS2</td>
<td>Staff increase secured on time and recruited on time; Current management of the operational team covers allocation of PO / PSO to CS1 and CS2. Similar approach for admin team; Criticalities consistently dealt with according to priorities</td>
</tr>
<tr>
<td>The Partners’ activities (GAPs) need to be completed in 2016. Risk of possible delays and related impact on demonstrations activities (if affected).</td>
<td>Accurate planning of all active GAPs has to be performed; weekly monitor of project execution and amendments requests. Clear message to be sent to Topic Managers and ITDs. Criticality also to be mentioned to GB.</td>
<td>Weekly monitor has been performed and will be continued. The JU’s monitoring efforts have been successful, there is only a very limited number of active GAPs left for Q4-16, which will be closely supervised</td>
</tr>
</tbody>
</table>

**CS2 Programme:**

Conflicts of priorities may happen within industrial companies, or change of strategy, resulting in a lack of resources available for Clean Sky 2 and delays in the completion of the activities.

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.

>80% of Launch Reviews held. Outcomes of these plus monitoring of progress were effectively used to reconsider some technical start dates and scope [eg CROR in CS2]

Technical setbacks in one or several ITDs may result in a significant under-spending of annual budget.

Re-balance the budget across ITDs/IADPs and with Partners if necessary at mid-year, according to the 2nd quarterly reports.

Not yet relevant given phase of programme execution.
<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Action Plan Summary from Work Plan 2015</th>
<th>Comments on mitigation of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>The potential resourcing shortfall in CS2 due to CS projects being completed may result in a scattering of beneficiaries’ resources, a delay in Clean Sky 2 ramp-up and an overload for the CS team.</td>
<td>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</td>
<td>With &gt;80% of Launch Reviews held risks, dependencies and resources have received a first “stress test”. Next update of CS2DP will consolidate all cost-to-completion estimates enabling a review of budget</td>
</tr>
<tr>
<td>Guidelines for Clean Sky 2 preparation documents may be not clear and/or stable enough, leading to late or incomplete ITD submissions to the JU.</td>
<td>Have clear management plan and templates for required documentation, defined at the start of the programme.</td>
<td>The risk could be effectively mitigated. CSMM updates completed and communicated by mid-year, allowing timely start to major amendments / inputs such as AAR, WP, CD2DP, GAMs etc.</td>
</tr>
<tr>
<td>Core Partner call may be not answered or quality of submissions results in non-selection</td>
<td>Continue to inform and engage as open a discussion as possible with potential CP. Ensure well written description of CP technical activities / Ensure adequate involvement and attention of Industry leaders in the strategic topic definition process</td>
<td>Info days were extensively used in the 3 Core Partner calls as well as engagement of SRG; Call response has been adequate with a low topic failure rate [5-7%]. POs have monitored topics definition closely in order to avoid any descriptions carrying a risk of low interest. The risk could be effectively mitigated.</td>
</tr>
<tr>
<td>Planning for cost and effort for complex, large ground and flight demonstrators (10 year programme) may lack accuracy</td>
<td>Each IADP / ITD to deploy an individual, tailored risk management and to completion plan</td>
<td>Risk management per IADP/ITD has been implemented at WP and QR level, with first ARs also showing a healthy and robust risk analysis. However CS2DP cost-to-completion remains missing and risk of cost/resource overruns remains real.</td>
</tr>
<tr>
<td>Negotiation processes with Core Partners may be lengthy, leading to delayed start of technical activities</td>
<td>Ensure appropriate training to Winners and Topic Managers; have a close follow-up of all negotiations and early warning / escalating process for solving issues.</td>
<td>Time-to-Grant of the Core Partner calls was not excessive and largely in line with planning. Achieved through a gate-review process by POs and a well-communicated schedule. In approx. 10% of topics the negotiation process required active JU mediation / intervention; no topic / negotiation failures were recorded. The risk could be mitigated</td>
</tr>
<tr>
<td>Risk Description</td>
<td>Action Plan Summary from Work Plan 2015</td>
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</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Efforts for interfaces and cooperation of partners for flight worthy hardware and complex flight demonstrators may be initially underestimated</td>
<td>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</td>
<td>Remains an ongoing risk due to highly integrated key demonstrators in the programme requiring e.g. Permit to Fly. This will be monitored via the call planning schedule with clear milestones for topic lists, draft and final descriptions and a technical check performed by the PS, with expert topic analysis commissioned where appropriate.</td>
</tr>
<tr>
<td>Competences and resource to successfully enable flight testing may be insufficient</td>
<td>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 Reviews (and further reviews)</td>
<td>At overall IADP / ITD level this was “stress tested” in the Launch Reviews [&gt;80% performed in 2015]. At consortium level the identification of Core Partners through the calls and their evaluation, and the allocation of core tasks was monitored closely by the PO team. A diligent review of the Call topics, close evaluation of capabilities in the selection of participants and in negotiation will remain a key task for the PO team.</td>
</tr>
<tr>
<td>The lack of guidelines for inclusion of some Level 2 projects may lead to an unclear perspective and lack of commitment of Members</td>
<td>Agree strategic priorities with GB. Adapt the technical content. Revise JTP and relevant ITD (IADP), with a target of EoY 2014.</td>
<td>Resolved via planned exercise in which Leaders as well as external stakeholders [IMG4] participated. One outstanding possible scope revision remains outstanding and subject to budget availability and priority via the routine CS2DP updating process [MINAEE]</td>
</tr>
<tr>
<td>Some costs may be overrun, and some participants may be unable to carry on until completion.</td>
<td>Manage priorities: abandon non crucial technology development and integrate only the crucial ones in the demonstration.</td>
<td>In 2015, actions were not yet required, as priority management and considerations on a contingency margin would</td>
</tr>
<tr>
<td>Risk Description</td>
<td>Action Plan Summary from Work Plan 2015</td>
<td>Comments on mitigation of risk</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td></td>
<td>Consider the implementation of a contingency margin.</td>
<td>have been too early. The risk will be further monitored via CS2DP and CtoC.</td>
</tr>
</tbody>
</table>

Risk assessment – Both programmes

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

- During the planning and programming phase:
  - Identification of risks in relation to the foreseen activities/objectives during the grant preparation phase. Project officers and Programme managers review the risks when preparing the annexes containing the description of work; critical risks are listed together with the envisaged mitigating actions in the Annual Work Plans and in detailed JU action plans.
  - Follow-up on risk management during the annual reviews
  - Specific risk reviews presented for the presentation in each Governing Board meeting during the technical progress reviews
  - Annual risk review of the JU management on global programme level

- As part of the reporting:
  - Presentation of risks and risks management in the Annual Activity Report. We refer to the description in the dedicated section 4.1.6 below.

Risk areas on JU level in 2015 (all levels from important to critical residual risk levels, not sorted) for consideration of JU management:

- **Steer the JU: change in top management: (I)**
  - Risk of loss of continuity and information, (in particular with a view to the next point)
- **Manage the quality: delay in updating quality system for Clean Sky 2 JU: (II)**
  - Risk of unclear processes and procedures;

### 4.1.7. 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. During the year 2015 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. Indeed the time to pay KPI shows the best result ever in the history of the JU from the year 2015 – this despite the lack of financial officers for part of the year.

Other elements of internal controls included an assessment of the CSJU 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. Almost all actions remaining from the year 2014 were closed in 2015. A description of the assessment performed by the JU’s Accounting
Officer is provided in a specific document for the year 2015. 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 2 programme budgets to the maximum possible. The financial circuits now put in place since 1st of October 2014 respect the segregation of duties and take into account the fact that the JU now runs 2 programmes and has some new actors entering the circuits internally.

Internal controls in Grant management

With regard to 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 expected, including distribution of funds and reporting of income have been addressed by the JU towards the members. New developments of GMT were completed in 2015 by which the JU made the GMT 2 modules available for CS2 reporting in March 2015. This was a significant milestone as the JU was, from the beginning in a position to record the cost statements of the beneficiaries of the GAM directly in the IT application rather than relying on excel tables etc. In addition, an upgrade of GMT for CS1 programme was made (GMT 1.5) with enhanced features and developments relating to the ex-post audit process. The JU, on request of the industry also began work on the planning module for the GAMs through GMT. This was rolled out and will be further implemented in 2016 making the grant management of members more efficient going forward. This was well received by the private members. Finally user videos to show how to use the system were established for the beneficiaries to follow all of the main steps in the process.

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 drafted.

Document management

On the request of the HAF, a small task force was established to revisit the document management policy of the JU. The project is divided in 2 phases comprising a total of 5 topics to be addressed, namely:

1) Organization and structure (references and processes)
2) Access policy (access / confidentiality policy / Classification “light” overview / folders naming convention)
3) Version control, naming convention of individual files and registration
4) Formatting / Logo / Branding / templates updating and location
5) Archiving (Shared drive / Physical archiving / GMT/ SESAM/FORCE/ H2020 tools / new CS2 internal tool)

The objective of the Document Management Policy (DMP) project was to include procedures and tools in place for managing the processing of documents to correspond to the current requirements regarding access, security and confidentiality, classification scheme of documents, workflow and authorization, quality assurance, harmonised
The DMP document was agreed in November and the first information session for staff took place in December 2015. The policy is aligned with the relevant parts of the key procedures (i.e. accounting and Grant Management) and IT tools (GMT, SESAM, H2020 tools) that concern the documentation of relevant steps and outputs, and as such, will prevent human errors in the handling and storing of documents. It covers all paper, born-digital and electronic documents, as drawn up or received by CSJU and belonging to CSJU’s documentary resources and the procedures managed by the IT systems. The DMP document constitutes the common standard to be complied with by all CSJU staff.
5. MANAGEMENT ASSURANCE

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

To be drafted at the final AAR stage.

5.1.2. Elements supporting assurance

Besides the dedicated supervisory activities of the Executive Director, the main elements supporting the assurance are:
- the Certificate of the Accounting officer
- The implementation of the recommendations arising from the validation of the JU’s accounting systems made by the Accounting Officer
- 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 results of the ex-post audit process in the year 2014 (and before) and the related implementation
- the information received from the Data Protection Officer
- the results of audits 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 2014 as supervised by the Executive Director
- the key performance indicators in place
- the dedicated ex-ante controls of the JU’s operational expenditure

5.1.3. Reservations

No reservation is entered for 2015.

5.1.4. Overall conclusion

Not applicable.
6. DECLARATION OF ASSURANCE

I, the undersigned, Eric Dautriat, 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 view².

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.

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

Place Brussels, date 29.02.2016

(signed)

Eric Dautriat

² True and fair in this context means a reliable, complete and correct view on the state of affairs in the Joint Undertaking.
ANNEXES

1. Organizational chart

Legend:
EPAO = Ex Post Audit Officer
PSO = Project Support Officer
GAP = Grant Agreements for Partners
### Establishment plan

<table>
<thead>
<tr>
<th>Category and grade</th>
<th>Staff population actually filled at 31.12.2014</th>
<th>Staff population actually filled at 30.06.2015</th>
<th>Establishment plan 2015</th>
</tr>
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<td>TA</td>
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<td><strong>Total AST</strong></td>
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<td>CA FG I</td>
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<td><strong>Total CA</strong></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>32</strong></td>
<td></td>
<td><strong>37</strong></td>
</tr>
</tbody>
</table>
4. Publications from projects

I. List of Clean Sky publications and dissemination events presentations:

a) In addition to large events and air shows, Clean Sky management and staff delivered presentations at the events below:

- **Feb-15**: NCP transport (Brussels): Presentation about the calls in CS2 and replies to questions by NCPs.
- **Mar-15**: International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles (ESARS) in Aachen: *Clean Sky Projects on the More Electric Aircraft*;
- **Apr-15**: FEAMA Amsterdam: Forum for European Aerospace Market Analysts; delivery of CS presentation as technology driver evolution of A/C configuration.
- **June-30**: EUCASS in Krakow: delivery of a keynote, general CS presentation
- **Sep-9**: CEAS conference in Delft: Keynote on Clean Sky and participation in a dedicated session
- **Sep-15**: EASN Workshop in Manchester: 5th International Workshop on Aerostructures; presentation entitled: *Scientific and technological challenges of the Clean Sky Initiative. Introduction to the 2nd CS call for proposals*
- **Sep-15**: AHS Sustainability 2015 in Montréal (International conference on Environmental Sustainability in air vehicle design and operations of helicopters and airplanes). Delivery of CS presentation: *Clean Sky Perspectives*
- **Nov-15**: Second annual Aerospace Symposium “The Aerospace Ecosystem” University of Glasgow – 2 November 2015: Presentation entitled: *Sustainable development - Clean Sky and the technology challenges*
- **Nov-15**: XXIII Conference of the Italian Association of Aeronautics and Astronautics - AIDAA 2015 in Turin, hosted by Politecnico and by the Aerospace & Defence meeting: Coordination of a Clean Sky Round Table with the participation of representatives from the Italian Aerospace Clusters.
- **E-Break Technology Transfer Workshop**: Presentation “Technology Transfer into Engine Demonstrators: Clean Sky 1 and Clean Sky 2”, 5-6 March 2015, Brussels
- **CS General Forum**: Round Table: “Session 1: From the classroom to the test bench: How to assemble and empower the best innovation chains within Clean Sky ?”, 17 March 2015
- **Promo-Air Final Workshop**: Presentation “Attracting high-school students in the Aeronautics Profession - the Clean Sky Perspective –”, 23 April 2015, Brussels.
- **Le Bourget**: CS Academy Presentation + Workshop, 18 June 2015

b) List of SFWA publications 2015:

<table>
<thead>
<tr>
<th>Author(s)/Org.</th>
<th>Title / Where published / Date</th>
<th>WP</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Lepage, Y. Amosse, D. Le Bihan, C. Poussot-Vassal, V. Brion, ONERA, &amp; Eric Rantet, Aviation Design</td>
<td>A complete experimental investigation of gust load: from generation to active control – International Forum on Aeroelasticity and Structural Dynamics, 28 June - 2 July 2015, St. Petersburg, Russia</td>
<td>WP1.2.4</td>
</tr>
<tr>
<td>A. Lepage, A. Geeraert, J. Dandois, P. Molton, F. Ternoy, J-B. Dor, E. Coustols, ONERA</td>
<td>An experimental demonstration of active transonic buffet control using a closed-loop methodology – International Forum on Aeroelasticity and Structural Dynamics, 28 June - 2 July 2015, St. Petersburg, Russia</td>
<td>WP1.1.2</td>
</tr>
<tr>
<td>Arnaud Geeraert, Cyrille Stephan, ONERA</td>
<td>CROR blade deformation, part 1: Experimental results by Strain Pattern Analysis – International Forum on Aeroelasticity and Structural Dynamics, 28 June - 2 July 2015, St. Petersburg, Russia</td>
<td>WP2.2.2</td>
</tr>
<tr>
<td>Yann Mauffrey, Arnaud Geeraert, ONERA</td>
<td>CROR blade deformation, part 2: Aeroelastic computations and comparison with experiments – International Forum on Aeroelasticity and Structural Dynamics, 28 June - 2 July 2015, St. Petersburg, Russia</td>
<td>WP2.2.2</td>
</tr>
<tr>
<td>F. Moëns and J.</td>
<td>Optimization of Passive Devices for the Performance</td>
<td>WP1.1.4</td>
</tr>
<tr>
<td>Author(s)/Org.</td>
<td>Title / Where published / Date</td>
<td>WP</td>
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<tr>
<td>Dandois, ONERA</td>
<td>Improvement of a Slat-less High-Lift Configuration</td>
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<td></td>
<td>– Journal of Aircraft, to be published, 2015</td>
<td></td>
</tr>
<tr>
<td>V. Brion, A. Lepage, Y. Amosse, D. Soulevant, P. Senecat, J.C. Abart, P. Paillart, ONERA</td>
<td>Generation of vertical gusts in a transonic wind tunnel – Submitted to “Experiments in Fluids”, 2015</td>
<td>WP1.2.4</td>
</tr>
<tr>
<td>S. Lawson, D. Greenwell, ARA</td>
<td>BUUCOLIC – Characterisation of Buffet on a Civil Aircraft Wing – AIAA Science and Technology Forum and Exposition (SciTech 2016), 4 - 8 January 2016, San Diego, California</td>
<td>WP1.1.2 CFP</td>
</tr>
<tr>
<td>Christine Radermacher et al.</td>
<td>An innovative semi-empirical system for laminar wing ice protection – InAIPS – AIAA Journal</td>
<td>WP3.2 CFP</td>
</tr>
<tr>
<td>Thomas Deconinck, Virginie Barbieux, Charles Hirsch, NUMECA</td>
<td>Integrated “CFD - Acoustic” Computational Approach to the Simulation of Open Rotors – AIAA Journal</td>
<td>WP2.2.4 CFP</td>
</tr>
<tr>
<td>Miguel Á. Castillo Acero, Aernnova</td>
<td>Automating Aircraft Assemblies with Tight Tolerances – AIAA Journal</td>
<td>WP3.1</td>
</tr>
<tr>
<td>Thomas Streit, Sven Wedler, Martin Kruse, DLR</td>
<td>DLR natural &amp; hybrid transonic laminar wing design incorporating new methodologies – Aeronautical Journal</td>
<td>WP1.1.2</td>
</tr>
<tr>
<td>Russell Older, Airbus</td>
<td>The Natural Laminar Flow Ground Based Demonstrator – AIAA Journal</td>
<td>WP2.1.2</td>
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<tr>
<td>M. Fiore, O. Vermeersch, M. Forte, G. Casalis, C. Francois ONERA</td>
<td>Characterization of an highly efficient chevron-shape Anti Contamination Device – Experiments in Fluids manuscript</td>
<td>WP1.1.3</td>
</tr>
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</table>
Author(s)/Org. | Title / Where published / Date | WP
---|---|---
Dr. Yves Toso, DLR | Investigations of Bird Strike on a Front Composite CROR-Aerofoil – ASIDI-Conference in Sevilla, 17-19 Nov 2015 – ASIDI-Conference proceedings | WP2.2.2
Patrik Dreher, DLR | Design methodology of CROR rotor blades – PERMAS Users’ Conference 2016 in Stuttgart | WP2.2.2
Prof. Dr. Mirco Imlau, Uni Osnabrueck | Riblet Sensor - Light Scattering on Micro Structured Surface Coatings – Website arxiv.org | WP1.1.3

II. List of Clean Sky achievements and visuals can be accessed here:
http://www.cleansky.eu/content/page/clean-sky-achievements

III. List of Clean Sky success stories and highlights on Clean Sky projects and topics as well as interviews from key players can be accessed here:
http://www.cleansky.eu/lists/interviews

IV. Session 1A – Greening of Aviation – Clean Sky Forum; Overview of Clean Sky Technical Programme and Achievements to date - presented at Aerodays 2015 – London
Introduction

The aviation industry is one of Europe’s main industrial sectors of excellence, with globally competitive leaders and a robust supply chain. This industry has a very high societal impact through its vital role of connecting people and regions. Its environmental impact is limited – accounting for approximately 3% of global man-made carbon dioxide emissions – but the continuous growth of air transport worldwide, at close to 5% a year, makes it necessary to mitigate its CO2 footprint. Similarly, noise must be continuously reduced. This is where Clean Sky comes in.

We are a public-private partnership founded in 2008 by the European Commission and most of the industrial leaders of European aeronautics. By coordinating and funding a Europe-wide research and innovation network in green aeronautical technologies, we are the main contributor to reaching the Advisory Council for Aeronautics Research in Europe (ACARE) 2020 goals:

- A 50% reduction in fuel consumption and carbon dioxide (CO\(_2\)) emissions.
- An 80% reduction in nitrous oxides (NOX) emissions.
- An external noise reduction of 50%.
- Improved environmental impact of the lifecycle of aircraft and related products.\(^\text{13}\)

To develop the cutting-edge technologies required to meet these goals, €800 million in total were provided by the Commission; this value is matched (up to 75% of this funding), by financial and in-kind contributions from the members (12 industry leaders and 65 Associates) and is used for at least 25% (i.e. 200 m€) in Open Calls for Proposals (CfPs).

The calls are based on focussed research themes (topics) proposed by our members. The best proposals are evaluated and selected by independent external experts and become projects performed by the Partners, integrated with the overall work plan.

The Partners involved in the projects, are mainly aeronautical industries, SMEs, universities and research organisations. To the end of 2015 there are 527 entities involved as Partners.

The research network created is essential not only for guaranteeing environmental sustainability, but also for promoting European competitiveness and for driving growth and jobs in the European economy.

Programme Structure

\(^{13}\) All goals compared with levels in the year 2000.
Clean Sky activities are performed within six “Integrated Technology Demonstrators” (ITDs) and a “Technology Evaluator”.

The organisation is shown in the following figure:

![Organisation Diagram](image)

The three vehicle-based ITDs will develop, deliver and integrate technologies into concrete aircraft configurations. The three transversal ITDs are focused on propulsion, systems and design methodologies. They will deliver technologies, to be integrated at aircraft-level and in airframe-based technologies in the various aircraft configurations by the vehicle ITDs.

### Smart Fixed Wing Aircraft (SFWA)
- Co-led by Airbus and SAAB
- Will deliver innovative wing technologies together with new aircraft configurations, covering large aircraft and business jets. Key enabling technologies from the transversal ITDs, such as the contra-rotating open rotor, will be integrated into the demonstration programmes and concept aircraft.

### Green Regional Aircraft (GRA)
- Co-led by Alenia and EADS CASA
- Will develop new technologies to reduce noise and emissions. These include in particular advanced low-weight and high-performance structures; incorporation of all-electric systems; bleed-less engine architectures; low noise/high efficiency aerodynamics; and environmentally optimised mission and trajectory management.

### Green Rotorcraft (GRC)
- Co-led by AgustaWestland and Airbus Helicopters
- Will deliver innovative rotor blade technologies for a reduction in rotor noise and power consumption, technologies for lower airframe drag, environmentally friendly flight paths, the integration of diesel engine technology, and advanced electrical systems to eliminate the need for hydraulic fluid and for improved fuel consumption.

### Sustainable and Green Engines (SAGE)
- Co-led by Rolls-Royce and Safran
- Will design and build five engine demonstrators to integrate technologies for low fuel consumption, whilst reducing noise levels and nitrous oxides. The open rotor is the target of two demonstrators. The others address geared turbofan technology, low pressure stages of a three-shaft engine and a new turboshaft engine for helicopters.

### Systems for Green Operations (SGO)
- Co-led by Liebherr and Thales
- Will focus on all electrical aircraft equipment and system architectures, thermal management, capabilities for environmentally-friendly trajectories and missions, and improved ground operations to give any aircraft the capability to fully exploit the benefits of the ‘Single European Sky’.

### Eco-Design (ECO)
- Co-led by Dassault Aviation and Fraunhofer Gesellschaft
- Will support the ITDs with environmental impact analysis of the product life-cycle. Eco-Design will focus on green design and production, maintenance, withdrawal, and recycling of aircraft. The optimal use of raw materials and energies, avoidance of hazardous materials, and the reduction of non-renewable energy consumption of on-board systems will help to reduce considerably the environmental impact of the aircraft and its systems.
Complementing these six ITDs, the Technology Evaluator (TE) is a dedicated evaluation platform covering all segments of the Clean Sky programme. The TE is co-led by DLR and Thales, and includes the major European aeronautical research organisations. It will assess the environmental impact of the technologies developed by the ITDs and integrated into the concept aircraft. In this way, the TE will enable Clean Sky to measure and report the level of success in achieving the environmental objectives and its contribution towards the ACARE goals. In addition to a mission-level analysis (aircraft-level), the positive impact of the Clean Sky technologies will be shown within an airport environment and across the global air transport system.

The progress in the achievement of the targets is assessed by the TE. The status is presented below in the document.

The global budget is pre-assigned to the different ITDs according to the Statutes, as follows:

<table>
<thead>
<tr>
<th>ITD</th>
<th>Budget Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAGE</td>
<td>27%</td>
</tr>
<tr>
<td>SFWA</td>
<td>24%</td>
</tr>
<tr>
<td>SGO</td>
<td>19%</td>
</tr>
<tr>
<td>GRA</td>
<td>11%</td>
</tr>
<tr>
<td>GRC</td>
<td>10%</td>
</tr>
<tr>
<td>ED</td>
<td>7%</td>
</tr>
<tr>
<td>TE</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Development strategy**

Technologies, concept aircraft and demonstration programmes form the three complementary instruments used by Clean Sky to meet its goals:

a) **Technologies** are selected, developed and monitored in terms of maturity or ‘technology readiness level’ (TRL). More than one hundred key technologies are monitored. The technologies developed by Clean Sky will cover all major segments of commercial aircraft. They were identified as the most promising in terms of potential impact on the environmental performance of future aircraft.

b) **Concept aircraft** are design studies dedicated to integrating technologies into a viable conceptual configuration. They cover a broad range, representing the major future aircraft families: business jets, regional and large commercial aircraft, as well as rotorcraft. Clean Sky’s environmental results are measured and reported principally by comparing these concept aircraft to existing aircraft and aircraft incorporating ‘evolutionary technology’ in the world fleet.

c) **Demonstration Programmes** include physical demonstrators that integrate several technologies at a larger ‘system’ or aircraft level, and validate their feasibility in operating conditions. This helps to determine the actual potential of the technologies. Demonstrations enable technologies to reach a higher level of maturity. The ultimate goal of Clean Sky is to achieve successful demonstrations in a relevant operating environment, i.e. up to TRL 6.

The CS Development Program is the continuously updated document approved by the Governing Board where the technology strategy and link to product/market scenarios is provided as reference for the ITD internal programs.
The most significant technologies matured to high TRL level are quoted in the relevant description of the demonstrators.

**Concept aircraft and environmental objectives**

Concept aircraft enable assessment of the environmental benefits of Clean Sky technologies across nearly the full spectrum of commercial aviation. Some key configurations which will be developed are set out below.

**Business jet concept aircraft**

- **Low-sweep business jet [LSBJ]**

  This concept aircraft for coast to coast missions includes a low-drag laminar flow wing with low sweep, and will feature a radically redesigned rear empennage (tail surfaces). This innovative empennage aims to significantly reduce noise levels for communities on the ground from a future generation turbofan engine by blocking sound waves with elements of the horizontal and vertical tail-plane:

<table>
<thead>
<tr>
<th>Technologies and configurations:</th>
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<tbody>
<tr>
<td>Low drag natural laminar wing</td>
</tr>
<tr>
<td>U-Tail or innovative empennage for noise shielding</td>
</tr>
<tr>
<td>Engine with a 2020 EIS (SN)</td>
</tr>
<tr>
<td>Less hydraulic power architecture</td>
</tr>
<tr>
<td>Electro thermal WIPS</td>
</tr>
<tr>
<td>FBW flight controls.</td>
</tr>
<tr>
<td>Smart flap</td>
</tr>
</tbody>
</table>

- **High-speed business jet [HSBJ]**

  This concept aircraft for Long Range performance includes a ‘smart’ low-drag, highly swept wing design, making use of passive and active laminar flow. The wing’s high-speed design aims to include a ‘smart flap’ concept. New environmentally friendly materials and processes complemented by new flight trajectories will be included.

<table>
<thead>
<tr>
<th>Incorporating these technologies and configurations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLF wing lower side</td>
</tr>
<tr>
<td>Load and vibration control</td>
</tr>
<tr>
<td>NLF on lifting surfaces control</td>
</tr>
<tr>
<td>Innovative 3 engine afterbody</td>
</tr>
<tr>
<td>DA 2020 engine</td>
</tr>
</tbody>
</table>

**Regional concept aircraft [TP90]**

The 90-passenger regional turboprop aircraft represents a concept for a next generation turboprop that could enter service in 2020-2025.
Technologies and configurations:
- Advanced Metallic Material
- Advanced Composite Materials
- Structure Health Monitoring
- Low Noise Landing Gear
- Low Noise & High Efficiency High Lift Devices
- Advanced Electrical Power Generation and Distribution System
- Electrical Environmental Control System
- EMA for Primary Flight Control System Actuation
- EMA for Landing Gear Actuation
- Mission Trajectory Management optimization

- Regional jet [GTF 130]:
The 130-passenger regional jet aircraft is a concept aircraft that could also come into service in 2020-2025. Using a next-generation power-plant (either GTF or Open Rotor

Large commercial concept aircraft

- Short/medium-range (SMR) aircraft, [APL2]
This concept aircraft includes the ‘smart’ laminar-flow wing. It will incorporate the contra-rotating open rotor (CROR) engine concept, developed within the Clean Sky programme. Flight-testing of a representative Laminar Wing and of a full-size CROR engine demonstrator, are planned now beyond the framework of the programme, and moved to CS2. Advanced systems and new flight trajectories already matured to appropriate level are included in the architecture.
- Long-range aircraft (LR), next generation large turbofan [APL3]

The long-range aircraft concept will provide the vehicle-level platform to integrate the next-generation large three-shaft turbofan engine using Clean Sky technologies. The focus of Clean Sky in this aircraft category is predominantly on improved engines and systems.

- Light single-engine helicopter [SEL]

The light single-engine helicopter concept, equipped with either a future generation single turboshift or diesel piston engine, will be developed within the Green Rotorcraft ITD of the programme.
- Light/medium/heavy multi-engine helicopter [TEH]:

**Generic light, medium and heavy multi-engine helicopter concepts, equipped with future generation turboshaft engine installations, will be developed within the Clean Sky programme. Their performance will be further enhanced by incorporating the latest innovative active blade technologies, radical structural redesign, and the introduction of advanced electrical systems (including an electric tail rotor) to eliminate the use of noxious hydraulic fluid and to reduce fuel consumption.**

- Tilt-rotor [TR]:

**The conceptual tilt-rotor aircraft is based on the European ERICA tilt-rotor concept, characterised by a small rotor diameter and tiltable wings. Performance is enhanced by aerodynamic optimisation and the installation of a future generation turboshaft engine.**

The role of the Technology evaluator

The environmental performance gains to be confirmed through demonstration of the technologies are depicted in the graphic, at the level of assessment in mid-2015. They are representative across different aircraft types and sectors (business jets, regional aircraft, large commercial aircraft and rotorcraft).

Some highlights of the progress are provided below:

In the business jet sector, a novel, radical re-design of the empennage shows very substantial benefits in shielding from engine noise in operation at low altitude: in some cases up to a two-thirds reduction in noise footprint on take-off can be achieved.

The figures in our assessments for the single-aisle short- to medium-range large passenger aircraft assume the use of CROR as engine architecture. Long-range commercial aircraft are set to benefit from new engine technology being developed in the Clean Sky SAGE programme area for large high-bypass turbofans.

In rotorcraft, strong improvements in noise footprint and emissions are foreseen. One innovation being investigated concerns the adoption of diesel propulsion (on so-called light single-engine helicopters).

With regard to the global ACARE 2020 goals, the first two Technology Evaluator assessments were completed in 2012 and 2013. Their results broadly confirm the environmental objectives set for the programme. To further hone Clean Sky’s effectiveness, annual implementation plans are produced every year and research priorities are (re)calibrated based on the findings obtained from the
demonstration activities. As such, Clean Sky is well on its way to being the main contributor to achieving the emissions and noise targets outlined earlier.

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>noise area reduction take-off [%]</th>
<th>noise reduction take-off [dB]*</th>
<th>CO2 reduction per pax [%]</th>
<th>Nox reduction per pax [%]</th>
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</thead>
<tbody>
<tr>
<td>Noise footprints and missions 75dB-85dB/500-2800NM</td>
<td>75 dB/500-2800NM</td>
<td>500-2800NM</td>
<td>500-2800NM</td>
<td></td>
</tr>
<tr>
<td>APL2 vs RPL1 Average delta value</td>
<td>NA</td>
<td>-1.0</td>
<td>-38%</td>
<td>-33%</td>
</tr>
<tr>
<td>Noise footprints and missions 80dB-90 dB/1000-7000NM</td>
<td>80 dB/1000-7000NM</td>
<td>1000-7000NM</td>
<td>1000-7000NM</td>
<td></td>
</tr>
<tr>
<td>APL3 vs RPL2 Average delta value</td>
<td>-81%</td>
<td>-6.5</td>
<td>-18%</td>
<td>-46%</td>
</tr>
<tr>
<td>Noise footprints and missions 55dB-75dB/100-500NM</td>
<td>55dB/100-500NM</td>
<td>100-500NM</td>
<td>100-500NM</td>
<td></td>
</tr>
<tr>
<td>TP90 2020 vs TP90 2000 Average delta value</td>
<td>-71%</td>
<td>-13.43</td>
<td>-30%</td>
<td>-34%</td>
</tr>
<tr>
<td>Noise footprints and missions 55dB-75dB/100-500NM</td>
<td>55dB/100-500NM</td>
<td>100-500NM</td>
<td>100-500NM</td>
<td></td>
</tr>
<tr>
<td>GTF130 2020 vs TF130 2000 Average delta value</td>
<td>-76%</td>
<td>-14.00</td>
<td>-21%</td>
<td>-34%</td>
</tr>
<tr>
<td>Noise footprints and missions 55dB-75dB/100-500NM</td>
<td>55dB/100-500NM</td>
<td>100-500NM</td>
<td>100-500NM</td>
<td></td>
</tr>
<tr>
<td>LSBJ 2020 vs LSBJ 2000 Average delta value</td>
<td>-58%</td>
<td>-5.50</td>
<td>-33%</td>
<td>-34%</td>
</tr>
<tr>
<td>Noise footprints and missions 55dB-75dB/100-6400NM</td>
<td>55dB/100-6400NM</td>
<td>100-6400NM</td>
<td>100-6400NM</td>
<td></td>
</tr>
<tr>
<td>HSBJ 2020 vs HSBJ 2000 Average delta value</td>
<td>-10%</td>
<td>-1.13</td>
<td>-19%</td>
<td>-26%</td>
</tr>
</tbody>
</table>

*average dB reduction of a given noise footprint

Table 1: Clean Sky benefits per considered 2020 concept aircraft and rotorcraft

**Demonstration programme**

While some technologies can be assessed during their development phase at component or system level, many key technologies will need to be validated via dedicated test programmes, involving large-scale ground or in-flight demonstration installations. These demonstrators integrate several technologies at a major system level or at aircraft level, enabling them to be tested in a relevant operating environment.

To date, more than 30 demonstrators are being developed at a very high technological maturity level. Demonstrations enable technologies to reach a higher level of maturity (TRL), which is the very justification of Clean Sky as a ‘Level 3’ highly-integrated project and Joint Technology Initiative (JTI) within the European Framework Research and Innovation Programme.
In the following sections the most significant and representative demonstrators from each ITD are presented with the highlights of their content.

The demonstrations already performed are listed by year and by ITD.

The demonstrations to be achieved in the last part of the Clean Sky programme are also presented by time allocation from Q4-15 to end 2016 and by ITD.

For a more complete list refer to the brochure CS at a Glance.

Main Demonstrators achieved

<table>
<thead>
<tr>
<th>“Advanced Lip Extended Acoustic Panel” – ALEAP</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Airbus A380 ALEAP flight test demonstrator team after successful CleanSky flight test campaign in 2010" /></td>
<td></td>
</tr>
<tr>
<td>The technology to reduce the Fan noise of large turbofan engine was validated in operational conditions at original scale in a flight test campaign in 2010. After the successful validation in flight, the technology to manufacture the key parts relevant for this technology shall be reviewed and matured to reach TRL6 (activities to be carried out outside of SFWA)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SFWA Laminar Wing Ground Based Demonstrator</th>
<th>TRL4 for the Structural Concept in November 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="SFWA Laminar Wing Ground Based Demonstrator" /></td>
<td></td>
</tr>
<tr>
<td>The Ground Based Demonstrator (GBD) is a full scale partial wingbox demonstration of the structure and systems needed to produce a leading edge solution to meet the strict requirements to achieve Natural Laminar Flow (NLF). The flight testing, based on an A340 flying test bed and featuring two different NLF wing demonstrators, will be started later than 2016, but still in the framework of the CS SFWA activities.</td>
<td></td>
</tr>
<tr>
<td>The task made use of the support of the Partners (GKN), with Airbus together with the Manufacturing Technology Centre at Coventry undertook the assembly and testing of the integrated product.</td>
<td></td>
</tr>
<tr>
<td><strong>Main features:</strong></td>
<td></td>
</tr>
<tr>
<td>• The GBD is a 4.5m long by 1m wide section of flight-representative wing leading edge attached to a partial wing box assembly. The leading edge accommodates a Krueger flap in two sections. This split has allowed GKN Aerospace engineers to</td>
<td></td>
</tr>
</tbody>
</table>
investigate two very different design philosophies.

- **Major outcomes are:**
  - Ground Based Demonstrator (full scale Leading edge) now fully functional
  - Installation of electro-thermal anti-ice system, moveable Krueger flaps, bird strike and lightening protection
  - Numerous manufacturing & assembly lessons learnt (esp. wrt. accessibility)

<table>
<thead>
<tr>
<th>Contra-Rotating Open Rotor demo engine flying test bed - CROR</th>
<th>DNW testing in 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major contributors are:</strong></td>
<td><strong>Objective:</strong> to demonstrate viability of full scale innovative engine concept in operational condition</td>
</tr>
<tr>
<td>Airbus, SNECMA, ONERA, DLR, NLR</td>
<td><strong>Main features:</strong></td>
</tr>
<tr>
<td>IBK, ARA, NUMECA, VKI, ISAE, Swerea, Magsoar, DNW</td>
<td>- New propeller design (high performance, low noise)</td>
</tr>
<tr>
<td></td>
<td>- Engine – pylon – aircraft integration concept</td>
</tr>
<tr>
<td></td>
<td>- New CROR – engine integration technology</td>
</tr>
<tr>
<td></td>
<td>- Advanced CROR aero-acoustic design</td>
</tr>
<tr>
<td></td>
<td><strong>Expected benefits:</strong> fuel burn saving on short and mid-range aircraft compared to current fleet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GRA ATR first flight, Crown Panel</th>
<th>9 July 2015, TRL 5/6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovative CFRP fuselage “crown” panel</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Contributions from ALENIA (design), ATR (installation and operation; test aircraft), Fraunhofer (panel instrumentation)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Aim of Flight test campaign was to support the development of innovative CFRP panel with embedded layer to provide additional acoustic damping</strong></td>
<td></td>
</tr>
<tr>
<td><strong>The expected benefits concern weight, internal noise, assembly costs and structural health monitoring</strong></td>
<td></td>
</tr>
</tbody>
</table>
### GRC Demonstration of Diesel powered light helicopter –

A flying Demonstrator based on an EC120 serial helicopter and fitted with a newly designed **High Compression Engine (HCE)**, a reciprocating engine using Kerosene, has been developed by Airbus Helicopters in the frame of GRC4, part of Clean Sky’s Green Rotorcraft ITD.

For this Research project, Airbus Helicopters teamed up with TEOS Powertrain Engineering, France (leader of the Consortium) and AustroEngine GmbH, Austria, a partnership which was organised in the Consortium HIPE 440 selected to work for Clean Sky via a Call for Proposal in 2011.

In the power class related to EC120 engines (300 to 400kW), the main advantages of HCEs compared to turboshaft engines are the lower specific fuel consumption, lower CO$_2$ emissions, higher performance in hot/high conditions thanks to the superchargers.

In order to limit the mass penalty and reach a high helicopter performance level, the fully-installed Powerpack was targeted to a mass-to-power ratio of less than 0.8kg/kW.

---

### GRC Demonstration of Helicopter Low Noise Procedures

**May 2015 TRL 6**

- Successfully demonstrating low-noise helicopter instrument (IFR) approaches at an airport with commercial airline traffic.
- Outcome of a seven-year project devoted to environment-friendly helicopter approach procedures, Airbus Helicopters used an H175 helicopter to fly **low-noise IFR approaches** to the heliport of Toulouse-Blagnac airport in south-western France.
- The approach procedures were flown using accurate lateral and vertical guidance provided by **EGNOS** (European Geostationary Navigation Overlay Service), the European Satellite-Based Augmentation System (SBAS), and in the presence of airplane traffic simultaneously approaching and departing to/from airport runways, which proved the suitability of these helicopter-specific procedures to achieve **Simultaneous Non Interfering (SNI)** aircraft and rotorcraft IFR operations at a medium-size commercial airport.
- The low-noise helicopter-specific IFR approach procedures are based on the noise optimised flight paths successfully validated in 2013 with an H155 and having demonstrated noise footprint reductions of up to 50 per cent, which is one of the Clean Sky initiative’s high-level goals.
- Detailed design and integration of the procedures in Toulouse airspace was achieved by GARDEN, a partner project with expertise in Air Traffic Management (ATM).
<table>
<thead>
<tr>
<th>SAGE 5 First rotation of TECH800</th>
<th>Tests on FETT 2 are planned end of 2015</th>
<th>TRL 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 April 2013 TURBOMECA</td>
<td></td>
<td>Core turboshaft engine demonstrators in the power range 1,000-2,000 SHP. High efficiency compressor, combustion chamber, high-pressure and low-pressure turbine Turbomeca developed the technologies with support of several partners. Full scale &amp; life cycle validation</td>
</tr>
</tbody>
</table>

| SAGE 3 (ALPS) first flight | Q1-Q4/2014 | Rolls-Royce goals to deliver a 20% fuel efficiency improvement, compared to the first generation of Trent engines for the Advance and UltraFan™ engines for a timeframe of 2020 and 2025) are pursued through the Advanced Low Pressure System (ALPS), part of the SAGE 3 ITD. One of the most striking advances has been testing of the composite fan that will be incorporated into both engine designs. The CTi (Carbon Titanium) fan blade and associated composite engine casings deliver a weight saving of around 1,500 lb on a twin engine aircraft. Composite panels containing electrical harnesses and pipework fit around the fancase, reducing weight and simplifying maintenance. Testing in 2014 was consisting of first testbed runs in Derby, UK, to crosswind testing at the Rolls-Royce facility at the John C. Stennis Space Centre, Mississippi, and most recently full flight tests on a Rolls-Royce Boeing 747 flying testbed at Tucson, Arizona, where one of the four RB211 engines was replaced with a Trent 1000 “donor” engine with CTi blades. A total of six flights took place over eleven days in October 2014. |

<p>| SGO - Icing Wind Tunnel tests of 3 WIPS technologies (by Airbus, Liebherr, SAAB Zodiac) | 2012 NASA IWT | Three different technologies for the electrical Wing Ice Protection System (eWIPS) have been investigated up to TRL 3: ETIPS (Electro-Thermal) EMIPS (Electro-mechanical) HYLIPS (Hybrid) Dedicated representative models have been tested in large scale Icing Wind Tunnels (both in US and EU). The flight testing activities have been postponed to a later stage. |</p>
<table>
<thead>
<tr>
<th>Multi Criteria Departure Procedure function pilot-in-the–loop ground tests*</th>
<th>Q2-14 TRL5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus- Thales</td>
<td>AIRLAB Thales simulator</td>
</tr>
</tbody>
</table>

Cockpit with real software products (real code on native platform) and simulated equipment. Used by Operational (as VALORIE) for MCDP function evaluation

MCDP / A-IGS / MSC functions are developed to optimize A/C trajectories wrt. environmental criteria and flight operation efficiency
- Define green trajectories (departure, cruise and final approach)
- Demonstrate the environmental friendliness of the functions in a representative operational environment
- Follow-up the technical maturity of the technologies and system architectures

<table>
<thead>
<tr>
<th>SGO Skin heat exchanger (LSHX) – A320 ATRA FTD Sept 2014</th>
<th>Q3-2014 TRL5/6 passed in Dec-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus, DLR and Liebherr</td>
<td></td>
</tr>
</tbody>
</table>

As part of the development for advanced Cooling systems, a Skin heat exchanger (LSHX) has been installed on the A320 ATRA flying test bed of DLR for two test campaigns (September to December 2014).

The SHX performances have been assessed for different Reynolds numbers, analyzing the aerodynamic data (boundary layer, heat transfer coefficient), allowing the Validation & improvement of numerical models

<table>
<thead>
<tr>
<th>Electrical Power Distribution Centre (EPDC HVDC &amp; Power Electronic modules)</th>
<th>Demonstration on PROVEN test rig June 2015 Q2-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zodiac Aero Electric (Zodiac Aerospace group)</td>
<td></td>
</tr>
</tbody>
</table>

In the frame of the Systems for Green Operations (SGO) ITD, an innovative Electrical Power Distribution Center (EPDC) adapted to “More Electrical Aircraft” architecture and sized for a single aisle airliner has been developed.

The Electrical Power Distribution Center (EPDC) is the vital link between the electrical power sources of the aircraft (main generators, batteries, ram air turbine, external ground park, auxiliary power unit etc.) and the electrical power consumers (environment conditioning system, in-flight entertainment, electrical deicing, actuators, pumps, galleys etc.).

The Clean Sky EPDC designed by Zodiac Aero Electric integrates many Line Replaceable Unit (LRU) boxes with simple interfaces: HVAC/HVDC converters; rectifier. New
feature is a liquid cooling system into the EPDC. The EPDC prototype was delivered to the Airbus PROVEN test rig in Toulouse.

**ECO DESIGN**

**Electrical Test Bench – [COPPER Bird]**

Labinal Power System

The COPPER BIRD® was created in 2002 to meet the needs of more electrical aircraft, in the context of the POA (Power Optimised Aircraft) European project to characterize an innovative electrical architecture and define a new integration methodology for Electrical Aircraft Equipment.

With Clean Sky the Labinal Power systems’ test rig has reached further capabilities, complying with airframers new requirements, and providing a state of the art Electrical Test Bench for small aircraft and helicopters, towards the More Electric Aircraft architectures

COPPER = Characterization and Optimization of Power Plant Equipment Rig

**ECO DESIGN**

**Thermal Test Bench –**

Fraunhofer IBP

The TTB plays a key role in the simulation and testing of new systems with regard to thermal behavior, allowing a wide range of thermal measurements to be conducted on a genuine aircraft fuselage split into the three main sections of cockpit, cabin and empennage.

The test facility also includes the Aircraft Calorimeter (ACC) that simulates extreme conditions such as rapid decompression and thermal shock, i.e. extremely rapid changes in temperature..

The main benefit offered by the TTB is the reduction of real-life test flights, while simultaneously protecting the environment..
## Major Demonstrators planned

<table>
<thead>
<tr>
<th>SFWA Wing assembly for the BLADE demonstrator - AERNNOVA</th>
<th>Q4-15</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Wing assembly" /></td>
<td></td>
</tr>
</tbody>
</table>

As the evolution of the concept to a flyable demonstration, after the successful GBD, two semi wing (8 m span each) were designed and manufactured with involvement of SAAB and of GKK UK for two different solutions (fully integrated composite; standard wing design); both of them complying with the stringent requirements of tolerance, stability and accuracy of the shape of the wing to keep the laminarity in all flight regimes. The Krueger flap is used to cope with the contamination and protect the Leading edge of the wing.

After this assembly the wings will be delivered to Airbus-us for integration in the A340 Flying test bed.

Wind tunnel test have been conducted to assess the handling qualities of this modified configuration.

### “Breakthrough Laminar Aircraft Demonstrator in Europe” – BLADE

- **Major partners are:**
  - Airbus, Dassault, Aernnova, Saab, INCAS, Romaero, ONERA, DLR
  - SERTEC, BIAS, GKN, ASCO, Aritex, Ascamm, ITA, VEW, 5micron GmbH, FTI Engineering Network GmbH

- **Test Aircraft modifications (A340-300) and manufacturing of NLF wing parts on going.‘Power-on’ of the Aircraft planned by end of 2016, followed by the start of flight-test activities in 2017**

- **Objective:** to demonstrate in flight that the Natural Laminar Flow (NLF) wing produced at ‘industrial scales’ will confer significant performance, with low maintenance and operational costs

- **Main features:**
  - Advanced passive laminar wing aerodynamic design
  - Two alternative integrated structural concepts for a laminar wing
  - High quality, low tolerance manufacturing and repair techniques
  - Anti-contamination surface coating
  - Shielding Krueger high lift device

- **Expected benefits:** fuel burn saving on short and mid-range aircraft compared with an equivalent aircraft with a conventional wing
<table>
<thead>
<tr>
<th><strong>SFWA Low Speed BizJet (LSBJ)</strong></th>
<th>Scaled model representative of the LSBJ conceptual bizjet aircraft with U-tail (based on a Falcon configuration) Aerodynamic characterization tests in DNW WT to be followed by acoustics tests on the same model with dedicated test set-up.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>SFWA Full scale Ground demonstrator for U-Tail configuration</strong></th>
<th>2016-Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major partners are: Dassault, ONERA, NL-Cluster INCAS, AVIOANE</td>
<td></td>
</tr>
<tr>
<td><strong>Objectives:</strong> Noise shielding measurement, acoustic &amp; fatigue characterization and thermal characterization for U-Tail configuration</td>
<td></td>
</tr>
<tr>
<td><strong>Main features:</strong></td>
<td></td>
</tr>
<tr>
<td>- far field microphones installed on the ground for installation effect measurements</td>
<td></td>
</tr>
<tr>
<td>- Metallic and composite panels installed on the U-tail for thermal and acoustic fatigue measurements</td>
<td></td>
</tr>
<tr>
<td><strong>Expected benefits:</strong> Noise reduction on short range flights compared to current fleet</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>GRC Active Gurney Flap - Whirl tower Test (TRL 5), to be followed by Flight testing [TRL6]</strong></th>
<th>The full development of the Innovative rotor blade concepts consists of several activities: Model Rotor test2 D Static Test (at CIRA WT) Whirl Tower- Flight test on a AW139 helicopter to reach TRL 6, while collecting flight data on the Full system operation</th>
</tr>
</thead>
</table>
The scope of this demonstration is the electrification of the tail rotor drive function.

The 'Electric Tail Demonstrator' task uses the concepts explored by the ELETAD project performed by a Partner, and incorporates the high power/weight ratio laboratory motor design into a high integrity aircraft system capable of installation and dynamic evaluation on an aircraft tail demonstration rig.

The Electric Tail Demonstrator system is currently TRL 3, with the key motor parts from ELETAD that are at TRL4.

The ground demonstration will dynamically evaluate the system representing flight mission profiles, reaching TRL5.

---

GRC Electric Tail Demonstration - TRL 5

**The ATR 72 FTB A/C will be modified at the end of the structural test campaign for the AEA Technologies flight demonstration.**

**This include:**
- **EPGS:** Electrical Power
  - Installation of 270 HVDC Generation distribution including Electrical Power Center (EPC) and Simulated Resistive Electrical Load (SREL)
- **E-ECS Mod:** Air Conditioning – Installation of the Experimental electrical environmental control sys. E-ECS (35 kW)
- **EMAs:** Installation of two electrical actuators (one for FCS, one for LG (each mounted on a dedicated test bench, both located in Cabin).

An FTI/Flight Test Station (FTES) will also be installed in the cabin.
<table>
<thead>
<tr>
<th><strong>GRA Fuselage demonstrator</strong>&lt;br&gt;One Piece Barrel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The fuselage demonstrator has 2 parts, the fabrication of the fuselage barrel as a Composite “one piece barrel” and the testing of this barrel for fatigue and static behaviour. The work progress shown looks very good. The tests on the fuselage barrel are scheduled to start end of 2015.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>GRA Cockpit demonstrator</strong></th>
<th>Q2-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>A second cockpit ground demonstrator has been prepared, and has achieved a major step towards the internal target of 10% weight saving. Different frame materials are still under future investigation to identify the best material for acoustic, fatigue and crash behaviour.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SAGE4 DEMONSTRATOR – MTU</strong>&lt;br&gt;Q4-15</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Geared Turbofan Demonstrator, with MTU and Partners contribution with innovative technologies concerning materials and manufacturing processes. Engine components concerned: ▪ New highly efficient high-pressure compressor ▪ Light weight, high speed low-pressure turbine ▪ Advanced light weight and efficient turbine structures ▪ Light weight and reliable fan drive gear system ▪ New systems for a more electric engine</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SAGE2 CROR GTD – Safran SNECMA</strong>&lt;br&gt;Q2-16</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Counter Rotating Open Rotor (based on a geared unducted architecture) is an aircraft engine offering a 30 % fuel burn reduction compared to the CFM56® engine, allowing to a significant decrease of the CO2 emissions. The Open Rotor configuration aims at meeting several technological challenges such as a new propulsion mode, an innovative aerodynamic configuration and unprecedented manufacturing processes. The main innovative elements of the design concern the blades of the propellers, the blade pitch change mechanism, the gearbox and the rotating structure. By intensive aero-acoustic wind tunnel testing of several design optimizations, Safran demonstrated that this architecture is compliant</td>
<td></td>
</tr>
</tbody>
</table>
with the new noise standards for certification (chapter 14) and consistent with expected performance level.

Safran is leading the SAGE2 Consortium (including several Partners) which aims at delivering and ground testing a full-scale Open Rotor engine on a brand-new Safran open-air facility located in Istres.

<table>
<thead>
<tr>
<th>SAGE6 Demonstrator - R-R</th>
<th>Q3-16</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="SAGE6 Demonstrator" /></td>
<td>The Lean Burn Programme objective is to deliver a verified generic Lean Burn System against a set of validated requirements complying with regulatory and company demands for emissions and safety, and with acceptable reliability at minimum life cycle cost and weight.</td>
</tr>
<tr>
<td><img src="image" alt="Trent 1000" /></td>
<td>• The test programme is based on Trent 1000 donor engines (ALECSYS) for engine ground testing.</td>
</tr>
<tr>
<td><img src="image" alt="Environmentally Friendly Engine" /></td>
<td>• Emissions capability at representative future cycles has been demonstrated in a dedicated core engine experiment on the EFE vehicle (Environmentally Friendly Engine).</td>
</tr>
<tr>
<td><img src="image" alt="B747 flying testbed" /></td>
<td>• The programme is also envisaging a full scale flight test campaign on a B747 flying testbed.</td>
</tr>
<tr>
<td><img src="image" alt="Technology Readiness TRL6/MCRL4" /></td>
<td>• The programme is scheduled to achieve Technology Readiness TRL6/MCRL4 by mid-2016.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SGO A320 e-FTD</th>
<th>Q2-16</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="A320 e-FTD" /></td>
<td>The A320 will be configured for flight testing in two test campaigns of More Electric Aircraft architecture, integrating the following items:</td>
</tr>
<tr>
<td><img src="image" alt="Liebherr 50kW e-ECS" /></td>
<td>• Liebherr 50kW e-ECS, verifying the interaction &amp; control laws between compressors &amp; scoop air intake &amp; A/C, and the Electrical functionality and associated DC system / power electronics. Also part of this effort is the Scoop air intake performance.</td>
</tr>
<tr>
<td><img src="image" alt="Primary Ice Detection System" /></td>
<td>The Electrical Power Centre is based on HVDC and several sensors.</td>
</tr>
<tr>
<td><img src="image" alt="The Primary Ice Detection System" /></td>
<td>The Primary Ice Detection System (PFIDS), whose goal is to automatically activate the Ice Protection System, when the A/C encounters icing conditions (from -40°C to +10°C), is currently at TRL 5 as a component, after Verification of the Detection performance in Icing Wind Tunnel (IWT).</td>
</tr>
</tbody>
</table>


**Concluding remarks**

Clean Sky has implemented the concept of the PPP / JTI designed for FP7 and the Joint Undertaking has managed the programme developed by the all members (industry, academia, research centers, SMEs).

Some successful examples of demonstrators achieved have been presented, as well the most significant demonstration activities planned by the end of Clean Sky (2016).

Some activities will be continued beyond this deadline, to 2020 and beyond by the Clean Sky 2 programme launched in June 2014.

For more information about the future activities of the Clean Sky Joint Undertaking, visit the Clean Sky website at [www.cleansky.eu](http://www.cleansky.eu) and refer to the other presentations / papers about Clean Sky in different parallel sessions at Aerodays.
## 5. Scoreboard of Horizon 2020 and FP7 KPIs

<table>
<thead>
<tr>
<th>Description</th>
<th>Targets</th>
<th>2015 Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H2020 Results</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Budget implementation/execution</strong></td>
<td>Payment appropriations</td>
<td>Payment appropriations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operational: &gt;85%</td>
<td>Operational: 81%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Admin: &gt;75%</td>
<td>Admin: 75%</td>
<td></td>
</tr>
<tr>
<td><strong>Country distribution (EU Member States and Associated countries)</strong></td>
<td>EU 28: 95%</td>
<td>EU 28 &gt;98%</td>
<td>measured in numbers; in terms of contribution, the result would be close to 100% for participants from EU 28.</td>
</tr>
<tr>
<td></td>
<td>Associated: 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SME participation -financial contribution</strong></td>
<td>17.5%</td>
<td>13%</td>
<td>in numbers the percentage of SMEs is 18 % until December 2015; the remaining grants, which are not yet signed will however change the result of this first H2020 call.</td>
</tr>
<tr>
<td><strong>Gender balance - Advisors and experts</strong></td>
<td>no target</td>
<td>Female Participation Rates: 22.3% in Evaluations 3.2% in Annual Reviews 4.3% in Technical Reviews 14.3% in the Scientific Committees 16.7% in the Program Coordination Committees</td>
<td></td>
</tr>
<tr>
<td><strong>Innovation Actions (IAs)</strong></td>
<td>Leaders: 100% Core Partners: 100% Partners: 70%</td>
<td>GAMs: 100% CFP projects awarded (CFP01): IA % of projects = 51 % IA % in funding = 41 %</td>
<td></td>
</tr>
<tr>
<td><strong>Horizon 2020 beneficiaries from the private for profit sector - number of participants</strong></td>
<td>75%</td>
<td>GAMs: 80% CFP (CFP01): = 42 %</td>
<td>The same indicator referring to the financial contribution is 92% for GAMs</td>
</tr>
<tr>
<td><strong>PPPs leverage effect</strong></td>
<td></td>
<td>€ 236.94 million</td>
<td>Represents the value of the reported AAs (still estimated and uncertified)</td>
</tr>
<tr>
<td>Description</td>
<td>Targets</td>
<td>2015 Results</td>
<td>Comments</td>
</tr>
</tbody>
</table>
|--------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
| Distribution of Proposal evaluators by country   | <33% from one country          | 22 countries in total; Amongst them highest % for France (13.7%), then Italy and Germany both 12.9%, Spain (11.5%) Belgium 7.9% Non-EU nationalities: 5%, out of which Turkey (3%), Israel (0.7%), Switzerland (0.7%)14. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Distribution of proposal evaluators by type of organization | <66% from one sector          | Higher Education Establishments (33%), Non-research commercial sector including SMEs (20%), Consultancy firms (12%), Public Research Centers (8%), Private Non-profit Research Centers (6%). |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Ethics efficiency (time from information letter sent until final clearance) | undetected cases: 0 45 days | one detected case, clearance time: 14 days |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Time to grant (TTG) (< 8 months from call deadline to signature) | 80% 0% | 1 CFP evaluated so far; we reached 63% within 9 months |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Redress after evaluations                        | <2% of proposals 1.98%        | 1 CFP evaluated so far; we reached 63% within 9 months |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Time to pay (payments made on time)              | 85% 90%                        | Operational and admin payments;                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Vacancy rate                                     | 0% 14%15                      | 1 CFP evaluated so far; we reached 63% within 9 months |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Call topics success rate                         | > 90% 93%                     | it is premature, but on the basis of 3 calls, of which one is finalized, this would be the result. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Launch reviews                                   | 3 reviews planned 80%         | percentage of total major demo activity where Launch Reviews held and resulting in agreed launch of major projects |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

14 These results are established taking into consideration the calls evaluated in the period 01.01.2015-31.12.2015. the accumulated results for the CS2 programme are available in section 1.1.5.
15 The vacancy rate at the time of establishing the Provisional AAR is 10%.
## FP7 results

<table>
<thead>
<tr>
<th>Description</th>
<th>Targets</th>
<th>Results 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration activities</td>
<td>Plan 18-20</td>
<td>46</td>
</tr>
<tr>
<td>SME share - value</td>
<td>&gt; 35%</td>
<td>35%</td>
</tr>
<tr>
<td>SME share - numbers</td>
<td>&gt; 40%</td>
<td>36%</td>
</tr>
<tr>
<td>SME share in CFPs - numbers</td>
<td>&gt;40%</td>
<td>41%</td>
</tr>
<tr>
<td>Error rates</td>
<td>&lt;2%</td>
<td>1,22%</td>
</tr>
<tr>
<td>Ex-post audit coverage</td>
<td>20%</td>
<td>23,2%</td>
</tr>
</tbody>
</table>

## Dissemination and usage of results FP7

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECO</td>
<td>200</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>GRA</td>
<td>121</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>GRC</td>
<td>119</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>SAGE</td>
<td>43</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>SFWA</td>
<td>70</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>SGO</td>
<td>150</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>TE</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total JU</td>
<td>716</td>
<td>186</td>
</tr>
</tbody>
</table>

## Communication results

<table>
<thead>
<tr>
<th>Description</th>
<th>2015 Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large events, e.g. conferences: 18</td>
<td>The results are taken for H2020, but the majority of the publication events are equally dealing with FP7.</td>
</tr>
<tr>
<td></td>
<td>Web traffic (visitors on CSJU website): 141.892</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Campaigns: 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Press articles: 230</td>
<td></td>
</tr>
<tr>
<td></td>
<td>News through web releases: 52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Followers in Twitter: 340</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Followers in Linkedin: 880</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posted videos on You Tube: 35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Publications: 12</td>
<td></td>
</tr>
</tbody>
</table>
6. Provisional accounts

The main tables of the Provisional Accounts 2015 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 2015 is provided in the Notes to the Provisional Accounts, which form part of the Provisional Accounts document itself.

Economic Outturn

The Statement on Financial Performance presents the economic result of the CSJU in the reporting period (01.01.2015 – 31.12.2015).

The most substantial component 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.

Due to the specific accounting rules applied by CSJU 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 on Commission funds, 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 31.12.2015. 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 balances of the JU increased compared to 2014 (2014: €20,2 million, 2015: €62,0 million).

The increase in fixed asset is due to the further development costs of the grant management tool (GMT) and the purchase of new IT equipment.

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

The Net Assets in the Balance Sheet of the JU’s Provisional Accounts 2015 show a negative balance of €74,55 million.

The main element derives from the non-validated member in-kind contribution. The estimated 2015 operational expenses are already booked on the Economic Outturn (EOA) while the related in-kind contribution has not been yet 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
Provisional Accounts ("on-hold" claims not meeting with all the reporting requirements) which are recognised in the EOA but not yet in the Net Assets.

The cost claims for GAMs 2015 are due in March 2016 the validation of the management can commence only after this date. These in-kind contributions are planned to be approved by the Governing Board in May 2016.

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 2016, these in-kind contributions will be transferred to the Net Assets of the CSJU in the 2015 Provisional Accounts. 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

<table>
<thead>
<tr>
<th>Description</th>
<th>31/12/2015</th>
<th>31/12/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. NON CURRENT ASSETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets (net)</td>
<td>92,841.00</td>
<td>106,987.73</td>
</tr>
<tr>
<td>Intangible fixed assets (net)</td>
<td>360,297.00</td>
<td>247,622.99</td>
</tr>
<tr>
<td><strong>TOTAL NON-CURRENT ASSETS</strong></td>
<td><strong>453,138.00</strong></td>
<td><strong>354,610.72</strong></td>
</tr>
<tr>
<td><strong>B. CURRENT ASSETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-term pre-financing</td>
<td>64,925,344.99</td>
<td>41,027,687.83</td>
</tr>
<tr>
<td>Short-term pre-financing Clean Sky JU</td>
<td>64,925,344.99</td>
<td>41,027,687.83</td>
</tr>
<tr>
<td><strong>Short-term receivables</strong></td>
<td><strong>234,245.62</strong></td>
<td><strong>2,941,113.07</strong></td>
</tr>
<tr>
<td>Short term receivables - recoveries from members and partners</td>
<td>162,301.93</td>
<td>2,510,921.37</td>
</tr>
<tr>
<td>Other short term receivables</td>
<td>19,560.42</td>
<td>13,070.37</td>
</tr>
<tr>
<td>Deferred charges and accrued income</td>
<td>52,383.27</td>
<td>417,121.33</td>
</tr>
<tr>
<td><strong>Cash and cash equivalents</strong></td>
<td><strong>62,014,184.00</strong></td>
<td><strong>20,176,791.28</strong></td>
</tr>
<tr>
<td><strong>TOTAL CURRENT ASSETS</strong></td>
<td><strong>127,173,774.61</strong></td>
<td><strong>64,145,592.18</strong></td>
</tr>
</tbody>
</table>

**TOTAL ASSETS**

<table>
<thead>
<tr>
<th></th>
<th>31/12/2015</th>
<th>31/12/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>127,626,912.61</strong></td>
<td><strong>64,500,202.90</strong></td>
</tr>
</tbody>
</table>

#### LIABILITIES

<table>
<thead>
<tr>
<th>Description</th>
<th>31/12/2015</th>
<th>31/12/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C. NET ASSETS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions received from Members (EU &amp; industry)</td>
<td>880,377,359.79</td>
<td>652,482,122.52</td>
</tr>
<tr>
<td>Contributions in kind received from Members (Industry)</td>
<td>477,377,638.43</td>
<td>448,424,340.47</td>
</tr>
<tr>
<td>Contributions used during previous years</td>
<td>(1,167,029,929.46)</td>
<td>(929,987,297.05)</td>
</tr>
<tr>
<td>Contributions used during the year (EOA)</td>
<td>(265,276,429.57)</td>
<td>(237,042,632.41)</td>
</tr>
<tr>
<td><strong>TOTAL NET ASSETS</strong></td>
<td><strong>(74,551,360.81)</strong></td>
<td><strong>(66,123,466.47)</strong></td>
</tr>
</tbody>
</table>

#### D. CURRENT LIABILITIES

<table>
<thead>
<tr>
<th>Description</th>
<th>31/12/2015</th>
<th>31/12/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members contribution to be validated</td>
<td>121,831,424.70</td>
<td>44,293,777.56</td>
</tr>
<tr>
<td>Accounts payable and accrued charges</td>
<td>80,317,124.80</td>
<td>85,519,389.22</td>
</tr>
<tr>
<td>Amounts payable - consolidated entities</td>
<td>0.00</td>
<td>3,741,150.20</td>
</tr>
<tr>
<td>Amounts payable - beneficiaries and suppliers</td>
<td>28,792,017.98</td>
<td>32,718,025.21</td>
</tr>
<tr>
<td>Amounts payable - staff</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other payables</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Accrued charges</td>
<td>51,525,106.82</td>
<td>49,060,213.81</td>
</tr>
<tr>
<td><strong>Provision for risks and charges - short term</strong></td>
<td><strong>29,723.92</strong></td>
<td><strong>810,502.59</strong></td>
</tr>
<tr>
<td><strong>TOTAL CURRENT LIABILITIES</strong></td>
<td><strong>202,178,273.42</strong></td>
<td><strong>130,623,669.37</strong></td>
</tr>
</tbody>
</table>

**TOTAL LIABILITIES**

<table>
<thead>
<tr>
<th></th>
<th>31/12/2015</th>
<th>31/12/2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>127,626,912.61</strong></td>
<td><strong>64,500,202.90</strong></td>
</tr>
</tbody>
</table>
### ECONOMIC OUTTURN ACCOUNT

#### REVENUES

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NON-EXCHANGE REVENUES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other revenue</td>
<td>45,006.29</td>
<td>3,986,365.64</td>
</tr>
<tr>
<td>Exchange gains</td>
<td>890.66</td>
<td>2,703.46</td>
</tr>
<tr>
<td><strong>TOTAL NON-EXCHANGE REVENUES</strong></td>
<td><strong>45,896.95</strong></td>
<td><strong>3,989,069.10</strong></td>
</tr>
</tbody>
</table>

#### OPERATIONAL EXPENSES

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operational expenses funded by CSJU in cash</strong></td>
<td>151,807,192.88</td>
<td>139,747,726.94</td>
</tr>
<tr>
<td><strong>Operational expenses contributed in kind by members</strong></td>
<td>106,501,312.36</td>
<td>95,652,537.52</td>
</tr>
<tr>
<td><strong>TOTAL OPERATIONAL EXPENSES</strong></td>
<td><strong>258,308,505.24</strong></td>
<td><strong>235,400,264.46</strong></td>
</tr>
</tbody>
</table>

#### OPERATING EXPENSES

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Administrative expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff expenses</td>
<td>3,370,166.05</td>
<td>2,559,915.49</td>
</tr>
<tr>
<td>Depreciation &amp; amortisation of fixed assets</td>
<td>131,311.83</td>
<td>107,161.40</td>
</tr>
<tr>
<td>Rent of building</td>
<td>555,456.63</td>
<td>618,162.29</td>
</tr>
<tr>
<td>Rent of furniture</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Office suppliers &amp; maintenance</td>
<td>12,995.33</td>
<td>77,831.39</td>
</tr>
<tr>
<td>Communication &amp; publications</td>
<td>319,192.96</td>
<td>395,931.34</td>
</tr>
<tr>
<td>Transport expenses</td>
<td>4,466.87</td>
<td>3,315.92</td>
</tr>
<tr>
<td>Recruitment costs</td>
<td>6,820.41</td>
<td>7,569.49</td>
</tr>
<tr>
<td>Training costs</td>
<td>11,884.95</td>
<td>2,975.25</td>
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<tr>
<td>Missions</td>
<td>275,472.62</td>
<td>206,696.04</td>
</tr>
<tr>
<td>Experts and related expenditures</td>
<td>1,273,195.65</td>
<td>544,047.05</td>
</tr>
<tr>
<td>IT costs - external service</td>
<td>160,838.75</td>
<td>109,767.18</td>
</tr>
<tr>
<td>Other external service provider</td>
<td>994,574.07</td>
<td>1,054,687.31</td>
</tr>
<tr>
<td>Provisions for other liabilities</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total administrative expenses</strong></td>
<td><strong>7,116,376.12</strong></td>
<td><strong>5,688,060.15</strong></td>
</tr>
<tr>
<td><strong>Other operating expenses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exchange losses</td>
<td>613.47</td>
<td>1,956.42</td>
</tr>
<tr>
<td><strong>Total other operating expenses</strong></td>
<td><strong>613.47</strong></td>
<td><strong>1,956.42</strong></td>
</tr>
<tr>
<td><strong>TOTAL OPERATING EXPENSES</strong></td>
<td><strong>7,116,989.59</strong></td>
<td><strong>5,690,016.57</strong></td>
</tr>
</tbody>
</table>

#### OPERATING RESULT

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating result</strong></td>
<td>(265,379,597.88)</td>
<td>(237,101,211.93)</td>
</tr>
</tbody>
</table>

#### FINANCIAL INCOME

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bank interest on pre-financing from EU</strong></td>
<td>91,763.59</td>
<td>66,600.55</td>
</tr>
<tr>
<td>Interest on late payment (income)</td>
<td>785.54</td>
<td>0.00</td>
</tr>
<tr>
<td>Interests on pre-financing given to Members</td>
<td>22,676.42</td>
<td>32,190.66</td>
</tr>
<tr>
<td><strong>Total financial income</strong></td>
<td><strong>115,225.55</strong></td>
<td><strong>98,791.21</strong></td>
</tr>
</tbody>
</table>

#### FINANCIAL EXPENSES

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Financial expenses</strong></td>
<td>12,057.24</td>
<td>40,211.69</td>
</tr>
<tr>
<td><strong>Total financial expenses</strong></td>
<td><strong>12,057.24</strong></td>
<td><strong>40,211.69</strong></td>
</tr>
</tbody>
</table>

#### FINANCIAL RESULT

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Financial result</strong></td>
<td>103,168.31</td>
<td>58,579.52</td>
</tr>
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</table>

#### ECONOMIC RESULT OF THE YEAR

<table>
<thead>
<tr>
<th>Ref.</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economic result of the year</strong></td>
<td>(265,276,429.57)</td>
<td>(237,042,632.41)</td>
</tr>
</tbody>
</table>
### Changes in Net Assets and Liabilities

<table>
<thead>
<tr>
<th>Net Assets</th>
<th>EURO</th>
<th>EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Balance as of 31st December 2014</strong></td>
<td>(66,123,466.47)</td>
<td></td>
</tr>
<tr>
<td><strong>Contributions received from members during the year 2015:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC Clean Sky Programme (FP7) (cash)</td>
<td>124,940,863.00</td>
<td></td>
</tr>
<tr>
<td>EC Clean Sky 2 Programme (H2020) (cash)</td>
<td>99,059,467.00</td>
<td></td>
</tr>
<tr>
<td>Other members Clean Sky Programme (FP7) (cash)</td>
<td>1,401,883.25</td>
<td></td>
</tr>
<tr>
<td>Other members Clean Sky 2 Programme (H2020) (cash)</td>
<td>2,493,024.02</td>
<td></td>
</tr>
<tr>
<td>Other members contributions in kind from 2008-2014 validated in 2015</td>
<td>28,953,297.96</td>
<td></td>
</tr>
<tr>
<td><strong>Total contributions in 2015</strong></td>
<td>256,848,535.23</td>
<td></td>
</tr>
<tr>
<td><strong>Economic Outturn for 2015</strong></td>
<td>(265,276,429.57)</td>
<td></td>
</tr>
<tr>
<td><strong>Balance as of 31st December 2015</strong></td>
<td>(74,551,360.81)</td>
<td></td>
</tr>
</tbody>
</table>

### Cash Flows from operating activities

<table>
<thead>
<tr>
<th>Surplus/(deficit) from operating activities</th>
<th>(265,276,429.57)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation and amortisation</td>
<td>131,311.83</td>
<td></td>
</tr>
<tr>
<td>Increase/(decrease) in Provisions for risks and liabilities</td>
<td>(780,778.67)</td>
<td></td>
</tr>
<tr>
<td>(Increase)/decrease in Stock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Increase)/decrease in Short term pre-financing</td>
<td>(23,897,657.16)</td>
<td></td>
</tr>
<tr>
<td>(Increase)/decrease in Short term Receivables</td>
<td>2,706,867.45</td>
<td></td>
</tr>
<tr>
<td>Increase/(decrease) in Long term liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase/(decrease) in Payables and Accruals</td>
<td>(5,202,264.42)</td>
<td></td>
</tr>
<tr>
<td>(Gains)/losses on sale of Property, plant and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraordinary items</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Cash Flow from operating activities</strong></td>
<td>(292,318,950.54)</td>
<td></td>
</tr>
</tbody>
</table>

### Cash Flows from investing activities

| Acquisition of tangible and intangible fixed assets | (229,839.11) | |
| Proceeds from tangible and intangible fixed assets | 0.00 | |
| Extraordinary items | 0.00 | |
| **Net Cash Flow from investing activities** | (229,839.11) | |

### Financing activities

| In cash contributions from Members (EC & Industry) | 227,895,237.27 | |
| In kind expense contribution from Members | 106,501,312.36 | |
| Reduction in members’ contributions due to rejected and negative claims | (10,367.26) | |
| Extraordinary items | 0.00 | |
| **Net Cash Flow from financing activities** | 334,386,182.37 | |

| Net increase/(decrease) in cash and cash equivalents | 41,837,392.72 | |
| Cash and cash equivalents at the beginning of the period | 20,176,791.28 | |
| **Cash and cash equivalents at the end of the period** | 62,014,184.00 | |
7. 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

Because of its multiannual nature, the effectiveness of the CSJU’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 programme, 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 of the CSJU 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 CSJU, 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:

\[
\text{WAER}\% = \frac{\sum (er)}{A} = \text{RepER}\%
\]

Where:

\[\sum (er) = \text{sum of all individual errors of the sample (in value). Only the errors in favour of the JU will be taken into consideration.}\]

\[n = \text{sample size}\]

\[A = \text{total amount of the audited sample expressed in €.}\]

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).

\[
\text{ResER}\% = \frac{(\text{RepER}\% \times (P-A)) - (\text{RepERsys}\% \times E)}{P}
\]

Where:

\[P = \text{total amount of the auditable population expressed in €.}\]

\[E = \text{total amount of the extrapolated population expressed in €.}\]
\[ \text{ResER}\% = \text{residual error rate, expressed as a percentage.} \]

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

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

\[ P = \text{total amount of the auditable population of cost claims in } \varepsilon \]

\[ A = \text{total amount of the audited sample expressed in } \varepsilon. \]

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

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 the CS programme, 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:

\[
\text{WAvResER}\% = \frac{\sum_{i=1}^{n} (\text{Res ER}_i \times p_i)}{\sum_{i=1}^{n} p_i}
\]

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 the CS programme. 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. 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.
In case it turns out, that an adequate calculation of the residual error rate during or at the end of the programme 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 analyzing 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 programme. 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.
8. Results of technical review

A summary of the 2015 Technical reviews of the ITDs is not available at the time of establishing the Provisional AAR 2015. This will be provided in the Final AAR 2015.
9. Members achievement through GAM

CLEAN SKY PROGRAMME - REMINDER OF RESEARCH OBJECTIVES

→ SFWA - Smart Fixed Wing Aircraft ITD

The majority of work in 2015 was dedicated to prepare and to conduct large test demonstrations (towards TRL 5 by end 2016) along the main technology streams, namely the natural laminar flow wing, the smart flap for low speed applications, low speed vibration ground tests, the business jet innovative after body demonstrator, as well as simulator tests. Based on the following WBS (*), major achievements, milestones and deliverables are described here below as well as communication and dissemination activities per Work Package:


WP 1 Smart wing technologies

WP 1.1 Flow Control

This WP covers passive and active flow control technologies for drag reduction and separation control. The aim is to bring these technologies to a sufficiently high readiness level so that they can be progressed within work package 2 and flight tested within work package 3.

For buffet control for turbulent wings (see the GAP BUCOLIC), active shock induced buffet control technologies such as fluidic jet devices (either continuous or pulsed flow rate) and synthetic jet...
actuators (zero-net-mass flux) ahead of the shock position have been tested in wind tunnels to examine their applicability to control shock induced buffet. Furthermore, buffet characterisation for a laminar-type air foil has been carried out in order to generate a detailed data base, useful for CFD validation purpose and drag extraction.

Concerning Laminar Wing Surface Technologies and Repair Concepts, the activity has been closed via the GAP "RIBLET master mould" project.

To enhance the performance of a slat-less configuration or a droop-nose-like device, suitable for a laminar wing, a technology enabling the delay of separation and, thus, enhancing the maximal lift capability has been developed. This has been achieved with the GAP STARLET (awarded at Clean Sky “best project” contest)

**WP 1.2 Load Control**

The objective is to develop means (including methods and tools) to mitigate manoeuvre or gust loads impacts via:

- Active (control surface and innovative sensors) or passive (structural composite design) ones

For active control, analysis of open loop database and support to numerical restitution by ONERA and aero-elastic restitution of gust generator wind tunnel tests by Dassault

For passive control, introduction of gust loads into sizing process and influence of aero-elastic tailoring on fatigue loads by DLR, introduction of elasticity effects and assessment of load alleviation efficiencies with an elastic wing including the sensitivity to flexible effects on the wing tip by Airbus D&S

- Vibration control laws, loads monitoring and damage detection systems

In 2015, the activity was dedicated to vibration control and the successful completion of the Ground Vibration tests on Falcon F7X in May 2015 (see illustration)

Vibration reduction has been confirmed by pilot feelings. However, new control laws for flight test with sufficient robustness will be necessary.

The methodology for vibration control law design has been validated.

The instrumentation required for efficient control law is the most extensive envisaged, leading to a complex integration for flight test

**WP 1.3 Integration of flow and load control systems**

The overall objective of this WP is to provide a system solution to support the implementation of load & flow control concepts in a future aircraft. The IACD (Integrated Active Component Demonstrator) as demonstrator platform to enhance interaction has been evaluated after the wind tunnel test and relates to flow control systems. It contains 2 parts:
• Iron Bird
  – to verify physical integration of embedded and virtual systems and wiring
  – to evaluate electrical characteristics of the embedded systems and wiring

The iron bird is designed and manufactured.

• Flap with Fluidic Actuation
  – to verify aerodynamic behaviour of flap with embedded fluidic actuators
  – to demonstrate integration of systems

Flap with fluidic actuation demonstrator and tests are finished and compact Wiring installed for EMC & thermal tests (see illustration)

IACD: test setup for compact wiring – thermal verification

Multi bundle variable separation has been setup on two composite & metallic wing environments

WP 2 New configuration

WP 2.2 Integration of other smart components into OAD

The objective is to integrate new types of engines and aft bodies (aft fuselage and empennages) in order to:

• Lower engine turbo machinery and jet noise (engine level, but also A/C manufacturer level) through shielding, by designing innovative aft body shapes, while retaining or improving fuel savings brought by new technologies.
• Translate potential gains brought by innovative power plant into improved acoustic and carbon footprint characteristics on an integrated aircraft design
• Maximize the integrated platform efficiency

For the installed CROR characterization, although there were no milestones and key deliverables in 2015, the scope of activities was two-fold: structural, safety and certificability activities on one side, and aero-acoustic characterization on the other side.

• For structural and aircraft certificability tasks:
  o Closure of tasks for reducing A/C threat blade design solution and airframe shielding. TRL 3 has been achieved based in particular on Airbus Group SAS (AGI) work on pre-design for blade impact energy absorbing concepts and evaluation of the capabilities of an absorber under high speed dynamic impact loads.
  o Nominal progress on propeller blade kinematics with ONERA and Airbus
• Aero-acoustic related activities have been dedicated to the continuation and closure of task on noise reduction and search of innovative solutions towards an economic viability improvement (with a progressive hand over within CleanSk2). In this objective, we can note the following activities:

  o Until end of 2015, and in the frame of numerical and experimental installed CROR assessment, the post-test computations (CFD/CAA) on Z49 High Speed model tests (see below) have been pursued with ONERA and DLR.

  o Blade and pylon design: pylon wake active flow control system via the GAP ACctiom and the effect of a turbulent boundary layer on noise propagation at high speed with ARA wind tunnel and Free Field Technologies via the GAP ENITEP

  o Concerning the installed CROR characterization, preparation of two GAPs (measurement techniques and tests) with DNW-LLF initially planned for maturation of noise reduction technologies (model called “Z49 Pack1”, scale 1/5) and reoriented towards economic viability via weight reduction (with a model called “Z08”, full scale 1/7 powered model including rear puller installation effects). See illustration here below:

For both rear-end turbofan and CROR installation, completion of wind tunnel testing for the CROR characterisation and for turbofan noise measurements at low speed

**WP 2.3 Interfaces & Technology assessment**

The general objective is to collect data from all ITDs (SGO, SAGE, SFWA and Eco Design) and perform evaluations and sensitivity studies for noise, emissions, weight and performance impacts of the different technologies from business jet airplanes to large long range aircraft:

- Business jet: High Sweep Bizjet 2020 with loads and vibration control, NLF on lifting surfaces control and wing lower surface, 3-engine after body, smart flaps.
- Large aircraft: short-medium range (SMR 2025) and long range (LR 2025)

The final delivery of PANEM to the Technology Evaluator including all conceptual platforms and technologies has been done by September (Bizjets) and November 2015 (Large A/C):

- For Business jets:
  - Based on 2000 A/C reference, emission and noise computations have been performed for various missions and trajectories (eg: 800, 1500, 2900 nm for LSBJ concept)
- For Large Aircraft:
  - Open rotor technology not applicable to LR advanced platform
- Natural Laminar Wing chosen for SMR 2030 platform
- From SAGE-ITD, Advanced 3-shaft TF and lean burn technology: developed specifically for LR advanced platforms and not applicable to SMR one
- From SGO-ITD
  - Multi-step cruise: developed specifically for LR missions, not applicable to SMR,
  - Multi-criteria departure procedures (developed specifically on SMR), electrical-taxi: model adapted by Messier to SMR 2030 platform and not compatible with LR (impact on fuel burn)
  - Bleed less: designed for a and A320-like platform, a rough transposition of the system onto a LR platform has been looked at. The integration has been judged too approximative to see any benefit of the technology
- From Eco-Design and coming from ITD Airframe, integration of selected technology onto SMR 2030 such as advanced alloys, out of autoclave CFRP’s, various surface treatments. The LR platform has been judged not disruptive enough for the integration of the Eco-Design technologies.

**WP 3 Flight Demonstration**

**WP 3.1 High speed smart wing flight demonstrator**

For large A/C, 2015 was dedicated to flight tests supporting activities the Flight Physics, systems, Flight Test Instrumentation (FTI), test A/C integration and manufacturing domains.

Considering the slat less configuration, a stall angle strategy has been defined via a nacelle strake in order to regain Angle-of Attack margin. In terms of Handling Qualities, the VFE (Velocity Flap Extended) increase has been decided to regain margin v/s stall and a set of requirements has been compiled. To prevent insect contamination during flight tests via paper cover, preparation of wind tunnel test activities in Filton LSWT for tests in Q1/2016

Major outcomes were on manufacturing of the Starboard and Port Leading Edge and Upper Covers of the wing from GKN and SAAB (UC panel#1), including surface quality control.

At the same time, all DFM (Design for Manufacturing) data have been delivered and manufacturing started for outer wing components Wing Tip Pod, Aero Fairing and Mid Box (Transition Zone, Trailing Edge and Leading Edge). Support to wing assembly (concessions) has to be insured.

A major milestone in 2015 was the Critical Design Review at A/C level (based on the previous Wing “Mat C” review in November 2014) followed by the Industrial Readiness Review in April 2015.

For the metallic parts, satisfactory progress on Aero-fairing (4 months delay on rear spars but still on plan), Wing Tip Pod and on the transition structure.

For the outer wing FTI, C-maturity passed and a significant progress has been made on all pre-FAL installation needs.

For systems installation, DFM delivery completed, CDR held for all impacted systems and clarification of HQ modification for the flight control computers.
An agreement has been reached on Permit-to-Fly deliverables across the systems. The wings assembly has started on 23rd November at Aernnova pre-FAL after delivery of GKN Upper Cover. The SAAB Upper Cover has been delivered on 13th December.

Hand Over ceremony of the Upper covers delivered to Aernnova Plant in Berantevilla

A compact and modular FTI as well as data acquisition center (see pictures) leading to significant weight and cost savings, has been installed on to the A340MSN1. The interface between the aircraft and the new core FTI has been successfully tested. The power on of the aircraft and a rolling take-off has been performed.

A340 #1 in Hangar in Tarbes

A340#1 Flight test installation
Activities have been also dedicated to MSN1 integration (assembly tooling preparation, access area and wing assembly sequence) as well as testing (Internal Waviness measurement system manufacturing, software development of reflectometry and shadow casting,...) and Vertical Tailplane container parts manufacturing and assembly tests.

**WP 3.2 Low speed smart wing flight demonstrator**

SFWA is developing a number of innovative high lift concepts (fixed leading edge with separation control, smart droop nose, very high performance control surfaces (flaps), supporting the development of very efficient wings (see WP 2.1). Demonstration of the low speed / high lift performances of these high lift concepts to support a maturity demonstration at the level of a TRL up to 6 is one main objective of WP 3.2.

Also SFWA is developing, based on the same control surfaces, high performance load and vibration control solutions with the aim of weight reduction from reduced loads and of increased comfort from vibration reduction (see WP 1.2). Demonstration of performances of these solutions to support a maturity demonstration at the level of a TRL up to 6 is also an objective of WP 3.2.

End of 2015, the sub-component tests have been finished and reported. The manufacturing aspects have been evaluated. The resulting improvements in Aircraft performance will be determined in 2016 for all aspects, such as maximum lift, improved cruise performance, system weight, etc.

**WP 3.3 Innovative Engine (CROR) Demonstrator/ Future Flying Test Beds**

This WP deals with the elaboration of a demonstrator strategy for CROR as well as for any future in-flight demonstrators

Further to the decision to pursue the CROR demonstration activities in Clean Sky 2, the activity in 2015 was dedicated to the technical follow-up of the GAP OPTIMAL: development of a flightworthy pylon loads measurement system with CROR engine towards a TRL 2 by Q1/2016

**WP 3.5 Innovative Empennage Large Demonstrator**

The scope is focused on key enablers to new aft body configurations:
- Demonstration of noise shielding performances (complement to WP2.2)
- Demonstration of structural feasibility: aero-elastic stability, fatigue due to jet proximity, thermal loading

The Ground Demonstrator (SHIELD Project) is in the manufacturing phase and some components are already built such as test panels and one Vertical Tail Plane.

The Wind Tunnel Model is about to be delivered to ONERA for lab test (expected end October).

The Lab test is ongoing and will continue until the wind tunnel test scheduled in June 2016

**Communication & Dissemination**

In this section are presented all the events organised and the papers released about the activity carried out in SFWA in 2015. The full list of publication is made available in Annex 4 of this AAR.

- Publishable Progress Report 2014
  
  The hardware on display was the result of excellent European research and seen and appreciated by public at large, company and academia representatives, students and EU policy makers at various levels. The full report and pictures can be seen at www.cleansky.eu
• Contribution to Aerodays (20. - 23. October 2015) with the following activities:

  ▪ Preparation of the Airbus A340-300 BLADE Natural Laminar Wing Flight Test Demonstrator  
    → SFWA GAM Airbus
  ▪ Innovative Semi-Empirical System for Laminar Wing Ice Protection  
    → SFWA GAP TWT
  ▪ Integrated CFD-Acoustic Computation Approach to the Simulation of Open Rotors  
    → SFWA GAP NUMECA
  ▪ BUCOLIC - Characterization of Buffet on a Civil Aircraft Wing  
    → SFWA GAP ARA
  ▪ Automating Aircraft Assemblies with Tight Tolerances  
    → SFWA GAM AERNNOVA
  ▪ Airbus A340-300 BLADE (hardware)  
    → SFWA GAM Airbus
  ▪ Smart Flap Composite Load Introduction Rib (hardware)  
    → SFWA GAM Fokker Aerostructures, Airborne & NLR
  ▪ Innovative Aircraft Ice Protection System (hardware)  
    → SFWA GAP InAIPS
  ▪ VIPER Pulsed Jet Actuator for Flow Control Separation (hardware)  
    → SFWA GAP CFD CEDRAT

• Contribution to CS e-News were done, e.g.

  ▪ BLADE notice about transfer of test A/C to Tarbes
  ▪ 1st complete leading edge & upper cover for BLADE cured

• SFWA Movie was presented (intermediate version)
• Diverse publications for journals, meetings etc. were disseminated.

Glossary

OAD : Overall Aircraft Design
PANEM : Parametrical Noise and Emission Model
SMR : Short Medium Range
LSBJ : Low Sweep Business Jet
HSBJ : High Sweep Business Jet
SOG : Systems On Ground
EMC : Electro-Magnetic Compatibility
CROR : Contra Rotative Open Rotor
TRL : Technology Readiness Level
WBS : Work Breakdown Structure
LR : Long Range
CFD/CAA : Computational Fluid Dynamics/Computational Aeroacoustics
A/C : Aircraft
CDR : Critical Design Review
NLF : Natural Laminar Flow
LSWT : Low Speed Wind Tunnel
FAL : Final Assembly Line
FTI : Flight Test Instrumentation
DFM : Design For Manufacturing
WP : Work Package
Year 2015 saw the preparation, manufacturing and assembling of the GRA Flight and Ground integrated technology Demonstrators, supported by significant range of laboratory tests, devoted to Permit-to-Fly issuance by EASA too.

The original Programme Master Phasing Plan has been fulfilled in terms of research targets, mostly at TRLs 4 and TRL 5 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 both for Reference (Year 2000 Technology) & Green (Year 2020 Technology) 90 pax and 130 pax A/C, based on 3rd activities loop including the MTM technology, were delivered to TE.

Completion of GRA Flight Simulator Demonstration in GRA TP90 configuration and the assessment of environmental impact reduction due to MTM technologies was successfully achieved.

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 too: both REG IADP and GRA started to be managed through a unique Integrated Risk Management Plan (RMP) since the former follows on from and partly builds up on the results obtained by the latter, allowing and contributing to the finalisation of research activities initiated under Regulation (EC) No 71/2008. For all timeframe 2014-2017, whereas the two Programmes are going to be implemented in parallel, CS-to-CS2 cross-fertilization will be realised through many of GRA Demonstrators to be utilised for selected technologies continued development, as proof of Programmes continuity. GRA Relevant Projects Leaders, as relevant CS2 Waves Coordinators too, will realise the transition (for use only) of Demonstrators per selected technologies.

To improve the effectiveness of Programme strategies, GRA adapted their own 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 MSN098 A/C availability, provided by ATR. Referring to GAM 2015-2016 value (Requests for Changes included), in total, GRA’s utilization of resources in 2015 was 109% of the planned value vs about 78% progress in key deliverables. The reason is a discrepancy between actual expenses for producing hardware and intermediate test results, reflecting real needs and risk mitigation against pre-programmed value of work and formal process of deliverables approval.

GRA ITD final demonstrations performed throughout the year:

- GRA 90-seat A/C configuration - Low-Noise Main Landing Gear demonstration (“ALLEGRA” Project) performed on March 2015;
- GRA Low Weight Configuration Flying Demonstration performed on July 2015;
- GRA 90-seat A/C configuration - GRA Flight Simulations performed on May-Nov 2015;
- GRA 130-seat A/C configuration - Droop Nose aerodynamics demonstration performed on Nov. 2015;
- GRA 130-seat A/C configuration: - Morphing Flap mechanics demonstration performed on Dec. 2015;
- GRA 130-seat A/C configuration - Gust Load Alleviation control system architecture demonstration performed on Dec. 2015.
Seventy-seven Dissemination events were registered throughout the year, shared by Domains as follows:

<table>
<thead>
<tr>
<th>Domain</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Weight Configuration (LWC)</td>
<td>38</td>
</tr>
<tr>
<td>Low Noise Configuration (LNC)</td>
<td>26</td>
</tr>
<tr>
<td>All Electric Aircraft (AEA)</td>
<td>4</td>
</tr>
<tr>
<td>Mission &amp; Trajectory Management (MTM)</td>
<td>2</td>
</tr>
<tr>
<td>New Configurations (NC)</td>
<td>7</td>
</tr>
</tbody>
</table>

0. Management

Milestone status:
No significant milestones have been planned for year 2015.

Key Deliverables status:
- Nr of key deliverables due in 2015: 4
- Nr of key deliverables issued due at the end of 2015: 4
- Nr of key deliverables pending by the end of 2015: 0

1. Low Weight Configuration (LWC)

- In 2015 main activities in the frame of LWC domain were concerning:
  - About the In-flight demonstration:
    - References flight tests and respective analysis of acoustic data measured in-flight on ATR MSN098 with aluminium crown panel have been executed.
    - Manufacturing of components, subcomponents and elements for experimental activities needed for Permit to Fly has been completed.
    - Tension tests on orbital hybrid joint and longitudinal hybrid joint and the respective numerical/experimental data correlations have been completed.
    - Compression, tension and shear tests on stiffened panels and the respective numerical/experimental data correlations have been completed.
    - The in-flight test plan has been agreed and finalized.
    - Drawings of sensors, flight test instrumentation and flight telemetry instrumentation for SHM to be included on panel to be tested in-flight have been frozen.
    - Crown panel for flight tests has been instrumented with conventional strain gauges, optical fibres and piezoelectric actuators/sensors for SHM and shipped to Toulouse.
    - The dismounting of aluminium crown panel and the assembling of the composite one have been performed.
    - The final connection and relevant tests of SHM sensors have been executed.
    - The full scale ground pressurization, electrical continuity and electrical resistance tests have been executed.
    - The numerical/experimental analysis and correlation of ground pressurization data has been executed.
    - The “Permit to Fly” document, the “Flight conditions approval sheet”, the “Flight clearance certificate” and the “Attestation of conformity to I.T.U radio regulations” have been issued and the authorization to flight has been obtained.
    - Flights have been successfully performed.
A new ATR 72 MSN098 aluminium Crown Panel needed for refurbishment after flight tests has been provided. After flight tests, the composite sensorized crown panel has been dismounted and replaced by the aluminium one. The flight tests results analyses have been started.

About the On-Ground Fuselage demonstration:

- the Central, the FWD and the AFT one piece fuselage barrels have been manufactured, jointed and inspected through NDI.
- The fuselage barrel frames has been completed and assembled into fuselage demonstrator.
- The pax and cargo floors have been assembled into fuselage demonstrator.
- The two pressure bulkheads (one with man hole access) have been manufactured.
- The fuselage test plan has been agreed and finalized.
- The fuselage demonstrator has been preliminarily instrumented, before the final assembling of the pressure bulkheads, with conventional strain gauges, optical fibres and piezoelectric actuators/sensors for SHM.

About the On-Ground Inner Wing Box demonstration:

- the RTM ribs, front and rear spars have been manufactured and inspected through NDI.
- Due to some geometrical discrepancies found on the inner wing box upper stiffened panel, all needed actions to study and solve the problem have been executed and the re-built of a new upper stiffened panel has been started.
- The 2 metallic dummy structures and 2 metallic tension fittings for the 2 sides of composite inner wing box are almost completed.
- The request for inner wing box test has been agreed and finalized.
- The master model and structural analyses of test wing box demonstrator have been updated.

About the On-Ground Cockpit demonstration:

- The test plan for impact & damage detection in stiffened panels under realistic conditions has been provided.
- The cockpit test plan has been agreed and finalized.
- Complementary drawings/CATIA models of cockpit instrumentation for MT1 have been finalized. Drawings and CATIA models of cockpit instrumentation for MT2 have been also executed.
- Two cockpit demonstrators MT1 and MT2 have been manufactured and provided.
- The test rig has been provided and the cockpit demonstrator MT1 has been installed on it.
- Test performance for MT1 including pressurization proofs, vibro-acoustic and ground vibration tests, electrical bonding and grounding measurement have been performed.
- 1st Static Test on MT1 including have been executed max. positive and negative bending, ground cases and Pressurization and respective results have been analysed.

Milestone status:

2 (of 2) planned milestones have been postponed:
✓ GRA1 - Fuselage Ground Demo Test article availability and TRR Full Scale Demonstrator
  The barrel GD has been shifted due to longer duration of Frames and Bulkheads parts manufacturing; consequently the TRR has been re-planned;
✓ 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.

Key Deliverables status:
Nr of key deliverables due in 2015: 18
Nr of key deliverables issued in 2015: 12
Nr of key deliverables pending by the end of 2015: 6

CfP status:
In 2015 no Calls have been launched by GRA LWC, all relevant planned topics having been already covered by previous or ongoing projects.

2. Low Noise Configuration (LNC)

In 2015 main activities in the frame of LNC domain were concerning: i) Application Studies and ii) 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. Such activities are hereinafter briefly recalled.

- GTF 130-seat A/C / NLF wing
  ➢ Completion of structural design and definition of actuation/kinematics system layout of Krueger flap, T/E Fowler single-slotted flap and LC&A devices (small tabs and split ailerons) – by ALA and HAI.
  ➢ WT demo of aerodynamic and aeroacoustic performances of Droop Nose on a half-wing 1:6 (2.6m span) model. Relevant tests were performed (November 2015) in the automotive WT facility of Weissach (Germany); data analysis is in progress – by FhG.
  ➢ Preparation (components/equipment provision and installation, preliminary integration and functionality tests, etc.) of ground demo of Load Alleviation Control System architecture. The concerned test rig is inserted in a realistic HW/SW environment (aileron actuator and control electronics, primary flight control unit implementing developed control laws, simulated sensors, etc.). Relevant tests are in progress (December 2015) – by ALA.
  ➢ Manufacturing of 1:1 (3.6m span) prototype of the 3D morphing flap, based on the Smart Actuation Compliant Mechanism (SACM) concept, sized to inner half panel of the outboard (tapered, swept) flap. This novel architecture is conceived to enable dual-morphing functions: i) controlled flap camber as HLD and ii) actuation of T/E tab as LC device. The concerned ground demonstrator is aimed to assess: i) flap morphing performances matching target shapes under simulated aerodynamic loads and ii) structure capability in withstanding static limit loads. Relevant tests are in progress (December 2015) – by AirGreen (UniNA).
  ➢ On-going activities, in the frame of projects under CfP supported and monitored by ALA as relevant Topic Manager, concerning other technologies demonstrations:
- WT demo of transonic NLF wing and of Load Control performances in high-speed steady conditions on a half-wing innovative elastic 1:3 (=5.7m span) model. - Project ETRIOILLA (CfP GRA-02-019); status: WT model manufacturing in progress.
- WT demo of Gust Load Alleviation strategy on 1:6 (=2.5m span) aero-servo-elastic A/C half-model. - Project GLAMOUR (CfP GRA-02-22); status: manufacturing of WT model and of gust generator vanes in progress.
- WT demo of aircraft low-speed aerodynamic performances (high-lift in take-off and landing, S&C derivatives) and aeroacoustic impact (assessment of noise sources and HLD low-noise solutions) on a complete A/C powered 1:7 (=4.9m span) model. - Projects ESICAPIA/EASIER (CfPs GRA-05-007/-008) in synergy with NC domain; status: WT model design completed, engines simulator tests performed; WT model manufacturing going to start.

TP 90-seat A/C
- Structural design and definition of actuation/kinematics system layout of T/E Fowler single-slotted flap – by ALA and HAI.
- WT demo of Main Landing Gear low-noise technologies (fairings, meshes, hubcaps, bay acoustic treatments) on a half-scale model reproducing the MLG installed configuration (gear, bay, doors, part of fuselage). Relevant tests were performed (March 2015) in the aeroacoustic WT facility of Pininfarina (Turin, Italy) – Project ALLEGRA (CfP GRA-02-017).
- On-going activities, in the frame of projects under CfP supported and monitored by ALA as relevant Topic Manager, concerning other demonstrations:
  - WT demo of aircraft low-speed aerodynamic performances (high-lift in take-off and landing, S&C derivatives) and of aeroacoustic impact (assessment of noise sources and HLD low-noise solutions) on a complete A/C powered 1:6.5 (=4.9m span) model. - Projects LOSITA/WITTINESS (CfPs GRA-02-020/-025); status: WT model design almost completed.
  - 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). - Project ARTIC (CfP GRA-02-021); status: WT model manufacturing in progress.

The overall reporting on 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 work programme, i.e.: enabling technologies development, applications studies and to-date demonstrations.

Work Package LNC has partially met its goals in 2015. Some relevant activities will be completed in 2016.

Milestones status:
- 2 (of 2) planned milestones have been postponed:
  - GRA2 - NLF wing 1:3 Wind Tunnel model (HW) (ETRIOLLA project under CfP): further delay in the manufacturing of the WT model;
  - GRA2 - WTT First Complete Aerodynamic Test: WTT postponed due to further delay in the model manufacturing and to climatic constraints (tests on laminar flow not recommended in spring/summer season).

Key Deliverables status:
- Nr of key deliverables due in 2015: 7
- Nr of key deliverables issued in 2015: 7
- Nr of key deliverables pending by the end of 2015: 0
CfP status: In 2015 no Calls have been launched by GRA LNC, all relevant planned topics having been already covered by previous or ongoing projects.

3. All Electrical Aircraft (AEA)

The end of the improved Shared Simulation Environment (iSSE) project, in charge of a Partner via CfP, has been formally postponed to December 2015, therefore the final validation of project results, which integrates simulating models of the on-board systems, are expected to be performed by beginning of 2016. Regarding “Application studies” number of steps has been achieved:

• performed the TRL4 review of Electrical Environmental Control System (E-ECS). The E-ECS TRL5 moved to 2016 according to completion of equipment integration and test on A/C Demonstrator. Electrical Power Generation (EPG) equipment TRL5 moved to 2016 waiting for completion of test on COPPER BIRD.

• Completed the Development of the SABER Simulation model of the Electrical Power Generation and Distribution of the Demo Electrical Channel of the A/C demonstrator including the SABER models of the electrical loads such as the Simulated Resistive Electrical Load (SREL), the Electrical Power Center (EPC) and Electro-mechanical Actuators.

• Completed the building of the single channel RIG to support the Saber Simulation Model activities of the Demo channel focused on the power quality tests.

• Manufactured and delivered the Ground Test Bench of the Electro-Mechanical Actuator (LGS EMA, “ARMLIGHT” CfP).

• Moved to the beginning of 2016 the delivery of the Ground Test Bench of the FCS Electro-Mechanical Actuator (FCS EMA, “FLIGHT EMA” CfPs)

Validation of the above EMAs CfP project results by middle of 2016 following equipment test on COPPER BIRD.

Preparation of flight Demonstration for AEA has been advanced by performing:

• Almost completed the parts manufacturing and FTI purchasing for Systems and structural modifications to be implemented on the A/C demonstrator:
  o Electrical Environmental Control System (E-ECS),
  o Electrical Energy Management (E-EM),
  o New Electrical Power Generation for Demo Supply Channel,
  o EMAs Loads and associated test Bench Test introduction on-board,
  o FTI.

• Manufactured and delivered:
  o The Electrical Rack assy (by ALA),
  o The Simulated Resistive Electrical Load (SREL, DANA CfP),
  o The Electrical Power Center (EPC, “EPOCAL” CfP),
  o The In-Flight Test bench of the MLG Electro-Mechanical Actuator (MLG EMA, “ARMLIGHT” CfP).

• Moved to the beginning of 2016 the delivery of the In-Flight Test Bench of the FCS Electro-Mechanical Actuator (FCS EMA, “FLIGHT EMA” CfP).

Validation of the above CfP projects results by middle of 2016 following equipment integration and test on A/C Demonstrator.

• Equipment delivered:
• The Electrical Power Generation Equipment (Alternators, BPCU, GCUs, TRUs, CTs) manufactured and qualified by Thales;
  o The E-ECS Pack and Rack manufactured and qualified by Liebherr.

• Close to be completed the installation on demo A/C of all the above indicated equipment, components and parts.

• Close to be frozen:
  o 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;
  o Documentation for the Flight clearance of the modified aircraft.

Completion of the activities related to the release of the Modified Demo Aircraft and of the experimental Permit to Fly (PtF) is expected by February 2016.

Milestones status:
  1 (of 1) planned milestones have been postponed:
                                                                  ✓ GRA3 - E-ECS verification of integration on A/C on ground": delay due to longer duration of Parts Manufacturing and installation on A/C phases.

Key Deliverables status:
  Nr of key deliverables due in 2015: 4
  Nr of key deliverables issued in 2015: 3
  Nr of key deliverables pending by the end of 2015: 1

CfP status:
  In 2015 no Calls have been launched by GRA AEA, all relevant planned topics having been already covered by previous or ongoing projects.

4. Mission and Trajectory Management

Following activities have been closed during 2015:
  • Preparation of GRA Flight simulator in GRA TP90 configuration.
  • Execution of Operational Validation by means of GRA flight simulator.
  • Execution of simulation with GRASM for environmental impact assessment.
  • Assessment of environmental impact reduction due to MTM technologies.

As far as final MTM report is concerned, the document is almost completed.

Milestones status:
  1 planned milestone “GRA4 - Completion of Flight Simulator Demonstration “has been successfully achieved.

Key Deliverables status:
  Nr of key deliverables due in 2015: 1
  Nr of key deliverables issued in 2015: 1
  Nr of key deliverables pending by the end of 2015: 0

CfP status:
  All activities related to the CfPs have been completed.

Based on that it can be stated that technical activities of MTM domain have been successfully closed.
5. **New Configurations**

In 2015 main activities in the frame of NC domain were concerning:

- Update of the Aircraft Simulation Model for the Green A/Cs 90 pax configuration to Technology Evaluator – (based on 3rd loop activities including the MTM technology).
- Update of the Aircraft Simulation Model for the Green A/Cs 130 pax configuration to Technology Evaluator – (based on 3rd loop activities including the MTM technology).
- Acoustic computations of OR configuration tested in wind-tunnel (GRA-05-005 “WENEMOR” CfP).
- Collaboration activity with NLR relative to the Airport Level 2015.
- Technical activities performed on the integration of the Open Rotor concept in terms of assessment of the noise shielding effectiveness for the selected WENEMOR configurations.

**Milestones status:**

1 (of 1) planned milestone has been postponed:

- ✓ GRA5 - WTT Demo Large Scale 130 Pax ("ESICAPIA/EASIER" projects under CfP): delayed due to model manufacturing issues.

**Key Deliverables status:**

- Nr of key deliverables due in 2015: 3
- Nr of key deliverables issued in 2015: 2
- Nr of key deliverables pending by the end of 2015: 1

**CfP Status:**

In 2015 no Calls have been launched by GRA NC, all relevant planned topics having been already covered by previous or ongoing projects.
Progress over 2015 is summarized in the following table, providing the comparison between the level of achievements (via deliverables and milestones) and resources assigned to the project.

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>Milestones</th>
<th>Effort (Person Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Released</td>
</tr>
<tr>
<td>GRC0</td>
<td>6</td>
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</tr>
<tr>
<td>GRC1</td>
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<tr>
<td>Total</td>
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<td>22</td>
</tr>
<tr>
<td>Synthesis %</td>
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<td>73%</td>
</tr>
</tbody>
</table>

* Best estimate based on Q1, Q2 and Q3 available data and Q4 prediction.

Main deliverables and milestones

**GRC1 - Innovative Rotors**

Activities Performed: Data analysis from 2D test at University of Twente; Preparation of 2D Dynamic test at CIRA: Model rotor blade manufacture and testing (PoliMi); Design of major components for full scale rotor with Active Gurney flap; CDR Active Gurney Flap blade: Supply donor blade; passive optimised blade aerodynamic blade face.

**GRC2 - Airframe drag reduction**

Activities performed: flight tests of the optimised airframe and hub fairings of the Bluecopter of AHD have been completed (TRL6), still to test in flight the new side intake already measured at full scale in wind tunnel (TRL4).

Flight tests of the new beanie for the AW169 have also been conducted (TRL6). The wind tunnel tests about passive shape optimisation and active means on the fuselage and rotor head are completed (TRL4). Concerning the optimised hub fairings aerodynamic design: final shape achieved (TRL3) and wind tunnel tests partly achieved (TRL4).

**GRC3 - Electrical Systems.**

The final report deliverable for the Brushless Starter Generator technology issued.

Several further final report deliverables for GRC3 have been delayed following the agreed extended test and analysis of technologies for Power Converter, Energy Storage, HEMAS Flight Control actuator and the HERRB Rotor Brake technologies. These reports will now be delivered in 2016 on completion of the technology evaluation.

A milestone for the Electric Tail Demonstrator Motor CDR was achieved earlier than planned, and the TRL assessment for the Power Converter and Energy Storage systems completed.
The other planned TRL assessments for the HEMAS and ELETAD Tail Drive systems will be conducted after conclusion of the rescheduled bench testing (now in 2016).

**GRC4 - High-Compression Engine on Light Helicopter.**

Two main milestones have been achieved in 2015: Ground runs completed in March, and Maiden Flight achieved on November 6th, after Partners finished the Powerpack endurance tests, needed to flight-clear the engine.

**GRC5 - Environment-friendly flight paths.**

VFR procedures for helicopter validated by PITL (pilot in the loop) simulations in laboratory environment; low-noise trajectories for Tiltrotor IFR procedures defined; report of Pilot-in-the-loop tests of helicopter FMS with run-time low-noise planning.

**GRC6 - Eco-Design for rotorcraft airframe**

Manufacturing and assembly of tail boom demonstrator; prove of co-melt technology on test panel and go-decision made to scale up to real scale component. Transmission demonstrators manufactured, test and evaluation also executed taking the projects to completion.

**GRC7 – Interface with Technology Evaluator**

Fourth annual release of rotorcraft software and data package for the TEM, TEHU1, SELU1 & HCE was delivered to the TE. Slightly behind original schedule of December 2015, the TELU2 will be delivered to the TE in the first quarter of 2016 with no negative impact to their assessment schedule.

**GRC0 – ITD Management**

The GRC consortium management “Coordination” task was taken over in November by AW from AH-D and keep coordination role until the end of the project. The new project Coordinator is Antonio Antifora who will organise the next GRC events and required deliveries like:

- To prepare and organize 4 Management Committee meetings, 4 Steering Committee meetings, 3 Consortium Committee meetings, Final Review meeting and Final Steering Committee.
- To coordinate the preparation of the contractual and management documents: Technical Annexes (IA and IB) for GAM amendment (if necessary), Periodic Report for 2015, Half-Year Assessment report and Quarterly Reports and Annual and Final technical report.
- To manage the finances of the consortium;
- To coordinate dissemination activities which were quite extensive in 2015

The project data are maintained in a dedicated GRC repository where all relevant data are uploaded.

**GRC1 – Innovative rotor blades**

With the exception of the Active Twist technology, significant GRC1 achievements were obtained by both Airbus Helicopters and AgustaWestland. Manpower use across all partners neared targets, indicating full commitment from all of the technology centres. Inevitably with research, major technical challenges were faced, the majority of which were resolved, largely with minimal time frame implications. The programme now progresses towards full scale demonstration in 2016.
Airbus Helicopters - Active twist

Two problems were encountered by DLR that delayed the start of testing until 2016. The first was a problem with the supply of low voltage actuators, acting as replacements for earlier items that were damaged during blade section manufacture. These items had a very long lead time which inevitably impacted DLR’s build sequence. A second problem was encountered with the manufacture of the spars for the blade specimens. Manufacturing mistakes meant that the spars had to be reworked, again with timeframe implications. Testing is now scheduled for 2016.

Airbus Helicopters - Passive Optimised blade

Excellent progress was made with the Passive Optimised blade in 2015. Following decisions taken in late 2014 to pursue a lower risk solution, structural and dynamic blade layout were finished at mid-year and CDR was achieved in July. From this, blade tooling was defined, supplied and validated. Manufacturing documents of the base blade have been defined and materials are procured. The first blade build study started in November.

AgustaWestland – Active Gurney Flap

Very significant progress was made on the AGF technologies in 2015, with another of the four main elements of test being completed to schedule.

The 2D Static test at the University of Twente was completed in 2014 so the activities in 2015 related to the analysis of the test data. This included aerodynamics data, laser based Particle Image Velocimetry (PIV) and acoustic data. This provided critical information about the twin vortex sheet formation aft of the AGF, with the PIV measurements being a ‘world first’ and being reported at conferences. The Acoustic data was analysed by NLR and reported mid-year. It indicated that the shed vortex frequency could be acoustically observable externally to the aircraft. Flight trials will confirm whether this is a real full-scale problem or just an artefact of this particular test.

The CIRA 2D Dynamic blade section hardware was successfully prepared and evaluated ahead of wind tunnel entry. Their Icing wind tunnel (IWT), to be used for this test, encountered significant mechanical failures that have required a multi Euro Million refit by CIRA. This work was not completed until Q3 2015, after which acceptance trials were started on the replacement system (no cost to CleanSky). This however has delayed testing of the 2D Dynamic blade section until Q2 2016. AgustaWestland has confirmed that there is still value, merit and hence a need to conduct the test.

The AGF Model Rotor programme was the outstanding success of the year. Blade design was completed early in the year following the completion of bench trials. Low energy tooling was developed and supplied by GAP partner CIDAUT for the novel manufacturing methods to be used for the blade (Airborne proprietary). The precision AGF units based upon solid stated piezo actuation were supplied by Active Space Technologies (Portugal). Blade manufacture progressed throughout the summer across the pan European consortium (Portugal, Spain, Netherlands, Poland) followed by structural substantiation testing. Meanwhile, the electronic control systems were prepared and tested (UK), shipped to the wind tunnel (Italy) and preparations made for the actual tests themselves. The tests were conducted throughout October and included Particle Image Velocimetry test of a rotating, operative rotor for the first time. The complex blade Active Gurney Flap systems worked well, reaching all conditions except only the highest rotational speeds. Throughout the remainder of the year the results were analysed and the test evidence is being used to inform the flight schedule of the full scale main rotor system to be tested in 2016. The test was completed to cost and GAM11 schedule and considerable praise is given to the partners who were involved for their achievements.
Finally, much work has been carried out on the AGF Whirl Tower/flight test blade design and development. Blade CDR was completed in February 2015, following a series of technical challenges that have held back design. This allowed tooling to start and the beginning of the build of the donor blades. Sample actuators /controllers have been supplied and have been undergoing evaluation. Much of the aircraft hardware has been procured and is either in stock or on order. Receipt of tooling has allowed the start of fabrication of detailed blade structure.

KPI Deliverables across GRC1 achieved a high rate of success with 4 out of 6 being achieved. Milestones however fared less well (0 out of 2 achieved) for reasons previously stated that include the delays of the Active Twist blade test specimen testing and delayed supply of the AGF donor blades. Importantly, in all cases, the deficits resulted from technical difficulties, not resourcing.

All GAP’s have worked extremely well across the GRC1 project and have been commended for the value they have brought to the programme. This is particularly so for the AGF Model rotor programme that had three separate GAPs within its consortium.

**GRC2 Reduced drag of airframe and dynamic systems activities**

In GRC2 (Reduced drag of airframe and non-lifting rotating system activities), main tasks focused on aerodynamic optimisation of rotor hub, fuselage and engine installation.

Flight tests have been conducted about the **Bluecopter** (modified EC135) of AHD featuring an improved aft body, faired landing skids and new hub fairings. A global drag reduction of about 17% could be assessed based on flight test measurements data. The demonstrator undergoes a lay-up, in which a new side intake and plenum are being installed. These components have been already measured in wind tunnel in the context of the partner project ATHENAI. Flight tests about the new intake are planned for Q1-2016.

Flight test have been conducted about the **AW169** mounting the new beany. TRL6 review is in preparation.

Concerning the reduction of airframe drag, especially for blunt aft bodies and for the tail, improved aerodynamic design of the common helicopter and tilt-rotor platforms had been conducted, incorporating passive flow control systems and tested in wind tunnel, thus achieving TRL4. The optimised airframe of the common helicopter and tilt-rotor platforms were tested respectively in the partner project ROD and DREAM-TILT; both projects have been closed in 2015. A total drag reduction of about 5% has been assessed for both configurations.

Wind tunnel tests (partner project CARD) were also accomplished, thus reaching TRL4, for the **EC155** helicopter model featuring new hub fairings. A global drag reduction of about 7% was measured in the wind tunnel.

In 2015 GRC2 supported GRC7 in defining the aerodynamic characteristics of fuselage and empennage of the second update of the Single and Twin Engine Light (SEL and TEL) and of the first update of the Twin Engine Medium (TEM) conceptual helicopter models for the “Y2020 reference” and “Y2020+CS conceptual” fleets.

**GRC3 Integration of Innovative Electrical Systems for Rotorcraft**

In GRC3 (Integration of innovative electrical systems activities), analysis reports covering technologies across differing helicopter types were delivered and data from the CfPs regarding system mass and future electrical power requirements provided to GRC7. Deliverables of this period included data for TEM, SEL & TEH configurations.
System power management strategies continued to be refined and principles aligned with the evolving CfP technology developments and leading power supply technologies.

Optimised electrical architectures were further refined in Electrical network simulations utilising software models.

The technologies for improved electrical system efficiency were further developed, with all major projects progressed with CfP partners.

The Starter Generator project completed prototype testing, analysis and final reporting.

The Power Converter and Energy Storage CfPs were successfully completed following partner test and reporting. Hardware was transferred to AW Yeovil for concluding integrated analysis, and will provide a final reporting in 2016.

Energy Recovery technologies were appraised in 2015, and the decision taken not to proceed to test. This resulted in the preparation and delivery of a closure document.

The EMA for Rotor Brake provided a test prototype machine and analysis. So as to fully explore the technical capabilities of the technology, further tests beyond the CfP closure date were agreed, and these will be formally reported in 2016.

**Electrical tail rotor drive** for conventional tail rotors has provided innovative concepts. The open tail rotor solution has created two prototype motors designs, which have initiated test bench and ongoing analysis. This technology has also progressed towards provision of a tail demonstrator in 2016, by the preparatory design and provisioning of electrical test facilities and agreed supply of an airframe tail ground test rig at AW.

The HEMAS system assessments planned in 2015 on the Electrical Test Bench/Copper Bird did not occur. Prototypes have been manufactured and assembled ready for the re-planned Integration Test now to be conducted in Ottobrunn from Jan to Jun 2016.

Overall in 2015 GRC3 had good progress against its work plan, by providing prototypes and extending the evaluation periods of several technologies. The delivery of 25% of planned reports and 60% of milestones was lower than expected, but this was due to the rescheduling and additional technology tests, causing a shift in these KPIs to 2016.

**Note:** Items in Italics are provided based on the GRC3 Lead’s assessment, but subject to further verification or amendment from AH but not available in the requested timescale.

**GRC4 – Integration of a Diesel engine on a light helicopter**

For GRC4, the target for 2015 was to complete Ground and Flight tests. The Ground runs have been achieved end of March. The endurance needed to get the Flight Conditions Note (FCN) of the Powerpack has been finished in June. The FCN has been delivered by the Partners in September 23rd, after full analysis of the endurance results. The Maiden Flight was then achieved on November 6th. A video and press article was released by Airbus Helicopters:


A second flight has been conducted on December 15th, enabling to reach 1000m altitude and 100kts with very good results on fuel consumption (up to -50%), rotor speed control, vibration, torque oscillations, cooling system and noise.
Additional activities and resources were needed (both at Partners and Topic Manager levels) to handle the Powerpack maturation on test bench and FADEC optimisation on Demonstrator Helicopter during Ground runs.

Due to further issue during Powerpack development, the FCN was delivered later than expected and so the full Flight test campaign could not be completed until end of 2015. It will finish in 2016.

**GRC5 – Environment-friendly flight paths**

After the re-organization of the activities on specific and well-defined Technology Products, occurred in 2012, now GRC5 is grouped in four Technology Streams: eco-Flight Procedures, eco-Flight Planner, eco-Flight Guidance and eco-Technologies.

The main activities completed on 2015 are:

For eco-Flight Procedures:

- Computation of low-noise trajectories for AW139 helicopter; FMS simulation (core + HMI) coupled to AWARE simulator; H/C VFR procedures validated by PITL simulations in laboratory environment; Airport VFR area charts T/R with some low-noise routes depicted; Rotorcraft IFR approach procedure charts; T/R eco-IFR procedures validated by PITL simulations in laboratory environment with ATC; Processes and criteria for low noise IFR helicopter operations; Completion of in-flight demonstrations of low noise IFR procedures at Toulouse airport with H175 helicopter.

For eco-Flight Planner, the activities had been completed in 2014.

For eco-Flight Guidance:

- Pilot-in-the-loop test of helicopter FMS with run-time low-noise planning (LNA); VFR noise abatement flight procedures evaluated using the helmet mounted display.

For eco-Technologies:

- Generic VFR LNP ready for TEM; Generic IFR LNP ready for T/R; Generic Low Noise VFR Procedure for T/R & expected benefits; Impact of atmospheric conditions on helicopter noise abatement approach procedures.

**GRC6 – Eco-design Rotorcraft Demonstrators**

In GRC6 the completion of manufacturing and testing of the demonstrators has been the main topic during 2015. These demonstrators are two thermoplastic composite structures (a stiffened helicopter tail cone and co-melted panel and an aerodynamic fairing) for composite manufacturing technologies and two metallic demonstrator groups (a tail rotor gear box including a thermoplastic drive shaft and a main rotor gear box) for new treatment methods.

The tailcone manufacture and assembly is now completed equally manufacture of the test rig is completed, and therefore the testing phase is due to be completed in Q1 2016.

The testing and evaluation of the thermoplastic fairing are complete.

The test of surface treated metallic parts (tail gear-box and main shaft), of the main rotor gear box, and of the thermoplastic components have been completed. Evaluation reports also delivered. The REMART project is now concluded and the deliverable report is delivered

The manufacture and test of the co-melt test panel led to the decision to complete the design and manufacture plan for the full scale demonstrator. Due to some reproducibility problems, the full
scale component manufacture has been delayed and consequently some of the testing (process qualification) necessary for subsequent the demonstrator flight.

Those tasks have been re-planned for completion in Q3 2016 as well as the budgeted allocated to the execution of these tasks.

**GRC7 – Interface with the Technology Evaluator**

GRC7 had five external deliverables and milestones relating to the delivery of the Phoenix platform V5.1 and V6.1 for the Technology Evaluator’s (TE)’s Fourth and Fifth Assessments respectively.

The data and software packages deliverables for the Twin Engine Heavy (TEHU1) and High Compression Engine (HCE) for a light generic rotorcraft were delivered to the TE as planned.

The Twin Engine Medium (TEM), Single Engine Light (SELU1) suffered minor delays due to the noise aspect of the model and first incorporation of the GRC5 benefits. TELU2 deliverable and milestone due to industry resource availability has suffered major delay. Its planned delivery date of September 2015 is now shifted to the first quarter in 2016. The rescheduled delivery of the TELU2 has a minor impact on the TE’s fifth assessment which is due to start in June 2016.

Good progress was made with the development of TEMU1, SELU2 and HCE due for delivery in 2016. GRC7 milestones are based on the receipt and integration of the Phoenix V5.1 and V6.1 into the TE’s platform and the generation of their assessment results.
SAGE – Sustainable and Green Engine ITD

2015 has been another year of demonstration for the SAGE ITD, in particular with the SAGE 4 and 5 demonstrators. SAGE 4 successfully completed their demonstration and the SAGE 5 build 2 was completed in 2015. SAGE 1 completed all its final four work packages in 2015. Lots of hardware has been delivered SAGE 2 and 6 in preparation for demonstrations in 2016. Additionally, SAGE 2 completed the CDR and ground works for the test rig have commenced, whilst SAGE 6 completed both PDR and CDR in 2015.

The CfP’s in 2015 continue to deliver some excellent achievements, which has contributed to the success of this year for the SAGE ITD.

SAGE 1 completed the work in the 4 main work packages that were defined in 2014 – 1.1 Fast CFD Solver; 1.2. Component Integrity; 1.3. Forced Response and 1.4. Noise. The programme of work was focused on the R&T activities in place at Universities to ensure continuation and completion of their research.

WP 1.1: was performed at the University of Cambridge to validate the fast CFD solver tool for the Open Rotor case. This work has been completed in 2015 and has focussed on validating extreme blade angles of attack against rig Z08 blade surface measurements.

WP 1.2: was performed by the University of Oxford and evaluated blade design and material options. This included a sample test programme under high strain rate, whilst shear extension experiments. This project was completed in 2015.

WP 1.3: was performed at Imperial College. It focused on validating methods for stability, flutter and forced response against available rig data. This programme was completed in 2015.

WP 1.4: was performed at the University of Southampton. The programme focussed on validation of far field and near field noise methods for open rotor designs using available rig data. This programme was completed in 2015.

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 finalized 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) have been staged with the first one for the blades done on May 2014. In 2014 and 2015, all the CDR was 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, have already been delivered to the dedicated assembly workshop at Snecma Vernon.

The assembly of the engine started in October 2015 and the balancing and instrumentation of some parts begun.

The civil engineering of the Ground Test facility was finalized and the assembly of the test bench started.

The Ground Demonstration objectives, plan and sequences have been defined. Regarding CFPs, several projects are running to support the Open Rotor demonstrator.

Considerable progress was made in all elements of the working programme of Project SAGE 3 in 2015. The work-plan includes two main work-streams: (i) demonstration at indoor and outdoor
engine test level of the newly conceived Roll-Royce Composite Fan System, constituting the great part of the overall effort in 2015 as well as (ii) engine demonstration of the performance of a novel Low Pressure Turbine system design reducing Turbine weight and increasing efficiency, including testing of vibration structural aspects.

The Composite Fan System demonstration focused on the ALPS CFS1 Outdoor Fan Blade Damage Test with composite fan blades being successfully completed at Stennis-USA on-schedule and hence hitting a very high value Milestone for this Project. Fan Blade Tip rub data were acquired and submitted to support future engine designs. ALPS CFS2 engine testing, involving flutter, blade tip clearance, and air intake acoustic impedance testing was delayed to 2016, due to significant technical challenge encountered in the design and make of the composite fan case system. However, the manufacturing of the composite fan case, including novel acoustic liners for community noise reduction and fan blade flutter margin improvement, is now scheduled to be completed in February 2017, having the initial difficulties been overcome in the course of the year. Planning and engine build activities were completed for the Back-to-Back Performance test including Composite Fan Blades and latest Titanium blades technology also planned in 2015, whilst the actual engine test was delayed due to operational issues to January 2016. Planning for the ALPS icing test is also underway and delayed to Q4 2016 due to test bed availability and conflicting priorities. Another very significant Milestone for the entire composite fan system development programme was achieved the planned Trailing Blade Integrity test completed in Q2 2015. A large amount of valuable data was generated influencing the blade design and therefore influencing the future directions of the Composite Fan system wider project. The annulus filler TRL6 review has been successfully completed. As a result of the work undertaken within this work package potential future routes to exploitation are being investigated within current and future Rolls-Royce projects.

As far as the Low Pressure Turbine work-strand is concerned, the engine testing demonstration was completed and good quality data were collected. The strip of the relevant engine has been also completed in Q4 2015 and post-test data analysis from Rolls-Royce Performance and ITP is well under-way.

The Virtual Engine validation of deflected geometries based on Thermo-mechanical and CFD simulations was completed, and an improving computational approach was recommended that has been demonstrated to achieve a 3 to 10 times speed up in the simulation time.

In 2015, SAGE4 has successfully completed engine assembly and engine testing. In total 107 hours and 500 cycles of engine testing have been accumulated. All requested test jobs have been executed and the installed instrumentation has collected valuable data.

The engine test data have been evaluated online during the test campaign and a pre-assessment of the mechanical behaviour of the hardware has been performed via borescope inspection.

With the accomplished engine test programme and the assessment up to now, all the incorporated technologies in HPC, LPT and TEC module have successfully demonstrated their capability at engine conditions.

In 2016 a tear down of the engine and detailed hardware inspection is planned to confirm these presumption and verify the mechanical condition of each technology.

Also the SAGE 4 partner companies like GKN and Meggitt have evaluated the test data out of the engine test campaign. As well, these partner test job requests have been performed completely and the test data have been evaluated to assess their new measurement techniques and cooling technology.
SAGE 4 partner Avio made significant progress in building a new test facility for gear boxes (CfP Project GeT FuTuRe). Also the manufacturing, instrumentation and assembly of the IDS test hardware have been completed. The test activities are planned to start at the beginning of 2016.

All in all, the SAGE 4 project in 2015 successfully proceeded on its way to realise the defined project targets within the Clean Sky timeframe.

The aim of the project SAGE 5 is to demonstrate several innovative technologies at high temperature. First step of the demonstration has been achieved in 2013. It 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 continue at the high TET target (build 2).

The Built 2 first engine test occurred in mid-2014. It aimed to test the engine in all operating range at ISA sea level, to confirm that the fix implemented to solve vibration issues were successful. Engine performance test has been recorded and analysed. The engine models have been updated with test data. The global target of 15% reduction in fuel consumption has been confirmed.

The built 2 test campaign was completed in 2015 by a highly instrumented test in order to measure the secondary air system and HP components performance. The engine investigation and final test report will be completed beginning 2016.

SAGE 6 made significant progress turning the lean burn development programme from the concept and design phase into hardware manufacture and engine build. All schemes for the first lean burn demonstrator engine (ALECSys Advanced Low Emissions Combustion System) have been released and the engine is technically sealed. Key hardware has been received which enabled build start of the Trent1000 based ground test engine in October.

The further advanced lean burn fuel system passed a preliminary design review with the Rolls-Royce corporate audit team in March. The related critical design review was successfully held in November and the new improved staging unit is currently in manufacture to be available for build of the second ALECSys engine. This engine will then be installed under the wing of the RR B747 flying testbed for flight testing in the second half of 2016.

A highly successful full annular combustor rig test has been completed at the end of the reporting period with the preliminary results for altitude relight, cold day ignition and quick relight all within or exceeding expectation.

The LeVeRig suffered from a number of problems during commissioning and a decision has been taken to re-configure the rig to a less complicated version allowing essential testing in order to de-risk the engine running.

→ **SGO – Systems for Green Operations ITD**

In 2015 SGO has continued to be focussed on achieving progress on all developed technologies to prepare the major demonstrations – both in flight and on ground – which are planned between mid-2014 and mid-2016. Some of these major demonstrations have been already achieved.

With reference to the annual grant agreement, the currently estimated overall consumption of resources amounts to 95% of the planned value 2015, including the amendment applied during 2015.
In WP1, for large Aircraft applications, the data packages and detailed architecture for cycle 2 has been released in 2015. It provides an update of both the short range reference aircraft and more electric aircraft including description of the architectures for energy and thermal systems. This reference package has been used in 2015 to conduct SGO MAE system assessment for large aircraft in both WP2 and WP1. The consolidated assessment for cycle 2, fed by WP2 activities was close to completion in 2015, to be released beginning of 2016.

In 2015, WP1 also contributed to certifiability assessment upon SGO solution. Work on certification topic has been initiated in WP5 leading to the release of General certification rules interpretation and principles upon SGO solutions. Then, discussion has been conducted with certification authorities in December 2015 to consolidate an analysis of consolidated design recommendations and certifiability strategy performed in WP1. The report is under finalization and will be released beginning of 2016.

In WP2, work on technologies for electrical and thermal energy management has moved on. Throughout 2015, further equipment and systems have been successfully delivered to the various ground and flight test rigs and supported the successful execution of different TRL reviews. However, some developments are delayed and dedicated TRL reviews are to be shifted into 2016.

Based on cycle 1 preliminary technology results and the cycle 2 workshop in January 2014, a list of improvement ideas have been created which did find their way into the cycle 2 design guideline document which has been released by Airbus in December 2014. Now, as cycle 2 is heading towards its end, Airbus is finalizing the cycle 2 architecture assessment for Large Aircraft which will be released early 2016.

The work in the Method and Tools work package has progressed as planned with testing the different use cases. The WP has closed its activities through a Lessons-Learned meeting conducted with all relevant WP2.1 stakeholders at DLR Oberpfaffenhofen in November 2015.

The electrical power centre (EPDC) has been delivered to PROVEN ground test rig at Airbus in Toulouse in 2014 for further system testing in relevant aircraft environment. The associated pre-integration campaign and tests have been conducted by mid 2015 and the dedicated TRL4 milestone of the EPDC was achieved in July 2015. The modular power electronic modules (IPEM) for integration into the EPDC were delivered by Thales but it was decided to split the TRL4 milestone for IPEM into a pre-TRL4 gate which was conducted in October 2015, and the final TRL4 review in April 2016 after full IPEM integration into the EPDC.

A major success in MAE in 2015 was the conducted flight test of the Primary Inflight Ice Detection System (PFIDS) demonstrator, developed by Zodiac, on the Airbus A320 MSN1 in November 2015. The prototype hardware has been manufactured throughout 2014 and 2015, a TRL5 review ahead of the flight test has been successfully passed in July 2015.

In 2015 the MAE Wing Ice Protection technology were mainly focused on the work of Liebherr together with Airbus on the optimization of the proposed WIPS architecture for large aircraft. The TRL4 closure review, which was a follow-up of the first TRL4 review in 2014, was successfully passed in June 2015.

In 2013 and 2014, the work on the re-sized electrical ECS Large Aircraft flight test hardware (50kW) had begun and continued throughout 2015. The power-on of the demonstrator for the ground test campaign was achieved in August 2015. Today, the performance, achieved in the tests, is as expected. The test campaign on ground including test in altitude chamber will continue until Q1-2016.
In the frame of the electrical ECS work for regional aircraft, the flight test qualification of the demonstrator has been finished in summer 2015 followed by the delivery of the hardware from Liebherr to ATR in August 2015. The flight test campaign will happen in Q1-2016.

In the frame of WP2 thermal management activities, a major milestone has been achieved through the successful execution of the flight test campaign for the Skin Heat Exchanger in September 2014 and the subsequent TRL5 and TRL6 review which have been held and passed in December 2014. In early 2015 a detailed review and assessment of the flight test results have been conducted by the involved partners Airbus, Liebherr and DLR.

The development of the Thermal Management Function (TMF) has continued in 2015 implementing a new architecture with additional functionalities. Throughout 2015 the development of the TMF has made good progress and was finally validated in a desktop environment end 2015. The so-called “pre-TRL4” gate of the TMF with rapid prototyping hardware is scheduled for 2016.

In 2015 several equipment and systems for electrical power generation and distribution have been delivered to the other aircraft COPPER Bird test rig at SAFRAN Labinal Power Systems but also to Alenia for integration into the ATR aircraft conducting the more-electric flight test campaign early 2016. In April 2015 the delivery of an update of the DGCU software from Thales to COPPER Bird enabling parallel operation of generation channel 1 and 2 has been achieved. The bidirectional DC/DC-converters have also been delivered to COPPER Bird in April 2015 but with reduced functionality only. The manufacturing of a complete shipset for power generation (including TRU 270VDC) dedicated to Alenia flight test campaign has been finished followed by successful qualification and delivery to Alenia in April 2015.

An electromechanical actuation system for a helicopter swashplate (HEMAS) is developed in cooperation with GRC ITD. In 2015 the manufacturing of the HEMAS hardware e.g. electrical motors, actuators and actuator control electronic (ACE) progressed quite good. The actuators were tested and delivered from Liebherr to Airbus for integration into the system test rig. But the overall delay of the system demonstrator hardware will induce a change of the planning. The test campaign to achieve finally TRL4 will now be conducted in Airbus Group Innovation only and not in COPPER Bird as initially planned.

In the field of WP3 – Mission and Trajectory Management (MTM), 2014 has brought major progress towards the final demonstration stages planned in 2015 and 16.

New flight management functions have now reached TRL5 as planned, by evaluation in representative conditions on simulators and integrated in existing Flight Management Systems:

The function covering the climb (Multi Criteria Departure Procedure) had already reached TRL5 in July 2014, and the final implementation of the optimisation function in an Electronic Flight Bag System is-going, targeting final test in 2016.

The function has been fully implemented in the software architecture of the FMS, and integrated in the system simulator. The TRL5 has been reached end November 2015.

Flight tests of a Flight Management function allowing continuous descent in time constrained environment have been completed, with tests both on a Cessna Citation aircraft and on an A320, with two different system configurations and operational concepts.

Integration of new weather radar algorithms and trajectory optimisation functions into an Electronic Flight Bag platform has been completed and integrated in the GRA Regional simulator. The TRL5 for both Advanced weather Radar algorithms and for the trajectory optimisation function have been passed.
The on-board wheel actuator system developed by Safran Messier Bugatti Dowty has reached a complete System integration level, and full scale dynamometer tests have been carried out.

In 2015, the work on major ground and flight demonstration in WP4 was carried on leading to significant achievement for MAE.

For ground demonstrations, on the PROVEN electrical rig, a first step of pre-integration has been successfully completed for EPDC and related equipment in June 2015. The test campaign started S2 2015 and will be completed mid 2016 after a second step of pre-integration of the Power Electronic Module functions. Significant work has been performed to consolidate the simulation platform and the virtual electrical test activity supported both the pre-integration phase and the test campaign.

Concerning the thermal test rig AVANT, the activity in 2015 focused on the development of system rig test means. The CfP TEMGIR to develop a set of electrical equipment that is able to supply various loads and simulate thermal behaviour passed PDR and CDR. The building has been completed in 2015 and the test rig infrastructure is in preparation.

Regarding the ice protection system handling qualities requirements, wind tunnel tests in High Reynolds have been completed within European Transonic Wind tunnel in September 2015.

Regarding the Flight demonstration, strong progress has been achieved regarding flight test preparation, realisation and exploitation.

Hence, the evaluation of results of the flight test performed on DLR A320 and dedicated on the Liquid skin heat exchanger and related liquid loop system has been released in December 2015.

For the Primary Ice Detection System, following the delivery of the hardware in S2 2015, first flights have been performed on Airbus A320 MSN01. Further flight tests are foreseen in 2016.

Regarding the electrical flight test demonstrator, contributions and deliveries in 2015 from all SGO shareholders allowed to keep the schedule leading to perform the flight test in Q2 2016. Ice detection system hardware has been delivered in S2 2015. Electrical Power center power on has been performed in August 2015 and a significant part of the ground test campaign, including TAES converters integration and validation, has been completed. For the scoop air intake, the CDR took place in September 2015. The Power electronics from Liebherr have been delivered in December 2015 to be tested during the ground test campaign. Finally, working party on A320 started in 2015.

Regarding MTM pillar, MCDP activities focused on providing expertise and support to ATAEGINA initiative within G7.

During 2014, WP5 has used the progression of development of the different technologies in WP2 and WP3 to feed the works in the Industrial Exploitation and the Assessment domains. In the area of the Certification, the activities remained quite low. The confirmation by EASA of their low level of involvement and puntual potential contribution can explain this fact. The activities related to the impact on Design Standards has been shared between the collection of data allowing the analysis and the dissemination of reports outside the Europe in order to make a link with the broader engineering communities. The state of the art of Qualification and Design Standards applicable to technologies and systems have been identified. For each technology, a report providing the critical rules for the equipment and how they have to / might be amended with the use on new technologies is progressing. In parallel of this, a workshop has been held in October to address the problematic of the use of new refrigerant fluids with this objective of producing a final report on this topic before mid-2015. An Aerospace Information Report on ways of dealing with electrical power regeneration has been produced in order to allow a link between Clean Sky results and the International Community. Another AIR Report has been prepared on modelling and simulation.
aiming for establishing a common language between partners from around the world who are involved in activities in this domain of MEA electric power systems.

In the field of the General Assessment, the deliverable “ITD level Technology assessment” has been issued. This report relates at system level the benefits provided by the selected technologies and new FMS functions developed in SGO. It will contribute to issue the assessment at A/C level. This work at preliminary stage will be completed later, as planned in the DoW, to incorporate the conclusions raised after the completion of the development work in other work-packages.

Communication and Dissemination activities in 2015 have accelerated in SGO, with more than 50 individual actions.

**ECO – Eco-Design ITD**

Eco-Design ITD is organized in the two major areas of EDA (Eco-Design for Airframe) and EDS (Eco-Design for Systems, mostly for small aircraft). The EDA part of the Eco-Design ITD is meant to tackle the environmental issues of aircrafts currently in operation by focusing on the following challenges:

- To identify and mature environmentally sound (“green”) technologies for materials and processes for aircraft production.
- To identify and mature environmentally sound (“green”) technologies for materials and processes for aircraft maintenance and use.
- To improve the field of end-of-life aircraft operations, including reuse, recyclability and disposal (“elimination”) issues.
- To provide tools and guidelines for an eco-design process in order to minimize the overall environmental impact of aircraft production, use/maintenance, and disposal.

In 2015, the technical work in the frame of EDA progressed toward the finalisation of the ITD, in line with Eco design contractual frame on the following Work Packages:

- WP A.2 Technology Development (mainly for materials, surface treatments, manufacturing, end of life),
- WP A.3 Application Studies (mainly Life Cycle Assessment tools, final Eco statements),
- WP A.5/6 Demonstration (aircraft airframe structures and equipment).

In WP A.2, the work was dedicated to the maturation of last batch of >100 innovative technologies selected as eco-design relevant, in particular through the completion of the partners projects (GAP) linked to demonstrator validation.

The general synthesis of the WP has been updated to take into account latest outcomes from GAPs achievements as well as technological maturation performed through demonstrator manufacturing. In WP A.3, 2 work packages aimed to Life Cycle Assessment and Eco design industrial applications were still active and finalised in 2015:

- In WP A.3.1 (Eco-statements), after the finalisation of the development of evaluation tools for Life Cycle Assessment (LCA) and eco-statement on state of art technologies, the work on 2015 has been devoted to finalisation of data collection on new technologies (data to be processed
and then loaded in the EDA LCA database) on one hand, and on Eco-Statements of demonstrator parts on the other hand.

At end of 2015 the elaboration of the EDA LCA database (Clean Sky - Aviation Environmental Database or CS-AED) is finalized and this is considered a major achievement of the programme (WP A.3.1.1).

- In WP A.3.2 activities have been finalised on the extrapolation of some technologies developed in WP A.2 to industrial conditions. The WP has been finalised and the final meeting has been held on February 2015.

In WP A.6 the demonstration activity has been finalised in 2015 on the defined 18 demonstrators based on 41 parts in total. This includes 10 airframe demonstrators, 2 cabin interior and 6 equipment demonstrators.

The general objective of the EDS part of the Eco-Design ITD is to gain a valuable and comprehensive insight into the concept of more/all-electric aircraft architectures. It is expected that the use of electricity as the only energy medium, by removing the hydraulic fluid and by the use of on-board power-by–wire will offer significant benefits in terms of aircraft maintenance and disposal environmental impact, and will yield new possibilities in terms of energy management (e.g.: intelligent load shedding, power regeneration on actuators, sharing of Electrical Control Unit over actuator).

The work performed in 2015 consisted in finalising the common activities (WP S.1), performing the characterization of the business jet sub-systems architectures (WP S.2). Further during 2015, the benches related activities and tests campaigns (ETB: Electrical Test Bench for WP S.3; TTB: Thermal Test Bench for WP S.4) progressed towards completion.

The WP S.1 common activities progressed in 2015 mainly through finalisation of electrical and thermal modelling tools and progress on the “ecolonomic” models (WP S.1.1), towards the final general synthesis of the project.

The equipment development and follow-up activity, as part of this WP, has been closed at end of 2015. As examples:

- The alternator with associated power electronics developed in the frame of related GAP has been tested and delivered to the ETB for the finalisation of the Generic Architecture (GA) test campaign.
- Challenges encountered on the bi-way converter led to significant delay in testing.
  - Alternative solution was applied in 2015 to allow an adequate level of test execution and further research in this domain is worth to be conducted.

The work within WP S.2 continued on 2015 at the level of the business jet architecture trade-off (S.2.6) supported by modelling activities (S.2.5).

An update of the comparison between architecture candidates has been carried out by implementing a finer analysis of mass savings. The result of the analysis showed that the mass of the aircraft with an all-electric “oil less” architecture is now equivalent to the mass of the reference aircraft. Most of the gain is coming from improved Electrical Power Generation System (EPGS).

The WP S.3 (Electrical Test Bench) integration continued and finalised beginning of 2015. Planned tests on the generic architecture (GA) already initiated during previous periods were completed in 2015. A dedicated test campaign for the GRA architecture was also carried out. Foreseen campaign on GRC architecture was not performed due to key equipment non delivery on time.

The WP S.4 (Thermal Test Bench) test activities continued on aircraft sections installed in the bench and were finalised in 2015:

- Business jet carbon fibre cockpit part (T12 section) test campaign allowed the thermal model validation.
- Metallic fuselage (T23 section) test campaign has been finalised including Loop Heat Pipe project. The thermal model validation was finalised as well.
- The rear fuselage (T5 section) integration and installation has been finalised beginning of 2015 and the tests have been carried out including model validation.
- The aircraft calorimeter integration has been concluded with the Test Readiness Review in 1st quarter of 2015. The tests and associated model validation have been conducted on the 1st semester 2015.

Several partners projects (around 30 GAPs) have been technically completed, contributing to overall Eco design objectives.

Dissemination and Communication

The Eco-Design ITD technical activities are considered closed in 2015, both for EDA and EDS projects.

The overall activity progressed in line with the scope with some activity requiring a consolidation in 2015 in line with the last applicable amendment. Personnel cost spending was kept in line with the planning while some deliverables will be consolidated and submitted early 2016.

The main technical deliverables produced on 2015 are available in the following table. Mainly for EDS the most of expected deliverables have been not formally submitted.

Periodic deliverables (e.g. Annual Activity Report, reviews) are excluded from this table.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Deliverable title</th>
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<tbody>
<tr>
<td>D 01-47</td>
<td>2014 Annual Activity report</td>
</tr>
<tr>
<td>D 01-48</td>
<td>2014 Annual Review</td>
</tr>
<tr>
<td>D 01-49</td>
<td>First 2015 Quarterly report</td>
</tr>
<tr>
<td>D 01-50</td>
<td>Mid-year 2015 status report (including 2nd quarterly report)</td>
</tr>
<tr>
<td>D 01-53</td>
<td>Interim Progress Review 2015</td>
</tr>
<tr>
<td>D 01-54</td>
<td>3rd 2015 Quarterly report</td>
</tr>
<tr>
<td>DA 2-04b</td>
<td>General synthesis of WP A.2</td>
</tr>
<tr>
<td>DA 52-02</td>
<td>Equipment demonstration preparation: Synthesis Report</td>
</tr>
<tr>
<td>DA 62-02</td>
<td>Equipment demonstration: Synthesis Report</td>
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<tr>
<td>DA 61-01b</td>
<td>Equipped Airframe demonstration: Synthesis Report</td>
</tr>
<tr>
<td>DA 61-02b to DA 61-013b</td>
<td>Equipped Airframe demonstrators: final results</td>
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<tr>
<td>DS 3-256</td>
<td>Control System validation report</td>
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</table>

The main milestones passed in 2015 are given on the following table.

Periodic events (e.g. Annual Review, Intermediate Progress Review) are not mentioned on the table.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Milestone title</th>
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<tr>
<td>MA 51-02</td>
<td>PDR, CDR of demonstrators – Equipped airframe</td>
</tr>
<tr>
<td>MA 61-01</td>
<td>Equipped airframe demonstration: data for LCA</td>
</tr>
<tr>
<td>A 52</td>
<td>PDR, CDR of demonstrators - Equipment</td>
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<tr>
<td>MA 313-01</td>
<td>Detailed final eco-statement (demonstrators parts)</td>
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<tr>
<td>MA 2-02</td>
<td>Final mapping of single technology TRL</td>
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<tr>
<td>MA 3-03</td>
<td>Application studies: Synthesis Workshop 2</td>
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<tr>
<td>MA 31-04</td>
<td>Final Eco-Statement</td>
</tr>
<tr>
<td>MS 4-03</td>
<td>End of Mock-Up integration (3 a/c sections)</td>
</tr>
<tr>
<td>MS 4-02</td>
<td>End of Air Cooling Calorimeter integration</td>
</tr>
<tr>
<td>MS 3-02</td>
<td>ETB Final Readiness Review including equipments &amp; loads</td>
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<tr>
<td>MS 4-04</td>
<td>TTB Final Readiness Review</td>
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</table>
**TE – Technology Evaluator**

All TE Work Packages had activities and deliverables (or outputs) in 2015:
- 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 2015 a global environmental assessment was performed as planned.

In WP1, during 2015 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 from 2015-2016 and its linkage and timing to the TE assessments. Part of this is also the linkage between the ITD aircraft models and demonstration activities of the ITDs.

In WP2 updates of the PANEM, GRASM and Phoenix models were delivered. It must be noted that in WP2 the TE consortium operates as a de-facto supply chain manager: all the major component conceptual models are delivered by the Aircraft ITDs.

The 2015 ITD aircraft model development scope included:
- SFWA LR (Long Range): further development of the PANEM model (Parametric Aircraft Noise and Emissions Model) for the long range aircraft with a SAGE 3 and 6 engine, and integration of the SGO MSC function
- SFWA SMR (Short and Medium Range): further development of the PANEM model (Parametric Aircraft Noise and Emissions Model) for the short medium range aircraft including a SAGE 2 CROR engine and a natural laminar wing, SGO functionalities and including electric taxiing as a separate tool.
- GRC: updates of the SEL (single engine light) and Twin Engine Heavy (TEH) and delivery of the HCE model
- GRA: delivery of an update of the GRA Simulation Model (GRASM) for loop 3 GRA-90 Turboprop and GRA 130 Geared TF aircraft including mission trajectory optimization for cruise level which were delivered Mid November. Note that the cruise optimization functionality will be part of the 2016 last assessment.

In WP3 the TE-Information System was further developed in 2015. The 2015 assessment results have now been added in the TEIS repository part.

In WP4, in September 2015, the key TE to JU output has been produced. It is the 2015 environmental assessment report named “DJU4.6-4: “2015 assessment synthesis report”.

The main results presented in this report, and the progress made in 2015 with respect to previous assessments are summarized in the tables hereafter

Leading up to the 2015 assessment, other key activities/deliverables were conducted, including:
- Specification report of the mission-level assessment
- Specification report of the airport level assessment
- Specification report of the ATS level assessment
- Specification report of the LCA level assessment
2015 assessment results at a/c level

The following tables hereafter present the summary of the assessment results at aircraft and rotorcraft level. These tables are devoted to respectively mainliners, regional aircraft and rotorcraft.

<table>
<thead>
<tr>
<th>SMR aircraft</th>
<th>noise area reduction take-off [%] (**)</th>
<th>noise reduction take-off <a href="*">dB</a> (**)</th>
<th>CO2 reduction per pax [%] (**)</th>
<th>CO2 reduction per pax [%] (**)</th>
<th>NOx reduction per pax [%] (**)</th>
<th>NOx reduction per pax [%] (**)</th>
<th>Perceived noise reduction take off [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise footprints and missions</td>
<td>75dB-85dB/500-2600NM</td>
<td>75 dB/500-2600NM</td>
<td>500-2600NM</td>
<td>500-2600NM</td>
<td>500-2600NM</td>
<td>500-2600NM</td>
<td>75 dB/500-2800NM</td>
</tr>
<tr>
<td>APL2 vs RPL3 Average delta value</td>
<td>-55%</td>
<td>-3.7</td>
<td>-40%</td>
<td>-39%</td>
<td>-44%</td>
<td>-44%</td>
<td>-21%</td>
</tr>
<tr>
<td>LR Aircraft (****)</td>
<td>noise area reduction take-off [%]</td>
<td>noise reduction take-off <a href="*">dB</a></td>
<td>CO2 reduction per pax [%]</td>
<td>NOx reduction per pax [%]</td>
<td>Perceived noise reduction take off [%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise footprints and missions</td>
<td>80dB-90dB/1000-7000NM</td>
<td>80 dB/1000-7000NM</td>
<td>1000-7000NM</td>
<td>1000-7000NM</td>
<td>80 dB/1000-7000NM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APL3 vs RPL Average delta value</td>
<td>-79%</td>
<td>-5.7</td>
<td>-19%</td>
<td>-50%</td>
<td>-33%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Short/medium and Long Range aircraft TE results in 2015

* Average dB reduction of a given noise footprint
** AIGS and MCDP low noise tuning for APL2
*** AIGS and MCDP low emissions tuning for APL2
**** AIGS and MSC not optimal 3000NM – 7000NM

Short or Medium Range aircraft

Airbus PANEM 1.4.2 version has been delivered to TE in Mid 2015 for the short medium range concept aircraft (APL2) including the natural laminar wing and the counter rotating open rotor SAGE2 engine incorporating the best knowledge Airbus and SNECMA have on the installation, geometry, weights and the performance of this platform and based on latest wind tunnel tests results.

This version of the APL2 model yielded an average per passenger reduction in CO2 of 39-40% and a reduction of 44% for NOx (see Table 1). Noise results with an updated reference 2000 aircraft yielded a very good result with 55% noise area reduction at take-off. This PANEM version includes SGO functionalities for APL2, i.e. Advanced Increased Glide Slope (AIGS) and Multi Criteria Departure Procedure (MCDP). Noise and emissions optimized MCDP has been applied. A final update of the PANEM model was provided in November 2015 which will be used for the final assessment in 2016.

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Long range aircraft

Airbus PANEM 1.4.2 contains also the long range concept aircraft model (APL3) including an advanced 3-shaft turbofan SAGE3 engine and the combustor lean burn system as demonstrated in SAGE6. This version of the APL3 model gives results at mission level with a very good achievement towards the ACARE goals (see Table 1). Noise levels at take-off and landing are computed by the PANEM noise module. The NOx emission computation method has been improved and outputs are consistent with Airbus and Rolls-Royce expectation for a 2020 advanced turbofan aircraft equipped with the Clean Sky lean burn system.

This PANEM version includes also SGO functionalities for APL3, i.e. Advanced Increased Glide Slope (AIGS) and Multi Step Cruise optimization (MSC). MSC has been applied but is not yet fully optimized for 3000 to 7000 nautical miles missions. A final update of the PANEM model was provided in November 2015 which will be used for the final assessment in 2016.

Regional aircraft

<table>
<thead>
<tr>
<th>Regional aircrafts</th>
<th>noise area reduction landing [%]</th>
<th>noise area reduction landing [dB]*</th>
<th>noise area reduction take-off [%]</th>
<th>noise reduction take-off [dB]*</th>
<th>CO2 reduction per pax [%]</th>
<th>NOx reduction per pax [%]</th>
<th>Perceived noise reduction take off [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise footprints and missions</td>
<td>55dB- 75dB/100-500NM</td>
<td>55dB/100-500NM</td>
<td>55dB- 75dB/100-500NM</td>
<td>55dB/100-500NM</td>
<td>100-500NM</td>
<td>100-500NM</td>
<td>55dB/100-500NM</td>
</tr>
<tr>
<td>TP90 2020 vs TP90 2000</td>
<td>-40%</td>
<td>-4.80</td>
<td>NA</td>
<td>NA</td>
<td>-20%</td>
<td>-42%</td>
<td>-85%</td>
</tr>
<tr>
<td>Average delta value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise footprints and missions</td>
<td>55dB- 75dB/300-1000NM</td>
<td>55dB/300-1000NM</td>
<td>55dB- 75dB/300-1000NM</td>
<td>55dB/300-1000NM</td>
<td>300-1000NM</td>
<td>300-1000NM</td>
<td>55dB/300-1000NM</td>
</tr>
<tr>
<td>GTF130 2020 vs TF130 2000</td>
<td>-40%</td>
<td>-8.30</td>
<td>-57%</td>
<td>-10.10</td>
<td>-27%</td>
<td>-35%</td>
<td>-50%</td>
</tr>
<tr>
<td>Average delta value</td>
<td></td>
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</tr>
</tbody>
</table>

Table 2: Regional aircraft TE results in 2015
* Average dB reduction of a given noise footprint

Table 2 shows the GRASM results through the GRASM 5.0 model that has been delivered by end 2014. These GRASMs, realized utilizing the results of the Concept aircraft Loop 3 Preliminary Design activities performed inside Green Regional Aircraft ITD, give results at mission level with a very good achievement towards the ACARE goals with 27% CO2 reduction (see table 2).
In particular, the TP90 concept aircraft, TP90 2020, used for this 2015 TE assessment is a result of a trade-off activity on the engine performance released from the two Engine Manufacturers inside the GRA ITD.

Regarding the 130 Pax configuration, the Concept Aircraft used is the Geared Turbofan aircraft, GTF130 2020, with a rear engine as result of the trade off with the under wing engine installation. The results of Loop 3 preliminary design activities inside GRA ITD take into account the feedback coming from the engine database and the demo results for the delivery of the final aircraft sizing TP90 and GTF130 to be used for the relative GRASMs.

**Rotorcraft**

<table>
<thead>
<tr>
<th>Rotorcrafts</th>
<th>noise area reduction [%]</th>
<th>CO2 reduction [%]</th>
<th>NOx reduction [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mission type</td>
<td>SAR</td>
<td>SAR</td>
<td>SAR</td>
</tr>
<tr>
<td>TEM 2020 vs TEM 2000</td>
<td>-23%</td>
<td>-10%</td>
<td>-36%</td>
</tr>
<tr>
<td>Mission type</td>
<td>Fire suppression</td>
<td>Fire suppression</td>
<td>Fire suppression</td>
</tr>
<tr>
<td>TEM 2020 vs TEM 2000</td>
<td>-20%</td>
<td>-12%</td>
<td>-46%</td>
</tr>
<tr>
<td>Mission type</td>
<td>Passenger</td>
<td>Passenger</td>
<td>Passenger</td>
</tr>
<tr>
<td>SEL U1 2020 vs SEL 2000</td>
<td>-25%</td>
<td>-20%</td>
<td>-58%</td>
</tr>
<tr>
<td>Mission type</td>
<td>Oil &amp; gas</td>
<td>Oil &amp; gas</td>
<td>Oil &amp; gas</td>
</tr>
<tr>
<td>TEH 2020 U1 vs TEH 2000</td>
<td>NA</td>
<td>-21%</td>
<td>-55%</td>
</tr>
</tbody>
</table>

Table 3: rotorcraft TE results in 2015

In 2015 assessments for the following rotorcraft classes were performed: SEL_U1 (Single Engine Light – Update 1), TEM (Twin Engine Medium), TEH_U1 (Twin Engine Heavy – Update 1) and HCE (High Compression Engine). Table 3 shows the noise and emissions results for Year 2000 Reference technology versus Year 2020 Conceptual rotorcraft. The reference configurations are without Clean Sky benefits. Results show relative delta values for selected performance metrics namely fuel burn, CO2, NOx and noise ground footprint for the rotorcraft categories compared.

For example the deployment of the Year 2020 Concept TEH helicopter configuration may result in a percentage reduction in fuel burn and CO2 of the order of 21% and 55% for NOx relative to the Year 2000 Reference configuration for a typical oil and gas mission. For the TEM assessment two types of mission were flown: the SAR and fire suppression. For the SEL the passenger transport mission was flown. Some Phoenix rotorcraft model updates are still expected for the final assessment in 2016.
Aircraft fleet at various airports

In the 2015 assessment for regional and mainliner aircraft traffic at airport level, five airports were considered to determine potential Clean Sky benefits by comparing a year 2020 fleet scenario with reference 2000 aircraft and a year 2020 fleet scenario with concept (or Clean Sky) aircraft. These airports were two primary hub airports with a complex geometry, one primary hub airport with a simple geometry, one secondary hub airport, and one regional airport. The concept aircraft considered in the appropriate airport traffic scenarios were GRA’s turboprop aircraft and geared turbofan aircraft, and SFWA/Airbus’ short-medium range aircraft and long-range aircraft.

Although not all technologies under development in the Clean Sky ITDs are yet available (i.e. integrated into the concept aircraft models from ITDs) and these ITD aircraft models are not yet all fully matured, provisional results of the calculations for the 2015 assessment at airport level indicate that Clean Sky technologies could bring environmental benefits: reductions in fuel burn and emissions, which are in general between 40-45% for fuel burn and CO2 and between 40%-50% as for NOX. Provisional results for noise point to reductions in surface area of noise contours for higher noise levels (i.e. higher than 60 dB(A) Lden) of around 20%. The effect of those noise contour reductions on the population exposed varies per airport, but for most of the airports addressed, the population exposed to the associated noise levels is reduced. In those cases, the reductions start from 15% for one airport and can go up to more than 70% for another airport.

Global Business jet fleet

At Air Transport System level an HSBJ fleet assessment was performed in 2015. The fleet consisted either of HSBJ 2000 or HSBJ 2020 technology aircraft. Covering minimum to maximum ranges flown of 1000 Nautical Miles (1852 km) to 6400 Nautical Miles (11852 km) the fleet traffic scenario covered about 6550 airport pairs and about 22000 movements flown for the September 2020 month. Comparing the September 2020 fleet traffic scenario either with HSBJ 2000 technology or HSBJ 2020 technology aircraft the results yielded a 17% CO2 and a 27% NOx reduction. The September 2020 business jet fleet traffic scenario was derived from the September 2020 mainliner fleet traffic scenario. This was due to the fact that for business jet fleets no regular flight schedules are available as business jet passenger transportation is mainly consisting of VIP transport with a very large number of private operators with fleets of only up to a few aircraft.

Conclusion

The 2015 assessment was progressing in terms of a more complete coverage at Mission level including SGO mission trajectory management optimization functionalities for Short Medium range and Long Range aircraft. These new functionalities are: Advanced Increased Glide Slope (AIGS), Multi Criteria Departure Procedure (MCDP) either for noise or emissions optimization and Multi Step Cruise optimization (MSC).
CLEAN SKY 2 PROGRAMME – REMINDER OF RESEARCH OBJECTIVES

→ **LPA – Large Passenger Aircraft IADP**

Essentially build upon the positive experiences of the CleanSky SFWA project, 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” 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 will be worked out may find an earlier application. These technologies spin-offs would be candidate for an incremental development of the existing family of commercial airplanes. 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 focus to mature and validated technologies with potential of high improvement potential and which have reached elevated maturity already, typically based on integrated ground and flight demonstrators of large or full scale.

**Implementation of main work packages and operational ramp up of the project**

The key focus of activities in 2015 was laid on the

- Completion of the technical management structure
- Implementation of Core Partners and associated activities into the work plan 2015
- Definition and implementation of Partner activities through three CleanSky open calls for Partners (CP), to become active from January 2016 on
- Ramp up of R&T activities, details described in the following paragraphs for each of the three LPA Platforms
- Establishment of a detailed work plan for 2016 and 2017, including the planning of the engagement of further Core Partners and Partners to be selected through open calls

The formal LPA programme kick-off meeting was held early July 2015 in coincidence with the contractual implementation of the CleanSky 2 first Core Partner Call, namely Aernnova, DLR, GE Avio, GKN, ONERA and Zodiac Aerospace.
**LPA Platform 1 activities and progress of work in 2015**

Five Core Partners were successfully integrated in Platform 1 after their accession to the GAM and the Consortium Agreement (DLR, ONERA, Aernnova, GE Avio, GKN Aero). In addition, two Partners from CFP01 (NLR, IK4-Lortek) have joined the Platform 1 through an Implementation Agreement with Airbus. For both Core Partner and Partner wave 2, the Platform 1 proposal topics (CPW2 and CFP02) were processed throughout the 2nd semester of 2015 targeting the consensus meeting phase in Jan. 2016.

All main work packages are active and progressing. Progress Review Meetings were established (2-3 per anno) to monitor the technical progress for each major technology, the communication lines are established for all active work packages (stakeholder matrix, communication means such as bi-weeklies, etc.).

Three Launch Reviews for major technologies were performed in 2015, “hybrid propulsion” (WP1.6/WP1.6.2), “scaled-flight testing” (WP1.3) and “hybrid laminar flow control technology applied on horizontal tail plane” in (WP1.4). The plan for the next Launch Reviews in 2016 was compiled.

CROR Flight Test Demonstrator activities (WP1.1) focused on building up a new demonstrator roadmap which considers a clear decision gate 2017 (eco-viability gate for the engine architecture to be flight tested). Alternative scenarios have been worked out in view of a major decision milestones scheduled for mid of 2017. Further main activities concentrated on architecture maturation contributing to economic viability studies. A first communication about the new CROR FTD roadmap to the CSJU took place early November. As an outcome of this meeting it was agreed to demonstrate the detailed plan at a dedicated Launch Review in January 2016. With respect to the Non-Propulsive-Energy (NPE) distribution topic, the involved partners developed architecture dossiers, both for LPA and biz-jet aircraft.

For the Innovative Rear End – demonstrator (WP1.2) the project development plan was re-worked to consider the dependencies with the CROR-engine major decision gate mid of 2017 with respect to workload ramp-up, spent forecast and the type of activities to be performed until the gate with the emphasize laid on non-specific design work and capability build-up.

In the Scaled Flight Test demonstration work package (WP1.3) activities focused on building up the technical management organization and work package setup in coordination with an already engaged Core Partner and Partners to be engaged, e.g. by CFP02 for test aircraft preparation and qualification. First activities have started to define similarity and representativeness conditions/limitations of the scaled aircraft and to compile the requirements for testing.

In 2015 WP1.4 started with the aerodynamic design of the HLFC HTP and working on the structure concept. The non-specific design of essential sub structures has started accompanied by the manufacture of test samples for coupon testing in early 2016. The design target for the HLFC VTP was confirmed as well as the concept for the manufacturing process.

The major results of the value-for-money analysis, finalized in late autumn 2015, was to continue the plan to flight test the “UltraFan” engine on a FTD. In addition the V&V strategy for the key technologies and the engine integration was elaborated. Based on this outcome the both hosting work packages WP1.5.2 (technologies) and WP1.6.4 (FTD) have been updated accordingly.

In addition in WP1.5.3 the development plan and V&V plan for Active Flow Control (AFC) applied on wing/pylon area has been further developed including the wind-tunnel and flight-test strategy.

In the context of the Radical Aircraft Configuration work package WP1.6.2 the sub-system “energy storage” was specified and purchased as well as already integrated into the test bench.

**LPA Platform 2 activities and progress of work in 2015**

In parallel to the ramp up of technical activities in Platform 2 the organizational setup (work break down structure WBS) was changed to both streamline the set of activities towards the
demonstrators and to clarify the content and the objectives, while the technologies and the planned activities within Clean Sky2 remained unchanged.

Three and four topics for Partners have been defined and published respectively in the second and the third Call for Proposals (High production rate composite Keel Beam feasibility, Integrated main landing gear bay, Development of System Components for automated Cabin and Cargo Installation, Assembly Planning and Simulation of an Aircraft Final Assembly Line (FAL) and Structural Energy Storage are examples for activities within 2nd and 3rd Call for Partners).

In 2015 multifunctional concepts with DLR were developed within WP 2.1 “Multifunctional Fuselage Demonstrator”. In WP 2.2 “Cabin & Cargo Demonstrator”, a Kick-off meeting took place with Zodiac Aerospace awarded as Core Partner to perform three different activities in Cabin & Cargo. This led to a significant ramp up of activities in the second semester of 2015. In WP 2.3 “Lower Centre Fuselage demonstrator”, an Innovative architecture compliant with body landing gear was set up. In WP 2.4, innovative technologies for elementary parts, sub-components and modules were developed.

**LPA Platform 3 activities and progress of work in 2015**

In 2015, the key focus of activities was laid on the ramp up of two main areas of work related to innovative cockpit concepts: WP3.1 “Enhanced Flight Operations and Functions” and WP3.2 “Innovative Enabling Technologies”. A significant share of research activities in these two work packages will be covered by three Core Partners to be selected within in the second call for Core Partners. They will join the LPA Platform 3 team by end of May 2016, after successful completion of the negotiation. Two topics were launched in the 2nd Call for proposal addressing both the development of touchscreen control panels for critical system management functions, and the head-up display system integration in next generation cockpits. The work is scheduled to start in June 2016.

Another major stream of activities, related to Maintenance, was laid on work package WP3.6 ADVANCE (Advanced Value and Service driven Architectures for Maintenance), with the development of operational scenarios, technical concepts and requirements to prepare use case definition, technology selections and the E2E architecture and the definition of an Integrated Health Monitoring and Management (IHMM).

In the 1st Call for proposal, three large partner topics related to the WP3.6 ADVANCE have been performed in 2015 with two of them successfully completed in December 2015. The calls are addressing the major technical enablers of the E2E Maintenance Architecture to develop and demonstrate methods and solutions for an advanced end-to-end maintenance architecture, to develop prognostic solutions and tools applicable for aircraft fleets of an airline, and to implement such a solution to a real service environment. The activity started with 2 of the awarded Partners in December 2015.

In summary, the implementation of work was as planned and mainly focused on the ramp up of activities and the selection of Core Partners.

**Major milestones accomplished in 2015**

**Platform 1**

- Engagement of Core Partners, first wave update of associate sections of the work plan
- Identification of Call-for-proposal Partners, first call
- Identification of Core Partners, second wave
- Endorsement of updated Project Development Plan for CROR FTD, including economic viability gates (finally completed at Launch Review, 26.1.2016)
- Compilation of the Project Development Plan for the rear-end demonstrator in WP1.2.
• In WP1.4 the target design and manufacturing process for the Hybrid Laminar Flow Control (HLFC) nose applied on vertical tail plane was confirmed and frozen based on results of AFLoNext, HIGHER-LE, requirements from CS2 (long-term testing, operational readiness) were incorporated.
• In WP1.4 some adaptation of the strategy to develop and mature the HLFC-technology has been made in 2015 with the selected Core Partners
• Freeze of wind tunnel model configuration for AFC on engine/pylon (WP1.5.3)
• Economic viability analysis for the definition of the best “Validation and Verification” strategy for UHBR engine integration on long-range-aircraft type FTD, WP1.5.2/WP1.6.4.

Platform 2
• Launch of activities for all three main demonstrators in Platform 2 with all the parties involved (both Leaders and Core Partners)
• Call for Proposals: Definition of six and four topics for publication respectively in the second and the third wave

Platform 3
• Three Core Partner topics and six Call for Proposals topics were submitted for CP Wave 2 and for CFP Wave 1, CFP Wave 2 and CFP wave 3.
• Operational workshops held to support crew workload reduction functions and technologies requirements
• Selection of Partners for ADVANCE End to end maintenance demonstrators, and accession to the Platform 3 consortium
• Kick-off and ramp-up of ADVANCE leading partner activities (Thales/Dassault; Airbus in 2014) on major technical concepts (E2E Architecture, IHMM platform, SHM, prognostics)
• Kick off meeting held with ADVANCE Partners to launch activities on End to end maintenance architecture and scenarios

Major deliverables accomplished in 2015:

Platform 1
• Successful accession of Core Partners Wave 1 to the GAM and Consortium Agreement
• Successful preparation of work with Partners from 1st Wave with start of activities end of 2015
• Topics for 2nd and 3rd call for Core Partners and Partners submitted and launched
• Concept study report for Non Propulsive Energy (NPE) applied for LPA and biz jets (WP1.1.10)
• Architecture dossier for NPE applied for LPA and biz jets (WP1.1.10)
• Reports of pre-design phase (WP1.4.1)
• Micro-perforated coupons for flight testing at DLR (WP1.4.1)
• Reports on surface and system requirements for HLFC HTP (WP1.4.1)
• Report on suction panel strategies (WP1.4.1)
• Requirements and development plan and definition of technical interfaces (WP1.5)
• Energy storage specification (WP1.6.2)
• Energy storage design (WP1.6.2)
• Energy storage hardware (WP1.6.2)

Platform 2
• Detailed work plan for all Platform 2 main work packages for 2016-2017
• Identification and preparation of concept phase for Multifunctional Fuselage Demonstrator, Cabin & Cargo Demonstrator and Lower Centre Fuselage demonstrator.
Identification of activities and interfaces between three demonstrators and “Non-specific cross functions” (WP 2.4)
Identification of enabler and concepts for multifunctional demonstrator (WP2.1)
High level requirements definition initiated for an A320 aircraft platform (WP2.2)
The body landing gear architecture has been developed internally by Airbus (WP2.3)
Analysis of current technological requirements of the FAL with respect to future FAL objectives (WP2.4)

Platform 3
- Intermediate analysis of operational scenarios, security, and platform connectivity for the “E2E” maintenance concept (WP 3.6.1)
- Preliminary Integrated Health Monitoring & Management state of the Art and evaluation and demonstration plan (WP 3.6.1)
- Structural Health Monitoring use case analysis (WP 3.6.2)
- Conceptual development of System prognostics for “E2E” maintenance concept (WP 3.6.2)
- High level requirements and concept of operations documents for innovative cockpit functions for crew workload reduction (WP 3.1.2 and WP 3.1.3)
- Concept of Operations for Aircraft Monitoring chain for ground support (WP 3.2.2)

→ REG – Regional Aircraft IADP

As per Work Plan 2014-2015, the activities performed during the year 2015 by the CS2 Leaders (Alenia Aermacchi, Airbus DS) allowed to achieve a detailed definition of technical activities for the whole REG IADP. Such technical definition was further consolidated in several workpackages with important contributions from relevant Core Partners selected in Wave 1 (AIRGREEN2 and ASTIB). Furthermore all the necessary support was provided for the selection of Core Partners Wave 2 (IRON, EWIRA) that after the completion of negotiations will start their activities in 2016. The Grant Agreement 2014-2015 was properly amended and duly signed in order to incorporate Core Partners AIRGREEN and ASTIB that started the activities in October 2015. Hereafter it is reported a brief description of management and technical activities performed during 2015 as well as the status of deliverables/milestones w.r.t the GAM 2014-2015 Amdt.

WP0 - Management

Main activities performed during 2015:
Program Coordination: interface with CSJU, participation to PCC and Sherpa, coordination of interfaces with other SPDs; continuous coordination between Alenia Aermacchi and Airbus DS through video/phone conference and some meetings. Management of transition from GRA and Risk assessment integrated with GRA. Technical and financial reporting for 2014 activities; periodic reporting for 2015 activities (Q1, Q2, Q3). Preparation and signature of the REG IADP Consortium Agreement and REG IADP Steering Committee Rules of Procedures.
Completion by Alenia Aermacchi of the tender process for the subcontracting “Administrative Support”: 3 Proposals received and evaluated, ARTTIs one selected.
Activities related to System Engineering Management Plan and IT tools and methods implementation plan continued by Alenia.
Preparation of the GAM 2014-2015 Amendment for the incorporation of Core Partners AIRGREEN2 and ASTIB and preparation of the GAM Amendment for the years 2016-2017.
Management activities to support selection and negotiations Core Partners Wave 1 as well as selection of Core Partners Wave 2. Management activities related to the preparation of Topic Descriptions for Call for Proposals.

Preparation of the first Launch Review to be held in January 2016. Preparation and organization of the 3 Steering Committees held during 2015.

All planned deliverables of this WP were completed during 2015. For what concerns the milestone M0-2 “1st Launch Review”, all the preparatory activities for the review were performed in the last months of 2015, for logistics reasons the launch review meeting will be held on 19 January 2016.

WP1 High Efficiency Regional Aircraft

Main activities performed during 2015 by Alenia Aermacchi:

Top Level Aircraft Requirements preliminary definition for both high efficiency configurations was performed and subsequently the relative deliverable (D1.2.01) was issued.

The Strategic Topic related to “Green and Cost efficient Conceptual Aircraft Design including Innovative Turbo-Propeller Power-plant” was finalized and launched. All WAL support was provided from the Info Days to the starting of the negotiation activities with the Core Partner.

Definition activities for technologies and cost 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. The finalization of costs reduction targets has to be completed in the first months of 2016.

Moreover, a preliminary design loop (loop 0) for sizing and performance estimation for both the innovative architecture with EIS beyond year 2035 and the conventional one was finalized.

The Reference Aircraft configuration definition for the innovative configuration was re-planned in 2016 due to the fact that the decision inhering the reference platform is still in progress. The deliverable D-1.2.2-02 related to power-plant requirements has been rescheduled to the end of February 2016, due to delay of the inputs necessary for the definition of both technological targets that has logically caused the postponement of both sizing (and configuration definition) and power-plant requirements activities, for both A/C configurations.

WP 2 Technologies Development

Main activities performed during 2015 by Alenia Aermacchi are described hereafter. Airgreen2 activities in WP 2.1 and ASTIB activities in WP 2.3 and 3.4 performed in the last quarter of 2015 are also included in this description.

WP 2.1 Adaptive Electric Wing

Contribution to the selection, negotiation and integration of the selected Core Partner Airgreen2 was provided.

Within the WP2.1.1, related to wing advanced structure, the following main technical activities were performed: definition of specification including requirements at A/C level of methodologies for aircraft life cycle; definition of the first wing box structural concept design including manufacturing and assembling preliminary constraints; manufacturing of a medium scale stiffened wing box panel as manufacturing trial including first design concepts; definition of preliminary requirements for pilot fabrication and assembling processes; manufacturing of medium scale stiffened panel considering GRA / EDA demonstrators process outcomes.

For the Wing Technologies activities tasks (WP 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.6) the following technical activities were performed: definition of qualification programme plans for following validation and demonstration phases; preparation of the topic description for the Call for Proposal related to Wind
Tunnel tests; finalization of initial requirements for technology development and preparation of starting inputs data for Airgreen2 consortium.

In the last quarter of the year, the Core Partner Airgreen2 started their technical activities and a first Technical Coordination meeting between Alenia Aermacchi and Airgreen2 was held, discussing in details the tasks objectives, contents, time schedule and links with other workpackages.

The planned milestone M2.1-Ϭϭ “First wing structural concept design” was achieved on schedule and the related deliverable D-2.1-02 was issued. The deviations from the initial plan for WP2.1 were the following:
- Delays in the availability of experimental validation for LC&A devices and system, Clean Sky GRA (WP2), didn’t allow to complete the technology requirements of present technologies configuration on the CS2 REG wing.
- Final down selection criteria definition delayed following the time planning of evaluation first sessions, moved from 2016 to 2017.

**WP 2.2 Regional Avionics**
Following a prioritization of activities performed by Alenia Aermacchi during 2015 and since the potential interactions with System ITD were not finalized, no technical activities were performed for the WP2.2.1 and WP2.2.2. So, 2015 activities were concentrated on the WP 2.2.3 Performance and Health Monitoring (P/HM). In this WP the following main activities were performed: Kick Off Meeting with all the involved Alenia Aermacchi technical departments; support to negotiation and integration of ASTIB Core Partner for aspects related to EMA HM; preparation of preliminary operation scenario (almost completed).
Finalization of D2.2.3-Ϭϭ “P/HM preliminary scenario” was postponed to first month of 2016. This postponement was due to some delays in the synchronization with other WPs covering HM topics.

**WP 2.3 Energy Optimized Regional Aircraft**
A review of enabling technologies was initiated by Alenia Aermacchi for several systems, which had driven the preparation of a list of CfPs that will be proposed to be launched during the next waves and will drive in the coming months the definition of preliminary systems requirements together with the preparation of preliminary V&V plans. The activities related to systems V&V plans were re-planned more in details and transferred to the GAM 2016 -2017 where relevant deliverable D-2.3-01 and milestone M 2.3-01 were scheduled in 2016.
For the Innovative Propeller, contribution to the selection of Core Partner IRON was provided. Interactions with Systems ITD members continued and a cooperation agreement between Alenia Aermacchi and Liebherr (LTS) was reached for an E-ECS demonstrator to be integrated in R-IADP cabin/fuselage demonstrator.

**WP 2.4 Innovative FCS**
FCS architecture to be tested in Iron Bird and in FTB1 was preliminarly defined. Support to negotiations and integration of ASTIB consortium was ensured through definition of high level requirement and participation to several meetings that enabled to: define the number of units to be developed and produced; to preliminarily define Iron Bird architecture concerning FCS aspects; to define prognostic & health Management (PHM) objectives; to finalize and agree the description of work for the ASTIB project.
Support to negotiations with Airgreen2 consortium was also provided. The topic description for the CfP concerning Aileron actuator was prepared. Activities to be performed for the FCC were identified and the
FCS technology road map was defined. The deliverable D-2.4-01 “Verification and Validation Plan for FCS configuration” was issued.

The ASTIB consortium started their technical activities in the last quarter of 2015 in coordination with Alenia Aermacchi; due to some delays in internal ASTIB activities the deliverable D-2.4-02 “Review of EMA technology Roadmap” was not issued and it will be finalized within the end of February 2016.

**WP 3 Demonstrations**

Main activities performed by Alenia Aermacchi during 2015 are described hereafter for WPs 3.1 to 3.4. Activities performed by Airgreen2 in WP3.1 and ASTIB in WP 3.4 are included in this description. Then, the description of activities performed by Airbus DS within WP3.5 is provided.

**WP 3.1 Flying Test Bed #1 (FTB1)**

Contribution to negotiation and integration of selected Core Partners (Airgreen2 and ASTIB projects). Definition of the initial requirements for the Flight Demonstration Program with the development of the initial assumptions and objectives for the FTB#1. The related deliverable D-3.1-01 “FTB#1 preliminary requirements” was completed.

**WP 3.2 Full Scale Fuselage and Pax Cabin Demonstrator:** No activities planned in the GAM 2014-2015

**WP 3.3 Flight Simulator:** As result of Alenia Aermacchi prioritization activities performed during 2015, this workpackage was put in stand-by and no activities are planned in the GAM Amendment for 2016-2017.

**WP 3.4 Iron Bird**

Support to negotiation and integration of ASTIB defining and sharing the final version of the description of work by means of several meetings held during 2015.

Assessment of the physical constraints for the Iron Bird and identification of the Iron Bird location; definition of the Iron Bird high level preliminary requirements (HW&SW), preliminary definition of mechanical & electrical architecture, assessment of physical constraints and relevant installation features, functions and operation defining the goals, typology of testing and the configuration under test.

Main activities performed by Airbus DS during 2015 are described hereafter.

**WP 3.5 Integrated Technologies Demonstrator – Flying Test Bed#2 (FTB2)**

The activities completed during 2015 in WP 3.5 were focused on Overall Aircraft Design disciplines; all related to the Regional FTB#2 Demonstrator.

- **The aerodynamic studies** (D-3.5.1-01, and D-3.5.3-04) covered wing devices like a new spoiler, morphing winglets, leading edge (D-3.5.1-03), aileron and multifunctional flaps. The studies were based on theoretical approaches and numerical simulations (CFDs). Promising results in flap design drove to a second loop which may improve significantly the demonstrator performance. Significant advances in definition of Wind Tunnel Tests were done during the period: in model definition and conceptual approach of the campaigns.

- The first loop of **components loads for design** has been completed, considering static and dynamic cases. These loads are primary inputs for the structural design of wing box and wing control surfaces.
- The first **aeroelastic assessments** were covered and outputs with respect to flutter (D-3.5.1-02) and static aeroelasticity were done. It shows remarkable improvements in the methods for structural dynamics and aeroelasticity studies.

- Finally, the first **structural architecture definitions** of aileron and spoiler have been completed. The configurations defined will be part of the initial data provided to the Core Partner which join the Work Package in 2016.

**WP 4 Technologies Development & Demonstation 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.

**WP4.2 – Ecodesign Assessment**
Discussion about the interfaces of REG IADP with the ECO TA continued during the reporting period and participation to the Workshop organized by the ECO TA Leader was ensured.

**Main REG IADP Deliverables and Milestones 2015**

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FRC – Fast Rotorcraft IADP

The Fast Rotorcraft IADP of Clean Sky 2 consists of two separate demonstrators, the NextGenCTR tiltrotor (leader: AgustaWestland) 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. NextGenCTR will be dedicated to design, build and fly an innovative next generation civil tiltrotor technology 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 its architecture, technologies/systems and operational concepts. They will show significant improvement with respect to current Tiltrotors. NextGenCTR will continue to develop what has been 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. The new proprotor will require substantial research to reduce noise emissions. 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 current 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 in 2015

WP 0: Consortium Management

The FRC consortium management task was insured by Airbus Helicopters. The main activities were on

- Preparing and organizing the first Steering Committee meeting;
- Coordinating the preparation of contractual and management documents: GAM annexes 1 and 2 for amendment 1 (additional linked third party to AH sas), amendment 2 (Integration of the first selected Core Partners), Periodic Report for 2014 and Quarterly Reports;
- Managing the finances of the consortium;
- Maintaining relevant documents and data in a dedicated FRC repository.

The preparation of GAM amendment 3 for years 2016 and 17 was started. Due to WBS reorganization and schedule realignment following key design milestones for the two FRC demonstrators, detailed work plan development for the 2014-17 period turned out to be a
significant task requiring time and efforts. A three-month extension was requested to CSJU to allow finalization of the GAM amendment 3 documents.

The first FRC Steering Committee held in September was fully supported and established the integrated management approach across all FRC work packages.

One major topic to be further reviewed with the JU, is the implications of current Call for Partner funding constraints and budget distribution and its potential impact on programme execution.

The FRC Consortium Agreement has been agreed as signed by participating legal entity representatives establishing a foundation for the core partner accession.

Both FRC Leaders participated actively in the Info Days organized by the JU aiming to attract proposals for partnership in the Calls.

**WP1 – NextGenCTR - Next Generation Civil Tiltrotor Demonstrator**

*Main WP1 achievements in 2015:*

- Preliminary Design Requirements and Objectives
- Vehicle Technical Specification-v1
- Preliminary Requirement Review
- System Concept Review
- System Requirement Review
- Drive Systems Trade Studies

**WP1.0 – Management**

The NGCTR Management team has been established with the appointment of a dedicated Programme Manager, Chief Engineer and wider roles within the AW organisation. In view of no Core Partner or Partner selection in support of NGCTR in 2015, Programme Management Committee meetings were not initiated during this period. In December a successful formal launch review for NGCTR was held with CSJU that reviewed the overall programme objectives, the master schedule, budgeting and resource deployment, risk identification and mitigation. It should be noted that the WP1 level 2 and level 3 WBS is to be modified as part of the 2016-2017 work definition to assist in management of overall programme delivery.

**WP1.1 – System Integration & Demonstration**

A systems engineering approach has been established as the basis for planning and delivering technical activities over the duration of the programme. Following initiation of technical activities in 2015, various concepts were established and appraised at a System Concept Review (SCR) in June to select preferred options that had the potential for satisfying stakeholder requirements and converge on a viable, traceable set of system requirements that are balanced with system performance, cost, schedule, partnering strategy and risk. Following SCR, trade-off studies and configuration options continued to be evaluated and matured. This led to a System Requirements Review (SRR) being held in December. This review has defined the key requirements to allow final NGCTR sizing to be completed and the basic design criteria to be established. Further requirements definition and derivation will continue through to the SFR phase to enable sub-system requirements and interface definition to be completed. Verification and validation strategies were also reviewed and will continue to be developed throughout 2016.
WP 1.2 - Proprotor design

The unique requirements for a tiltrotor proprotor over convention rotor blades have been established, but overall sizing is dependent upon conclusion of the overall aircraft configuration which is not yet frozen. Based on initial sizing, trade studies have been performed to compare various rotor blade/rotor hub configurations to provide optimum design. A Call for Partner was submitted for high-reliability heater hats under CfP02.

WP 1.3 – Highly Reliable, Safe & Environmentally Friendly Drive System

In support overall aircraft architecture design, trade Studies were initiated to investigate detailed gear layout definition, the tilting mechanism concept, the lubrication system concept, the main skeleton definition and predicted weight estimate and breakdown. In addition three transmission related Calls for Partner were launched in 2015 relating to ALM housing, freewheel clutch and heat exchanger.

WP 1.4 - Fuselage and Tilting Wing design

The NGCTR Fuselage is being developed under the Airframe IDP for which three Calls for Core Partner were issued to design, develop and supply the cockpit, centre fuselage and tail sections of the airframe.

The wing requirements and options for design have been studied extensively during the period. The tiltrotor wing is more complex than conventional aircraft due to large wing tip mass, stiffness requirements for aerodynamic stability and architecture to maximise hover performance.

WP 1.5 - Nacelle, Fuel System and Engine Control System design

Operational requirements and location are the main items been evaluated and informed the general architecture of the overall design. Discussions were held with potential engine suppliers. Working groups have been established to progress trade-off studies and mature system requirements.

WP 1.6 - Electric Power Generation and Distribution System (EPGDS), Flight control System (FCS) and Pressurization and Environmental Control System (ECS) design

The EPGDS architecture has been studied to ensure key high power, safety critical system requirements are defined and primary power sources documented. HVDC considered for primary power to minimise power transmission and conversion losses.

WP 1.7 – Technology Evaluator Interface

All TE activity in 2015 was aligned to WP4.

WP2 – LifeRCraft - Compound Rotorcraft Demonstrator

Main WP2 achievements in 2015:

- In the Call for Core Partners CPW3, 4 call topics for strategic participation to the LifeRCraft demonstrator defined and opened;
- In the Call for Proposals CfP2, 6 call topics for Partners contributions to the LifeRCraft demonstrator defined and opened in FRC, plus 2 other related ones in AIRFRAME ITD;
- Preparation of Call for Proposals CfP3, with 2 call topics for Partners defined;
- Negotiation with Core Partners selected from CPW1 completed; Core Partners activities started in July;
- Grant preparation with 8 partners/consortia from CfP1 nearly completed by end 2015;
- LifeRCraft feasibility study concluded and general programme specification frozen;
- Preliminary design started; 2 wind tunnel campaign performed and a 3\textsuperscript{rd} one being prepared end 2015.

**WP 2.1: Project Management & Integration Activities (Techno Area 2A)**

The general programme specification was detailed and finally frozen, with strong emphasis placed on low noise footprint, large cabin volume and mission performance and versatility. The general architecture resulting from the feasibility study was substantially modified in the early preliminary design phase in order to meet this specification.

A first wind tunnel test campaign was performed in February using AH own wind tunnel facility, with a model featuring the configuration produced during the feasibility study and a second one in August with a model representing the modified configuration; results of the second one were found satisfactory in terms of drag and aerodynamic stability. Piloted flight simulations allowed preparing the design of the flight control system and assessing the transient flight performance and handling qualities. IT and communication tools have been selected and partially implemented to support collaborative design and consistent configuration management (Extended Enterprise concept), including the installation of two plateau-type facilities for collocated work with Core Partners.

After mid-year, the Core Partner Consortium NACOR (ONERA, DLR) started its activities in AIRFRAME ITD with some work packages contributing to the LifeRCraft aerodynamic design: aerodynamic optimization of the wing and lateral rotor combination, aerodynamic optimization of the tail surfaces, noise model of the full vehicle.

Four partner proposals have been selected in CfP1 that will also contribute to the aerodynamic and aeroacoustic modelization and optimization of LifeRCraft: projects CA3TCH (University of Stuttgart), FURADO (TU Munich), PROPTER (NLR/TU Delft), HEIAIrcOPT (Altran).

The re-definition of the general architecture after the feasibility phase along with the long negotiation cycle with the selected Core Partners and Partners was responsible for a project time shift w.r.t. initial schedule: the Preliminary Design Review planned end 2015 has been rescheduled mid-2016.

The WP2 Launch Review successfully passed with the FRC Core Partners and JU in November allowed to report the status and outcome of activities performed so far and to settle the work plan for the next years.

**WPs 2.2; 2.3, 2.11: Airframe, Landing System, Cabin & Mission Equipment (Techno Area 2B)**

The leader Airbus Helicopters performed the definition of the airframe general architecture based on the new rotorcraft architecture issued by WP 2.1. Particular care was devoted to the central fuselage section where interfaces between wing, main gear box, flight controls, engines and main landing gear are located. After mid-year, the Core Partner INCAS started its activity with the preliminary design of the fuselage structure based on interfaces and specification provided by the Leader.

In parallel, The University of Nottingham and GE Aviation (Hamble), as Core Partners in AIRFRAME ITD WP B1.1, started the preliminary design of the wing component. The Spanish cluster OUTCOME, as Core Partners in AIRFRAME ITD WP B4.1, also started the preliminary design of the tail unit in collaboration with the leader Airbus Helicopters.
The landing gear general architecture and interfaces have been specified and submitted as a topic for a Core Partner in the call CPW3.

End 2015, the collaboration for the design of the doors started with the Partner consortium FRCDoorDemonstrator lead by AIT/LKR which was selected in call CfP1 (ITD Airframe).

Subsystem specifications have been provided to all active Core Partners and Partners.

Further call topics for Partners have been opened in 2015 concerning the canopy, the windshield and two others within the Airframe ITD, concerning tooling for tail unit manufacturing and assembly.

WPs 2.4; 2.5, 2.6, 2.7, 2.9: Main and Lateral Rotors, Drive train, Powerplant, Flight controls (Techno Area 2C)

The leader Airbus Helicopters addressed the dynamic systems general architecture based on the new vehicle architecture issued by WP 2.1, with particular focus on the following subsystems:

- the transmission chain concept and geometrical interfaces;
- the lateral rotor pitch control system and hydraulic system;
- the flight control system mechanical architecture;
- the engine selection and engine installation.

After mid-year, the Core Partner Avio Aero started its activity with the preliminary design of the Lateral Gear Boxes and High Speed Input Stages based on interfaces and specification provided by the Leader.

From the vehicle general architecture study (WP2.1), it soon appeared that the existing Main Gear Box initially envisaged to be re-used is not compatible with the geometrical constraints and torque requirements and has to be re-designed specifically. Consequently a new Core Partner has been called in CPW3, intended to be tasked with the design and production of three major MGB modules, one of which to be co-developed jointly with AH.

Three topics for partner proposals have been defined for call CfP2: Multipurpose test rig for transmission gear boxes; fuel bladder tanks; equipped engine compartments.

One topic for partner proposals has been defined for call CfP3: Advanced Health Monitoring System for gear boxes managed by Avio Aero.

WPs 2.8; 2.10; 2.12: Electrical System, Avionics, Flight Control, Navigation (Techno Area 2D)

The electrical architecture is based on implementation of High Voltage Direct Current network exploiting some results of Clean Sky GRC and SGO. Four partner proposals have been selected in CfP1 that will lead to development of critical HVDC equipment for the LifeRCraft demonstrator: projects ISG (Starter-Generator: Labinal Power Systems), VOLT (HV Battery: Zodiac Aerospace and Accuwatt), POCOL (Power Converter: TFE and Nottingham University), HVEMB (Power Distribution Unit: Leach). The HV main generator is subject of a call topic opened in call CfP3.

The design and manufacturing of the Electrical Wiring Integrated System is proposed for Core Partner under a topic defined and opened in the call CPW3.

One topic for partner proposals has been defined for call CfP3: High Voltage Direct Current Components.
Due to the elongation of the preliminary design phase and insufficient inputs available from WP2.1, only very limited activity could be performed concerning avionics and navigation system. Concerning flight control, the activity has been limited to support to flight simulation.

**WP3 - Eco-Design interface for fast rotorcraft**

In view to exploit and further expand the results of Clean Sky Eco-Design and Green Rotorcraft activities, the Leaders Airbus Helicopters and AgustaWestland exchanged propositions and hold several conferences aiming to build together a coordinated work plan for the application on demonstrators of environmentally friendly materials and production process, and also the installation of Life Cycle Assessment tools enabling to assess the environmental impact of production process and to support the designers in the selection of technologies.

A workshop organized on Oct 26th, 2015 by the ECO-TA Leader Fraunhofer Institute aiming to define the collaboration scheme across all IADP’s and ITD’s have been attended by the WP3 leader and was prepared by previous on-line conferences.

Although the FRC Leaders have reached a certain understanding of a general roadmap, the strong involvement of Core Partners and Partners in the construction of demonstrators requires that the calls and their selection be completed before a work plan can be built and agreed, including coordination with ECO-TA; this step is expected to be completed by end 2016.

**WP4 - Technology Evaluator interface for fast rotorcraft**

Two workshops were held during 2015, the first a general workshop with all ITD/IADPs, the second workshop was FRC specific between Airbus Helicopters, AgustaWestland, DLR (TE-TA Leader) and CSJU project officers. The workshops enabled DLR to explain their anticipated approach to satisfying the principles defined in the CS2DP and the FRC leaders to explain their expected approach to data provision. In addition a provisional timeline for TE data maturity was discussed.

An approach to environmental impact was established under Clean Sky 1 and in principle will be used for Clean Sky 2, but the additional assessment of socio-economic benefits and targets (Mobility/Connectivity, Employment, GDP impact; EU competitiveness) will require careful consideration. Endorsement of the proposed TE governance approach at the GB in December 2015 allows more in-depth discussion on implementation of the TE approach for KPIs and metrics during 2016 than was achieved during 2015.
Airframe ITD

The Airframe ITD will target 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 2 major Activity Lines:

- Activity Line 1: Demonstration of airframe technologies focused toward High Performance & Energy Efficiency; Related Technology Streams are noted “A” hereafter.
- Activity Line 2: Demonstration of airframe technologies focused toward High Versatility and Cost Efficiency. Related Technology Streams are noted “B” hereafter.

Activity Line 1: High Performance & Energy Efficiency

Management and interface A-0

On WP A-0.1 (Overall Management), four Steering Committee meetings and three HPE and HVC were held on 2015. The ITD Launch Review took place on the 9th and 10th of December. Main activities were (DAv):

- General Financial and Administration activities.
- Coordination of preparation of CPW01 to CPW03 and CfP01 to CfP03.

In WP A-0.2, DAv designed a reference Aircraft to assess CS2 innovative technologies. This A/C is a typical business jet with Year 2015 technologies (DAv).

In WP A-0.4, FhG started the collection of technology proposals for the planned demonstrator “hybrid seating cushion” and technologies for the other demonstrators in airframe with FhG participation (FhG).

Technology Stream A-1: Innovative Aircraft Architecture

2014 has allowed starting activities related to future powerplant integration within WP A-1.2 (UHBR & CROR Configuration). The 2015 activities in WP A-1.2.1 focused on UHBR engine-integration technologies related to both small and large engines. In the mean-time, the Airbus activities started towards the demonstration of economic viability of a CROR Aircraft in WP A-1.2.2 in a complementary manner to the ongoing, remaining activities in Clean Sky / SFWA WP 2.2. (AIB)

In WP A-1.4 (Novel Certification Process) the activity has been reoriented to focus on definition of development and improvement of modeling tools for virtual certification purposes (DAv).

Technology Stream A-2: Advanced Laminarity

On WP A-2.1 (Laminar Nacelle) the activity was focused on the elaboration of a laminar nacelle aero-shape for the BJ application and on the definition of the activity to be carried out with the CP of the NACOR project and the Partner selected on CFPW01 (DAv).

In WP A-2.2 (NLF Smart Integrated Wing), definition and preparation of work for ground tests with respect to structure and systems verification and validation have been performed (AIB). During 2015, analysis, tests and development of improved production processes for large complex co-cured composite structures such as leading edge and upper cover wing covers for natural laminar flow wings has been performed (SAAB).
In **WP A-2.3** (Based on a preparation phase in 2014 and 2015 performed in German funding project scheme, a flight test has been performed in 2015 with a NLF Horizontal Tail Plan mounted on A320 to validate the chosen structural concept (AIB).

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

In **WP A-3.1**, 2 topics related to “Tool-Part-Interaction simulation process” and “Robot based NDT and man-robot collaboration” have been launched on CfP02. The definition of technologies which shall be demonstrated on the Aileron demonstrator platform has been initiated (SAAB).

For the BJ application related to the wing root box demonstrator, a preliminary architecture study has been carried out (DAv).

In **WP A-3.3**, for the BJ centre (or fuselage) wing box demonstrator, activities have started on the general definition and sizing of the demonstrator. A conceptual design of a panel demonstrator including selection of materials and manufacturing route / processes has been done.

Definition of technologies to be part of the metallic door demonstrator has been initiated as well as activities within the field of additive manufacturing (SAAB).

In **WP A-3.4** DAv, AIB and FhG have submitted a Strategic Topic (ST) to the CPW02 “Development of airframe technologies aiming at improving aircraft life cycle environmental footprint” and the integration of the selected CP has been prepared (DAv).

Initial work on stress sensor technology for advanced joining has been performed regarding specification and design of the monitoring system for monitoring deformation, stress and damage (FhG).

**Technology Stream A-4: Novel Control**

Activity on **WP A-4.1** was related to the preparation of the cooperation with the GAINS consortium on ice protection systems. The baseline was a demonstration at TRL 6 of the manufacturing of a metallic slat, which was replaced by the manufacturing of a composite leading edge section (DAv).

In the frame of **WP A-4.2** (Active Load Control), initial work started concentrating on the definition of wing concepts featuring an active winglet for load and span control. Based on this, the work in 2015 focused until now on initial wing/winglet aero shape design and the definition of folding kinematics and movables concepts. Also, the compilation of a joint CPW3 proposal has started (DAV, AIB, SAAB).

Work on material development and development of energy harvesting systems for load monitoring systems has been done (FhG).

**Technology Stream A-5: Novel Travel Experience**

In **WP A-5.1** (Ergonomic flexible cabin), the following topic was launched in CfP01: “Technology evaluation of immersive technologies for in-flight applications”. The activities shall evaluate the use of immersive technologies (Virtual Reality and Augmented Reality) for passengers and cabin crew during flight operation (AIB).

On **WP A-5.2** (Office Centered Cabin) the analysis to identify the essential functions participating in BJ cabin comfort has been initiated (DAv).

**Activity Line 2: High Versatility and Cost Efficiency**

**Management and interface B-0**

On **WP B-0.1** (Overall Management), the main activity was (CASA): General Management and coordination activities into the AIRFRAME / HVC. Three PMCs held, contribution to SCs, AR, and Launch Review. Synergies and collaboration initiatives with FhG and SAAB pushed or started. General Financial and Administration activities. GAM Update and Quarterly Reports.

On **WP B-0.2** (Small Air Transport Overall A/C Design & Configuration Management) Transversal coordination, CfP, CP topics preparation, Preparation on GAM 2016/17 annexes, Definition of reference aircraft delayed - in progress, Top Level Aircraft requirements (TLAR) (SAT).
On **WP B-0.3**, General Management and coordination activities and interfaces between AIR-ITD and FRC IADP (AH-D).

General Management and coordination activities and interfaces between AIR-ITD and FRC IADP (AW).

On **WP B-0.4**, the main activity was management and coordination of interfaces between IADP REG and ITD AIR (CASA).

Support to AIRBUS DS for interaction and interface with REGIONAL IADP; Delivery of Regional a/c Configuration data for WP B-4.3 & B-4.4 (ALA).

On **WP B-0.5**, General Eco-Design Management activities and coordination within ITD (FhG).

**Technology Stream B-1: Next generation optimized wing**

In the frame of **WP B-1.1** (Wing for lift & incremental mission shaft integration), works done for Preliminary Design Review of wing with lateral rotors, with big collaboration of CPW01 (ASTRAL and NACOR), NACOR, in addition, started Noise emissions assessment (AH-D).

On **WP B-1.2** (More affordable composite structures): material and process selection for SAT composite wing demonstrator; investigation of appropriate technologies for manufacturing of thermoplastic; Core Partner in wave02 ready for negotiation (SAT).

On **WP B-1.3** (More efficient Wing technologies): for Morphing Winglet concept design activities started, with big collaboration with Core Partner (OUTCOME) of wave01, in order to achieve a feasibility review by beginning 2016, and preliminary requirements for flap actuator completed (CASA).

On **WP B-1.4** (Flow and Shape Control), for Morphing Leading Edge technology line, initial aerodynamics shapes studies performed and initial top level structure requirements; first meeting with FhG held in order to define way forward for potential synergies and collaboration. For Loads Control system, Flight Control System architecture and requirements was completed (CASA).

First contacts with CASA to find synergies for further aeronautic application of the Morphing Technology developed during CS1 (FhG).

**Technology Stream B-2: Optimized high lift configurations**

On **WP-B 2.1** (High Wing Large Turbo-Prop Nacelle), for Ice Protection LHP system line, state of the art studies were finalized and High Level Requirements definition; corresponding call for proposal launched in wave03 (CASA).

On **WP-B 2.2** (High Lift Wing), for External Wing Box and Multifunctional Flap, started studies of concept design, and manufacturing and assembly process, with big collaboration with Core Partner (OUTCOME) of wave01, in order to achieve a feasibility review by beginning 2016; preliminary requirements for flap tab actuator completed (CASA).

For SAT, works for selection of technology for innovative high lift devices on leading and trailing edge with cost effectiveness evaluation and trade off studies on technology for innovative high lift devices on leading and trailing edge (SAT).

**Technology Stream B-3: Advanced integrated structures**

On **WP B-3.2** (All electrical wing), state of the art studies completed for SATCOM embedded antenna and Induction Ice Protection system; works on concept design and High Level Requirements done for SATCOM, Ice Protection and new HVDC electrical generation system needed to power new technologies to be developed in the frame of FTB#2 demonstrator; 3 calls for proposal launched in wave02 for the above technology projects; in addition, initial definition for on ground demonstrator for FTB#2 and requirements for all wing actuation systems completed (CASA).

For Smart hybrid Ice Protection System, investigation on the improvement of the all-over equally heat distribution on the heating area in dependency to the connection and power supply (FhG).

On **WP B-3.3** (Highly Integrated Cockpit), for LPA innovative components, 1 call for proposal launched for wave02. (AIB)
For Airframe on-ground structural and functional tests of advanced structures to be demonstrated on Structural Cockpit of Regional FTB#2, Core Partner of wave02 selected and ready for negotiation beginning 2016; Semi-active shock absorption based on Magneto-rheological fluids concept definition for Landin Gear Loads control purposes completed (CASA).

For Ice Impact and Lightning Strike technology line, state of the art studies about simulations of hail started (FhG).

On WP B-3.4 (More Affordable Small a/c Manufacturing), studies on automated processes in low volume production of metallic assemblies; works on innovative joining methods; works on technology development principles of non-jig (jigless) assembling of selected structures; design of selected structure (aileron) finished; testing of samples started (SAT).

On WP B-3.6 (New Materials and Manufacturing), state of the art studies for Eco and New manufacturing technologies, eco-efficient factories, more automated and integrated manufacturing and assembly process, completed; Core Partner in wave02 selected for this projects and 1 call for proposal wave03 launched (CASA).

Meetings held in order to find potential collaborations for ALM technology projects with SAAB and CASA; initially collaboration will be done with SAAB’s Door demonstrator in Aluminum (FhG).

Technology Stream B-4: Advanced fuselage

On WP B-4.1 (Rotor-less tail for Fast Rotorcraft), activities for Preliminary Design Review, with collaboration of Core Partner wave01 (OUTCOME) for concurrence engineering; Core Partner NACOR started activities on geometry; 2 Call for Proposal launched for wave02 and 1 for wave03 (AH-E).

On WP B-4.2 (Pressurised Fuselage for Fast Rotorcraft), works on Vehicle Technical Specification for Nose, Central and Tail Section for Fuselage; preparation of 3 CPW03; 1 topic for CFP03 (AW).

On WP B-4.3 (More affordable composite fuselage), for Rapid metal and composite distortion methods, works on Numerical models and report: for metal, on development of rapid ALM distortion predictions and machining distortion prediction including identification of key distortion modes and evaluation of gap closing / assembly to set tolerance requirements; for composite, on identification of the key distortion modes, obtaining sufficient prediction accuracy for these modes, add trimming / machining simulation and evaluate gap closing / assembly to set tolerance requirements (AIB).

Definition of the first fuselage structural concept design and identification of methodologies for design, manufacturing and assembling; identification for maintenance/repair, NDI/SHM for fuselage application and relevant recycling techniques; First identification of preliminary requirements for pilot fabrication facilities; Core Partner wave01 SHERLOC activities started in the frame of these projects; and one CFP02 launched. (ALA)

On WP B-4.4 (Low weight, low cost cabin): Definition of key cabin drivers for passenger/crew comfort and preliminary assessment of cabin architectures and a topic for CPW02 ready for negotiation (ALA).

For Human Centered Cabin Design Approach and Environmental Friendly Materials Objectives, Literature survey of acoustical measures for airplanes in progress, Survey of acoustic standards for airplanes in progress and development of a suitable demonstrator in progress; these projects are performed in collaboration with ALA (FhG).

**Main AIRFRAME Deliverables**

<table>
<thead>
<tr>
<th>WP</th>
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<td>D-A-0.1-2</td>
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<td>26/05/2015</td>
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<td>D-A-0.1-3</td>
<td>Input to Work Plan 2016-2017</td>
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<td>D-A-4.1.1.0.1</td>
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## ENG – Engines ITD

### Work Package 0: Engine ITD Management (RR/Snecma/MTU)

2015 has been a year where the management of the ENGINES ITD was established and rapidly matured and stabilised, to provide members of the ITD a strong platform for delivering its various commitments to the Clean Sky 2 programme whilst accelerating the delivery of their respective programmes. A number of key management processes have been defined, trialled and established and is now in the phase where continuous improvement is applied to further optimise the process, making it more robust and efficient. This includes the management of:

- Steering Committee Meetings
- GAM and GAM updates
- Calls for Partners (Proposals) and Calls for Core Partners
- Deliverable and Milestone status tracking, including an ECM process for deliverable submission
- The ENGINES ITD’s information management and sharing system via SharePoint

Three GAM updates were completed in 2015. The first GAM amendment (Amendment #1) was concluded with the integration of Piaggio Aerospace into the ENGINES ITD GAM, formalising the interaction between the SAT ITD and the ENGINES ITD. The second GAM amendment (Amendment #2) was focused on the accession of Core Partners from Call for Core Partner Wave #1, as well as the re-baselining of some Work Packages. The third GAM amendment (Amendment #3) was concluded just before the end of the year to include contents for 2016-2017 for all partners. This puts the ENGINES ITD in a very strong position as it will have full contract cover at the very start of 2016.

2015 also saw the conclusion of the negotiation with Core Partners from “Call for Core Partners Wave #1” (7 projects, total funding €69.9M), as well as the negotiations with Partners from “Call for
Partners Wave #1”. It is also the year where the ENGINES ITD published 10 topics worth €10.1M in “Call for Partners Wave #2”, and a further 10 topics worth €13.0M in “Call for Partner Wave #3”. In parallel, the ENGINES ITD supported the evaluation of proposals in response to “Call for Core Partner Wave #2”, which has 4 topics worth €14.0M, and published a further 4 topics in “Call for Core Partner Wave #3”, worth €16.5M.

The ENGINES ITD welcomes ITP, GKN, DLR, GE Avio, GE Aviation Czech, GE Deutschland and GE Aviation Systems into the ENGINES ITD, via their accession into the ITD as a result of “Call for Core Partner Wave #1”. A Launch Meeting was successfully held in Brussels with the new Core Partners on the 6th and 7th of July 2015.

The 2015 ENGINES ITD Annual Review was hosted by Rolls-Royce in Derby between the 17th and 19th of November 2015. It was attended by four expert reviewers and the CSJU, along with a good attendance from all the partners of the ENGINED ITD. Key successes include demonstrable and effective interaction between the engine manufacturers and airframers, as well as the general openness in which information was shared by the various partners during the review.

**Work Package 2 - Ultra High Propulsive Efficiency (UHPE) Demonstrator for Short / Medium Range aircraft (Snecma)**

2015 was dedicated to the selection of the major items of the UHPE demonstrator architecture including selection of the Core. Trade studies were performed on 4 types of existing Cores to define the best UHPE Engine Candidate allowing the maximization of the Low Pressure system representativeness (system integration, supercritical shaft behaviour, number of stages, bearings locations…). This has been done taking into account the product configuration as planned for the enter into service of the target Engine (UHBR). Engine cycles and analysis on modules level were also performed for each of those 4 Cores. Thanks to these studies, Snecma graded the 4 Cores and prepared the dedicated UHPE architectures. Based on Snecma and UHPE Beneficiaries technical assumptions, a general concept has been considered for the Aircraft Power and Propulsive System integration. The preliminary UHPE cross-sections preparation has been performed based on:

- Preliminary studies on Reduction Gear Box,
- Flow path and interfaces between Booster, High Pressure Core and Low Pressure Turbine

Main and Critical enabling technologies were also investigated.

The UHPE Project Management focused in 2015 on the set up of the coordination between Snecma and the UHPE beneficiaries. The Kick off Meeting with Airbus has been held on April 20th, 2015.

2015 marked the arrival of the first Core Partners, selected during the Call for Core Partners (CfCP) wave #1.

- GKN has joined the project as Core Partners for Low Pressure turbine rear frame and Low pressure shaft for ground test UHPE demo for SMR Aircraft (KoM : 10/09/2015)
- Avio Aero has joined the project as Core Partners for Power Gear Box for UHPE demo for SMR Aircraft (KoM : 15/10/2015)

The CfCP#2 and CfP #1 topics have been evaluated. CfCP #3 and CfP #2 topics were launched and CfP #3 prepared.

Finally, 2015 focused on the implementation of the Project Management Organization. Snecma and its selected Beneficiaries have realized the deployment of the WP2 WBS and the identification of internal focal points of each modules or main technical aspects. A dedicated Collaborative Platform
has been put in place with specific and bilateral partnership areas in order to ease collaboration and exchange of information.

**Work Package 3 - Business Aviation / Short Range Regional TP Demonstrator (Turbomeca)**

In 2015, Turbomeca froze the detailed structure of the Business & Regional Turboprop Engine demonstrator project and the plan to perform this project. The structure is based on a modular approach of the whole Integrated Power Plant System (IPPS), integrating the engine itself, the propeller & the associated propeller controls, the air intake and the nacelle. As far as the integration is concerned, both the engine assy and engine mounting systems are also addressed, as well as the necessary equipments to be installed into the nacelle (oil cooling system, electrical machine, etc...).

The purpose is to demonstrate benefits from an overall approach, by optimizing each component taking into account the other interfaced parts, rather than optimizing the components separately.

The approach of the IPPS, including the integration of the various modules, is meant to better understand and therefore better address the needs of an airframer to get the best possible efficiency of the propulsive system.

The organization was set in Turbomeca as to the respective Engineering teams. The teams are now operating.

The strategy for partnership for the Business & Regional Turboprop Engine demonstrator was defined in relationship with the modular Work Breakdown Structure. It first led to the choice of a main topic for Core Partner Calls Wave 1. With no response to Core Partner call wave 1, decision was taken to reorganize the initial call into two separate Core Partner Calls for Wave 2.

The topics for Partners Calls were also defined. Two topics were issued for Partners Call Wave 2 and three topics were submitted for Partners Call Wave 3.

The high level specification for the whole IPPS was defined and made official. From the specification for the full IPPS, specifications for each module of the IPPS were defined. Together with the specifications, the interfaces between modules were defined. Within the core engine module (including the Power & Accessory Gear Box - PAGB), the studies for major components started. Questions in relation to the engine integration and the IPPS integration were analyzed and started to be addressed.

Several technical reviews were performed during the year in order to both verify that the project responses are matching the initial high level specifications and to validate the main technical solutions. Following this iterative approach, the PDR was successfully performed at the end of 2015. With this major milestone, an important toll gate was passed, which was reported with the main deliverable of 2015 for this project.


In 2015, MTU successfully continued its technology development activities within the Clean Sky 2 engine ITD and added the two core partners DLR and GKN to the project, hereby completing the core partner addition for WP4.

In 2015 a first identification and selection of the technology streams was carried out to ensure that the selected technologies will be available at the necessary TRL level for incorporation in the demonstrator vehicles. The engineering team was ramped up to achieve the planned goals for the WP4.

The conceptual design studies were continued for Engine Demo and Rigs under the assumptions of the preselected technologies. Main focus are on the materials and manufacturing technologies and further design features as the main contributors to meet the overall Clean Sky 2 objectives and achievements. D4.1.1.1 High Bypass Engine Concepts describes this concept and was finished as planned.
The compression system concept was detailed further. The first compression system rig will be used to advance the understanding of inter compressor ducts by obtaining measurement data and calibrating the CFD methods with this data.

Operating points for the ICD rig have been derived from the notional engine. The points chosen span the whole operating range of the engine.

The compression system conceptual design is fixed for the ICD tests. Numerous CFD studies have been performed to characterize ICDs for the notional engine. Main parameters are the slope and the area ratio. From these studies relevant ICD geometries will be chosen for the test. The scaling of the notional engine concept to the test rig environment has been fixed. The concept for the mechanical lay-out for the ICD test rig consists of an inlet, LPC outlet guide vanes, the ICD and HPC inlet guide vanes.

The work split between the companies has been fixed and the concept for the mechanical lay-out is defined.

The concept has passed the relevant reviews and will be detailed in the next project phase to allow testing of the ICD rig in 2017 as planned in the project plan.

The planned deliverables for 2015, D4.2.1.1, D4.2.4.1 and D4.3.1.1 were completed as planned.

In 2015 the expansion system conceptual design activities in Clean Sky 2 work package 4 with respect to exhaust system development were summarised. A preliminary engine demo systems requirement specification has been derived from the notional engine concept as described in deliverable “D4.1.1.1 High Bypass Engine Concepts”. Based on the requirements specification a preliminary concept for the engine demo has been established. Furthermore, first consultations for the technology development and engine demonstrator design together with the core partner GKN are going to start in 2016.

In 2015, a preliminary conceptual design has been established considering aspects and properties regarding integration of CMC technology, compliance of the design with the validation requirements documented in the technology validation matrix for the expansion system, realization of the requested temperature and mechanical load levels for the test items and cost efficient operation of the test item at the planned test bench. Preliminary 3D models are available, from which a general arrangement of the demonstrator ITD / TCF has been derived.

A detailed schedule has been elaborated for synchronizing the development of the engine demonstrator with the connected technology projects. A performance validation strategy has been set up, that identifies the necessary boundary conditions for the engine demonstrator with respect to an efficient and effective technology validation.

The expansion system concept was prepared for the next relevant preliminary reviews and will be further detailed in the next project phase to eventually allow testing of the demonstrator in 2019 as planned in the project plan.

The planned deliverables for 2015, D4.4.1.1, D4.4.2.1, D4.4.3.1 and D4.5.1.1 were completed as planned.

MTU’s Call for Proposal wave #1 topic AlloxITD has been started in December while other topics in consecutive waves are submitted and in their respective stages.

**Work Package 5 – VHBR – Middle of Market Technology (Rolls-Royce)**

2015 has been a significant year for the Power Gearbox System. Rolls-Royce has delivered major progress towards the designing and sourcing of the first gearbox (gears, bearings, structure and oil system) to be tested in 2016 in a new facility in the Rolls-Royce Deutschland site. The thrust level is significantly in excess of existing aerospace experience, so this represents a key first learning step for the Power Gearbox System. The design of the rotating components and static structures is complete with detailed drawings being generated. A key milestone was achieved when a Joint Venture with Liebherr Aerospace called Aerospace Transmission Technologies (ATT) was launched. Design of the second design iteration of gearbox has started in Rolls-Royce Deutschland, Dahlewitz with Rolls-
Royce UK supporting the effort; the architecture concepts have been audited and the detailed design planning has now commenced taking lessons learned from the first gearbox.

Rolls-Royce has also made significant progress in the development of the Fan, Structural and Turbine sub-systems for the UltraFan™ demonstrator. The initial manufacturability assessment for large low speed composite fan system is now complete. The experimental rig definition for the fan system was also completed in 2015. With regards to the delivery of the UltraFan™ Structural and Turbine sub-systems, Rolls-Royce has successfully acceded GKN (for Structural sub-system) and ITP (for Turbines sub-system) to support the technical development (in WP5) and the supply of the UltraFan™ demonstrator hardware (in WP6).

**Work Package 6 – VHBR – Large Turbofan Demonstrator (Rolls-Royce)**

2015 built on the considerable successes of 2014 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 2015, Rolls-Royce continued the preliminary design with key deliverables including 2 further design iterations on Fan/IP turbine optimisation and engine core design optimisation. This culminated in a design assessment incorporating 2025 engine technologies into the UltraFan™ engine core with associated improvements in fuel burn and specific fuel consumption which was subject to a concept review and discussions with Airbus as part of LPA.

Scalability studies concluded in 2015 explored the full thrust range of likely UltraFan™ product. Additionally, a specific point case study baseline engine definition for a circa 40kib thrust class UltraFan™ engine was delivered that highlighted the architectural differences between large and medium thrust class engines. This was in order to determine how the UltraFan engine would meet the requirements of a middle of the market product.

2015 also saw the definition of a development/validation plan, known as the Engine Development Plan - EDP, which includes a definition of the number of engines required to achieve TRL6 including ground and flight tests. This included a detailed review of the infrastructure modification requirements to test this type and scale of aircraft. Additionally Rolls-Royce and Airbus agreed to work towards the realisation of the UltraFan flight test demonstrator (in LPA) with a formal go/no go decision in late 2017. In addition, detailed design of long lead time items has been completed and long lead time items have been placed on order.

Advance3 made significant progress in 2015 towards the delivery of a ground-based demonstrator for testing in 2016. Detailed definitions of the bill of material and of specific components were completed. A comprehensive build, instrumentation and test plan has also been developed. Tooling and instrumentation required for the testing of the Advance3 demonstrator have been ordered and delivery of these items have already commenced. Although some of the ordered items have arrived at the end of 2015, further delivery of remaining items will continue into 2016 until the demonstrator is fully built. The facility for the demonstrator is almost ready and the technical resource for performing the actual build is also aligned to fully support the programme.

**Work Package 7 – Small Aircraft Engine Demonstrator**

The year 2015 was dedicated to the preparation of work to be developed by the partners (CfPs) in 2016 and after.

WP7.1: many endurance tests have been performed in order to push the baseline engine to its limits and establish specifications for a higher power density SR305 engine (originally 230 hp). Some have been done in synergy with WP7.3 (propeller)

WP7.2: many tests have been performed in order to push the turbocharger to its limits and establish specification for higher performance turbocharger. SMA 2015 in kind activities have been very significant.
WP7.3: In synergy with WP7.1 some tests have been performed up to 280 hp in order to study the propeller stress, propeller dynamic, coupled engine-propeller dynamic and establish a baseline propeller capability.

WP7.4: R&T at low TRL for a single cylinder unit to demonstrate high power density capabilities. A value much above 100 kW/l have been demonstrated. SMA 2015 in kind activities have been very significant.

Pre-studies of architecture variants of multi-cylinders engine based on this single cylinder have been performed, including innovative cooling solutions. R&T with a higher TRL has been prepared in order to develop a SR460 engine, a 6 cylinder variant of the current SR305 engine. This activity paved the way of the 2016 partner work.

WP7.5: Analysis of twin engine specifications in order to prepare 2016 work with an partner airframer.

For all WP7.x, except for WP7.3, 2015 has been the year of partners (4 Cfp#1) selection and process up to the agreement, in order to be able to initiate partners activities beginning 2016.

For WP7.3, a Call (CFP#2) has been launched in 2015, the process of selection will be conducted in 2016.

Another WP (WP7.6) has been identified and should be included as a partner topic (may be CfP#4) to focus on the engine control system.

ECO design themes have been established.

**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 7 sub workpackages as described below.

WP8.0 aimed at delivering the System Specification of the Target Engine by means of a report that has been postponed in Q1 2016 and this has delayed 2015 activities within the workpackage.

WP8.1 objectives were to complete the Engine concept trade studies and to define the Engine Modules requirements. This has seen the advancements of conceptual studies and mathematical modelling to come up with requirements definition for engine control system development. Also, the engine model development has been launched together with the provision of a trade study between a reference engine and the "New Centreline Turboprop".

WP8.2 was devoted to define the modules’ technical requirements, to complete both the Concept Design of the baseline Reduction Gearbox and the initial low-noise propeller design. This has seen the accomplishment of: i) a preliminary design activities to define a baseline integrated Low Noise Propulsive System; ii) a preliminary trade studies for LP spool system optimization prior to requirements definition in order to allow a preliminary Propeller Gearbox concept layout and gear ratio definition; iii) an initial baseline propeller that satisfies the required thrust and performance at take-off, climb and cruise flight conditions.

WP8.3 aimed to complete both the Conceptual Design Review of the axial compressor stages aerodynamic and the analytical assessment of an optimized compressor inlet. To do that, several concepts for the compressor configuration have been evaluated and the most promising compressor configuration for the planned future turboprop engine has been selected. Aerodynamic and aeromechanical design of the compressor has been carried out. Also several design iterations for each airfoil have been run together with aeromechanics and assessed for their aerodynamic performance at several key operating conditions.

WP8.4 aimed at completing both the Concept and Preliminary Design of the Ultra-Compact Combustor Module and the first Advanced CFD analysis from diffuser to combustor exit. This has
been accomplished by completing the Preliminary Design of the ultra-compact combustor configuration and by setting up the first combustor. Moreover, it has been launched the procurement of all materials and tooling necessary for the manufacturing of the test article and it has been selected a subcontractor in charge of the design and manufacturing of a new rig for the combustion test in the 2016.

WP8.5 aimed at delivering the initial technical requirements of the Power Turbine (PT) and Exhaust and at completing the High-swirl exhaust optimization. This was done by: i) assessing and defining overall system parameter and specification to enable the PT module efficiency target; ii) performing the multi-disciplinary optimization to achieve the integrated target of optimal total engine weight and performance. iii) optimising the Power Turbine aero design was optimized including the HPT-PT inter-turbine duct as well as exhaust collector and loss; iv) adopting innovative CFD to define an optimal exhaust duct shape, limited by the mechanical constraints.

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 (technical coordination and risk management) and on the dissemination, exploitation and communication activities. Deviations from GAM schedule and their impacts on other tasks

The System Specification Report in WP8.0, the RGC and Propeller Initial Design in WP8.2 have been postponed to Q1 2016, with respect to the GAM 2015 Target (December ‘15).

→ SYS – Systems ITD

Systems and equipment play a central role in aircraft operation, flight optimisation and air transport safety:

- Direct contributions to environmental objectives: for example optimized green trajectories or electrical taxiing have a direct impact on CO2 emissions, fuel consumption, etc.
- Enablers for other innovations: in particular for innovative engines or new aircraft configurations;
- Enablers for air transport system optimization: improving greening aviation, mobility or ATS efficiency can only be reached through the development and the integration of on-board systems;
- Smart answers to market demands: systems and equipment have to increase their intrinsic performance to meet new aircraft needs without a corresponding increase in weight and volume.
- Customization, integration and maturation of these individual systems and equipment in IADP demonstrators. This will enable full integrated demonstrations and assessment of benefits in representative conditions.
- Transverse actions will also be defined to mature processes and technologies with potential impact on all systems, either during development or operational use.

ITD Systems Activities 2015

WP1 Avionics Extended Cockpit

The definition of the extended cockpit has started with the gathering of the market and user requirements, looking at the trend for aircraft operations in several segments (large aircrafts, business jets, regional aircrafts and helicopters). This resulted in an analysis of the required capacities of a future cockpit, considering commonalities for each segment and identifying variability constraints.

In a second step, the functional architecture for the cockpit has been defined, with variants according to different segments.
In a third step, the high level specification of each functional block has been derived.
In parallel to this architecture work, initial development on functions and technologies has started,
providing preliminary design dossier or mock-ups in several domains (in particular: small multi-
functions tactile display, Flight Management System evolution to address high accuracy and integrity
approach, voice control interaction, Modular Inertial Reference Unit, Fly-by-trajectory concept).
A first instance of Cockpit Demonstrator was developed, to serve as state-of-the-art reference for
future evolution.

WP2 Cabin & Cargo
This WP is not started yet. A Call for Core Partner will be issued in 2016.

WP3 Innovative Electrical wing
The smart integrated wing systems architecture design progressed in 2015 with trade-off studies and
will be further elaborated and matured in 2016, integrating Partners contribution and expertise. The
system architecture is based on a German national funded project. A technology screening will
define the perimeter of the different architectures.
In the meantime, the first development step to replace all engine driven pumps (EDPs) by generators
started, keeping hydraulic actuation as a reference. Tests are conducted to measure the
performance of Electro-Hydrostatic Actuation (EHA) and identify possible improvements.
In Parallel, electro mechanical actuation and power electronics technology bricks have been matured
under national projects, and continue with the technical contribution out of the calls for proposal.
For RA-IADP (FTB2) and based on the development Plan for Spoilers, Aileron, winglets & Flaps,
different analysis and fruitful discussions have been held with AIRBUS-DS regarding requirements
definitions and their impact on actuation systems design.

WP4 Landing Gear Systems
WP4.1:
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.
The work plan has been refined with interface with new Core Partner, and future call for partners
have been defined.
• WP4.2:
The definition of system specification was completed, including requirements validation, trade-off
studies for baseline system architecture up to a preliminary system design for a local hydraulic
landing gear actuation system. A Call for Core partner to work on composite LG structure was
prepared.
The Nose Landing Gear (NLG) development activities focused on Electro-Hydraulic Actuation (EHA) in
the first place, whereas additional content has been defined in the third wave of Core Partners on
light weight structural components.
Full system and equipment design activities has been made available for the first Preliminary Design
Review (PDR). This was held in the last quarter of 2015. The preliminary design phase is going to be
closed by the first quarter of 2016. Detailed design phase will continue later in 2016.
• WP4.3:
Development of preliminary design of an electro-mechanical retraction actuator, including the build-
up of a functional test unit and functional testing. Preparation of CPW03 Call for electro-mechanical
brake.
The Rotorcraft landing gear system focuses on the electro-mechanical R/E actuator and preliminary design are yet available for technical review including a functional demonstrator build-up for risk mitigation.

**WP5 Electrical chain**
For power generation, discussions with aircraft manufacturers have been held to define needs on power electrical generating System (EPGS). In parallel, the generation control unit foreseen in full digital technology has continued to be defined. Technology bricks have also been launched through CfP and CP to bring innovative solutions for the next generation of electrical machines and conversion units.
For Electrical Network activities, technical workshops have been organized to define EDCU and specify high level requirements: platforms target, modularity needs, voltages used, added functions. In parallel, the topology study has progressed: tools have started to be developed, preliminary tradeoff was gathered, paving the way to a more intensive work in 2016 to quantify the potential benefits.
For Energy management, the activities in 2015 were focused on specification of power management center for energy distribution including power electronics and definition of cooling functions. This definition phase has been completed with a consolidation of the TRL roadmap and the schedule, the definition of the demonstration activities on PROVEN test bench and the definition of requirements for possible integration tests in Liebherr facilities.
A Call for Core Partner has been prepared and released for a HVDC Power Management Center, targeting integration in PROVEN test bench together with other equipment coming from other work packages.

**WP6 Major Loads**
In 2015, a trade-off on new electrical ECS architectures for a single-aisle application, extended to thermal management and with Trans ATA consideration, was launched based on experience gained on Clean Sky 1 studies and demonstrations.
The trade-off architecture for EECS for L/A is needed to define CS2 baseline. The work has been focused on this study in order to preselect in June 2016 the EECS optimized architecture.
For the EECS for R/A, the activity was mainly focus on the finalization the objectives with the airframer. The trade-off will be available in 2016.
For Air quality, preliminary discussions were needed in 2015 to define the air quality for bizjet aircraft applications. Following some technical workshops, the analyses are ongoing and should be available in 2016.
For Wing Ice Protection System, the activity has started with reduced scale Icing Wing Tunnel test campaign performed at COX Icing Wind Tunnel (US) facilities end of 2015. After analysis to evaluate the performances of different architectures: an optimized architecture will be selected end-2016.
For Ice detection, a call for Core Partner has been prepared and released for the development and test of an Icing Detection System for the detection, discrimination and characterization of icing conditions, as well as automatic activation of Ice Protection System.
For demonstrator activities, the definition of requirement is ongoing with clarification of the objectives, the contribution to the TRL roadmap, the complementarity with demonstrators, etc.
A call for Core Partner has been prepared for Adaptive ECS, and the eECS integration tests strategy has been reviewed with LTS to consider AVANT tests bench integration and flight tests integration.

**WP7 Small Air Transport Activities**
WP 7.1 Efficient operation of small aircraft with affordable health monitoring system
- Study for selection of the system component among the small aircraft systems to be involved in the health monitoring demonstration. These studies have conducted to define the
general architecture of an innovative electromechanical actuator and a dedicated CfP for Efficient operation of small aircraft with affordable health monitoring systems.

WP 7.2 More electric / Electronic technologies for small aircraft
Preliminary study on small aircraft electrical power generation and distribution architecture with preliminary specification to be used in the preparation of CfP.
The technical discussion with Thales about the generation is in progress and based on this the generation and distribution architecture shall be defined.

WP 7.3 Fly by wire architecture for small aircraft
Preliminary study of FbW architecture for small aircraft has been performed with preliminary specification to be used in preparation of CfP.
The preliminary study has conducted to define a trade off with a general architecture to be used for FbW.

WP 7.4 - Affordable SESAR operation, modern cockpit and avionic solutions for small a/c
Activities in 2014 put more precisely technical content for CP, which will be invited to enter programme in CPW2. Based on the Leaders agreement and to fulfil target of WP were agreed topic “Affordable SESAR operation, modern cockpit and avionics solutions for small aircraft” with aim to equip category of small aircraft with affordable avionics system enabling cost-effective operation while still keeping the high level of flight safety and dispatch reliability.

WP 7.5 - Comfortable and safe cabin for small aircraft
The main activities in year 2015 were focused on the following activities:
Specific theoretical background for materials passive insulation of heat and noise fields was created.
Description and definition boundary condition for laboratory work and practical flight measurements in fuselage of testing aircrafts was carried out.
Research study of seat crash safety was finished by the summarizing deliverable. Works on preliminary seat design based on virtual material data was started. Basic design and computation manual was created.
During 2015 were completed some research studies about thermal comfort. They were focused on thermal comfort definitions, regulations, solutions in public transport, computational models and numerical modelling. In the second half of 2015 preparations for creation of computational model started.

WP100.1 – Power Electronics
Activities started in Q4 2015 with a technical workshop agree on the interfaces between the transverse Power Electronics topics and the major demonstrations in other WPs of SYSTEMS ITD.
In parallel, provisional investigations towards definition of EPS with paralleled operation of 2 power cores have been started. These include both analytical studies (definition of EPS architecture, parametrization, local controls, power quality and stability) as well as activities towards building an experimental test rig.
Some initial studies started in other technical areas like e.g. parallel operation of reversible 270V DC sources.

WP100.2 – ECO Design
The activities started in the second half of 2015 with mostly screening of new painting systems, namely by replacing the lack with a substitute without Chromium 6. The Characterization of new High Temperature Aluminum Alloy has started and will continue in 2016. Manufacturing trial was also performed with high temperature casting aluminum alloy. Some manufacturing trials with
electron beam process were performed. The introduction of a new member has been prepared and more technical activities will start in 2016.

**WP100.3 – Model tools and simulation**
Activities have started in Q3-2015. Requirements evaluation and definition has been initiated, and performance, connectivity and usability of core modeling environment (Simulation-X) have been improved. Workflows for virtual testing, model-based algorithms and general modeling and simulation environment, and a proposal for extension of functional mock-up interface standard have been drafted.

**Major milestones and Results accomplished in 2015:**

WP1 –
- Definition of Extended Cockpit needs, architecture and functional specification
- Mock-up of Small Integrated Multifunction Display (tactile)
- Fly by trajectory concept initial mock-up
- Initial Cockpit Demonstrator version

WP3 – Innovative Electrical Wing
- EHA system concept
- Preliminary requirements analysis for Flight Control System testing activities for RA-IADP FTB2)
- Preliminary Wing system architecture for large aircraft
- Preliminary Wing systems definition to fit architecture
- Design criteria for autonomous Electro-Hydrostatic Actuation

WP4 – Landing Gear System
- Launch of Smart Braking EMA design
- Main landing Gear Concept Review (CR), Preliminary Design Review (PDR) and TRL3
- EMA R/E actuator

WP6 – Major Loads
- Reduced scale Icing Wing Tunnel test campaign performed

WP7 – Small Air Transport
- Several reports issued summarizing the state-of-the-art constraints, method and tools to address cabin systems for passenger comfort and safety (heat, noise control, seat crashworthiness, ...)

WP100.2 – ECO Design
- Development of new painting without chrome
SAT – Small Air Transport Transverse Activity

The activities in 2015 were mainly dedicated to the selection of Core partners and Partners. Four topics for Core Partners have been evaluated and Core Partners selected:

- one for ITD engines, in the WP8 with AVIO GE as coordinator of a consortium with several GE European entities.
- one for ITD systems for a new affordable cockpit and avionics systems. Honeywell has been selected coordinator of a consortium.
- two for ITD airframes, one covering more affordable composite aero structures with focus on cost effective existing materials (IAI selected), the other covering metallic manufacturing (ILOT as a coordinator) looking for more affordable manufacturing and assembling of metallic and hybrid structures of the small aircraft.

In parallel, several topics for partners have been written:

- For engines, SMA, leader of WP7 has issued topics for Turbocharger, High Performance Turbine, Integration, and Propeller for its engine.
- In systems, topics have been written and published for 3 topics on aeronautical materials, thermal and acoustic treatment and seats.

In 2015, we run the first CMC (Coordination management Committee): this is the place to manage at overall level the SAT activities, spread in the 3 ITDs (Engines, Systems and Airframes). We have started to write the SAT GAM which will cover 2016 and 17 and will focus on management and Integration activities.

ECO – Eco Design Transverse Activity

Eco design TA continued in 2015 the effort to set-up the transversal activity across the Clean Sky 2 programme. Fraunhofer as leader of the transverse action, supported by the JU, operated during the year with the aim to collect and collate programme-level Eco requirements and guide the SPDs towards the selection of candidate Eco technologies. Key considerations were ensuring additionality with Eco actions to the technical programme of CS2 and continuity with the Clean Sky programme. Dedicated Eco design related work-packages have been activated in most of the SPDs. In parallel to this and to adhere to the Eco design framework defined in the JTP, the elaboration of an Eco design GAM Annex has been initiated, to allow the leader to properly coordinate the action and ensure synergies. The leader Fraunhofer participates in fact as a beneficiary in 2 SPDs (LPA, AIR) and a coordination GAM could ensure a proper level of cooperation with all SPDs. Through the coordination GAM the leader could also support SPDs through dedicated work / task elements at the Eco-design discipline level (materials, processes, production, end of life,...) and a coherent LCA process and tools development. Activity in 2015 was mainly focused on technology screening in the former of these two elements, with limited effort to date aimed at LCA process harmonization.

Several workshops with leaders were held through the year to further discuss the Eco design TA collaboration framework, scoping and interactions.

After the collection of preliminary proposals from SPDs related to the Eco theme, a provisional Eco TA committee was formed in October with involvement of all SPDs and a first draft of Rules of Procedure [RoP] provided. A coordination agreement will need to be developed to cope with the specific TA needs, together with clear criteria for the selection of Eco design themes. A selected number of topics for calls coming from SPDs have been defined with a potential link with the action.

Concerning interaction with SPDs the following activity was performed:
Airframe ITD: initial activity mostly addressed to the strategic topic in CPW02 “Development of airframe technologies aiming at improving aircraft life cycle environmental footprint” and in the frame of Eco design related work-package in AIR A. Activity was depending also on Eco design Clean Sky programme achievements expected by end 2015.

Systems ITD: some interaction performed in the frame of dedicated Eco work-package focused to Eco compliant production processes (mainly screening of novel painting technology avoiding Chromium and development of new high temperature aluminium alloys).

Engine ITD: some interaction performed and dedicated workshop performed mid-July. Initial proposals for Eco design related themes from SPDs circulated. No dedicated Eco work-package defined.

LPA IADP: limited activity performed during the year.

Regional IADP: some interaction performed in the frame of dedicated Eco work-package. No specific theme highlighted.

FRC IADP: some interaction performed in the frame of dedicated Eco work-package. No specific theme highlighted even interest to cooperate with Eco TA shown.

Some deliverable expected by end 2015 from SPDs regarding priorities at technological level and overall Eco design approach to define next periods end ensure the development of the action.

→ **TE – Technology Evaluator**

A GAM has been signed to allow DLR to coordinate the TE activity. Rules of Procedures have been prepared along with a Coordination Agreement. The models and the associated mission level assessment will be done in the TA, with input from the ITDs/IADPs. Several meetings took place to prepare a set of new metrics, covering CO2, NOx and Noise but also competitiveness, mobility and connectivity. The Partners of TE will be selected in 2016, through call for proposals.
10. List of acronyms

AAR: Annual activity report
AB: Annual Budget
ACARE: Advisory Council for Aeronautics Research in Europe
AIP: Annual Implementation Plan
ATM: Air Traffic Management
CA: Commitment Appropriations
CDR: Critical Design Review
CFP: Call for Proposals
CFT: Call for Tender
CROR: Counter Rotating Open Rotor
CSJU: Clean Sky Joint Undertaking/ Clean Sky 2 Joint Undertaking
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
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