Research Organisations in Clean Sky
Research centres are the bridge between academia and industry

For aviation, the road towards climate neutrality is neither straight nor simple. Disruptive, daring innovation in aviation is needed if we are to reach climate-neutrality by 2050.

As Rosalinde van der Vlies, the Clean Planet Director at the European Commission, points out in her article for this edition of Skyline, business as usual is no longer an option. A coherent, aligned approach between all segments of the aviation sector is needed to reach our goals – and this is one of the core beliefs of Clean Sky. This edition of Skyline aims to highlight the achievements of research organisations within the Clean Sky ecosystem on our journey towards sustainable flight.

So far, 113 research organisations from 21 countries have taken part in Clean Sky’s projects. Their role within our ecosystem is vital – on top of initiating and developing their own new technical proposals, they act as incubators, taking ideas and concepts that have been developed through academia and transforming them into technologies that have useful applications for industry and subsequently, society.

Research centres often bridge the gap between academic concepts and real-world solutions – and that is why they are an integral part of the Clean Sky Programme. They are skilled at identifying the best routes for technology transfer, opening up conversations around the potential of academic concepts for industrial use and investigating the most promising possibilities.

An additional value of research centres is that they bring expertise and knowledge from other sectors to the forefront. A research centre might house experts in laminar flow technologies, or thermoplastics, or 3D printing, which might be used in another context but can be applied to aviation challenges. The automobile sector, for example, often develops technologies which can be modified for use in aviation, and vice versa.

At Clean Sky’s Spring Event in April this year, Prof. Anke Kaysser-Pyzalla of DLR outlined this as a key benefit. ‘We combine our knowledge from aerospace and from other sectors,’ she said. ‘This accelerates our research toward our common goal of sustainable aviation.’

Research organisations not only take part in our research projects, they also conduct important studies and evaluate Clean Sky’s progress.

For example, DLR, the German Aerospace Centre, leads the evaluation of Clean Sky’s success as part of the Technology Evaluator framework. Under Clean Sky 2, two assessments will take place – the first has just been completed, and concluded that Clean Sky delivers in line with its objectives. You can read about the results of the First Global Assessment of Clean Sky here.

Clean Sky research organisations recently took part in a study on what the future of aviation would look like, organised by ERA, the Association of European Research Establishments in Aeronautics. This interesting study designed four possible future aviation scenarios. “Scenarios make it possible to visualise a future direction and to build a plan of actions,” says Ligeia Paletti of the Royal Netherlands Aerospace Centre.

The Netherlands Aerospace Centre also believes we should not underestimte the potential of drones when developing the future air fleet. Take a look at the article on page 7 to discover why small can also be mighty!

The French Aerospace Lab (ONERA) and the Italian Aerospace Centre (CIRA) are two research organisations that have a long history with Clean Sky. From DRAGON to HIGHTRIP (ONERA) to SAT-AM and T-WING (CIRA) projects, their innovative work and out-of-the-box thinking has been an inspiration! Read more about their contributions to Clean Sky’s success on pages 8 and 9.

FIDAMC, with its focus on lightweight and robust composite materials, fits perfectly with Clean Sky’s objectives. The use of composite materials will be extremely important in the sustainable aviation fleet of the future – and FIDAMC is helping to make their uptake a success!

The Łukasiewicz Research Network - Institute of Aviation (Łukasiewicz – ILOT) is one of the oldest research facilities in Europe. The strategic research areas of the Institute are aviation, space and unmanned technologies, making them perfect partners for Clean Sky projects.

Together with ROMAERO SA, INCAS, the Romanian National Institute for Aerospace Research ‘Elie Carafoli’, form the Romanian RoRCraft Consortium which is strongly involved in the RACER project. They recently reached an important milestone – the delivery of the central fuselage – and hosted a high-level event to mark the occasion in Romania.

The Aircraft Research Association (ARA), based in the UK, have worked closely with both Rolls-Royce and Airbus on various Clean Sky projects. Currently, Clean Sky research projects account for 10-15% of ARA’s annual research programme, which shows how important the goals of sustainable aviation have become!

Our research organisation partners are a critical part of Clean Sky’s success. They are constantly working on the interface between academia and industry, making them experts in transforming knowledge into actionable results. They are a binding force for connectivity and innovation, and with the diverse range of expertise available through them, they regularly come up with groundbreaking new ideas, pushing the boundaries in clean aviation technology.

I hope you enjoy reading about our research organisations within the pages of this edition of Skyline. We trust that they will help us achieve our ambitious vision – climate-neutral aviation by 2050!
Dear Skyline readers,

A year ago, nobody could have predicted the scale of societal and economic challenges inflicted by COVID-19. As vaccination is underway, we can all agree that European R&I significantly contributed in accelerating the global response. This makes us proud and gives us the strength to continue with even more determination. Earlier this month, the European Commission’s President Ursula von der Leyen announced new research efforts on mutations of the COVID-19 virus, in a bid to prepare the next generation of vaccines; these initiatives will also have benefits for aviation and mobility.

The EU’s long-term budget, coupled with NextGenerationEU, will be the largest stimulus package ever financed through the EU budget. A total of €1.8 trillion will help rebuild a post-COVID-19 Europe. It will be a greener, more digital and more resilient Europe. Making the EU the world’s first climate-neutral continent by 2050 remains our objective and priority. As much as 37% of the recovery plan will be devoted to fighting climate change, not only with short-term mitigation and adaptation solutions, but also with investments for sectors that are difficult to decarbonise, such as aviation. European aviation has to grasp this opportunity, to decarbonise, such as aviation. European

development – and, of course, research and innovation. There are many success stories we can be proud of. For example, many EU-funded R&I projects (e.g. ATICA, ALFA-BIRD, DREAM, NEWAC, BIO4A) contributed to the success of the recent A350 test flight fuelled by 100% SAF. Our efforts in aviation technologies are complementing new pathways for renewable sustainable aviation fuels with new pilot and scale-up SAF projects aligned with the ReFuelEU aviation legislative process. Horizon Europe, with a budget of €95.5 billion for the next seven years - the biggest EU programme for research and innovation ever - will invest in enabling technologies (e.g. hydrogen, batteries, AI, HPC, ATM and manufacturing) that will allow aviation to take a transformative path.

Business as usual is no longer an option. We need to focus on high risk, breakthrough technologies in order to deliver on our European Green Deal objectives. We also need this for the competitiveness of our European industry. The Strategic Research and Innovation Agendas (SRIs) for the European partnerships, in particular the Clean Aviation partnership, will need this for the competitiveness of our European Green Deal objectives. We also need this for the competitiveness of our European industry. The Strategic Research and Innovation Agendas (SRIs) for the European partnerships, in particular the Clean Aviation partnership, will need to reflect this common ambition. I would like to take the opportunity to congratulate the European aviation ecosystem and their international partners.

The European Commission, on behalf of the Union, leads and connects an array of aviation activities such as regulatory, financial, operational, certification, and infrastructure for all the high-level reports, initiatives and proposals that you delivered recently. The Aviation Round Table Report on the Recovery of European Aviation, the Destination 2050 Roadmap, the ATAG 2050, the World Economic Forum Clean Skies for Tomorrow Coalition, the FCH-CS2 report on hydrogen-powered aviation, the upcoming EREA vision study and of course the focused SRIA, serve as an excellent basis for this new start.

In our path to climate neutrality, more than ever we need to join forces and work together across the value chains and exploit synergies between the EU and national aviation programmes, as well as between aeronautics, transport, space and defence. We all play a role to foster those links and I see a particular role for the Association of European Research Establishments in Aeronautics to foster links between EU and national aviation programmes and bring together academia and industry, including SMEs.

Beyond congratulating the Clean Sky team for the excellent organisation and outcome of the annual event, my final message is a pledge towards a coherent, aligned and win-win approach in all the aviation threads of Horizon Europe. Through all the instruments available at EU level to support aviation research and innovation, in particular the future Clean Aviation partnership, we should deliver more and with higher impact than in the past, for the globally sustainable competitiveness of the EU aviation industry and clear benefits for EU citizens. By joining our forces and communicating to the European citizens the benefits of European cooperation in the area of aviation, we will lead by example towards a healthy, clean and prosperous Europe and world.

Making the EU the world’s first climate-neutral continent by 2050 remains our objective and priority.

We need to focus on high risk, breakthrough technologies in order to deliver on our European Green Deal objectives.
During the uncertain times of the COVID-19 pandemic, EREA built its own vision of the future of civil aviation. The result, published in the spring of 2021, is a study detailing four scenarios of what the future could look like and what the associated R&D topics for civil aviation could be. Ligeia Paletti, consultant at the Royal Netherlands Aerospace Centre, is the coordinator of the study.

Why did EREA deem such study necessary?

In 2019 an increased societal awareness of the impact of climate change showed us that radical change is needed. I believe it is our job as research establishments to make sure aviation is an active part of this change, so clearly it was time for a rigorous update of our vision of the future of aviation. In order to initiate change, there needs to be an image to aspire towards. Scenarios make it possible to visualise a future direction and to build a plan of actions.

So, what might the future of aviation look like?

The future is not set in stone. Therefore, the study gives a range of possibilities on how the future might develop, identified in four scenarios: Mad Max, Tech for You, Stripping Down, and Optimising Together.

If you were to wake up in 2050, aviation will still be there, but possibly different than it is today. Changes can be dramatic, with urban skies filled with drones; or more subtle, with aircraft that look familiar but dated due to lack of resources, or made from different materials and powered by new energy sources, with zero environmental impact. There has been no stopping automation and digitalisation. Those aspects permeate all aviation activities, from design to traffic control, and ensure safety and security, also related to health concerns. Interestingly some trends that are seen today as inevitable do not appear so certain.

Note that the scenarios are consciously extreme. The rise of nationalist movements, deglobalisation and Brexit inspire a fragmented and unstable scenario, which is counterbalanced by an ideal scenario of harmony, in which aviation is growing limitlessly without any negative impact on environment and society. The truth may be none of these extremes, but rather a mix. Which mix exactly, is up to the reader and the future.

What is the difference between this study and others on the future of aviation?

Since the COVID-19 crisis, many studies about the ‘future’ have been released. In my opinion, that is a common way to deal with uncertainty: trying to regain control when ‘normal’ is taken away from us by making predictions and forecasts. This is also true for our study. But what makes it unique is that it is the perspective of the research community: the culmination of an intensive collaboration of over 100 EREA colleagues from 15 institutes and 14 countries.

EREA’s goal is to support and guide the research in the aviation sector. The study does not provide a conclusion on how to get to specific goals by 2050, but it does give our view on how the future of aviation can develop and it enables us to make conscious and active choices towards scenarios that seem more favourable or desirable.

What is the most important take-away of this study?

For EREA and its experts, the Vision Study is meant to be an inspiration for research activities. For policy-makers, the take-away is that seemingly small decisions today may have huge repercussions in a more distant future for the wellbeing of research and the aviation sector. For other aviation stakeholders, especially industry, the study helps to think beyond a technological or profit perspective. Society will influence aviation more than we have experienced so far.

Finally, I really hope to reach my own family and friends, but also the general public. It is about sending a message that we are listening to them for a better, sustainable aviation future.

The study is available for download at www.erea.org.

The study has been made possible with support of Noorderwind and Mike Fairbanks of Taylor Airey Limited.
T he German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) will help to shape the transformation towards Zero Emission Aviation with its multidisciplinary expertise and competences. Achieving global Zero Emission Aviation is not a national mission, but requires global solutions. With European funding programmes such as Clean Sky, all the relevant stakeholders are working closely together to perform target-oriented research and development and thus provide a overall European system capability.

What key Clean Sky projects are you working on?

DLR leads the ‘Technology Evaluator’. This is where research findings from the Clean Sky projects, integrated into virtual aircraft models, are analysed regarding their environmental, societal and economic impact by simulating future scenarios and fleet compositions.

For DLR, European collaboration is important. DLR is a founding member of the Association of European Research Establishments in Aeronautics (EREA) and an active contributor to the strategic research and innovation agendas of the Advisory Council for Aviation Research and Innovation in Europe (ACARE). Combining DLR’s competences and capabilities in the frame of Clean Sky with those of our established and new partners in research (EREA), industry (ASD), academia (EASN), regulators (EASA) and operators creates the critical mass to achieve the top level goals of Flightpath 2050: serving society’s needs and maintaining European leadership.

Through Clean Sky, DLR increased the leverage of its research by collaborating with European partners and establishing new contacts.

What is your hope for the participation of research organisations in the future partnership for Clean Aviation?

The goal of climate-neutral aviation requires both a step-by-step transformation and the development of radical technologies in all fields with feasible objectives. In addition to revolutionary aircraft and propulsion concepts, synthetic fuels and flight routing are also important. DLR wants to continue sharing its expertise in highly innovative research that addresses Zero Emission Aviation. Since the future Clean Aviation partnership will be an industrially-driven high impact work programme, the research establishments can and will support the technology transfer of our technology developments into industrial products.

In cooperation with all its partners, DLR wants to address technological challenges through the Clean Aviation partnership. Following the different emission reduction contributions defined in the Clean Aviation Work Plan, DLR will contribute to an integral research approach with all its multi-disciplinary capabilities. For the development of energy-efficient technologies: physical and virtual research, experimental and demonstration facilities, connected test rigs, wind tunnels and demonstrators must be set up both on the ground and in the air. The Clean Aviation partnership should support research on propulsion systems for hydrogen, their integration into the aircraft and the climate impact of all emissions including water steam, as well as optimising the aircraft for the efficient use of sustainable aviation fuels (SAF).

Green aviation has never been so reachable, and together we will shape the transformation towards Zero Emission Aviation.
Problems occur in different sizes: small and big. To tackle them, solutions of the same proportion are mostly considered as an appropriate response. In this case however ‘little’ drones can be the answer for the development of full scale new airplanes.

Although they sound futuristic, drones go back a long way. Already in 1849, during the First Italian War of Independence, Unmanned Aerial Vehicles (UAVs) took off. Austrians launched several hundred unmanned balloons carrying bombs with time fuses against the Venetians. Success was limited as the wind took its turn.

Over 170 years later a new wind blows and all countries around the globe face a completely different and common enemy called climate change. After fierce negotiations Europe recently decided to be at the forefront of tackling greenhouse gas emissions. As research and innovation institutes, we are committed to help achieve the 55% reduction goal in 2030 and reach climate neutrality by 2050. Drones can once again play an important role to help beat the opponent.

Future generation airplanes

In the NOVAIR project, researchers focus on how the next generation of large passenger aircraft can be equipped with hybrid electric propulsion. Next to this, these future generation airplanes will have a completely different fuselage and pair of wings to be able to fly more efficiently to contribute to sustainable aviation. In addition to researching the design of aircraft and propulsion concepts, developing new testing methods for these concepts is also an important part of the NOVAIR project. This is where drones step in.

Scaled airplane

The project SCALAIR (the name comes from ‘van Scaled Aircraft’) is a part of the Clean Sky 2 programme. Royal NLR - Netherlands Aerospace Centre is responsible for the design, development, qualification and conducting flights of a drone modelled according to an Airbus A320-200 (scale 18.5). This Scaled Flight Demonstrator (SFD) – named ‘René Eveleens’ to commemorate our colleague, as it was thanks to his enthusiasm the demonstrator became a reality – has a wingspan of approximately 4 metres and has a take-off weight of nearly 140kg. The SFD also contains several measurement instruments developed by NLR as part of NOVAIR.

The aim of both the SCALAIR and NOVAIR projects is to link the flying behaviour of the drone with the actual full scale airplane. If these two can be related appropriately this could pave the way to produce new, not yet existing models of planes with configurations that look completely different to current ones.

The knowledge and experience gained with fixed wing scaled models can eventually lead to improvements of the construction of full scale concepts of airplanes, which is expected to result in considerable savings of risks, costs, and lead-time.

Technology infrastructures

Innovation in drone technology helps us to deploy new kinds of airplanes within an acceptable timeframe. This emphasises the fact that we have to learn to think in new ways to tackle current issues. But to develop the technologies needed, we require facilities to fully test, validate, and certify them, which requires large scale investments and upgrades.

At the same time, we must recognise that we do not only talk about large facilities, such as the German-Dutch Wind Tunnels (DNW), but also about smaller, more distributed infrastructures. This is an essential part of completing a true European Research Area.

Together we are facing a global challenge that reaches further than our individual capabilities. But as history has shown, humanity has always been able to come up with inventive solutions. Some big. But never underestimate the power of the smaller ones.

In both NOVAIR and SCALAIR, NLR cooperates with Airbus, ONERA, CIRA and Delft University of Technology. The projects have received funding from the Clean Sky 2 Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreements No 717183 and 945583.
ONERA: A MAJOR PARTNER IN AVIATION RESEARCH

Bruno Sainjon
CEO, ONERA

What key Clean Sky projects are you working on?

Within the Clean Sky 2 (CS2) programme, ONERA is one of the major research partners contributing to most of the strategic platforms. ONERA acts as a Core Partner (CP), Partner (P), or member of 4 consortia which won thematic topics (THT) calls. In a nutshell, hereafter is the involvement of ONERA in the following platforms:

- Fast Rotorcraft IADP: CONCERTO & HIGHTRIP (P)
- Large Passenger Aircraft IADP: ADEC & HLFC-WIN (CP), AIRMES & SYNJET 3C (P)
- Regional Aircraft IADP: AIR GREEN 2 & IRON (CP), POLITE, PERTURB & ESTRO (P)
- Airframe ITD: NACOR (CP), ASPIRE & OPTIWIND (P)
- Engines ITD: ANTARES (CP)
- Systems ITD: ANALYST, EFAICTS & IDEAS (P)
- THT RAPTOR, ACONIT, U-HARWARD & SOLIFLY

Due to its pluridisciplinary expertise, ONERA is involved in 9 out of 16 demonstrators in LPA Platform 1 (leading the Scaled Flight Testing Demonstrator D03 and Radical FTD D08), as well as in 4 out of 9 technology streams in the Airframe ITD (leading the Advanced Laminarity TS A-2). These contributions allow ONERA to participate in the IADP/ITD Programme Management Committee and thus be involved when technical orientations are presented.

ONERA is also contributing to:
- The next generation of engine integration, such as Open Rotor and Stator, Boundary Layer Interaction, Ultra High Bypass Ratio, Turbo-propeller;
- Distributed electric propulsion with the DRAGON (‘Distributed fans Research Aircraft with electric Generators by ONERA’) concept for short- and medium-range missions (~150 pax, transonic cruise conditions);
- Definition of scale flight testing approach: validation of the method (D03) and testing of radical configuration with distributed electric propulsion (D08);
- Aero-design of some RACER parts as well as the preparation of the Flight Test Demonstrator (effect of cross-wind);
- Consolidation and maturity of higher aircraft performances via incremental evolution of technologies investigated within Clean Sky, for instance: laminarity, load control, noise reduction using liners, gust load characterisation and control.

Last but not least, ONERA’s contributions to CS2’s major demonstrators, as well as studies at lower TRLs in thematic topics and complementary H2020 projects, allow ONERA to initiate the development of new aircraft configurations to be climate-neutral by 2050. These technological advances are carried out with many EU partners (industrial leaders, research centres and universities).

Knowing that decarbonisation is not an easy task, ONERA will support both aircraft and engine manufacturers to achieve higher maturity levels for new technologies for propulsion (related to either sustainable fuels or hydrogen) and airframe in the future public-private Clean Aviation partnership.

How do you foster a close relationship with the rest of the European aviation sector – industry, SMEs, universities – and what are the benefits of working in this collaborative partnership?

In order to prepare tomorrow’s technologies and innovations, ONERA is fully committed at the core of the European innovation ecosystem in the field of aviation and addresses the entire research and innovation chain.

Through its role as a bridge between academia and industry, ONERA is a key element in fostering a close relationship with the entire European sector and addressing both bottom-up (up to disruption) and top-down (i.e. finalised) research needs. Our in-depth knowledge in aeronautics, space, security and defence makes us an essential partner for fostering synergies, which is one of ONERA’s assets compared to other research establishments.

ONERA is very involved in EREA, which brings together Europe’s most outstanding research establishments in aeronautics and plays a vital role in addressing European aeronautical issues with its partners in other Member States, in Horizon Europe collaborative research and the future Clean Aviation partnership.

ONERA supports the future of the European aeronautics sector by providing multidisciplinary expertise, playing an independent advisory role, and developing and consolidating powerful experimental and digital tools to serve industrial competitiveness. ONERA has a fleet of aeronautical facilities; some of them, unique in Europe or in the world, are operated for partners or customers from countries inside and outside the EU, which is another important asset for Europe and its international cooperation. Finally ONERA ensures technology transfer by helping industry to move from TRL 2 to 6.

The advantage of the CS2 and upcoming Clean Aviation partnerships is that they bring the whole ecosystem together, allowing it to interact and cooperate within the framework of the partnership to achieve its ultimate goals and deliver the expected impact.

What is your hope for the participation of research organisations in the future partnership for Clean Aviation?

Our expectations for the future Clean Aviation partnership are that it will allow the European aviation research and innovation ecosystem to achieve the objective of climate neutrality and meet the expectations of society, citizens and young generations. This vision is also shared by France (cf. national recovery plan).

To achieve this common goal, we will only succeed if we align our views (through dialogues and synergies). It is necessary to invest, to connect well the representatives of the ecosystem (industries, RTOs, universities, SMEs – also at a governance level) and to build synergies between the different independent programmes. On this last point, the work carried out at the level of national institutions is essential; the involvement of ONERA in some of the projects funded by the French DIGAC reinforces the synergies with EU programmes e.g. in the field of reducing the environmental impact, such synergies are able to generate a leverage effect in Europe.

Let me conclude this interview by underlining that the current and future years bring their own challenges, but I am confident that by all working together and staying focused on our priorities, these challenges will be met.
CIRA’S NEW TECHNOLOGIES AND APPROACHES FOR GREENER AVIATION

Dr. Ing. Raffaele Salvatore Donelli, Strategic Programming and Business Development, CIRA
Mariapia Amelio, Communications, CIRA

The Italian Aerospace Research Centre (CIRA) performs research and technology development activities, including experimental testing, within the strategic research programme PRORA, in support of the national and European aerospace community. CIRA is a member of several national, European and international associations (e.g. EREA, ACARE, IFAR); a signatory of important international agreements with key stakeholders, research institutes, universities and SMEs; and is deeply involved in public-private partnerships (PPPs) such as Clean Sky 2 (CS2) and Sesar2020.

CIRA is involved in several CS2-funded projects as a Core Partner in almost all ITDs and IADPs. These activities aim to reduce aviation’s environmental impact on climate change by developing, deploying and integrating new technologies and approaches for ground and flight operations, thus achieving a cleaner air transport system according to the European High Level Objectives. Below, we will mention a few highlights of CIRA’s contributions to CS2.

In the sector of short/medium-range vertical take-off and landing (VTOL) capabilities, CIRA is engaged in two main demonstrators: the Next Generation Civil Tilt Rotor (led by Leonardo Helicopters) and the high-speed compound helicopter RACER (led by Airbus Helicopters). As the coordinator of the T-WING consortium, CIRA is designing an optimised NextGenCTR wing integrated in a complex configuration where the front part of the engine tilts while the rear part is fixed with the wing. The wing houses fuel tanks and the fuel distribution system with cables, sensors and the control unit (in cooperation with the DEFENDER project). An additional complexity in the wing design is introduced by a thinner profile, which will improve efficiency in terms of drag divergence and aero-elastic behaviour to torsional stiffness, and by reducing weight.

Meanwhile, the ANGELA consortium is working on the development of RACER’s landing gear. Already designed, manufactured and tested, this innovative landing gear will be integrated in the wing and fuselage with a movable door system of the high-speed demonstrator, allowing drag to be minimised when retracted and providing a large track for a safe landing when extended.

The IRON project is contributing to the design of a green, high-performing 90-seat regional aircraft with a low noise propeller, as well as the development of new concepts for propeller ice protection.

AIRGREEN2 is dedicated to designing the wing of a future regional aircraft. The wing is characterised by a large natural laminar flow extension with new shapes obtained through morphing technologies, allowing higher efficiency and a large reduction of fuel consumption. Manufacturing and assembly process technologies to apply on the outer wing box (e.g. liquid resin infusion and automatic manufacturing techniques for composite structures) are also addressed in order to reduce costs of the entire life cycle and its environmental impact.

In the CASTLE project, CIRA is developing new technologies to increase cabin comfort conditions for the regional and business jet airplane classes, by implementing new noise and vibration reduction systems, new eco-friendly coatings and design processes integrated and supported by virtual reality.

Within the SAT-AM and OPTICOMS projects, CIRA is investigating how to reduce manufacturing and maintenance costs for small general aviation aircraft up to 19 passengers. Flightpath 2050, in fact, recommends increased use of both small aircraft and the large number of regional airports in Europe.

CIRA is also working on projects for Large Passenger Aircraft, aiming to improve flight safety (GAINS project), as well as to develop new enabling technologies for the future generation of electric or hybrid-electric aircraft (HYPER-F and SOLIFY projects). The first project is developing methods and tools to design efficient hybrid-electric propulsion systems (disrupting aircraft configurations by exploiting boundary layer ingestion), and the second is in charge of multifunctional structural components with integrated electrical energy storage devices.

CIRA considers the cooperation with European SMEs, industries and academia very important for ensuring well-focused research and development activities and also for the professional growth of its researchers. CIRA has signed the Letter of Commitment for the establishment of the future public-private partnership dedicated to Clean Aviation within Horizon Europe, and is willing to contribute to green and climate-neutral air transport while maintaining high levels of safety and security.

Airgreen 2 Morphing Winglet currently undergoing structural and functionality tests
Test T Wing in IWT
Composite materials have gained presence in the aeronautical industry in the last decades. Their performance is highly proven and their advantages undeniable. Nevertheless, it is necessary to take a step forward. Continued investment in research and development for new materials and production processes could result in higher production rates and lower costs, without compromising safety. Additionally, the trend towards a circular economy model forces us to find environmentally-friendly solutions for these materials beyond their service life in terms of recyclability and re-valorisation.

Since its creation 15 years ago, FIDAMC has aimed to become the main reference centre for research, development and application of composite materials in Europe, and has dedicated resources to provide the aeronautical industry with new solutions to optimise its products. We can say, without doubt, that the Clean Sky programmes have been an important source of motivation to reach this goal.

Since the launch of these programmes, the participation of FIDAMC as a Core Partner in two platforms and as a consortium member in specific topics has led to significant technological advances in FIDAMC’s processes and products. FIDAMC began its participation in European R&D programmes during the Seventh Framework programme and continued with Clean Sky. The foundation took a step forward with the launch of the Clean Sky 2 (CS2) programme, getting involved as a Core Partner in the Airframe ITD with the OUTCOME project and in the Large Passenger Aircraft IADP.

In OUTCOME, the design and analysis of the Upper Skin for the C295 military aircraft has been developed. The selected material for the work is a unidirectional composite material with PEEK as thermoplastic matrix and carbon fibre as reinforcement. Flat panels and detailed components have been manufactured to meet the necessary design allowances. Moreover, with the goal of cost reduction, productivity increases and environmental impact control, the selected manufacturing processes have been: a) hot-forming in oven and/or self-heated tooling for stringers manufacturing, and b) out of autoclave consolidation by automatic lamination in one step, with full integration of the skin with the stringers.

The challenge for CS2’s Large Passenger Aircraft platform is to further mature and validate key technologies such as advanced wings and empennages design, making use of hybrid laminar airflow wing developments, as well as all-new next generation fuselage cabin and cockpit navigation.

As a Core Partner, FIDAMC is working to support the development of a new fuselage based on the use of thermoplastic composite materials. In-situ consolidation has been selected as the technology to produce the demonstrators by using LMPAEK-based material. This technology automatically lays the skin up on top of pre-obtained press-formed stiffeners.

As a consortium partner, FIDAMC has participated in the completed CS2 projects NEOdAMP and REDISH, and is currently participating in the ECOFUNEL and FUSINBUL projects.

In the ECOFUNEL project, FIDAMC coordinated the development of novel electrically conductive thermoplastic formulations for environmental control systems (ECS). The substitution of metal parts by composites in ECS brings significant advantages in terms of weight and manufacturability, but presents issues such as electrical continuity of the ducts. The new injection moulding composites created allowed for an eight-fold increase in the electrical properties with only a 20% penalisation in mechanical performance. It also allows the static currents produced by the fluid to be discharged without electrical bridges.

FIDAMC leads the FUSINBUL project, which is developing the full-scale innovative pressure bulkhead for Leonardo’s Fuselage Demonstrator in the Regional IADP. Two different manufacturing techniques have been carried out: co-bonding process with carbon fibre pre-preg cured in autoclave, and LRI (liquid resin infusion) process with dry fibre (out of autoclave). The main technological advantage of this project is the infusion technology in high-dimension structures.

In both cases, the most advanced techniques of lay-up have been used to reduce recurrent costs and increase the level of automatisation. Manufacturing cost, manufacturing process flow, energy savings and reduction have been also taken into account during the project.

In FIDAMC’s view, the creation of a ‘knowledge environment’ composed of academia, research centres and industry is as important as the technological step forward that the Clean Sky programmes have promoted. This ‘natural flow’ has been so well demonstrated during the programme development that we can proudly assure that all the stakeholders in the chain have realised the importance of working together in pursuit of a common target. The need for a closer link between academia and industry was a recurrent demand and there’s no doubt that technological centres have successfully filled this void. The consortium structure ‘University - Research centre - Final user’ has probably been a key to success during the Clean Sky programme.

Now that this environment has been created and lessons learned, we are looking forward to the launch of the future Clean Aviation programme. One main challenge is on the table: low-emission aircraft for a climate-neutral aviation sector, and multiple convergent research lines to reach it. The competition with other transport means and the new legal frameworks are forcing the aeronautic sector to a ‘mind reset’ in terms of sustainable fuels and greener operations. This will probably be the greatest challenge in recent aviation history. Only with the very close collaboration of all the technical actors and public entities will we be able to make the new age of aeronautics happen.
DESIGNING THE FUTURE OF AVIATION: ŁUKASIEWICZ – ILOT IN THE SPOTLIGHT

Katarzyna Kowalska

International Cooperation, Łukasiewicz Research Network, Institute of Aviation

The Łukasiewicz Research Network - Institute of Aviation (Łukasiewicz - ILOT) is one of the oldest research facilities in Europe, with traditions dating back to 1926. The Institute closely cooperates with global tycoons of the aviation industry, such as GE, Airbus, Pratt & Whitney, and institutions from the space industry, including the European Space Agency. Strategic research areas of the Institute are aviation, space and unmanned technologies. It also provides research and services for domestic and foreign industries in the fields of materials, composites, additives, remote sensing, and energy mining technologies. Łukasiewicz - ILOT as an entity, and also as a member of European Research Establishments in Aeronautics (EREA), stresses the importance of research entities being present in designing the future of aviation.

This is shown through our active participation in European programmes, such as Clean Sky. Łukasiewicz - ILOT is engaged in many projects, including the few mentioned below.

The biggest project Łukasiewicz - ILOT is participating in is the More Affordable Small Aircraft Manufacturing (SAT-AM) project, where we are part of a consortium with such entities as Italian Aerospace Research Entity (CIRA), Eurotech, Szel-Tech, P.W. “Metrol”, Ultratech, P.ZL Mielec and Margarinski & Myśliwski. The main objective of this project is to develop innovative design processes and manufacturing technologies in order to increase aircraft flight safety, while reducing manufacturing costs. The new, composite engine nacelle developed within the project could replace the traditional metal structure, thus reducing the weight of current design by at least 10%. The main project activities include a full scale ground demonstrator of the M28 aircraft cabin, built and assembled with the use of innovative technologies such as: friction stir welding, additive manufacturing (aka 3D printing), block structures, high speed machining, out of autoclave composites and superhydrophobic coatings. Application of the above-mentioned technologies results in reduction of parts used by about 35% and reduction in the number of joints, which will significantly reduce the lead times of production and assembly. What should be highlighted is that, at the end of 2020, flight tests of the M28 aircraft with a composite engine nacelle were carried out. As part of SAT-AM, new technologies of aviation structures were developed, and the flight tests carried out at PZL Mielec confirmed the design assumptions and the suitability of the developed solution for future design changes in aviation.

Full Fairing for Main Rotor Head of the LifeRCraft (RACER) demonstrator (LATTE): this project aims to develop the design and manufacturing of aviation composite parts. The scope of the project covers detailed design and manufacturing of flightworthy main rotor head fairings for the new compound rotorcraft RACER (previously known as LifeRCraft) being developed by Airbus Helicopters in the frame of the Clean Sky 2 programme. Key elements aim to minimise the compound rotorcraft drag by reducing the main rotor head drag, thanks to the aerodynamically-optimised shape of the fairings and implementation of innovative partial air sealing between mobile parts of the fairing. The consortium includes the Czech research institute VZLU and private company LA Composite.

Another project focussing on the use of composites is Design and Realization of equipped engine compartments including cowling for a fast compound Rotorcraft (DREAM). The aim of the project is development in the field of design and manufacturing of aviation composite parts – such as engine compartment cowlings (including air inlet ducts and ventilation ducts) – and manufacturing parts for Airbus Helicopters’ RACER demonstrator.

HIGH speed civil Tilt Rotor wind tunnel (HIGHTRIP) is another project co-financed by the European Commission in the frame of Clean Sky 2 (Horizon 2020). The project is coordinated by NLR, and includes four partners. Łukasiewicz – ILOT is participating in the design activities, while the companies PW.Metrol and Szel-Tech are working on the manufacturing activities together with NLR. The goal of the HIGHTRIP project is the design, manufacturing and tests of a wind tunnel model of the new tiltrotor being developed by Leonardo Helicopters in cooperation with partners under Clean Sky 2.

Finally, the project Optimization of APU Exhaust Muffler Thermal Barrier and Air Intakes construction Technologies (“CHRZĄSZCZ” - the Polish for “beetle”) concentrates on using new materials to design, test, and manufacture elements used in the APU compartment of an aircraft (air inlet, exhaust outlet, etc.). These new elements will meet the functional requirements related to, inter alia, weight reduction, noise suppression, thermal and fire protection. The use of new materials will reduce production costs and time as well as reduce the environmental impact by reducing noise and weight of components.
MANUFACTURING AND DELIVERY OF THE CENTRAL FUSELAGE FOR THE RACER DEMONSTRATOR

Adrian Gâz  Chief Engineer & Project Manager RoRCraft CS2, INCAS
Dr. Daniela Mocenco  RoRCraft Projects Coordinator, INCAS
Katrin Mayrhofer  Clean Sky 2 Management Team, INCAS

The Romanian RoRCraft Consortium (RoC), formed by INCAS (National Institute for Aerospace Research ‘Elie Carafoli’) and ROMAERO SA, is a Core Partner in Clean Sky 2. INCAS has already signed the Memorandum of Commitment for becoming a founding member of the future European Partnership for Clean Aviation. Together with the platform leader Airbus Helicopters (AH), and under the coordination of the Clean Sky 2 Joint Undertaking, RoC finalised a very important stage within the Innovative Aircraft Demonstrator Platform (IADP) for Fast RotorCraft - the completion of manufacturing and preparation for delivery of the central fuselage of the RACER demonstrator. This important milestone was marked with an event hosted by RoC on 15 March 2021, which presented the helicopter fuselage. This event brought together important guest representatives from the aeronautic sector, European Commission and Romanian national government organisations (the ministry and contracting authorities).

The goal of the RACER project is to create a functional demonstrator for a new generation of helicopters, which incorporates new technologies which are able to meet current and future development requirements. The RACER demonstrator is a compound helicopter designed to cruise almost twice as fast as conventional helicopters, with a cruise speed of up to 400km/h (250mph), while being around 25% cheaper to run. Thanks to an increased ‘golden hour distance’ (the range achievable in one hour of flight), RACER aims to support social needs and enhance mobility of EU citizens while achieving ambitious environmental objectives (reduction of noise, CO₂ and NOx >20%).

The main activities covered by the RoRCraft project are the conception, design, production, testing, and Permit to Fly support for the fuselage of the RACER demonstrator. For the first time in Romania, on a technological and industrial level, flightworthy hybrid composite-metal structures were created. In addition, manufacturing was carried out and the required assembly technologies were implemented at ROMAERO.

Simultaneously with the activities of RACER, RoC initiated RoRCraft CompAct – a project co-financed under the “Operational Program Competitiveness 2014-2020, Action 1.1.3 - Creating Synergies with RDI actions” of the European Union’s Horizon 2020 Framework Programme and other international RDI programmes, in the context of the Memorandum of Understanding signed in 2015 between the Clean Sky 2 Contracting Authority and the Romanian National Authority for Scientific Research and Innovation - ANCSI (currently the Ministry of Research, Innovation and Digitalisation).

The next activities that RoC aim to achieve within the project are meeting the requirements for the RACER to obtain its Permit to Fly and also to give support within the flight test campaign. These activities are in close cooperation with Airbus Helicopters.

Adrian Gâz, Chief Engineer & Project Manager RoRCraft CS2 (INCAS), says: ‘This participation within IADP Fast Rotorcraft’s RACER Demonstrator gave us the opportunity to better understand certain processes outside the sphere of influence of a Lead Design. The delivery and the acceptance by AH of the flightworthy Main Fuselage gives us the confidence based on experience, in approaching complex projects in the future.’

Dr. Daniela Mocenco, RoRCraft Projects Coordinator (INCAS), says: ‘The participation within IADP Fast Rotorcraft’s RACER Demonstrator enabled us to reach this challenging milestone and not even the COVID-19 pandemic could change that. It’s fantastic to see it growing and to create value with our common work.’

The Executive Unit for Financing Higher Education, Research, Development and Innovation (UEFISCDI) supports the participation of Romanian organisations in H2020 projects, including RoRCraft, through its programme PNCDI-3.6 subprogram 3.6 Awarding Participation in Horizon 2020. This has allowed the RoRCraft Consortium to deepen its research and train young researchers in the field of design, calculation and testing of composite components.

Dr. Daniela Mocenco, RoRCraft Projects Coordinator (INCAS), says: ‘The participation within IADP Fast Rotorcraft’s RACER Demonstrator gave us the opportunity to continue improving and developing new capabilities within this sector. The coordination of projects financed by three different contracting authorities (Clean Sky Joint Undertaking and Romanian National Authorities: UEFISCDI and OPC 2014-2020) represented a big challenge for me, but also an opportunity to gain more experience and take advantage of the benefits that come with it in the context created.’

Katrin Mayrhofer, Clean Sky 2 Management Team (INCAS), says: ‘The participation within the Clean Sky 2 journey towards innovation with interfaces across Europe. The trustful and stable relation between INCAS and all stakeholders enabled us to reach this challenging milestone and not even the COVID-19 pandemic could change that. It’s fantastic to see it growing and to create value with our common work.’

Katrin Mayrhofer
RoRCraft Projects Coordinator (INCAS)
The Aircraft Research Association (ARA) is a research organisation (RTO) based in Bedford, UK. The Association was founded in 1952 by 14 UK aerospace companies to develop and operate a large transonic wind tunnel. Since then, ARA has grown to encompass many different strands of aerodynamic research with a worldwide customer base. ARA has been involved in the Clean Sky Joint Undertaking since its inception and has enjoyed success through the open Calls for Proposals (CfP) instrument. Clean Sky research projects have become a major part of ARA’s business, accounting for 10-15% of its annual turnover. ARA sees the international collaboration with both academia and SMEs as extremely valuable in establishing partnerships for future research programmes, as well as appreciating the opportunity to establish strong connections with the leading European airframe and engine manufacturers.

ARA has been particularly successful in Clean Sky 2 (CS2), being part of 10 CfP winning consortia, either as the project coordinator or as a partner. In pursuit of CS2’s objective to reduce aircraft emissions, various themes have been developed within ARA’s CS2 portfolio: advanced turbofan research; novel configurations; and installed propeller aerodynamics. These themes are delivering technical capability for future exploitation to ARA in various ways, among them: the development of engine testbeds and rigs; optical experimental measurement techniques; advanced design and manufacturing procedures; and data fusion methodology.

The projects directed towards next generation powerplants are all driven by Rolls-Royce – AvAUNT, ANACO, ODIN and TRUFlow. AvAUNT is delivering a dual-stream nozzle rig with a wing simulator for transonic flow applications and this will be used in ODIN, which together with ANACO is developing design guidelines for short-cowl nacelles at off-design and cruise conditions, respectively – geometries relevant to UHBR engines. TRUFlow is developing computational methodologies and a testbed for thrust reverser units (which is shown in Figure 1).

Through the projects RELOAD, POLITE and PERTURB (all with Airbus Defence & Space as Topic Manager), ARA is supporting the Clean Sky 2 Regional Flight Test Bed 2 demonstrator programme, with the design, manufacture and test of a wind-model in the RUAG and ONERA F1 facilities. ARA is also involved in the use of numerical simulation of the unpowered and powered aircraft at a range of flow conditions and Reynolds numbers (see Figure 2), to enable the extrapolation of aerodynamic data to flight scale by fusing experimental and numerical data sets.

Next generation civil transport may look very different to today’s configurations. For instance, the opportunities to improve engine efficiency and, hence, fuel burn through the use of boundary layer ingestion (BLI) are being pursued through the SUBLIME project (Safran as Topic Manager) with the development of an experimental rig for studying various aft-mounted, close-coupled engine configurations. The use of hybrid laminar flow control (HLFC) to reduce aircraft drag continues to be pursued through the development of the LPA (Large Passenger Aircraft platform) ground-based demonstrator in the form of a large wind tunnel model, which is being designed and manufactured in the COMPACT project (with ONERA as Topic Manager) for testing in the ONERA S1MA wind tunnel.

ARA looks forward to the continuation of the Clean Sky concept as part of the Horizon Europe programme and intends to play its part in the furtherance of advanced technologies for sustainable aviation. Its contributions are seen as a key part of the company’s future prosperity as an RTO and as a leading research player in the European scene.
CLEAN AVIATION FOR A COMPETITIVE GREEN RECOVERY IN EUROPE: INNOVATIVE IDEAS TAKE FLIGHT

The path ahead is a major challenge – climate neutrality by 2050. For aviation we need a moon-shot approach with huge research & development efforts, within a very ambitious timeframe.

Axel Krein — Executive Director, Clean Sky

We have a huge challenge ahead of us, which is to decarbonise this industry. Aviation is in my view the mode of transport of the future. But we have a carbon challenge and we want to take the bull by the horns. We don’t have much time. We need support.

Guillaume Faury — CEO, Airbus

Research and innovation is crucial at this time, if we want to fulfil the EU’s Green Deal objectives. Clean Sky is the place where we can do this.

Marian-Jean Marinescu — Member of the European Parliament

I’m impressed by the EU aviation industry coming together, including the research organisations and knowledge across our SME and innovation ecosystems, to bring Europe’s industry into a clean future.

Jean-Eric Paquet — Director-General, Directorate Research & Innovation, European Commission

I am convinced that zero-emission aircraft will usher in a new era of aviation, that will also contribute to maintaining the leading position of the European industry.

Thierry Breton — Commissioner for Internal Market, European Commission
European leaders in aviation joined Clean Sky’s online spring event ‘Clean Aviation for a Competitive Green Recovery in Europe: Innovative Ideas Take Flight’ on 22 April 2021. Almost 1000 participants tuned in to hear their insights on how pursuing sustainable aviation objectives can help to power a competitive recovery for the sector. The main message: ambitious, rapid investment in research and innovation is crucial.

Read the full summary on our website: https://www.cleansky.eu/news/clean-aviation-for-a-competitive-green-recovery-in-europe

“Clean Sky’s results over the years speak for themselves – it is certainly an initiative that deserves to be supported and continued. Aviation is and will continue to be run by a small number of large firms. Beyond that we have a big number of SMEs, universities and research centres that can provide novel solutions for all of us. This is very important for the future of Clean Sky and Horizon Europe.”

Eduardo Maldonado — Portuguese Ministry of Science, Technology and Higher Education

“Europe has the willingness and the talent to be the number one climate-neutral continent by 2050!”

Olivier Andriès — CEO, Safran

“We – the industry - have taken the opportunity of the COVID crisis to work together. We need to be disruptive!”

Olivier Jankovec — Director General, Airports Council International Europe

“Recovery is a primary focus; recovery is an opportunity to change. If we want to reach climate neutrality by 2050 we have to start now with the development of carbon-neutral aircraft.”

Adina Vălean — Commissioner for Transport, European Commission

“Europe is leading in the right direction. Sustainability is going to be the key driver of growth for aviation, not only in the EU but worldwide.”

Alessandro Profumo — CEO, Leonardo
ANNOUNCEMENTS

Read Clean Sky’s ‘Highlights 2020’!

Our newly-published ‘Highlights 2020’ report is this year’s must-read! Delve into our latest technology developments, find out about our new innovations, discover our synergies and see who’s taking part in our projects. [https://www.cleansky.eu/news/highlights-2020](https://www.cleansky.eu/news/highlights-2020)

Technology Evaluator assessment says Clean Sky 2 is progressing well

Clean Sky 2 is well on the way to achieving its objectives, according to the first global assessment of Clean Sky’s technologies via the Technology Evaluator. Clean Sky’s impact is measured primarily in terms of environmental benefits (CO₂, NOx and noise reductions) along with its socio-economic impact on the aeronautical sector at large. This is the first of two assessments, and was completed at the end of 2020. The next and final assessment is due at the closure of the Clean Sky 2 programme at the end of 2024. Read the full report and the executive summary on our website. [https://www.cleansky.eu/publications](https://www.cleansky.eu/publications)

Discover Clean Sky’s innovations at our online stand!

Have you visited our online stand yet? Discover Clean Sky’s latest innovations, with interactive 3D models and interviews with the experts! The stand has just had an update with two new technologies: Liebherr’s eECS is taking an innovative approach to better cabin air, by processing air from outside the aircraft (instead of from the engine) for pressurisation/air-conditioning. Airbus’ MFFD explores the full potential of thermoplastic composites to help future European airliner production become faster, greener, and more competitive! [https://cleansky.virtualfair.be/hangar](https://cleansky.virtualfair.be/hangar)

Check out our new infographic!

Our brand new infographic is now online. If you’ve been wondering about our roadmap to climate-neutral aviation, take a look! Discover our ambitious environmental targets, our wide ecosystem of participants and our key demonstrators for greener aviation! [https://cleansky.eu/discover-the-new-clean-sky-2-infographic](https://cleansky.eu/discover-the-new-clean-sky-2-infographic)

Coming soon: 25 brand-new success stories!

Keep your eyes peeled in the coming weeks as we publish 25 brand-new articles taking an in-depth look at some of our flagship demonstrators and projects from Clean Sky 2! [https://www.cleansky.eu/zoom-in-on-clean-sky-2-results](https://www.cleansky.eu/zoom-in-on-clean-sky-2-results)